2016 PEANUT Information

Prepared by

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EXTENSION PERSONNEL WORKING WITH PEANUTS

County Extension personnel with peanut responsibilities as of January 1, 2016:

County	Name	City	Telephone
Beaufort	Rod Gurganus	Washington	(252) 946-0111
Bertie	Jarette Hurry	Windsor	(252) 794-5317
Bladen	Becky Spearman	Elizabethtown	(910) 862-4591
Chowan	Matthew Leary	Edenton	(252) 482-6585
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Duplin	Vacant	Kenansville	(910) 296-2143
Edgecombe	Art Bradley	Tarboro	(252) 641-7815
Gates	Paul Smith	Gatesville	(252) 357-1400
Greene	Roy Thagard	Snow Hill	(252) 747-5831
Halifax	Arthur Whitehead	Halifax	(252) 583-5161
Harnett	Brian Parrish	Lillington	(910) 893-7530
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Martin	Al Cochran	Williamston	(252) 792-1621
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Perquimans	Paul Smith	Hertford	(252) 426-5428
Pitt	Lance Grimes	Greenville	(252) 902-1702
Robeson	Mac Malloy	Lumberton	(910) 671-3276
Sampson	Della King	Clinton	(910) 592-7161
Scotland	Randy Wood	Laurinburg	(910) 277-2422
Washington	Anna-Beth Stewart	Plymouth	(252) 793-2163
Wayne	Tyler Whaley	Goldsboro	(919) 731-1520
Wilson	Norman Harrell	Wilson	(252) 237-0111

NC State University Extension specialists with peanut responsibilities as of January 1, 2016 and directors of peanut grower organizations:

Rick Brandenburg	Insects, NC State University	(919) 515-8876
Blake Brown	Economics, NC State University	(919) 515-4536
Gary Bullen	Economics, NC State University	(919) 515-6095
David Jordan	Agronomy & Weeds, NC State University	(919) 515-4068
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Bob Sutter	N.C. Peanut Growers Association Inc.	(252) 459-5060
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1. SITUATION AND OUTLOOK

A. VIRGINIA TYPE PEANUTS: SITUATION AND OUTLOOK

A. Blake Brown
Extension Economist—Agricultural and Resource Economics

U.S. peanut production was estimated at 6.322 billion pounds in 2015, according to the USDA October Crop Report, up from 5.19 billion in 2014. Harvested acres increased from 1.322 million in 2014 to 1.582 million in 2015. Yield per acre in 2015 was estimated at 3,997 pounds, up from 3,923 in 2014.

In North Carolina, harvested acreage as reported by USDA decreased from 93,000 acres in 2014 to an estimated 89,000 acres in 2015. Yields in North Carolina were down from an average yield of 4,320 pounds per acre in 2014 to an average of 4,000 pounds per acre in 2015. The USDA October crop report placed North Carolina production at 356 million pounds in 2015, down from 401.8 million pounds in 2014.

The Price Loss Coverage (PLC) provisions for peanuts under the 2014 Farm Bill are the primary drivers for increased acreage of peanuts. With the reference price for peanuts of $535 per ton well above the cost of production in the runner areas, farmers with peanut and generic base overwhelmingly chose the Price Loss Coverage option. PLC payment rate for peanuts equals the difference between the reference price of $535 per ton of PLC yield and the greater of the national marketing year average (MYA) price or loan rate of $355 per ton. Payments are on 85% of base acres and are reduced by 7.2% for sequestration. For the 2014 crop, it appears the MYA price will be $440 per ton giving a payment rate of $95 per ton of PLC yield. Accounting for payment for 85% of base acres and the 7.2% sequestration reduction gives a payment per ton of PLC yield on base acres of about $75. Payments are supposed to be made in October of the crop marketing year following the year of planting. As of writing, the payments for the 2014 crop had not been received. Farmers were not required to plant peanut base acres to receive this payment but were required to plant generic acres in order to receive the PLC payments. Further complicating this scenario is that a farm's PLC payments by commodity were prorated by the proportions of generic base planted to various program crops.

Generic base acres for a farm were based on the farm's 2013 cotton base acres. At the national level, 2013 cotton base acres were 15.9 million acres. Cotton 2013 base acres in Georgia were 1.46 million acres and 849 thousand acres in North Carolina. Given this situation, peanut planted acres are not limited by generic base acres. But the PLC provisions for peanuts give strong incentives to farmers, particularly in runner areas, to maximize peanut planted acres on generic base acres. Limiting factors on planting peanuts are then capacity in terms of investment in specialized peanut equipment and farm program payment limitations. Payments for peanuts have a separate payment limitation of $125,000 per legal entity. This gives farmers incentives to maximize the number of legal entities allowed by USDA Farm Service Agency and to fully utilize current production capacity for peanuts to maximize generic base planted in peanuts.

For the 2015 crop, the MYA price will likely be close to or below $400 per ton. If this is the case, then the PLC payment rate could be $135 per ton of PLC yield. Payment on 85% of base and the 7.2% sequestration reduction imply payments per ton of base yield of over $105 for the 2015 crop. As a result of expected further increases in production and lower market prices, peanut buyers have little incentive to forward contract peanuts. While some contracts may be given for Virginia type peanuts, most of the crop will not likely be under contract, and market prices of Virginias will be well below traditional Virginia type peanut prices of $500 or more per ton. With market prices for Virginia type peanuts falling toward $400 per ton, even with a PLC payment of around $100 per ton of PLC base yield, VC producers are not likely to increase production. However, peanut acres in runner areas, such as Georgia, may increase again in 2016.

Not surprisingly, stocks of peanuts are rising. Peanut stocks in commercial storage as of July 31, 2015 were 2.1 billion pounds, up from 1.86 billion pounds a year earlier at the end of the 2013 crop marketing year. Given the increase in 2015 production, stocks will increase further for the 2015 crop marketing year. Lower peanut prices will stimulate increased use but not enough to offset increased production. Peanut butter use for August 2014 through July 2015 increased to 1.303 billion pounds from 1.218 billion pounds for the previous year.

B. PEANUT PRODUCTION BUDGETS

S. Gary Bullen
Extension Economist—Agricultural and Resource Economics
David Jordan
Peanut Specialist—Crop Science

The budgets in the following tables represent costs and returns that are achieved by many growers in different regions of North Carolina using strip-till or conventional production technologies. The budgets do not represent average costs and returns.

Budgets are intended to be used as guides for planning purposes only. They do not include sprays for Sclerotinia blight or fumigation for CBR. The cost of gypsum is assumed to be $51.51 per ton; less expensive sources are available, although transportation costs can be significant.

Current information on the peanut outlook and situation, budgets, farm management, and more is available at the North Carolina State University Department of Agricultural and Resource Economics website: **www.ag-econ.ncsu.edu**.

Table 1-1. Estimated Costs and Returns Per Acre of RUNNER STRIP-TILL Peanuts, 2016—3,800-Pound Yield, 4-Row Equipment

Item	Quantity and Unit	Price or Cost per Unit ($)	Total per Acre ($)	Your Farm
1. GROSS RECEIPTS Peanuts	3,800 lb	0.20	760.00	
Total Receipts			**760.00**	
2. VARIABLE COSTS*				
Seed	110.00 lb	.088	96.80	
Inoculant	1.00 acre	6.00	6.00	
Fertilizer				
Nitrogen	15.00 lb	0.63	9.45	
Phosphate	30.00 lb	0.60	18.00	
Potash	90.00 lb	0.42	37.80	
Manganese	3.00 lb	0.35	1.05	
Boron	2.50 lb	3.13	7.83	
Lime (prorated)	0.50 ton	47.50	23.75	
Gypsum	0.60 ton	58.70	35.22	
Herbicides	1.00 acre	51.79	51.79	
Insecticides	1.00 acre	37.37	37.37	
Fungicides	1.00 acre	83.02	83.02	
Scouting	1.00 acre	8.00	8.00	
Hauling	1.90 ton	12.00	22.75	
Drying & Cleaning	1.90 ton	45.00	85.33	
State Check-off Fee	1.90 ton	3.00	5.69	
National Assessment	$760.00	0.01	7.60	
Crop Insurance	1.00 acre	30.00	30.00	
Tractor/Machinery	1.00 acre	59.86	59.86	
Labor	3.78 hours	10.23	38.67	
Interest on Operating Capital	$253.31	5.30%	13.30	
Total Variable Costs			**679.28**	
3. INCOME ABOVE VARIABLE COSTS			**80.72**	
4. FIXED COSTS				
Tractor/Machinery	1.00 acre	133.91	133.91	
Total Fixed Costs			**133.91**	
5. TOTAL COSTS			**813.19**	
6. NET RETURNS TO LAND, RISK, & MANAGEMENT			**-53.19**	

***Please note**: This budget is for planning purposes only. It does not include sprays for Sclerotinia blight, fumigation for CBR, or land rent.*

Table 1-2. Estimated Costs and Returns Per Acre of RUNNER CONVENTIONAL-TILL Peanuts. 2016—3,800-Pound Yield, 4-Row Equipment

Item	Quantity and Unit	Price or Cost per Unit ($)	Total per Acre ($)	Your Farm
1. GROSS RECEIPTS Peanuts	3,800 lb	0.20	760.00	
Total Receipts			**760.00**	
2. VARIABLE COSTS				
Seed	110.00 lb	0.88	96.80	
Inoculant	1.00 acre	6.00	6.00	
Fertilizer				
Nitrogen	15.00 lb	0.63	9.45	
Phosphate	30.00 lb	0.60	18.00	
Potash	90.00 lb	0.42	37.80	
Boron	2.50 lb	3.13	7.83	
Manganese	3.00 lb	0.35	1.05	
Lime (prorated)	0.50 ton	47.50	23.75	
Gypsum	0.60 ton	58.70	35.22	
Herbicides	1.00 acre	38.80	38.80	
Insecticides	1.00 acre	37.22	37.22	
Fungicides	1.00 acre	82.87	82.87	
Scouting	1.00 acre	8.00	8.00	
Hauling	1.90 ton	12.00	22.75	
Drying & Cleaning	1.90 ton	45.00	85.33	
State Check-off Fee	1.90 ton	3.00	5.69	
National Assessment	$760.00	0.01	7.60	
Crop Insurance	1.00 acre	30.00	30.00	
Tractor/Machinery	1.00 acre	63.14	63.14	
Labor	3.76 hour	10.23	40.10	
Interest on Operating Capital	$249.02	5.30%	13.07	
Total Variable Costs			**670.48**	
3. INCOME ABOVE VARIABLE COSTS			**89.52**	
4. FIXED COSTS				
Tractor/Machinery	1.00 acre	131.17	131.17	
Total Fixed Costs			**131.17**	
5. TOTAL COSTS			**801.65**	
6. NET RETURNS TO LAND, RISK, & MANAGEMENT			**-41.65**	

Please note: *This budget is for planning purposes only. It does not include sprays for Sclerotinia blight, fumigation for CBR, or land rent.*

Table 1-3. Estimated Costs and Returns Per Acre of VIRGINIA STRIP-TILL Peanuts, 2016—3,800-Pound Yield, 4-Row Equipment

Item	Quantity and Unit	Price or Cost/ Unit ($)	Total per Acre ($)	Your Farm
1. GROSS RECEIPTS				
Peanuts	3,800 lb	0.23	**874.00**	
Total Receipts			**874.00**	
2. VARIABLE COSTS				
Seed	130.00 lb	0.93	120.90	
Inoculant	1.00 acre	6.00	6.00	
Fertilizer				
Nitrogen	15.00 lb	0.63	9.45	
Phosphate	30.00 lb	0.60	18.00	
Potash	90.00 lb	0.42	37.80	
Manganese	3.00 lb	0.35	1.05	
Boron	2.50 lb	3.13	7.83	
Lime (prorated)	0.50 ton	47.50	23.75	
Gypsum	0.60 ton	58.70	35.22	
Herbicides	1.00 acre	51.79	51.79	
Insecticides	1.00 acre	37.37	37.37	
Fungicides	1.00 acre	83.02	83.02	
Scouting	1.00 acre	8.00	8.00	
Hauling	1.90 ton	12.00	22.75	
Drying & Cleaning	1.90 ton	45.00	85.33	
State Check-off Fee	1.90 ton	3.00	5.69	
National Assessment	$874.00	0.01	8.74	
Crop Insurance	1.00 acre	30.00	30.00	
Tractor/Machinery	1.00 acre	59.86	59.86	
Labor	3.78 hours	10.23	38.67	
Interest on Operating Capital	$269.36	5.30%	14.14	
Total Variable Costs			**705.36**	
3. INCOME ABOVE VARIABLE COSTS			**168.64**	
4. FIXED COSTS				
Tractor/Machinery	1.00 acre	135.74	135.74	
Total Fixed Costs			**135.74**	
5. TOTAL COSTS			**841.10**	
6. NET RETURNS TO LAND, RISK, & MANAGEMENT			**$32.90**	

Please note: This budget is for planning purposes only. It does not include sprays for Sclerotinia blight, fumigation for CBR, and land rent.

Table 1-4. Estimated Costs and Returns Per Acre of VIRGINIA CONVENTIONAL-TILL Peanuts, 2016—3,800-Pound Yield, 4-Row Equipment

Item	Quantity and Unit	Price or Cost per Unit ($)	Total per Acre ($)	Your Farm
1. GROSS RECEIPTS				
Peanuts	3800 lb	0.23	874.00	
Total Receipts			**874.00**	
2. VARIABLE COSTS				
Seed	130.00 lb	0.93	120.90	
Inoculant	1.00 acre	6.00	6.00	
Fertilizer				
Nitrogen	15.00 lb	0.63	9.45	
Phosphate	30.00 lb	0.60	18.00	
Potash	90.00 lb	0.42	37.80	
Manganese	3.00 lb	0.35	1.05	
Boron	2.50 lb	3.13	7.83	
Lime (prorated)	0.50 ton	47.50	23.75	
Gypsum	0.60 ton	58.70	35.22	
Herbicides	1.00 acre	38.80	38.80	
Insecticides	1.00 acre	37.22	37.22	
Fungicides	1.00 acre	82.87	82.87	
Scouting	1.00 acre	8.00	8.00	
Hauling	1.90 ton	12.00	22.75	
Drying & Cleaning	1.90 ton	45.00	85.33	
State Check-off Fee	1.90 ton	3.00	5.69	
National Assessment	$874.00	0.01	8.74	
Crop Insurance	1.00 acre	30.00	30.00	
Tractor/Machinery	1.00 acre	63.14	63.14	
Labor	3.92 hour	10.23	40.10	
Interest on Operating Capital	$261.07	5.30%	13.71	
Total Variable Costs			**696.36**	
3. INCOME ABOVE VARIABLE COSTS			**177.64**	
4. FIXED COSTS				
Tractor/Machinery	1.00 acre	132.99	132.99	
Total Fixed Costs			**132.99**	
5. TOTAL COSTS			**829.35**	
6. NET RETURNS TO LAND, RISK, & MANAGEMENT			**$44.65**	

Please note: *This budget is for planning purposes only. It does not include sprays for Sclerotinia blight, fumigation for CBR, and land rent.*

Table 1-5. Return to Land, Overhead, and Management for Peanut at Various Yields and Costs of Production for Peanut

	Net Return ($/acre) at $600/ton Potential Contract Price					
	Total Cost ($/acre)					
Peanut Yield (pounds/acre)	750	800	850	900	950	1000
	Net Return ($/acre)					
3000 (1.5 tons)	150	100	50	0	-50	-100
3500 (1.75 tons)	300	250	200	150	100	50
4000 (2 tons)	450	400	**350**	300	250	200
4500 (2.25 tons)	600	550	500	450	400	350
5000 (2.5 tons)	750	700	650	600	550	500

	Net Return ($/acre) at $535/ton Reference Price Over Potential Contract Price					
	Total Cost ($/acre)					
Peanut Yield (pounds/acre)	750	800	850	900	950	1000
	Net Return ($/acre)					
3000 (1.5 tons)	53	3	-47	-97	-147	-197
3500 (1.75 tons)	186	136	86	36	-14	-64
4000 (2 tons)	320	270	**220**	170	120	70
4500 (2.25 tons)	454	404	354	304	254	204
5000 (2.5 tons)	588	538	488	438	388	338

	Net Return ($/acre) at $470/ton Loan Rate Plus Payment Rate					
	Total Cost ($/acre)					
Peanut Yield (pounds/acre)	750	800	850	900	950	1000
	Net Return ($/acre)					
3000 (1.5 tons)	-45	-95	-145	-195	-245	-295
3500 (1.75 tons)	73	23	-27	-77	-127	-177
4000 (2 tons)	190	140	**90**	40	-10	-60
4500 (2.25 tons)	308	258	208	158	108	58
5000 (2.5 tons)	425	375	325	275	225	175

Continued on the next page.

Table 1-5. Return to Land, Overhead, and Management for Peanut at Various Yields and Costs of Production for Peanut (continued)

Peanut Yield (pounds/acre)	Net Return ($/acre) at $405/ton Estimated Average World Price					
	Total Cost ($/acre)					
	750	800	850	900	950	1000
	Net Return ($/acre)					
3000 (1.5 tons)	-143	-193	-243	-293	-343	-393
3500 (1.75 tons)	-41	-91	-141	-198	-241	-291
4000 (2 tons)	60	10	**-40**	-90	-140	-190
4500 (2.25 tons)	161	111	61	11	-39	-89
5000 (2.5 tons)	263	213	163	113	63	13

Peanut Yield (pounds/acre)	Net Return ($/acre) at $355/ton Loan Rate					
	Total Cost ($/acre)					
	750	800	850	900	950	1000
	Net Return ($/acre)					
3000 (1.5 tons)	-218	-268	-318	-368	-418	-468
3500 (1.75 tons)	-129	-179	-229	-279	-329	-379
4000 (2 tons)	-40	-90	**-140**	-190	-240	-290
4500 (2.25 tons)	49	-1	-51	-101	-151	-201
5000 (2.5 tons)	138	88	-12	-62	-112	-162

Table 1-6. Return to Land, Overhead, and Management for Peanut at Various Yields and Costs of Production for Corn

Corn Yield (bushels/acre)	**Net Return ($/acre) at $3/bushel Price**				
	Total Cost ($/acre)				
	400	450	500	550	600
	Net Return ($/acre)				
60	-220	-270	-320	-370	-420
90	-130	-180	-230	-280	-330
120	-40	-90	**-140**	-190	-240
150	50	0	-50	-100	-150
180	140	90	40	-10	-60

Corn Yield (bushels/acre)	**Net Return ($/acre) at $5/bushel Price**				
	Total Cost ($/acre)				
	400	450	500	550	600
	Net Return ($/acre)				
60	-100	-150	-200	-250	-300
90	50	0	-50	-100	-150
120	200	150	**100**	50	0
150	350	300	250	200	150
180	500	450	400	350	300

Corn Yield (bushels/acre)	**Net Return ($/acre) at $7/bushel Price**				
	Total Cost ($/acre)				
	400	450	500	550	600
	Net Return ($/acre)				
60	20	-30	-80	-130	-180
90	230	180	130	80	30
120	440	390	**340**	290	240
150	650	600	550	500	450
180	860	810	760	710	660

Table 1-7. Return to Land, Overhead, and Management for Peanut at Various Yields and Costs of Production for Grain Sorghum

Grain Sorghum Yield (bushels/acre)	**Net Return ($/acre) at $2.55/bushel Price**				
	Total Cost ($/acre)				
	350	400	450	500	550
	Net Return ($/acre)				
60	-197	-247	-297	-347	-397
90	-121	-171	-221	-271	-321
120	-44	-94	**-144**	-194	-244
150	33	-17	-67	-117	-167
180	109	159	209	259	309

Grain Sorghum Yield (bushels/acre)	**Net Return ($/acre) at $4.25/bushel Price**				
	Total Cost ($/acre)				
	350	400	450	500	550
	Net Return ($/acre)				
60	-95	-145	-195	-215	-265
90	33	-17	-67	-117	-167
120	160	110	**60**	10	-40
150	288	238	188	138	88
180	415	365	315	265	215

Grain Sorghum Yield (bushels/acre)	**Net Return ($/acre) at $6.15/bushel Price**				
	Total Cost ($/acre)				
	350	400	450	500	550
	Net Return ($/acre)				
60	19	-31	-81	-131	-181
90	204	154	104	54	4
120	388	338	**288**	238	188
150	573	523	473	423	373
180	757	707	657	607	557

Table 1-8. Return to Land, Overhead, and Management for Peanut at Various Yields and Costs of Production for Cotton

Cotton Yield (pounds lint/acre)	Net Return ($/acre) at $0.60/pound Price				
	Total Cost ($/acre)				
	500	550	600	650	700
	Net Return ($/acre)				
300	-320	-370	-420	-470	-520
600	-140	-190	-240	-290	-340
900	40	-10	**-60**	-110	-160
1200	220	170	120	70	20
1500	400	350	300	250	200

Cotton Yield (pounds lint/acre)	Net Return ($/acre) at $0.80/pound Price				
	Total Cost ($/acre)				
	500	550	600	650	700
	Net Return ($/acre)				
300	-260	-310	-360	-410	-460
600	-20	-70	-120	-170	-220
900	220	170	**120**	70	20
1200	460	410	360	310	260
1500	700	650	600	550	500

Cotton Yield (pounds lint/acre)	Net Return ($/acre) at $1.00/pound Price				
	Total Cost ($/acre)				
	500	550	600	650	700
	Net Return ($/acre)				
300	-200	-250	-300	-350	-400
600	100	50	0	-50	-100
900	400	350	**300**	250	200
1200	700	650	600	550	500
1500	1000	950	900	850	800

Table 1-9. Return to Land, Overhead, and Management for Peanut at Various Yields and Costs of Production for Soybean

Soybean Yield (bushels/acre)	**Net Return ($/acre) at $6/bushel Price**				
	Total Cost ($/acre)				
	160	190	220	250	280
	Net Return ($/acre)				
20	-40	-70	-100	-130	-160
30	20	-10	-40	-70	-100
40	80	50	**20**	-10	-40
50	140	110	80	50	20
60	200	170	140	110	80

Soybean Yield (bushels/acre)	**Net Return ($/acre) at $10/bushel Price**				
	Total Cost ($/acre)				
	160	190	220	250	280
	Net Return ($/acre)				
20	40	10	-20	-50	-80
30	140	110	80	50	20
40	240	210	**180**	150	120
50	340	310	280	250	220
60	440	410	380	350	320

Soybean Yield (bushels/acre)	**Net Return ($/acre) at $14/bushel Price**				
	Total Cost ($/acre)				
	160	190	220	250	280
	Net Return ($/acre)				
20	120	90	60	30	0
30	260	230	200	170	140
40	400	370	**340**	310	280
50	540	510	480	450	420
60	680	650	620	590	560

Table 1-10. Return to Land, Overhead, and Management for Peanut at Various Yields and Costs of Production for Wheat

Wheat Yield (bushels/acre)	Net Return ($/acre) at $3/bushel Price				
	Total Cost ($/acre)				
	250	300	350	400	450
	Net Return ($/acre)				
50	-100	-150	-200	-250	-300
65	-55	-105	-155	-205	-255
80	-10	-60	**-110**	-160	-210
95	35	-15	-65	-115	-165
110	80	30	-20	-70	-120

Wheat Yield (bushels/acre)	Net Return ($/acre) at $5/bushel Price				
	Total Cost ($/acre)				
	250	300	350	400	450
	Net Return ($/acre)				
50	0	-50	-100	-150	-200
65	75	25	-25	-75	-125
80	150	100	**50**	0	-50
95	225	175	125	75	25
110	300	250	200	150	100

Wheat Yield (bushels/acre)	Net Return ($/acre) at $7/bushel Price				
	Total Cost ($/acre)				
	250	300	350	400	450
	Net Return ($/acre)				
50	100	50	0	-50	-100
65	205	155	105	55	5
80	310	260	**210**	160	110
95	415	365	315	265	215
110	520	470	420	370	320

2. PEANUT SEED

David Jordan
Extension Specialist—Crop Science

A uniform stand of healthy, vigorous plants is essential if growers are to achieve the yields and quality needed for profitable peanut production. It is important for growers to plant high-quality seed of varieties adapted to their farm situations, management styles, and intended market uses.

WHAT'S IN A BAG OF PEANUT SEED?

A bag of seed peanuts contains thousands of potential plants. To grow a uniform stand of healthy plants, you need genetically pure seed that has been produced under a management system that maximizes seed health, germination, and vigor. The genetic composition of a peanut variety dictates maturity date, disease and insect resistance, peanut quality, grade, and many other characteristics. The best assurance of obtaining genetically pure seed is to purchase certified seed.

Seed health is related to seed-borne pathogens present on or in peanut seeds. Pathogens can reduce germination potential and can in some cases transmit peanut diseases. Professional seed producers take specific measures to reduce the level of seed-borne pathogens. The extra steps they take minimize the chance for the spread of unwanted diseases. Seed lots high in germination and vigor potential will germinate more rapidly and produce more robust seedlings. These seedlings are more likely to survive moderate stress during the weeks following planting.

Always purchase seed from a reputable, professional seed dealer. Bargain seed from a stranger, or even a neighbor, may not be such a bargain. Along with their seed, you could be buying weed seed or mixed varieties. You could even introduce diseases onto your farm.

PEANUT SEED PRODUCTION

The key component to producing high-quality peanut seed is to make the seed crop your highest farm priority. Attention to details is essential, and critical steps include:

- field selection,
- seed selection,
- cleaning and tuning up planting equipment,
- applying gypsum and boron at the right time,
- digging the crop when a majority of the pods are close to maturity,

- adjusting harvesting equipment to minimize mechanical damage,
- curing the peanuts slowly, and
- storing the seeds in a cool, dry environment.

Production of high-quality peanut seeds requires a high level of management that begins before planting and continues through delivery of seeds to the peanut farmer. A detailed description of peanut seed production can be found in *Peanut Seed Production: A Guide For Producers of Virginia-type Peanut Seed* (AG-622), which can be obtained free from your county Extension center or viewed online: **www.peanuts.ncsu.edu/PDFFiles/004968/Peanut_Seed_Production_Guide.pdf**

SAVING SEED

In years when profits are low, some growers may decide that saving their own seed will help reduce production costs. Cleaning, treating, and bagging seed, however, can be expensive, and a grower may not save more than a few cents per acre. In fact, a loss may occur if the seeds they planted were of poor quality. Seed germination and vigor of saved seed can be an issue, and growers are urged to have germination tests run on saved seed immediately after harvest and again about six weeks before planting. Checking the quality of the seed early will tell the grower if the seed is worth saving. The second test will tell the grower if the seed is worth planting. Seed production is a specialized process; varietal purity, seed quality, and seed health are carefully monitored throughout the growing season and during the digging, combining, curing, cleaning, storage, and treating operations. Saving seed should not be an afterthought, but rather a process that begins well before the seed crop is planted.

Growers who decide to save seed should be aware that they might be in violation of the North Carolina State Seed Law, the Plant Variety Protection Act (PVPA), and Title V of the Federal Seed Act if they sell that saved seed.

According to regulations, growers may save enough seed of a PVPA-protected variety to plant back on their own holdings (land owned, leased, or rented). If planting intentions change and if a variety is PVPA-1970 protected, the farmer may sell that saved seed, but only that amount saved to plant his or her holdings. If the variety is protected under the amended 1995 PVPA, a farmer may not sell any seed without the permission of the variety owner. Very few varieties currently grown in the mid-Atlantic states are PVPA-1970 protected varieties. Growers who are considering selling saved seed are encouraged to consult with their department of agriculture seed sections to be sure of the variety protection level. See Table 2-1 for a list of popular Virginia market type varieties and their level of protection.

North Carolina Seed Regulations require variety labeling on all peanut seed sold in the state, regardless of whether the seed is certified or farmer stock. No peanut seed can be sold as *variety not stated*, even if the variety is not known or the seed is a mixture of varieties.

CO-OP SEED DISTRIBUTION

Some growers are members of a co-op, and questions have been raised about co-op distribution of seed to growers. A farmer may bring saved seed into the co-op to be shelled, cleaned, treated, and bagged. But the entire quantity of saved seed must be returned to the farmer who produced it. The seed may not be co-mingled with seed from any other grower, and the seed may not be sold, traded, or given to any other grower. These actions are a violation of PVPA and the Federal Seed Act. The amount of peanuts shelled, cleaned, treated, and bagged must not exceed the amount the grower may legally save.

A co-op may become a licensed seed dealer, allowing co-op members to produce their own seed as a group with seed from several growers combined and distributed among the membership. If so, steps must be taken before planting to ensure proper certification and state seed law requirements have been met. Certified seed must be grown from foundation or registered seed, fields must be inspected, and the seed must meet minimum germination standards. The co-op must be licensed under the North Carolina State Seed Law. Contact the North Carolina Crop Improvement Association (919-515-2851) for details on how to certify peanut seed and the North Carolina Department of Agriculture and Consumer Services Seed Section (919-733 3930) for details about becoming a licensed seed dealer.

Table 2-1. List of Varieties and Requirements for Sale

Variety	Can you save seed?	Can you sell that saved seed?	Must the saved seed be sold as a class of certified seed?
Bailey	Yes	Only with permission	Yes
Brantley	Yes	Only with permission	Yes
CHAMPS	Yes	Only with permission	Yes
Gregory	Yes	Only with permission	Yes
Perry	Yes	Only with permission	Yes
Phillips	Yes	Only with permission	Yes
NC-V 11	Yes	Only with permission	Yes
Sugg	Yes	Only with permission	Yes
Sullivan	Yes	Only with permission	Yes
Wynne	Yes	Only with permission	Yes

3. PEANUT PRODUCTION PRACTICES

David L. Jordan
Extension Specialist—Crop Science

Successful production of quality peanuts requires growers to plan an effective production and marketing program and to implement that program on a timely basis during the season. Each cultural practice and marketing decision must be effectively integrated into the total farm management plan to produce optimum profits from the whole farm. In recent years yields have increased significantly with several records set since 2011. Several factors have contributed to high yields and include improved genetics, production of peanut on soils that are adapted to peanut production, long rotations that minimize impact of disease, availability of plant protection products for virtually all pests, and skills of famers and their support staff that manage peanut extremely well. In North Carolina weather conditions can have a major impact on yield given only 15% of acreage is irrigated. But given good weather conditions, average yields of two tons per acre are now common in North Carolina.

STAND ESTABLISHMENT

Soil temperatures need to be above 65°F for germination to proceed at an acceptable rate. Large-seeded Virginia market type peanuts planted under favorable moisture and temperature conditions will show beginning radicle (root) growth in about 60 hours. If conditions are ideal, sprouting young seedlings should be visible in seven days for smaller-seeded varieties like Bailey and in 10 days for larger-seeded varieties like Wynne.

Peanuts should not be planted until the soil temperature at a 4-inch depth is 65°F or above at noon for three days. Favorable weather for peanut germination should also be forecast for the next 72 hours after planting. The soil should be moist enough for rapid water absorption by the seed. The planter should firm the seedbed so there is good soil-to-seed contact. Growers should establish at least four plants per foot of row regardless of variety. This generally means setting the planter to deliver five seeds per foot of row. Peanuts can emerge from depths as low as 3 inches.

VARIETY SELECTION

Yield and quality are two major factors that influence variety selection. Growers with significant disease history may need to choose a variety with disease tolerance or resistance. Planting at least three varieties with differing maturity dates will permit efficient use of limited harvesting and curing capacities. Planting varieties with different genetic pedigrees reduces the risk of crop failure because of adverse weather or unexpected disease epidemics. In recent years the variety Bailey has become the dominant variety in North Carolina because of its high yield potential and disease resistance. There is concern that heavy reliance on this variety will increase risk that is often minimized by planting a group of varieties on each farm.

The selection of a variety should be based on more than one year's data. Performance of our most popular peanut varieties from reports prepared by Dr. Tom Isleib (peanut breeder at NC State University) and Dr. Maria Balota's PVQE (Peanut Variety and Quality Evaluation) program is presented in Tables 3-1 and 3-2, respectively. Yield data from research stations and by David Jordan and Dewayne Johnson (North Carolina Cooperative Extension) are presented in Table 3-3. Varietal characteristics are listed in Table 3-4. Disease reaction of varieties can be found in Chapter 6, "Peanut Disease Management."

Table 3-1. Pod Yield and Market Grade Characteristics of Bailey and Sugg Compared with Other Commercially Available Virginia Market Type Varieties

Variety	% Fancy	% ELK	% SMK	Meat Content (%)	Yield (lb/acre)
Bailey	84	42	65	72	4,650
Sugg	87	45	64	72	4,378
Gregory	92	48	63	69	4,299
CHAMPS	86	40	64	71	4,378
Sullivan	85	44	64	71	4,415
Wynne	90	44	62	70	4,381
Spain	91	42	54	67	4,030
Georgia 08V	88	49	64	74	4,571

*Data are from Isleib et al. (March 2014) and are pooled over 20 tests over five years except Spain (only 7 tests).

Table 3-2. Percentages of FP, ELK, SMK, and Total Kernels and Pod Yield for the Major Virginia Market Type Varieties

Variety	% FP	% ELK	% SMK	Total Kernels (%)	Yield (lb/acre)
NC-V 11	79	41	67	73	5,233
Gregory	92	52	66	72	4,993
Perry	81	44	66	74	4,906
CHAMPS	81	43	68	74	4,917
Phillips	85	51	68	75	5,066
Bailey	77	44	67	74	5,460
Sugg	84	49	66	75	5,230

*Data are from Balota et al. (PVQE Director) from 2009 – 2013.

Table 3-3. Comparison of Yield from Commercially Available Varieties Planted in Mid-May During 2012 (Lewiston) or 2013 (Rocky Mount). Yield in Pounds Per Acre.

	2012			2013		
Name	**Sept. 28**	**Oct. 17**	**Highest of Dig Dates**	**Sept. 27**	**Oct. 18**	**Highest of Dig Dates**
Spain	5,688	6,137	6,137	5,428	5,501	5,501
CHAMPS	5,270	5,986	5,986	6,161	5,146	6,161
Sugg	5,234	6,186	6,186	5,831	5,462	5,831
Perry	4,993	6,046	6,046	6,125	5,200	6,125
Bailey	5,075	5,932	5,932	6,627	5,765	6,627

VARIETY CHARACTERISTICS

Bailey is a large-seeded Virginia market type peanut with resistance to several key peanut diseases. This variety offers tolerance to CBR, Sclerotinia blight, tomato spotted wilt, and stem rot. Seed size for Bailey is small compared with all other Virginia market types.

CHAMPS is a large-seeded peanut that matures slightly earlier than other varieties. It is intermediate in resistance to tomato spotted wilt and is moderately susceptible to most other diseases.

Gregory is a large-seeded Virginia market type peanut with growth habit intermediate between bunch and runner, a pink seed coat, and a high percentage of jumbo pods and extra large kernels. It is susceptible to most diseases. Because of its large seed size, Gregory has a high calcium requirement and may show reduced seedling vigor compared with other varieties. Other than Bailey, Gregory offers the best resistance to tomato spotted wilt virus of commercially available Virginia market types when planted at optimum seeding rates.

Sugg is a large-seeded Virginia market type peanut with a disease management package that approaches that of Bailey. Although not as resistant to disease as Bailey, Sugg has larger pods.

Spain is a large-seeded Virginia market type peanut that has high yield potential under irrigation. Pod size is similar to or larger than Gregory. Spain matures later than all other Virginia market types. Spain is an exclusive variety available only through Birdsong Peanut Company.

Sullivan is a large-seeded Virginia market type that possess the high-oleic trait and offers some resistance to some of the key diseases found in peanut in North Carolina. This variety does not have excessive vine growth like Bailey and has yielded well in many trials. Pod size is larger than Bailey but not as large as Gregory or Wynne.

Wynne is a large-seeded Virginia market type possessing the high-oleic trait like Sullivan and offers some resistance to some of the key diseases. Pod size is larger than all Virginia market types except Gregory.

Table 3-4. Varietal Characteristics

Factors	Bailey	CHAMPS	Gregory	Sugg	Sullivan	Wynne
Growth habit (R = runner; SR = semi-runner)	SR	R	R	SR	R	SR
Heat unit requirement	2,590	2,550	2,650	2,630	2,630	2,700
Comparative days to optimum maturity	+2	0	+6	+4	+4	+8
Seed per pound	600	535	450	575	575	450
Need for calcium (M = moderate; H = high)	M	M	H	M	M	H

Heat unit requirement = degree day accumulation (56°F base and a 95°F ceiling) required to reach optimum maturity, assuming adequate soil moisture for sustained growth and development.
In comparative days to optimum maturity, **–** = optimum maturity for the variety occurs prior to 0; **+** = optimum maturity for variety occurs after 0.

SELECTING AND MANAGING SOIL RESOURCES

Peanuts are best adapted to well-drained, sandy loam soils, such as Norfolk, Orangeburg, and Goldsboro sandy loam soils. These soils are loose, friable, and easily tilled with a moderately deep rooting zone for easy penetration by air, water, and roots. A balanced supply of nutrients is needed. Soil pH should be in the range of 5.8 to 6.2. Peanuts grown in favorable soil conditions are healthier and more able to withstand climatic and biotic stresses.

Crop Rotation

A long crop rotation program is essential for efficient peanut production. The peanut plant responds to both the harmful and beneficial effects of other crops grown in the same field. Research shows that long rotations are best for maintaining peanut yields and quality. Benefits and potential problems associated with crops typically found within peanut-based cropping systems can be found in Chapter 6, “Peanut Disease Management.” Research conducted at the Peanut Belt Research Station demonstrates the benefits of long rotations with corn and cotton.

In recent years, there has been interest in crop yields, especially grains, when transitioning out of traditional peanut rotations. Results indicate that corn, cotton, soybeans, and wheat are not affected by rotation to the extent that peanuts are affected. Peanut was planted in these trials during 2013, and results indicate that the effects of rotation on peanut noted earlier are minimized when peanut is not included in the field for six years. The value of sod-based rotations on yields of peanuts and other crops has been demonstrated in the southeastern United States. In North Carolina a trial was recently completed where peanuts and other row crops were planted in either killed fescue sod or standard reduced-tillage cropping systems, including combinations of cotton and corn. During both 2010 and 2011, corn yield was higher after sod compared with combinations of traditional agronomic crops when planted several years after sod termination. Cotton yield did not differ during 2012 when compared to planting after tall fescue or agronomic crops. Peanut yield during 2013 was higher following tall fescue. In other research peanut yield following grain sorghum was similar to that of peanut following corn or cotton. Sweet potato is a good rotation crop for peanut, while some decreases in peanut yield have been observed when peanut follows sage. Growers should plant corn, cotton, or grain sorghum for at least one year following sage before planting peanut.

FERTILIZING PEANUTS

Lime

Peanuts grow best on soils limed to a pH of 5.8 to 6.2, provided other essential elements are in balance and available to the plant. Yields of peanuts and other crops planted in soil with four differing pH regimens are provided in Table 3-5. Dolomitic limestone is the desired liming material because it provides both calcium and magnesium. Strongly acidic soils reduce the efficient uptake and use of most nutrients and may enhance the uptake of zinc to potentially toxic levels. The efficiency of nitrogen fixation is reduced in acid soils. Molybdenum is an essential element in biological nitrogen fixation, and it can be limiting at low soil pH. Soils too high in pH are not desirable because some elements are less available to the peanut plant, and incidence of Sclerotinia blight may be greater. Manganese deficiency is often observed in fields that are overlimed. Some research has demonstrated that higher rates of calcium sulfate (gypsum or land plaster) can reduce peanut yield when soil pH in the pegging zone is relatively low (Table 3-6). These results remind us that soil pH should be maintained around 6.0 and that gypsum should be applied at rates not exceeding those currently recommended for Virginia market type peanuts. Increased broiler production in North Carolina and use of manure as a fertilizer source has increased concern over micronutrient toxicity. Several peanut fields have exhibited severe and yield-limiting zinc toxicities. These toxicities are increased in fields with low pH because zinc is more available at a lower pH. Maintaining soil pH around 6.0 is important in minimizing the adverse effects of zinc, and growers are cautioned not to overload fields with high levels of waste products. Micronutrient levels can build up quickly. Peanuts generally are able to tolerate zinc indices of 250. However, zinc toxicity can occur with lower index values if soil pH is low.

