



2017 - 2018

WHEAT

PRODUCTION GUIDE



1785

The University of Georgia

College of Agricultural and Environmental Sciences
Cooperative Extension Service

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2017-2018 Wheat Production Guide

Total planted wheat acreage in the 2016-17 season (160,000) was less than the previous year, following the overall decline observed over the past three years. Profitable wheat management was challenged by the weak market, coupled with disease pressure and environmental conditions. In 2017, growers harvested only ~70,000 acres with a state average yield of 47 bushels per acre.

Above average temperatures through the fall and winter generally reduced vernalization, especially for medium- to late-maturing varieties with extended vernalization requirements. Georgia also experienced a late frost in mid-March which resulted in added damage to the wheat crop in some areas of the state. These environmental issues, combined with additional damage and costs due to another year of Fusarium head blight (FHB) infection had significant impact on yield and returns.

Here are a few critical items to consider in preparation for the 2017-2018 wheat season:

- 1) Prepare ground well in advance for planting. This will enable timely planting when adequate rainfall occurs for germination. Optimum planting dates will be the week prior to and week after the average first frost date for your area. Be conscious of soil moisture and try to time planting with rainfall events to maximize emergence.
- 2) Partition some of your nitrogen fertilizer for the early season (at planting or shortly after) to support fall tiller production. Approximately, 85% of yield potential comes from fall tillers.
- 3) Choose top yielding varieties for your area with good disease resistance and good stalk strength. If Fusarium head blight is a concern, pay close attention to resistance ratings in the variety characteristics table, as FHB resistance is somewhat limited in current varieties. The occurrence of head blight infection depends largely on weather conditions during the flowering stage.
- 4) Be prepared to control weeds early. Planting on time will enable you to apply your herbicides early and maximize your control. Avoid “revenge killing” and control weeds early to reduce competition and protect yield potential.

Recommended Wheat Varieties for Fall Planting, 2017-2018

One of the most important decisions to make for profitable wheat production is choosing the right variety or varieties to plant. Many differences exist among the varieties, and it is critical to assess what characteristics are most important in a given production area. Growers should choose multiple varieties to plant to reduce risk and improve chances of success every season. The following information (Tables 1-4) is provided to compare and understand the differences between each of the varieties recommended in Georgia. In Table 1, consider the footnotes regarding the best areas of adaptation, as well as specific susceptibilities to note.

Table 1. Recommended Wheat Varieties for 2017

AGS 2024 (S)	Dyna-Gro 9171 (P) ³	Pioneer 26R10 (P)
*AGS 2026 (S)	Dyna-Gro 9522 (P)	Pioneer 26R41 (P) ²
AGS 2027 (S)	Dyna-Gro Savoy (S)	Pioneer 26R59 (P) ³
AGS 2033 (S)	Hilliard (P) ³	Pioneer 26R94 (C)
AGS 2035 (S)	*Jamestown (S) ^{2,3}	SH 5550 (S)
AGS 2038 (S)	PGX 16-1 (P)	SRW 9410 (P)
AGS 2055 (P)	PGX 16-4 (P)	SS 8415 (S)
AGS 3000 (C)		*USG 3024 (P)

1. P = Piedmont; C = Coastal Plain; S = Statewide.
 2. Consider using a labeled fungicide; highly susceptible to powdery mildew, leaf rust, stripe rust or crown rust.
 3. Susceptible to some Hessian fly; consider using an insecticide.
- * To be dropped from list in 2018. Certified seed producers may want to consider reducing the seed supply due to the supply of better, more adaptable varieties.

Sources of seed:

AGS varieties: AGSouth Genetics supplier

Dyna-Gro and Oglethorpe: Dyna-Gro seed supplier

Pioneer varieties: Pioneer seed supplier

Southern Harvest 555: Meherrin Agricultural Chemical and Supply

SS varieties: Southern States Coop

USG: UniSouth Genetics, Inc. seed supplier

Jamestown: PVP public seed supplier

Pay close attention to each characteristic in Table 2 as this may require specific modifications in your production practices to achieve the best yield and quality of grain. Vernalization requirement is an important column to recognize if you may be planting later than the recommended planting period. In this case, select varieties with a short to medium vernalization requirement per chance of a warmer-than-average winter.

Table 2. Characteristics of 2017 recommended wheat varieties

Brand-Variety	Leaf rust	Stripe rust	Glume blotch	Powdery mildew	BYD1	SBWM2	Head scab	Hessian fly	Test wt	Maturity	Straw strength	Vernal. Requr.	Awned
AGS 2024	good	good	fair	good	fair	good	fair	fair	good	medium	good	medium	yes
AGS 2026	good	good	good	good	fair	good	poor	good*	good	medium	fair	short	no
AGS 2027	good	good	good	good	fair	good	fair	good*	good	medium	fair	medium	no
AGS 2033	good	good	good	good	fair	good	fair	good	good	medium	good	medium	yes
AGS 2035	good	good	fair	fair	fair	good	fair	good	good	medium	good	short	yes
AGS 2038	good	good	fair	good	fair	good	fair	fair	good	med. late	good	medium	Yes
AGS 2055	good	good	-	good	-	-	-	fair	good	med. late	good	-	-
AGS 3000	poor	good	-	good	-	-	-	fair	good	early	good	-	-
Dyna-Gro 9171	fair	good	good	fair	fair	good	good	poor	fair	late	good	long	yes
Dyna-Gro 9522	poor	good	-	good	-	-	-	poor	fair	med. late	good		yes
Dyna-Gro Savoy	good	good	good	good	fair	good	fair	good*	good	early	good	short	no
Hilliard	good	good	-	good	-	-	-	poor	good	medium	good	-	yes
Jamestown	good	good	fair	good	fair	good	good	poor	good	medium	good	short	yes
PGX 16-1	fair	good	-	good	-	-	-	poor	good	medium	good	-	-
PGX 16-4	good	good	-	good	-	-	-	poor	good	medium	good	-	--
Pioneer 26R10	fair	good	good	fair	fair	good	fair	good	good	late	good	long	yes
Pioneer 26R41	fair	good	fair	good	good	fair	good	good*	good	late	good	long	yes
Pioneer 26R59	fair	good	-	good	-	-	-	poor	fair	medium	good		no
Pioneer 26R94	good	good	fair	good	fair	good	fair	good	good	medium	good	short	yes
SH 5550	good	good	good	good	fair	good	fair	fair	good	medium	good	medium	no
SRW 9410	fair	good	fair	fair	fair	good	good	good*	good	medium	fair	medium	yes
SS 8415	fair	good	-	good	fair	good	good	good*	good	late	good	long	no
USG 3024	good	good	good	good	fair	good	poor	fair	good	medium	good	medium	yes

1. Barley yellow dwarf virus.
 2. Soil-born wheat mosaic virus.
- * Resistant to Bio- Type L.

Table 3:	Summary of 2017 Wheat Yields with Two- and Three- Year Averages								
Brand-Variety	Yield ¹								
	South ²			North ³			Statewide ⁴		
	2017	2-Year Average	3-Year Average	2017 Average	2-Year Average ⁴	3-Year Average ⁵	2017 Average	2-Year Average	3-Year Average
AGS 2024	85.7	87.9	76.3	67.3	75.6	80.4	81.1	84.8	77.3
AGS 2027	78.4	.	.	.	.	.	.	.	.
AGS 2033	86.1	87.7	77.8	.	.	.	.	.	.
AGS 2035	66.2	.	.	.	.	.	.	.	.
AGS 2038	68.7	79.8	66.5	.	.	.	.	.	.
AGS 2055	.	.	.	94.3	81.0	77.8	.	.	.
AGS 3000	24.9	56.7	.	.	.	.	.	.	.
Dyna-Gro 9171	.	.	.	85.8	78.0	83.8	.	.	.
Dyna-Gro 9522	.	.	.	80.8	78.6	84.1	.	.	.
Dyna-Gro Savoy	62.8	84.6	76.4	45.3	74.1	75.0	58.4	82.0	76.0
Hilliard	67.7	75.4	66.9	77.9	82.0	82.0	70.3	77.1	70.6
PGX 16-1	80.2	80.3	72.3	78.0	74.5	75.6	79.7	78.8	73.1
PGX 16-4	73.8	78.3	69.6	84.0	78.1	74.6	76.3	78.2	70.8
Pioneer 26R10	36.6	48.4	45.6	74.7	72.9	80.7	46.1	54.5	54.3
Pioneer 26R41	62.7	66.3	61.3	90.8	87.1	91.0	69.7	71.5	68.7
Pioneer 26R59	35.4	50.7	49.2	87.6	87.5	93.7	48.4	59.9	60.3
Pioneer 26R94	71.5	77.9	68.5	43.3	56.0	60.9	64.4	72.4	66.6
SH 5550	83.6	85.9	75.1	61.5	65.7	72.9	78.1	80.9	74.6
SRW 9410	55.5	65.6	61.1	80.5	77.6	73.4	61.7	68.6	64.2
SS 8415	57.2	61.5	56.0	70.7	71.0	76.1	60.6	63.9	61.0

1. Yields calculated at 60 pounds per bushel at 13.5% moisture.
 2. Tifton, Plains, and Midville.
 3. Athens and Calhoun. No 2017 Calhoun data available due to drought conditions.
 4. 2-year average data comprised of 2017 Athens, 2016 Griffin, and 2016 Calhoun data. Griffin provided Piedmont region data in previous years.
 5. 3-year average data comprised of 2017 Athens, 2015 Griffin, and 2015 Calhoun data.
- Bolding** indicates entries yielding equal to highest yielding entry within a column based on Fisher's protected LSD (P = 0.10).

Table 4: Yield and test weights of recommended varieties tested at Tifton, Plains, Midville, and Athens, Georgia, 2017

Brand-Variety	Tifton				Plains				Midville				Athens			
	yield ¹	2-yr	3-yr	test weight	yield ¹	2-yr	3-yr	test weight	yield ¹	2-yr	3-yr	test weight	yield ¹	2-yr	3-yr	test weight
	--- bu/ac ---			lb/bu	--- bu/ac ---			lb/bu	--- bu/ac ---			lb/bu	--- bu/ac ---			lb/bu
AGS 2024	91.6	98.9	81.1	58.1	101.3	93.9	83.4	55	64.4	70.8	64.2	54.7	67.3	-	-	52.3
AGS 2027	94.6	-	-	55.7	81.9	-	-	54.4	58.7	-	-	52.8	-	-	-	-
AGS 2033	102.9	101	83.9	58	92.9	86.1	79.2	56.7	62.4	76	70.3	54.7	-	-	-	-
AGS 2035	73.7	-	-	58.3	74.1	-	-	54.3	50.9	-	-	54.2	-	-	-	-
AGS 2038	85.5	88	66.6	57.8	82.2	80.3	69.9	56.3	38.3	71	63.1	53.4	-	-	-	-
AGS 2055	-	-	-	-	-	-	-	-	-	-	-	-	94.3	-	-	48
AGS 3000	31.5	64.8	-	57.5	24.3	55.8	-	53.7	19.1	48.8	-	53	-	-	-	-
Dyna-Gro 9171	-	-	-	-	-	-	-	-	-	-	-	-	85.8	-	-	46.6
Dyna-Gro 9522	-	-	-	-	-	-	-	-	-	-	-	-	80.8	-	-	47
Dyna-Gro Savoy	76.7	90.8	76.9	58.1	67.9	84.5	78.7	53.5	43.7	78.7	73.5	53	45.3	-	-	33.8
Hilliard	76	86.9	70.9	55.2	77.3	77	71.1	54	49.8	62.4	58.6	51.2	77.9	-	-	44.2
PGX16-1	94.2	96.2	80.9	57.5	93.2	81	72.2	55.8	53.2	63.6	63.7	54.1	78	-	-	47.6
PGX16-4	91.1	93.1	75	57.5	83.3	79.9	72.6	56.2	46.9	61.8	61.2	54.1	84	-	-	50.3
Pioneer 26R10	34.6	45.9	36	47.9	46.4	50.3	49	50.3	28.7	48.9	51.6	49.6	74.7	-	-	45.4
Pioneer 26R41	76.1	73.1	59.3	54.3	71.7	70.3	68.1	52.5	40.3	55.4	56.5	51.6	90.8	-	-	49
Pioneer 26R59	37.7	52.3	41.9	47.4	49.8	55.8	57.1	49.6	18.8	44	48.4	47.4	87.6	-	-	47.5
Pioneer 26R94	82.4	89.6	71.9	58.9	86.1	84.2	75.5	55.5	46	59.9	58.2	53.8	43.3	-	-	40
SH 5550	99.5	98.3	81.2	57.2	88.8	80.7	72.9	54.1	62.6	78.7	71.3	53.2	61.5	-	-	48.6
SRW 9410	65.4	73.7	64.4	53.8	66.5	70.1	65.9	54	34.5	53.1	53	51.5	80.5	-	-	46.3
SS 8415	50.2	62.6	53	49.8	72.3	65.7	61.5	53.1	49.2	56.1	53.6	49.6	70.7	-	-	44

1. Yields calculated at 60 pounds per bushel at 13.5% moisture.

Please be aware of all rules regulations regarding certified seed and patented or PVP varieties.

Consider using varieties tagged with an official certification tag. Certified seed ensures the highest quality seed available with good germination and freedom from noxious weeds. Contact the Georgia Crop Improvement Association regarding any questions with certified seed at 706/542.2351

The University of Georgia Grain Crops web page can be found at the following url:
<http://www.caes.uga.edu/commodities/fieldcrops/gagrains/index.html>

LAND PREPARATION AND TRAFFIC PATTERNS

Reagan L. Noland and Dewey Lee

The soil environment plays a critical role in optimizing wheat growth and development. Research from Alabama, Georgia and South Carolina has consistently shown increased wheat yields with deep tillage. In fields with a hard pan or compacted soils, tillage enables easier root growth and penetration, increasing the potential for water and nutrient uptake. Tillage also serves to reduce surface residue that may host diseases and pests. In wet years, compacted, dense soils can result in very low soil-oxygen conditions, which can reduce yields of most small grains due to poor root production and nutrient uptake.

No-till is less common in wheat production due to observed yield reductions ranging from 3 to 20%. With the understanding that no-till management often has a wheat yield penalty, it may be considered as a decision for the whole farm system to reduce erosion and save on tillage costs. Disking is a common tillage practice that can provide an excellent seedbed but may lead to the formation of a compacted layer of soil. The weight of the implement is concentrated in a very small area at the tip of the disk and when disking is repeated several times, a hardpan can form. Deep tillage (bottom or paraplowing or V-ripping) is the most reliable tillage option to optimize yield potential. It is slower and more expensive than disking, but is usually cost effective with improved yields. When double-cropping field operations make it impractical to deep till, chiseling or subsoiling can be a beneficial alternative.

Consistent and proper seed placement will influence the uniformity of emergence, final stand, and potential yield of wheat. Good seed soil contact with soil moisture promotes rapid emergence and good root development. Wheat should be planted at least 1 to 1.5 inches deep when soil moisture is adequate for good germination. Take care to achieve uniform planting depth, as poor depth control leaves seed too deep or too shallow for uniform emergence. Planting wheat with a properly calibrated drill is preferred over broadcasting, as uniform emergence is very difficult to achieve when broadcasting wheat. Studies conducted in the southeastern U.S. demonstrate that higher yields are consistently achieved with a properly calibrated drill compared with broadcasting.