Table 3-5. Crop Response to Soil pH

Approximate Soil pH	**Percentage of Yield at Lower pH Values Compared with Yield at pH 5.9**					
	Corn	**Cotton**	**Peanut**	**Soybean**	**Wheat**	**Grain Sorghum**
4.3	26	24	55	45	41	78
4.9	76	57	62	62	72	83
5.4	99	89	83	90	100	94
5.9	100	100	100	100	100	100
Years	2	2	3	2	2	2

Table 3-6. Peanut Response to Gypsum Rate at Three Soil pH Values

Relative Gypsum Rate	**Soil pH**		
	5.0	**5.5**	**6.0**
0	1,920	2,720	2,900
0.5X	1,930	2,690	3,320
1.0X	2,110	2,190	3,250

Data are pooled over three years.

Nitrogen

Roots of peanuts can be infected by *Bradyrhizobium* bacteria. Nodules form on the roots at the infection sites. Within these nodules, the bacteria can convert atmospheric nitrogen into a nitrogen form that can be used by plants through a process called biological nitrogen fixation. This symbiotic relationship provides sufficient nitrogen for peanut production if the roots are properly nodulated. Growers should inoculate their peanut seed or fields to ensure that adequate levels of Rhizobia are present in each field. The data in Table 3-7 are from multiple locations and years and give an indication of the possible response of peanuts to inoculant applied as a liquid or granular in the seed furrow. These data demonstrate that while peanut response to rotation is often predictable, response to inoculant and rotation combinations is less predictable. Therefore, peanuts should be inoculated in all years regardless of previous rotation history to minimize risk and maintain yield. Generally, a peanut plant with 15 nodules by 40 days after emergence has adequate nodulation. Oftentimes foliar symptoms of nitrogen deficiency will be apparent by this time if nodulation is not effective. Later in the season the plant will need many more nodules, more than 100, for optimum growth, development, and yield. If fewer than 15 nodules are noted 40 days after emergence, especially if peanut foliage is yellow, growers should consider application of ammonium sulfate.

Table 3-7. Peanut Yield Response in Fields without a History of Peanuts versus Fields with Frequent Plantings of Peanuts (1999–2014)

Inoculant Use	New Peanut Fields	Fields with a Recent History of Peanuts
No inoculant	3,507	4,256
Inoculant	5,072	4,454
Difference	1,565	198
Number of Trials	35	35
Years	1999–2014	1999–2014

Commercial inoculants can be added to the seed or put into the furrow with the seed at planting. In-furrow inoculants are available in either granular or liquid form. When inoculants are applied directly in the seed furrow, either as a spray or granular, it is essential that the product reach the bottom of the seed furrow so that infection occurs as the root system develops. Some growers have had difficulty in obtaining nodulation because soil moved in the seed furrow after seed drop but before inoculant spray or granules entered the seed furrow. Delivering granular or in-furrow sprays above seed placement also will compromise effectiveness of systemic insecticides and fungicides.

Additionally, shallow planting along with in-furrow spray inoculants have performed poorly under hot and dry soil conditions. Peanuts are capable of emerging from depths of at least 3 inches; therefore, it is advisable to plant deep to protect sprayed inoculant from breakdown caused by high temperatures. Direct applications of nitrogen to peanuts are not generally needed. However, application of nitrogen fertilizers can increase yield, but only when peanuts are not nodulating and nitrogen deficiency is obvious. Research indicates that 90 to 120 pounds actual nitrogen per acre as a single application may be needed to obtain yields similar to adequately nodulating peanuts when a true nitrogen deficiency exists (Table 3-8). Economic return on investment of inoculant and various rates of ammonium sulfate are also compared in Table 3-8 at a peanut price of $560/ton and fertilizer cost of $0.29/pound ammonium sulfate. While a rate of 90 pounds of nitrogen is the most economically effective, in some trials 120 pounds of nitrogen were needed when late-season rainfall was excessive. Lower rates also may be effective but perform inconsistently. Research also suggests that ammonium sulfate is a more effective source than ammonium nitrate. Split applications may be more efficient than a single application.

Best results are obtained when applications are made early in the season. Peanuts grown on deep, sandy soils often respond to nitrogen fertilization and may lap middles more quickly, even when inoculation is adequate. Rapid canopy closure results in cooler soil temperatures in the pegging zone. When soils have high temperatures, pegs cannot survive.

Table 3-8. Peanut Response to Ammonium Sulfate in New Ground with Observable Nitrogen Deficiency in Leaves. Data are pooled over 10 experiments from 2007–2014. Ammonium sulfate cost of $0.29/lb and peanut price of $0.28/lb ($560/ton).

Ammonium Sulfate Rate	Actual Nitrogen Rate	Ammonium Sulfate or Inoculant Cost	Actual Peanut Yield	Peanut Yield above No-Inoculant and No-Ammonium Sulfate Control	Economic Return above Inoculant or Ammonium Sulfate Cost
lb/acre	lb/acre	$/acre	lb/acre	lb/acre	$/acre
0	0	0	3,161	–	–
285	60	83	3,867	692	111
428	90	124	4,163	991	154
571	120	166	4,225	1,061	131
714	150	207	4,261	1,094	99
Inoculant	0	8	4,335	1,261	345

Potassium and Phosphorus

The most efficient and easiest way to apply potassium is to apply it to the crop preceding peanuts. This usually increases the yield of the preceding crop and allows the potassium to leach into the area where the peanut root system obtains most of its nutrients. However, if North Carolina Department of Agriculture and Consumer Services soil test recommendations indicate that potassium and phosphorus are needed, then the appropriate levels of these nutrients should be applied.

Many growers and researchers feel that high levels of soil potassium in the fruiting zone (the upper 2 or 3 inches of soil) result in more pod rot and interfere with the uptake of calcium by pegs and pods, which results in a higher percentage of “pops” and calcium deficiency in the seeds. If the potassium level is high in the fruiting zone, a higher rate of gypsum may be needed.

Most of the peanut soils in North Carolina have adequate levels of phosphorus for good peanut production. Once a medium or higher level of phosphorus is achieved, it remains quite stable over a number of years. The addition of phosphorus-containing fertilizer to peanuts is generally not needed if it is applied to other crops in the rotation. However, soil testing is the only way to be sure.

Calcium

Perhaps the most critical element in the production of large-seeded Virginia market type peanuts is calcium. Lack of calcium uptake by peanuts causes “pops” and is often reflected as darkened plumules in the seed. Seeds with dark plumules usually fail to germinate.

Calcium must be available for both vegetative growth and pod growth. Calcium moves upward in the peanut plant but does not move downward. Thus, calcium does not move to the peg and pod and developing kernels. The peg and developing pod absorb calcium directly from soil, so it must be readily available in the soil.

Adequate soil calcium is usually available for good plant growth but not for pod development for good quality peanuts. It is important to provide calcium in the fruiting zone through gypsum applications. Gypsum should be applied to all Virginia market types, regardless of the soil characteristics or soil nutrient levels. The calcium supplied through gypsum application is relatively water soluble (compared to other calcium sources) and more readily available for uptake by peanut pegs and pods. Each pod must absorb adequate calcium to develop normally.

Gypsum product materials vary in elemental calcium content. Studies show that all forms of gypsum effectively supply needed calcium when used at rates that provide equivalent calcium levels uniformly in the fruiting zone. General recommendations for application rates are given in Table 3-9.

Table 3-9. Gypsum Sources and Application Rates

		Application Rate (lb/acre)	
Source	**% $CaSO_4$***	**Band (16-18 in)**	**Broadcast**
USG Ben Franklin	85	600	—
USG 420 Granular	83	—	1,215
USG 500	70	—	1,300
Super Gyp 85	85	—	1,200
TG Phosphogypsum	50	—	2,000
Agri Gypsum	60	—	1,800
Gyp Soil	85	—	1,200
Buckshot	**	—	2,000

*Guaranteed analysis percentage in registration with North Carolina Department of Agriculture and Consumer Services.
**Buckshot is considered a lime by-product material and not a gypsum product.

The use of gypsum on large-seeded peanuts is very effective in improving peanut seed quality and grades. Some research data indicate that high rates of gypsum may control or reduce the pod rot disease complex. Gypsum should not be broadcast before land preparation or before planting because too much rain may leach the calcium below the fruiting zone.

Best results are obtained when gypsum is applied in late June or early July. The availability of calcium supplied by gypsum application is also influenced by the amount of rainfall. Moisture is needed to make gypsum soluble and calcium available to the peanut fruit. In unusually dry years, peanuts may show symptoms of calcium deficiency, even when recommended rates of gypsum are applied.

Increasingly, there are questions concerning the need to apply gypsum as supplemental calcium to peanuts. Sometimes peanuts do not respond to supplemental calcium. Sometimes peanuts respond well to half the amount given in Table 3-9. The interactions of environmental conditions, seed size, soil series, native fertility, and soil moisture are unpredictable. However, for a consistent response over a wide range of soil characteristics and weather conditions, the full rate of gypsum is recommended for Virginia market types. Growers are encouraged to evaluate peanut response to gypsum on their own farms before leaving off this input or reducing rates below those presented in Table 3-9. Data from twelve trials (Table 3-10) indicate that gypsum at rates below those recommended in Table 3-9 can, in some cases, be effective.

Table 3-10. Pod Yield Following Application of Gypsum at 0.5 and 1 Times (X) the Recommended Use Rate for Virginia Market Types.

Pod Yield (lb/acre)	No. of Trials	Pod Yield (lb/acre)		
		No Gypsum	0.5X Gypsum	1.0X Gypsum
Actual yield	12	3,970	4,510	4,590
Increase in yield over no-gypsum control	—	—	540	620

In some years, for example 2013, excessive rainfall occurred during June and July after gypsum had been applied. If rainfall exceeding 5 inches occurs over a short period of time within a few weeks after gypsum is applied, growers should consider applying a rate of 0.5X the normal use rate to make sure sufficient calcium is in soil during the entire period of reproductive growth. Likewise, if growers cannot get into fields to apply gypsum on time due to wet soils, gypsum still needs to be applied even if application is delayed until early to mid-August. While liquid calcium products are available, they are not a substitute for gypsum.

There is also a question of whether or not the gypsum rate needs to be increased for extremely large-seeded Virginia market type varieties, such as Gregory. Results from 2001 to 2005 at two locations, during each year, indicated that a rate of gypsum 1.5 times the recommended rate did not increase pod yield over the normal use rate in most experiments. While the data did indicate that the large-seeded variety Gregory was more responsive to gypsum than the much smaller-seeded variety NC-V 11, there was no advantage to applying gypsum at rates exceeding those rates listed in Table 3-9.

In recent years runner market type varieties referred to as "jumbo runners" have become more popular. These varieties, such as Georgia 06G, will require supplemental calcium compared to the smaller-seeded runners like Georgia Green. Growers should apply at least half the rate recommended for Virginia market types (Table 3-9).

Manganese and Boron

Two other elements often found to be deficient in peanuts are manganese and boron. Manganese deficiency usually occurs when soil is overlimed. Increasing the soil pH reduces the plant's uptake of manganese. The symptom of manganese deficiency is interveinal chlorosis. This symptom can be confused with carryover of atrazine (from corn) or Cotoran/Meturon (from cotton). A deficiency can be corrected by a foliar application of manganese sulfate. The usual practice is to apply 3.5 to 4 pounds per acre of dry material when the deficiency is observed.

Boron plays an important role in kernel quality and flavor. Boron deficiency may occur in peanuts produced on deep, sandy soils. Deficient kernels are referred to as having "hollow hearts." The inner surfaces of the cotyledons are depressed and darkened, so they are graded as damaged kernels. A general recommendation is to apply 0.5 pound of actual boron per acre as a foliar spray in early July. Several formulations of boron are available. Some growers apply boron with their preplant incorporated herbicides, and others have boron added to their fertilizers.

Growers are advised to make sure boron and manganese sources provide sufficient elemental boron. Several liquid boron and manganese formulations are available. Although liquid sources are more convenient to use than some dry products, some of the liquid products contain only a fraction of the needed boron or manganese. The amount of formulated product needed to supply 0.5 pound elemental boron per acre is provided in Table 3-11. Similarly, the amount of formulated manganese product needed to supply 1.0 pound of manganese per acre or two applications of 0.5 pounds of manganese spaced 10 to 14 days apart is provided in Table 3-12. Lower rates of boron or manganese are often applied for "maintenance." Growers should make sure the product they purchase supplies the amount of boron or manganese the plant needs.

Table 3-11. Amount of Formulated Product Needed to Provide Equivalent Amounts of Elemental Boron per Acre

Source	**Amount Needed to Supply 0.5 lb Boron per Acre**
Boric acid	3.0 lb
Disodium octaborate (Solubor, 17.5% boron)	2.8 lb
Liquid (9.0% boron)	2.2 qt

Table 3-12. Amount of Formulated Manganese Products Needed to Provide Equivalent Amounts of Elemental Manganese per Acre

Source	**Amount Needed to Supply 1.0 lb Manganese per Acre**
Manganese sulfate (Techmangum, 27% manganese)	3.7 lb
Manganese sulfate (8% manganese)	1.2 gal

The percentage of element (in this case, manganese or boron) or the weight of the element per unit volume of product can be used to determine the amount of liquid product needed to correct a nutrient deficiency. For example, if 1 pound of manganese is needed per acre, the following formulas can be used to determine the amount of 8% water-soluble manganese product needed per acre.

Step 1. Figure the weight of manganese per gallon by multiplying the percentage of manganese in product in pounds by the weight of product in pounds per gallon:

% manganese in product × lb product per gal = lb manganese per gal

Step 2. Figure the gallons of manganese product per acre by dividing the desired amount of manganese in pounds per acre by the weight of the manganese per gallon:

$$\frac{\text{desired lb manganese per acre}}{\text{lb manganese per gal}} = \text{gal manganese product per acre}$$

Example:

Step 1.

0.08 × 10.5 lb manganese sulfate per gal = 0.84 lb manganese sulfate per gal

Step 2.

$$\frac{\text{1 lb manganese per acre desired}}{\text{0.84 lb manganese per gal}} = \text{1.2 gal 8\% manganese product per acre}$$

LAND PREPARATION

Historically, peanut growers have planted into conventionally prepared seedbeds to obtain a smooth, uniform, residue-free seedbed for planting. The effectiveness of burial of old crop residue and weed seed in the long-term suppression of soilborne diseases and short-term suppression of some weed problems was noted when the moldboard plow was used. However, only 7% of acres were treated this way, based on a 2009 survey in North Carolina (Table 3-13), in part because newer plant protection products are very effective. There is also a growing trend toward reduced-tillage crop production in North Carolina, and some growers are successfully using these practices. There has also been a significant decrease in the number of growers using moldboard plowing. Changes in tillage systems over the past decade are presented in Table 3-13.

Table 3-13. Percentage of Farmers Using Certain Tillage Practices on at Least a Portion of Their Farms

Tillage	**1998**	**2004**	**2009**	**2014**
Disk	90	78	71	75
Chisel	25	23	27	12
Moldboard plow	58	17	7	5
Field cultivate	75	55	42	44
Rip and bed	49	39	40	55
Bed	44	35	32	25
Reduced tillage	10	23	41	20

There is concern about stratification of nutrients in reduced-tillage systems. For example, repeated applications of potassium in reduced-tillage cotton may result in excessive amounts of this nutrient in the pegging zone when peanuts are planted in a reduced-tillage system. Growers are encouraged to test soils for excessive potassium levels and incorporate this nutrient with tillage, if needed.

Many peanut growers bed their peanut fields either in the fall or the spring. Many growers prefer planting on raised beds rather than flat planting. The beds often give faster germination and early growth, provide drainage, and may reduce pod losses during digging. While reduced-tillage systems can be as successful as conventional-tillage systems, reduced-tillage systems often have less consistent yields than conventional-tillage systems. However, most peanut production has shifted to sandy soils that respond more favorably to reduced-tillage systems. A summary of peanut response to tillage is presented in Table 3-14.

Table 3-14. Peanut Yield Response to Tillage Practices in North Carolina,1999–2013. A positive value indicates that yield of peanut in conventional tillage exceeded yield of peanut in reduced tillage.

No. of Trials	Years	Actual Yield Difference (lb/acre)	Yield Difference (%)	Range of Yield Difference (%)
65	1997–2013	+132	+3.4	-16.1 to +27.5

Table 3-15. Advisory Index for Determining the Risk of Peanut Yield in Reduced-Tillage Systems Being Lower Than Yield in Conventional-Tillage Systems

Soil series Roanoke and Craven…40 points Goldsboro and Lynchburg…20 points Norfolk…10 points Conetoe and Wanda…0 points Pod loss on finer-textured soils, such as those on the Roanoke and Craven series, is often greater than on coarser-textured soils, such as Conetoe and Wanda series, regardless of tillage system. Difficulty in digging can increase when these soils become hard in the fall if rainfall is limited.	**Soil series** **Your score:**
Tillage intensity No tillage into flat ground…35 points Strip tillage into flat ground…10 points Strip tillage into stale seedbeds…0 points Peanut response to reduced-tillage systems is invariably correlated with the degree of tillage. Efficient digging can be difficult when peanuts are planted in flat ground in reduced-tillage systems. Although fields may appear to be flat and uniformly level, often fields are more rugged than they appear, and setting up the digger to match unforeseen contours in the field can be difficult. Strip tillage into flat ground is a better alternative than no tillage into flat ground, although digging peanuts planted on flat ground can be more challenging regardless of the tillage system. Strip tillage into preformed beds often results in yields approaching those of conventional tillage.	**Tillage intensity** **Your score:**
Risk of yield being lower in reduced tillage than in conventional tillage: 35 or Less—Low Risk 40 to 50—Moderate Risk 60 or more—High risk	**Total index value** **Your score:**

Because of concern about digging losses on finer-textured soils, it is recommended that beds be established in the fall with a grass cover crop with peanuts strip-tilled into previously prepared beds. Research during 2005 and 2006 demonstrated that wheat, cereal (cover crop), rye, oats, and triticale can serve equally well as wheat when used as a cover crop grown the winter and spring prior to planting peanuts. A risk advisory index has been developed to assist growers in deciding the risk of peanut yield in reduced-tillage systems being lower than yield in conventional-tillage systems (Table 3-15). Additional information can be obtained from *Soil Facts: Conservation Tillage Use in Peanut Production*, AG-439-73W. Research also suggests that prior cropping history generally does not affect peanut response to tillage. However, peanuts are often more responsive to tillage systems, primarily because of the digging requirement. The risk advisory index has been modified from the initial version. A positive value indicates that yield was higher in conventional tillage than in reduced tillage.

PLANTING

Varieties grown in North Carolina can require as many as 160 days for full pod maturity, depending upon soil moisture and temperature. Along with yield and market grades, planting date can affect disease and insect development (see chapters 5 and 6). Less damage from thrips and lower incidence of tomato spotted wilt virus have been associated with later plantings. Peanut yields are often the highest when peanuts are planted in mid-May. However, in some years peanuts planted later can yield quite well. Conditions in the fall, especially night temperatures, can have a great impact on yield when they prevent peanut pods from reaching optimum maturity.

Data for the variety Bailey during 2013, 2014, and 2015 exposed to three planting dates when peanut was dug at optimum maturity based on pod mesocarp color are provided in Table 3-16. Yield was notably lower when peanut was planted in early May compared with mid-May or late-May plantings. During 2014, when peanut was dug at optimum maturity, yield was highest (5,682 or 5,660 pounds per acre) with early and mid-May planting compared with late May (5,289 pounds per acre).

Table 3-16. Yield (lb/acre) of the Variety Bailey as Influenced by Planting Dates at Lewiston-Woodville during 2013, 2014, and 2015.

Planting Date	2013	2014	2015
May 3–4	5,157	5,228	4,921
May 16–19	6,423	4,838	6,495
May 28	6,875	4,131	4,612

Seeding Rates and Twin Rows

Table 3-17 provides the conversion of seed per foot of row to pounds per acre in order to establish the desired plant population for a given variety. Germination percentage is not considered in this conversion, but it should be considered when planning planting.

Table 3-17. Approximate Pounds of Peanut Seed Required per Acre to Provide 3, 4, and 5 Seeds per Foot of Row on 36-Inch Rows

		Pounds per Acre (36-inch rows)		
Variety	**Seed/lb**	**3 Seeds/ft**	**4 Seeds/ft**	**5 Seeds/ft**
Bailey	600	72	95	120
CHAMPS	535	76	102	127
Gregory	450	97	129	161
Sugg	575	76	101	126
Florida 07*	650	64	87	110
Georgia 06G*	650	64	87	110
Sullivan	575	76	101	126
Wynne	450	97	129	161

*Denotes runner market types. All other varieties are Virginia market types.

In the Southeast, less tomato spotted wilt virus has been associated with twin row plantings than with single rows. Similar results have been observed in North Carolina. Higher plant populations and closer row spacings often result in fewer symptoms of virus. Pod yield of peanut in twin rows was higher than yield of single rows by 235 pounds per acre (Table 3-18). Seeding peanuts in narrow rows or at extremely high seeding rates has not increased yield over twin row plantings that establish a plant population of five plants per foot of row (sum of both twin rows). Although higher seeding rates are needed, and higher rates of in-furrow insecticide and inoculant are required, twin rows tend to produce a greater taproot crop rather than a limb crop. This can improve uniformity of harvested peanuts, and in a dry season when peanut vines do not lap, this can result in higher yields. One of the detriments of twin row plantings, especially with the higher plant populations, is excessive vine growth, which can make digging more difficult.

Table 3-18. Peanut Yield Response to Twin Row Planting

Planting Pattern	**Pod Yield (pounds/acre)**
Single Rows	3,760
Twin Rows	3,995
Difference	235
Number of Trials	20

IRRIGATION

Having adequate water available throughout the peanut life cycle is important for optimal plant growth and development. Drought or flood can have tremendously negative impacts on peanut yields and quality. Likewise, pest infestation and severity of damage from these pests is influenced by available water, either in the form of rainfall or irrigation. Understanding how environmental conditions, and in particular irrigation, affect pest complexes is important in developing appropriate management strategies. Although less than 20% of North Carolina peanut acreage is irrigated, irrigation is a powerful production tool. Irrigation minimizes risk and enhances consistency of yield. Additionally, irrigation improves consistency of pesticide performance and in many ways the predictability of pest complexes. The major production and pest management practices employed in North Carolina peanut production are listed in Table 3-19, with brief comments on how irrigation or ample rainfall affect efforts to manage pests or supply peanuts with adequate nutrition. Research supported by the North Carolina Peanut Growers Association has been conducted to determine the feasibility of subsurface drip irrigation. While there are many logistical issues associated with this approach, data collected at Lewiston-Woodville in corn, cotton, and peanut indicate that this approach to irrigation is feasible. As expected, corn yield was affected more than cotton or peanut yield by irrigation. Peanut yield was maintained more effectively than cotton in dry years without irrigation. These data give a good indication of yield under growing conditions where water is not limiting relative to dry-land production for these crops.

Table 3-19. Impact of Irrigation on Production and Pest Management Strategies

Production or Pest Management Practice	Benefits of Irrigation or Optimum Rainfall
Land preparation	Helps in establishment of seedbeds, either conventional or reduced tillage.
Seed germination	Ensures germination of seed when existing soil moisture is marginal for complete stand establishment.
Weed management	Irrigation or adequate rainfall activates preemergence herbicides and minimizes plant stress. Less moisture stress often enhances control by postemergence herbicides and enables peanut to recover more rapidly from herbicide damage.

Table 3-19. Impact of Irrigation continues on the next page.

Table 3-19. Impact of Irrigation on Production and Pest Management Strategies

Insect management	Important for activation of in-furrow insecticides. Improves plant growth and root establishment, which is important in absorption of in-furrow insecticides. Improves peanut recovery from early season insect damage and insecticide phytotoxicity. Increases likelihood of southern corn rootworm survival and subsequent damage to pods but can protect against damage from lesser cornstalk borer. Minimizes potential damage from corn earworms and armyworms by establishment of a dense canopy that can withstand damage from feeding. Reduces the likelihood of spider mite damage by keeping spider mite populations low.
Disease management	Wet conditions early in the season can favor infection of peanut by CBR, but can minimize potential for crown rot. Irrigation increases likelihood of having a favorable microclimate for development of foliar and soilborne disease. A dense canopy that is supplemented by irrigation increases humidity within the canopy and minimizes airflow, all of which favor pathogen and disease development. Symptoms associated with tomato spotted wilt of peanut are often more pronounced when peanuts are growing under dry and especially hot conditions. Timely irrigation will reduce plant stress and possibly enable plants to withstand tomato spotted wilt more effectively than nonirrigated, water-stressed plants.
Pod maturation	Irrigation buffers against extremes in moisture and reduces stress (heat and drought), which allows normal flower production and kernel development. Maturation is more predictable and generally earlier. Limited rainfall during reproductive growth often causes delays in maturation and establishment of “multiple crops” or “split crops” on the same plant. Sufficient rainfall is critical for complete kernel development and pod fill. Limited soil moisture during flowering can reduce pegging. Irrigation modeling programs often include soil temperature as a trigger for irrigation during pegging.
Supplemental calcium	Kernels need adequate calcium to become mature and completely developed. Irrigation buffers against drought, which reduces calcium concentration in soil water and mass flow movement into developing pegs.
Digging	Ability to supply soil water to improve digging conditions (reduces hardness of soil), improves digging efficiency, and minimizes pod loss during the digging process.

DETERMINING MATURITY

Maturity affects flavor, grade, milling quality, and shelf life. Not only do mature peanuts have the quality characteristics that the consumer desires; they are also worth more to the producer. However, the indeterminate fruiting pattern of peanuts makes it difficult to determine when optimum maturity occurs. The fruiting pattern can vary considerably from year to year, mostly because of the weather. Therefore, each field should be checked before digging begins.

Figure 3-1. The traditional profile board shown below was developed for runner market type production in the Southeastern United States.

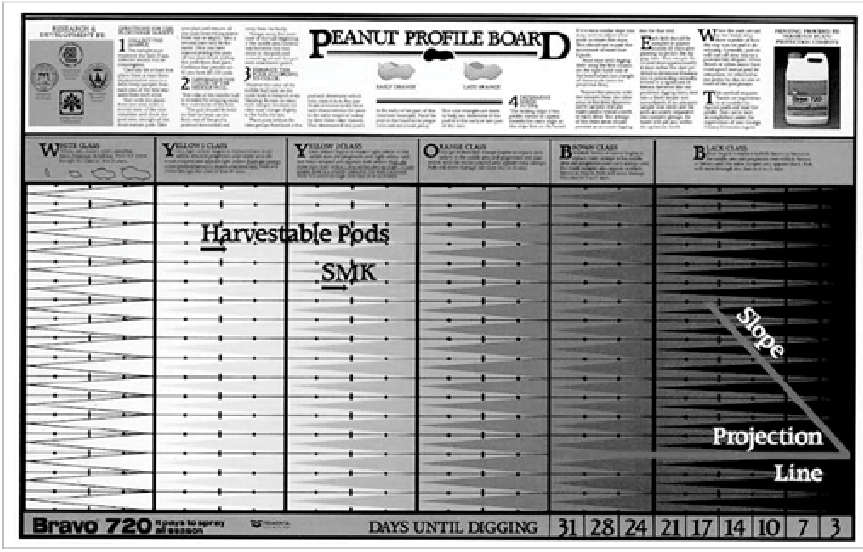
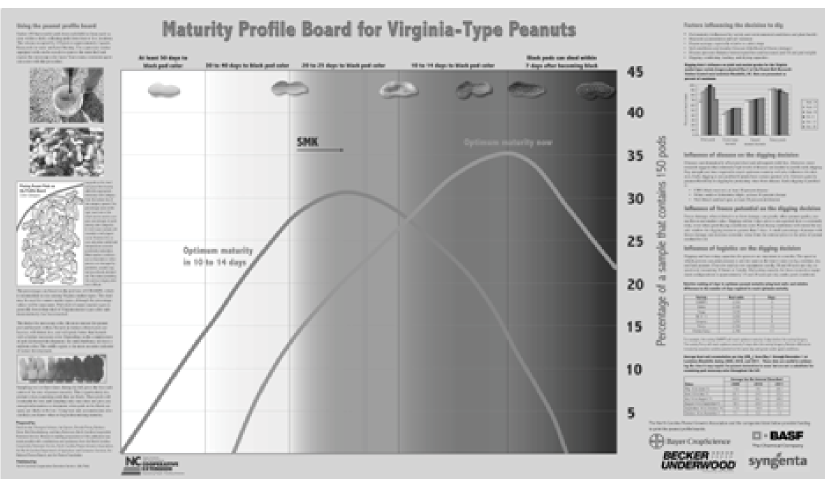


Figure 3-2. The peanut profile board shown below was developed for Virginia market types.



The hull-scrape method, currently the most objective method, requires the use of a peanut profile board that is available at county Extension centers. The peanut profile board in Figure 3-1 was developed for runner market types grown in the southeastern United States. A version of the peanut profile board was developed for Virginia market types grown in the V-C Region (Figure 3-2). It is important to follow a specific maturity prediction method to achieve maximum dollar value for peanuts.

Heat units, or growing degree days (DD), can be a means of determining maturity. One growing degree day (base 56°F) accumulates when the average daily high and low temperature is 57°F. If the average daily high and low temperatures were 76°F, then 20 growing degree days accumulate for that day. Research has shown that 2,520 to 2,770 growing degree days are needed for Virginia market types to mature if soil moisture is not limiting. Variation in heat unit accumulation for 2009 to 2015 is presented in Table 3-20. Pod maturation generally ceases in the fall when night temperatures are in the mid- to high 40s for two nights in a row. Even though day temperatures may increase considerably, the plant seldom recovers from these cooler night temperatures. In 2011 at Lewiston-Woodville, low temperatures ranged from 44 to 47°F from October 1 to 4 and essentially eliminated any further maturation of pods. During 2012 at this location, daily lows of 46°F were noted on two consecutive days (September 24 and 25). Temperature was between 42 and 45°F on four consecutive days from October 11 to October 14, 2012. However, during 2012 temperature and heat units in early October increased considerably compared with other years, allowing peanut to continue maturing.

Table 3-20. Average Heat Unit Accumulation per Day (DD56) from May 16 through November 1 at Lewiston-Woodville for Various Categories

	Average for the Interval Described						
Time period	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
May 16–June 15	17.8	19.1	20.7	15.4	17.6	15.9	19.5
June 16–July 15	20.1	24.5	25.2	23.0	21.2	22.5	25.5
July 16–August 15	22.9	26.3	28.0	24.8	22.4	18.9	23.5
August 16–September 15	18.5	20.9	21.3	20.2	20.9	20.0	23.5
September 16–October 15	11.9	14.4	11.1	20.3	10.6	11.1	12.8
October 16–November 1	7.1	9.3	1.3	4.5	3.8	2.9	2.8

Pod yields from 2012 to 2014 for the variety Bailey are presented over six digging dates starting in early September and occurring on intervals of approximately one week (Figure 3-3). While yields increased as digging was delayed during 2012 and 2013 well into October, a more typical yield curve for digging trials was observed in 2014. Many peanut fields had a very "tight" maturity profile during 2014 compared with previous years. Although this characteristic can increase yield and market grades, if digging is delayed past the optimum window, yield can decrease more rapidly. A typical response of peanut to digging date can also be seen for the variety Gregory and includes both yield and key market grade factors (Figure 3-4).

Although market grade characteristics often remain high when peanuts are dug later in the fall, yield is often lower due to pod shed. A balance between digging too soon and digging before frost or inclement weather needs to be reached to maximize yield and quality.

At harvest, growers should follow the weather forecast closely and not dig peanuts when freezing temperatures are expected. It is also important to have adequate harvesting and curing equipment so that the peanut crop can be handled within a reasonable period of time. At least three days, and in many cases more than three days, are needed between the time of digging and frost to allow sufficient drying to prevent freeze damage.

Digging and harvest capacity for growers are important to consider. The speed at which growers can plant peanuts is not the same as the time and labor it takes to dig, combine, dry, and haul peanuts. Most crops require a one-step process to harvest, while peanuts require two stages. Soil conditions during digging must be ideal to effectively remove peanuts from the soil and invert vines. Growers need to realistically determine the amount of time these operations will require.

With respect to digging, it is estimated that with four-row equipment and six-row equipment, 30 and 40 acres can be dug per day if growers dig for 10 hours a day driving at 3 mph with no interruptions. A six-row self-propelled combine can harvest 20 acres in a day driving at 1.5 mph, while four- and six-row pull-type combines can harvest 15 to 20 acres in a day, respectively. Weather conditions can have a tremendous impact on the number of hours peanut can be dug and combined in a given day, and the estimates provided here relative to time represent a best-case scenario.

As stated previously, both planting and digging date can have an impact on peanut yield and quality. Disease can have an impact on peanut response to digging date. Results with Dr. Barbara Shew from research conducted with the variety Gregory over six years demonstrate the value of digging peanut at optimum maturity (October 15 and controlling foliar disease (five-spray fungicide program) (Table 3-21). Yield increased by 400 to 550 lb/acre over the three digging intervals (September 20 to October 15).

Digging very early resulted in lower yields even when disease was controlled. The balance between pod loss from disease and immature peanut resulted in no

Figure 3-3. Response of the variety Bailey to digging date. Peanut was planted approximately May 3 during 2012, 2013, and 2014.

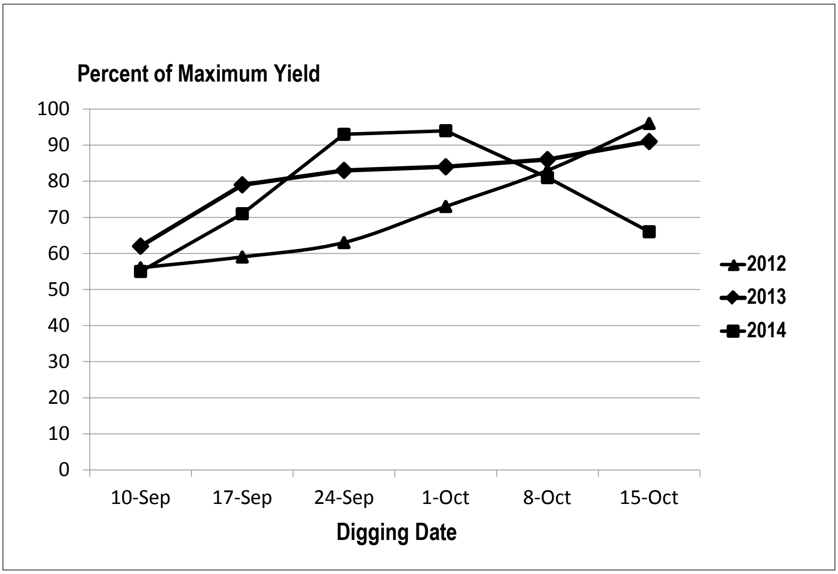
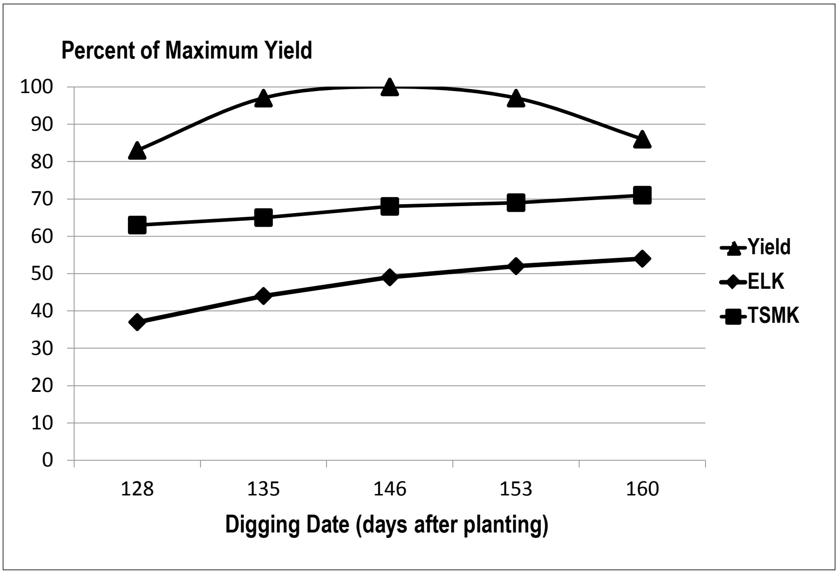


Figure 3-4. Pod yield (lb/acre) and percentages of extra large kernels (ELK) and total sound mature kernels (TSMK) for the variety Gregory to digging date. Data are from 18 trials during 2003 – 2013.



difference in yield across digging dates. See Chapter 6 for more information on disease management in peanuts.

Table 3-21. Percent Canopy Defoliation, Pod Yield, and Percentage of Extra Large Kernels for the Variety Gregory as Influenced by the Interaction of Digging Date and Fungicide

	Fungicide program		
Digging date	**None**	**2 sprays**	**5 sprays**
	Canopy defoliation (%)		
September 20	22 c	9 d	3 e
October 5	38 b	15 d	3 e
October 15	57 a	41 b	4 e
	Pod yield (pounds/acre)		
September 20	3200 de	3,280 cd	3,540 bc
October 5	3230 d	3,290 cd	3,680 ab
October 15	2930 e	3,330 cd	3,880 a
	Extra large kernels (%)		
September 20	48 f	48 f	50 e
October 5	51 d	50 e	53 b
October 15	52 c	52 c	54 a

Means followed by the same letter are not significantly different, according to Fisher's Protected LSD test at $p < 0.05$. Data are pooled over six experiments.

Adequate control of thrips continues to be very important to optimize yield in North Carolina. A trial was conducted during 2013 with the variety Bailey to determine the influence of planting date on thrips control and peanut yield with combinations of Thimet applied in the seed furrow and Orthene applied two weeks after peanut emergence. While several interactions were noted, the value of adequate thrips control is summarized in Table 3-22. While both Thimet and Orthene protected yield, the combination of both insecticides provided the greatest protection of yield. Thrips pressure was high during 2013 at this location during all of May and well into June. During 2014, results were slightly different than in 2013. The value of Orthene was less pronounced in 2014 with the in-furrow treatment the most effective approach. Thrips injury was higher in 2013 than 2014 and most likely contributed to the minor impact of Orthene on yield. Peanut did not respond to insecticide during 2015. While this was surprising, in some years peanuts are able to recover quickly from thrips feeding and yield is not reduced.

Thrips damage is generally more severe with early plantings in North Carolina due to cooler weather early in the season, which slows peanut growth and allows thrips damage to have a greater impact on plant recovery. Thrips populations can be lower when peanuts emerge from later plantings.

Table 3-22. Interactions of Thimet and Orthene Spray Programs at Lewiston-Woodville during 2013, 2014, and 2015.

Insecticide		2013		2014		2015	
In-furrow	Post-emergence	Thrips Damage (Scale 0-5)	Pod Yield in lb/acre (yield increase over nontreated control)	Thrips Damage (Scale 0-5)	Pod Yield in lb/acre (yield increase over nontreated control)	Thrips Damage (Scale 0-5)	Pod Yield in lb/acre (yield increase over nontreated control)
No Thimet	No Orthene	3.3	5,232	2.3	4,741	2.6	5,238
Thimet	No Orthene	1.1	5,651 (384)	0.7	4,982 (241)	0.8	5,246 (8)
No Thimet	Orthene	1.7	5,642 (278)	1.0	4,780 (39)	1.0	5,295 (49)
Thimet	Orthene	0.5	5,878 (645)	0.4	4,972 (231)	0.3	5,278 (40)

Data are pooled over planting dates.

In a second trial involving planting dates at this location, the value of treating seed with fungicide was apparent relative to peanut yield at all three planting dates (Table 3-23). Yield was most likely lower due to poorer stands and less seedling vigor when seed was not treated with fungicide. Drs. Brandenburg and Shew will have more information on thrips management and seedling disease management in their respective chapters.

Table 3-23. Influence of Planting Date and Fungicide Seed Treatment on Peanut Stand and Pod Yield at Lewiston-Woodville during 2013, 2014, and 2015. Data are pooled over insecticide treatments.

	Peanut Stand (Plants/20 ft of row)		Pod yield (lb/acre)	
	Fungicide Seed Treatment		Fungicide Seed Treatment	
Planting Date	No	Yes	No	Yes
2013				
May 4	56	80	2,597	4,544
May 16	55	72	4,736	5,420
May 28	71	86	5,273	6,001
2014				
May 4	21	52	3,937	4,860
May 19	36	56	4,148	4,476
May 28	17	48	3,022	4,187
2015				
May 4	45	95	4,024	4,535
May 19	73	102	5,703	5,803
May 28	75	83	4,912	5,503

RUNNER MARKET TYPES

There is some demand for runner market type peanut production in North Carolina. Part of this interest is related to market demand and sheller operations in the region. Runner production is also appealing to some growers because of potential savings in production of runners compared with Virginia market type peanuts (approximately 110 pounds of seed for runners versus 125 to 160 pounds of seed for Virginia market types and lower requirements for supplemental calcium by runner market types). Yield of runner market types often perform as well as the Virginia types.

CULTURAL PRACTICES AND TOMATO SPOTTED WILT VIRUS

Tomato spotted wilt virus can be a problem in North Carolina, with no control practices available after peanuts have been planted. Planting peanuts in reduced-tillage systems (no till or strip till), seeding peanuts at higher rates (establishing four or more plants per row foot in single rows), planting twin rows, applying Thimet or Phorate in furrow, delaying planting until mid-May, planting tolerant varieties, and maintaining good soil fertility can lessen the impact of tomato spotted wilt on peanut growth and yield. However, each of these cultural practices presents a range of risks and benefits. A tomato spotted wilt virus advisory, AG-638, *Managing Tomato Spotted Wilt Virus in Peanuts in North Carolina and Virginia*, was initially prepared in 2003 with an updated version of the advisory provided in Chapter 5.

PLANT GROWTH REGULATORS

Apogee and Kudos (prohexadione calcium) are registered for use in peanuts. Research has demonstrated that prohexadione calcium improves row definition, which can lead to increased efficiency in the digging and inversion process. Prohexadione calcium should be applied when 50% of vines from adjacent rows are touching. Sequential applications (7.2 ounces per acre followed by 7.2 ounces per acre) spaced two to three weeks apart are generally needed. Include crop oil concentrate and nitrogen solution (UAN) or ammonium sulfate with prohexadione calcium. Depending upon growing conditions, soil fertility, frequency of rainfall and irrigation, and variety selection, row visibility obtained in mid-August may not be sufficient through digging. Research suggests that in addition to increased row visibility, prohexadione calcium minimizes pod shed and pod loss during digging and harvesting operations. When pooled over 121 trials from 1997 to 2014, yield following two applications of prohexadione calcium was 96 pounds per acre higher than yield from nontreated peanut (4,223 versus 4,319 pounds per acre). Some environmental conditions and subsequent vine growth were not excessive in some of the trials in this data set, suggesting that the yield difference may be underestimated.

However, in recent years with the variety Bailey, very few differences in yield with prohexadione calcium have been noted. While Apogee always improves row visibility, this characteristic has not always translated into yield increases with prohexadione calcium. The lack of yield response may be associated with excellent pod retention for Bailey, which would limit the value of prohexadione calcium in terms of yield increase.

Work conducted in cooperation with Dr. Gary Roberson in 2009 to 2011 compared benefits of Apogee with precision digging. In these studies Apogee did not affect peanut yield. However, yield increased with precision digging (Table 3-24). These data demonstrate the value of auto-steer relative to efficient peanut digging. See Chapter 7 for more details related to precision agricultural tools for peanuts. Investment in guidance systems for digging can be expensive. However, these systems have been very effective in minimizing challenges in digging, especially when vine growth is excessive, tractor operators are fatigued, and peanuts are not planted on beds. Apogee can improve row visibility but may not minimize operator fatigue. Guidance systems will not affect pod retention in a manner similar to Apogee.

Table 3-24. Acres Required to Capture Investment Cost of Guidance System ($23,000). Data are pooled over four experiments and were conducted in cooperation with Gary Roberson.

Mode	Pod Yield (pounds/acre)	Peanut Price ($/pound)				
		0.20	**0.25**	**0.3**	**0.35**	**0.40**
Manual steering	4,121					
Guidance	4,574					
Value of guidance	453	254	203	169	145	127

4. PEANUT WEED MANAGEMENT

David L. Jordan
Extension Specialist—Crop Science

Effective weed management is essential for profitable peanut production. Peanuts are not very competitive with weeds and thus require higher levels of weed control than most other agronomic crops to avoid yield losses. Weeds may also decrease digging efficiency, so effective late-season weed control can minimize losses during harvest. A weed management program in peanuts consists of good weed control in rotational crops; cultivation, if needed; establishment of a satisfactory stand and growing a competitive crop; and proper selection and use of herbicides. Finally, weeds interfere with fungicide movement into the peanut canopy, often referred to as deposition, and this can negatively affect disease control.

CROP ROTATION

Rotate peanuts with corn or cotton to help manage various pests, including weeds. Crop rotation allows the use of different herbicides on the same field in different years. Crop and herbicide rotation, along with good weed control in the rotational crops, helps prevent the buildup of problem weeds and helps keep the overall weed population at lower levels. Crop rotation will also help reduce the chance of developing populations of weeds that are resistant to herbicides.

CULTIVATION

Cultivation is an excellent way to supplement chemical weed control. One or two "non-dirting" cultivations can improve weed control. Additionally, cultivation in combination with banded herbicide applications can reduce costs. However, cultivation can damage the crop and reduce yield if not done properly. Moving soil onto the lower branches and around the base of the plants causes physical damage and enhances development of stem and pod diseases. Deep cultivation also destroys residual herbicide barriers and brings up additional weed seeds. Cultivate when peanuts are small. Set sweeps to run flat and shallow to avoid throwing soil onto the peanut plants. Generally, in-season cultivation of peanuts is not recommended.

WEED SCOUTING

All fields, regardless of the crop being grown, should be surveyed for weeds between mid-August and the first killing frost. Record the weed species present and note the general level of infestation of each species (light, moderate, or heavy). Weeds present in the fall will be the ones most likely to be problems the following year. Knowing what problems to expect allows you to better plan a weed management program for the following crop.

Scout peanut fields weekly from planting through mid-July to determine if or when postemergence herbicide treatment is needed. Proper weed identification is necessary because species respond differently to various herbicides. Contact your county Extension center for aid in weed identification. Timely application of postemergence herbicides is critical for effective control. Cultivation may be more appropriate if herbicide-resistant biotypes increase in prevalence.

WebHADSS (Herbicide Application Decision Support System), a computer-based program designed to assist in making decisions pertaining to postemergence herbicide applications, is available online through North Carolina Cooperative Extension (**www.webhadss.ncsu.edu**). Weed density, predicted crop value, predicted weed-free crop yield, herbicide and application costs, and herbicide efficacy are used to develop a ranking of the economics of herbicide options for a specific weed complex. This approach does not consider the long-term effect of weed seed production if weeds are not controlled. More importantly, allowing herbicide-resistant biotypes to reproduce, especially when they are first appearing in fields, can result in a tremendous long-term problem. The patchiness of weeds in each field and the time needed to scout fields are limitations to this approach. However, this decision support system is beneficial in explaining herbicide options. Listed below are the competitive index values assigned to weeds typically found in North Carolina peanut fields (Table 4-1). Cocklebur, with a ranking of 10, is considered the most competitive weed in peanut.

Table 4-1. Competitive Indices for Weeds in Peanut*

Weed	Rank	Weed	Rank
Common cocklebur	10.0	Fall panicum	1.8
Jimsonweed	5.8	Florida pusley	1.5
Common lambsquarters	5.2	Tropic croton	1.2
Smartweed	4.7	Dayflower	1.2
Redroot pigweed	4.0	Common purslane	1.2
Common ragweed	3.8	Prickly sida	1.2
Sicklepod	3.6	Horsenettle	1.1
Pitted morningglory	3.6	Yellow nutsedge	0.3
Entireleaf morningglory	3.2	Purple nutsedge	0.2
Velvetleaf	3.0	Goosegrass	0.2
Broadleaf signalgrass	1.8	Crabgrass	0.2
Eclipta	1.8		

*10 = most competitive weed

The combined effect of interference by the weed complex is used to predict yield loss in the WebHADSS program. For example, a weed complex containing one Palmer amaranth, five yellow nutsedge, four broadleaf signalgrass, and one sicklepod per 100 square feet (33 feet of row with rows spaced 3 feet apart) would reduce peanut yield by 16%, based on a projected weed-free yield of 4,500 pounds per acre (Table 4-2). Using WebHADSS and given a crop value of $535 per ton, adequate growing conditions (good soil moisture for satisfactory herbicide performance), and large size weeds (at least 4 inches tall), WebHADSS would provide the suggestions in Table 4-3 with various economic returns. In this example, peanuts were planted May 6 and emerged May 14. The field was scouted June 4 and herbicide sprayed soon thereafter. Although issues relative to accuracy and time required for weed scouting do exist, the WebHADSS program does allow a relatively quick and clear comparison of herbicide options while taking herbicide efficacy, herbicide cost, and economic return from that investment into account.

Table 4-2. Potential Yield and Economic Losses if Weeds Are Not Controlled as Compared to Weed-Free Peanuts*

Weed species	**Population**	**Yield Loss (lb per acre)**	**Yield Loss (% of weed-free yield)**	**Economic Loss ($ per acre)**
Palmer amaranth	1	180	4.0	48
Sicklepod	1	162	3.6	43
Signalgrass	4	324	7.2	87
Yellow nutsedge	5	66	1.5	18
Total Estimated Loss		734	16.3	196

*Anticipated yield of 4,500 pounds per acre and crop value of $535 per ton farmer stock peanuts.

Table 4-3. Ranking of Selected Herbicide Options Considering Efficacy and Economics*

Herbicide	**Gain by Applying Herbicide ($ per acre)**	**Cost of Weed Control ($ per acre)**
Paraquat	170	5.1
Cadre + 2,4-DB	144	29
Clethodim then Storm + 2,4-DB	121	33

*Herbicide options other than these were listed. Includes adjuvant and application costs.

COMMENTS ON PEANUT HERBICIDES

Preplant Burndown Herbicides

Glyphosate (various formulations) and Gramoxone SL (other formulations are available) are relatively nonselective herbicides that control many of the winter weeds present in reduced tillage fields (Table 4-4). Harmony Extra and 2,4-D (various formulations) can also be applied. Harmony Extra can be applied no closer to planting than 45 days before planting. 2,4-D should be applied at least 30 days before planting.

Preplant Incorporated, Preemergence, and Postemergence Herbicides

Numerous herbicides are labeled for use in peanuts (Tables 4-5, 4-6, 4-7). Timely application of the appropriate herbicide at the correct rate is essential for successful weed control in peanuts. Additional information on feeding restrictions of peanut hay (Table 4-8), suggested rain-free period to maintain control (Table 4-9), and rotation restrictions on herbicide use (Table 4-10) are provided.

Reduced Rates of Herbicides

When crop prices are low, producers are looking for ways to reduce production costs. One possibility is to reduce the application rate of herbicides. Under certain environmental conditions and with certain weed species or weed complexes, specific herbicides can be applied below the manufacturer's suggested use rate without sacrificing weed control. However, growers are cautioned that herbicides applied at reduced rates often do not control weeds adequately when environmental conditions (soil moisture in particular) do not favor herbicide activity. Applying herbicides at reduced rates to large weeds or weeds that are "hardened" often results in poor control as well. Weeds can also be more difficult to control if they were injured by herbicide with previous treatment. Using reduced rates will require that growers apply herbicides in a more timely manner and when weeds are not stressed. Regardless of the previously mentioned factors relative to reduced rates, manufacturers of herbicides will not back up their products when they are applied below the suggested use rate. Liability falls exclusively to the grower.

COMPATIBILITY OF AGROCHEMICALS

Compatibility is an important consideration when applying two or more products in the same tank. See Chapter 9 for more information on agrochemical compatibility. Consult product labels, Chapter 9, and your local Extension agent for more information on agricultural chemical compatibility.

Table 4-4. Weed Responses to Herbicides Applied Prior to Peanut Planting in Reduced Tillage Systems[1,3]

Species	Gramoxone SL	Glyphosate	2,4-D	Glyphosate + Harmony Extra	Glyphosate + 2,4-D	Glyphosate + Valor SX[2]
Bluegrass	GE	E	N	E	E	E
Buttercup	E	E	G	E	E	E
Chickweed	E	E	P	E	E	E
Curly dock	NP	E	F	E	FG	G
Geranium	GE	PF	PF	GE	F	GE
Henbit	E	E	FG	E	E	E
Horseweed	PF	GE	GE	E	E	E
Mustard	FG	FG	GE	GE	E	E
Primrose	PF	F	E	FG	E	G
Ryegrass	G	E	N	E	E	E
Small grains	GE	E	N	E	E	E
Swinecress	P	FG	F	GE	G	E

[1] Gramoxone SL can be applied after peanut emergence; see notes in Table 4-7. Glyphosate (various formations) can be applied at or before ground cracking. 2,4-D (various formulations) should be applied 3 or more weeks before planting. Harmony Extra cannot be applied closer than 45 days prior to planting. See specific product labels for tank mixtures with these herbicides.

[2] Valor SX can be applied prior to planting up to 2 days after planting. See product label for information on sprayer cleanout.

3 E = excellent control, 90% or better; G = good control, 80 to 90%; F = fair control, 50 to 80%; P = poor control, 25 to 50%; N = no control, less than 25%.

CHEMICAL WEED CONTROL IN PEANUTS

Control of witchweed is part of the State/Federal Quarantine Program. Contact the N.C. Department of Agriculture, Plant Industry Division, at 1-800-206-9333.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PREPLANT INCORPORATED				
Annual grasses and small-seeded broadleaf weeds	alachlor (Intrro) 4 EC MOA 15	2 to 3 qt	2 to 3	Incorporate no deeper than 2 in.; see label for specific instructions. Unless shallowly incorporated, Intrro is more consistently effective when applied pre-emergence. Weak on Texas panicum. Do not apply more than 4 qt of Intrro per acre per season. Before using Intrro, check with buyers to determine if there are marketing restrictions on Intrro-treated peanuts.
	acetochlor (Warrant) 3 ME, MOA 15	1.25 to 2 qt	0.94 to 1.5	
	ethalfluralin (Sonalan) 3 EC, MOA 3	1.5 to 2 pt	0.56 to 0.75	Controls common annual grasses including Texas panicum. Use 3 pt of Prowl H_2O or 2 pt of Sonalan for control of broadleaf signalgrass, Texas panicum, and fall panicum. Incorporate 3 in. deep for Texas panicum; otherwise, incorporate 2 to 3 in. deep. See labels for maximum waiting period between application and incorporation. Immediate incorporation is best. Dual Magnum or Outlook may be tank mixed with Prowl or Sonalan to suppress yellow nutsedge.
	pendimethalin (Prowl H_2O) 3.8, MOA 3	1.5 to 3 pt	0.71 to 1.43	

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PREPLANT INCORPORATED (continued)				
Annual grasses, small-seeded broadleaf weeds, and nutsedge	dimethenamid (Outlook) 6.0 L MOA 15	16 to 21 fl oz	0.75 to 1	Apply and incorporate in top 2 in. of soil within 14 days of planting. Use high rate of Dual Magnum or Outlook for yellow nutsedge and broadleaf signalgrass. Not effective on purple nutsedge. Weak on Texas panicum. May be tank mixed with Prowl or Sonalan.
	metolachlor, MOA 15 (Dual Magnum) 7.62 EC (Stalwart) 8 EC	1 to 1.33 pt	0.95 to 1.27 1 to 1.33	
Broadleaf weeds and suppression of nutsedge	diclosulam (Strongarm) 84 WDG, MOA 2	0.45 oz	0.024	Effective on common cocklebur, morningglory, common ragweed, eclipta, and common lambsquarters. Suppresses yellow and purple nutsedge. Does not control sicklepod. More effective when applied in combination with Dual Magnum, Outlook, Prowl H_2O, Sonalan, or Stalwart. See label for rotation restrictions, especially corn and grain sorghum. Growers are cautioned that Strongarm applied at rates exceeding 0.45 oz per acre can injure cotton the following year on soils with a shallow hardpan (less than 10 inches) and/or loam soils. Cotton grown under early season stress resulting from conditions such as excessively cool, wet, dry, or crusted soils may be particularly susceptible to carryover of Strongarm. Some weed species have developed resistance to Strongarm.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PREPLANT INCORPORATED (continued)				
Annual grasses, broadleaf weeds, and suppression of nutsedge	diclosulam (Strongarm) 84 WDG, MOA 2 + pendimethalin (Prowl H_2O) 3.8, MOA 3 or ethalfluralin (Sonalan) 3 EC, MOA 3 or metolachlor, MOA 15 (Dual Magnum) 7.62 EC, (Stalwart) 8 EC or dimethenamid (Outlook) 6.0 L, MOA 15 or acetochlor (Warrant) 3 ME, MOA 15	0.45 oz + 1.5 to 3 pt or 1.5 to 2 pt or 1 to 1.33 pt or 16 to 21 fl oz or 1.25 to 2 qt	0.024 + 0.71 to 1.43 or 0.56 to 0.75 or 0.95 to 1.27 1 to 1.33 or 0.75 to 1 or 0.94 to 1.5	Effective on annual grasses, common cocklebur, common ragweed, eclipta, morningglory, and common lambsquarters. Suppresses purple and yellow nutsedge. Does not control sicklepod. See Strongarm label for rotation restrictions.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PPI FOLLOWED BY PRE				
Annual grasses, broadleaf weeds, and suppression of nutsedge	pendimethalin (Prowl H_2O) 3.8, MOA 3 or ethalfluralin (Sonalan) 3 EC, MOA 3 or metolachlor, MOA 15 (Dual Magnum) 7.62 EC, (Stalwart) 8 EC or dimethenamid (Outlook) 6.0 L, MOA 15 or acetochlor (Warrant) 3 ME, MOA 15 followed by diclosulam (Strongarm) 84 WDG, MOA 2 or flumioxazin (Valor SX) 51 WDG, MOA 14	1.5 to 3 pt or or 1.5 to 2 pt or 1 to 1.33 pt or 16 to 24 fl oz or 1.25 to 2 qt 0.45 oz or 2 oz	0.71 to 1.43 or 0.56 to 0.75 or 0.95 to 1.27 1 to 1.33 or 0.75 to 1 or 0.94 to 1.5 0.024 or 0.063	Controls most broadleaf weeds. Will not control sicklepod and is marginal on certain large-seeded broadleaf weeds. Do not incorporate Valor. Valor SX should be applied to the soil surface immediately after planting. Significant injury can occur if Valor is incorporated or applied three or more days after planting. Significant injury from Valor SX was noted in 2001, 2004, 2006, 2009, and 2012, even when applied according to label recommendations. However, injury is generally transient and does not affect yield. Strongarm can carry over and injure corn and grain sorghum. Cotton grown under early season stress from conditions like excessively cool, wet, or crusted soils may be particularly susceptible to carryover of Strongarm. Some weed species have developed resistance to Strongarm.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
SPLIT APPLICATION (PPI + POST)				
Most broadleaf weeds and nutsedge	imazethapyr (Pursuit) 2 AS, MOA 2	2 + 2 oz	0.031 + 0.031	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control eclipta, lambsquarters, ragweed, or croton. Pursuit will usually control seedling johnsongrass and foxtails. For control of other annual grasses, Pursuit may be tank mixed with Dual Magnum, Outlook, Prowl H_2O, or Sonalan and incorporated. See label for incorporation directions and rotational restrictions. Some weed species have developed resistance to Pursuit. Research in N.C. has generally shown more effective control of a broader spectrum of weeds with split applications of half of the Pursuit applied preplant incorporated followed by the other half applied early postemergence.
PREEMERGENCE				
Annual grasses and small-seeded broadleaf weeds	alachlor (Intrro) 4 EC, MOA 15	2 to 3 qt	2 to 3	Apply as soon after planting as possible. All three herbicides are weak on Texas panicum. Before using Intrro, check with buyers to determine if there are marketing restrictions on Intrro-treated peanuts.
	dimethenamid (Outlook) 6.0 L, MOA 15	16 to 21 fl oz	0.75 to 1	
	metolachlor, MOA 15 (Dual Magnum) 7.62 EC, (Stalwart) 8 EC	1 to 1.33 pt	0.95 to 1.27 1 to 1.33	
	acetochlor (Warrant) 3 ME, MOA 15	1.25 to 2 qt	0.94 to 1.5	

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PREEMERGENCE (continued)				
Broadleaf weeds	flumioxazin (Valor SX) 51 WDG MOA 14	2 oz	0.063	Apply within 2 days after planting. Significant injury can occur if Valor SX is incorporated or applied 3 or more days after seeding. Controls carpetweed, common lambsquarters, Florida pusley, nightshade, pigweeds, prickly sida, and spotted spurge. Does not control sicklepod, yellow and purple nutsedge, or annual grasses. Significant injury from Valor SX was noted in 2001, 2004, 2006, 2009, and 2012, even when applied according to label recommendations. However, injury is generally transient and does not affect yield. Injury may occur if excessive and forceful rainfall occurs when peanut is emerging. Peanut recovers from injury by midseason in most instances. See product label for comments on sprayer cleanup.
Annual grasses, broadleaf weeds, and suppression of nutsedge	flumioxazin (Valor SX) 51 WDG, MOA 14 + metolachlor, MOA 15 (Dual Magnum) 7.62 EC, (Stalwart) 8 EC or dimethenamid (Outlook) 6.0 L, MOA 15 **or** acetochlor (Warrant) 3 ME, MOA 15	2 oz + to 1.33 pt or 16 to 21 fl oz or 1.25 to 2 qt	0.063 + 0.95 to 1.27 1 to 1.33 or 0.75 to 1 or 0.94 to 1.5	Apply within 2 days after planting. Significant injury can occur if applied 3 or more days after planting. This combination does not control sicklepod but will control annual grasses (except Texas panicum) and will suppress yellow nutsedge. Significant injury from Valor was noted in 2001, 2004, and 2006, even when applied according to label recommendations. However, injury is generally transient and does not affect yield. Injury may occur if excessive and forceful rainfall occurs when peanut is emerging. Peanut recovers from injury by midseason in most instances. See product label for comments on sprayer cleanup.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PREEMERGENCE (continued)				
Broadleaf weeds and suppression of nutsedge	diclosulam (Strongarm) 84 WDG, MOA 2	0.45 oz	0.024	Effective on common cocklebur, morningglory, common ragweed, eclipta, and common lambsquarters. Suppresses yellow and purple nutsedge. Does not control sicklepod. More effective when applied in combination with Dual Magnum, Outlook, Prowl H_2O, Sonalan, or Stalwart. See label for rotation restrictions, especially corn and grain sorghum. Growers are cautioned that Strongarm applied at rates exceeding 0.45 oz per acre can injure cotton the following year on soils with a shallow hardpan (less than 10 inches) and/or loam soils. Cotton grown under early season stress resulting from conditions such as excessively cool, wet, dry, or crusted soils may be particularly susceptible to carryover of Strongarm. Some weed species have developed resistance to Strongarm.
	sulfentrazone, MOA 14 + carfentrazone, MOA 14 (Spartan Charge) 0.35 + 3.15F	3 to 5 fl oz	0.07 + 0.12	Do not apply Spartan Charge after peanuts crack soil. Application immediately after planting is advised. See Spartan Charge label for specific rates based on soil texture and organic matter content. See product label for comments on application with other herbicides. Rotation restrictions for planting cotton following Spartan Charge at recommended rates for peanuts are 12 months.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PREEMERGENCE (continued)				
Annual grasses, broadleaf weeds, and suppression of nutsedge	diclosulam (Strongarm) 84 WDG, MOA 2 + metolachlor, MOA 15 (Dual Magnum) 7.62 EC, (Stalwart) 8 EC or dimethenamid (Outlook) 6.0 L, MOA 15 or acetochlor (Warrant) 3 ME, MOA 15	0.45 oz + 1 to 1.33 pt or 16 to 21 fl oz or 1.25 to 2 qt	0.024 + 0.95 to 1.27 1 to 1.33 or 0.75 to 1 or 0.94 to 1.5	Effective on annual grasses, common cocklebur, common ragweed, eclipta, morningglory, and common lambsquarters. Suppresses purple and yellow nutsedge. Does not control sicklepod. See label for rotation restrictions, expecially relative to corn and grain sorghum. Some weed species have developed resistance to Strongarm. Cotton grown under early season stress, such as excessively cool, wet, or dry weather, or crusted soils may be particularly susceptible to carryover of Strongarm.
Most annual broadleaf weeds and nutsedge	imazethapyr (Pursuit) 2 AS, MOA 2	4 oz	0.063	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control ragweed, eclipta, lambsquarters, or croton. Pursuit may be tank mixed with Dual Magnum, Intrro, Outlook, or Stalwart for annual grass control. See label for rotational restrictions. Some weed species have developed resistance to Pursuit. Research in N.C. has generally shown more effective control of a broader spectrum of weeds with split applications of half of the Pursuit applied preplant incorporated followed by the other half applied early postemergence.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
CRACKING STAGE				
Emerged annual grasses and broadleaf weeds	paraquat, MOA 22 (Firestorm or Parazone) 3.0 SL (Gramoxone SL) 2.5 L	5.4 fl oz 8 fl oz	0.13	Apply at ground cracking for control of small emerged annual grasses and broadleaf weeds. May be tank mixed with Dual Magnum, Outlook, or Stalwart for residual control. Tank mix may cause severe injury to emerged peanuts. Add1 pt nonionic surfactant per 100 gal spray solution. Follow all safety precautions on label. May also be tank mixed with Pursuit for residual control of nutsedge and broadleaf weeds. Applying Basagran at 0.5 pt per acre will reduce injury.
Additional residual control of annual grasses and certain small-seeded broadleaf weeds	alachlor (Intrro) 4 EC, MOA 15	2 to 3 qt	2 to 3	Use as a supplement to preplant or preemergence herbicides to provide additional residual control of annual grasses and certain small-seeded broadleaf weeds such as pigweed and eclipta. This treatment will not control emerged grasses or broadleaf weeds. Do not apply more than 4 qt Intrro, 21 oz Outlook, or 2.6 pt Dual Magnum or Stalwart per acre per season. Before using Intrro, check with buyers to determine if there are marketing restrictions on Intrro-treated peanuts.
	dimethenamid (Outlook) 6.0 L, MOA 15	16 to 21 fl oz	0.75 to 1	
	metolachlor, MOA 15 (Dual Magnum) 7.62 EC, (Stalwart) 8 EC or acetochlor (Warrant) 3 ME, MOA 15	1 to 1.33 pt or 1.25 to 2 qt	0.95 to 1.27 1 to 1.33 or 0.94 to 1.5	

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
CRACKING STAGE (continued)				
Most annual broadleaf weeds and nutsedge	imazethapyr (Pursuit) 2 AS, MOA 2	4 oz	0.063	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control ragweed, eclipta, lambsquarters, or croton. If weeds are emerged, add surfactant or crop oil according to label directions. See label for rotational restrictions. Pursuit may be tank mixed with paraquat. Some weed species have developed resistance to Pursuit. Research in N.C. has generally shown more effective control of a broader spectrum of weeds with split applications of half of the Pursuit applied preplant incorporated followed by the other half applied early postemergence.
Some emerged broadleaf weeds and suppression of eclipta and yellow nutsedge	diclosulam (Strongarm) 84 WDG, MOA 2	0.45 oz	0.024	Strongarm can be applied through the cracking stage. Add 1 qt nonionic surfactant per 100 gal. The spectrum of weeds controlled is much narrower when Strongarm is applied to emerged weeds. Strongarm will not control emerged common lambsquarters or pigweeds but will control common ragweed and morningglories. Strongarm will suppress yellow nutsedge and eclipta. See product labels for information on mixing Strongarm with other herbicides. Some weed species have developed resistance to Strongarm.
POSTEMERGENCE				
Annual broadleaf weeds	acifluorfen (Ultra Blazer) 2L, MOA 14	1 to 1.5 pt	0.25 to 0.38	Apply when weeds are small and actively growing. Use minimum of 20 GPA and high pressure (40 to 60 psi). See label for species controlled, maximum weed size to treat, and addition of surfactant. Do not apply more than 2 pt postemergence per acre per season. May make sequential applications of 1 pt per acre followed by 1 pt per acre. Allow at least 15 days between sequential applications.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POSTEMERGENCE (continued)				
Annual broadleaf weeds (continued)	acifluorfen (Ultra Blazer) 2L, MOA 14 + 2,4-DB (Butyrac 200) 2L, MOA 4	1 to 1.5 pt + 16 fl oz	0.25 to 0.38 + 0.25	Addition of 2,4-DB to Ultra Blazer improves the control of certain weeds when weed size exceeds that specified on the Ultra Blazer label. See above comments on Ultra Blazer. See label for suggestions on use of surfactant or crop oil. Apply when peanuts are at least 2 weeks old and before pod filling begins. Make only one application per year. Other trade names for 2,4-DB may be available.
	bentazon, MOA 6 (Basagran) 4 L, MOA 6	1.5 to 2 pt	0.75 to 1	Apply when weeds are small and actively growing. Use minimum of 20 GPA and high pressure (40 to 60 psi). See label for addition of oil concentrate, species controlled, and maximum weed size to treat. Basagran may also be applied at 1 pt per acre for control of cocklebur, jimsonweed, and smartweed 4 in. or less. Do not apply more than 4 pt of Basagran per acre per season.
	bentazon, MOA 6 (Basagran) 4 L, MOA 6 + acifluorfen (Ultra Blazer) 2L, MOA 14	1 to 2 pt + 1 to 1.5 pt	0.5 to 1 + 0.25 to 0.38	See above comments for Basagran and Ultra Blazer. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POSTEMERGENCE (continued)				
Annual broadleaf weeds (continued)	bentazon, MOA 6 + acifluorfen, MOA 14 (Storm) 4 L	1.5 pt	0.5 + 0.25	Apply when weeds are small and actively growing. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. These rates of bentazon and acifluorfen may not provide consistent control of lambsquarters, prickly sida, and spurred anoda. Do not apply more than 3 pt of Storm per season.
	bentazon, MOA 6 + acifluorfen, MOA 14 (Storm) 4 L + 2,4-DB (Butyrac 200) 2 L, MOA 4	1.5 pt + 8 to 16 fl oz	0.5 + 0.25 + 0.125 to 0.25	Adding 2,4-DB will improve control of larger morningglory, cocklebur, common ragweed, pigweed, jimsonweed, and citron. Add surfactant or crop oil according to label directions. Make only one appli-cation per year. Apply when peanuts are at least 2 weeks old. Do not apply after pod filling begins. See comments for Storm alone.
	bentazon, MOA 6 (Basagran) 4 L, MOA 6 + 2,4-DB (Butyrac 200) 2 L, MOA 4	1 to 2 pt + 8 fl oz	0.75 to 1 + 0.125	Addition of 2,4-DB to Basagran improves control of morningglories. See above comments for Basagran. Add surfactant or crop oil according to label directions. Do not make more than two applications per year. Apply when peanuts are at least 2 weeks old and not within 45 days of harvest.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POSTEMERGENCE (continued)				
Annual broadleaf weeds (continued)	imazapic (Cadre or Impose) 2 AS MOA 2	4 oz	0.063	Controls most broadleaf weeds except ragweed, croton, lambsquarters, and eclipta. Apply before weeds exceed 2 to 4 in.; see label for specific weed sizes to treat. Add nonionic surfactant at 1 qt per 100 gal or crop oil concentrate at 1 qt per acre. A soil-applied grass control herbicide should be used. However, Cadre and Impose will usually control escaped broadleaf signalgrass, fall panicum, and Texas panicum. See label for rotational restrictions. Some weed species have developed resistance to Cadre and Impose.
	imazethapyr (Pursuit) 2 AS MOA 2	4 oz	0.063	Effective on most common broadleaf weeds and yellow and purple nutsedge. Does not control eclipta, lambsquarters, ragweed, or croton. Apply when weeds are 3 in. tall or less. Add surfactant or crop oil according to label directions. See label for rotational restrictions. Pursuit may be tank mixed with Basagran, Ultra Blazer, paraquat formulations, and 2,4-DB. Some weed species have developed resistance to Pursuit. Research in N.C. has generally shown more effective control of a broader spectrum of weeds with split applications of half of the Pursuit applied preplant incorporated followed by the other half applied early postemergence. Some weeds, especially Palmer amaranth, are resistant to Pursuit.
	2,4-DB (Butyrac 200) 2 L, MOA 4	1 pt	0.2 to 0.25	Effective on cocklebur and morningglory; pitted morningglory may be only partially controlled. Best results achieved when applied to small weeds. May use two applications per year. Do not apply within 45 days before harvest. Other trade names for 2,4-DB may be available.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POSTEMERGENCE (continued)				
Annual broadleaf weeds (continued)	lactofen (Cobra) 2 EC, MOA 14	12.5 fl oz	0.2	Apply after peanuts have at least six true leaves. Apply to actively growing peanut. Controls most annual broadleaf weeds. Use minimum of 10 GPA and high pressure (40 to 60 psi). See label for species controlled and maximum weed size to treat. Add nonionic surfactant at 1 qt per 100 gal or crop oil concentrate or methylated seed oil at 1 to 2 pt per acre. See label on when to use various adjuvants. Allow at least 14 days between applications. Can be tank mixed with Basagran, Pursuit, Cadre, Impose, 2,4-DB, and/or Select.
	lactofen (Cobra) 2 EC, MOA 14 + bentazon, MOA 6 (Basagran) 4 L, MOA 6	12.5 fl oz + 1.5 to 2 pt	0.2 + 0.75 to 1	See above comments for Cobra and Basagran. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants.
	lactofen (Cobra) 2 EC, MOA 14 + bentazon, MOA 6 (Basagran) 4 L, MOA 6 + 2.4-DB (Butyrac 200) 2 L, MOA 4	12.5 fl oz + 1.5 to 2 pt + 8 to 16 fl oz	0.2 + 0.75 to 1 + 0.125 to 0.25	Adding 2,4-DB will improve control of larger morningglory, cocklebur, common ragweed, jimsonweed, and citron. See above comments for Cobra, Basagran, and 2,4-DB. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Other trade names for 2,4-DB may be available.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POSTEMERGENCE (continued)				
Annual broadleaf weeds (continued)	lactofen (Cobra) 2 EC, MOA 14 + imazapic (Cadre or Impose) 2 AS, MOA 2	12.5 fl oz + 4 oz	0.2 + 0.063	See above comments for Cobra and Cadre and Impose. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Some weed species have developed resistance to Cadre and Impose.
	lactofen (Cobra) 2 EC, MOA 14 + imazethapyr (Pursuit) 2 AS, MOA 2	12.5 fl oz + 4 oz	0.2 + 0.063	See above comments for Cobra and Pursuit. See labels for weeds controlled, maximum weed size to treat, and use of adjuvants. Some weed species have developed resistance to Pursuit.
	pyraflufen ethyl (ET) 2.5 EC, MOA 14	1 to 2 fl oz	0.02 to 0.04	Controls morningglories when applied alone and can improve control when mixed with paraquat and other broadleaf herbicides. Apply with nonionic surfactant at 1 quart/100 gal. Do not apply with crop oil concentrate. Can be applied up to 7 days prior to digging peanut.
Annual grasses and broadleaf weeds	paraquat, MOA 22 (Firestorm or Parazone) 3.0 SL (Gramoxone SL) 2.5 L	5.4 fl oz 8 fl oz	0.13	See label for weeds controlled and maximum weed size to treat; best results if weeds 1 in. or less. A postemergence application may be made following an at-crack application. Do not make more than two applications per season, do not apply later than 28 days after ground cracking, and do not apply to peanuts under stress, including damage from thrips feeding. Add 1 pt of nonionic surfactant per 100 gal of spray solution. Will cause foliar burn on peanuts, but the crop recovers and yield not affected. Follow all safety precautions on label. Do not apply to peanuts showing symptoms of significant thrips damage.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POSTEMERGENCE (continued)				
Annual grasses and broadleaf weeds (continued)	paraquat, MOA 22 (Firestorm or Parazone) 3.0 SL (Gramoxone SL) 2.5 L + bentazon, MOA 6 (Basagran) 4 L, MOA 6	5.4 fl oz 8 fl oz + 0.5 to 1.5 pt	0.13 + 0.25 to 0.75	See previous comments for paraquat alone. Adding Basagran improves control of common ragweed, prickly sida, smartweed, lambsquarters, and cocklebur and reduces injury to peanuts from paraquat. May be applied any time from ground cracking up to 28 days after ground cracking. Add 1 pt of nonionic surfactant per 100 gal of spray solution.
	paraquat, MOA 22 (Firestorm or Parazone) 3.0 SL (Gramoxone SL) 2.5 L + bentazon, MOA 6 + acifluorfen, MOA 14 (Storm) 4 L	5.4 fl oz 8 fl oz + 1.5 pt	0.13 + 0.5 0.25	See previous comments for Gramoxone SL alone. Storm improves control of common ragweed, smartweed, lambsquarters, common cocklebur, tropic croton, and spurred anoda. May be applied anytime from ground cracking up to 28 days after ground cracking. Add 0.5 pt of nonionic surfactant per 100 gal of spray solution.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POSTEMERGENCE (continued)				
Florida beggarweed	chlorimuron (Classic) 25 DF, MOA 2	0.5 oz	0.008	Use only for control of Florida beggarweed. Apply from 60 days after crop emergence to within 45 days of harvest. Application to peanuts less than 60 days old will result in crop injury and yield reduction. Apply before Florida beggarweed has begun to bloom and before it has reached 10 in. tall. Larger beggarweed may only be suppressed. Add 1 qt of nonionic surfactant per 100 gal spray solution; do not add crop oil. May be tank mixed with 2,4-DB; see label for rates and precautions. Recommended as a salvage treatment only.
Yellow nutsedge	bentazon, MOA 6 (Basagran) 4 L, MOA 6	1.5 to 2 pt	0.75 to 1	Apply when nutsedge is 6 to 8 in. tall. A repeat application 7 to 10 days later may be needed. Adding crop oil concentrate at 1 qt per acre will increase control. Do not apply more than 4 pt of Basagran per season. Not effective on purple nutsedge.
Yellow and purple nutsedge	imazapic (Cadre or Impose) 2 AS, MOA 2	4 oz	0.063	Apply postemergence when nutsedge is 4 in. or less. Add nonionic surfactant at 1 qt per 100 gal or crop oil concentrate at 1 qt per acre. See label for rotational restrictions.
	imazethapyr (Pursuit) 2 AS, MOA 2	4 oz	0.063	Apply before nutsedge is larger than 3 in. tall. Add surfactant at 1 qt per 100 gal or crop oil concentrate at 1 qt per acre. Do not mix with Basagran for nutsedge control. See label for rotational restrictions. A split application with half of the Pursuit applied preplant incorporated and half applied early post-emergence may be more effective than applying all of the Pursuit at one time.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POSTEMERGENCE (continued)				
Annual grasses	clethodim, MOA 1 (Arrow, Select, or Volunteer) 2 EC (Select MAX or TapOut) 0.97 EC	6 to 8 fl oz 9 to 16 fl oz	0.094 to 0.125 0.068 to 0.121	Apply Arrow, Poast, Poast Plus, Select 2 EC, Select MAX, TapOut, or Volunteer to actively growing grass not under drought stress. Consult labels for maximum grass size to treat. Apply in 5 to 20 GPA at 40 to 60 psi. Add 2 pt of crop oil concentrate per acre to Poast or Poast Plus. Do not cultivate within 7 days before or after application. Poast Plus is often slightly better than Poast. Add crop oil concentrate at 1 qt per acre to Arrow, Select 2 EC, Select MAX, TapOut, and Volunteer. Nonionic surfactant at 1 qt per 100 gal can be applied with Select MAX rather than crop oil concentrate. Some herbicides and fungicides can reduce the efficacy of Arrow, Select 2 EC, Select MAX, Volunteer, Poast, and Poast Plus when applied in tank mixtures. See product labels for specific instructions concerning compatibility with other chemicals. Also see chapter 9 in this publication.
	sethoxydim, MOA 1 (Poast) 1.5 EC (Poast Plus) 1 EC	1 pt 1.5 pt	0.19	
Bermudagrass	clethodim, MOA 1 (Arrow, Select, or Volunteer) 2 EC (Select MAX or TapOut) 0.97 EC	8 to 16 fl oz 12 to 32 fl oz	0.125 to 0.25 0.091 to 0.24	Apply to actively growing bermudagrass before runners exceed 6 in. In most cases, a second application will be needed. Make second application of 1 pt of Poast or 1.5 pt of Poast Plus per acre if regrowth occurs. Add 2 pt per acre of crop oil concentrate. Poast Plus is often slightly better than Poast. If needed, make a second application of Arrow, Select 2 EC, TapOut, or Volunteer at 8 to 16 oz per acre when regrowth is less than 6 in. Add crop oil concentrate at 1 qt per acre to Arrow, Select 2 EC, TapOut, and Volunteer. Crop oil concentrate (1 qt per acre) or nonionic surfactant (1 qt per 100 gallons) should be applied with Select MAX. See product labels for specific instructions concerning compatibility with other chemicals. Also see chapter 9 in this publication.
	sethoxydim, MOA 1 (Poast) 1.5 EC (Poast Plus) 1 EC	1.5 pt 2.25 pt	0.28	

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POSTEMERGENCE (continued)				
Rhizome johnsongrass	clethodim, MOA 1 (Arrow, Select, or Volunteer) 2 EC (Select MAX or TapOut) 0.97 EC	8 to 16 fl oz 12 to 32 fl oz	0.125 to 0.25 0.091 to 0.24	Apply to actively growing johnsongrass before it exceeds 25 in. tall. Add 2 pt per acre of crop oil concentrate. A second application of the same rates can be made if needed before new plants or regrowth exceeds 12 in. Apply Arrow, Select 2 EC, TapOut, or Volunteer when johnsongrass is 12 to 24 in. tall. If needed, make a second application when regrowth is 6 to 18 in. Add crop oil concentrate at 1 qt per acre to Arrow, Select 2 EC, Select MAX, TapOut, and Volunteer. Crop oil concentrate (1 qt per acre) or nonionic surfactant (1 qt per 100 gallons) should be applied with Select MAX. For specific instructions for compatibility concerns with other chemicals, see product labels and chapter 9 in in this publication.
	sethoxydim, MOA 1 (Poast) 1.5 EC (Poast Plus) 1 EC	1 pt 1.5 pt	0.19	
Suppression of large Palmer amaranth and other pigweed species that are resistant to the ALS inhibiting herbicides Cadre, Classic, Impose, Pursuit, and Strongarm	2,4-DB (Butyrac 200 and others) 2 L, MOA 4 + lactofen (Cobra) 2 EC, MOA 14 or acifluorfen (Ultra Blazer) 2 L, MOA 14	16 oz + 12.5 oz or 1.5 pt	0.25 + 0.20 or 0.38	Suppresses and does not completely control Palmer amaranth and other pigweed species that exceed 8 inches. Suppression of weeds exceeding 12 inches will be less than suppression of smaller weeds. Do not expect suppression to exceed 60%. Applying 2,4-DB 3 to 4 days prior to Cobra or Ultra Blazer may be more effective than tank mixtures of 2,4-DB with Cobra or Ultra Blazer. Cobra is generally more effective on larger Palmer amaranth and other pigweed species than Ultra Blazer. Apply crop oil concentrate at 1% (v/v) with Cobra and Ultra Blazer. Do not apply adjuvant with 2,4-DB alone. See product labels for comments on spray volume and effects on peanut especially during pod set and pod fill. Higher spray volumes are more effective by increasing spray coverage of the contact herbicides Cobra and Ultra Blazer.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POSTEMERGENCE (continued)				
Suppression of large Palmer amaranth and other pigweed species that are resistant to the ALS inhibiting herbicides Cadre, Classic, Impose, Pursuit, and Strongarm (continued)	2,4-DB (Butyrac 200 and others) 2 L, MOA 4 then lactofen (Cobra) 2 EC or acifluorfen (Ultra Blazer) 2 L, MOA 14	16 oz then 12.5 oz or 1.5 pt	0.25 then 0.20 or 0.38	Two applications of 2,4-DB spaced 10 to 14 days apart will suppress Palmer amaranth and other pigweed species. Although suppression by 2,4-DB is lower than sequential or tank mix application of 2,4-DB and Cobra or Ultra Blazer within two weeks after application, suppression by sequential applications of 2,4-DB 4 to 5 weeks after initial application is only slightly lower than suppression by sequential or tank mix application of 2,4-DB and Cobra or Ultra Blazer.
	2,4-DB (Butyrac 200) 2 L, MOA 4 then 2,4-DB (Butyrac 200) 2 L, MOA 4	16 oz then 16 oz	0.25 then 0.25	
	Paraquat, MOA 22 (Gramoxone SL) 2.5L	See comments	See comments	Apply in roller/wiper implement. Best control when at least 60% coverage of weed foliage can be achieved. Do not allow paraquat to contact peanut foliage. Mix 1 part Gramoxone SL with 1 to 1.5 parts water to prepare a 40% to 50% solution. Add nonionic surfactant at 0.25% (v/v) or 1 qt/100 gallons. Adjust roller/wiper system to apply up to 2 pt/A of the herbicide-water mixture.