Establishing a row traffic pattern at planting or soon after emergence, for all post-emergence field traffic, can be beneficial. Traffic patterns or tramlines can be established by closing one or more openings in the drill when planting the crop. This can be done by retrofitting the drill with clutches attached to the metering cup that can close the opening to leave unplanted rows that match the wheel spacing of your sprayer or tractor. Devices for drills can be purchased to establish tramlines on any tractor width in any multiple of drill widths.

Tramlines may also be established after the crop has emerged by chemically killing the rows with glyphosate that match the wheel spacing of the implement used to apply fertilizer or pesticides. Precision agriculture tools such as light bars and GPS guidance systems can help reduce the error of overlapping when chemically killing rows to establish tramlines. This method should be applied early, once the wheat has one to two developed leaves.

Using tramlines in intensively managed wheat enables uniform applications of nutrients and pesticides with improved precision and timeliness. Tramlines can save on the cost of aerial applications, and can reduce the chance of disease development when compared to plants that are

crushed by running over standing wheat. Studies have shown that the border plants will compensate 50 to 60% of the yield lost by the missing rows, whereas plants damaged by tires rarely produce good grain.

PLANTING DATES

Reagan L. Noland and Dewey Lee

Planting date is another critical component of successful wheat production. Planting too early or too late reduces yield potential. Always plant late maturing varieties first since these varieties most often have the longest vernalization requirements. Recognize though that some medium maturing varieties may have also have long vernalization requirements which makes them less suitable for late planting.

Vernalization requirement varies widely with variety. In order for wheat to vernalize, temperatures must be low and remain cold for a specific length of time. In the absence of cold weather, wheat waits until enough heat units have accumulated and nights are short before heading. This delay in heading usually results in wheat filling the grain during a hot and dry time of the year such as May or early June. The warmer the temperature during grain fill, the poorer the yield and weight.

If planting late in the season, choose an early maturing variety because they have, in general, very low vernalization requirements. This ensures the crop will vernalize properly even in a mild or warm winter. Caution should be taken to avoid planting these types of varieties too early in the season. Due to their short season growing abilities, these varieties may enter the jointing and heading phase too quickly and therefore be subject to severe winter kill or damage from late spring freezes. In fact, varieties with very short vernalization requirements such as AGS 2040, Coker 9700 etc., often perform best when planted between December 1 and December 15th. In this case, the recommended planting dates are two weeks later than the recommended dates for most other varieties.

The effect of planting date on three popular varieties are shown in Tables 6. Notice the loss in yield at the late planting date with the late maturing variety. This variety requires longer vernalization and growing degree days than the early or medium maturing varieties. The effects of late planting can be severe depending on variety.

Table 6. Effect of Planting Date on Yield (bu/A) of Soft Red Winter Wheat, Tifton

Planting Date	Early	Medium	Late
Nov 23	76.8	78.6	76.5
Dec 7	71.4	69.2	68.8
Dec 20	54.2	47.1	25.3

Data in Table 7 illustrates how severely wheat yields are penalized as planting is delayed into the winter. It is important to plant within the recommended planting time for high yields.

Table 7. Effect of Planting Date on Yield (bu/A) of Soft Red Winter Wheat, Tifton

Planting Date	Early	Medium	Late
Nov 15	64.5	60.4	56.1
Dec 7	42.2	38.6	39.6
Dec 15	39.6	31.9	33.4
Jan 5	11.1	7.5	6.7

Figure 1. Response of three popular varieties to planting date in Alabama. PD1 to PD2 is the recommended time period for each region.

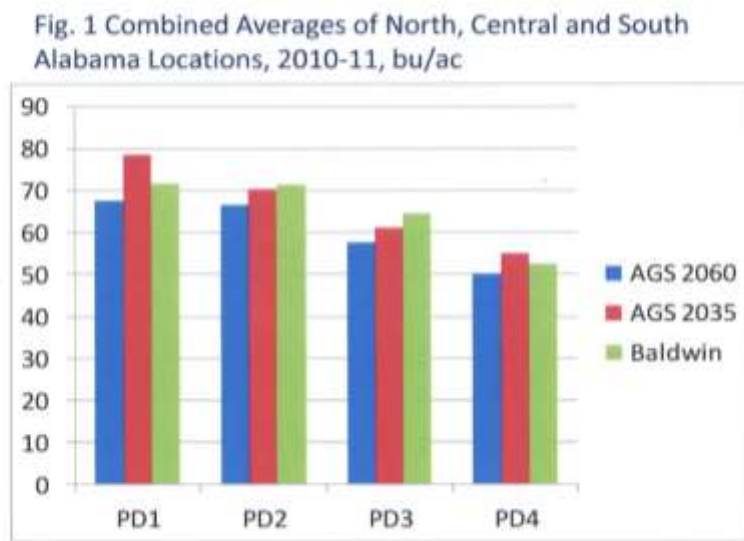


Table 8 lists the recommended planting dates for different regions of the state. These dates represent a tradeoff between planting early enough for adequate tillering before cold weather begins and planting late enough to avoid excessive heat and moisture stress. In many parts of the country, planting dates are set late in order to avoid problems with the Hessian fly, but in Georgia there is no such thing as a "fly-free date".

The optimum window for wheat planting in Georgia is typically within one week before or after the average first frost date for a given area. Planting during the appropriate time for your area will allow wheat to develop enough tillers prior to January or early February which reduces the likelihood of needing two applications of N fertilizer in the spring. Fall produced tillers will have

stronger root systems, tolerate more stress, and produce larger heads with greater potential for high test weight. **Studies show that fall tillers account for about 85% of the yield.** If the crop is planted late and plants do not tiller well prior to the onset of winter days, then the crop will be dependent of spring tillers. Spring tillers generally have smaller heads, fewer spikelets and less opportunity to produce grain. Planting on-time ensures the best chance to obtain the proper number of tillers by GS 30 or stem elongation. High yield wheat requires about 100 tillers per square foot at GS 30. If your stand has fewer tillers i.e. 50 to 60 by GS 25, then early nitrogen applications will be needed to support additional tiller production (See the fertility section for additional info).

Table 8. General planting times for most wheat varieties grown in Georgia.

Region	Planting Period
Mountain, Limestone Valley	October 10 - November 1
Piedmont	October 25 - November 15
Upper & Middle Coastal Plain	November 7 - December 1
Lower Coastal Plain	November 15 - December 1
Lower Coastal Plains**	December 1 – December 15

**Only varieties with short vernalization requirements

SEEDING RATES

Reagan L. Noland and Dewey Lee

Optimum seeding rates for wheat can vary widely due to differences in seed quality, genetics, planting conditions or planting dates, and planting methods (drill or broadcast). Seeding based on seeds per acre is much more accurate than seeding based on weight per acre. Multiple seeding rates studies have been conducted throughout the southeastern U.S. and most show that seeding 1.2 million to 1.5 million seeds per acre is optimum. This is equal to seeding about 30 - 35 seeds per square foot. However, achieving this rate will require knowledge of seed size (aka-number of seeds per pound).

In a normal year, wheat cultivars vary between 10,000 and 18,000 seeds per pound. This difference can impact the actual seeding rate if a grower seeds wheat in bushels per acre. For example, in Table 8, seeds per pound of variety 4 and variety 6 vary by 35%. If a grower planted according to bushels per acre, he would plant 35% more seed of variety 6 than variety 4, potentially over-planting or under-planting one of the cultivars. This illustrates the importance of purchasing wheat seed based on seeds per pound with a target of 30-35 seeds per square foot, rather than bushels per acre.

Table 9. Example of seeds per pound of wheat grown in one year in Georgia.

Variety	Seed/pound
1	9,610
2	11,340
3	14,823
4	12,064
5	11,172
6	16,316
7	12,741
8	14,538
9	15,534
Average # seeds per pound	13,126

Information in table 10 provides appropriate seeds per row foot for various row widths. When planting on 7.5 inch row widths each linear foot of row should contain 20-25 seeds depending on germination. This provides enough seed to achieve the target number of live plants per acre for high yield. If planting date is delayed, seeding rates should be increased by 15-20%.

The use of certified seed will help insure you are planting seed with a minimum germination of 85% and free of noxious weeds. Planting bin-run seed is not recommended for intensively managed wheat. However, it is important to test for germination if you choose to use bin-run seed. Thorough seed cleaning will often increase the germination of a seed lot because it eliminates some non-viable seed.

Table 10. Seeds per linear row foot needed to achieve certain seeds per square foot at different seeding widths.

Row widths in.	Seeds /sq. ft.			
	30	35	40	45
6	15	18	20	23
7	18	20	23	26
7.5	19	22	25	28
8	20	23	27	30
10	25	29	33	38

Information in table 11, illustrates the differences in pounds per acre between two lots of seed planted at various row widths and seeds per row foot. If you had a variety with approximately 12,000 seeds per pound and you planted on a 7.5 inch row width with a target of 22 seeds per row foot, then you would need to purchase 128 lbs of seed per acre. If the seed were smaller and the variety had 15,000 seed per pound, then you would need to purchase only 102 lbs per acre to achieve the same target population.

Yield potential is maintained when wheat is planted as accurately as possible. Therefore, calibrate grain drills each time you change cultivar or seed lots to achieve the desired number of plants per acre.

Calibrating a drill can be as simple as filling the bottom portion of the seed hopper and catching seed from the down spout that leads to disk openers. First, measure off a known distance that you can calibrate to an acre. Remove the rubber tubes that lead to the disk openers. Use individual plastic bags or small bottles to catch seed from several tubes as you travel the known distance. Then count the number of seed or weigh the amount of seed captured. Then determine if you captured the appropriate amount for the desired seeding rate by distance or by determining the amount by weight needed to get the amount of seed by pounds. You will have to know the number of seeds per pound to determine the amount by weight.

Table 11. An example of pounds of seed per acre as determined by row width, seeding rate and seeds per pound.

Seed/row ft.	Row width					
	6"		7.5"		10"	
	<u>12,000</u>	<u>15,000</u>	<u>12,000</u>	<u>15,000</u>	<u>12,000</u>	<u>15,000</u>
18	130.7	104.5	104.5	83.6	78.4	62.7
22	159.7	127.8	127.7	102.2	95.8	76.7
26	188.8	151.0	151.0	120.8	113.3	90.6
30	217.8	174.2	174.2	139.4	130.7	104.5

Straw Utilization

Straw utilization has become increasingly important in the economic value of wheat production. There are many uses of wheat straw such as; residue for conservation tillage, landscaping, residue to reduce soil erosion during road or building construction, mushroom production, horse bedding, hay feeding and others.

Varieties vary in their ability to produce straw from year to year. Table 12 is provided to demonstrate the range of straw heights and production across wheat varieties in Griffin, GA. In general, higher grain yield correlates to greater straw production. If the straw is removed from the field, remember to apply the same amount of nutrients to the subsequent crop that are removed by the straw.

Table 12. Example of Straw Yield of Different Soft Red Winter Wheat Varieties (lbs/A), Griffin.

Variety	Height (in.)	Straw yield (lbs/acre)
1	38	2572
2	36	3149
3	38	2021
4	37	2777
5	40	2666
6	36	2173
7	34	2352
8	34	2235
9	33	2478

FERTILITY RECOMMENDATIONS

Glendon Harris

Soil fertility is one of the primary yield building components of small grain management. A properly managed fertility program, including recommended fertilization and liming practices, can improve yield and quality more than any other single management practice. Such a program includes soil testing, knowledge of crop nutrient requirements and removal, timely application of nutrients and record-keeping.

Nutrient uptake and removal varies with yield (Table 13). Most fertilizer recommendations account only for nutrients removed in the grain. When straw is also removed, additions of phosphorus (P), potassium (K), and sulfur (S) should be increased for the following crop.

**Table 13. Nutrient uptake and nutrient removal by wheat at different yield levels.
Removal based on grain only.**

	Yield bu/A					
	40		70		100	
Nutrient	Uptake	Removal	Uptake	Removal	Uptake	Removal
	-----pounds per acre-----					
N	75	46	130	80	188	115
P ₂ O ₅	27	22	47	38	68	55
K ₂ O	81	14	142	24	203	34
Mg	12	NA	21	NA	30	NA
S	10	NA	18	NA	25	NA

Nitrogen (N)

Nitrogen rates and timing of application are key management factors for making good wheat yields. Nitrogen rates should be based on soil potential, cultivar, realistic yield goal, previous crop and residual N. For expected wheat yields of 40 to 70 bushels per acre, use a total N rate of 80 to 100 pounds per acre. Higher yields will likely require rates of 100 to 130 lbs per acre or more.

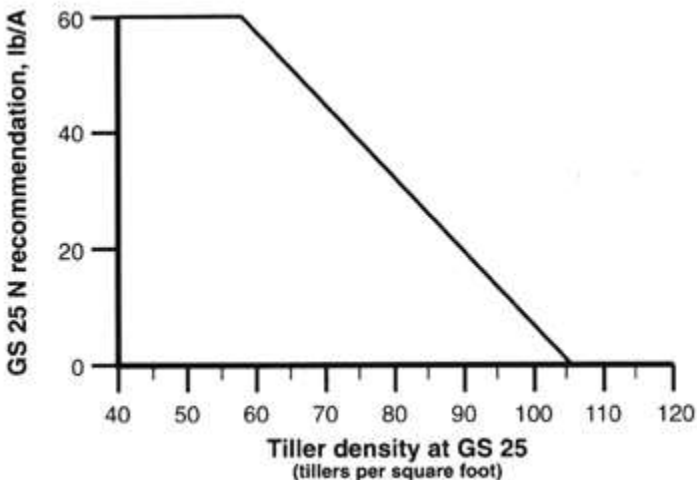
Apply nitrogen in the fall is critical to encourage good tiller production prior to the onset of winter. Adjust this rate based on the preceding crop. In general, apply N (based on the previous crop rotation) as follows:

- Cotton: 35 to 40 lbs ac
- Corn: 30 to 35 lbs ac
- Fallow: 25 to 30 lbs ac
- Soybeans: 15 to 20 lbs ac
- Peanuts: 0 to 15 lbs ac

Tillers produced in the fall generally produce the most grain per unit area. It is important though, not to over-fertilize with nitrogen in the fall as it may cause excessive growth and result in winter injury.

Timing of N fertilization should be based on the pattern of uptake by the crop. Demand for N is relatively low in the fall but increases rapidly in the spring just prior to stem elongation. Therefore, make the fall applications of nitrogen at planting, and the remaining N prior to stem elongation (Zadoks 30). Use the lower rate of fall applied nitrogen at planting on heavier-textured soils and the higher rate on sandy soils.

When the wheat crop reaches the growth stage Zadoks GS 25, begin counting tillers to determine the need for additional nitrogen applications for the proper tiller production prior to the onset of stem elongation. This stage of growth generally occurs during the mid to later week of January in south GA and late January to mid-February in north GA. Randomly chose about 10 to 15 areas in the field to obtain an accurate estimate of tillers per square foot. The graph below can be used to get a nitrogen rate recommendation after counting the tillers. If the tiller counts (a stem with at least three leaves) are low, 80 tillers per square foot or less, nitrogen applications at this time are **critical** for improving the yield potential of the crop. Some nitrogen will still be needed to maximize the yield potential if the tiller counts are lower than 100. If the tiller count exceeds 100 or more per square foot at Zadoks GS 25, then apply all remaining nitrogen at or just before GS 30 (stem elongation). Usually Zadoks GS 30 (or Feekes 5) occurs during early to mid-February in the southern half of Georgia. In extreme N. GA, stem elongation may not occur till early March.