Table 4-5. Herbicide Information for Peanuts

Weed	Herbicide and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POSTEMERGENCE (continued)				
Annual grasses and certain small-seeded broadleaf weeds	dimethenamid (Outlook) 6.0 L, MOA 15	16 to 21 fl oz	0.75 to 1	Will not control emerged grasses or weeds; apply following a cultivation or appropriate postemergence herbicide if emerged grasses or broadleaf weeds are present. Benefit likely only on very sandy fields heavily infested with annual grasses that receive above normal rainfall during the first 4 to 5 weeks of the growing season. Lay-by of Dual Magnum or Outlook may also be of value in fields with a history of eclipta problems; the application must be made before eclipta emerges. Rates are on a broadcast basis; apply in an 18-in. band to row middles. The maximum use rate of Dual Magnum is 2.6 pt per acre per season. The maximum rate of Outlook is 21 fl oz per acre per season. Do not apply Outlook within 80 days of harvest.
	metolachlor, MOA 15 (Dual Magnum) 7.62 EC	0.67 to 0.88 pt	0.64 to 0.84	

Table 4-6. Weed Response to Preplant Incorporated (PPI), Preemergence (PRE), and At-Cracking (AC) Herbicides in Peanuts

	Prowl or Sonalan PPI	Prowl or Sonalan + Metolachlor PPI	Prowl or Sonalan + Outlook PPI	Metolachlor PPI	Acetochlor PPI	Outlook PPI	Strongarm PPI or PRE	Prowl or Sonalan + Strongarm PPI	Metolachlor or Outlook + Strongarm PPI or PRE	Pursuit PPI + POST	Metolachlor PRE	Acetochlor PRE	Intrro PRE	Outlook PRE	Valor SX PRE	Prowl or Sonalan PPI + Valor SX PRE	Metolachlor or Outlook + Valor SX PRE	Metolachlor AC[1]	Intrro AC [1]	Outlook A [1]	Gramoxone Inteon AC	Strongarm AC [2]	Paraquat + Strongarm AC [2]
Bermudagrass	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N	P
Black nightshade	N	F	F	F	F	F	N	N	F	G	F	FG	FG	F	E	E	E	F	FG	F	PF	N	G
Broadleaf signalgrass	G	E	E	G	FG	FG	P	G	G	G	G	FG	FG	FG	P	G	FG	G	FG	FG	E	N	GE
Carpetweed	G	G	G	FG	FG	FG	G	G	G	FG	FG	FG	FG	G	—	G	G	FG	FG	G	FG	—	G
Cocklebur	N	N	N	N	N	N	G	G	G	GE	N	N	N	N	PF	PF	PF	N	N	N	E	E	E
Common ragweed	N	P	PF	PF	PF	F	G	G	GE	P	PF	PF	PF	F	FG	G	GE	PF	PF	F	F	E	E
Crabgrass	E	E	E	E	E	E	P	E	E	F	E	E	E	E	PF	E	E	E	E	E	G	N	G
Crowfootgrass	E	E	E	E	E	E	—	—	—	—	E	E	E	E	PF	G	G	E	E	E	E	N	GE
Dayflower	P	GE	—	GE	—	—	G	G	GE	—	GE	F	—	—	F	F	GE	GE	—	—	—	—	G
Eclipta	N	G	G	G	FG	G	GE	GE	GE	P	FG	FG	FG	FG	G	G	GE	FG	FG	FG	FG	NP	FG
Fall panicum	G	E	E	E	E	E	P	E	E	PF	E	E	E	E	PF	FG	GE	E	E	E	E	N	GE
Florida beggarweed	N	PF	PF	F	E	F	F	F	F	P	F	F	F	F	G	GE	E	F	F	F	E	FG	G
Foxtails	E	E	E	E	E	E	P	E	E	G	E	E	E	E	PF	E	E	E	E	E	E	N	GE
Goosegrass	E	E	E	E	E	E	P	E	E	PF	E	E	E	E	PF	GE	E	E	E	E	E	N	GE
Jimsonweed	N	N	N	N	N	N	GE	GE	GE	G	N	N	N	N	G	G	GE	N	N	N	E	—	E
Johnsongrass, Seedling	G	G	G	PF	PF	PF	N	G	PF	GE	PF	PF	PF	PF	N	FG	PF	PF	PF	PF	E	N	GE
Johnsongrass, Rhizome	P	PF	PF	N	N	N	N	P	N	FG	N	N	N	N	N	N	N	N	N	N	P	N	P
Lambsquarters	G	NG	G	F	F	FG	FG	GE	GE	FG	F	F	F	FG	GE	GE	GE	F	F	FG	F	N	G
Morningglory	P	P	P	N	N	N	G	G	G	G	N	FG	N	N	FG	G	G	N	N	N	F	GE	E

Table 4-6. Weed Response to Preplant Incorporated, Preemergence, and At-Cracking Herbicides in Peanuts (continued)

	Prowl or Sonalan PPI	Prowl or Sonalan + Metolachlor PPI	Prowl or Sonalan + Outlook PPI	Metolachlor PPI	Acetochlor PPI	Outlook PPI	Strongarm PPI or PRE	Prowl or Sonalan + Strongarm PPI	Metolachlor or Outlook + Strongarm PPI or PRE	Pursuit PPI + POST	Metolachlor PRE	Acetochlor PRE	Intrro PRE	Outlook PRE	Valor SX PRE	Prowl or Sonalan PPI + Valor SX PRE	Metolachlor or Outlook + Valor SX PRE	Metolachlor AC[1]	Intrro AC [1]	Outlook A [1]	Gramoxone Inteon AC	Strongarm AC [2]	Paraquat + Strongarm AC [2]
Nutsedge, Yellow	N	G	FG	G	N	FG	FG	FG	G	FG	FG	NP	P	F	P	PF	FG	FG	P	F	PF	PF	G
Nutsedge, Purple	N	N	N	N	N	N	FG	FG	FG	FG	N	N	N	N	P	P	P	N	N	N	PF	NP	PF
Pigweed	G	E	E	G	G	G	G	E	E	E	G	P	GE	GE	E	E	E	G	GE	GE	E	NP	E
Prickly sida	N	P	P	P	P	P	FG	FG	FG	G	P	N	P	P	FG	G	G	P	P	P	F	—	G
Purslane	G	GE	GE	G	FG	G	—	G	G	—	G	PF	G	G	G	GE	GE	GE	P	P	—	—	—
Sicklepod	N	NP	NP	NP	NP	NP	P	P	P	P	NP	N	PF	NP	P	PF	PF	NP	PF	NP	G	N	G
Smartweed	N	N	N	N	N	N	G	G	G	G	N	N	N	N	—	—	—	N	N	N	G	—	E
Spurge spp.	P	F	F	PF	P	PF	—	—	—	P	F	P	P	F	G	G	G	N	N	N	F	—	F
Spurred anoda	N	N	N	N	N	N	FG	FG	FG	G	N	N	N	N	F	FG	FG	N	N	N	P	—	G
Texas panicum	G	G	G	PF	PF	PF	P	G	PF	PF	PF	PF	PF	PF	PF	G	F	PF	PF	PF	E	N	GE
Tropic croton	N	N	N	N	N	N	PF	PF	PF	P	N	N	N	N	—	—	—	N	N	N	F	—	F
Velvetleaf	N	N	N	N	N	N	GE	GE	GE	FG	N	N	N	N	F	FG	FG	N	N	N	F	—	FG

[1]Residual control only.

[2]Assumes weeds are 1- to 2-in. tall or smaller.

Key:

E = excellent control, 90% or better | G = good control, 80% to 90% | F = fair control, 50% to 80%

P = poor control, 25% to 50% | N = no control, less than 25%

Table 4-7. Weed Response to Postemergence Herbicides — Peanuts

Species	2,4-DB	Paraquat [1]	Paraquat + 2,4-DB	Paraquat + Basagran	Paraquat + Storm	Basagran	Basagran + 2,4-DB	Ultra Blazer	Ultra Blazer + 2,4-DB	Basagran + Ultra Blazer [2]	Storm	Storm + 2,4-DB	Pursuit + 2,4-DB	Cadre or Impose	Cobra	Cobra + Basagran	Cobra + Basagran + 2,4-DB	Cobra + Cadre or Impose	Cobra + Pursuit	Poast or Poast Plus	Clethodim
Bermudagrass	N	P	P	P	P	N	N	N	N	P	N	N	N	N	N	N	N	N	N	FG	G
Black nightshade	N	PF	PF	PF	G	P	P	G[1]	G[1]	G[1]	G[1]	G[1]	G	G	G[1]	G[1]	G[1]	G	G	N	N
Broadleaf signalgrass	N	GE	GE	E	GE	N	N	NP	NP	P	NP	NP	G	G	N	N	N	G	G	E	E
Carpetweed	P	FG	FG	FG	G	P	P	GE	E	E	G	G	FG	FG	G	G	G	G	G	N	N
Cocklebur	E	G	E	E	E	E	E	G	E	E	E	E	E	E	G	G	E	E	E	N	N
Common ragweed	PF	F	F	G	E	G4	G4	E[1]	E[1]	E[1]	E[1]	E[1]	P	PF	E	E	E	E	E	N	N
Crabgrass	N	G	G	G	G	N	N	N	N	N	N	N	FG	FG	N	N	N	FG	FG	GE	GE
Crowfootgrass	N	GE	GE	G	GE	N	N	P	P	P	P	P	P	G	N	N	N	G	P	F	G
Dayflower	—	G	G	G	FG	G	G	—	—	G	FG	FG	—	G	—	G	G	G	—	N	N
Eclipta	P	F	F	F	FG	FG	FG	G	G	G	FG	FG	P	F	G	G	G	G	G	N	N
Fall panicum	N	GE	GE	G	GE	N	N	PF	PF	P	PF	PF	PF	G	N	N	N	G	PF	E	E
Florida beggarweed	P	G	E	GE	G	N	P	PF	F	F	P	P	P	F	F	F	F	F	F	N	N
Foxtails	N	GE	GE	G	GE	N	N	PF	PF	P	PF	PF	G	G	N	N	N	G	G	E	E
Goosegrass	N	GE	GE	G	GE	N	N	N	N	N	N	N	N	F	N	N	N	F	N	GE	GE
Jimsonweed	P	G	G	E	E	E	E	E	E	E	E	E	G	E	E	E	E	E	E	N	N
Johnsongrass	N	GE	GE	GE	GE	N	N	P	P	P	P	P	GE	E	N	N	N	E	GE	E	E
Seedling Johnsongrass	N	P	P	P	P	N	N	N	N	N	N	N	F	FG	N	N	N	FG	F	G	GE
Rhizome Lambsquarters	PF	F	F	G	G	FG	G4	G	G	GE	G	G	P	PF	P	FG	G	PF	P	N	N
Morningglory, Pitted	FG	F	G	FG	E	P	G	E	E	E	E	E	G	GE	G	G	G	GE	G	N	N
Morningglory, Others	E	F	E	FG	E	P	E	GE	E	E	GE	E	E	G	G	G	E	G	E	N	N
Nutsedge, Yellow	N	PF	PF	FG	G	G[3]	G	N	N	G	F	F	F	G	N	G[3]	G[3]	G	F	N	N
Nutsedge, Purple	N	PF	PF	PF	PF	NP	P	N	N	P	N	N	FG	G	N	P	P	G	FG	N	N

Table 4-7. Weed Response to Postemergence Herbicides — Peanuts (continued)

Species	2,4-DB	Paraquat [1]	Paraquat + 2,4-DB	Paraquat + Basagran	Paraquat + Storm	Basagran	Basagran + 2,4-DB	Ultra Blazer	Ultra Blazer + 2,4-DB	Basagran + Ultra Blazer [2]	Storm	Storm + 2,4-DB	Pursuit + 2,4-DB	Cadre or Impose	Cobra	Cobra + Basagran	Cobra + Basagran + 2,4-DB	Cobra + Cadre or Impose	Cobra + Pursuit	Poast or Poast Plus	Clethodim
Pigweed	PF	G	G	G	E	N	P	E	E	E	E	E	E	E	E	E	E	E	E	N	N
Prickly Sida	F	F	F	G	G	G	G	N	F	G	FG	G	P	G	G	G	G	G	G	N	N
Purslane	FG	—	FG	G	G	G	G	E	E	E	GE	GE	FG	—	E	E	E	E	E	N	N
Sicklepod	G[3]	G	G	G	G	N	G[6]	NP	G[6]	NP	NP	G[6]	G[6]	E	P	P	G6	E	F	N	N
Smartweed	PF	G	G	E	E	E	E	GE	E	E	E	E	G	F	F	E	E	F	G	N	N
Spurge	P	F	F	F	F	F	P	P	F	F	F	PF	PF	PF	—	F	F	F	—	N	N
Spurred anoda	P	P	P	FG	G	G	GE	P	P	G	F	F	F	G	F	G	GE	G	F	N	N
Texas panicum	N	GE	GE	G	GE	N	N	NP	NP	NP	NP	NP	NP	G	N	N	N	G	NP	E	E
Tropic croton	PF	F	F	F	G	F	F	G	G	G	G	G	P	P	G	G	G	G	G	N	N
Velvetleaf	P	F	F	G	FG	G	G	PF	PF	FG	FG	FG	FG	G	G	G	G	G	G	N	N

[1] Assumes weeds are 1- to 2-in. tall or smaller.

[2] Assumes optimum rates and ratios of Basagran and Blazer; see labels.

[3] Two applications, 10 to 14 days apart.

[4] Assumes optimum conditions and addition of crop oil concentrate.

[5] Ratings assume weeds in one- to two-leaf stage.

[6] Assumes follow-up treatment with 2,4-DB.

Key: E = excellent control, 90% or better; G = good control, 80% to 90%; F = fair control, 50% to 80%; P = poor control, 25% to 50%; N = no control, less than 25%.

Table 4-8. Restriction on Feeding Peanut Hay to Livestock Following Treatment with Herbicides

Feeding Restricted (Do not feed treated hay to livestock.)	No Feeding Restrictions
2,4-DB, Arrow, Ultra Blazer, Cadre, Cobra, Impose, Poast, Poast Plus, Pursuit, Select, Sonalan, Storm	Basagran, Dual Magnum, Gramoxone SL, Outlook*, Prowl

* No restriction on feeding 80 days after last application.

Table 4-9. Suggested Rain-free Periods After Application of Postemergence Herbicides

Herbicide	Rain-free Period (hours)	Herbicide	Rain-free Period (hours)
2,4-DB	NR**	Paraquat	0.5
Arrow	1	Poast	1
Basagran	NR*	Poast Plus	1
Ultra Blazer	NR*	Pursuit	1
Cadre, Impose	3	Select, Select MAX	1
Classic	1	Storm	NR*
Cobra	1		

* No restriction listed on label. Suggest 4 to 6 hours for best results.
** No restriction listed on label. Suggest at least 1 hour for best results.

Table 4-10. Restrictions on Crop Rotation of Herbicides with Significant Residual Activity Applied to Peanuts

Herbicide	Corn	Cotton	Soybean	Tobacco	Wheat	Grain Sorghum
Cadre, Impose	9 months	18 months	9 months	9 months	4 months	18 months
Pursuit	NR/8.5 months*	9.5 months/ 18 months*	NR	9.5 months	4 months	18 months
Strongarm	18 months**	9 months	NR	> 18 months	4 months	18 months
Valor	NR	NR	NR	NR	4 months	NR
Prowl	Following year	NR	NR	NR	4 months	NR
Outlook	NR	Following year	NR	Following year	4 months	NR
Dual	NR	NR	NR	Following year	4.5 months	NR

NR = no restriction.
*No restriction and 9.5 months if applied postmergence; 8.5 and 18 months if applied preplant incorporated. See label on rainfall and temperature requirements.
**No restriction if appropriate IMI-tolerant corn hybrid is planted. See label for specific instructions.

PREVENTING AND MANAGING HERBICIDE-RESISTANT WEEDS

In recent years, populations of weeds that were once controlled by specific herbicides have developed resistance to these herbicides. Historically, the resistance of individual weeds within a population of a species has rarely occurred. However, increased selection pressure and the occurrence of cross and multiple resistance have resulted in increased frequency of herbicide resistance in some peanut fields. Two steps are critical to prevent yield loss from weed interference and preserve herbicide effectiveness: (1) determine whether weed escapes are herbicide resistant, and (2) develop an appropriate management strategy for herbicide-resistant weeds. While most weed escapes are the result of an application error or weather conditions, herbicide resistance is a real threat. Indicators of herbicide resistance, approaches to managing herbicide-resistant weed populations, and classification of resistance potential by mode of action are listed in Tables 4-11 and 4-12. Note that herbicides that are generally not prone to having resistance populations develop can become ineffective if they are used repeatedly without implementation of other weed management practices. The intensity of selection pressure (frequency of application) and likelihood of resistance to develop for a particular herbicide are the two essential elements in determining occurrence of herbicide resistant biotypes. Contact your local Cooperative Extension agent if herbicide resistance is suspected.

In North Carolina, populations of pigweeds resistant to acetolactate synthase (ALS) inhibiting herbicides have been confirmed. The effectiveness of the herbicides Cadre, Pursuit, and Strongarm will be less in fields where resistant populations exist. Common ragweed resistance to ALS-inhibiting herbicides also has been confirmed. To manage weeds in these fields, growers must use herbicides with a different mode of action from the ALS-inhibiting herbicides. This can be accomplished in a variety of ways, including application of herbicide mixtures to broaden the spectrum of control.

Table 4-11. Identification and Management of Herbicide-Resistant Weeds

Possible reasons why herbicides do not control weeds that are NOT associated with herbicide resistance:
Improper herbicide choice or rate. Poor or improper application of herbicide. Poor timing of herbicide application. Weather conditions were not favorable when herbicide was applied. Weeds emerged after the postemergence herbicide was applied. Other chemicals antagonized the herbicide.
Indicators suggesting that weeds are resistant to herbicides:
Herbicide normally controls the weed in question. Performance poor on one species while other species are controlled well. Poor control is confined to spots in the field. Some plants of the weed in question are controlled well while other plants of that species are controlled poorly. Field history of heavy use of herbicides with the same mechanism of action.
Steps to take to prevent or manage herbicide resistance:
Rotate herbicides having different mechanisms of action. Use tank mixes or sequential applications of herbicides having different mechanisms of action. Be especially vigilant when using herbicides with higher risk of resistance development. Integrate nonchemical controls when possible. Avoid allowing weeds to produce seeds when herbicide resistance is suspected.
Additional key points:
Although some herbicides inherently are at low risk for resistance development, selection pressure (the frequency of herbicide applications with the same mode of action) can overcome the low or moderate theoretical possibility of resistance developing. Spraying weeds that are large and beyond the recommendation on the herbicide label is equivalent to applying herbicides at rates lower than the recommended labeled rates applied to small weeds. This approach increases the possibility of developing resistance.

Table 4-12. Herbicide Categories Prone to Have Weeds Develop Resistance

Tradename	Common Name	Family	MOA
ALS* Inhibitors—Weeds highly susceptible to developing resistance			
Cadre, Impose, Pursuit	Imazapic, Imazethapyr	Imidazolinone	2
Strongarm	Diclosulam	Triazolopyrimidine	2
Classic	Chlorimuron	Sulfonyl urea	2
ACCase* Inhibitor—Weeds moderately to highly susceptible to developing resistance			
Arrow, Clethodim, Select, Select MAX, Tapout, Volunteer	Clethodim	Cyclohexanedione	1
Poast, Poast Plus	Sethoxydim	Cyclohexanedione	1
Microtubule Assembly Inhibition—Weeds moderately susceptible to developing resistance			
Prowl	Pendimethalin	Dinitroaniline	3
Sonalan	Ethafluralin	Dinitroaniline	3
Herbicides at low risk for resistance development			
Aim	Carfentrazone ethyl	Aryltriazinone	14
Basagran	Bentazon	Benzothiadiazole	6
Cobra	Lactofen	Diphenylether	14
Gramoxone SL	Paraquat	Bipyridilium	22
Dual Magnum	Metolachlor	Chloroacetamide	15
ET	Pyraflufen ethyl	Phenylpyrazole	14
Intro	Alachlor	Chloroacetamide	15
Outlook	Dimethenamid	Chloroacetamide	15
Spartan Charge	Carfentrazone + Sulfentrazone	Triazolinone + Triazolinone	14
Storm	Acifluorfen + Bentazon	Diphenylether + Benzothiadiazole	14 + 6
Ultra Blazer	Acifluorfen	Diphenylether	14
Valor SX	Flumioxazin	N-phenylphtalimide derivative	14
Warrant	Acetochlor	Chloroacetamide	15
2,4-DB (various formulations)	2,4-DB	Phenoxy	4

*ALS = acetolactate synthase; ACCase = acetyl CoA carboxylase; MOA, mode of action.

MANAGING PALMER AMARANTH IN PEANUTS

Palmer amaranth has become one of the most difficult weeds to control in peanuts and other crops throughout North Carolina. This weed is very competitive with crops and produces an abundant amount of seed if left uncontrolled. Development of herbicide-resistant biotypes including those resistant to glyphosate and ALS inhibitors (Cadre, Impose, Pursuit, Strongarm, Classic) has contributed to the challenge in controlling Palmer amaranth. A comprehensive strategy is necessary to control this weed and includes intensive preplant incorporated and preemergence herbicide applications and multiple and timely postemergence herbicide applications. Specific herbicide programs and limitations of these programs are listed in Table 4-13.
The importance of timely application of all postemergence herbicides cannot be emphasized enough. A general recommendation for weed control is provided in Table 4-14.

Table 4-13. Herbicide Programs for Palmer Amaranth Control in Peanuts[1]

Preplant incorporated	Preemergence	Cracking or early postemergence[2] (Palmer < 2 in.)	Postemergence[3,4] (Palmer < 3 in.)	Postemergence[5] (Palmer >10 in.)
Prowl[6] or Sonalan + Dual Magnum[7] or Outlook or Warrant		Paraquat, Paraquat + Basagran, or Paraquat + Storm	Cobra, Storm, or Ultra Blazer + 2,4-DB	2,4-DB followed by 2,4-DB or Gramoxone SL applied using a roller/wiper system
Prowl[6] or Sonalan		Dual Magnum[7] + Paraquat + Basagran or Outlook + Paraquat + Basagran or Warrant + Paraquat + Basagran		
Prowl[6] or Sonalan	Valor SX			
Prowl[6] or Sonalan	Strongarm[8]			
	Valor SX + Dual Magnum[7] or Valor SX+ Outlook or Valor SX+ Warrant			
	Strongarm[8] + Dual Magnum[7] or Strongarm + Outlook or Valor SX+ Warrant			

[1] Glyphosate- and ALS-resistant Palmer amaranth are very serious concerns. An aggressive management program is necessary to slow the spread of the resistant biotypes and to reduce selection pressure in areas currently not infested with resistant biotypes. Good control in peanuts rotated with cotton will aid control in cotton.

[2] Apply cracking or early postemergence treatment only if weeds are emerged.

[3] Timing of application is critical. Cobra, Storm, or Ultra Blazer plus 2,4-DB will control Palmer amaranth 3 inches tall or less. Weeds taller than 3 inches will only be suppressed.

[4] Cadre or Pursuit may be included with Cobra, Storm, or Ultra Blazer. Cadre and Pursuit are ALS inhibitors. Because of concerns with weed resistance to ALS inhibitors, a mixture of Cobra, Storm, or Ultra Blazer with Cadre or Pursuit would be preferred over

Cadre or Pursuit alone. However, Cadre and Pursuit have rotational restrictions for cotton.

[5] Sequential applications of 2,4-DB will suppress Palmer amaranth approximately 50%. Gramoxone applied using a roller/wiper applicator will control large Palmer amaranth if 65% or more of the Palmer amaranth plant is wiped. Do not allow Gramoxone to contact peanut foliage.

[6] Generic brands of pendimethalin (Prowl) are available and perform similarly.

[7] Generic brands of metolachlor are available. However, these products may not provide the same length of residual control as Dual Magnum (which contains *S*-metolachlor).

[8] Strongarm is an ALS inhibitor. Because of concerns with weed resistance to ALS inhibitors, Strongarm is suggested only when other non-ALS options are not adequate for the weeds expected.

Table 4-14. General Recommendations on Herbicides to Use in a Comprehensive Weed Management Program for Peanuts

Herbicide	Timing	Should this treatment be used?
Prowl or Sonalan	Preplant incorporated	Yes. These herbicides are relatively inexpensive and provide early season control of grasses and small-seeded broadleaf weeds. Although Prowl can be applied preemergence, it is generally more effective incorporated. Sonalan always needs to be incorporated. These herbicides are an important part of a comprehensive weed management strategy and should always be applied.
Dual Magnum, Outlook, or Warrant	Preplant incorporated or preemergence	Yes. These herbicides are important in suppressing yellow nutsedge, especially Dual Magnum, and provide control of small-seeded broadleaf weeds including pigweeds. While these herbicides do not control weeds for the entire season, they provide good early-season control and are an important foundation of a comprehensive weed management strategy for peanuts.
Valor SX or Strongarm	Preemergence	Yes. Under current situations with increased prevalence of Palmer amaranth and traditional broadleaf weeds such as eclipta, common ragweed, and common lambsquarters, one of these two herbicides is needed in a comprehensive weed management strategy for peanuts. Valor SX provides excellent rotation options for crops grown the following season, while Strongarm will carry over to corn and grain sorghum, and there is some concern about carryover to cotton on some soils. Weeds present, especially Palmer amaranth, that express resistance to Strongarm keep this herbicide from being a complete answer in some fields. Although Valor SX is effective early in the season, the rate used in peanut (2 oz/acre) generally does not control morningglories and will not control other weeds season-long every year.
Paraquat plus Basagran plus Dual Magnum or Outlook	At cracking or early postemergence	Yes. Given that Palmer amaranth is present in many fields and that preplant incorporated and preemergence herbicides often are incomplete in control due to weather conditions or poor incorporation, this treatment (paraquat, with Gramoxone SL being the most prevalent commercial product) can often clean up fields when applied on time, taking pressure off of other postemergence options. Basagaran reduces injury from paraquat. In fields with known histories of Palmer amaranth and other problematic weeds, applying Dual Magnum or Outlook with paraquat plus Basagran will improve early-season weed control. Apply paraquat early in the season, no later than 28 days after peanuts emerge, but preferably within the first three weeks.

Table 4-14. General Recommendations on Herbicides to Use in a Comprehensive Weed Management Program for Peanuts (continued)

Herbicide	Timing	Should this treatment be used?
Cobra, Ultra Blazer, Storm, Basagran	Postemergence	Most likely. These herbicides should be applied as needed. In fact, many if not most peanut fields will need at least one application of these herbicides. Weed size has a major impact on the degree of control obtained with these herbicides. If weeds exceed 3 inches, control is often incomplete. When preplant incorporated or preemergence herbicides are not applied or are marginally effective, growers often have to apply repeat applications of these herbicides (Cobra, Storm, Ultra Blazer). Multiple applications in some cases can negatively affect peanut yield. For this reason growers are encouraged to have a comprehensive program of preplant incorporated and preemergence herbicides to take the pressure off of Cobra, Storm, and Ultra Blazer. Note that Storm does not contain sufficient Ultra Blazer to control Palmer amaranth and other weeds, so adding additional Ultra Blazer to Storm is recommended in some circumstances.
Postemergence grass herbicides (clethodim and sethoxydim are active ingredients in these herbicies)	Postemergence	Most likely. Preplant incorporated and preemergence herbicides often control annual grasses through midseason and sometimes late into the season. However, many fields need a postemergence application of sethoxydim (several formulations) and clethodim (several formulations). These herbicides should be applied as needed because grasses often cause peanut pod loss during the digging process.
Cadre, Pursuit	Postemergence	In many cases. Pursuit is used much less often now than in previous years. Cadre (also formulated as Impose) is a very good herbicide that controls yellow and purple nutsedge, annual grasses in many cases, and a range of broadleaf weeds. The challenge with Cadre is presence of resistant Palmer amaranth and carryover potential to cotton and grain sorghum. Cadre continues to be a good option for peanut growers as long as they realize carryover potential and whether or not resistance to this herbicide is present in certain fields.
2,4-DB	Postemergence	Yes. The broadleaf herbicides mentioned above, with the exception of paraquat, benefit from the addition of 2,4-DB. For example, when Palmer amaranth is slightly larger than the size recommended for complete control by Cobra, Ultra Blazer, or Storm, the inclusion of 2,4-DB can help obtain complete control. 2,4-DB is often effective when applied alone, but this is very species dependent. For example, common cocklebur can be controlled completely by 2,4-DB. 2,4-DB is also a viable option for suppression of escapes of sicklepod and Palmer amaranth when applied sequentially.

5. PEANUT INSECT AND MITE MANAGEMENT

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We know that 2015 was a pretty tough year with big swings in the weather from wet to dry and back to wet again. Caterpillars were a little too abundant at times, but we had plenty of vines for them to feed on except in dry areas where spider mites were serious problems. Thrips were average, and tomato spotted wilt virus (TSWV) was out there, but only a few fields had high levels of incidence. As always, it is important to look at lessons we can learn from the past year, and I will review our standard insect control efforts in this section. **Note that significant changes were made in the insect control recommendations for 2016. Please review them carefully.**

2015 IN REVIEW

Thrips occurred as usual in peanut fields this year, so TSWV was present throughout the areas of production and appeared to be about the same as last year and not a big threat to yield. The continued presence of TSWV in peanuts reminds us to keep using the practices that limit TSWV. Thrips migration into peanut fields was normal and resulted in the typical stunted plants early in the season. Corn earworms and other caterpillars were a problem, with some reports of poor insecticide performance and pyrethroid resistance. These appear to be issues we will need to address. However, we did see a number of fields infested with tobacco budworm, which caused control problems. This is discussed in the next section, “Foliar Insects.” Spider mites were a serious problem in areas that missed the rains in July, August, and September across the peanut production areas. We had some rootworm, cutworm, and wireworm injury in a few areas as well, which we would expect in most years.

FOLIAR INSECTS

Thrips and leafhoppers are usually found in peanut fields. An in-furrow systemic insecticide applied at planting is the most common approach used to reduce seedling damage from thrips and leafhopper damage. A number of caterpillars (usually corn earworm) will also attack peanuts during August and September.

Thrips and TSWV

TSWV incidence was a bit higher but remained much lower than the serious levels we had in 2002. I believe it is safe to assume that this disease is still a threat and can also make a comeback. The incidence of the disease will be influenced by the winter and spring weather and the summer growing conditions. The virus is found in many weeds and even in winter annuals, such as chickweed and henbit, providing an opportunity for the thrips to pick up the virus each spring.

The future of TSWV in North Carolina cannot be predicted. Dr. David Jordan helped coordinate an effort initiated in 2001 and concluded in 2006 to develop management recommendations based upon field research. Our approach was based upon successful efforts in Georgia. One important point to understand is that TSWV does not justify a foliar treatment at midseason. Research in Georgia indicates that follow-up treatments to reduce the virus once it is established in the field are like throwing money away. Studies conducted from 2003 through 2006 confirm this management issue for North Carolina. Our research revealed the following trends for managing TSWV. We saw less virus in VA 98R, NC-V11, and Gregory. More recently, we view Gregory, Georgia Green, and Bailey as the best for reducing the incidence of TWSV. Less virus also occurred in twin-row production and in plots planted at higher seeding rates. At-plant, in-furrow insecticides do help reduce the virus, and Thimet (phorate) appeared to be the most effective insecticide for reducing virus, but it was only slightly better than Temik (aldicarb). Reduced tillage or strip till production also appears to help minimize the level of virus.

Our 2003 through 2006 trials indicate that in most years the earliest-planted and latest-planted peanuts are probably at greatest risk from the virus. We have found that varieties like Perry, which are a little more susceptible to the TSWV, can still be planted with confidence if the grower follows the other practices for reducing virus. Our findings are consistent with the results of testing in Georgia. I am quick to point out, however, that recommended practices help reduce the incidence of virus; they do not eliminate it. Managing TSWV, which outlines a virus index and provides guidance on its management, is found later in this chapter.

Use of Systemic Insecticides

Systemic insecticides are an effective production tool. Over 90% of the North Carolina peanut acreage has been treated annually with phorate (Thimet), imidacloprid (Admire), or acephate (Orthene). This eliminates the need for most foliar insecticides unless worms or mites become a problem in August or September. Systemic insecticides are applied in-furrow at planting as a granular formulation. Temik was discontinued in 2011, and farmers have used alternatives since then. We are always evaluating products and revising the products recommended for at-plant protection. These recommendations include listings of Cruiser (suppression only) and Admire. Cruiser has given us inconsistent results in numerous trials, but Admire has performed quite well in recent studies.

Acephate (Orthene) 97, a spray formulation, allows the use of acephate as an in-furrow spray. This approach has proven successful and offers an additional option for at-plant thrips management. While we observed some delayed emergence in 2011 in fields using acephate in furrow, I am not convinced that other factors didn't play a major role in this. We did not observe this as a common problem in 2012 to 2015, but some concern remains among growers. There has been increasing interest in the use of acephate (Orthene) as an additional foliar spray at about three weeks after planting. Our data often show a favorable yield response from those applications.

When foliar insecticides are used in addition to fungicides, spider mite outbreaks often occur if hot, dry weather persists. The use of systemic insecticides at planting eliminates the need for foliar insecticide treatments for thrips early in the season and for leafhoppers in July, and this practice may decrease the likelihood of mite buildup. Systemic insecticides are not effective against worms; if peanuts are attacked by worms in August and September, foliar sprays may be needed.

On-demand treatments. Integrated pest management focuses on treating only when necessary. At-planting treatments are contrary to that idea. However, the convenience and effectiveness of these in-furrow treatments make most other options less attractive. At-planting treatments provide some peace of mind because growers know that they suppress any potential early-season pests (thrips and leafhoppers). However, such treatments assume that these insect pests will be present in economically damaging numbers. Foliar treatments seem to have less of an impact in reducing the levels of TSWV than at-plant treatments do.

On the other hand, on-demand foliar insecticides are used only when insect populations reach or exceed a predetermined economic threshold. While insect populations are below this level, there is no need to treat; when they exceed the threshold, treatments can be applied to prevent economic damage. Such an approach requires a commitment to an effective scouting program.

Foliar Insecticides

A number of insecticides are labeled for use on peanuts as foliar sprays. Often, only one insecticide is needed for season-long control of foliar peanut insect pests in North Carolina. Growers should check their fields, know the pest situation, and treat only as needed.

Thrips can be serious pests early in the season if at-planting systemic insecticides were not used, but foliar sprays can be effective. The economic threshold for thrips is 25% leaf damage. It is very important to follow this guideline closely. Delaying thrips treatment will still provide control but may not provide any real benefits in plant response.

Potato leafhoppers can also damage peanuts; however, research indicates the economic threshold should be somewhere below 50% leaf damage. Such levels are not commonly seen, but leafhoppers have been more of a problem in recent years, particularly in fields not treated for rootworms.

Several types of caterpillars or "worms" may attack the crop later in the season. The most common is the corn earworm. The threshold for treatment varies with the time of year. Generally, earworms occur in August, and the threshold for treatment is as soon as the worms reach four per row foot. In early September, at least six worms per row foot are necessary to cause economic loss, and by mid-September no treatment is justified unless at least 10 worms per row foot are seen. My experience tells me that the "old" thresholds are too low for today's varieties. I think that at least six worms per row foot is probably a better threshold to use. Danitol, an insecticide for corn earworms and spider mites, showed good effectiveness against fall armyworms as well as earworms, spider mites, and leafhoppers in one test. In recent years we have seen more variety in the worm complex that attacks peanuts and more beet and fall armyworms. These are more difficult to control, and it is important to get species identification and to select the proper product. Fall armyworms have been very common in recent years, but their damage is less than that of corn earworms. Fall armyworms damage the leaves with what I call an "onion skin" appearance. In 2014 and 2015 we saw tobacco budworms in peanuts, usually in fields that had been sprayed for earworms and the grower noticed poor control. Budworms are harder and more expensive to control than earworms. This has caused some growers to think we are having insecticide resistance problems. While corn earworms are showing more resistance to pyrethroid insecticide use in peanuts, there is more going on than just modest resistance. We are going to keep monitoring the species each year before we make any major adjustments to our control recommendations.