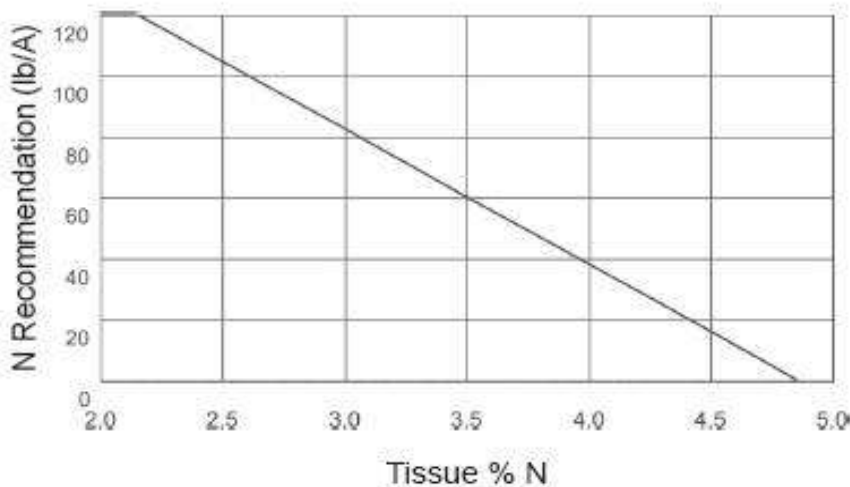


Splitting spring nitrogen applications can improve yields when N leaching conditions occur. Although yields may not always be improved, this practice can also reduce the amount of N released into the environment, and offers the chance to adjust N rates downward if climatic or economic conditions do not warrant the added expense of the last N application.

The graph below is a guide used by growers in North Carolina and Virginia to determine the

need for nitrogen at GS 30 (or Feekes 5). It assumes that the average tiller count will be above 100 per square foot. GS 30 is when the leaf sheaths of the wheat plant are strongly erected and splitting the stem shows a hollow internode area about 1/4 to 1/2 inch in length. It is important to have an accurate assessment of the nitrogen content at the right growth stage prior to completing the final N applications. Obtain a representative tissue sample from about 20 areas in the field. Cut the samples about 1/2 inch above the soil surface making sure to shake any dirt away from the tissue. Pick away any debris or dead leaves from the sample. Combine the samples and mix thoroughly. Take two to three handfuls out of the combined sample for testing and place in a paper bag. Send the sample immediately to an appropriate lab.

Use the graph below to obtain the rate recommendation from tissue test results taken just prior to the onset of stem elongation. Total N applications generally should not exceed 130 lbs N per acre. Make the final N adjustments based on these results.



For example, let's say the tissue analysis results show a 3.0% N content at GS 30 but you applied 20 lbs N at planting and 40 lbs N at GS 25. If the graph calls for 80 lbs then only apply 70 of the 80 lbs of N the graph suggest since it would exceed the upper limit of 130 lbs N in the season (20 +40 = 60; 60 +70 =130).

Nitrogen fertilizer prices have increased significantly over the last five years but declined slightly this fall as compared to last year. Therefore, choosing the proper rate and timing of application is critical in terms of making an economic yield. Also, there are still a good number of different nitrogen fertilizers to choose from that vary in characteristics and price. Be careful not to choose a nitrogen fertilizer based on price alone. In addition, there is currently a shift away from ammonium nitrate to urea. Urea volatilization is of greater concern under hot and dry conditions. The timing of N applications on wheat are typically not that conducive to losing large amounts of N from urea. Irrigation or rainfall can also reduce N losses from volatilization of urea. Urease inhibitors such as Agrotain are commercially available and when added to urea can reduce volatilization losses, especially in dryland conditions.

Other Nutrients

Since 65% of the total P uptake and 90% of the total K uptake occurs before the boot stage, these nutrients should be applied according to soil test before planting and thoroughly incorporated into the rooting zone. When double cropping after wheat, apply P and K for fall and spring crops prior to fall planting, except on deep sands. In this case, split K applications between the fall and spring crops.

Sulfur (S) leaches readily in sandy soil horizons, but accumulates in subsoil clay horizons. If the depth to clay is greater than 16 inches, apply at least 10 pounds of S per acre. Best results are obtained when S is supplied with topdress N applications.

Micronutrient levels in Georgia's soils are usually adequate for wheat production unless soils have been over-limed. Low zinc (Zn) levels may occur in soils of the Coastal Plain. A soil test readily detects these conditions, and it is easily corrected by applications of three pounds of elemental Zn per acre in the preplant fertilizer. Manganese (Mn) deficiency occurs most frequently in poorly drained soils of the Flatwoods region. Availability of Mn declines significantly as pH increases above 6.2 to 6.5 in these soils. Soil applications seldom correct the problem since Mn is readily converted to unavailable forms. Foliar applications of 0.5 pounds of Mn per acre as $MnSO_4$ or 0.25 pounds of Mn per acre as Mn chelate will correct deficiencies, but two or more applications may be required.

Poultry Litter

Managed properly, poultry litter (manure mixed with bedding material) can be a valuable source of plant nutrients for wheat production. It is most like a complete fertilizer, containing significant amounts of primary, secondary and micronutrients except for boron. On average, broiler litter contains approximately 3 % N, 3 % P_2O_5 and 2 % K_2O (fertilizer value of 3-3-2). Based on this average, one ton of poultry litter contains 60 lbs of N, 40 lbs of P_2O_5 and 40 lbs of K_2O . Based on current fertilizer prices for N, P and K, poultry litter is valued at approximately \$50/ton. This figure **does** take into account that only 60 % of the total N is available to the first crop and P and K, 80 %. Also, the nutrient content of litter does vary significantly, depending on moisture content, type of bird, feed ration and especially storage and handling methods. Therefore, it is highly recommended that litter be analyzed for nutrients by a reputable laboratory before determining application rates and value.

Application rates of poultry litter for fertilizer are usually based on the nitrogen requirement for the crop grown. Buildup of phosphorus however is an increasing concern due to water quality issues. Therefore poultry litter is best used as a preplant incorporated, complete fertilizer to supply P, K, secondary and micronutrients to the crop on a timely basis. For wheat, an application of 2 ton/a of poultry litter (preplant incorporated) will supply an adequate amount of fall N and should meet the P and K requirements of even a soil testing low in P and K. The remainder of the N requirement should then be applied in the spring using inorganic/commercial N fertilizer. Release of N from litter in the spring will depend on a number of factors, especially weather conditions. Therefore, the crop should be monitored in the spring; and topdress applications of inorganic, commercial fertilizer N should be adjusted accordingly.

WEED CONTROL IN WHEAT

Stanley CluPPER

Effective weed management is one of many critical components of successful wheat production. Weeds compete with wheat for light, nutrients, water, and space while often harboring deleterious insects and diseases. Severe weed infestations can essentially eliminate wheat production and/or harvest efficiency while also creating weedy plant fragments often reducing food and feed value.

Winter annual broadleaf weeds such as wild radish, common chickweed, and henbit; perennials such as wild garlic and curly dock; and Italian ryegrass are often the most problematic weeds in wheat. In fact, wheat production in Georgia is in jeopardy as a result of weed resistance. Ryegrass resistant to all currently labeled postemergence herbicides has been documented and is becoming more common. Growers must implement management programs to delay the development or spread of resistant ryegrass.

Cultural Control Methods

One of the best tools for suppressing weeds in wheat is a healthy, vigorous crop. Good crop management practices that result in rapid wheat stand establishment and canopy development minimize the effects of weeds. Recommended cultural practices include the following:

- 1) Planting certified seed (free of weed seeds and garlic bulblets)
- 2) Good seedbed preparation including free of emerged weeds at planting
- 3) Proper fertilization
- 4) Seeding at the proper rate, planting depth, and time of year
- 5) Management of diseases and insects

Site selection also is important for weed control. Rotation away from fields infested with troublesome weed species, such as herbicide-resistant ryegrass, may reduce the presence of these weeds and allow for the use of alternative crops and control methods. Additionally, so as to prevent weed spread from field to field during harvest, equipment should be cleaned when moving from infested areas. This precaution can be of significant consequence in preventing or minimizing the introduction of new weed species into 'clean areas' when commercial combine operators who travel long distances are used for harvest.

Planning a Herbicide Program

Before using herbicides, growers should know what weeds are present or expected to appear, soil characteristics (such as texture and organic matter content), capabilities and limitations including carryover of the various herbicides, how best to apply each herbicide, and of extreme importance is knowing when to apply each herbicide relative to crop and weed stage of growth.

Weed Mapping

The first step in a weed management program is to identify the problem; this task is best accomplished by weed mapping. Surveys should be developed each spring to provide a written record of the species present and their population levels.

In-season Monitoring

Fields should be monitored periodically to identify the need for postemergence herbicides. Even after herbicides are applied, monitoring should be continued to evaluate the success of the weed management program and to determine the need for additional control tactics. Proper weed identification is necessary to ensure effective control since weed species respond differently to various herbicides. Contact your local Extension office for aid in weed identification.

Managing Weeds with Herbicides

If applying herbicides, read and follow label recommendations. Information concerning weed response to herbicides, herbicide rates, and grazing restrictions for wheat are provided in Tables 16, 17 and 18. Refer to product labels for up-to-date suggestions and restrictions.

Larger weeds are often more difficult to control than smaller weeds; therefore, timely herbicide applications are critical. Many herbicides used in wheat affect growth processes within the weed. In essence, the more actively the plant is growing, the better the control. Applications made to stressed weeds (i.e. drought, wet, cold) will often result in decreased control.

All wheat herbicides are restricted to certain growth stages to minimize crop injury (Table 14) and/or to ensure illegal pesticide residues are avoided. Although the stage of development provides a good indicator for application timing, factors such as environmental conditions, health of the crop, and variety (early vs. late maturity) also have an impact on crop tolerance.

Table 14. The Effect of Stage of Growth on Wheat Injury by Various Herbicides.

Percent Injury by Stage of Growth^{1, 2}				
Herbicide	0-1 tiller	2-3 tillers	full tiller	Jointing
2,4-D	>70%	35%	0-10%	70-90%
MCPA	>30%	0-5%	0-5%	50-70%
Peak	0-5%	0-5%	0-5%	0-5%
Express or Harmony Extra	0-5%	0-5%	0-5%	0-5%
Express or Harmony + MCPA	>30%	10%	0-5%	50-70%
Express or Harmony + 2,4-D	>70%	35%	0-10%	70-90%
Osprey	0-15%	0-15%	0-10%	0-10%
PowerFlex	0-15%	0-15%	0-10%	0-10%

¹Refer to Figure 1 and the small grain production guide for growth stages.

²Percent injury (visual chlorosis, necrosis, tiller malformation, and/or stunting).

Herbicides for Controlling Broadleaf Weeds

2,4-D controls many common winter broadleaf weeds such as buttercups, cornflower, cutleaf eveningprimrose, wild mustard, and wild radish (Table 16). However, 2,4-D often does not adequately control chickweed and henbit; thus, *mixtures with Harmony Extra or Express are advised.*

This phenoxy herbicide is available in several formulations (amines, esters, and acid + ester mixtures). Ester or acid + ester formulations tend to be more effective under very cold conditions as compared to amine formulations; rarely are large differences noted among formulations. Additionally, ester and acid + ester formulations mix well with liquid nitrogen. Amine formulations can usually be mixed with liquid nitrogen, but the amine herbicide often must first be premixed with water (one part herbicide to four parts water) and then the water-herbicide mixture added to the nitrogen with good agitation. Amines tend to cause less burn on the wheat than esters when nitrogen is used as the carrier. Amine formulations of 2,4-D are MUCH safer to use when sensitive plants are nearby; volatility of ester and acid + ester formulations of 2,4-D can be significant. *Georgia research has shown nearly 90% less impact from volatility of an amine formulation of 2,4-D when compared to an ester formulation of 2,4-D during hot weather.*

Timing of application of 2,4-D is critical to avoid injury to wheat. The critical period for 2,4-D applications is after wheat is fully tillered but before jointing (Feekes stages 4 and 5, Figure 1). Application before this growth stage may cause a “rat-tail” effect whereby the leaf does not form and unfurl properly. The crop may appear stunted and delayed in maturity, and tiller development may be adversely affected. Conversely, application after jointing has commenced may result in malformed seed heads often reducing yield.

MCPA is similar to 2,4-D in that it is a phenoxy herbicide controlling a broad spectrum of broadleaf weeds (Table 16). When compared to 2,4-D, MCPA is generally less injurious to wheat but also less effective on larger weed species. Application of MCPA is after wheat tillers (preferably 2+ tillers) at a rate of 12 to 16 oz/A (3.7 to 4.0 lb ai material) up to just before jointing; if wheat is fully tillered a rate of 1 to 1.5 pt/A may be applied (Figure 1).

MCPA plus Harmony Extra offers weed control similar to 2,4-D plus Harmony Extra with less crop injury potential.

Harmony Extra is a prepackaged mixture of the sulfonylurea herbicides thifensulfuron-methyl and tribenuron-methyl and can be applied in wheat after the two-leaf stage but before the flag leaf is visible (Figure 1). Applications should be completed by the fully tillered stage for improved spray coverage on weeds.

Harmony Extra controls many of the common winter annual broadleaf weeds including wild garlic and curly dock (Table 16). However, cornflower and wild radish are exceptions while henbit can be challenging to control depending on its physiological maturity. MCPA or 2,4-D at 0.375 pound active ingredient per acre may be mixed with Harmony Extra for excellent wild radish control and

improved control of cornflower; these mixtures must follow the application growth stage restrictions noted with 2,4-D or MCPA.

A nonionic surfactant at the rate of 1 quart per 100 gallons of spray solution is recommended when Harmony Extra is applied in water. Harmony Extra also may be applied using liquid nitrogen as the carrier. In this case, premix the herbicide in water and add the mixture to the nitrogen with agitation. Adding surfactant when using nitrogen as a carrier will increase burn on the wheat foliage. Thus, when applying Harmony Extra in nitrogen, reduce the surfactant rate to 0.5 to 1.0 pint per 100 gallons of spray solution. For easy-to-control weeds, consider eliminating the surfactant when nitrogen is the carrier. However, do not eliminate surfactant when treating wild garlic or wild radish. Do not use surfactant when mixtures of Harmony Extra plus 2,4-D or MCPA are applied in nitrogen.

An advantage of Harmony Extra compared to 2,4-D or MCPA is the wide window of application; however, tank mixtures of these herbicides are suggested for wheat in the appropriate growth stage.

See Table 17 for the appropriate rate depending on the formulation used.

Express (tribenuron) and **Peak** (prosulfuron) are sulfonyleurea herbicides that are effective on many winter annual broadleaf weeds (Table 16). However, Harmony Extra is superior to Express in controlling henbit, shepherd's-purse, and wild garlic. Peak is often the most effective option for controlling wild garlic but, a 10 month rotation restriction for soybeans, peanuts, and cotton exist for Peak at 0.75 oz of product per acre.

Express can be applied after the wheat has two leaves but before the flag leaf is visible (Figure 1). Peak can be applied after wheat has reached the three-leaf stage but before the second detectable node of stem elongation. These herbicides also have an advantage over the phenoxy-type compounds such as 2,4-D because they can be used later in the season. Similar to Harmony Extra, Express may be tank mixed with 0.375 lb active ingredient of 2,4-D or MCPA for improved control of wild radish. Express may be also be slurried with water and then added to liquid nitrogen solutions.

Use 1.0 qt of surfactant per 100 gallons of spray solution when applying Express in water; use 1 pt of surfactant per 100 gallons when mixing with nitrogen, 2,4-D or MCPA; use ½ pt of surfactant per 100 gallons when mixing with nitrogen plus 2,4-D or MCPA.

Wild Radish Control

Wild radish can be controlled effectively with numerous herbicide options (Table 15). Harmony Extra + MCPA or 2,4-D is suggested to control wild radish as well as most other commonly present broadleaf weeds. PowerFlex, an effective ryegrass herbicide, is also a very good option for controlling wild radish.

Table 15. The Effect of Stage of Growth on Wild Radish Control in Wheat.

Herbicide	Percent Control By Stage of Growth ¹			
	0-4 inches	4-8 inches	8-12 inches	Bolting/Flowering
2,4-D	>99%	>95%	>90%	80-90%
MCPA	>99%	>95%	>80%	70-80%
Peak	>90%	>85%	70-80%	<40%
Express	60-90%	50-70%	40-60%	<40%
Harmony Extra	70-90%	60-80%	40-70%	<40%
Express + MCPA or 2,4-D	>99%	>99%	>90%	70-85%
Harmony + MCPA or 2,4-D	>99%	>99%	>95%	80-95%
Osprey	>99%	80-95%	60-75%	40-65%
PowerFlex	>99%	>95%	>85%	75-90%

¹Wild radish size in diameter of leaf rosette.

Wild Garlic

Wild garlic is virtually noncompetitive with small grains. However, the aerial bulblets harvested with the grain impart a garlic flavor to flour made from infested wheat. Off-flavor milk products result when dairy cows are fed infested small grains. Growers receive a substantial discount for garlicky wheat.

Harmony Extra with TotalSol (50 SG) at 0.75 to 0.9 ounce per acre is very effective on wild garlic. Wild garlic should be less than 12 inches tall and should have 2 to 4 inches of new growth (if treated in the spring) when Harmony Extra is applied. Temperatures of 50^o F or higher will enhance control. Peak will also control wild garlic very well. It is at least as effective on wild garlic as Harmony Extra, but it is less effective than Harmony Extra on several broadleaf weeds. Add a nonionic surfactant or crop oil according to label directions.

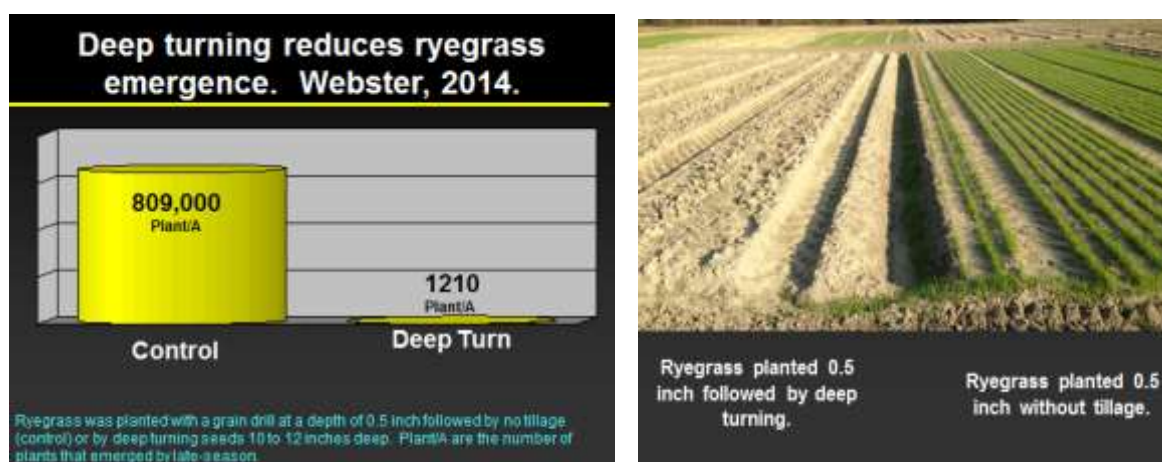
There are no rotational restrictions following wheat treated with Harmony Extra. There is a 10-month rotational restriction for all soybeans, cotton, peanuts, and tobacco following application of Peak. Soybeans should not be double-cropped behind small grains treated with Peak.

Italian or Annual Ryegrass

Georgia wheat production is in jeopardy due to herbicide resistant ryegrass. Ryegrass resistant to all currently labeled postemergence herbicides has been documented and is becoming more common. Growers must implement management programs to delay the development or spread of resistant ryegrass immediately.

Research has shown that wheat yields can be reduced 0.4% for every ryegrass plant per square yard. Heavy infestations, if uncontrolled, can eliminate production. Italian and annual ryegrasses are annuals with spread through seed production. Management practices to reduce seed production and spread will greatly decrease ryegrass problems. Such practices may include the following: cleaning equipment from field to field, maintaining clean fence rows and ditch banks surrounding the fields, avoiding those fields with heavy ryegrass populations, and avoiding saving and then planting seed harvested from fields infested with ryegrass the previous season.

Additionally, research has confirmed deep turning can have a significant influence on the emergence of annual ryegrass. The graph and picture below note how effective deep turning may be in reducing ryegrass emergence. By spring in this experiment, ryegrass emergence was reduced over 99% with deep turning. Although this experiment does not address ryegrass seed spread throughout the soil profile which is present in grower fields, it does suggest ryegrass seed do not emerge very well when placed deep in the soil profile. The next step is to understand how long the seed will live buried in our soils and our environment.



Rarely will any cultural or mechanical practice effectively control ryegrass by itself. Thus, an herbicide program will usually be needed. Options include the following:

Axial XL, active ingredient pinoxaden, at 16.4 fl oz/A can be applied postemergence to wheat having at least two leaves up to pre-boot stage (Figure 1). Ryegrass resistant to Hoelon may be cross resistant to Axial XL, although in many cases Axial XL is still effective in Georgia. Apply in no less than 10 gallons of water per acre. Rain falling 30 minutes after application will not impact control. Axial can be applied only once per crop and will not offer residual control.

Axial may be mixed with Harmony Extra for broadleaf weed control. Add the Harmony first, then Axial XL. According to the label, Axial XL may also be applied in mixture with liquid nitrogen fertilizers with up to 50% liquid nitrogen by volume. Add water to the tank, then add Axial XL; mix thoroughly and then add nitrogen. *The University of Georgia recommends STRONGLY against mixing Axial XL with nitrogen fertilizer as a carrier because of the potential for reduced ryegrass control.*

Labeled rotational crop restrictions include 30 days for leafy and root crops and 120 days for all other crops including other cereal grains.

Axiom, active ingredients flufenacet and metribuzin, can be applied to wheat after the spike stage of growth up to the 2 leaf stage (Figure 1). Preemergence applications can cause severe crop injury, especially on sandier soils when conditions are wet during crop emergence. Injury has also been observed occasionally when Axiom is applied during the spike stage of growth if heavy rains or recurring rainfalls/irrigation occur within a few days of application.

If Axiom is activated prior to ryegrass emergence then control will be good, but if ryegrass emerges prior to Axiom being activated then control will be poor. Axiom will also provide fair to good control of several problematic broadleaf weeds, including wild radish and henbit.

Axiom may be used as part of an herbicide resistance management program because it has an alternate mode of action for the control of ryegrass compared to typically used products such as Axial, Hoelon, Osprey and PowerFlex.

Those wanting to use Axiom need to review the label very carefully regarding injury potential and use rates. Most Georgia growers will be using 6 oz (or maybe less in some environments) of product per acre, but, again this should be determined from your soil type and label restrictions.

Onions and sugar beets can be planted 18 months after applying Axiom; cotton 8 months; and potato 1 month. No plant back issues exist for corn or soybean. See label for other crops.

Fierce, containing the active ingredients flumioxazin plus pyroxasulfone, has obtained a Section 24 (c) Special Local Need label for Georgia wheat. This is a new tool to help Georgia wheat producers but it must be used on a small scale until experience can be obtained as injury can occur in some environments.

Wheat must be planted between 1 and 1.5 inches deep; Fierce cannot be applied to wheat that has been broadcast and shallow incorporated. Fierce at 1.5 oz of product per acre mixed with only water can be applied topically once 95% of the wheat is in the spike to 2-leaf stage of growth.

Rainfall or irrigation of ½ inch must occur prior to ryegrass reaching ½ in height; good control of wild radish will also be achieved as long as it is less than ½ inch at time of activation.

DO NOT apply Fierce to heavy sands or low organic matter soils as injury is expected.

Hoelon, containing the active ingredient diclofop-methyl, can be applied in wheat to control annual ryegrass. Hoelon does not control broadleaf weeds, wild garlic, or annual bluegrass. Hoelon can be applied postemergence in any variety of wheat any time before the first node, or joint, develops (up

to Feekes stage 6, Figure 1).

Timely application of Hoelon to annual ryegrass is essential for good control. Best control is obtained when treating one- to three-leaf ryegrass (about 2 to 3 inches tall), which usually occurs prior to Christmas. Higher rates are required for larger ryegrass, and even then control decreases. Better activity is obtained under warmer temperatures; night-time temperatures should be above 35° F for three days before and three days after application.

Postemergence Hoelon rates for ryegrass		Postemergence Hoelon effectiveness	
Ryegrass growth stage	Hoelon rate (pints per acre)	Ryegrass height	Percent control
1 to 3 leaves	1.33	2 inches	100
3 to 4 leaves	1.33 to 2.0	4 inches	80-90
5 leaves to 2 tillers	2.0 to 2.67	6 inches	50

The Hoelon label allows for the addition of crop oil concentrate. Crop oil is usually not necessary, and it may increase the risk of crop injury under stressful conditions. However, a crop oil can improve control under dry conditions or when treating large ryegrass.

Hoelon should NOT be applied postemergence in nitrogen or tank mixed with other herbicides. Either of these situations can reduce ryegrass control. Additionally, to avoid reduced ryegrass control, do not apply 2,4-D within five days of applying Hoelon.

Ryegrass resistant to Hoelon is quite common throughout Georgia.

Prowl H₂O, active ingredient pendimethalin, at 1.5 to 2.5 pt/A can be applied postemergence to wheat as long as the wheat is between the 1st leaf stage and the flag leaf being visible (Figure 1). Prowl does not control emerged weeds, but can provide residual control of sensitive weed species if the herbicide is activated by rainfall or irrigation in a timely manner. For ryegrass, Prowl can provide 50 to 80% control at 30 d after application, as long as the Prowl was activated prior to ryegrass germination. Research results on Prowl's ability to control broadleaf weeds like henbit, chickweed, etc. is currently limited. The Prowl H₂O label allows for mixtures with any labeled postemergence wheat herbicide.

The two greatest uses for Prowl H₂O might be the following: First, a mixture of Prowl H₂O with a postemergence annual ryegrass herbicide. In theory with this application, the postemergence herbicide would control the emerged ryegrass and the Prowl H₂O would provide residual control of germinating ryegrass for a couple of weeks. However, it is worth mentioning that most of the ryegrass seen at harvest is not ryegrass that emerged after postemergence herbicide treatment, but rather is ryegrass that was not controlled with a postemergence herbicide because the ryegrass was too large or resistant when treated...Prowl H₂O will not help with this situation.

A second use for Prowl H₂O in wheat would be in a situation where the wheat emerges while the ryegrass is late to emerge. In this situation, Prowl H₂O applied over one leaf wheat and activated by rainfall or irrigation could provide control of that later emerging ryegrass.

Osprey, active ingredient mesosulfuron-methyl, is a postemergent herbicide applied at 4.75 oz per acre in wheat from emergence up to the jointing stage (Figure 1). For annual ryegrass control, applications must be made between 1-leaf and 2-tillers. If applied properly and timely, Osprey controls ryegrass very well and very consistently, including Hoelon-resistant ryegrass, as long as it is not ALS-resistant ryegrass.

Osprey is a sulfonyleurea-type herbicide and works slowly. Symptoms appear three to four weeks after application but eight weeks may pass before ryegrass dies. Four hour rain fastness required.

An adjuvant is required with Osprey. The manufacturer is currently recommending a nonionic surfactant containing at least 80% surface-active agents plus an ammonium nitrogen source for wheat in Georgia. The nonionic surfactant should be used at a rate of 0.5% by volume (2 quarts per 100 gallons spray solution). In addition to the nonionic surfactant, also include 1 to 2 quarts per acre of urea ammonium nitrogen fertilizer (28-0-0, 30-0-0, or 32-0-0) or ammonium sulfate fertilizer at 1.5 to 3 pounds per acre (21-0-0-24).

Apply Osprey in 12 to 15 gallons of water per acre; do not use liquid nitrogen as a carrier; and do NOT apply Osprey within 14 days of topdressing. Occasionally, significant injury has been observed when wheat has been top-dressed shortly after an Osprey application. Separate Osprey and 2,4-D applications by at least 5 days.

Osprey may be mixed with Harmony Extra to improve control of broadleaf weeds. The label also allows a mixture with MCPA; however, antagonism (reduced ryegrass control) with Osprey/MCPA mixtures has been noted in several Georgia research studies. Osprey will also provide good control of henbit, wild radish, and common chickweed if applied when these weeds are small (≤ 2 inch). Osprey is VERY effective on annual bluegrass but does not control little barley.

The rotational restriction following Osprey application is 30 days for barley and sunflower; 90 days for cotton, peanut, soybean, rice, lentils, peas, and dry beans; 12 months for corn; and 10 months for other crops.

Resistance to Osprey and PowerFlex is now common. Growers should rotate PowerFlex OR Osprey with alternative chemistries every year; never treat the same piece of land more than once in a two year time period with either Osprey or Powerflex.

PowerFlex HL, active ingredient pyroxsulam, can be applied from the three-leaf stage until jointing (Figure 1). Apply after the majority of the ryegrass has emerged but before it exceeds the two-tiller stage which means most applications should occur prior to Christmas.

The current formulation of PowerFlex HL should be a 13.13 WDG where 2.0 oz/A is the appropriate rate. Applications should be made in 12 to 15 gallons per acre and include a crop oil concentrate at 1 to 1.25% v/v (1 to 1.25 gal crop oil per 100 gal spray solution). Four hours is needed prior to the first rain.

In addition to ryegrass, the PowerFlex HL label claims control of several broadleaf weeds including Carolina geranium, common chickweed, hairy vetch, wild mustard and suppression of

henbit. The label does not mention wild radish but numerous Georgia studies suggest excellent control of radish up to 8 inches in height (Table 13).

For additional broadleaf control, PowerFlex HL may be mixed with Harmony Extra. Do not mix with dicamba, 2,4-D, or MCPA. Also, do not mix with or spray within 5 days of organophosphate insecticides.

Do not fertilize with an independent liquid ammonium nitrogen application within 7 days before or after a PowerFlex application. However, the label allows for Powerflex to be mixed in water-nitrogen mixtures containing up to 50% liquid nitrogen (<30 lb actual nitrogen per acre). When PowerFlex is applied with nitrogen, use a nonionic surfactant at 1 pt per 100 gallon (0.25% v/v) of solution instead of crop oil. *UGA STRONGLY recommends against mixing PowerFlex with nitrogen fertilizer as a carrier because of the potential for reduced ryegrass control.*

PowerFlex is a sulfonyleurea-type herbicide, and similar to other sulfonyleureas, PowerFlex works slowly. Symptoms appear three to four weeks after application with up to eight weeks passing before the ryegrass actually dies.

Ryegrass resistance to PowerFlex and Osprey are now common. Growers should rotate PowerFlex OR Osprey with alternative chemistry every year; never treat the same piece of land more than once in a two year time period with either of these herbicides.