Application of Foliar Sprays

Calibrate the sprayer accurately to ensure application of the recommended amounts of insecticides. Check the calibration periodically during the season.

Spray for thrips, leafhoppers, corn earworms, fall armyworms, and other foliar-feeding insects on peanuts with hollow-cone or solid-cone nozzles at a minimum of 40 psi and a total of 10 to 15 gallons per acre. Low-volume sprays are ineffective for spider mite control. Apply a minimum of 25 gallons of spray per acre for this pest, with adequate pressure for the nozzle setup on the sprayers. Many growers combine spider mite treatments with their leafspot fungicide application. Spray volume commonly used for fungicide application (12 to 14 gallons per acre) may not be sufficient for good mite control. Change nozzles or slow down if past experience has given poor results.

Use flat fan nozzles to apply a minimum of 20 to 40 gallons of spray per acre directed at the base of the plant for lesser cornstalk borer control. Low gallonage applications for lesser cornstalk borer are an absolute waste of time! Concerns were expressed in 2010 about potential insecticide resistance in the caterpillar populations in North Carolina peanut fields. Dr. Ames Herbert at Virginia Tech tested for resistance in 2011 and saw little evidence of a problem, but in 2015 the resistance levels did increase and showed slight increases over 2014. This is not a big concern at this time, but we will monitor resistance in the future and watch carefully for the presence of tobacco budworms in the field, which are more difficult to control. Changes in resistance and in budworm populations could force us to use more expensive products in the future.

Spider Mites

Spider mites were a major problem for peanut farmers in 2010, 2011, and 2015 due to hot and dry weather throughout the peanut growing areas, but they were much less of a problem in 2012, 2013, and 2014 due to plenty of rainfall. While problems with spider mites usually worsen when certain fungicides and insecticides are used, the overwhelming effect of hot and dry weather caused spider mite problems — despite our best efforts to minimize their populations. The use of a leafspot advisory system rather than a calendar approach to fungicide sprays has been documented to help reduce mites in peanuts. Suggestions for reducing the threat of spider mites are listed in the control recommendations at the end of this chapter. The use of Lorsban can also increase the likelihood of spider mite outbreaks. Check peanut fields frequently for spider mites during late July and August, especially if they are next to cornfields.

Options for control of spider mites are limited to two miticides at this time: Comite and Danitol. Therefore, it is important to scout fields and use a spray only when necessary. Spider mites have a great ability to develop resistance, and until new materials are available, we run the risk of resistance developing to our only available miticides. It is important to remember that like peanut disease problems, spider mites are very much regulated by the weather, as we observed this past year. Therefore, it is important to look at management of this pest in much the same way one looks at managing a disease. Unlike caterpillars, for example—which, once treated, are generally gone for the year—spider mites have the ability to bounce back in hot, dry weather.

It is important to note, however, that controlling mites usually requires two applications. Treating one time often will not stop a spider mite problem because Comite or Danitol will not kill the eggs. If you find the infestation very early, one application may be effective, but usually we don’t see the mites until damage and populations are high. Unless it rains, mites almost certainly will come back with a vengeance in a couple of weeks. Using one spray and taking a wait and see approach is often not best unless the problem is caught very early in the season before a lot of eggs are present. With the two-spray technique, the first spray gets the mites already present, and the second gets all the mites that have hatched from the eggs present during the first spray. It is also important to note that using your leafspot spray set-up may not provide good enough coverage to get a high level of mite control. Higher pressure and higher volumes are often required. Keep the practices that reduce mite outbreaks at the forefront because they have served us well over the past 10 to 20 years.

Some formulations of bifenthrin, such as Brigade, have a label for spider mite control in peanuts. They are not on my list for spider mite control for one main reason. Bifenthrin is very active against beneficial insects. While this insecticide will do a good job on mites, it does have a tendency, under continuing hot and dry weather, to allow for a more rapid resurgence of the mites. I don't like to see it used before late summer. Bifenthrin, in my opinion, is best suited as a cleanup spray later in the season, when there is less chance of a resurgence of the mites.

SOIL INSECTS

The southern corn rootworm is one of the most troublesome insects for peanut producers. Whereas pests like caterpillars, thrips, and spider mites can cause severe damage that is often quite obvious above the ground, rootworms feed below the soil surface.

Beginning in late July and continuing through August, beetles lay eggs in the peanut field. Egg-laying and the survival of these eggs depend on the soil being moist. If the soil is hot and dry, many eggs will not hatch. Rootworm beetles lay most of their eggs in the soil near the base of the plant. The soil stays wetter there than in the row middles. Adequate rainfall in late July and early August can result in rootworm infestation, and most areas had good rains in late summer. Rootworms often damage irrigated fields. Heavier soils also are more likely to have rootworm problems. The heavier the soil, the better its water-holding ability, so this soil is more likely to have the moisture rootworms need for survival. However, this does not mean that sandy soils can't have rootworm problems. If the soil moisture is adequate, rootworms can occur in almost any field.

Management Decisions

The standard management approach for rootworms is an at-pegging granular insecticide application in a band over the row. Dr. Ames Herbert at Virginia Tech and I developed a southern corn rootworm advisory, which is shown later in this chapter. This index relies on soil type to help make a good decision about treatment. Heavier soils are more of a risk, for reasons already discussed. Any soils referred to as "stiff land" probably should be treated. Fields under irrigation run a greater risk from rootworms because higher soil moisture favors egg laying, egg hatch, and rootworm survival. Early maturing varieties can sometimes escape the damage. David Jordan and I also made a couple of new categories in the index based upon irrigation.

Monitoring the soil moisture doesn't offer much help for decision making. The critical time for adequate soil moisture to ensure rootworm survival is early August. But treatments need to be applied before the grower knows if soil moisture is going to be adequate. Even if an at-pegging preventive treatment is applied and the conditions that follow do not encourage a rootworm outbreak, some benefits are still derived from the application. These insecticides protect the crop from leafhoppers, offer some white mold suppression, and give some protection should any cornstalk borers and cutworms be present.

Remember, however, that this is not a blanket recommendation to treat every acre of peanuts with a rootworm insecticide. Treat those fields that are high risk or those in which problems have occurred in the past. The use of rootworm insecticides can increase the likelihood of spider mite outbreaks, which is another good reason to avoid the unnecessary use of such products. As production has moved to the more southern counties, the soil types found there have made problems with rootworms in peanut much less than 20 years ago.

Treatment and Application Options

Rootworm treatments are usually applied after July 4 with ground equipment using properly calibrated hopper boxes to place the insecticide in a 16- to 18-inch band over the row. This provides an important zone of protection around the developing pods. Check the height of the bander over the row, and make sure that the granules are striking the top of the foliage in at least an 8- to 10-inch band. Granules falling down through the plant should be distributed in a 16- to 18-inch band. Research has shown that light incorporation of the insecticide improves its performance. However, this is often difficult, as the row middles may be closed when the materials are applied.

Insecticides can be applied any time from mid-June to the first of August. Treatments applied after August 5 may not prevent some of the early-hatching larvae from feeding on pods. Once the larvae hatch and begin feeding, an insecticide treatment is not effective. If growers wait until the end of the first week in August to determine if there was adequate soil moisture to allow a rootworm infestation, it may be too late for the treatment to achieve sufficient control. NC State University studies have shown that treatments after the first week of August do very little to protect pods from rootworm damage (see section titled "Application after August 1").

Two modified approaches to rootworm control can be used with favorable results, but growers must understand the risks involved. With these two options, growers can save a few dollars or gain additional benefits from rootworm treatment, but they may also increase their risk of crop loss. It is also important to keep in mind that we have observed a few isolated fields in which chlorpyrifos (Lorsban and generics) has failed to prevent rootworm damage. We have been studying these situations for several years, and while we do not yet know why this happens, there are some fields where Lorsban does not work at all. We believe these are isolated occurrences and do not apply as a general rule for how well Lorsban and the generics of chlorpyrifos work against rootworms. Our trials have demonstrated that in fields where chlorpyrifos performs poorly, increasing the rate does not improve performance.

Early Application

Many growers have considered the early application of their rootworm insecticides. This early application would be at flowering, or approximately mid-June, rather than at pegging (mid-July). There are several possible advantages to this early application. First, growers begin gaining the benefits of leafhopper control much earlier. In addition, some products offer white mold suppression. Earlier application would also mean the middles are more open, and fewer vines would be run over with the standard four-row equipment used for granular application. One final benefit would be that some products might offer some lesser cornstalk borer protection should conditions be extremely dry in late June and July. However, I want to point out that over the last three years we have observed some situations in heavier soils where the early application has not performed as well. We are doing more research on this, but it has caused me to be a little more cautious about recommending early application.

Application after August 1

The option for rootworm control other than the standard pegging-time treatment is a delayed treatment. This delayed treatment is often not intentional but rather the result of wet weather in July that delayed the ground application. If the application of rootworm insecticides is delayed until after August 1, there are risks involved. First, the middles will be more closed, so the use of ground equipment will crush more vines. Most importantly, the insecticide must be applied by August 5. Any delay beyond this date may allow rootworms to begin feeding on pods and do significant damage. Although you wouldn’t plan this delay, it can often happen if we get substantial rainfall in the first week in August and the soil is too wet to run ground equipment across the field. As a general rule, I do not recommend planning to treat for rootworms after August 1 simply because I've seen too many situations where it rained and treatment was delayed beyond the date for which it would have still provided an economic benefit.

PREVENTING INSECT AND MITE PROBLEMS

Many things can be done to help prevent damaging insect and mite infestations. Where possible, consider the following suggestions:

1. Do not treat on a schedule or because a neighbor is spraying.
2. Scout fields and treat only as needed around fields in fall or early spring.
3. Maintain an area clear of weeds and briars around fields during the early growing season. Do not mow weeds around fields from late June through early September.
4. To reduce the probability of spider mite buildup, avoid using foliar insecticides in July and August unless needed to control damaging insect infestations. The fewer insecticide applications used, the lower the probability of creating a pesticide-induced outbreak of mites. Using the leafspot advisory for leafspot applications will help reduce the likelihood of spider mite outbreaks. Avoid unnecessary applications for rootworms.
5. Avoid moving workers and equipment from mite-infested areas to noninfested areas.
6. Avoid planting peanuts immediately adjacent to fields of sweet corn. Spider mite populations often disperse into peanuts as the corn matures.

Safe Use

Phorate (Thimet) and methomyl (Lannate) are extremely toxic to people, animals, and fish. Some other products are toxic to fish. Always carefully read and observe all safety precautions on the label when handling or applying these materials. Use only insecticides labeled and recommended for peanuts. Follow suggestions on dosage and time of application to avoid residues. See North Carolina Cooperative Extension publication AG-463-5, *Pesticides and Wildlife— Peanuts*, for additional information on minimizing pesticide impact on wildlife.

INSECT CONTROL ON PEANUTS

Table 5-1. Insect Control on Peanuts (PHI = preharvest interval)

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
SEASONAL CONTROL OF THRIPS AND LEAFHOPPERS		
Thrips at Planting		
acephate (Orthene 97) (generics available)	0.75 to 1 lb	Apply as in-furrow spray in 3 to 5 gallons of water per acre. State (24c) label must be in possession at time of application.
phorate (Thimet) (generics available)	5.0 lb of 20% granules	
Imidacloprid (Admire Pro)	7.0-10.5 fl oz	In furrow spray during planting, directed on or below seed.
Thiamethoxam + Mefenoxam + Fludioxonil + azoxystrobin (Cruiser Maxx Peanuts)	treated peanut seed	Suppression only
Thrips foliar postermergence		
acephate (Orthene) 97 (generics available)	0.375 to 0.75 lb	Do not feed or graze livestock on treated vines. Apply 10 to 50 gallons spray solution per acre to foliage. Do not apply more than 4.125 pounds per acre (4 pounds a.i. per acre) per season.
Beta-cyfluthrin (Baythroid XL)	2.8 oz	
Bifenthrin (Brigade)	2.1-6.4 fl oz	Pre-harvest interval of 14 days.
CONTROL OF SPECIFIC PESTS		
Beet Armyworm		
Bacillus thuringiensis (Xentari)	0.5 to 2 lb	Apply to small caterpillars. Use highest rate for larger worms or high populations; 0 day harvest restriction.
methomyl (Lannate LV)	0.75 to 3 pt	Apply broadcast in sufficient water for good coverage when worms are small. Do not apply within 21 days of harvest. See fall armyworm for additional restrictions.
indoxacarb (Steward)	9.2 to 11.3 oz	Do not apply more than 45 ounces per acre per crop. 14-day preharvest interval.

Table 5-1. Insect Control on Peanuts (PHI = preharvest interval)

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
Beet Armyworm (continued)		
spinosad (Blackhawk)	1.5 to 3 fl oz	Do not apply more than 9 fluid ounces per season or make more than three applications. 3-day preharvest interval.
Flubendiamide (Belt)	2.0-4.0 fl oz	
Bifenthrin (Brigade)	2.1-6.4 fl oz	Pre-harvest interval 3 days, Do Not apply more than 4.0 fluid ounces in 7 day interval or more than 12.0 ounces per cropping season
Chlorantraniliprole (Prevathon)	14.0-20.0 fl oz/A	Pre-harvest interval of 14 days. Make no more than 4 applications per crop per year.
Corn Earworm, Southern Armyworm, Green Cloverworm, Velvetbean Caterpillar		
acephate (Orthene) 97 (generics available)	0.75 to 1 lb	Do not feed or graze livestock on acephate-treated vines. Do not apply within 14 days of harvest (digging).
Bacillus thuringiensis		For velvetbean caterpillar control only. Apply to small caterpillars and use highest rate for larger worms and/or high populations; 0 day harvest restriction. Xentari also controls southern armyworm.
(Dipel DF)	0.5 to 2 lb	
(Dipel ES)	1 to 2 pt	
(Xentari)	0.5 to 2 lb	
esfenvalerate (Asana XL)	2.9 to 5.8 oz	Do not feed Asana-treated vines or graze livestock on treated plants.
fenpropathrin (Danitol) 2.4 EC	10.67 to 16 fl oz	Do not exceed 2.67 pints per acre per season. Use 10 to 50 gallons per acre by ground and 5 to 10 gallons per acre by air. Repeat no more often than every 7 days. Do not apply within 14 days of digging and do not feed or graze vines within 14 days of last application.
indoxacarb (Steward)	9.2 to 11.3 oz	Do not apply more than 45 ounces per acre per crop. 14 day preharvest interval. For corn earworm.
lambda-cyhalothrin (Karate Z)	1.28 to 1.92 oz	Do not feed or graze livestock on Karate-treated plants.
methomyl (Lannate LV)	0.75 to 3 pt	Apply to foliage when four or more worms are present per foot of row and preferably when worms are small. Do not apply methomyl within 21 days of harvest. Do not feed methomyl-treated vines to livestock. Use minimum of 3 gallons of water for aerial application.

Table 5-1. Insect Control on Peanuts (PHI = preharvest interval)

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
Corn Earworm, Southern Armyworm, Green Cloverworm, Velvetbean Caterpillar (continued)		
spinosad (Blackhawk)	2 to 3 fl oz	Do not apply more than 9 fluid ounces per season or make more than three applications. 3-day preharvest interval.
Flubendiamide (Belt)	2.0-4.0 fl oz.	Pre-harvest interval 3 days, Do Not apply more than 4.0 fluid ounces in 7 day interval or more than 12.0 ounces per cropping season.
Bifenthrin (Brigade)	2.1-6.4 fl oz	Pre-harvest interval of 14 days.
Chlorantraniliprole+ lambda-cyhalothrin (Besiege)	6.0-10.0 fl oz/A	Pre-harvest interval 14 days. Do not exceed a total of 31 fluid ounces of Besiege per acre per year.
Chlorantraniliprole (Prevathon)	14.0-20.0 fl oz/A	Make no more than 4 applications per crop per year.
Cutworm		
chlorpyrifos (Lorsban) 15 G	1.33 lb	Apply in 16- to 18-inch band over row when infestation is first seen. May be applied by air. Do not graze or feed immature crop to livestock.
esfenvalerate (Asana XL)	5.8 to 9.6 oz	Do not feed treated vines to livestock.
indoxacarb (Steward)	9.2 to 11.3 oz	Do not apply more than 45 ounces per acre per crop. 14 day preharvest interval.
lambda-cyhalothrin (Karate Z)	0.96 to 1.6 oz	Do not use treated vines or hay for animal feed.
methomyl (Lannate LV)	1.5 to 3 pt	Do not apply within 21 days of harvest. Do not feed treated vines to livestock.
Flubendiamide (Belt)	2.0-4.0 fl oz	Pre-harvest interval 3 days, Do Not apply more than 4.0 fluid ounces in 7 day interval or more than 12.0 ounces per cropping season
Bifenthrin (Brigade)	2.1-6.4 fl oz	Pre-harvest interval of 14 days.
Chlorantraniliprole + lambda-cyhalothrin (Besiege)	5.0-8.0 fl oz/A	Pre-harvest interval 14 days. Do not exceed a total of 31 fluid ounces of Besiege per acre per year.

Table 5-1. Insect Control on Peanuts (PHI = preharvest interval)

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
Fall Armyworm		
acephate (Orthene) 97 (generics available)	0.75 to 1 lb	Do not apply within 14 days of harvest (digging). Do not feed or graze livestock on vines treated with acephate. Apply 10 to 50 gallons spray solution per acre. Do not apply more than 4.13 pounds per acre (4 pounds a.i. per acre per season).
fenpropathrin (Danitol) 2.4 EC	10 2/3 to 16 fl oz	Do not exceed 2.67 pints per acre per season. Repeat no more often than every 7 days. Do not apply within 14 days of digging and do not feed or graze vines within 14 days of last application.
indoxacarb (Steward)	9.2 to 11.3 oz	Do not apply more than 45 ounces per acre per crop. 14 day preharvest interval.
lambda-cyhalothrin (Karate Z)	1.28 to 1.92 oz	
methomyl (Lannate LV)	0.75 to 1.5 pt	Effective against all sizes of worms. Use minimum of 3 gallons of water for aerial application. Do not apply within 21 days of harvest. Do not feed methomyl-treated vines to livestock.
spinosad (Blackhawk) Flubendiamide (Belt) Bifenthrin (Brigade) Chlorantraniliprole+lambda-cyhalothrin (Besiege) Chlorantraniliprole (Prevathon)	2 to 3 fl oz 2.0-4.0 fl oz 2.1-6.4 fl oz 6.0-10.0 fl oz/A 14.0-20.0 fl oz/A	Do not apply more than 9 fluid ounces per season or make more than three applications. 3-day preharvest interval. Pre-harvest interval 3 days, Do Not apply more than 4.0 fluid ounces in 7 day interval or more than 12.0 ounces per cropping season Pre-harvest interval of 14 days. Pre-harvest interval 14 days. Do not exceed a total of 31 fluid ounces of Besiege per acre per year. Make no more than 4 applications per crop per year

Table 5-1. Insect Control on Peanuts (PHI = preharvest interval)

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
Leafhoppers		
acephate (Orthene) 97 (generics available)	0.75 to 1 lb	See remarks under Thrips.
esfenvalerate (Asana XL)	2.9 to 5.8 oz	Do not feed livestock Asana-treated vines or graze livestock on treated plants.
fenpropathrin (Danitol) 2.4 EC	6 to 10.67 fl oz	Do not exceed 2 2/3 pints per acre per season. Repeat no more often than every 7 days. Do not apply within 14 days of digging and do not feed or graze vines within 14 days of last application.
Chlorantraniliprole+lambda-cyhalothrin (Besiege)	6.0-10.0 fl oz/A	
lambda-cyhalothrin (Karate Z)	0.96 to 1.6 oz	Do not use treated vines or hay for animal feed.
methomyl (Lannate LV)	0.75 to 3 pt	Do not apply within 21 days of harvest. Do not use treated vines as feed.
Bifenthrin (Brigade)	2.1-6.4 fl oz	Pre-harvest interval of 14 days.
Lesser Cornstalk Borer		
chlorpyrifos (Lorsban, Pilot) 15 G (generics available)	7 to 14 lb	
Chlorantraniliprole+lambda-cyhalothrin (Besiege)	10.0 fl oz/A	Pre-harvest interval 14 days. Do not exceed a total of 31 fluid ounces of Besiege per acre per year.
Chlorantraniliprole (Prevathon)	14-20.0 fl oz/A	See label
Southern Corn Rootworm		
chlorpyrifos (Lorsban, Pilot) 15 G (generics available)	13.3 lb	Apply in a 16- to 18-inch band over the row just before pegging.
phorate (Thimet) 20 G (generics available)	10 lb	

Table 5-1. Insect Control on Peanuts (PHI = preharvest interval)

Insecticide and Formulation	Amount of Formulation Per Acre	Precautions and Remarks
Spider Mite		
propargite (Comite) 73 L	2 pt	Apply in at least 25 gallons of water per acre. Spider mite outbreaks are less likely to develop if foliar insecticides are not used during July and August and copper fungicides are used for Cercospora leafspot. Do not apply propargite within 14 days of harvest.
fenpropathrin (Danitol) 2.4 EC Bifenthrin (Brigade)	10.67 to 16 fl oz 5.1-6.4 fl oz.	Do not exceed 2.67 pints (42 2/3 fluid ounces) per acre per season. Use 10 to 50 gallons per acre by ground and 5 to 10 gallons per acre by air. Repeat no more often than every 7 days. Do not apply within 14 days of digging and do not feed or graze vines within 14 days of last application. Pre-harvest interval of 14 days.

MANAGING TOMATO SPOTTED WILT VIRUS IN PEANUTS IN NORTH CAROLINA AND VIRGINIA

Thrips transmit TSWV when they feed on peanut plants. Although most of the virus is transmitted early in the season when thrips are most abundant, thrips can transmit the virus throughout the season. Even though very little damage from thrips might be noticed because insecticides kill thrips, the virus is transmitted to the peanut plant rapidly before the thrips are killed with systemic insecticide.

A wide range of plants, both crops and weeds, are hosts for the virus and for the thrips that transmit it. Thrips must acquire the virus by feeding on infected host plants. Thrips feed and overwinter in and among many plants. During the spring while peanut plants are emerging, the thrips move into fields, feeding on peanut plants and transmitting disease.

Even though it seems logical that killing many of the plants that harbor thrips and virus in areas adjacent to peanut fields will reduce levels of virus in peanut, thrips can enter fields from great distances. Depending on wind currents and weather patterns, thrips from many miles away can land and feed on peanuts and subsequently transmit the virus. Efforts to kill all of the vegetation adjacent to peanut fields most likely will not reduce virus in peanuts.

There are no control practices that can be implemented to reduce the virus after peanuts are planted. The major factors that influence the level of virus in peanut — including variety selection, planting date, plant population, in-furrow insecticide, row pattern, and tillage system — are considered and implemented prior to planting. Poor and inconsistent emergence of peanuts and establishment of spotty peanut stands increase incidence of TSWV regardless of variety selection, planting date, insecticide choice, and tillage system. Establishing optimum plant stands is critical in managing this pest.

An insect management program that effectively controls thrips will lower the amount of TSWV. Unlike many of the other pests found in peanuts, considerable variation in response to management strategies occurs and should be expected. Weather conditions that influence populations of thrips, the vector for this virus, and their subsequent arrival in fields can vary considerably from year to year. Variation in strains of the virus and the ability of the virus to adapt also contribute to variations in response.

Some production practices can be implemented with no additional equipment investment. These variables include planting date, variety selection, seeding rate, and insecticide selection. Planting peanuts in twin rows or in reduced tillage systems may require equipment purchase. The strengths and weaknesses of each input must be considered when developing a TSWV management program. Contact your local Cooperative Extension agent for additional information on developing pest management and production systems for peanuts grown in North Carolina.

Table 5-2. Advisory Index for Managing TSWV in North Carolina Peanuts

Peanut Variety	Points	Score
Sugg, CHAMPS	30	
Georgia 06G, Florida 07, Gregory, Bailey	20	
Georgia 06G and Florida 07 are runner market types. CHAMPS, Sugg, Gregory, and Bailey are Virginia market types. While not shown here, other runner market type varieties as well as Virginia market types developed in the southeastern U.S., where TSWV is more common, often express elevated resistance to TSWV but have not been thoroughly evaluated In North Carolina. Seed for large- seeded varieties require more pounds to achieve optimum plant stands, resulting in greater expense compared with small-seeded varieties. Growers are tempted to reduce seeding rates below recommended levels. Low planting rates may negate any benefits of partial resistance to TSWV.		
Planting Date	**Points**	**Score**
Prior to May 6	20	
May 6-15	10	
After May 15	15	
In absence of spotted wilt, higher yields are often obtained when peanuts are planted prior to May 15. Crop maturity can be affected by many factors. Planting a late-maturing variety end of May to avoid spotted wilt may result in lower yields and market grades because pods do not have sufficient time and heat units to adequately mature.		
Plant Population (actual, not projected, stand)	**Points**	**Score**
2 or fewer plants per row foot	25	
3 to 4 plants per row foot	15	
5 or more plants per linear foot of row	5	
Seed size and count per pound should always be considered when planting Virginia market type peanuts. The varieties and seeding rates in pounds per acre (listed in parentheses) needed to establish a plant population of 4 plants per row foot assuming 80% germination (planting 5 seeds per row foot to get 4 plants per row foot): Georgia 06G and Florida 07 (110 lb/acre); CHAMPS, Bailey, Sugg, and Sullivan (126 lb/ acre), and Wynne (161 lb/acre). Actual seed count and germination can vary by year and lot. Consider the characteristics of the peanut seed you have purchased when setting your planter. For twin rows, the final plant population per linear foot of row is the sum of individual twin rows.		

Table 5-2. Advisory Index for Managing TSWV in North Carolina Peanuts

Insecticide/Nematicide	Points	Score
None Orthene early postemergence and Cruiser Maxx Admire Pro, or Orthene in-furrow Thimet 20G or Phorate 20G in-furrow	25 20 10 5	
The influence of insecticide on TSWV should not be the overriding consideration for selection. Also consider effectiveness against thrips, injury potential from insecticides, cost of treatment, and possible interactions of insecticides with herbicides.		
Tillage	**Points**	**Score**
Conventional tillage Strip tillage into killed cover crop or previous crop residue	10 5	
Research in North Carolina and Virginia has shown lower yields on average when peanuts are seeded into stubble from the previous crop. Establishing beds in the fall, seeding a cover crop, and then strip tilling peanuts into the killed cover crop has been the most effective reduced tillage system, with yields from this approach similar to yields in conventional tillage systems. Yield potential has been more difficult to maintain on finer-textured soils when peanuts are strip tilled into the stubble from the previous crop and little or no bed is present. Using reduced tillage exclusively to manage TSWV is not recommended.		
Total Score		
Less than 60, low risk; 65-85, moderate risk; greater than 90, high risk		

Examples of the Advisory Index

All management options designed to minimize TSWV:

Plant the variety Bailey (20 points) after May 5 but before May 16 (10 points) in strip tillage (5 points) at a plant population of 5 plants per row foot (5 points) using Thimet 20G in-furrow (5 points).
Advisory index = 45 (low risk)

No management options designed to minimize TSWV:

Plant the variety Sugg (30) before May 5 (25) in conventional tillage (10) at a plant population of 2 plants per row foot (25) using no in-furrow insecticide (25).
Advisory index = 115 (high risk)

Compromise situation—Finer-textured soil with history of Sclerotinia blight and CBR:

Plant the variety Sugg (30) between May 6 and 15 (10) in conventional tillage (15) at a plant population of 5 plants per foot of row (5) using Phorate 20G in-furrow (5).
Advisory index = 65 (moderate risk)

Compromise situation—Coarse-textured soil with history of Sclerotinia blight in the extreme northern range of North Carolina production:

Plant the variety Bailey (20) prior to May 5 (25) in strip tillage (5) at a plant population of 5 plants per foot of row (5) using Orthene in-furrow (10).
Advisory index = 65 (moderate risk)

Table 5-3. One-Minute SCR Field Index Score

Soil texture	**Points**	**Score**
Loamy sand	5	
Fine sandy loam	10	
Loam	15	
Drainage class	**Points**	**Score**
Well drained	5	
Moderately well drained	10	
Somewhat poorly drained	15	
Poorly drained	20	
Field history of rootworm damage	**Points**	**Score**
None	0	
Low	5	
Moderate	10	
High	15	
Planting date		
Before May 1	5	
May 2-May 15	10	
After May 15	15	
Cultivar resistance	**Points**	**Score**
CHAMPS	10	
Wynne, Bailey, Sugg, Florida 07, GA 06G	20	
Irrigation	**Points**	**Score**
No irrigation	0	
Periodic irrigation or frequent rainfall	20	
Intensive Irrigation	45	
Total score		

MANAGING PEANUT ROOTWORM

Peanut Rootworm Advisory: What's the risk of SCR in your fields?

70 or above **High risk** **Treatment needed**

Treat high-risk fields with rootworm insecticides from about June 20 to July 10. All irrigated fields should be treated.

55 to 65 **Moderate risk** **May not need treatment**

Treatment decisions for moderate-score fields depend on additional factors, such as weather and land-lease requirements. In many moderate-score fields, especially those at the low end of the range, rootworm damage does not reach economically damaging levels. In most years, pod damage in moderate-risk fields is not likely, so treatment may not provide an economic return and may, in fact, help create a spider mite problem. All irrigated fields should be treated.

50 or less **Low risk** **No treatment needed**

Irrigation or wet weather may make rootworm problems worse. Always treat irrigated fields. Rainfall patterns are unpredictable, and growing seasons can occasionally experience rainfall throughout the entire season that equals and in some cases exceeds intensive irrigation, with 2014 being a prime example. The decision to apply insecticide for SCR is made in late June and throughout early to mid-July to be most effective. When rainfall patterns are similar to those in 2014, fields that register low to moderate risk of SCR can actually be at greater risk because of the excessive and uniform moisture in soil. The SCR index during the vast majority of years is reliable because rainfall tends to be more sporadic and dry weather occurs periodically throughout the growing season in absence of irrigation.

Can You Count on the SCR Advisory?

The SCR advisory was tested on 436 commercial peanut fields in Virginia and North Carolina from 1989 to 2002. Farmers who followed the advisory recommendations were protected 96.5% of the time; 3.5% of the fields examined had damage above the SCR threshold.

Was the SCR Advisory Index Tested Near You?

The SCR Index was tested on farmer fields in these North Carolina counties: Bertie, Bladen, Chowan, Edgecombe, Gates, Halifax, Martin, Northampton, Perquimans, and Pitt. It was also tested in the following Virginia locations: Dinwiddie, Greensville, Isle of Wight, Prince George, Southampton, Suffolk, Surry, and Sussex.

What Are the Keys to Fields with Low Scores?

- Resistant cultivars. The early-maturing pods of CHAMPS are not as susceptible to rootworm attack during the peak pest pressure in late July and early August.
- Good drainage and sandy soils. SCR larvae prefer moist soils. Irrigation, high loam content, and poor drainage increase the risk of damage. Always treat irrigated fields.
- Early planting. Early planting reduces risk because pods tend to mature before rootworm feeding.
- Known history. Base your estimate on experience in previous years with damage levels in areas of the field not treated with insecticide. If fields have always been treated, estimate a moderate level of damage.

For more information about the SCR Advisory, contact your county Extension agent.

6. PEANUT DISEASE MANAGEMENT

Barbara Shew
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This chapter provides details about how to use integrated methods to manage major peanut diseases. Selection and integration of appropriate rotations, cultivars, cultural methods, and chemical controls can help growers maintain a healthy crop and attain high yield potential while minimizing expensive inputs.

IDENTIFYING DISEASES

Before you take steps to manage a disease, it must be identified correctly. This chapter describes the characteristic symptoms of peanut diseases commonly found in North Carolina. Photos of these diseases can be found online at **plantpathology.ces.ncsu.edu/pp-field-crops/pp-field-crops-peanuts/**.

Symptoms caused by cultural problems can be mistaken for diseases, but cultural problems will not respond to fungicide applications and other disease control practices. The time and pattern of symptom appearance can help you separate diseases from cultural and insect problems. Diseases typically build slowly and are found in clusters or hot spots during early stages of development. In contrast, symptoms of nutritional problems, excess moisture, drought stress, and chemical injury usually appear quickly in regular or widespread patterns.

Contact your county Extension agent for help with problem diagnosis, or submit samples to the NC State Plant Disease and Insect Clinic (**www.ncsu.edu/pdic**).

FIELD HISTORY, SCOUTING, AND WEATHER-BASED ADVISORIES

Know the disease and rotation history of each field so that you can select the most appropriate management tactics and crop protection products. Careful record keeping is vital because some disease management choices, such as rotation and cultivar selection, must be made before planting. During the season, keep detailed records of the specific diseases observed, when they appeared, and where they were found. Save these records as guides for future pest management decisions (Table 6-1). The Peanut Risk Management website (**www.peanuts.ncsu.edu/ riskmgmt**) can help you see how different field histories and management decisions affect overall risks of disease in peanut production.

Careful scouting can help you find disease, insect, or weed problems when they are easiest to control and before they become serious. Scouting also can alert you to any pesticide application errors and other cultural problems. Begin scouting for disease no later than early pegging and continue weekly until digging.

Because we have very limited ability to cure diseases, effective management often depends on anticipating disease outbreaks even before symptoms are apparent. Weather has a profound effect on disease problems, and weather-based disease advisories can help to identify periods when disease outbreaks are likely. Following advisories can minimize unnecessary pesticide use and add precision to the applications that are necessary. Contact your county Extension agent to receive daily peanut disease advisories by email.

ROTATION

Rotations of three to four years or more are the most effective way to avoid disease problems. The fungi, bacteria, nematodes, and viruses that cause peanut diseases need to survive during times when peanuts or other host plants are not growing. The longer a pathogen goes without a host, the more likely it is to die, thus lowering the population of surviving pathogens. Rotation is most effective against pathogens that are not very mobile and those that have no host other than peanut. Not all rotation crops are equally effective in reducing disease risk (Table 6-2). In general, rotations with crops in the grass family, including corn, small grains, and sorghum, are the most effective because these plants are not hosts to most peanut pathogens. Rotations with cotton are beneficial for both crops. Soybeans and peanuts have many diseases in common so peanut-soybean rotations increase disease risk in both crops and should be avoided. When it is necessary to include soybeans in the rotation scheme, plant them AFTER peanut and extend rotations as long as possible. Double cropping with a small grain also will reduce risk. Be aware that adding a new crop to your usual rotation has the potential to change the risk of disease problems.

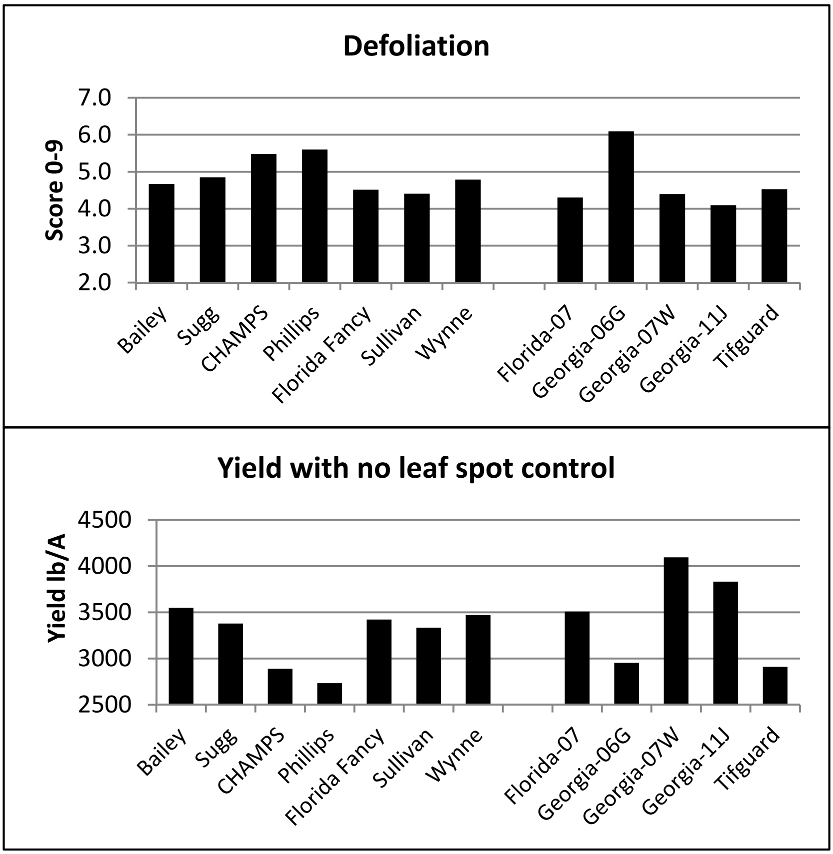
RESISTANCE

Using a resistant cultivar is very cost-effective: it costs little or nothing extra while reducing inputs and preserving yield. Always consider planting a resistant cultivar and avoid highly susceptible ones in fields with a history of disease problems. No peanut cultivar is immune to disease, but cultivars range in resistance to major diseases, from highly susceptible to moderately resistant (Figure 6-1). Among Virginia types,the cultivars Bailey and Sugg have good resistance to several diseases. Data from the NC State breeding program show that the new high oleic cultivars Sullivan and Wynne also have resistance to one or more diseases. In general, runner cultivars are less susceptible to most diseases than Virginia types, but there are exceptions with certain diseases and cultivars (Figure 6-1).

CULTURAL PRACTICES

Planting date, bedding, sanitation, soil fertility and pH, growth regulators, and irrigation can affect severity of peanut disease problems. The most favorable cultural practices for individual diseases are discussed below. More generally, good agronomic practices are an essential part of disease management because peanuts are less prone to infection and yield loss from disease when they are not stressed. On the other hand, irrigation and lush growth in unstressed plants can favor development

Figure 6-1. Disease Responses of Peanut Cultivars in North Carolina Breeding Trials[1]



[1] Data from Dr. Tom Isleib. Cultivars were evaluated in plots managed to create conditions highly favorable for each disease. Results are means across all years of testing. Ratings for runner cultivars may be less reliable than for others due to low trial numbers.