Labeled rotational restrictions include 1 month for wheat and triticale, 3 months for cotton, soybean, grain sorghum, and sunflower, 9 months for grasses including barley, field corn, millet, oats, popcorn, seed corn, sweet corn, and for broadleaves including alfalfa, canola, chickpea, dry bean, field pea, flax, lentil, mustard, potato, safflower, and sugar beet. All crops not listed have a 12 month rotational restriction.

Zidua, active ingredient pyroxasulfone, can be applied as a delayed preemergence or early postemergence in wheat that is planted between 0.75 to 1.25 inches deep.

Delayed preemergence applications can occur when 80% of the germinated wheat seeds have a shoot at least ½ inch long up until spiking; applications of 0.7 to 1.0 oz/A (coarse soils) are appropriate for most Georgia fields while the rate can be increased to 1.25 oz/A on medium to fine soils. Do not irrigate fields treated with a delayed preemergence application until wheat spiking *and DO NOT apply delayed preemergence applications to broadcast-seeded wheat.*

Early postemergence Zidua applications can be applied to wheat at spiking up to the fourth-tiller growth stage at a rate of 1.0 to 2.0 oz/A. Sequential applications may also be applied as long as the total use rate does not exceed 2.5 oz/A.

If Zidua is activated prior to ryegrass emergence, excellent control is expected; however, if ryegrass is up at time of Zidua application then control of the emerged plants will likely be poor. The label does allow mixtures with Axial.

Greatest potential for injury occurs when open/cracked seed furrow allows herbicides to directly contact the seed, when seed are planted too shallow, or when seed are planted in a deep furrow that

allows herbicide concentration after a rain/irrigation event during wheat germination.

Herbicide Resistance Management

Herbicide resistance is a natural inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide that normally controls that plant species. Resistant plants are not responsive to a particular herbicide because of a genetic change within the plant population. Herbicides do not “create” resistant plants; resistant plants are naturally present in very low numbers. Repeated use of the same herbicide, or those herbicides with the same mode of action, may select for resistant plants (in other words, allow the resistant plants to become the predominant type present). Resistant weed populations are allowed to flourish as competition from susceptible species is eliminated by the herbicide treatment.

Ryegrass with resistance to Hoelon has been a problem in Georgia for years. Osprey and PowerFlex-resistant ryegrass are now common because of repeated use of Osprey and/or PowerFlex. During 2009, ryegrass with resistance to Hoelon, Osprey, and PowerFlex was confirmed. And in 2011, numerous ryegrass populations with resistance to Hoelon, Osprey, Axial, and PowerFlex were confirmed.

One effective way to avoid or delay buildup of herbicide-resistant weed populations is rotation of herbicides with different modes of action. Additionally, integration of non-chemical controls, such as crop rotations and cultural control methods including deep turning of the land, can delay resistance evolution.

Early detection of herbicide-resistant weeds is important to limit their spread to other fields and farms currently not infested. Since some control failures are not due to weed resistance, growers should eliminate other possible causes of poor herbicide performance before assuming they have resistance. These causes include the following:

- 1) improper herbicide choice or rate
- 2) poor/improper application
- 3) POOR TIMING OF APPLICATION
- 4) unfavorable weather
- 5) later weed flushes
- 6) antagonism by other pesticides
- 7) time of day in which the herbicide was applied
- 8) weed covered by dirt during the planting process

After eliminating possible causes for control failure, then look for known indicators of resistance:

- 1) poor performance on one species while other species are controlled well
- 2) product that normally controls a weed in question performs poorly under ideal conditions
- 3) poor control confined to localized spots in a field, at least initially
- 4) within a species, some plants are controlled well whereas others are not
- 5) field history of heavy use of herbicides with same mode of action (not required but likely to increase the potential for resistance)

Liquid Nitrogen Tank Mixes

Although several herbicides used in wheat may be mixed with liquid nitrogen (see label of individual herbicides), herbicide and nitrogen timing for wheat applications may not coincide. For example, nitrogen should be applied at full tiller and prior to jointing, whereas herbicides should be applied when the weeds are small and the wheat will not be injured. Stretching the window for effective weed control to accommodate nitrogen fertilization may result in poor weed control and possibly greater wheat injury. *Additionally, nitrogen fertilizers should never be mixed with herbicides being applied to control annual ryegrass because of the strong potential for antagonism.*

Additional Considerations for No-Till Wheat Production

In no-till production systems, weed control at planting is critical because many winter annual weeds such as chickweed, henbit, annual bluegrass, and Italian ryegrass are already established at planting time. Paraquat (Gramoxone, etc) or glyphosate may be applied after planting **but before wheat emerges** (Tables 16 and 17) for control of emerged weeds.

A burndown herbicide is recommended in every case of no-till wheat production. Without a burndown application, winter annuals can quickly get too large to control easily and can cause substantial yield reduction. Higher rates of preplant burndown herbicides may be needed for dense weed populations, under drought or cool or cold growing conditions, or for specific problem weeds.

Just as is the case in all other crops, wheat should be planted into fields free from weeds.

Figure 1. Ideal Postemergence Timing of Herbicides Relative to Wheat Development in Georgia.

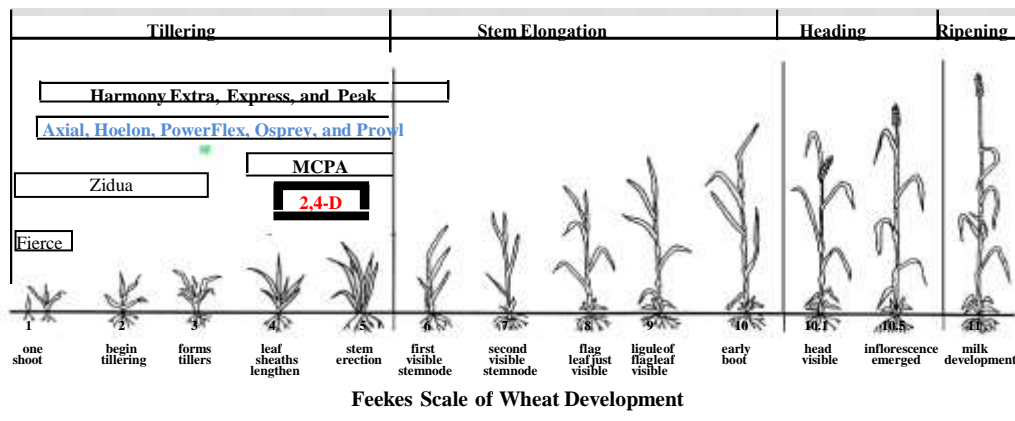


Table 16. Weed Responses to Broadleaf Herbicides Used in Wheat.

Weeds	2,4-D ¹	MCPA ¹	Express ¹	Express + MCPA or 2,4-D ¹	Buctril ¹	Harmony Extra ¹	Harmony Extra + MCPA or 2,4-D ¹	Peak ¹	Finesse ²
Annual bluegrass	N	N	N	N	N	N	N	N	N
Annual ryegrass	N	N	N	N	N	N	N	N	F
buttercup	G					G	GE		G
common chickweed	P	P	G	GE	PF	G	GE		G
common ragweed	G	F			E	PF	FG	E	
cornflower	G				GE	P	F		F
cudweed	GE	GE		E	G	E	E		
curly dock	P	P		P	PF	E	E		
dandelion	E	E		GE	E		GE		
dogfennel	G	F			GE	E	E		
evening primrose	E	E		E	F	F	E	FG	
field pennycress	G				G	G	GE		G
goldenrod	F	G			F				
hairy vetch	FG	FG			F	P	F		
henbit	P	P	F	G	F	G	GE	FG	G
horsenettle	F	F			F				
horseweed	F	F			F	FG	FG		
knawel	P				P	G	G		
Lambsquarters	G	G			E	E	E	G	
plantains	E	E		E	E	E	E		
shepherd's-purse	GE	GE		E	G	E	E	G	G
swinecress	G	G		GE	GE	E	E		
thistles	G	G			G	FG	G	FG	
vetch	G				F	P			
VA pepper-weed	E			E	FG	G	GE		
wild garlic	F	P			P	GE	GE	E	P
wild mustard	E	GE	F	E	G	FG	E	G	G
wild radish	E	GE	F	E	FG	FG	E	G	G

¹ Timely postemergence application.

² Applied preemergence.

Key: E = excellent control, 90% or better; G = good control, 80% to 90%; F = fair control, 70% to 80%; P = poor control, 25 to 50%; N = no control, less than 25%.

Table 16. Weed Responses to Grass and Broadleaf Herbicides Used in Wheat.

Weeds	Axiom ²	Fierce ²	Zidua ²	Hoelon ¹	Axial XL ¹	Osprey ¹	PowerFlex ¹
Annual bluegrass	G			N	N	GE	PF
Annual ryegrass	PG ³	GE ³	FE ³	E ⁴	GE ⁵	GE ⁶	GE ⁶
buttercup				N	N		
common chickweed				N	N	FG ⁷	FG ⁷
common ragweed				N	N		
cornflower				N	N	P	
cudweed				N	N		
curly dock				N	N	P	
dandelion				N	N		
dogfennel				N	N		
evening primrose		GE		N	N	P	P
field pennycress				N	N		
goldenrod				N	N		
hairy vetch				N	N		
henbit	GE	GE	PF	N	N	GE ⁷	FG
horsenettle				N	N		
horseweed				N	N		
knawel				N	N		
Lambsquarters				N	N		
plantains				N	N		
shepherd's-purse				N	N		
swinecress				N	N	E	
thistles				N	N		
vetch				N	N	PF ⁷	
VA pepper-weed				N	N		
wild garlic				N	N	P	
wild mustard	GE	GE	PF	N	N	G	GE
wild radish	GE	GE	PF	N	N	G	GE

¹ Timely postemergence application.

² Applied spike to wheat.

³ Axiom provides good control and Zidua provides excellent control if activated prior to ryegrass germination, poor control is often achieved if ryegrass emerges prior to herbicide activation. Fierce will provide excellent control if activated prior to ryegrass reaching ½ inch in height.

⁴ Will not control Hoelon-resistant ryegrass.

⁵ Axial XL & Hoelon have similar modes of action; Axial XL may not control Hoelon-resistant ryegrass and will not kill Axial-resistant ryegrass.

⁶ Will not control Osprey- or PowerFlex-resistant ryegrass.

⁷ Weeds must not be larger than 2 inches when treated.

Key: E = excellent control, 90% or better; G = good control, 80% to 90%; F = fair control, 70% to 80%; P = poor control, 25 to 50%; N = no control, less than 25%

Table 17. Chemical Weed Control in Wheat.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Category ¹	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
PREPLANT NO-TILL				
Emerged annual weeds; volunteer corn	paraquat (Gramoxone) 2 SL (Firestorm, Parazone) 3 SL MOA 22	2 to 4 pt 1.33 to 2.7 pt	0.5 to 1.0	Apply before crop emerges. Rate depends on weed size. Add nonionic surfactant at 1 pt per 100 gal of spray or crop oil concentrate at 1 gal per 100 gal of spray. Control of 12" corn at 1.5 pt/A is about 80% but may provide acceptable control until frost.
Emerged annual weeds, control or suppression of perennial weeds	glyphosate 3.57 SL (3 lb a.e.) 4 SL (3 lb a.e.) 5 SL (3.7 lb a.e.) 5.5 SL (4.5 lb a.e.) 6 SL (5 lb a.e.) MOA 9	32 to 48 fl oz 24 to 36 fl oz 23 to 34 fl oz 22 to 32 fl oz 19 to 29 fl oz	0.75 to 1.13	Apply before crop emerges. Adjuvant recommendation varies by glyphosate brand used.
Control of most winter weeds	glyphosate + 2,4-D amine MOA 9 + 4	see glyphosate + 12 to 16 fl oz	0.75 to 1.13 + 0.38 to 0.5	Check brand of 2,4-D used as some labels prohibit planting within 29 days of application. Research suggests plantback intervals of 24 days and 1 inch of rain between application and planting may be needed. Without required rainfall, serious injury can occur.
Summer and winter annual weeds including wild radish, henbit, chickweed	glyphosate + thifensulfuron-methyl + tribenuron-methyl (Harmony Extra SG with Total Sol) 50 SG MOA 9 + 2	see glyphosate + 0.45 to 0.9 oz	0.75 to 1.13 + 0.0094 to 0.0188 + 0.0047 to 0.0094	May be used as a burndown treatment prior to or shortly after planting, but prior to wheat emergence. Improves control of wild radish and chickweed; greatly improves henbit control.
Volunteer Roundup Ready Corn	glyphosate + clethodim (Select) 2 EC (Select Max) 0.97 EC MOA 9 + 1	see glyphosate + 4 to 8 fl oz 6 to 9 fl oz	0.75 to 1.13 + 0.06 to 0.12 0.05 to 0.07	Do not plant wheat for 30 days after applying clethodim. Corn < 12 inch: Select 4 to 6 oz; Select Max 6 oz. Corn 12-24 inch: Select 6 to 8 oz; Select Max 9 oz.
Summer and winter annual weeds including wild radish, henbit, chickweed; residual control of numerous weeds with ryegrass suppression	glyphosate + flumioxazin (Valor SX) 51 WDG MOA 9 + 14	see glyphosate + 1 to 2 oz	0.75 to 1.13 + 0.032 to 0.063	For Valor, a <u>minimum of 30 days</u> must pass, and 1 inch of rainfall/irrigation must occur, between application and planting of wheat. On sands, a plant back interval of 40 days is suggested. Significant injury is likely if required rainfall does not occur.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Category ¹	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
PREEMERGENCE				
Annual ryegrass and annual broadleaf weeds	chlorosulfuron + metsulfuron-methyl (Finesse, Report Extra) 75 WDG MOA 2 + 2	0.5 oz	0.0195 + 0.0039	Ryegrass control is variable; expect suppression. May stunt wheat on sandy soils; wheat seed must be planted at least 1" deep. Do not use where a later application of Osprey or PowerFlex is expected. Plant only STS soybeans following wheat harvest. Crop injury may result if organophosphate is used. SEE rotational restrictions. If ryegrass is not present then a lower rate may be used, see label.
DELAYED PREEMERGENCE				
Annual ryegrass	Pyroxasulfone (Zidua) 85 WG MOA 15	0.7 to 1.0	0.037 to 0.053	Plant wheat seed at least 0.75" deep. Do not apply to broadcast seeded wheat. Seed must be uniformly covered without furrows to avoid injury. Apply Zidua as a broadcast spray to the soil surface following wheat planting when 80% of germinated wheat seeds have a shoot at least ½ inch long up through wheat spiking. Use 0.7 to 1.0 oz/A on coarse soils; rate can be increased to 1.25 oz/A on medium to fine soils. Do not irrigate until wheat is emerged. DO NOT use Zidua or Fierce on the same field 2 years in a row.
SPIKE TO EARLY POST				
Wild radish, henbit, annual ryegrass, and annual bluegrass	flufenacet + metribuzin (Axiom) 68 WDG MOA 15 + 5	4 to 8 oz	0.136 to 0.027 + 0.34 to 0.068	Apply to wheat in the spike stage (up until the 2 leaf stage). Wheat seed should be planted at least 1 inch deep. Preemergence applications can cause severe injury. For most Georgia soils, ≤6 oz/A of product is ideal. Heavy rains following application can cause stunting even with a spike application. If Axiom is activated prior to ryegrass emergence then control will be good but if ryegrass emerges prior to Axiom activation then control will be poor. Rotation to soybean is 0 months, cotton 8 months, and many other crops 18 months.
Residual control of annual ryegrass	pyroxasulfone (Zidua) 85 WG MOA 15	1.0 to 2.0	0.037 to 0.074	Apply to wheat (drilled or broadcast) at spiking up to the 4th-tiller growth stage. Will provide ryegrass control for plants emerging after application and activation; however, little control of plants already emerged. May mix with Axial XL to control emerged ryegrass plants (those not resistant to Axial) and apply between 2-leaf and 4-tiller wheat. Much more effective than Prowl. Sequential applications made be made as to not exceed 2.5 oz/A per crop. DO NOT use Zidua or Fierce on the same field 2 years in a row.
Residual control of annual ryegrass, wild radish, and other weeds	pyroxasulfone + flumioxazin (Fierce) 76 WDG MOA 15 + 14	1.5 oz	0.04 + 0.031	Wheat must be planted 1 to 1.5 inch deep to avoid injury; cannot treat broadcast spread seed. Apply to wheat when 95% of wheat is in the spike to 2-leaf stage of growth; DO NOT apply preemergence. Weeds must be less than ¼" at time of application and activating rainfall/irrigation must occur prior to weeds reaching ½". Ideally herbicide is activated after wheat is up but before weed emergence. Apply only in water! New label try on few acres only. Visual leaf tip burn and minor chlorosis is expected. No rotational concern following wheat with cotton, peanut, soybean or corn. DO NOT use Zidua or Fierce on the same field 2 years in a row.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Category ¹	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
POSTEMERGENCE				
Annual ryegrass	diclofop-methyl (Hoelon) 3 EC MOA 1	1.33 to 2.67 pt	0.5 to 1.0	Apply before wheat begins to joint. Apply 1.33 pt/A on 2-leaf ryegrass, 2 pt/A on 2-leaf to initial tillering ryegrass; and 2.67 pt/A on 1- to 2-tiller ryegrass. Make only one application per season. Do not tank mix with broadleaf herbicides or use liquid nitrogen as the carrier. May add 1 to 2 pt per acre of crop oil concentrate when conditions are dry or when ryegrass is large. Crop oil usually not necessary. Crop injury may result if organophosphate is used. Ryegrass resistant to Hoelon is common. To minimize resistance: Make only one application of Hoelon OR Axial in a field every two years.
Annual ryegrass, small wild radish, and other broadleaf weeds Very effective on annual bluegrass	mesosulfuron-methyl (Osprey) 4.5 WDG MOA 2	4.75 oz	0.013	Apply to ryegrass between 1-If and 2-tiller and before wheat is jointing. Add a nonionic surfactant (at least 80% active) at 2 qts per 100 gallon spray solution plus ammonium nitrogen fertilizer (28-0-0, 30-0-0, 32-0-0) at 1 to 2 qt per acre. DO NOT top-dress within 14 days of Osprey application or mix with 2,4-D or MCPA. Do not use liquid nitrogen as the carrier. May mix Osprey with Harmony Extra. Cotton/soybean can be planted 90 days after application. Ryegrass resistant to Osprey or PowerFlex is common. To minimize resistance: Make only one application of Osprey OR PowerFlex in a field every two years.
Annual ryegrass	pinoxaden (Axial XL) 0.42 EC MOA 1	16.4 fl oz	0.053	Apply to ryegrass prior to two tillers while wheat is between 2 leaf and pre-boot. No adjuvant required. Mix with Harmony Extra for broadleaf control. UGA suggest not mixing with nitrogen but label allows water/nitrogen mixtures containing up to 50% liquid nitrogen by volume. Add water to tank, then add Axial; then mix thoroughly and add nitrogen. May mix with Zidua for residual control. Make only one application per crop and any crop can be planted 90 days after application. Axial and Hoelon have the same mode of action. Research in Georgia has shown Axial to kill about 50% of the Hoelon-resistant populations studied. To minimize resistance: Make only one application of Hoelon OR Axial in a field every two years.
Annual ryegrass, wild radish, and other broadleaf weeds	pyroxsulam (PowerFlex HL) 13.13 WDG MOA 2	2.0 oz	0.0164	Apply to ryegrass prior to two tillers while wheat is between 3-If and jointing. Add crop oil concentrate at 1.25 gal per 100 gal spray solution. May tank mix with Harmony Extra but NOT dicamba, 2,4-D, or MCPA. UGA suggest not mixing with nitrogen but label allows water-nitrogen mixture containing up to 50% liquid nitrogen by volume (< 30 lb/A of nitrogen). If applying in liquid nitrogen, use a nonionic surfactant at 0.25% v/v, instead of crop oil. An independent liquid ammonium nitrogen fertilizer application should not be made within 7 days of application; do not apply organophosphate within 5 days of application. Soybeans or cotton can be planted after the following April. Ryegrass resistant to Osprey or PowerFlex is common. To minimize resistance: Make only one application of Osprey OR PowerFlex in a field every two years.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Category ¹	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
POSTEMERGENCE (continued)				
Fair residual suppression of annual ryegrass	pendimethalin (Prowl H2O) 3.8 AS MOA 3	1.5 to 2.5 pt	0.71 to 1.18	Apply from 1 st leaf stage of wheat up to flag leaf. Prowl does not control emerged weeds. May tank mix with any postemergence herbicide labeled for use in wheat. <i>Zidua is more effective on ryegrass.</i>
Wild garlic, curly dock, and most winter annual broadleaf weeds except wild radish must be less than 1"	thifensulfuron-methyl + tribenuron-methyl (Harmony Extra SG with TotalSol) 50 SG	0.45 to 0.9 oz	0.0094 to 0.0188 + 0.0047 to 0.0094	Apply after 2-lf stage of wheat but prior to flag leaf. Most annuals can be controlled with 0.6 to 0.75 oz/A of Harmony Extra 50 SG; however, 0.75 to 0.9 oz/A is needed for wild garlic or wild radish. Apply when temps are above 50 F, and plants are not stressed. Garlic should be < 12" tall and should have 2-4" of new growth. Make no more than 2 applications per year applying a max of 1.5 oz/A per season of Harmony Extra Total Sol. A nonionic surfactant at the rate of 1 quart per 100 gal of spray solution is suggested when applied in water. Liquid nitrogen may be used as the carrier; in this case, premix the herbicide in water and add the mixture to nitrogen with agitation; add 0.5 to 1.0 pint nonionic surfactant per 100 gallons spray solution. For timely wild radish control, tank mix with MCPA or 2,4-D at 0.375 lb ai/A (12 oz/A of 4 lb ai material). Add 0.5 to 1.0 pint nonionic surfactant per 100 gallons spray solution. If mixing 2,4-D or MCPA with Harmony and using nitrogen as the carrier, eliminate surfactant. Follow wheat stage of growth restrictions for 2,4-D or MCPA with mixtures.
	(Harmony Extra, Nimble, others) 75 WDG MOA 2 + 2	0.3 to 0.6 oz		
Partial control of most weeds including wild radish Harmony Extra is usually more effective	tribenuron-methyl (Express SG with TotalSol) 50 SG (Express) 75 WDG MOA 2	0.25 to 0.5 oz 0.167 to 0.33 oz	0.008 to 0.0155	Apply after 2-lf stage of wheat but prior to flag leaf. Add 1 qt of nonionic surfactant per 100 gal of spray solution. Apply when weeds are small and not stressed. May be applied in mixture with some liquid fertilizers; however, some discoloration and stunting may occur; see label. If applying in liquid nitrogen; add 0.5 to 1 pint nonionic surfactant per 100 gallons of spray solution. Suggest mixtures with 0.375 lb active ingredient of 2,4-D or MCPA for improved control of wild radish (add 0.5 to 1.0 pint nonionic surfactant per 100 gallons spray solution). If mixing 2,4-D or MCPA with Express and using nitrogen as the carrier, use at most 0.5 pt of nonionic surfactant per 100 gallons of spray solution. Follow wheat stage of growth restrictions for MCPA or 2,4-D when using these mixtures.
Most winter annual broadleaf weeds except chickweed, henbit, knawel, red sorrel, and geranium	2,4-D amine (various brands) 3.8 L	1.0 to 1.25 pt	0.48 to 0.6	Apply to fully tillered wheat (stages 4 and 5 on Feekes scale) but before jointing. Spraying wheat too young or after jointing may reduce yields. Better results obtained when day-time temps are above 50 F. Increase rate by 50% to control corn cockle. For wild onion or wild garlic, increase rate according to labels. Greater injury by 2,4-D can occur when using liquid nitrogen as the carrier. Ester formulations can be added directly into nitrogen. If using amine formulation, premix in water (1 part 2,4-D to 4 parts water) and add mixture to nitrogen with strong agitation. Amine formulations give less burn than ester formulations in nitrogen. Ester formulations are far more volatile and should be avoided if possible. STRONGLY suggest mixtures with Harmony Extra, see above. Only 1 in crop application of 2,4-D allowed.
	2,4-D ester (various brands) 3.8 L	1.0 to 1.25 pt	0.48 to 0.6	
	2,4-D ester (various brands) 5.7 L	0.67 to 0.84 pt	0.48 to 0.6	
	2,4-D acid/ester (Weedone 638) 2.8 L	1.0 to 1.25 pt	0.35 to 0.43	
	MOA 4			
	MCPA (various brands) 4.0 L (various brands) 3.7 L MOA 4 MOA 4	0.75 to 1.25 pt 0.75 to 1.25 pt	0.375 to 0.625 0.347 to 0.58	Amine formulation suggested to help minimize off-target movement. Apply 12 to 16 oz/A when wheat has at least 2 tillers and 16 to 20 oz/A when wheat is fully tillered. Do not apply after wheat is jointing. Weeds should be less than two inches in height or diameter. No spray additive required. STRONGLY suggest mixtures with Harmony Extra, see above.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Category ¹	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
PRE-HARVEST				
Annual broadleaf and grass weeds, suppression of perennial weeds	<u>glyphosate</u> 3.57 SL (3 lb a.e.) 4 SL (3 lb a.e.) 5 SL (3.7 lb a.e.) 5.5 SL (4.5 lb a.e.) 6 SL (5 lb a.e.) MOA 9	1 to 2 pt 1 to 2 pt 0.8 to 1.6 pt 11 to 22 fl oz 10 to 20 fl oz	0.38 to 0.75	Apply after hard dough stage of grain (30% or less grain moisture) but at least 7 days before harvest. Do not apply to wheat grown for seed. A wiper application could be used for only rope/sponge applicators (33 to 75% of solution with water) or a panel applicator (33 to 100% of solution with water). Thirty five day pre-harvest interval for wiper applications.
Annual broadleaf weeds	<u>2,4-D amine</u> (various brands) 3.8 SL MOA 4	1 pt	0.48	Apply when grain is in the hard dough stage (30% or less grain moisture) or later. Do not allow drift to sensitive crops. Amine formulations only recommended. Pre-harvest interval of 14 days required.
<p>¹Mode of Action (MOA) code developed by the Weed Science Society of America. MOA codes can be used to increase herbicide diversity in a weed management program to delay the development of resistant weeds.</p> <p>Important Note: Observations in Georgia wheat fields indicate crop damage when 2,4-D is tank mixed with liquid nitrogen. This also may be evident with other herbicide-nitrogen mixtures. To avoid possible damage and obtain better weed control, herbicides and nitrogen should be applied separately.</p>				

Table 18. Forage, Feed, and Grazing Restrictions for Wheat Herbicides.

Trade Name	Restrictions (see specific label of product used as label restrictions do vary by product)
Axial	Do not graze livestock or harvest forage for hay for at least 30 days after application. Do not harvest grain or feed straw to livestock for at least 60 days after application.
Axiom	Do not graze within 30 days of application.
Express or Harmony Extra Total Sol	Allow 7 days between application and grazing treated forage or feeding forage to livestock. Allow 30 days between application and feeding hay to livestock. Harvested straw may be used for bedding and/or feed. Allow at least 45 days before harvesting grain.
Hoelon	Do not allow livestock to graze treated fields for 28 days after treatment. Do not harvest forage, hay, or straw from treated fields prior to grain harvest.
Fierce	Do not graze until wheat has reached 5 inches in height.
Finesse	No grazing restrictions.
MCPA	Do not forage or graze meat animals or dairy cattle within 7 days of slaughter.
Osprey	Do not apply within 30 days of harvesting wheat forage, and 60 days for hay, grain, and straw.
PowerFlex	Do not graze treated crop within 7 days following application. Do not cut the treated crop for hay within 28 days after application.
Prowl H20	Do not apply within 28 days of harvest of hay; within 11 days of harvest of forage; or within 60 days before harvest of grain or straw.
Roundup WeatherMax	Stubble may be grazed immediately after harvest.
Zidua	Wheat forage and hay can be fed or grazed 7 or more days after application.
2,4-D	Do not graze dairy animals within 7 days of application. Do not cut treated grass for hay within 7 day of applications. Remove meat animals from treated areas 3 day prior to slaughter.

INSECT PEST MANAGEMENT

David Buntin

This chapter discusses the major insect pests of wheat. Insect pests can reduce both grain yield and quality of small grain crops in Georgia. Historically, the Hessian fly, aphids, and cereal leaf beetle are the pests of significant economic importance. Aphids can directly damage wheat, but are of concern mostly because they transmit a viral disease called barley yellow dwarf (BYD). True armyworm and other insects also occasionally damage cereal grain crops.

Major Insect Pests

Aphids: Aphids are small, soft-bodied insects that can be found in wheat anytime during the growing season. The most common aphids found on wheat are the bird cherry-oat aphid, rice root aphid, greenbug, corn leaf aphid, and English grain aphid. The first four occur mostly in the fall and winter. Only the greenbug causes direct feeding damage that appears speckled brown and discolored with some leaf curling. The other aphids usually do not cause obvious feeding damage. The English grain aphid is mainly present in the spring and can reach large numbers on flag leaves and developing grain heads. Damage from this pest can reduce kernel size and lower grain test weight. Aphids are a serious pest of wheat because they also transmit a viral disease named barley yellow dwarf (BYD) and a related disease called cereal yellow dwarf. Wheat and barley can be severely damaged, but oats are most susceptible to this disease. A new aphid, *Sipha maydis*, has been found in the Southeast on wheat which also can transmit BYD but its impact on wheat production in Georgia is not yet known.

BYD is present in most fields in most years throughout Georgia. Yield losses are sporadic but losses of 5-15% are common and can exceed 30% during severe epidemics. Infection can occur from seedling emergence through heading, but yield loss is greatest when plants are infected as seedlings in the fall. Although all aphids can potentially transmit certain strains of the virus, infections in the Southeast are mostly associated with infestations of bird cherry-oat aphid and rice root aphid. Planting date is the single most important management practice, with early plantings having greater aphid numbers and greater BYD incidence than late plantings. For the most part, beneficial insects such as lady beetles are helpful in reducing aphid numbers in the fall before frost and in the spring, but they are not active during the winter when aphids can quickly increase to large numbers during warm periods.

Systemic seed treatments are available for controlling aphids in the fall and winter and may reduce infection rates of BYD. These seed treatments are more effective in the northern half of the state, but are only recommended when (1) grain yield potential is high (>60 bu/acre), (2) a field has a history of BYD infection, and/or (3) early plantings will be made. In the coastal plain region, seed treatments have been inconsistent in control and are not recommended for routine aphid control. A single, well-timed insecticide application of the insecticide lambda cyhalothrin (Warrior II, Silencer, and similar products) or gamma cyhalothrin (Declare) also can control aphids, reduce the incidence of BYD, and increase yields. The best time for treatment in northern Georgia usually is about 25 - 35 days after planting, although an application in the winter until full tiller also may be beneficial. In southern Georgia, the best treatment time usually

is at full-tiller stage in late January to mid-February. But, scout fields for aphids at 25 - 35 days after planting and during warm periods in January to determine if an insecticide application is needed. A lambda cyhalothrin or gamma cyhalothrin treatment at full tiller can be applied with top-dress nitrogen. Two new insecticides, Sivanto Prime and Transform WG, also will provide useful control but its effect on BYD infection has not determined. OP insecticides, such as dimethoate, also will control aphids but are not effective in preventing barley yellow dwarf infection.