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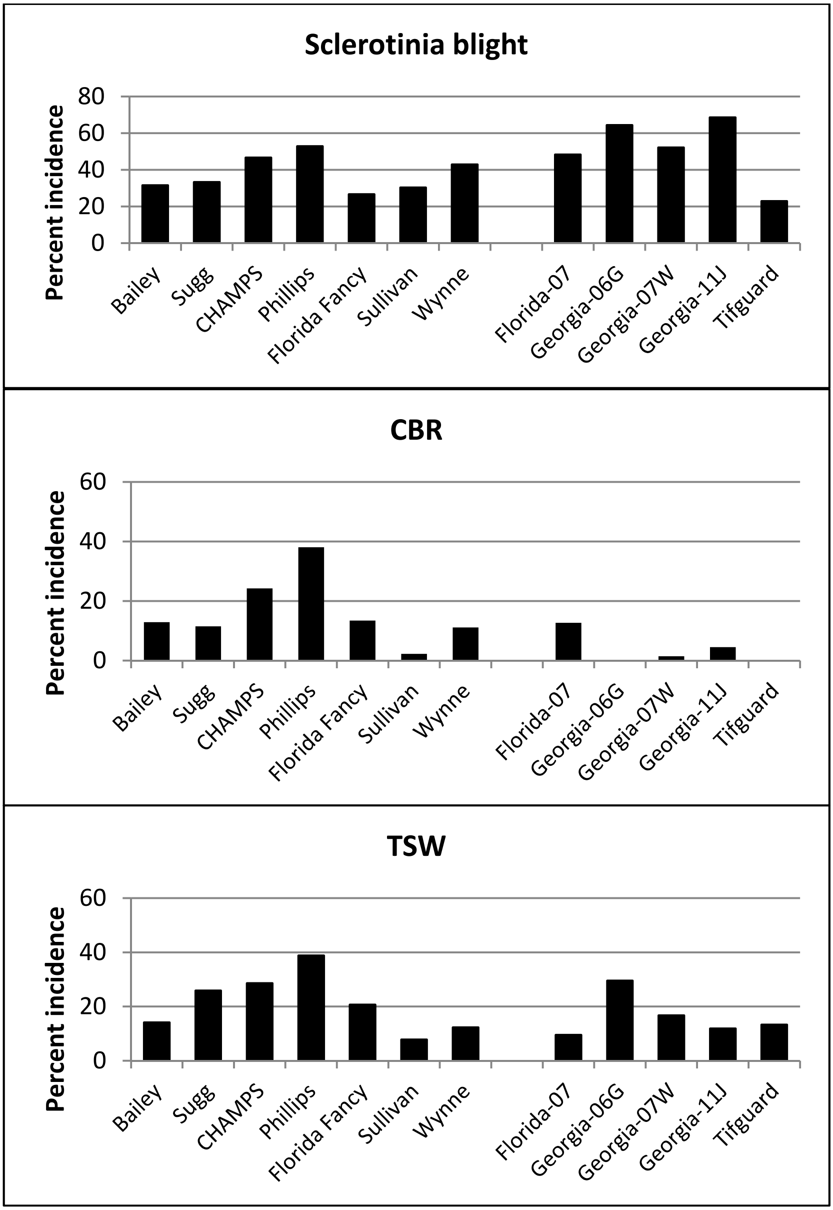

[1] Data from Dr. Tom Isleib. Cultivars were evaluated in plots managed to create conditions highly favorable for each disease. Results are means across all years of testing. Ratings for runner cultivars may be less reliable than for others due to low trial numbers.

of many diseases and make their control more difficult. Extra vigilance is needed under these conditions. Surprisingly, tillage does not seem to have much effect on peanut diseases, so tillage decisions can be made based on other considerations (Table 3-14).

CHEMICAL CONTROL

Pesticides should be used only when host resistance, rotation, and cultural practices are not sufficient to reduce disease to levels below economic thresholds. Choose the appropriate pesticide to control the particular disease or diseases of concern (Table 6-3). Keep in mind that inexpensive fungicides can be just as effective as more costly materials (Table 6-4), and that mixing or rotating fungicides with different group numbers is necessary to prevent fungicide resistance and loss of control (Table 6-5). Apply all pesticides according to label directions and understand all safety precautions. Check the label for formulation changes that may require larger or smaller amounts of a pesticide than you have applied in the past. Calibrate sprayers and other applicators at the start of the season, and check calibration from time to time during the season.

FOLIAR DISEASES

Peanut leaf spots are caused by two different fungi: *Cercospora arachidicola* (early leaf spot pathogen) and *Cercosporidium personatum* (late leaf spot pathogen). Other diseases cause spots on leaves, but they are not referred to as “leaf spot” (see other diseases listed below).

Late leaf spot has been the predominant leaf spot in North Carolina for the past several years. Late leaf spots may have yellow halos, so the presence or absence of a halo is NOT a good way to tell early and late leaf spot apart. Late leaf spot causes dark brown to black spots that can be distinguished from the lighter brown early leaf spots when seen on the underside of the leaf. In humid weather, late leaf spots produce dark brown spores. The mass of spores give the spot a velvety appearance, which can be seen without magnification on the underside of the leaf.

In general, late leaf spot requires more aggressive control than early leaf spot. Early leaf spot usually causes brown lesions (spots) that are surrounded by a yellow halo. The brown color is most evident on the underside of the leaf. Although early leaf spot can be found as soon as 30 days after planting, it is usually not observed until mid-July or later if good rotations are used. Early leaf spots produce tufts of silvery, hair-like spores on the top of the leaf in humid weather. If present, these spores may be seen with the help of a good magnifying glass.

Because peanuts are the only known hosts of leaf spot fungi, rotations (Table 6-2) are very effective in reducing disease. Peanut cultivars vary in susceptibility to leaf spots (Figure 6-1); follow a strict control program on highly susceptible cultivars.

In addition to rotation and cultivar selection, fungicide application is required for leaf spot control. Do not wait until leaf spot is apparent before starting a spray program. Instead, apply fungicides:

- on a set 14-day calendar schedule OR
- according to a weather-based leaf spot advisory.

In well-rotated fields, the first fungicide spray (calendar spray or advisory) should be applied at the very early pod stage (R3), which usually occurs in the first week of July. The first spray can be delayed by two weeks on moderately resistant cultivars such as Bailey and Sugg (Figure 6-1). After the first spray, reapply fungicides every 14 days. This will result in four (Bailey or Sugg) or five calendar sprays in most years. Since disease develops only when relative humidity is near 100%, weather-based advisories can be used to delay or eliminate sprays when weather does not favor disease. Eliminating unnecessary fungicide sprays during dry spells helps to prevent spider mite flare-ups (Chapter 5) and can reduce tractor damage to vines, making them less prone to Rhizoctonia limb rot and Botrytis blight. For more information on advisories in your area or to receive leaf spot advisories by email, contact your county Extension agent.

CAUTION: Leaf spot advisories are intended to be used on dry-land peanuts. Irrigated peanuts should be sprayed on a calendar schedule.

Many fungicides control early and late leaf spot (Tables 6-3 and 6-4), and most also control minor foliar diseases. In addition, some “leaf spot” fungicides also control or suppress stem rot, CBR, and Rhizoctonia limb and pod rot.

Leaf Spot Fungicide Resistance Management

Many common peanut fungicides belong to resistance groups 3, 7, or 11. The mode of action is indicated by the group number, which is prominently displayed on the fungicide label (Figure 6-2).

Figure 6-2. Example of a fungicide resistance group label

GROUP	11	FUNGICIDES

Continued use of fungicides from the same group (even if they are different products) may select for resistant strains of a fungus, causing the fungicide to lose effectiveness. To prevent fungicide resistance, mix or alternate fungicides from different groups (Table 6-5). To maintain fungicide efficacy:

- Mix or alternate sprays with fungicides from different group numbers.
- Do not use group 3, 7, or 11 fungicides at less than the recommended rates.
- Do not exceed the total number of sprays allowed for a particular fungicide or group number.
- Use a group M fungicide, such as chlorothalonil, for the first and last spray of the season. Group M fungicides are not vulnerable to resistance problems.
- Maintain a good foliar disease control program throughout the growing season.
- NEVER rely on "rescue" treatments with an unmixed fungicide to clean up foliar disease problems.

Fungicide labels provide additional resistance management information and recommendations.

NOTE: some very commonly used fungicides are now off-patent or will be soon. Check the group number and follow resistance management guidelines above when using generic products.

CAUTION: In 2015, some growers experienced a loss of leaf spot control when tebuconazole was applied without being mixed with another leaf spot fungicide. This problem has been observed periodically over the last 10 years and illustrates the importance of managing spray programs to avoid fungicide resistance. ALWAYS mix tebuconazole with another product for leaf spot control.

Rainfastness

Most peanut fungicides persist on foliage for about 14 days, but there is surprisingly little information about the rainfastness of peanut fungicides under field conditions. Frequent thunderstorms in summer mean that rain often falls soon after a fungicide is applied, which could wash it off. As a rule of thumb, reapply the fungicide, or an inexpensive protectant, if heavy rain falls within two hours of application. If rain falls within several more hours, consider shortening the interval to the next spray to 10 days. Remember that a systemic fungicide that is taken up by the plant is more likely to persist than a protectant that remains on the plant surface.

Leaf scorch and pepper spot are caused by the same fungus (*Leptosphaerulina crassiasca*). In early to mid-season, large v-shaped areas appear at the tips of the leaves, resulting in a scorch symptom similar in appearance to leafhopper damage.

Later in the season, leaves can be covered with numerous small dark spots (pepper spot). These diseases usually are not a problem when fungicides have been applied for leaf spot control. Pepper spot occasionally has been associated with severe vine decline that sometimes occurs after heavy late-season rains.

Botrytis blight (caused by the fungus *Botrytis cinerea*) most commonly is seen at the end of the season when conditions are cool and wet. Symptoms appear first on vines or leaves that have been injured by tractor tires or freezing temperatures. Massive numbers of gray to brown spores are produced on leaves and stems, covering them with gray fuzz. Although Botrytis blight usually does not cause serious losses, it can be alarming. Timely harvesting and avoiding plant injury will reduce incidence and severity. *Botrytis* can also cause a leaf spot. Symptoms begin as numerous small, light tan, irregular spots without obvious spores. Later, spots may increase to large, irregular tan blotches with characteristic gray spore masses. Fungicide sprays for leaf spot control will usually control this phase of the disease.

Web blotch (caused by the fungus *Phoma arachidicola*) has become very uncommon in the past several years. Historically, web blotch has been most serious in wet years, but even in the very wet fall of 2015, little to no web blotch was observed. Large (half-inch) dark patches or blotches with faint or irregular margins form on the upper surface of the leaf. Lesions may have a grayish cast at first and turn dark brown as they age. Infected leaves may dry and crack with age. To control web blotch, use long rotations (Table 6-2) with any crop other than peanut. Fungicides used to control early and late leaf spot also control web blotch (Tables 6-3 and 6-4). Pyraclostrobin (Headline) and boscalid (Endura) show excellent activity against web blotch. We have little information about the efficacy of recently labeled fungicides due to lack of disease. Likewise, we know little about susceptibility in newer cultivars.

Irregular (or physiological) leaf spot symptoms usually appear within 45 days of planting. Outbreaks of irregular leaf spot have been common in the past several years, but were not serious in 2015. Symptoms usually are widespread across a field and tend to be confined to leaves of about the same age. Some defoliation may occur, but yield losses have not been demonstrated. Irregular leaf spots can be almost impossible to distinguish from early leaf spot unless they are checked under a microscope. Irregular leaf spot is diagnosed if the fungal structures and spores typical of early or late leaf spot are absent even after incubation at high humidity. While the cause of irregular leaf spot is unknown, the uniform age and distribution of affected plants suggests that the problem is not caused by a fungus or other pathogen. Leaf-spot-like symptoms seen within 45 days of planting are probably due to irregular leaf spot or phytotoxicity. Since fungicides will not control either problem, do not make a fungicide application early in the season (prior to R3) without getting a confirmed diagnosis of early or late leaf spot.

Phytotoxicity (chemical toxicity) caused by insecticides and herbicides can be confused with leaf spots. Spots caused by phytotoxicity usually are found around the margins of the lowermost leaflets and generally are found before mid-June. Pesticides can also cause spots by burning areas contacted by spray droplets. Affected areas lack fungal structures or spores, and spray residues may be visible. Phytotoxicity symptoms tend to be distributed regularly (such as at the ends of rows) or uniformly over the field. Be aware of herbicide application practices that lead to plant injury (see Chapter 4).

SPOTTED WILT

Spotted wilt (caused by *Tomato spotted wilt virus*) is spread by thrips. These insects obtain the virus by feeding on infected plants and then transmit it to healthy ones. Symptoms vary, but twisted petioles and purplish spots or blotches on the undersides of leaves are the most diagnostic. Other symptoms can include stunting, dead terminal buds, pale yellow or white ring patterns on leaves, and stunted pods bearing seeds with dark red coats. Sometimes entire plants may wilt, turn yellow, and have root rot. Spotted wilt symptoms can be confused with CBR (Table 6-6). A simple test (dipstick ELISA) can be performed by the NC State University Plant Disease and Insect Clinic to confirm the diagnosis.

Rotation is not very effective in managing spotted wilt because the virus and the thrips that carry the virus have hundreds of cultivated and wild plant hosts. Spotted wilt outbreaks are unpredictable and cannot be stopped once symptoms appear.

There are no pesticides that can prevent or treat virus infections, so managing spotted wilt depends on risk reduction. Cultivar choice, plant stand, and planting date have the greatest effect on spotted wilt risk. The cultivars Bailey and Sugg have high levels of spotted wilt resistance in comparison to older Virginia types, and many runner cultivars also have good spotted wilt resistance. Planting a resistant cultivar (Figure 6-1) between May 5 and 15 in a stand of five or more plants per foot of row will minimize risk. Using an insecticide (acephate, phorate, or imidacloprid) in-furrow or postemergence (acephate) to kill thrips also reduces the risk of spotted wilt. Twin rows and minimum tillage slightly reduce the risk of spotted wilt. Each of these choices presents costs and benefits to overall crop productivity. Use the Tomato Spotted Wilt Risk Index (Chapter 5 or online) to assess options for minimizing the spotted wilt risk in a given field.

DISEASES CAUSED BY SOILBORNE PATHOGENS

Soilborne plant pathogens attack parts of the plant that grow in or near the soil, including roots, stems, pegs, pods, and seeds. The entire plant may become symptomatic or die in advanced stages of disease. Soilborne pathogens are very difficult to control because they can survive in soil for years once established. Prevent the buildup of disease problems by rotating to non-host crops (Table 6-2). Keep in mind that the same disease can have a different name in other crops. It is equally important to avoid introducing soilborne pathogens into uninfested areas. Use high quality treated seed and clean equipment frequently, particularly when moving from one field to another. Clean loose soil and debris from diggers and combines after they are used in heavily infested fields. Once heavy infestations occur, only very long rotations can reduce pathogen numbers below economic thresholds.

Soilborne pathogens have limited mobility, so mapping the location and intensity of the diseases they cause is a useful tool for choosing disease management tactics the next time peanuts are grown (Table 6-7).

Seed and seedling rots are caused by many fungi. Seeds may not germinate (seed rot), germinate but not emerge from the soil (preemergence damping off), or die shortly after emergence (postemergence damping off). Rots often develop after seeds and seedlings are weakened by environmental problems or poor seedbed conditions. Cold soils slow down germination and increase the risk of rots. Poor drainage can cause waterlogging, a major factor in seed and seedling rots. Soil temperature should be at least 65°F at a 4-inch depth for three consecutive days before planting. Bedding promotes soil warmth and drainage. Use high-quality seed coated with a good chemical seed treatment fungicide. Replanting is the only remedy for severe stand loss due to seedling disease. See Chapter 3 for information about effects of late planting dates on yield before deciding whether to replant.

Aspergillus crown rot (caused by *Aspergillus niger*) causes pre- and post-emergence damping off and can kill plants up to five weeks after planting. Seedlings rapidly collapse and die. Dark brown discoloration is common on decayed roots and hypocotyls. Later, these areas often are covered with moldy looking masses of black spores. Aspergillus crown rot is of minor importance when high-quality, fungicide-treated seed are planted in well-rotated fields; rotation and seed treatments control this disease.

Southern stem rot (caused by *Sclerotium rolfsii)* is very common and can be found in most peanut fields in North Carolina. The disease is also known as stem rot or white mold on peanut and as southern blight on vegetables. Damage ranges from mild to severe. Symptoms include stem lesions and wilted stems, shredded pegs, rotted pods, crown rot, and plant death. Affected tissues are similar in color to a brown paper bag. Coarse, white, fan-shaped patterns of fungus growth may be present near the base of the plant on stems, leaf litter, or soil. Later, round tan to brown sclerotia that look like mustard seed may be present. The white fungus growth and sclerotia are diagnostic of southern stem rot, but damage can occur even when aboveground signs of the fungus are absent. Fields with heavy vine growth and high moisture are most prone to stem rot. This disease is most active during the hottest part of the season, especially after a rainy period. In dry seasons, the fungus can be active underground, causing stem and pod damage that are not noticeable until digging.

Sclerotium rolfsii has an extremely broad host range, making rotation for disease control difficult. However, it does not attack small grains, corn, and many other grass species (Table 6-2), making these excellent rotation crops. Avoid rotations with soybeans, tobacco, melons, and vegetables. Bailey (and Sugg) has good resistance to southern stem rot. Older Virginia-type cultivars are susceptible or highly susceptible. We are still evaluating the level of southern stem rot resistance in Sullivan and Wynne. Using a fungicide to control stem rot and other soilborne diseases is beneficial in most fields. Many fungicides that control leaf spots also control stem rot (Tables 6-3 and 6-4), but higher rates than those needed for leaf spot control alone may be necessary. Other fungicides (flutolanil, tebuconazole) control southern stem rot but are weak or ineffective against foliar diseases, so they must be mixed with a foliar fungicide for leaf spot control. Fungicides work best when applied just before disease onset. Make one (Bailey and Sugg) or up to three (susceptible cultivars) applications of a fungicide active against stem rot according to the leaf spot advisory or calendar schedule between July 15 and the end of August. High spray volumes (20 gal water/acre) and spraying when leaves are folded (before dawn) can increase fungicide deposition on stems but may make foliar disease control less effective. In-furrow fungicide application may help to reduce stem rot and CBR problems in susceptible cultivars but is not necessary with Bailey.

Rhizoctonia limb and pod rot (caused by *Rhizoctonia* spp.) is sometimes confused with southern stem rot. While both pathogens infect the stems, *Rhizoctonia* produces dark- or grayish-brown lesions that are usually found where the undersides of stems touch the soil. The stem lesions usually have a dark border and a target-like pattern. Recently, scattered cases of large, gray-brown target-shaped spots have been observed on leaves, but so far damage has been minimal. This differs from the more common wet black foliar blight that Rhizoctonia sometimes causes in wet or irrigated fields, or where vine growth is thick. Rhizoctonia is most destructive when it causes a dark pod rot alone or in association with other fungi. Management practices and fungicides are the same as for southern stem rot (see above).

Sclerotinia blight (caused by *Sclerotinia minor*) is favored by cool, moist conditions. Infections usually start on individual limbs, but the tips of infected limbs may remain green and look healthy for several days before wilting is evident. Careful scouting is required to find symptoms and signs when they first appear. Scout by parting the vines to reveal bleached stems and the white cottony growth of the *Sclerotinia* fungus. Signs and symptoms are most visible on humid mornings or after a rain. Eventually, the light-colored stems become shredded and die. Small, black, irregularly shaped sclerotia that resemble mouse or insect droppings may be found on and in infected stems and pods. These sclerotia survive in soil for many years and can spread the fungus to other fields if moved on equipment.

To prevent build-up of damaging levels of Sclerotinia blight, rotate as long as possible with cotton, corn, or other grains (Table 6-2). Sclerotinia infects canola, sunflowers, cole crops, lettuce and snap beans, which should not be used in rotations. In addition, many common winter annual weeds are hosts. They support reproduction of the fungus during winter fallow, potentially reducing the benefits of rotation. Planting a small grain cover crop may help to reduce populations of the weeds that harbor Sclerotinia.

Avoid susceptible cultivars in fields with a history of disease. Bailey and Sugg have more resistance to Sclerotinia blight than many other cultivars (Figure 6-1) but still require fungicide applications under heavy disease pressure.

Frequent application of chlorothalonil (Bravo; various generic brands) can make Sclerotinia blight more difficult to control and should be avoided in infested fields. Sclerotinia blight becomes more severe as soil pH increases above 6.0. Carefully weigh all plant health factors when applying lime to fields where Sclerotinia blight is a problem (see Chapter 3).

The fungicides fluazinam (Omega) and boscalid (Endura) are effective against Sclerotinia blight when applied preventively (Table 6-3). Timing of the first spray is critical for season-long control. Fields with a history of serious problems should be scouted carefully, beginning when vines are within 6 inches of touching, or around July 4. A weather-based Sclerotinia blight advisory can be used to focus scouting efforts, time applications, and prevent unnecessary fungicide applications. Treat when Sclerotinia blight is first observed (on demand) or 60 to 70 days after planting (calendar program) or according to a Sclerotinia blight advisory. If the disease continues to spread, one or two more applications may be made at three- to four-week intervals, or according to the Sclerotinia advisory. Sclerotinia advisories are available by email every day during the growing season.

CBR (Cylindrocladium black rot or black root rot, caused by *Cylindrocladium parasiticum*) is a devastating disease on peanut. Infected plants turn light green or yellow, wilt, and die. Roots are blackened, brittle, and rotten. Typically, a CBR-infected plant will pull up or break off when tugged due to extensive rotting of the crown and taproot. The fungus produces numerous brick-red, pinhead- sized structures on crowns, lower stems, and pods, especially following moist weather. However, CBR may be present even when fungus structures are not evident. If no fungus structures are visible, late-season wilting and root rot symptoms of CBR can be confused with spotted wilt (Table 6-6).

CBR is strongly affected by rotation. Long rotations with non-hosts such as cotton, corn, sorghum, and small grains help to reduce losses from CBR (Table 6-6). Longer rotations probably explain why CBR problems have decreased in recent years, but growers need to remain vigilant against this disease. Short rotations with peanut or soybean will quickly lead to heavy losses.

Together with rotation, host resistance is the foundation of CBR control (Figure 6-1). Planting a resistant cultivar usually is all that is necessary in a well-rotated field with a history of less than 10% disease (Table 6-7). Highly susceptible cultivars should not be planted in fields with a history of CBR. Always use high-quality fungicide-treated seed to prevent problems with CBR and other diseases (see below).

CBR can be a problem even in a field where peanuts have never been planted if it has a history of soybean production. Symptoms of CBR in soybean (red crown rot) are not dramatic, so you may not be aware of the problem until peanuts are grown. If in doubt, select a CBR-resistant cultivar (Sugg or Bailey) the first time you plant peanuts in a field with a history of soybean production (Figure 6-1).

Although symptoms of CBR are most apparent in mid- to late summer, most infections occur in spring when soil is cool and wet. Promote soil warmth and drainage by bedding the soil and planting in mid-May.

The fungicide prothioconazole (found in Proline and Provost) provides some suppression of CBR when applied in-furrow (Proline) or as part of a leaf spot control program (Provost). Fungicides perform best when used in combination with a CBR-resistant cultivar. They will not correct a CBR problem once symptoms appear nor are they a substitute for fumigation in high-risk situations.

Root knot and ring nematode feeding (below) can make CBR problems worse. If a field has a history of CBR, submit a nematode sample the fall before peanuts are to be planted. Use a CBR-resistant cultivar and treat nematodes as recommended in the sample report.

Soil fumigation with metam sodium (Table 6-3) may be necessary to control CBR in fields with 10% or greater disease the last time peanuts were grown. Even if previous CBR incidence was less than 10%, fumigation may still be necessary with poor rotations.

Important Information about Fumigant Labels

Several restrictions have been placed on metam sodium use in recent years. Labels require respiratory protection (respirators) for handlers, the development of a fumigant management plan, buffer zones, and the annual communication of mandatory safety information to workers. In addition, many good agricultural practices (see below) are now label requirements. Check with your fumigant supplier for the latest label information. Comprehensive information on the new soil fumigant regulations may be found at **www2.epa.gov/soil-fumigants**.

Good Management Practices (see the label for additional requirements)

Fumigants must be injected 12 inches below the top of the bed (or 8 inches below the original soil surface) at least two weeks prior to planting. The chisel trace must be closed with a press wheel or similar device. Prevent all drips or leaks with proper application equipment as described on the fumigant label. Apply after soil temperatures reach 60°F at a 4-inch depth and temperatures of 60°F or higher are forecast for the next five days as reported by weather stations or **www.nc-climate.ncsu.edu**. However, do not apply at soil temperatures (3-inch depth) of 90°F or higher. Soil moisture at the start of application must be at 60% to 80% field capacity at 2 to 6 inches below the surface as determined by the USDA feel method. Delay fumigation if an inch or more of rain is forecast within three days. Cool or wet conditions after fumigation can slow the dispersion of the fumigant, resulting in poor control or damage to young plants. Minimize disturbance of fumigated soil; herbicides can be incorporated prior to bedding and injecting for adequate weed control.

CBR Seed Transmission

Seed can transmit CBR. Infected seeds have cinnamon-colored speckles about the size of pencil dots. The speckles are the resting structures (microsclerotia) of the fungus that causes CBR. Most microsclerotia die during winter storage, but any that survive can infect plants as they emerge from the speckled seed and can also infect nearby plants. Plant certified seed that is coated with commercially applied seed treatments to minimize transmission of CBR and other seed borne diseases.

Methods to Reduce or Eliminate CBR in Peanut for Seed Production

The North Carolina Crop Improvement Association supports the following recommendations that will reduce/eliminate seed transmission of *Cylindrocladium parasiticum* (CBR):

- Maintain accurate records of field history and maps of CBR incidence.
- Adopt a minimum of three-year rotations of peanut with non-hosts of *Cylindrocladium parasiticum* (Table 6-2).
- Select fields with little or no history of CBR or Sclerotinia blight for seed production.
- Fumigate fields with metam sodium following the guidelines above.
- Inspect fields at the end of the season.
- Selectively harvest infested fields to avoid heavily infested areas.
- Avoid harvesting seed peanuts where disease incidence exceeds 5%.

Diplodia collar rot, caused by *Diplodia gossypina*, is sometimes observed in North Carolina. Individual stems on the lower plant wilt suddenly and then collapse. Often one side of the plant is affected at first; later the entire plant may die. Splitting the root may reveal a dark border surrounding an oblong tan lesion that turns slate-gray in advanced stages of disease. Stems and pods typically are covered with dark-gray fungal structures about the size of a sand grain. Later these structures become quite prominent and turn coal-black. Often the dead plants nearly disintegrate, leaving only a few blackened leaves and stems.

Diplodia collar rot is seed-transmitted and usually can be prevented by planting high-quality treated seed. Collar rot is strongly associated with heat and water stress. If available, irrigation can help to reduce the risk of Diplodia collar rot. Encouraging rapid canopy development may help to shade stems and prevent heat injury.

Pod rot can be difficult to control because the causes are so diverse. Rotted pods may be infected singly or in combination with *Pythium, Rhizoctonia, Fusarium,* and several other species of soilborne fungi. Symptoms include spotted, dark, or rotted pods.

All of the diseases caused by soilborne pathogens discussed above can also have a pod rot phase. *Rhizoctonia* causes distinct brown areas of rot on the pod. Paper-thin, brown pods, shredded pegs, and white fungus growth are typical of southern stem rot. Pod rots from CBR or Sclerotinia blight generally are found in association with other symptoms and the brick-red (CBR) or black (Sclerotinia) fungal structures described above. Pod rot caused by *Pythium* can turn the entire pod black and soft. Poorly drained or heavy soils favor the development of *Pythium* pod rot and should be avoided.

Occasionally, outbreaks of pod rot occur in fields with little or no history of disease. Tops of plants look healthy, or even greener than normal, but pod rot is found upon digging, along with one or more of the common pod-rot fungi, especially *Pythium*. The reasons for these outbreaks are not known but probably are related to weather during pod filling.

Severe pod rot is usually the result of very short rotations or poor choice of rotational or cover crops. Long rotations with most grains reduce the numbers of pod-rotting organisms in soil (Table 6-2). Cultural practices and fungicides (Table 6-3) that control CBR, southern stem rot, Rhizoctonia, and Sclerotinia blight also help to reduce the risk of pod rots caused by these pathogens.

Sometimes pod rot symptoms result from poor calcium nutrition or excessive magnesium or potash levels, which weaken the hull and allow various soil fungi to grow into and rot the pod. Calcium deficiency is characterized by "pops" and brown plumules within the seed. Follow recommendations for land plaster application (Chapter 3) to reduce the likelihood of this problem.

NEMATODES

The nematodes that attack peanut are microscopic to barely visible roundworms that survive in the soil and feed on or inside roots. Nematodes can move very short distances in the gaps between soil particles. For this reason, nematode problems tend to be greatest in sandy soils.

Nematodes cause stunting, wilting, and yellowing of aboveground portions of the plant. Damage is often seen in clusters within a field. The northern root-knot (*Meloidogyne hapla*) and lesion nematodes (*Pratylenchus brachyurus*) are the most common species attacking peanut in North Carolina. The peanut root knot nematode (*Meloidogyne arenaria*) is uncommon in North Carolina but can be very damaging when present. Sting (*Belonolaimus longicaudatus*) nematodes can severely damage peanut, but problems are very rare and may be limited to certain populations. Ring nematode (*Criconemella ornata*) is fairly common but its impact on peanut is uncertain.

Root-knot nematodes cause galls on roots, pegs, and pods. The northern root knot nematode causes small galls that can be confused with beneficial nitrogen-fixing root nodules. Galls appear as irregular thickenings along the root itself, whereas nodules are round and found attached to the sides of the root. Infected root systems may look bushy, and pods may have dark spots about the size of a pinhead.

The peanut root knot nematode (*M. arenaria*) causes large swellings and severe galling on roots, pegs, and pods. Check pods and roots for galls immediately after digging, particularly in areas where plants were yellow or stunted (Table 6-7).

Lesion nematodes cause small brown areas (lesions) on peanut roots and pods. The most distinctive symptoms are small tan-to-brown spots on the pods that look like pin-pricks. These spots may expand over time. Likewise, affected areas on the roots may expand so that the entire root system becomes brown and damaged. Wounds from nematode feeding can make roots and pods more susceptible to damage by other fungi and bacteria that live in the soil, resulting in root and pod rot.

Nematode Control

The nematodes that infect peanut do not survive long periods of time without a suitable host, so rotation is a very effective means of control (Table 6-2). Rotation to peanut can be useful for minimizing nematode problems in rotation crops. Peanut generally is a non-host for most cotton nematodes; rotation with peanut can alleviate problems in cotton with southern root-knot nematode, Columbia lance nematode, and reniform nematode. Similarly, these nematodes will not affect peanut, so a cotton-peanut rotation is a win-win situation.

To identify nematode problems and to plan treatments, sample for nematodes in the fall (September through November) before planting in the following spring. Take samples in a zigzag pattern across the field. Take 20 probes (1 inch in diameter to an 8-inch depth in the row) for each sample, with one sample to each 4 or 5 acres. Samples will be more representative of the field if the soil is mixed by disking before samples are collected.

Divide large or non-uniform fields according to the row direction so that you can target infested areas for treatment if necessary. To prevent decomposition, keep nematode samples cool (50 to 60°F) and give them to your county agent or send to the North Carolina Department of Agriculture and Consumer Services (NCDA&CS) Nematode Advisory Service as soon as possible. See the NCDA&CS website for further information: **www.ncagr.gov/agronomi/nemhome.htm**.

Fields that are below NCDA&CS threshold levels (A category) need no control procedures. Fields that are B category are borderline cases; treatment may give a return on control investment but probably will not. C-category fields are above threshold levels and should be treated.

Fumigating with metam sodium will help reduce nematode populations, but this may not be adequate in C-category fields (Table 6-3). These fields may require treatment with a fumigant containing 1,3 dichloropropene (e.g., Telone II.) Be aware that labels for fumigants containing chloropicrin have stricter requirements than those for metam sodium (see above).

Growers have had few chemical options for nematode control in recent years. This situation will change in 2016 when Velum Total becomes available in North Carolina.

This product is a mixture of the insecticide imidacloprid and the fungicide/nematicide fluopyram and can be applied in-furrow for nematode and insect control (Table 6-3). We have tested this product over several years and have found it reduces nematode populations. However, we have not had the opportunity to observe performance against damaging levels of nematodes. We will continue to evaluate the efficacy of new products against plant parasitic nematodes in 2016 and beyond.

GENERAL INFORMATION

Zinc Toxicity

Peanuts are very sensitive to excess zinc. Symptoms include yellowing, stunting, and characteristic split stems. Typically, patches of poor growth may be found in areas where tin-roofed sheds stood for years. This is due to the leaching of zinc from the metal. Old hog pen areas may be contaminated with zinc due to the use of zinc supplements in hog feed.

Zinc is also added to chicken feed and is found in abundance in chicken litter. Repeated applications of chicken litter to soil can cause zinc to build up to levels that are toxic to peanuts (index of 200 to 400). Avoid poultry litter applications to peanut fields, and have soil tested if litter has been applied in the past.

Since zinc is not mobile in soil, high levels (zinc availability index greater than 250) are likely to damage peanuts for many years. Zinc toxicity is more severe in acid (low pH) soils, so maintain soil pH at 6 or greater.

Digging Dates and Estimating Percentage Disease

In general, early digging to minimize disease losses is a mistake. Measurable yield loss from leaf spots begins at about 30% defoliation. Once this level of disease has been reached, yield differences are not consistent between peanuts dug early (within 10 days of optimum maturity) or at optimum maturity.

For other diseases, harvesting early is a losing proposition until there is at least 50% disease (one out of every two plants diseased). Keep in mind that even half this much disease will look alarming, so count affected plants to determine the percentage of diseased plants. Divide the field into 1-acre blocks, select the worst block, and step off a 100-foot section of row. Count the number of feet of row within this section that are diseased. Repeat in two more 100-foot sections within the block. Average the percentages from the three samples. Five feet of diseased row out of 100 is 5% disease. If more than 50% of the plants are diseased, early digging may be advisable. Most diseases caused by soilborne pathogens are not evenly distributed across the field. Therefore, if you decide to dig early, dig the most diseased portion of a field early and the remainder at maturity (Chapter 3). Be sure to clean equipment thoroughly before moving it to healthy areas.

Adjuvants

Many adjuvants and other additives are marketed as products that will improve plant health and/or the performance of crop protection chemicals. Except as noted in Table 6-3, fungicides for peanut disease control do not need adjuvants for best performance. The added cost of these products generally will not be offset by increases in yield. Further, certain combinations of adjuvants and fungicides will cause injury or reduce fungicide efficacy and should not be used. Check the fungicide label before adding any adjuvant. See Chapter 9 for more information.

Table 6-1. Effects of Cultural and Disease Management Practices on Peanut Diseases

Practice	Diseases Controlled or Suppressed	Remarks
Crop rotation	ELS, LLS, web blotch, CBR, pod rot, seedling diseases, Aspergillus crown rot, nematodes, southern stem rot, Sclerotinia blight, Rhizoctonia limb and pod rot	Rotation length and type of crop needed varies with the disease (Table 6-2)
Resistant cultivars	ELS, LLS, spotted wilt, CBR, southern stem rot, Sclerotinia blight	See Figure 6-1
Seedbed preparation and drainage	Seedling diseases, CBR	
High-quality treated seed	Seedling diseases, Aspergillus crown rot, Diplodia collar rot, CBR, Sclerotinia blight	Highly recommended at all times
Fumigation (metam sodium)	Cylindrocladium black rot, nematodes (suppression)	
Planting date	Spotted wilt, CBR	May 6-15 optimal
High seeding rate	Spotted wilt	Increases risk of southern stem rot, Sclerotinia blight, Rhizoctonia limb and pod rot
In-furrow fungicide	Aspergillus crown rot, seedling diseases, ELS, LLS, Southern stem rot, CBR (suppression),	Most likely to affect yield when used with susceptible cultivars
Foliar fungicide	ELS, LLS, web blotch, pepper spot, Phyllosticta leaf spot	Start at R3; Many foliar fungicides also control soilborne diseases
Soil fungicide	Southern stem rot, Rhizoctonia limb and pod rot, Sclerotinia blight	Use in mid-seaon; Many soil fungicides also control foliar diseases
Irrigation	Diplodia pod rot, Aspergillus crown rot	Increases risk of ELS, LLS, southern stem rot, Sclerotinia blight, Rhizoctonia limb and pod rot

ELS = Early leaf spot; LLS = Late leaf spot; CBR = Cylindrocladium black rot

Table 6-2. Rotational Crops for Peanut Disease Management[1]

Disease	Rotational Crop							Years of Rotation for Suppression[3]
	Cotton	Corn	Sorghum	Soybean[2]	Tobacco	Small Grains	Vegetables or Melons	
Leaf spots (early and late)	G	G	G	G	G	G	G	2
Sclerotinia	G	G	G	P	N	G	P	4+
Southern stem rot (white mold)	G	G	G	P	P	G	P	2 to 4+
Pod rot[4]	N/P	G	G	P	P	G	N	2 to 4
CBR	G	G	G	P	P	G	G	2 to 4
Rhizoctonia	N	G	G	N	N/P	G	N	2 to 4
TSWV	N	N	N	N	N/P	N	N/P	—
Northern[5] root-knot nematode	G	G	G	P	P	G	P	2
Peanut root-knot nematode	G	P	P	P	G	G	P	2

[1] Poor, makes disease worse (P); good, is favorable for plant health (G); neutral or variable effect (N). Heavy weed infestations can reduce effectiveness of rotation for disease management.

[2] Rotation with soybean increases problems with northern root knot nematode, CBR, southern stem rot, and Sclerotinia blight. Problems are worse if soybeans are grown in the year proceeding peanuts. Soybeans double-cropped with a small grain cause fewer problems than full-season soybeans planted in the spring.

[3] Number of years a rotation crop is planted (for example, 2 means peanut is planted every third year)

[4] Cotton rotation may increase pod rot if soils are overfertilized with potash. Rye cover crops may increase pod rot problems.

[5] Most common root-knot species

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Disease or Diseases Controlled				
Aspergillus Crown Rot (Aspergillus); see also seedling diseases				
azoxystrobin (Abound, various brands) [1] 2.08 F (11)	0.4 to 0.8 fl oz/1,000 ft of row	At planting	NA	Apply as in-furrow spray with 3 to 5 gallons water.
Black Root Rot (CBR) (Cylindrocladium); see also seedling diseases				
metam sodium 42% (various brands) 4.25 F	7.5 gal (6.61 fl oz/100 ft of row)	At least 2 weeks before planting or longer if cool and/or wet	NA	Inject 10 to 12 inches below the bedded soil surface. If wet and/or cold weather occurs following fumigation, the waiting period should be extended. Soil aeration helps reduce residual chemical. When in doubt use a bioassay such as the lettuce seed germination test to determine if safe to plant. Buffer zones and other restrictions on metam sodium use have been implemented. See your county Extension center for details.
prothioconazole (Proline) 480 SC (3)	0.4 fl oz/1,000 ft of row	At planting or at full emergence	NA	Apply as in-furrow spray or banded at full emergence for suppression of CBR. Not a substitute for fumigation in fields with a history of more than10% CBR and rotations of less than 4 years.

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	**Amount of Formulation Per Acre**	**Application Schedule**	**Minimum Days to Harvest**	**Precautions and Remarks**
Disease or Diseases Controlled				
Early Leafspot (Cercospora)				
cupric hydroxide (Kocide, various brands and formulations) [2] (M1)	Various; see label	Begin applications at very early pod (R3). Repeat applications every 10 to 14 days.	0	Use nozzles that give a cone-shaped spray pattern. Use 12 to 24 gallons of water for spray materials applied by ground sprayers. Use at least 5 gallons of water for materials applied by air. **Calendar program**: Five or six applications suggested. Begin applications at very early pod (R3). Repeat applications at 10- to 14-day intervals. Scout fields: if 20% or more of leaflets have spots, switch to a more effective fungicide and stay on a 14-day spray program.
basic copper sulfate (various brands and formulations) [2] (M1)	Various; see label	See above	0	See above
mancozeb and copper hydroxide (Mankocide) [2] 61.1 DF (M3)	2 to 2.6 lb	See above	14	See above
mancozeb (Manzate, Koverall, various brands) [2] (M3) M45 F45 75 WDG 80 WP	 1 to 2 lb .8 to 1.6 qt 1 to 2 lb 1 to 2 lb	See above	14	See above
Sulfur (various brands and formulations) [2] (M2)	Various; see label	See above	0	See above

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Disease or Diseases Controlled				
Early Leafspot (Cercospora); Late Leafspot (Cercosporidium); Web Blotch (Ascochyta)				
chlorothalonil (Bravo, Echo, various brands) (M5) 720, 6 F 82.5 WDG 90 DF 500	 1 to1.5 pt .9 to 1.36 lb .875 to 1.25 lb 1.5 to 2.25 pt	Begin applications at very early pod (R3). Repeat applications every 14 days or according to daily weather based advisories. Begin 14-day program if web blotch is found	14	Use nozzles that give a cone-shaped spray pattern. Use 12 to 24 gallons of water for spray materials applied by ground sprayers. Use at least 5 gallons of water for materials applied by air. **14-day program:** Five or six applications suggested. Begin applications at very early pod (R3). Repeat applications at 10- to 14-day intervals. **Advisory:** Begin applications at very early pod (R3). Repeat applications when weather conditions become favorable as determined by peanut leaf spot advisories. This schedule requires strict adherence to the program guidelines and usually results in fewer fungicide applications than the 14-day schedule. Contact your county Extension center for details. Leafspot advisories are most effective if used with long rotations, resistant varieties, and high rates of effective fungicides. Scout fields: if 20% or more of leaflets have spots, switch to a more effective fungicide and stay on a 14-day spray program. Repeated applications of chlorothalonil can make spider mites and Sclerotinia blight more difficult to control.