To sample aphids, inspect plants in 12 inches of row in fall and 6 inches of row in winter. In spring, inspect 10 grain heads (+ flag leaf) per sample. Count all aphids on both the flag leaf and head for making control decisions. Sample plants at 5 to 10 locations per field. Treat when populations reach or exceed the following thresholds:

Seedlings: 1 bird cherry-oat aphids per row foot, or 10 greenbugs per row foot.

2 or more tillers per plant: 6 aphids per row foot.

Stem elongation to just before flag leaf emergence: 2 aphids per stem.

Flag leaf emergence: 5 aphids per flag leaf.

Heading emergence to early dough stage: 10 aphids per head.

Do not treat for aphids after mid-dough stage.

Hessian Fly: The Hessian fly, *Mayetiola destructor*, can cause severe damage to wheat production throughout the southern United States. Wheat is the primary host of the Hessian fly, but the insect also will damage triticale. Barley and rye also may be infested but damage normally is very limited. Hessian fly does not attack oats. Little barley is the only important non-crop host in Georgia.

Adult Hessian flies are small black flies about the size of a mosquito. Adults live about two days and females lay about 200 eggs in the grooves of the upper side of the wheat leaves. Eggs are orange-red, 1/32 inch long and hatch in 3 to 5 days. Young reddish larvae move along a leaf groove to the leaf sheath and then move between the leaf sheath and stem where they feed on the stem above the leaf base. Maggots become white after molting and appear greenish white when full grown. Once larvae move to the stem base, they are protected from weather extremes and foliar-applied insecticides. Maggots suck sap and stunt tillers presumably by injecting a toxin into the plant. Infested jointed stems are shortened and weakened at the joint where feeding occurs. Grain filling of infested stems is reduced and damaged stems may lodge before harvest. Generally, three generations occur in the Piedmont region and four generations occur in the Coastal Plain region of Georgia. The fall and winter generations stunt and kill seedling plants and vegetative tillers. The spring generation infests jointed stems during head emergence and grain filling. Yield losses usually occur when fall tiller infestations exceed 8% of tillers and when spring stem infestations exceed 15% of stems.

The Hessian fly is a cool season insect and is dormant over the summer in wheat stubble as a puparia which is sometimes called a 'flaxseed'. Adults begin to emerge about September 1. Since wheat is not yet planted, the first generation develops entirely in volunteer small grains and little barley. Thus reduced tillage, lack of crop rotation (wheat after wheat), and lack of

volunteer wheat control in summer crops enhance problems with Hessian fly in autumn.

Planting a Hessian fly-resistant variety is the most effective way to control Hessian fly.

Varieties in the Georgia state wheat variety trials are evaluated for Hessian fly resistance each year and these ratings also are available in the Small Grain Performance Tests Bulletin. The next table provides a list of varieties with good, fair and poor resistance to Hessian fly in Georgia. But also check the “Characteristics of Recommended Varieties” section in the first part of this publication, because some varieties may not be recommended due to agronomic problems.

Wheat variety rating for Hessian fly resistance in spring 2017.

Poor (Susceptible)	Fair	Good (Resistant)
AGS 2031, 2020, 2040, 3201, CL7 Croplan 8302 Dyna-Gro 9053, 9171, 9522, 9750, Dominion, McIntosh, Tribute Pioneer Brand 26R15, 26R22, 26R53, 26R59, 26R87 Progeny 117, 185, 308, 357, 870, #Boss Public: Roberts, Chesapeake, Jamestown, NC-Cape Fear, NC-Yadkin, Hillard SS 520, 560, 5205, 8340, 8404, 8412 Syngenta Seeds Panola, Gore, Magnolia, Arcadia, Cypress Syngenta Coker 9553, 9700, 9804, Viper Terral LA821, LA841, LA842, TV8525, TV8535, TV8626 USG 3153, 3201, 3244, 3251, 3404, 3438, 3555, 3689, 3694, 3933	AGS 2000, 2035, 2038 Dyna-Gro Baldwin Pioneer Brand 26R31 Progeny 122, 166 Public: Fleming, SS 8308, Syngenta AgriPro Cypress Syngenta-Coker 9152 Terral LA754 USG 3209, 3592, 3665, 3833	AGS 2026*, 2027, 2033, 2060, 2072, 3000 Dyna-Gro/CPS Oglethorpe*, Savoy, Dyna-Gro 9701 Pioneer Brand 26R10, 26R20, 26R38, 26R41, 26R61*, 26R94 Progeny Public: Roane SS 8415, 8629, 8641 Syngenta AgriPro Syngenta-Coker Sou. Harvest 5550 Terral TV8589, TV8848, TV8861 USG 3120 * Resistant to Biotype L.

For susceptible varieties, systemic seed treatments, such as Gaucho, Cruiser, or NipsIt Inside, when applied at a **high rate (see Table 20)** will suppress fall infestations but will not prevent **Hessian fly infestation** in winter or spring. In February through mid-March with a properly-timed foliar application of lambda cyhalothrin also may suppress spring infestation but consistent control is difficult. This application must be applied while adults are active and eggs are being laid, so sampling of eggs on leaves is needed for proper timing.

Cereal Leaf Beetle: Cereal leaf beetle, *Oulema melanopus*, was first discovered in northwest Georgia in 1989. The insect is spreading southward and now occurs throughout the mountain and Piedmont regions and in most of the upper coastal plain region. Larvae feed on many grasses including oats, wheat, barley, rye, orchard grass, and annual ryegrass, but the insect is a problem mostly on oats and wheat. Adult beetles are 5 mm long and blue-black with a reddish thorax (neck) and legs. Larvae are yellow-white and up to 6 mm long, but appear shiny and black, because they are covered with fecal material. Adults and larvae defoliate or skeletonize long narrow sections of the flag and upper leaves. Adults are present in wheat during March and April when they mate and lay eggs. Larvae are present during wheat head emergence through

dough stage. There is one generation per year; newly-emerged adults over summer and overwinter in fence rows and wooded areas. These adults will feed on green grasses in adjacent fields, such as corn, sorghum, and crabgrass, before moving to over-summering sites. Corn planted next to wheat fields can be damaged by the beetles, although damage to corn usually is confined to field margins.

Cereal leaf beetle can be effectively controlled by one application of an insecticide to foliage. Fields should be scouted by counting the number of larvae and adults on 10 stalks at 6 to 10 locations per field. Treatment should be considered when populations exceed 1 larva per 4 stems. Most insecticides should be applied after most eggs have hatched but before larval damage becomes extensive. Tank mixing with a foliar fungicide at heading time is usually feasible.

Fall Armyworm: Fall armyworm looks much like other armyworm species. It is brown to black in color with an inverted Y on its head and four dots spaced in a square on the upper side last abdominal segment. Fall armyworms cannot tolerate freezing temperatures and die out in Georgia each fall. The moths are migratory and fly up from southern Florida each spring. There are several generations and in outbreak years they heavily infest and damage pastures grasses in late summer and the fall. In these year fall armyworm also may infest seedling cereal grains especially fields planted early for grazing. If present, larvae can completely destroy a seedling stand of cereal grains. Field should be scouted soon after planting and an insecticide used if larvae are present and damage is occurring.

True Armyworm: The true armyworm looks much like other armyworm species. It is brown to black in color. Larvae have three, orange, white and brown stripes running the length of each side. The larvae will also have a narrow broken stripe down the center of its back. Wheat fields should be checked for the presence of true armyworms when wheat is heading usually in March and early April, two weeks later in north Georgia. Armyworms generally are active at night and rest during day under plant residue at the base of stems. Armyworms chew large irregular holes in leaves generally from the bottom up, but may climb stems and cut grain heads off the plant. Very large infestation sometimes will march in large numbers out of defoliated wheat fields to continue feeding on crops in nearby fields. Treatment should be considered if 4 or more worms per square foot are found before pollen-shed stage and if 8 or more worms per square foot are found after pollen-shed stage. Insecticides listed are effective but coverage of dense foliar and lodged plants sometimes makes control difficult.

Stink bugs: Wheat is often infested with stink bugs in spring during grain fill. The brown and southern green stink bugs may reproduce and have a complete generation in wheat before harvest. Rice stink bug adults also are common in wheat. As wheat dries down, stink bug adults will disperse to nearby summer crops such as corn and vegetable crops. Stink bugs almost never require control in wheat. Treat if 1 or more bugs per square foot are present at milk stage. Treatment is not needed in the dough stage, except to prevent dispersal to adjacent summer crops as wheat matures. However, stink bugs are highly mobile and in most cases it is best to scout and treat adjacent crops such as corn and vegetables when stink bugs move into and reach threshold levels in those summer crops.

Sampling for Insect Pests

Wheat should be scouted for aphids, cereal leaf beetle and secondary pests. Scout the entire field. Insects tend to clump, and thus an examination of the whole field should be made. Fields should be inspected soon after planting to verify timely emergence. If emergence is poor, the field should be checked for soil-inhabiting insects such fall armyworm before replanting.

After stand establishment, scout fields for aphids at 4 critical times: 25 - 45 days after planting, warm periods in January, full-tiller in mid-February, and boot stage to head emergence. The first three periods are intended to control BYD infection and some direct aphid damage; the last period is to prevent damage by grain aphids, armyworms and cereal leaf beetle.

To sample aphids, inspect plants in 12 inches of row in fall and 6 inches of row in winter. In spring, inspect 10 grain heads (+ flag leaf) per sample. Sample plants at 8 to 16 locations per field. Treat according to thresholds listed for aphids. Inspect fields for cereal leaf beetle adults and larvae weekly for several weeks beginning at boot stage. Count the number of larvae and adults on 10 stalks at 6 to 10 locations per field. No other insect pest justifies routine sampling in wheat except possibly inspecting fields for armyworms during a boot stage while sampling for aphids and cereal leaf beetle.

Insecticides

Except for the Hessian fly, most other insect pests can be controlled by applying foliar insecticides when population densities exceed economic thresholds (Table 19). Granular insecticides at planting, such as Thimet / Phorate 20G, are not registered for use on wheat. Systemic seed treatments such as Gaucho 600, Cruiser 5FS, or NipsIt Inside may control aphids, suppress BYD infection and at high rates control Hessian fly in the fall. Most insecticides registered for use on wheat also can be used on oats, rye, and barley with the exception of Transform WG, Fastac, Tombstone and similar products. For current insecticide recommendations see Table 20 and the most recent edition of the Georgia Pest Management Handbook, Commercial Edition.

<http://www.caes.uga.edu/departments/entomology/extension/pest-management-handbook.html>.

Summary of Management Practices for Insect Pest Control

1. Avoid continuous planting of wheat in the same field including wheat as a cover crop.
2. Control volunteer wheat.
3. Plow fields to bury wheat debris (burning wheat stubble alone is not effective without tillage).
4. Do not plant wheat for grain before the recommended planting date for your area.
5. Plant rye, oats, or ryegrass instead of wheat for grazing.
6. Select a Hessian fly resistant variety that is adapted to your area.
7. On Hessian fly susceptible varieties, consider using a systemic seed treatment if the field has a history of Hessian fly damage, is reduced tillage, or if planting before the recommended planting date.
8. Scout wheat periodically for aphids, true armyworms, and cereal leaf beetles. Apply a foliar insecticide if numbers exceed treatment thresholds.

Table 19. Damage Symptoms and Economic Thresholds of Insect Pests of Wheat.

Insect	Damage Symptoms	Treatment threshold
aphids	Suck plant sap and may cause yellowing and death of leaves. Reduce grain size when grain heads infested. Transmit barley yellow dwarf virus.	Seedlings: 1/row ft., 6-10 inch plants: 6/row ft., Stem elongation: 2 per stem, Flag leaf - head emergence: 5/stem, Full heading: 10 per head to include flag.
Hessian fly	<i>Vegetative plants</i> --tillers stunted dark green, tiller death; <i>Jointed stems</i> --stunted, weakening of stem at point of feeding injury. Reduced grain size and weight. Infested stems may lodge before harvest.	Fall - early winter: 8% infested tillers. Spring: 15% infested stems.
Cereal leaf beetle	Adults chew elongated holes in upper leaves, larvae remove leaf tissue leaving low epidermis causing "window pane" effect.	1 larvae or adult per 4 stems.
Chinch bugs	Suck plant sap causing discoloration.	Seedlings: 1 adult per 2 plants, Spring: 1 adult per stem.
True armyworm	Primarily occur in late winter and spring from stem elongation to maturity; chew foliage and seed head glumes, also clip awns and seed heads.	Before pollen shed: 4 or more worms/sq. ft. After pollen shed: 8 or more worms/sq. ft.
Fall armyworm, beet armyworm, & yellow-striped armyworm	Primarily occurs in the fall; small larvae cause "window pane" feeding on leaves; larger larvae consume leaves and plants and destroy stands	Do not treat unless seedling damage exceeds 50% defoliation and 2 or more armyworms per sq. ft. are present.
Grasshoppers	Destroy leaves of seedlings during fall. Damage common along field margins.	Do not treat unless damage exceeds 50% defoliation and 3 or more grasshoppers/sq yd are present.
Flea beetles	Destroy leaves of seedlings in fall. Damage common along field margins.	Do not treat unless seedling damage exceeds 50% defoliation and 2 beetles /row ft. are present.
European corn borer	Small larvae chew holes in leaves; large larvae tunnel in stem killing developing grain head.	Control almost never practical; Treat when larvae are small, borers numerous and before they bore into stems.
Mites, winter grain mite	Suck plant sap; cause leaf discoloration.	Treat when leaf discoloration appear over areas of a field. Usually in spots.
Thrips	Suck plant sap; may cause leaf discoloration.	Injury not economic; do not treat. Thrips may disperse to adjacent summer crops as wheat matures.
Stink bugs	In spring, feed on developing grain from milk to hard dough stage.	Treat if 1 or more bugs per sq. ft. at milk stage. Do not treat in dough stage.

Table 20. Insecticide recommendations for wheat insect pests.