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	**Amount of Formulation Per Acre**	**Application Schedule**	**Minimum Days to Harvest**	**Precautions and Remarks**
Disease or Diseases Controlled				
Early Leafspot (Cercospora); Late Leafspot (Cercosporidium); Web Blotch (Ascochyta) (continued)				
propiconazole + chlorothalonil premix (Tilt/Bravo SE) (3 + M5)	1.5 pt	See above	14	See above
boscalid (Endura) [2,3] 70 WDG (7)	10 oz	Make up to 2 or 3 applications in mid-season as part of a full-season, 14-day, or advisory program	14	See above. Primarily controls web blotch. Alternate with another fungicide or mix with 0.75 to 1 pint chlorothalonil to improve leaf spot control. Also controls Sclerotinia blight; see below.
thiophanate methyl (various brands) (1) 4.5 F 70 WP 85 WDG	 10 fl oz .5 lb .4 lb	14 day or advisory beginning at R3	14	See above. **Do not** apply alone. Mix with another leaf spot fungicide.
dodine (Elast) 400 F (U12)	1.5 pt	Make no more than 3 applications as part of a full-season, 14-day, or advisory program	14	See above
propiconazole (various brands) (3) 3.6 EC	2.5 to 4 fl oz	14 day or advisory beginning at R3	14	See above. Mix or alternate with another fungicide to improve foliar disease control and to reduce the risk of fungicide resistance.
cyproconazole (Alto) (3) 100SL	5.5 fl oz	14 day or advisory beginning at R3	30	See above. Mix or alternate with another fungicide reduce the risk of fungicide resistance.
flutriafol (Topguard) (3) 1.04 SC	7 to 14 fl oz	14 day or advisory beginning at R3	14	See above. Mix or alternate with another fungicide to reduce the risk of fungicide resistance

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Disease or Diseases Controlled				
Early Leafspot (Cercospora); Late Leafspot (Cercosporidium); Web Blotch (Ascochyta) (continued)				
tetraconazole (Eminent) (3) 125SL	6 to 13 fl oz	14 day or advisory beginning at R3	14	See above. Mix or alternate with another fungicide to reduce the risk of fungicide resistance
Early Leaf Spot (Cercospora); Late Leaf Spot (Cercosporidium); Web Blotch (Ascochyta); Limb Rot (Rhizoctonia)				
propiconazole + trifloxystrobin (Stratego) (3 + 11)	7 to 14 fl oz	14 day or advisory beginning at R3	14	See Early Leaf Spot, Late Leaf spot, and Web Blotch above. Use higher rates for soil-borne pathogens and under wet (rainfall or irrigation) conditions. No more than 6 applications per season.
tebuconazole + trifloxystrobin (Absolute) 500 SC (3 + 11)	3.5 to 7 fl oz	14 day or advisory beginning at R3	14	See above. Use higher rates for soil-borne pathogens. No more than 4 applications per season.
Early Leaf Spot (Cercospora); Late Leaf Spot (Cercosporidium); Web Blotch (Ascochyta); Limb Rot (Rhizoctonia); Stem Rot (Sclerotium rolfsii); Pod Rot (Sclerotium rolfsii, Rhizoctonia)				
prothioconazole + tebuconazole (Provost)[4] 433 SC (3+3)	7 to 10.7 fl oz	Make up to 2 to 4 applications in mid-season as part of a full-season, 14-day, or advisory program. For routine disease control, use 7 to 8 fl oz/A; also suppresses CBR at highest rate.	14	See Early Leaf Spot, Late Leaf Spot, and Web Blotch above. For best control of limb and pod rot, do not use a surfactant. Do not apply more than 3 times in a 5-spray program or after the first week in September. **Resistance management:** Site-specific fungicides (groups 3, 7, and 11) should be mixed or rotated with a fungicide from a different group to minimize the risk of fungus resistance development.

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Disease or Diseases Controlled				
Early Leaf Spot (Cercospora); Late Leaf Spot (Cercosporidium); Web Blotch (Ascochyta); Limb Rot (Rhizoctonia); Stem Rot (Sclerotium rolfsii); Pod Rot (Sclerotium rolfsii, Rhizoctonia) (continued)				
metconazole (Quash) 50 WDG (3)	2.5 to 4 oz	Make up to 2 to 4 applications in mid-season as part of a full-season, 14-day, or advisory program.	14	See above
tebuconazole (various brands) (3) 3.6 F 1.67 F	 7.2 fl oz 15.4 fl oz	See above	14	See above. Many populations of leaf spot fungi are not controlled by tebuconazole alone. Always mix with chlorothalonil or another fungicide (other than group 3) that is effective against leaf spots.
penthiopyrad (Fontelis)[3] 1.67 SC (7)	12 to 24 fl oz	Make up to 3 applications per season as part of a full-season, 14-day, or advisory program	14	See above. FRAC guidelines recommend no more than 2 applications of an unmixed group 7 fungicide in a 5-spray program. Use higher rates for stem and web blotch control. Also suppresses Sclerotinia blight; see below.
flutolanil + propiconazole (Artisan) 3.6 F (7 + 3)	26 fl oz See label	Use 1 to 3 times per season a full-season, 14-day, or advisory program.	40	See above. Alternate with another fungicide for foliar disease control or mix with 0.75 to 1 pint chlorothalonil to improve foliar disease control. Do not plant small grains within 5 months of last application. See label for detailed information on rates and for other plant-back restrictions.

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Disease or Diseases Controlled				
Early Leaf Spot (Cercospora); Late Leaf Spot (Cercosporidium); Web Blotch (Ascochyta); Limb Rot (Rhizoctonia); Stem Rot (Sclerotium rolfsii); Pod Rot (Sclerotium rolfsii, Rhizoctonia) (continued)				
azoxystrobin (Abound; various brands) [1,4] 2.08 F (11)	12.0 to 24.6 fl oz	Make up to 2 applications per season as part of a full-season, 14-day, or advisory program. Use higher rates for limb rot and stem rot control.	14	See above. Use in mid-season for best control of soil-borne pathogens. Use no more than 2 applications in a 5 spray program. **Resistance management**: Site-specific fungicides (groups 3, 7, and 11) should be mixed or rotated with a fungicide from a different group to minimize the risk of developing fungal resistance.
azoxystrobin + tebuconazole (Custodia SC) (11 + 3)	15.5 fl oz	Make up to 2 to 4 applications in mid-season as part of a full-season, 14-day, or advisory program.	14	See above
fluoxastrobin (Evito, Aftershock) [1] 480 SC (11)	5.7 fl oz	Make up to 2 applications per season as part of a full-season, 14-day, or advisory program.	14	See above **Resistance management**: Site-specific fungicides (groups 3, 7, and 11) should be mixed or rotated with a fungicide from a different group to minimize the risk of developing fungal resistance.

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	**Amount of Formulation Per Acre**	**Application Schedule**	**Minimum Days to Harvest**	**Precautions and Remarks**
Disease or Diseases Controlled				
Early Leaf Spot (Cercospora); Late Leaf Spot (Cercosporidium); Web Blotch (Ascochyta); Limb Rot (Rhizoctonia); Stem Rot (Sclerotium rolfsii); Pod Rot (Sclerotium rolfsii, Rhizoctonia) (continued)				
fluoxastrobin + tebuconazole (Evito T)	6 to 11.2 fl oz	Make up to 2 to 4 applications in mid-season as part of a full-season, 14-day, or advisory program.	14	See above
pyraclostrobin (Headline) [1,4] 2.09 EC, 2.08 SC (11)	6 to 15 fl oz	See above	14	See above **Resistance management**: Site-specific fungicides (groups 3, 7, and 11) should be mixed or rotated with a fungicide from a different group to minimize the risk of developing fungal resistance.
fluxapyroxad + pyraclostrobin (Priaxor) (7+11)	4 to 8 fl oz	Use 1 to 3 times per season a full-season, 14-day, or advisory program. Use higher rates for limb rot and stem rot control.	14	See above
Stem Rot (white mold, Southern blight, Sclerotium rolfsii); Limb Rot (Rhizoctonia); Pod Rot (Sclerotium rolfsii, Rhizoctonia)				
flutolanil (Convoy) 3.8 SC (7)	10 to 32 fl oz See label	Following leafspot advisories make 1 to 3 applications in mid-season. **Does not control foliar diseases.**	40	Apply up to 16 fluid ounces per acre at 2-week intervals or up to 32 fluid ounces per acre at 3- to 4-week intervals. Do not apply more than a combined total of 64 fluid ounces in a single growing season. See label for detailed information on rates. Do not plant small grains within 5 months of last application. See label for other plant-back restrictions.

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Disease or Diseases Controlled				
Limb Rot (Rhizoctonia)				
fluopyram + prothioconazole (Propulse) [4] (7 + 3)	13.7 fl oz	Follow leafspot advisories to make 1 or 2 applications in mid-season.	14	Apply during periods that favor limb rot development. Also suppresses Sclerotinia blight and Cylindrocladium black rot; see below.
Nematodes—Fumigants				
1-3 dichloropropene 97.5% (Telone II) 93.6% (Telone EC)	Various; see label	At least 2 weeks before planting	NA	Inject 8 to 10 inches below the soil surface. Very effective against all nematodes. Regulations require handler training and impose buffer zones and other restrictions on fumigant use. See the label and your county Extension center for details.
1-3 dichloropropene + chloropicrin 81.2% + 16.5% (Telone C-17) 63.4% + 34.7% (Telone C-35)	Various; see label	At least 2 weeks before planting	NA	Inject 8 to 10 inches below the soil surface. Very effective against all nematodes. Regulations require handler training and impose buffer zones and other restrictions on fumigant use. See the label your county Extension center for details.
metam sodium 42% (various brands) [5] 4.25 F	7.5 gal	At least 2 weeks before planting	NA	Inject 8 to 10 inches below the soil surface. If wet and/or cold weather occurs following fumigation, the waiting period should be extended. Soil aeration helps reduce residual chemical. When in doubt use a bioassay such as the lettuce seed germination test to determine if safe to plant. Moderately effective against Northern root knot nematode (M. hapla). Not very effective on peanut root knot nematode (M. arenaria). Buffer zones and other restrictions on metam sodium use are required. See your county Extension center for details.

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Disease or Diseases Controlled				
Nematodes- Nonfumigant				
fluopyram 15.4% + imidacloprid 22.2% (Velum Total) (7 + insecticide group 4A)	18 fl oz	At planting		Apply in-furrow at planting, directed on or below the seed. Also controls thrips, leaf hoppers, and aphids (see Chapter 5). Do not exceed 0.5 pound a.i./a imidacloprid for all seed, in-furrow, and foliar applications. See label for plant-back restrictions.
Seed and Seedling Rot; Pythium Pod Rot				
mefenoxam + azoxystrobin (Uniform) 390 SE (4 + 11)	.34 fl oz/1,000 ft of row	At planting	75	Apply as an in-furrow spray at planting. Only one application per season
azoxystrobin[1] (Abound 2.08 F; various brands) (11)	.4 to .8 fl oz/1,000 ft of row	At planting	14	Apply as an in-furrow spray at planting; counts as a group 11 application for resistance management purposes
mefenoxam (Ridomil Gold GR; various brands) (4) (Ridomil Gold SL; various brands) (4)	Per 1,000 ft of row: 6.5 oz .25 pt	At planting	75	Apply in-furrow or as a 7-inch band over row at planting
mefenoxam .50% + PCNB 10% (Ridomil Gold PC GR) (4 + 14)	12.5 to 25 lb	At planting	75	Apply in a 4-inch band

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Disease or Diseases Controlled				
Pesticide Formulation (FRAC Group Number)	**Amount of Formulation Per Acre**	**Application Schedule**	**Minimum Days to Harvest**	**Precautions and Remarks**
Seed and Seedling Rot; Pythium Pod Rot (continued)				
mefenoxam + PCNB 10% (Ridomil Gold PC GR) (4 + 14)	50 lb/14,520 linear ft of row	Early pegging	75	Apply in an 8- to 12-inch band. Do not apply to wet foliage as foliar toxicity may result. Use with other fungicides for late-season control of stem rot (*Sclerotium rolfsii*) and Rhizoctonia stem and pod rot (*Rhizoctonia* spp.).
mefenoxam (Ridomil Gold GR; various brands) (4) (Ridomil Gold SL; various brands) (4)	Per 1,000 ft of row: 13 oz .5 to 1 pt	Early pegging	75	Apply in an 8- to 12-inch band. Do not apply to wet foliage as foliar toxicity may result. Use with other fungicides for late-season control of stem rot (*Sclerotium rolfsii*) and Rhizoctonia stem and pod rot (*Rhizoctonia* spp.).
azoxystrobin (Abound)[1] 2.08 F (11)	24 fl oz	60 and 90 days after planting	14	Use no more than 2 applications of a group 11 fungicide per season. **Resistance management:** Site-specific fungicides should be mixed or rotated with another type of fungicide to minimize risk of developing fungal resistance. Also controls stem rot, Rhizoctonia limb and pod rot, and leaf spots.
azoxystrobin + fludioxonil + mefenoxam (Dynasty PD)[4] (11 + 12 + 4)	4 oz/100 lb seed	Seedling diseases: Apply to conditioned, untreated seed. Commercial application strongly recommended.	NA	Peanuts can be replanted immediately. Do not plant other crops within 45 days of planting treated seed.

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Disease or Diseases Controlled				
Seedling Diseases—Seed Treatments (continued)				
thiamethoxam + mefenoxam +fludioxonil + azoxystrobin (CruiserMaxx Peanuts)[4] (MOA 4A + 11 + 12 + 4)	3 to 4 oz/100 lb seed	See above	NA	Peanuts can be replanted immediately. See label for additional information about plant-back restrictions. Do not make any soil or foliar application of products containing thiamethoxam to crops grown from seed treated with CruiserMaxx Peanuts. Also controls some early season insects; see Chapter 5 for more information.
Sclerotinia Blight				
fluazinam (Omega) 500 F (29)	1 to 1.5 pt	1 to 3 applications according to weather-based advisory, field history, and scouting	30	Do not apply more than a combined total of 4 pints in a single growing season. Contact your county Extension center for details on weather-based Sclerotinia advisories.
boscalid (Endura)[2,3] 70 WG (7)	8 to 10 oz	See above	14	Make no more than two consecutive applications per season. Contact your county Extension center for details on weather-based Sclerotinia advisories. Also controls leaf spots and web blotch.
penthiopyrad (Fontelis)[3] 1.67 SC (7)	24 fl oz	1 to 3 applications according to weather-based advisory, field history, and scouting.	14	Suppression only. Apply at 2-week intervals or according to advisory. FRAC guidelines recommend no more than 2 applications of an unmixed group 7 fungicide in a 5-spray foliar disease control program. Do not apply more than 72 fluid ounces per season. Use on cultivars that have some Sclerotinia blight resistance, for example, Bailey. Also controls leafs spots, web blotch, southern stem rot, and Rhizoctonia limb and pod rot; see above.

Table 6-3. Peanut Disease Control (Most peanut disease control chemicals leave residues on peanut vines that make them unsuitable for hay. Check each label before using the material if you intend to feed hay to livestock.)

Pesticide Formulation (FRAC Group Number)	Amount of Formulation Per Acre	Application Schedule	Minimum Days to Harvest	Precautions and Remarks
Disease or Diseases Controlled				
Sclerotinia Blight (continued)				
fluopyram + prothioconazole (Propulse) (7 + 3)	13.7 fl oz	Use 1 to 3 times per season a full-season, 14-day, or advisory program	14	Suppression only. Apply at 2-week intervals or according to advisory. Use on cultivars that have some Sclerotinia blight resistance, for example, Bailey. Also controls southern stem rot and Rhizoctonia limb rot; see above.
Iprodione 4F (Rovral, various brands) (2)	24 fl oz	Use 1 to 3 times per season on a full-season, 14-day or advisory program	10	Suppression only. Apply at 2 to 3 week intervals or according to advisory. Apply at low pressure for a spray volume of at least 40 gal per acre. Do not apply more than 72 fluid ounces per season. Use on cultivars that have some Sclerotinia blight resistance, for example, Bailey.

Table 6-4. Characteristics of Selected Fungicides Labeled for Peanut Disease Control

Brand	Active Ingredient (group number)	Rate per Acre [1]	Controls [2]	Uses
Abound	azoxystrobin (11)	12.3 to 24.6 fl oz	ELS, LLS, web blotch, stem rot, Rhizoctonia limb and pod rot	Mid-season, especially where soilborne pathogens are a problem; no more than 2 applications of an unmixed group 11 fungicide in a 5-spray program.
Artisan	Propiconazole + flutolanil (3 + 7)	16 fl oz	ELS, stem rot, Rhizoctonia limb and pod rot	Mid-season, especially when soilborne pathogens are a problem; use a good leaf spot fungicide for next calendar or advisory spray
Bravo, various generic	chlorothalonil (M)	1.5 pt	ELS, LLS, web blotch, pepper spot	Inexpensive, resistance management. Repeated application can flare spider mites and Sclerotinia blight.
Convoy	flutolanil (7)	10 to 32 fl oz	stem rot, Rhizoctonia limb and pod rot	Mid-season; does not control foliar pathogens
Elatus	azoxystrobin (11) + benzovindiflupyr (7)	7.3 to 9.5 oz	ELS, LLS, web blotch, stem rot, Rhizoctonia limb rot	Mid-season, especially where soilborne pathogens are a problem; apply 7.3 oz/acre every 14 days or 9.5 oz/acre every 21 to 28 days.
Endura	boscalid (7)	8 to 10 oz	Sclerotinia blight; ELS, LLS, web blotch	At row closing or according to Sclerotinia advisory
Evito	fluoxastrobin (11)	5.7 oz	ELS, LLS, web blotch, stem rot, Rhizoctonia limb and pod rot	Mid-season, especially where soil borne pathogens are a problem; no more than 2 applications of an unmixed group 11 fungicide in a 5-spray program.
Fontelis	penthiopyrad (7)	12 to 24 fl oz	ELS, LLS, web blotch, stem rot, Rhizoctonia limb and pod rot	Mid-season, especially where soilborne pathogens are a problem; has some activity against Sclerotinia blight. No more than 2 applications in a 5-spray program.
Headline	pyraclostrobin (11)	6 to 15 fl oz	ELS, LLS, web blotch (all rates); stem rot, Rhizoctonia limb and pod rot (high rates)	Mid-to late season; no more than 2 applications of an unmixed group 11 fungicide in a 5-spray program.

[1]Rate listed is for most common formulation. Check label. [2] ELS=Early leaf spot; LLS=Late leaf spot.

Table 6-4. Characteristics of Selected Fungicides Labeled for Peanut Disease Control

Brand	Active Ingredient (group number)	Rate per Acre [1]	Controls [2]	Uses
Omega	fluazinam (29)	1 to 1.5 pt	Sclerotinia blight, suppresses stem rot	At row closing or according to Sclerotinia advisory
Priaxor	pyraclostrobin (11) + fluxapyroxad (7)	4 to 8 fl oz	ELS, LLS, web blotch, pepper spot (all rates); stem rot, Rhizoctonia limb and pod rot (high rates)	Mid-to late season; no more than 2 applications in a 5-spray program.
Proline	prothioconazole (3)	5.7 fl oz	CBR, Stem rot	Apply in furrow for suppression of CBR and stem rot.
Propulse	Fluopyram + prothioconazole (7 + 3)	13.7 fl oz	Stem rot, Rhizoctonia limb rot; suppresses Sclerotinia blight	Apply during periods that favor stem rot, limb rot, or Sclerotinia blight development.
Provost	tebuconazole + prothioconazole (3 + 3)	7 to 10.7 fl oz	ELS, LLS, web blotch, stem rot, Rhizoctonia limb and pod rot	Mid-season, especially where soilborne pathogens are a problem; no more than 3 applications per season (2 is preferred)
Stratego	propiconazole + trifloxystrobin (3 + 11)	7 to 14 oz	ELS, LLS, web blotch, pepper spot	Early season; counts as a strobilurin application
Various generic	tebuconazole (3)	7.2 oz	Stem rot, Rhizoctonia limb and pod rot. Not effective against some populations of ELS and LLS	Mid-season, especially where soilborne pathogens are a problem; always mix with chlorothalonil or other leaf spot fungicide for foliar disease control. Inexpensive.
Tilt, Bravo, various generic	Propiconazole + chlorothalonil (3 + M)	1.5 pt premix	ELS, LLS, web blotch, pepper spot	First spray, inexpensive, resistance management. Can be used full season if stem rot is not present; repeated use can flare spider mites in dry years.

[1]Rate listed is for most common formulation. Check label. [2] ELS=Early leaf spot; LLS=Late leaf spot.

Table 6-5. Managing the Risk of Fungicide Resistance in Fungicides Commonly Used for Peanut Disease Control

Group	Type	Fungicide	Resistance risk	Alternate With:
M	Multi-site	copper-containing and EBDC fungicides (Kocide, Mancozeb, various) Chlorothalonil (Bravo, various)	Very low	All
3	DMI	Tebuconazole (various), Tebuconazole + prothioconazole (Provost), Prothioconazole (Proline), Metconazole (Quash)	Moderate; some populations of leaf spot pathogens are not controlled by tebuconazole	Coppers, EBDCs, cholorothalonil, azoxystrobin, pyraclostrobin, fluoxastrobin, boscalid, flutalonil, penthiopyrad, fluxapyroxad
3 + M	DMI + multisite	Propiconazole + chlorothalonil (Tilt/Bravo)	Low when used as a mix	Coppers, EBDCs, chlorothalonil, azoxystrobin, pyraclostrobin, fluoxastrobin, boscalid, flutalonil
3 + 11	DMI + QOI (strobilurin)	Propiconazole + trifloxystrobin (Stratego), Tebuconazole + Trifloxystrobin (Absolute)	Low when used as a mix	Coppers, EBDCs, chlorothalonil, boscalid, flutalonil, penthiopyrad, fluxapyroxad
3 + 7	DMI + SDHI	Propiconazole + flutalonil (Artisan); Fluopyram + prothioconazole (Propulse)	Low when used as a mix	Coppers, EBDCs, chlorothalonil, azoxystrobin, pyraclostrobin, fluoxastrobin, fluxapyroxad
7	SDHI	Flutalonil (Convoy), Boscalid (Endura), Penthiopyrad (Fontelis)	Moderate	Coppers, EBDCs, chlorothalonil, tebuconazole, propiconazole + chlorothalonil, tebuconazole + prothioconazole, prothioconazole, azoxystrobin, pyraclostrobin, fluoxastrobin
7+11	SDHI + QOI	Fuxapyroxad + pyraclostrobin (Priaxor) (7+11), Azoxystrobin + benzovindiflupyr (Elatus) (11 + 7)	Low when used as a mix	Coppers, EBDCs, chlorothalonil , tebuconazole, tebuconazole + prothioconazole, prothioconazole, metconazole
11	QOI (strobilurin)	Azoxystrobin (Abound), Pyraclostrobin (Headline), Fluoxastrobin (Evito)	High	Coppers, EBDCs, chlorothalonil, tebuconazole, propiconazole + chlorothalonil, flutalonil + propiconazole, tebuconazole + prothioconazole, boscalid, fultalonil, penthiopyrad, fluopyram + prothioconazole

Table 6-6. A Comparison of CBR and Spotted Wilt Symptoms[1]

Symptoms	TSWV	CBR
Rings on leaves	Sometimes	No
Twisted petioles	Usually	No
Root rot	Sometimes	Yes
Wilting	Sometimes	Usually
Overall yellowing	Sometimes	Yes
Dead terminals	Sometimes	No
Brick-red fruiting bodies on stems or pods	No	Sometimes [2]
Stunted seeds, limbs, plant	Sometimes	No
Red seeds	Sometimes	No
Cracked seed coats	Usually	No
Cinnamon speckles on seed	No	Yes
Clumped in low areas	No	Often
Clearest symptoms	Early to mid-season	Late season
Dipstick ELISA test positive	Usually [3]	No

[1] Plants may have both diseases at the same time.

[2] If visible, CBR definitely is present.

[3] If positive, TSWV definitely is present.

Table 6-7. Peanut Disease Management Calendar

TIME OF YEAR		
Disease	**Threshold**	**Management Tactics**
SPRING (APRIL–JUNE)		
Spotted wilt virus (TSWV)	See TSWV risk index	Plant a resistant cultivar (Bailey, Georgia 07W, Sullivan or Wynne); use a high seeding rate or twin rows; plant after May 5 and before May 15; apply an insecticide in furrow. Consider an additional post-emergence insecticide application.
CBR (Cylindrocladium black rot)	1% to 10% disease in this field last time peanuts were grown (assumes good rotation; see Table 6-2)	Rotate 2 to 4 years; avoid soybeans in rotations. Plant a resistant cultivar (Bailey or Sugg). Consider an in-furrow fungicide application.
	More than 10% disease in this field last time peanuts were grown OR 1% to 10% disease if inadequate rotation (see Table 6-2)	Rotate 3 to 4 years; avoid soybeans in rotations. Plant a resistant cultivar (Bailey or Sugg) and fumigate before planting. Extend rotation if not fumigating.
JUNE–HARVEST		
Leaf spots, Web blotch, Pepper spot	R3 (beginning pods) R3+2 weeks (Bailey)	Rotate at least 2 years to any crop other than peanuts. Longer rotations are preferred. Plant a partially resistant cultivar (Bailey, Sugg, Sullivan, or Wynne). Use nozzles that give a cone-shaped spray pattern. Use 12 to 24 gal of water for ground sprayers or at least 5 gal of water for air application. **14-day program:** Four to six applications suggested. Begin applications at R3 (very early pod). The first application can be delayed 2 weeks on Bailey. Repeat applications at 14-day intervals. **Advisory:** Begin applications at very early pod (R3) or at R3+2 weeks on Bailey. Repeat applications when weather conditons become favorable as determined by peanut leaf spot advisories. This schedule requires strict adherence to the program guidelines and usually results in fewer fungicide applications than the 14-day schedule. Contact your County Extension center for details. **Scout fields:** if 20% or more leaflets have spots, begin a 10 to 14-day spray program.
	20% leaflets with spots	Reduce intervals to 10 days between sprays when over threshold. Switch to a more effective fungicide if late leaf spot, web blotch, or pepper spot becomes predominant. If using advisory, switch to a 10- to 14-day spray schedule.

Table 6-7. Peanut Disease Management Calendar

TIME OF YEAR		
Disease	**Threshold**	**Management Tactics**
JUNE–HARVEST (continued)		
Southern stem rot	Mid-July	Plant a partially resistant cultivar (Bailey or Sugg). Avoid highly susceptible cultivars. Rotate 2 to 4 years to nonhost crops. Use a soil fungicide or a foliar fungicide with efficacy against stem rot at least once from mid-July to mid-August, or up to three times on a susceptible cultivar. See leaf spots above for application information. Higher volumes of water (15 to 25 gal/a) or spraying at night may improve control.
Sclerotinia blight	In fields with a history of disease: begin CAREFUL scouting when rows are within 6 inches of touching, in early July, or according to advisory, whichever is earliest. Apply fungicide if disease is observed.	Plant a partially resistant cultivar (Bailey or Sugg). Avoid highly susceptible cultivars. Rotate 4+ years with nonhost crops. Continue scouting every two weeks or according to advisory and reapply fungicide if necessary.
SEPTEMBER–OCTOBER		
CBR, Sclerotinia blight, Southern stem rot	At digging	Inspect inverted roots and pods for disease symptoms and keep a map of problem areas. Use the map to plan rotations, cultivar selection, and control treatments for future peanut crops.
OCTOBER–NOVEMBER		
Nematode	Sample as indicated by the NCDA nematode-testing lab report	Plan rotation and nematicide use based on recommendations.

7. PLANTING, HARVESTING, AND CURING PEANUTS

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PLANTING

Factors discussed in earlier chapters, from land preparation to variety selection, have a direct impact on the planting operation. The planter should be selected and prepared to match the production practices to be used.

Planters are designed to perform five major functions: open a furrow, meter seed, place seed, cover the seed, and firm the soil around the seed. No-till planters, in addition to the five functions listed above, must also manage crop residue and prepare the row for planting. Peanuts are a fragile seed compared to corn, soybeans, or cotton. Seed damaged in planting may not germinate. A peanut planter must not only meter and place the seed accurately, it must handle the seed gently to avoid damage.

Planter Types

Two types of planters are available for peanuts: the plate planter and the air planter. Plate planters are divided into two groups based on the design of the plate: horizontal plate or inclined plate. Air planters used for peanuts also fall into two groups: pressure disk and vacuum disk. Air planters that use a seed drum are not recommended for peanuts.

Horizontal plate planters typically have a plate mounted in the bottom of the seed hopper. The plate for peanuts is modified to allow gentle handling of the seed as well as accurate metering. Usually the plate mechanism is an attachment that must be added in the seed hopper. Inclined plate planters may have one or two seed plates per row. The seed plate cells are sized and selected for peanuts and usually do not require modifications or attachments. Planters that have two seed plates per row have a lower plate speed, which provides gentle treatment. Plate planters, horizontal plate or inclined plate, are accurate and effective if properly set up and operated within the manufacturer's recommended ground speed range.

Air planters use a seed disk to meter the seed. The seed disk is mounted vertically in the metering chamber. Cells are cut or formed in the edge of the disk to meter the seed. Air pressure is used to hold the seed in the cells. Pressure disk planters use a fan to blow air into the metering chamber. Vacuum disk planters have a fan designed to remove air from a chamber behind the seed disk. The vacuum created holds seeds from the metering chamber in the disk's cells much like the pressure disk system. The key to accurate planting with an air planter is controlling air pressure or vacuum. If the pressure or vacuum is too strong, too many seeds may be held in the cell. Likewise, if the pressure or vacuum is too weak, the cells may not be properly filled. Brushes remove extra seeds from each cell. As with the plate planters, gentle treatment is important. Seed disks usually have more cells than seed plates, allowing the disk to turn slower. Air planters can maintain metering accuracy at higher ground speeds than plate planters and tolerate a broader range of seed sizes. Refer to the operator's manual for information on setup, operation, and speeds.

Preparing To Plant

Before the planting season, take time to give planting equipment a thorough examination. Look for signs of worn or damaged parts, drive chains, gears, and seed plates or disks. On air planters, look for cracks or leaks in the air tubes. Also check the air delivery on each fan. Make sure the drives are turning freely and lubricated, if required, according to the manufacturer's specifications. Seed plates are usually driven by a press wheel, gauge wheel, or transport wheel. This wheel provides power to turn the plates or disks, and often fertilizer or pesticide applicators as well. If the wheel is inflatable, check the air pressure. An overinflated or underinflated tire can seriously affect planting accuracy.

Be sure to calibrate fertilizer, pesticide, and planting equipment to ensure accuracy. Refer to the operator's manual to find the proper drive setup for your needs. Table 7-1 gives the necessary seed spacings for selected seed populations. Once the planter is set up, check its performance in the field to ensure continued accuracy.

Table 7-1. Seed Spacings for Various Seed Populations and Row Widths[1]

Row Spacing (Inches)	**Seed Population** (Seeds per Acre)				
	40,000	**45,000**	**50,000**	**55,000**	**60,000**
	Seed Spacing (Inches per Seed)				
34	4.6	4.1	3.7	3.4	3.1
36	4.4	3.9	3.5	3.2	2.9
38	4.1	3.7	3.3	3.0	2.8

[1] For twin rows on 36-inch beds, multiply the seed spacing for a single row by 2 to get the spacing in each of the twin rows.

HARVESTING

Preparing for Harvest

Successful harvesting begins with proper preseason maintenance of harvesting equipment. Peanut diggers and combines have many key parts that require service for good performance.

On diggers, start with the blades. The edge should be sharp, and the blade should not be worn away. As the blade wears it gets narrower and shorter, which means it may not do a good job of lifting the peanuts so the shaker can catch them. The shaker chain or shaker wheels are driven by either PTO or hydraulic power. For PTO-driven units, inspect the driveline carefully for wear or damage. Replace any missing safety shields! Repair any worn bearings or other parts in the driveline. For hydraulic powered diggers, inspect the hoses for wear or signs of leakage. Replace any damaged hose. Check the hydraulic control valve and the quick connects as well. Check the shaker chain or wheels for signs of wear. Replace any worn or damaged chain links, rattler bars, or kicker wheels. Also inspect the shafts and bearings for wear and replace where necessary. Finally, check the inverter arms. Be sure they are bent to the proper shape. Once your inspection is complete, hook up the digger and run the shaker. Once again, check for any signs of wear or damage in the system.

For peanut combines, start by checking the input driveline for wear in the universal joints and wear or damage to the telescoping tube and the coupler. Check the lubricant in the gearboxes and service as recommended by the manufacturer. Check chain drives for wear and proper tension. Replace any chain or sprocket that does not measure up to specifications. Check belts for wear and proper tension. Replace worn belts and pulleys as necessary. Check the condition of shafts and bearings to be sure they are acceptable. Look inside the combine and check the condition of stripper bars on the cylinders and on the concaves. Replace any broken stripper teeth. Look for clogged or blocked holes in the concaves. If the openings are blocked, peanuts cannot fall through into the cleaning pan. Check shaker pans or cylinders throughout the combine for proper movement or timing. Inspect the stemmer saws for proper alignment. Replace any blades that are broken. Check the condition of the shaker pans, lip screens, or other cleaning elements, and be sure they are set properly. Inspect fan blades for wear and fan housings and conveyor tubes for air leaks. Air leaks can prevent proper cleaning or handling of the peanuts. Look inside the elevator tubes for obstructions. Peanuts will crack if they hit obstructions, resulting in a lower grade. Finally, check the hopper and dump cylinders to be sure they are working.

Refer to the operator’s manual for recommended adjustments and settings. In addition to the recommendations above, give the machine a general inspection to find and repair loose or broken parts. A little time spent in preseason maintenance can save many hours during the harvest season. Above all, observe all safety precautions while servicing or operating the digger or combine!

Digging

Peanuts should be dug when maximum yield and quality can be obtained. The hull-scrape test can help predict the best time to dig. Contact the county Extension center for more information. Pay close attention to the weather when planning digging. If digging and combining are staggered, peanuts won't be left too long in the windrow.

Once digging begins, keep digging losses to a minimum. Most harvesting losses occur in the digging operation and can be enormous if not carefully managed. Heavy digging losses are unavoidable when pegs are weakened due to over maturity or premature defoliation caused by disease, or when the soil is very dry and hard. Under normal conditions, a yield loss of 5% or less should be possible if the digger is adjusted and operated properly.

Reducing Digging Losses. Digging losses can occur below ground or above ground. Losses that occur below ground level occur when peanuts are cut off when the blades are run too shallow and when peanuts are lost as the soil is pushed up the blades and fingers onto the shaker and are being lifted out of the soil. Losses also may occur as the plants are being elevated and shaken to remove dirt, and as the peanuts are placed in windrows. These losses are usually seen on top of the ground. Adjusting the digger for optimum performance requires considerable operator skill. The following guidelines should help with the adjustment process.

Blades should be sharp and should penetrate to the same depth from side to side. A slight forward pitch of the blades (the back edge slightly higher that the cutting edge) will loosen the soil around the pods, making their removal from the soil less likely to break the pegs. Refer to the operator manual for your blade manufacturer's recommendation. Ideally, the blades should cut the taproot of the plant just below the pods. In some fields, however, the blades may have to be run deeper in the heavier spots. Pay close attention the operator's manual for the digger for guidance on setting the depth of the plow. Most digger blades are designed to run with the bevel facing up or facing down. Install the blades with the bevel up for conditions where the soil is dry or difficult to penetrate. Adequate but not excessive soil moisture improves digger operations. Changes in soil type or moisture within a field can cause the digger to run deeper or shallower. If the digger runs shallow, peanuts will be lost when the blade cuts them off. Pay close attention to the windrow and look for signs of inadequate depth.

Proper synchronization of ground speed and shaker speed is essential to keep from dragging the plants forward, on the one hand, or snatching them backward out of the soil on the other. Optimum shaker speed is slightly faster than ground speed. The plant should rise vertically and fall back to the ground close to where it was growing. If the shaker is PTO-driven, there is a fixed ratio between ground speed and PTO speed in each tractor gear for most tractors. Thus, speed must be synchronized by selecting the proper gear to operate in. Most modern tractors have a sufficient selection of gears to allow synchronization. Some tractors may offer a PTO that is internally synchronized to ground speed. Hydrostatic drive tractors provide infinitely variable ground speed at any given engine speed, making it easier to achieve synchronization. Hydraulically driven diggers can provide a constant shaker speed at any engine speed that provides adequate oil flow in the hydraulic system. Hydraulic diggers can be synchronized more accurately by adjusting the tractor hydraulic control valve. The operator can chose the best gear for the tractor and then synchronize the digger to match it. Even with proper synchronization, ground speeds in excess of 4 miles per hour will tend to jerk the plants from the soil and cause heavy pod losses.

The final stage of the digging operation, windrowing can also lead to harvest losses. As the peanut vines flow off the shaker, they fall onto a kicker wheel assembly and slide across the inverter guide rods. Check the kicker wheel drive to be sure the kicker wheels are turning with the shaker chain. Carefully inspect the guide rod section of the implement to ensure the guide rods are properly spaced and positioned. If the rods are bent out of position, the peanuts will not flow with the rods but will push across them causing peanuts to be raked off the vine and lost. Make sure the rods are smooth and free of rust. Corroded or damaged rods can also impede the flow of vines and cause harvest loss.

In some cases, heavy vine growth makes it difficult to see the furrows during digging. Using a GPS receiver and a light bar as a guidance tool can make the digger operation much smoother. The light bar can help the operator stay properly positioned on the row and thus reduce potential losses.

Keep Windrows Loose. Windrows should be loose and fluffy for good drying and should be placed on level ground, or preferably, on a slight ridge for drainage. If flat cultivation was practiced, this will not present a problem. Otherwise, mount a device like a drag bar or leveler under the shaker to tear down the row beds and form a slight ridge under the windrow.

Inverters should be adjusted to turn the plants completely upside down so that the peanuts are fully exposed to air and sunlight for fast drying. Peanuts in contact with the ground do not dry as rapidly under normal conditions as those supported off the ground, and they will be much more susceptible to damage during adverse weather conditions. On hot, sunny days, peanuts very close to or in contact with the soil may get too hot and develop off-flavors or poor milling quality.

Lifting Windrows

Reshaking or lifting windows often helps with drying, particularly if the soil was wet at digging or if rain soon after digging stuck the vines to the soil. Two types of lifters are available: chain and finger. The chain lifter functions much like the shaker chain on the digger-shaker-inverter. Careful synchronization of the lifter conveyor with ground speed is necessary to avoid excessive harvest loss. The finger lifter has a digger style blade that runs just below the soil surface to break the vines free and elongated fingers to lift the vines and allow some dirt to separate. Breaking the soil crust with the blades may help speed field drying in some cases. Avoid lifting or reshaking when the vines have become very dry and brittle, otherwise heavy losses will likely occur.

Combining

Combining is the culmination of a year's peanut production efforts. As such, it deserves careful assessment to ensure the maximum yield and best quality. Modern combines will get peanuts off the vines under almost any circumstances. Field losses, mechanical injury, germination, and even flavor, however, may be influenced by the feeding rate into the combine, the cylinder speeds and clearances, the cleaning and conveying fan speeds, and the moisture content of both peanuts and vines at picking.

Tests by various researchers have indicated that hull damage, loose shelled kernels, and shelling damage (splitting and skinning) are less for peanuts combined at moisture contents of 25% to 35%. However, combining at 20% moisture will reduce curing time and costs. During periods of good drying weather, combining can safely be delayed to take advantage of additional infield drying. Vines should be dry enough to break and tear apart readily.

Picking action should be just aggressive enough to remove all the peanuts from the vine with a minimum of vine breakage. Excessive picking action takes more power and breaks the vines into short pieces so that instead of passing out over the vine racks, they fall through with the peanuts and overload the cleaning screens.

Stripper fingers or bars should be adjusted as moisture conditions change during the day. The front strippers are usually set to be more aggressive than those in the rear. Long, clean hay should be discharged from the machine with a minimum of short, broken vines in the hopper.

Cylinder speed should be kept to the manufacturer's recommendation or below and never more than is required to get the peanuts off the vines. Slow cylinder speeds are especially important when combining seed peanuts. Some cylinder speeds are adjustable independently of tractor engine rpm; on others, the speed is regulated by the tractor throttle and is generally correct when the tractor PTO is operating at rated PTO speed or the PTO speed recommended by the combine manufacturer.

Keep tractor engine speed near the recommended level in order for the cleaning and conveying components of the combine to work properly.

Watch Air Velocity. Air conveyors on the combine can cause considerable hull cracking if the fans are operated too fast or the dampers are not adjusted properly. Use only enough air velocity to lift the peanuts into the bin. The air velocity for the cleaning screens also requires frequent checking and adjustment. Sufficient air should be supplied to blow sticks, trash, and “pops”—but not marketable peanuts—out of the machine. If the screens become heavily loaded with trash, it may not be possible to get good separation. Consequently, either good peanuts will be blown out or trash will go into the bin. Overloading of the screens may indicate that picking action is too aggressive. Tail board adjustment also affects what is blown out of the back for any given fan setting.

Proper synchronization of the combine pickup with forward speed is important to minimize field loss of peanuts. The windrow should flow evenly and smoothly into the combine, without being pulled apart by a ground speed that is too slow or pushed ahead by a ground speed that is too fast. Either situation will cause peanuts to be lost off the vines before getting into the combine. Some combines have an adjustment to quickly change pickup reel speed; on others, a sprocket must be changed. In either case, changing gears on the tractor will affect synchronization and reel speed should be adjusted. The pickup tires should run just above the ground surface. If they are allowed to dig into the ground, they will pick up dirt and carry it in with the peanuts.

Combine pickup and cleaning losses (peanuts picked but blown out) can be appreciable. However, proper adjustment and operation of the equipment can virtually eliminate these losses.

Estimating Harvest Losses

The level of harvest loss in the field can be used to check digger or combine performance. Excessive losses may indicate problems with equipment adjustment or operation. Harvest losses can be estimated based on the number of pods left on or in the ground after digging or combining.

Measure a sample area behind your digger or combine. For example, if your row spacing is 36 inches, and you have 2 rows per windrow, you are working with a sample width of 72 inches or 6 feet. If you measure 20 inches along the row, you will have a sample area equivalent to 10 square feet. Any peanuts you pick up in that 10-square-foot sample can be used to estimate losses using Table 7-2 below. You can use any size area you want, but bear in mind that the larger the area, the more accurate your estimate will be. An alternative would be to use an area of 0.001 acres, 6 feet by 7.26 feet, or 43.56 square feet. Again, the number of pods picked up in the sample area is used to estimate yield loss.

To use the table, first measure your sample area and calculate its size. Then count the number of pods found in the sample area. Harvest loss is determined by converting the number of pods found in a given area into a pound per acre estimate. Say for example that you planted the Gregory cultivar. After combining, you marked off a 10-square-foot area and counted 20 pods on the ground. For the Gregory cultivar, the table tells us each pod in a 10-square-foot area is equivalent to 24 pounds per acre. Therefore, harvest losses would be 24 × 20, or 480 pounds per acre. If you used the 0.001-acre sample size, each pod collected in the sample for the Gregory cultivar would be equal to 5.51 pounds-per-acre yield loss. If 60 pods were collected, the yield loss would be 60 × 5.51, or 331 pounds per acre.

When estimating yield losses, particularly behind the digger, bear in mind some of the loss is due to overly mature pods, or "shedding" loss. There may be little you can do to the equipment to reduce this loss component.

Table 7-2. Harvest Loss Table

Cultivar	Loss (lb/a) for 1 Pod per Square Foot	Loss (lb/a) for 1 Pod per 10 Square Feet	Loss (lb/a) for 1 Pod per 0.001 Acre
Bailey[1]	219	21.9	5.04
Florigiant[1]	218	21.8	5.01
Gregory[1]	240	24.0	5.51
NC 12C[1]	224	23.4	5.15
NC 7[1]	244	24.4	5.59
NC-V 11[1]	215	21.5	5.95
Perry[1]	232	23.2	5.33
Phillips[1]	221	22.1	5.06
Sugg[1]	222	22.2	5.09
VA 98R[1]	217	21.7	5.08
VA-C 92R[1]	233	23.3	5.35
Wilson[1]	224	22.4	5.14
FCIC-Virginia Type Average[2]	187	18.7	4.29

[1]Based on pod weights from NC State University variety test data.

[2]Based on data from the Federal Crop Insurance Corp.

Harvest Safely

Always remember: tractors, diggers, and combines are potentially dangerous pieces of equipment. There are many moving parts, not all of which can be completely shielded. Always disengage power before making adjustments. Never allow bystanders or riders near the combine when it is in operation. Keep all protective shields and guards in place. Above all, be alert and on the lookout for hazardous situations. Read the operator's manual and observe all safety precautions.
Learn to recognize and avoid hazards. Contact the county Extension center for recommendations on improving safety in farm operations.

CURING PEANUTS

Efficient operation of the peanut curing system involves: (1) cleaning and repairing the equipment before harvest, (2) windrow curing the peanuts as long as practical, and (3) operating the equipment properly.

Preseason Operation

The preseason cleaning and repairing of the curing trailer, plenums and canvas connectors, and the fan and heater can pay big dividends. Dirt and old crop residue under the trailer curing floor and in the trailer plenum chamber can block air flow and contaminate the new peanuts with aflatoxin. The best way to clean the curing trailers is to remove the floor assembly and flush out the trailer with a stream of high-pressure water.

Clean leaves or trash from the fan and plenum. These can be a fire hazard when the burner is operating. Cut any grass and weeds that could restrict the air inlet to the fan. Remove all trash that could restrict air flow to the fan screen. Clean the dirt and trash off the fan blades to reduce drag.

Make sure that the LP gas line from the tank to the burner is in good condition and not damaged. Most peanut fans have a ring-type heater with many holes for gas-air mixture. Clean these burner holes to ensure good ignition and an even flame all the way around the burner. If some of the holes are plugged or partially closed, too little gas-air mixture may exit for good ignition or proper burning, which will waste fuel.

Check all electrical wiring, fuses, breakers, and controls. Make sure they are properly installed and functional. Have an electrician make upgrades or repairs.

Check the main air plenum, canvas connections, and the trailer air plenum for holes and leaks. Be sure to repair all leaks to conserve energy. Air leaks waste energy and increase the curing time. A crack or hole measuring only 1 inch by 24 inches will leak approximately 350 cubic feet per minute on a typical curing system. An extra gallon of LP gas will be required to heat the air leaking from this crack every 11 hours when the burner is raising the temperature 20 degrees, and the leak will also slightly lengthen the curing time. Before you begin harvesting peanuts, operate the fan and heater for about 30 minutes to make sure they are functioning properly. Also, while the fan and heater are operating, turn the thermostat and humidistat up and down to make sure that they are functioning properly.

Refer to the owner's manual for further recommendations on adjustments and maintenance of the curing equipment.

Windrow Drying

The cost of curing peanuts is greatly influenced by the time they remain in the windrow. The longer they remain in the windrow, the more the peanuts cure (dry), and the lower the curing fuel cost; however, windrow losses may begin to increase three to five days after digging and inverting the peanuts. Even though windrow losses may increase when the peanuts remain in the windrow too long, especially in bad weather, curing costs will decrease as the peanuts continue to dry in the windrow. The most economical time to combine the peanuts is when the curing cost savings from windrow drying equals the lost value of the additional peanut losses from windrow drying. As the cost of curing fuel increases, the time in the windrow must increase to achieve the maximum profit.

Curing Operations

Air Flow. To properly cure peanuts, maintain sufficient air flow and proper temperature. If air flow rates are too low, the peanuts will mold. If the air flow is excessive, the energy costs will be high. The recommended air flow rates were established to prevent mold development during curing; however, they have also proven to be the most economical. The general recommended air flow of 50 cubic feet per minute per square foot of curing floor (cfm/sq ft) at 0.75 inch static pressure is sufficient to cure up to 25% moisture peanuts 5 feet deep. The air flow provides 10 cubic feet per minute per cubic foot of peanuts at a depth of 5 feet.

Once the fan is selected, air flow adjustments must be made by varying the curing depth or by not using all of the trailers for the system. For example, filling all the trailers half full will result in a higher air flow than completely filling half the trailers. When filling the trailer, be sure to level the peanuts to ensure uniform air flow. Avoid overfilling the trailer. The minimum or desired air flow rates along with the maximum curing depth using the recommended curing fan is shown in Table 7-3.

Table 7-3. Recommended Air Flow Rates

Initial Moisture Content (%)	Minimum Air Flow Rate (CFM/cu ft)*	Maximum Curing Depth* (ft)
15	5	8
20	6	6
25	10	5
30	12	4
35	15	3

*Based on a system air flow rate of 50 cfm/sq. ft. At 0.75 in. S.P.

Heat. To maintain good flavor and milling quality in the peanuts, maintain the proper curing temperature. If the curing temperature is too high, the peanuts will split when shelled and may also develop a bad flavor. Never allow temperature to exceed 95°F. The recommended temperatures can be controlled by manually adjusting the heat or using a modulating thermostat, or by using a humidistat and an on-off thermostat. When using manual heat control, adjust the LP gas pressure to achieve the desired temperature rise or curing temperature. Most fan and burner units have a gas pressure versus heat chart. This chart usually shows the British Thermal Units (Btu) output for various gas pressures. If your burner has a "high" and "low" pressure heat value, be sure to use the low position for peanuts. The following formula is a useful aid in adjusting the heat input: Btu/hr = 1.1 × fan cfm × temperature rise.

When using an on-off thermostat and a humidistat, adjust the temperature rise to approximately 15 to 20 degrees to reduce the cycling of the burner flame early in the season when the weather is warm. The temperature rise can be increased late in the season when the nights get cold as shown in Table 7-4.

The best temperature controller is a modulating thermostat, which varies the temperature by raising and lowering the firing rate (flame size) without cycling when

Table 7-4.Temperature Adjustments

	Outside Relative Humidity (%)					
	90	60	30	90	60	30
Outside Temperature (°F)	Desired Temperature Rise (Added Heat, °F)			Desired Curing Temperature (°F)		
40	25	20	15	65	60	55
50	20	15	10	70	65	60
60	15	10	5	75	70	65
70	10	5	–	80	75	–
80	5	–	–	85	–	–

the weather changes. A modulating thermostat should be set on approximately 75°F if a constant temperature is desired; however, adjusting the setting for the weather conditions as shown in Table 7-4 is preferred.

Steps to Increase Curing Efficiency. When the hulls are wet, drying efficiency is very high. After hulls are dry, especially during the last half of the curing cycle, the drying efficiency decreases. Therefore, you need a higher air flow for the first half of curing than during the second half of the curing cycle. Air flow can be reduced during the last part of the curing cycle on a multiple trailer plenum system by partially closing the air gates of the trailers during the last half of the curing period. Generally, having the air gate half open keeps the curing efficiency high during the final curing stage. By reducing the air flow to some trailers in the final curing stages, the other trailers in the first curing stages containing peanuts with wet hulls will receive an increased air flow. Do not partially close enough air gates to restrict the fan or to cause the heater to malfunction.

On many curing systems, the trailer nearest the fan receives the least air. On these systems, the adjustments can be made by starting the newly filled trailers on the furthest end from the fan until the hulls are dry, and then moving this trailer to the other end of the plenum nearest the fan.

Another way to adjust air flow is to fill the peanut trailers only half full for the first half of the curing cycle to dry the hulls, then dump and mix two trailers into one trailer for the final half of the curing cycle. This method is more desirable than adjusting the air gates if dumping and handling facilities are available. The dumping and reloading of the peanuts will remove some dirt and mix the bottom layer of peanuts with the top layer resulting in a more uniform final moisture content.

Another way to save on heat energy cost and possibly improve curing quality is to recirculate part of the curing air to maintain an ideal curing temperature and relative humidity. This will require equipment changes or a specially designed curing building for the trailer and fans. Research indicates that 40% to 50% savings in energy consumption can be obtained using the recirculating systems compared to the conventional systems. A key advantage of the recirculating systems is that if the wagons leak air, the air goes back into the building and is recirculated—not lost to the outside. The economics of converting to a recirculating system will depend on the cost of the changes required and current energy cost.

PRECISION AGRICULTURE FOR PEANUTS

Precision agriculture is a combination of information resources, technology, and management practices designed to work together to improve productivity. Some of the technology that can be applied to peanut production includes GPS, GIS, guidance systems, variable rate controls, applicator controls, yield monitors, and automatic curing controls. Some of the more common technology resources and their possible application in peanut production are explained in this section.

Global Positioning System (GPS)

GPS receivers are designed to give the user accurate and precise position data, latitude and longitude, wherever the receiver is located, provided it can receive the satellite signal. GPS makes many other technologies in precision agriculture possible. Farmers have a wide range of choices in GPS receivers. The most common point of discussion is "How accurate is it?" GPS accuracy can be evaluated on the basis of static accuracy, the ability to return to an exact point after a long period of time. Pass-to-pass accuracy usually refers to the system's ability to track positions within a few minutes of each swath.

GPS accuracy is based on the type of differential correction used. Differential GPS (DGPS) systems include beacon correction (Coast Guard and DOT towers), the Wide Area Augmentation System (WAAS), and commercial satellite subscription systems. These systems typically provide meter-level static accuracy and can provide accuracy of several inches in pass-to-pass. Dual frequency GPS receivers are more accurate, providing accuracy of around 1-foot static and a few inches pass-to-pass. The most accurate GPS is real-time kinematic (RTK), which can deliver static and pass-to-pass accuracy of around an inch. RTK systems require a higher level of correction to achieve this accuracy. Farmers can either set up their own base station or take advantage of a dealer or cooperative RTK network that can be shared by many users.

Geographic Information Systems (GIS)

Geographic information systems is the term used to describe a family of computer software products used to manage data and information that can be georeferenced or tied to a map position. Many manufacturers offer a version of GIS software that is customized for farmers. These packages are often very user friendly and include the tools a farmer is likely to need. These include the ability to create field boundary maps, import maps from other sources, record field data, record scouting reports, assign crop enterprises, generate prescription application plans, and analyze yield maps. Some programs are available in both office and mobile versions. Office versions run on desktop or laptop computers, and mobile versions run on laptop or hand-held computers. Mobile software is extremely useful for field scouting and mapping boundaries. Some programs integrate well with other farm management software or programs to give the farmer a complete management package.

Guidance Systems

A guidance system is an electronic control system that aids the operator in steering or guiding a vehicle over a course or swath. Systems used in agriculture are based on the global positioning system (GPS). GPS data are used to determine accurate machine position, travel speed, and travel direction. Once position, speed, and direction are determined, the control program can monitor and provide correction information to keep the vehicles on the desired path. GPS can be utilized for guidance at any level of correction: WAAS, beacon, satellite subscription, and RTK. However, the higher the accuracy of the GPS service, the more precise the steering control will be.

Current guidance systems fall into two categories: steering aids and automatic steering. Steering aids include light bars and navigation screens. Light bars use a series of lights to indicate to the operator how much steering correction is needed to keep the vehicle on track. Each light left or right of the center can be programmed to represent whatever level of correction the operator wants to see. Navigation screens use a visual representation of the vehicle on a map. The guideline is projected on the map screen, and the operator uses the vehicle image on the map to keep the vehicle on the swath in the field. Some steering aids use both light bar and map screen layouts.

Automatic steering systems interface with the tractor steering system and provide steering control while the vehicle is on the swath. The operator still takes over steering control for turnarounds. In the event of a problem, the operator can override the automatic steering at any time. Automatic steering systems use guidelines established in the field to steer the vehicle. Like steering aids, the guidelines can be straight lines or curves, depending on the type of system. Once a set of guidelines are created, they can be used repeatedly in that field. Automatic steering systems fall into two types: steering wheel interface and electro-hydraulic interface. A steering wheel interface can be adapted to a wide range of vehicles. As its name suggests, it is attached to the steering column and engages the steering wheel much like an operator's hand. Precision motors are used to move the wheel to keep the vehicle on the swath. Electro-hydraulic interface systems use an electronically controlled hydraulic valve that is installed in the vehicle's hydraulic steering circuit. These systems must be matched to the specific vehicles they are designed for. Installation will require mounting the valve and its controls and sensors, as well as adding hydraulic hoses to tie into the hydraulic steering circuit.

Guidance systems can be used to advantage in almost any field operation in peanut production. The best uses, however, would be planting, cultivation, chemical application, and digging. Guidelines can be created at anytime; however, the best advantage is obtained when the guideline is created early and used to help control other operations throughout the season. For example, a guideline file can be created during bedding or planting and used to guide cultivation, chemical application, and digging. In a test conducted at the Peanut Belt Research Station in 2009, plots that were dug using a wheel-interface automatic steering system showed an increase in yield of 363 pounds per acre over plots dug with manual steering. In this test, the peanuts were planted using the automatic steering system and the planting guideline was used for digging. Based on a system cost of $23,500 for the automatic steering components and $0.25 per pound for peanuts, payback can be achieved in 256 acres. Further testing is needed to confirm that these results can be sustained.

Guidance systems used in crop production can provide many advantages:

- More uniform broadcast applications due to reduced skips and less overlap.
- Increased field capacity due if higher operating speeds are possible.
- Controlled traffic to reduce soil compaction.
- Ability to stay on swath in rank vine growth during late season spraying and digging.

Variable Rate and Applicator Controls

Variable rate control systems are available for a wide range of crop inputs: fungicides, insecticides, herbicides, lime, fertilizer, and others. If you can determine, through soil sampling, scouting, or other analysis, areas of a field that do not need as much of a particular input as others, then you may have a situation where variable rate control can be beneficial. Variable rate application may not reduce the total amount of an input, but will certainly allow you to use the input more efficiently by making sure you have the correct amount applied for any given area of the field.

Most variable rate control systems rely on georeferenced prescription maps. Systems are being developed to apply products based on real-time sensor data. The variable rate controller reads position data from a GPS receiver. The controller then determines the rate of input for that location stored on the prescription map. The rate information is converted into a control signal for the valve or motor that drives the applicator. Finally, a feedback signal is picked up and sent back to the rate controller to fine-tune the output. The result is an accurate application of the product based on the prescription recorded on the map. As an added advantage, the controller can also generate a record map of the exact rate applied by the system. This record can prove to be valuable documentation.

Applicator controls are also available to help the farmer control the system's operation in the field, even if a variable rate approach is not used. Many controls are available now that allow the farmer to automatically manage individual sections or rows of a sprayer or a planter. These controls can be particularly useful to avoid areas of double application around headlands in oddly shaped fields.

Crop Monitoring

There are many applications under development for collecting crop health or status data during the growing season. Satellites, airplanes, and unmanned aerial vehicles (UAV) are among the options available. Data in the form of visual images, multispectral images, hyperspectral images, and others are currently available. Applications of these sensor platforms and the data they generate for peanut are under development and may prove to be valuable management tools.

Yield Monitors

Yield monitoring provides a check to see if management and production practices throughout the season have paid off. Yield maps and the detailed analysis of yield response to inputs can help the farmer fine-tune production practices and enhance efficiency. At this point, there are no widely used commercial yield monitors available for peanuts. A basket load cell-based system was developed and licensed by the University of Georgia; however, it is no longer available from the manufacturer. Several studies have been conducted to adapt the cotton yield monitor to peanuts. Although this has been effective in some cases, it has not been adopted on a wide scale. Development of a reliable yield monitor for peanuts will complete the precision agriculture package.

A Comprehensive Approach

Precision agriculture, like most management systems, has some limitations and problems that must be overcome. When considering using precision agriculture technology for peanut production or for other crops, the farmer should consider the entire production system. Focus on technologies that are applicable to a particular problem, and also explore how these technologies can be used in other areas. Some applications are well developed, while others need further research to determine the best way to use the technology for crops such as peanuts. Multiple uses of equipment help spread the cost over several operations or even several crops. For example, a GPS-based guidance system selected to help guide a planter can also guide a sprayer and a digger. Rate controllers used for sprayers may also be able to control a planter. It may not be necessary to purchase every available technology on the market. Before launching into a system, compare the options and alternatives carefully. Start out with the most applicable technologies first, and then add to them as needed.

8. GUIDELINES FOR THE NORTH CAROLINA PEANUT PRODUCTION CONTEST

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BACKGROUND AND CRITERIA

For many years the North Carolina Peanut Growers Association, in cooperation with the North Carolina Cooperative Extension Service, has supported a peanut production contest at county and state levels. The contest involves a combination yield per acre and additional points based on total acreage. The following criteria are currently being used and include an example calculation.

1. *Eligibility:* Must produce at least 25 acres of peanuts.

2. *Requirements:*

   A. Variety—Any variety can be grown.
   B. Acreage—The entire peanut acreage under production by an individual will be used to determine official yields. The applicant enters the county in which he/she is a resident, regardless of the percentage of peanuts they produce in that county. The county of residence for the entrant must have at least 1,000 acres. In addition to applicants from counties with acreage exceeding 1,000 acres, growers in counties with fewer than 1,000 acres will be pooled into a category. The winner of this category will compete directly with winners from counties with at least 1,000 acres.
   C. Entry requirement—Official yields will be determined by the county Cooperative Extension Service agent. Unlike the past, the contest will require trust that the applicant is accurately providing yield and acreage information.

3. *Point System:* An example of point calculations is provided below. The official entry will be from the contestant's county of residence (Figure 1).

Step 1. Yield—Average yield per acre divided by 100
Step 2. Acreage—Points will be accumulated for acreage as follows:

A,	0 – 100 acres	0 points
B.	101 – 200 acres	1 additional point or fraction thereof
C.	201 – 300 acres	1 additional point or fraction thereof

D.	301 – 400 acres	1 additional point or fraction thereof
E.	401 – 500 acres	1 additional point or fraction thereof
F.	501 – 600 acres	1 additional point or fraction thereof
G.	601 or higher	No additional points

Sample calculation:

Farmer produces 2,397,407 pounds on 420.2 acres
Average yield = 2,397,407 divided by 420.2 = 5,705.4 pounds per acre

Step 1. 5,705.4/100 = 57.054
Step 2. Acreage

0 – 100 acres	=	0 point
101 – 200 acres	=	1 point
201 – 300 acres	=	1 point
301 – 400 acres	=	1 point
401 – 500 acres	=	0.202 point
Total Points	=	**60.256**

GROWER SURVEY

Applicants also must complete a survey of production and pest management practices (Figure 2). Results from surveys often are incorporated into recommendations for North Carolina peanut producers.

Figure 1. Sample Certification Form

CERTIFICATION OF POINTS IN PEANUT PRODUCTION CONTEST

Mail to: David Jordan, Box 7620, NC State University, Crop Science Department, 4207 Williams Hall, Raleigh, NC 27695-7620, Phone 919-515-4068, FAX 919-515-7959

Date ____________________

Applicant ____________________ County ____________________

Address ____________________ Total Points ____________________

____

Official Yield __________ ON ALL ACRES PRODUCED BY THE APPLICANT

THE APPLICANT CERTIFIES THAT ___________POUNDS OF PEANUTS WERE HARVESTED FROM_____________ACRES. THE UNDERSIGNED PARTICIPANT GUARANTEES, IN GOOD FAITH, THAT THE PRODUCTION FOR THE GIVEN CROP YIELD AND THE ACRES ON WHICH PRODUCTION OCCURRED ARE ACCURATE.

Average Yield/ Acre = ____________________ points

Acreage

A. 0–100 acres __________

B. 101–200 acres __________

C. 201–300 acres __________

D. 301–400 acres __________

E. 401–500 acres __________

F. 501–600 acres __________

G. 601 or higher __________

Total __________

Grand Total __________

Signatures

County Agent ____________________

Applicant ____________________

Figure 2. Sample Production Practices Survey

MANAGEMENT PRACTICES FOR PRODUCTION CHAMPION

Applicants must complete this form to be eligible for the contest.

Name ________________________________ County ____________________
Address _______________________________________
Date ___________________________
1. Planting date: _________________________
2. Seeding rate: _________________________
3. Row spacing: _________________________ Twin or single rows: __________
Please provide approximate percentage of acres for each.

4. Varieties (please indicate approximate percentage of acres for each variety):
____
5. Rotation Crops:
2014 _______________ (if more than one, please include percentage of acres)
2013 _______________ (if more than one, please include percentage of acres)
2012 _______________ (if more than one, please include percentage of acres)
2011 _______________ (if more than one, please include percentage of acres)
6. Lime applied and rate:
2015 ____________________ 2014 ____________________
7. Fertilizer used: ___________________________ (provide percentage of acres)
8. Land plaster (please list trade name):
A. Broadcast or Banded _____________
B. Bagged, Bulk, or Granular _____________
C. Rate and application date _____________
9. Herbicides:

Burndown	________	________	________
Preplant	________	________	________
Preemergence	________	________	________
At cracking	________	________	________
Postemergence	________	________	________

10. Leaf spot program: (list fungicide for each timing)

A.	________	E.	________
B.	________	F.	________
C.	________	G.	________
D.	________	H.	________

11. What percentage of your acreage was treated for Sclerotinia blight? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

12. What percentage of your acreage was fumigated for CBR? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

13. What percentage of your acreage was treated with an in-furrow insecticide? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

14. What percentage of your acreage was treated for foliar insects? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

15. What percentage of your acreage was treated for southern corn rootworm? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

16. What percentage of your acreage was treated for spider mites? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

17. What percentage of your acreage was irrigated? (circle the percentage)

0 20 40 60 80 100 Chemical used ____________________

18. Did you apply boron? ______ How much and what brand?___________________

19. Did you apply manganese? ______ How much and what brand? ______________

20. Did you inoculate? ______ What product and what percentage of acres?

____

21. What percent of your acreage received the following tillage practices?

Disk	0	20	40	60	80	100
Chisel	0	20	40	60	80	100
Moldboard plow	0	20	40	60	80	100
Field cultivate	0	20	40	60	80	100
Bed	0	20	40	60	80	100
Rip and bed	0	20	40	60	80	100
Strip till	0	20	40	60	80	100
No till	0	20	40	60	80	100

22. What percentage of your acreage was infested by tomato spotted wilt virus?

0 20 40 60 80 100

23. Which of the following practices did you use to deal with tomato spotted wilt virus?

Variety selection
Apply Thimet or Phorate rather than Orthene, Admire Pro, or Cruiser Maxx
Plant in twin rows rather than single rows
Plant later in the season (mid- to late May)
Plant in no till or strip till
Increased in-row seeding rate

24. Did you apply Apogee or Kudos on your peanuts? If so, what percentage and to what varieties?

____

25. What practices contributed most to your success?

9. COMPATIBILITY OF AGROCHEMICALS APPLIED TO PEANUT

David L. Jordan
Extension Specialist—Crop Science
Barbara B. Shew
Extension Specialist—Plant Pathology
Rick L. Brandenburg
Extension Specialist—Entomology

Numerous pests impact peanut growth and development as well as yield and quality (Table 9-1). Additionally, growers apply fertilizers and plant growth regulators to improve or manage peanuts (Table 9-1). Growers often apply more than one pesticide, foliar fertilizer, plant growth regulator, and adjuvant at the same time in order to save time and because a single application is more convenient. In many cases, applying agrochemicals at the same time as tank mixtures is successful in controlling pests and/or improving plant health. However, on occasion there can be problems associated with poor control and greater injury to peanut than normally expected. Also, in some cases precipitates form that can prevent delivery of spray solutions when products are tank mixed.

Defining interactions of agrochemicals before growers prepare spray solutions with multiple components in the mixture is one goal of research and extension efforts at NC State University. This can be challenging, especially given that several thousand possible combinations can be applied because of the diversity of products registered for weed, insect, and disease control and plant growth regulation. The following comments on agrochemical interactions were developed to provide a general sense of interactions that might occur. Product labels do not always provide adequate information on how products will interact in all instances, especially in regions where water quality and other factors differ. Also, the label for one product will in many cases refer the user to other product labels. Although it is clear that the most restrictive label is to be followed, there are challenges in understanding the intent of label recommendations. However, state and federal labels are the law, and users are required to follow the specifics of the product labels.

WHY TANK MIX?

Growers have limited time to complete all of their tasks in the field, and although sequential applications often are more effective, they require a greater investment in time and labor. Extra trips across the field also decrease the life of equipment and increase transportation of equipment and water to and from fields. Even though tank mixing can result in control of one species that is less than ideal, the value in

Table 9-1. Schedule for management of biotic and abiotic stresses in peanut. *Shaded months indicate a time when a stress is often addressed in peanut.*

STRESSES	APRIL	MAY	JUNE	JULY	AUG	SEPT
Weeds						
Broadleaf						
Sedge						
Grass						
Insects						
Thrips						
Corn rootworm						
Corn earworm						
Fall armyworm						
Beet armyworm						
Spider mites						
Diseases						
Botrytis						
Cylindrocladium black rot (CBR)						
Pythium						
Aspergillus crown rot						
Early leaf spot						
Late leaf spot						
Rhizoctonia limb rot						
Sclerotinia blight						
Spotted wilt virus						
Stem rot						
Web blotch						
Nematodes						
Nutrient and Vine Management						
Boron						
Bradyrhizobia						
Calcium						
Manganese						
Prohexadione calcium						

making a single application of several agrochemicals can outweigh the partial control obtained. This will depend on the pest in question and the degree of reduction in control, either through incompatibility or suboptimal timing of application for individual components of the mixture. For all pests, there is generally an optimum timing for control when considering pest size, stress status, and deposition of spray solutions in the peanut canopy. In some operations, especially large operations during the busiest times of the year, making a tank-mix application that controls most of the pests in a given field at the desired level is the goal. These growers can then go back to some of their acres with a second application to control the pest completely. For these growers this approach is often more feasible than spending time developing numerous programs for individual fields or groups of fields. Certainly the most informed decision and implementation of that decision on a field-by-field basis is desired, reflecting sound principles of integrated pest management. However, in practice this can be difficult in large operations. While the impact of tank mixing on crop response and pest control is very important, even before the sprayer reaches the field growers need to make sure the combination of products does not settle and create a load of water and agrochemical precipitates that has to be cleaned and disposed of in some manner.

SPECIFIC QUESTIONS TO CONSIDER

There are several specific questions that need to be addressed, either based on local conditions or recommendations and comments on labels of products. First, is the formulation more important than active ingredient in terms of impact on the tank mixture? Some formulations of chlorothalonil, for example, can affect control by grass herbicides more than others. Secondly, how does the adjuvant recommended for each component differ? For example, if you are trying to control annual grasses with a clethodim product or a sethoxydim product and want to add fungicides to control stem rot, how will the adjuvant recommendations for both products influence control of both weeds and disease? Clethodim and sethoxydim require crop oil concentrate, whereas fungicides designed to control stem rot generally do not require adjuvant. In fact, a crop oil concentrate most likely will retain much of the fungicide on peanut leaves, with an insufficient amount of fungicide reaching the base of the plant where it is needed for complete control of stem rot. A second example is mixtures of Omega 500 with clethodim or sethoxydim. These herbicides require crop oil, and Omega 500 needs to reach the base of the plant. The key is to make sure pesticide performance is optimized or at least considered when mixing, and the adjuvant required for both products should be considered. As mentioned previously, growers may need to balance the need to cover significant acres in a timely manner, which tank mixtures often facilitate, with obtaining adequate but not complete control of all pests in the equation.

Another question relates to water hardness and softness as well as the effects of spray solution pH. Some products can be adversely affected by positively charged compounds (referred to as cations) in the spray solution, with clethodim and sethoxydim being good examples. When control is compromised by presence of cations, other products that are added to the tank that generally affect control only slightly can have a much greater negative impact. Fortunately, many of the products used in peanut are not affected to a great extent by hard or soft water.

Stress and pest size can affect control achieved by tank mixtures compared with applying agrochemicals independently. If weeds are large or drought stressed, reductions in control that can occur are often greater in magnitude. When applying products together it is important to be timely in applications, as this can minimize adverse effects when extremes in stress or pest size exist. Also, when tank mixtures are applied, all of the target pests are generally not at the optimum size or stage of development. Mixtures are often applied at a time that hits a happy medium. While this is often not a big issue, in some cases poor control of one pest may occur because one pest gets larger and more difficult to control as application is delayed.

GENERAL OBSERVATIONS ABOUT TANK MIXING

It is important to remember that the product label is the most important reference on using pesticides. However, in many cases product labels are incomplete in terms of mixing products. The following are general comments about tank mixtures that have resulted from observations or reports and from detailed research projects at NC State University. These comments are to be used as a guide for products that can be applied legally based on the most recent product label for a particular agrochemical.

In-Furrow Products

When considering applying products in the seed furrow at planting, keep in mind that seed cost is the highest single investment, replanting is very expensive, the planting date window is very narrow in North Carolina, and spotty or low plant populations are more prone to having tomato spotted wilt. Typically, seed is pretreated with fungicide, and there are no reports of interactions with other agrochemicals with respect to fungicide seed treatments. Recently, Cruiser Maxx received registration in peanuts as a seed treatment for thrips suppression. There are currently no indications that peanut treated with Cruiser Maxx will be more or less prone to adverse interactions with in-furrow products or pesticides applied early in the growing season.

Many growers are applying inoculant in the seed furrow as a spray or granular material. It is important to keep in mind that inoculants contain *Bradyrhizobia*, a living bacteria that infects peanut roots and is responsible for biological nitrogen fixation.

It is important to treat inoculants properly to ensure that bacteria are alive and able to function adequately. The in-furrow insecticides currently used in peanut to control thrips—including Orthene, Admire Pro, and Thimet as well as the seed treatment Cruiser Maxx—are compatible with inoculants. Temik, a traditional standard across the peanut belt, also is compatible with inoculant. The database on compatibility of Admire Pro and Cruiser Maxx is much more limited than data for Thimet or Orthene, but currently it appears that these products will not adversely affect inoculant performance to a great extent.

In recent years companies have pursued labels for fungicides generally used later in the season for in-furrow application. For example, Folicur was labeled but often resulted in delayed peanut emergence; however, this did not negatively affect inoculant performance. More recently, Proline has been used to suppress CBR and improve stem rot control. Currently, Proline appears to be compatible with in-furrow inoculants and insecticides.

Several distributors have in-furrow products that serve as growth stimulants and enhancers, and some growers have used these products and feel that they affect peanuts positively. From a research standpoint, it is impossible to compare all products available on the market. While growth stimulants and enhancers may in some instances affect peanuts positively, in general these products will not improve emergence or early-season growth all of the time. In fact, they probably affect peanuts—both positively and negatively—only on occasion and under conditions that are unique and hard to repeat. Given the expense of peanut seed and the fact that many growers are already applying inoculant and insecticide (and in some cases fungicide) in the seed furrow, our general recommendation is to think carefully about the possible benefits and detriments of adding unproven products in the seed furrow.

Some growers apply relatively low rates of fertilizer either in the seed furrow or to the side and below the seed furrow. Generally, research has shown little benefit from startup fertilizers for peanuts. Corn certainly responds to these applications, especially phosphorus in some cases, but peanuts seldom respond to fertilizers at planting. In some instances growers have lost stands or had peanut stands decrease considerably due to fertilizers applied in the seed furrow. With the expense of seed, our recommendation is not to apply fertilizer in the seed furrow or as a band close to the seed furrow.

Weed Control with Paraquat

To minimize peanut injury from paraquat (various formulations) we recommend that growers always add Basagran at least 0.5 pt/acre to paraquat. This will reduce symptoms significantly, especially when paraquat is applied with residual herbicides such as metolachor or *S*–metolachlor (Dual Magnum and other products), dimethenamid–*P* (Outlook), or acetochlor (Warrant). Injury following application of paraquat with residual herbicides will always be higher than injury when these are not included, irrespective of Basagran treatment. In some cases less grass control occurs when Basagran is included, but other weeds such as yellow nutsedge and our typical complex of broadleaf weeds are controlled more effectively with the mixture of paraquat and Basagran compared with these herbicides applied alone. In fact, if considerable yellow nutsedge is present, a higher rate of Basagran is recommended when applied with paraquat. Paraquat is compatible with Orthene as an early postemergence spray. However, if thrips damage is significant, application of paraquat should be avoided. Some research indicates that peanut injury following Basagran is greater when Thimet, Phorate, or Di-Syston is applied in the seed furrow. This is infrequent and occurs when Basagran is applied at a higher rate for nutsedge control and when peanuts are planted on coarse-textured soils and are already suffering from injury caused by insecticides. Applications of Basagran later in the season, after peanuts have outgrown thrips damage and insecticide injury, are generally okay.

Weed Control with Grass and Broadleaf/Sedge Herbicides

Grass control by clethodim (various formulated products) and Poast is often reduced by Cobra, Storm, and Ultra Blazer (ranging from 10% to 40%, depending on many factors), is reduced less by Cadre and Pursuit (0% to 30%), and is reduced even less by 2,4-DB or residual herbicides (metolachlor or *S*–metolachlor products and Outlook) (10% or less). Broadleaf weed control by Cadre, Pursuit, Ultra Blazer, Cobra, Storm, and 2,4-DB is generally not affected by fungicides, insecticides, or other herbicides (up or down 10%). In some cases Basagran reduces control by Pursuit, but this mixture is seldom used in peanuts.

Grass control is generally lower when clethodim (various products) or Poast are applied with chlorothalonil products, Headline, and Abound more so than application with Provost, tebuconazole (various products), and Omega 500. Control reductions of as much as 60% can occur when these grass herbicides are applied with chlorothalonil, Headline, or Abound, but reductions in control most often fall in the range of 0% to 20% compared with the grass herbicide alone. Pyrethroid insecticides do not adversely affect grass control by clethodim products or Poast. Research suggests that Orthene can reduce grass control by these herbicides, but the reduction is minor.

Applying herbicides and other products sequentially eliminates the compatibility issue, especially when the grass herbicide is applied prior to the broadleaf/sedge herbicides. In some instances increasing the grass herbicide rate in the mixture by 25% to 50% can reduce the antagonism. However, this approach is product specific and is not always reflected on the label.

Disease Control

Disease control generally is not affected by insecticides or herbicides. Also, insect control is generally not affected by fungicides or herbicides. However, keep in mind that specific adjuvant recommendations need to be followed in order to optimize pesticide performance. Adjuvants are almost always recommended for use with herbicides, whereas adjuvants are only used on occasion with fungicides or insecticides, especially the products used in peanut. Fungicide mixtures often increase disease control and are an important tool in resistance management. Although the issue of compatibility is not related to interactions in the spray solution, mixtures of chlorothalonil with fungicides to control Sclerotinia blight can result in greater incidence of this disease.

Insect Control

Fungicides and herbicides generally do not affect insect control by insecticides. As was noted for fungicides, there are differences in recommendations relative to adjuvant selection and insecticide performance. While interactions with insecticides and other pesticides are often not noted in tank mixtures, use of insecticides can change the balance of beneficial and problematic insects resulting in the need to address secondary outbreaks of insects. This is particularly important when considering populations of spider mites.

Plant Growth Regulators

Performance of the plant growth regulators Apogee and Kudos (both contain the active ingredient prohexadione calcium) have not been affected by agrochemicals in trials conducted at NC State University. However, Apogee and Kudos are expensive require both crop oil or nonionic surfactant and, most importantly, nitrogen to perform at the highest level. Nitrogen is absolutely critical, and growers are encouraged to look closely at product labels to determine whether and how Apogee or Kudos should be applied with other products. Based on research conducted at NC State University, there appears to be no increase in injury or poor performance when other products are applied with Apogee with respect to row visibility (the primary role of Apogee and Kudos). Much less is known about the effect of Apogee or Kudos and the adjuvant system needed for these products on performance of fungicides or insecticides. Apogee and Kudos do not appear to negatively impact weed control by postemergence herbicides.

Micronutrients

Boron and manganese products generally do not affect pest control, but pesticide and adjuvant can affect absorption of micronutrients. There is little concern about increased burn from manganese products, but there is some concern relative to boron toxicity.

SUMMARY

Compatibility of agrochemicals is important to know but can be difficult to define, especially when three or more components are included in the mixture. A considerable amount of research has been conducted at NC State University and other universities in the peanut belt, but defining all possible combinations is not possible. A wide range of new pesticides or new formulations of older pesticides are currently available, and formulation is known to affect compatibility as much as the active ingredient for some pesticides. Distributors also market a wide range of growth enhancers and stimulants as well as formulations of micronutrients. Very little research is available on compatibility of more recently marketed materials with agrochemicals historically applied in peanut. Growers are encouraged to read product labels thoroughly, follow product label recommendations, and contact Cooperative Extension personnel, consultants, distributors, and manufacturers to get information on possible agrochemical interactions before mixing products.