CROP/PEST	INSECTICIDE	IRAC GROUP	AMOUNT OF FORMULATION PER ACRE	LB ACTIVE INGREDIENT PER ACRE	REI/PHI (Hours or Days) H=harvest grain G =grazing, hay	TREATMENT THRESHOLDS AND REMARKS
<p>Insecticides and products listed are for use on all cereal grain crops for grain production including wheat, triticale, barley, oats, and rye, except where listed or noted in the insecticide column and remarks section. Products labeled for use only on wheat or wheat and triticale are dimethoate, Fastac EC, and Tombstone.</p> <p>ALL PRODUCTS LISTED IN THIS SECTION HAVE A BEE HAZARD RESTRICTION, EXCEPT FOR CHLORANTRANILIPROLE (CORAGEN, PREVATHON)</p>						
Aphids	SEED TREATMENTS					<p>Inspect fields 25-35 days after planting, full tiller, and heading. Yield-reducing transmission of Barley Yellow Dwarf virus can occur during first two periods; transmission at heading is too late to reduce yield.</p> <p>Aphid treatment thresholds are: Seedlings (2/row ft), 6-10 inch plants (6/row ft), Stem elongation (2/stem), Flag leaf (5/flag), Heading (10/head to include flag), Soft/Hard Dough stages (Do not treat).</p> <p>NOTE: OP insecticides, such as dimethoate, control aphids but are not effective at suppressing Barley Yellow Dwarf disease.</p> <p>NOTE: At labeled rates, Gaucho XT and Enhance AW also contain two fungicides.</p> <p>NOTE: Cruiser 5FS is available as a commercial seed treatment. Rates of CruiserMaxx Cereals and CruiserMaxx Vibrance alone are too low for effective aphid control. Add 0.5 to 1 fl. oz. of Cruiser 5 FS/100 lb of seed</p> <p>NOTE: NipsIt Inside may be sold as NipsIt Suite Cereals CVR that includes 2 fungicides.</p> <p>NOTE: Warrior II Zeon will replace Karate Zeon.</p>
	<i>imidacloprid</i> Gaucho 600, Attendant 600, Axxcess Gaucho XT Enhance AW Warden Cereals HR	4A	0.8 fl oz/100 lb seed	0.03 lb/100 lb seed	12 hours/ 45 days	
	<i>thiamethoxam</i> Cruiser 5FS Cruiser Maxx Cereals plus Cruiser 5FS Cruiser Maxx Vibrance plus Cruiser 5FS	4A	1.0 fl oz/100 lb seed 5.0 fl oz/100 lb seed plus 0.5 fl oz/100 lb seed 5 – 10 fl. oz./100 lb seed	0.04 lb/100 lb seed 0.04 lb/100 lb seed (total)	12 hours/ Do not graze	
	<i>clothianidin</i> NipsIt Inside	4A	0.75-1.79 fl oz/100 lb seed	0.03 – 0.07 lb / 100 lb seed	12 hours/ Not specified	
	FOLIAR TREATMENTS					
	<i>beta-cyfluthrin</i> Baythroid XL 1EC	3A	2.4 fl oz	0.019	12 hours/ H - 30 days G – 3 days	
	<i>dimethoate</i> (wheat only) Dimethoate 4EC, 400 Dimethoate 2.67EC	1B	0.5-0.75 pt 0.75-1 pt	0.25-0.375 0.25-0.375	48 hours/ H - 35 days G- 35 days	
	<i>flupyradifurone</i> Sivanto Prime (200SL)	4D	7-10 fl oz	0.09125-0.13	4 hours/ H - 21 days G – 7 days	
	<i>gamma cyhalothrin</i> Declare 1.25 Proaxis 0.5	3A	1.54 fl oz 3.84 fl oz	0.015 0.015	24 hours/ H- 30 days G- 7 days	
	<i>lambda cyhalothrin</i> Warrior II Zeon 2.08, other Silencer, Lambda, & others 1.0	3A	1.28-1.92 fl oz 2.56-3.84 fl oz	0.02-0.03 0.02-0.03	24 hours/ H- 30 days G- 7 days	
<i>lambda cyhalothrin & chloantraniliprole</i> Besiege	3 & 28	5.0-10.0 fl oz/A	0.02-0.03 + 0.04-0.06	24 hours/ H - 30 days G - 7 days		
<i>sufloxafloor</i> Transform WG (wheat, barley, triticale)	4C	0.75 – 1.5 fl oz	0.023-0.047	24 hours/ H – 14 days G – 7 days		

SMALL GRAIN INSECT CONTROL

CROP/PEST	INSECTICIDE	IRAC GROUP	AMOUNT OF FORMULATION PER ACRE	LB ACTIVE INGREDIENT PER ACRE	REI/PHI (Hours or Days) H=harvest grain, G =grazing, hay	TREATMENT THRESHOLDS AND REMARKS
Armyworms: True armyworm, Fall armyworm, Beet armyworm, Yellowstriped armyworm, and Cutworms	<i>alpha-cypermethrin</i> Fastac 0.83 (wheat, triticale only)	3A	1.8-3.8 fl oz	0.012-0.025	24 hours/ H- 14 days G - 14 days	True armyworm usually infests wheat in late winter and spring at the boot/head stage. Treat when larval numbers exceed 4 larvae/sq ft before pollen shed and 8 larvae/sq ft after pollen shed. Fall armyworm, beet armyworm, yellowstriped armyworm and cutworm infestations usually occur in the fall on seedling plants. Treat when larval populations of any one or any combination of these insects exceed 3 larvae (1/2 inch long or larger)/sq ft. NOTE: Blackhawk and Radiant are most effective against small larvae. Blackhawk is not labeled for cutworm control. Radiant is not labeled for cutworms or yellowstriped armyworms NOTE: Baythroid and Tombstone products are effective against small larvae only. NOTE: Fastac and Tombstone products are not labeled for use on barley, oats, or rye.
	<i>beta-cyfluthrin</i> Baythroid XL 1EC	3A	1.8-2.4 fl oz	0.014-0.019	12 hours/ H- 30 days G- 3 days	
	<i>cyfluthrin</i> (wheat only) Tombstone Tombstone Helios 2.0	3A	1.8-2.4 fl oz	0.028-0.038	12 hours/ H- 30 days G- 3 days	
	<i>chlorantraniliprole</i> Coragen 1.67SC Prevathon 0.43	28	3.5-5.0 fl oz 14-20 fl oz	0.045-0.065 0.047-0.067	4 hours/ 21 days	
	<i>gamma cyhalothrin</i> Declare 1.25 Proaxis 0.5	3A	1.28-1.54 fl oz 3.2-3.84 fl oz	0.0125-0.015 0.0125-0.015	24 hours/ 30 days	
	<i>lambda cyhalothrin</i> Warrior II Zeon & others 2.08 Silencer, Lambda, & others 1.0	3A	1.6-1.92 fl oz 3.2-3.84 fl oz	0.025-0.03 0.025-0.03	24 hours/ H- 30 days G- 7 days	
	<i>lambda cyhalothrin & chloantraniliprole</i> Besiege	3 & 28	5.0-10.0 fl oz/A		24 hours/ H - 30 days G - 7 days	
	<i>spinosad</i> Blackhawk (36%)	5	1.7-3.5 oz	0.038-0.075	4 hours/ H -21 days G - 3 days	
	<i>spinetoram</i> Radiant 1SC	5	3-6 fl oz	0.0234-0.0469	4 hours/ H- 21 days G -3 days	
	<i>zeta-cypermethrin</i> Mustang Maxx, Respect 0.8EC	3A	3.2-4.0 fl oz	0.02-0.025	12 hours/ H- 14 days G - 14 days	
Cereal Leaf Beetle	<i>alpha-cypermethrin</i> Fastac 0.83 (wheat, triticale only)	3A	1.8-3.8 fl oz	0.012-0.025	24 hours/ H- 14 days G - 14 days	Treat when an average of 1 larva and adult/4 stems are found. Karate, Declare and similar products can be applied at 50% egg hatch. Other materials should not be applied until after 90% egg hatch. NOTE: lambda/gamma cyhalothrin products applied for cereal leaf beetle also provide aphid control for the remainder of the season NOTE: Fastac, Respect and Tombstone products are not labeled for use on barley, oats, and rye.
	<i>beta-cyfluthrin</i> Baythroid XL 1EC	3A	1.0-1.8 fl oz	0.008-0.014	12 hours/ H- 30 days G- 3 days	
	<i>cyfluthrin</i> (wheat only) Tombstone Tombstone Helios 2.0	3A	1.0-1.8 fl oz	0.016-0.028	12 hours/ H- 30 days G- 3 days	
	<i>gamma cyhalothrin</i> Declare 1.25 Proaxis 0.5	3A	0.77-1.54 fl oz 2.56-3.84 fl oz	0.0075-0.015 0.01-0.015	24 hours/ H- 30 days G- 3 days	

SMALL GRAIN INSECT CONTROL

CROP/PEST	INSECTICIDE	IRAC GROUP	AMOUNT OF FORMULATION PER ACRE	LB ACTIVE INGREDIENT PER ACRE	REI/PHI (Hours or Days) H=harvest grain, G =grazing, hay	TREATMENT THRESHOLDS AND REMARKS
Cereal Leaf Beetle <i>continued</i>	<i>lambda cyhalothrin</i> Warrior II Zeon & others 2.08 Silencer, Lambda, & others 1.0	3A	1.28-1.92 fl oz 2.56-3.84 fl oz	0.02-0.03 0.02-0.03	24 hours/ H- 30 days G- 7 days	
	<i>lambda cyhalothrin & chloantraniliprole</i> Besiege	3 & 28	5.0-10.0 fl oz/A	0.02-0.03 + 0.04 – 0.06	24 hours/ H- 30 days G- 7 days	
	<i>malathion</i> Malathion 57EC, 5EC Malathion 8EC	1B	1.5 pt 1.0 pt	0.94 1.0	12 hours/ H- 7 days G- 7 days	
	<i>zeta-cypermethrin</i> Mustang Maxx, Respect 0.8EC	3A	2.6-3.2 fl oz	0.015-0.02	12 hours/ H- 14 days G- 14 days	
Grasshoppers	<i>alpha-cypermethrin</i> Fastac 0.83 (wheat, triticale only)	3A	3.2-3.8 fl oz	0.020-0.025	24 hours/ 14 days	Treat when grasshoppers are causing excessive (greater than 50%) defoliation. NOTE: Fastac, Respect and Tombstone are not labeled for use on barley, oats, and rye.
	<i>beta-cyfluthrin</i> Baythroid XL 1EC	3A	1.8-2.4 fl oz	0.014-0.019	12 hours/ H- 30 days G- 3 days	
	<i>cyfluthrin</i> (wheat only) Tombstone Tombstone Helios 2.0	3A	1.8-2.4 fl oz	0.028-0.038	12 hours/ H- 30 days G- 3 days	
	<i>gamma cyhalothrin</i> Declare 1.25 Proaxis 0.5	3A	1.02-1.54 fl oz 2.56-3.84 fl oz	0.01-0.015 0.01-0.015	24 hours/ H- 30 days G- 7 days	
	<i>lambda cyhalothrin</i> Warrior II Zeon & others 2.08 Silencer, Lambda, & others 1.0	3A	1.28-1.92 fl oz 2.56-3.84 fl oz	0.02-0.03 0.02-0.03	24 hours/ H- 30 days G- 7 days	
	<i>lambda cyhalothrin & chloantraniliprole</i> Besiege	3 & 28	5.0-10.0 fl oz/A	0.02-0.03 + 0.04 – 0.06	24 hours/ H- 30 days G- 7 days	
	<i>malathion</i> Malathion 57EC, 5EC Malathion 8EC	1B	1.5 pt 1.0 pt	0.94 1.0	12 hours/ 7 days	
	<i>zeta-cypermethrin</i> Mustang Maxx, Respect 0.8EC	3A	3.2-4.0 fl oz	0.02-0.025	12 hours/ H- 14 days G- 14 days	
Chinch bug	<i>alpha-cypermethrin</i> Fastac 0.83 (wheat, triticale only)	3A	3.8 fl oz	0.025	12 hours/ H- 14 days G- 14 days	Treat during the seedling stage when an average of 1 adult/2 plants are found. On larger plants treat when 1 adult/stem or 50 percent of the plants are infested.
	<i>beta-cyfluthrin</i> Baythroid XL 1EC	3A	2.4 fl oz	0.019	12 hours/ H- 30 days G- 3 days	

SMALL GRAIN INSECT CONTROL

CROP/PEST	INSECTICIDE	IRAC GROUP	AMOUNT OF FORMULATION PER ACRE	LB ACTIVE INGREDIENT PER ACRE	REI/PHI (Hours or Days) H=harvest grain, G =grazing, hay	TREATMENT THRESHOLDS AND REMARKS
Chinch bug <i>continued</i>	<i>cyfluthrin</i> (wheat only) Tombstone Tombstone Helios 2.0	3A	2.4 fl oz	0.038	12 hours/ H-30 days G- 3 days	Gaucho, Attendant, and Cruiser seed treatments may provide control for a few weeks after planting. Chinch bugs are difficult to control in headed wheat. NOTE: Fastac, Respect and Tombstone are not labeled for use on barley, oats, and rye.
	<i>gamma cyhalothrin</i> Declare 1.25 Proaxis 0.5	3A	1.54 fl oz 3.84 fl oz	0.015 0.015	24 hours/ H- 30 days G- 7 days	
	<i>lambda cyhalothrin</i> Warrior II & others 2.08 Silencer, Lambda, & others 1.0	3A	1.92 fl oz 3.84 fl oz	0.03 0.03	24 hours/ H- 30 days G- 7 days	
	<i>lambda cyhalothrin & chloantraniliprole</i> Besiege	3 & 28	5.0-10.0 fl oz/A	0.02-0.03 + 0.04 – 0.06	24 hours/ H- 30 days G- 7 days	
	<i>zeta-cypermethrin</i> Mustang Maxx, Respect 0.8EC	3A	4.0 fl oz	0.025	12 hours/ 14 days	
Hessian fly	SEED TREATMENTS					Plant Hessian fly-resistant wheat varieties. Systemic insecticide seed treatments are recommended for susceptible cultivars. Systemic seed treatments may need highest rates for effective suppression. Gaucho XT alone may not provide effective control. Rate of CruiserMaxx Cereals or Cruiser Maxx Vibrance alone is too low for effective Hessian fly control. NOTE: Barley is tolerant. Damage only occurs under severe infestations. Rye is highly resistant and oats are immune to Hessian fly. NOTE: Apply Warrior II (formerly Karate) or Declare when adults are actively laying eggs. Apply based on egg sampling for best results.
	<i>imidacloprid</i> Gaucho 600, Attendant 600 Acess Gaucho XT plus Gaucho 600	4A	1.6-2.4 fl oz/100 lb seed 3.4 fl oz/100 lb seed plus 1.0 fl oz/100 lb seed	0.0625-0.094 lb/ 100 lb. seed Combined: 0.0675lb/ 100 lb. seed	12 hours/ 45 days	
	<i>thiamethoxam</i> Cruiser 5FS Cruiser Maxx Cereals plus Cruiser 5FS	4A	1.33 fl oz/10 0 lb seed 5.0 fl oz/100 lb seed plus 0.5 fl oz/100 lb seed	0.06 lb/100 lb seed 0.06 lb/100 lb seed (total)	12 hours/ --	
	<i>clothianidin</i> NipsIt Inside	4A	1.79 fl oz/ 100 lb seed	--	12 hours/ --	
	FOLIAR TREATMENTS					
	<i>gamma cyhalothrin</i> Declare 1.25 Proaxis 0.5	3A	1.54 fl oz 3.84 fl oz	0.015 0.015	24 hours/ H- 30 days G- 7 days	
	<i>lambda cyhalothrin</i> Warrior II Zeon & others 2.08 Silencer, Lambda, & others 1.0	3A	1.92 fl oz 3.84 fl oz	0.03 0.03	24 hours/ H- 30 days G- 7 days	
	<i>lambda cyhalothrin & chloantraniliprole</i> Besiege	3 & 28	5.0-10.0 fl oz/A	0.02-0.03 + 0.04 – 0.06	24 hours/ H- 30 days G- 7 days	

SMALL GRAIN INSECT CONTROL

CROP/PEST	INSECTICIDE	IRAC GROUP	AMOUNT OF FORMULATION PER ACRE	LB ACTIVE INGREDIENT PER ACRE	REI/PHI (Hours or Days) H=harvest grain, G =grazing, hay	TREATMENT THRESHOLDS AND REMARKS
Mites/Winter grain mite	<i>gamma cyhalothrin</i> Declare 1.25 Proaxis 0.5	3A	1.54 fl oz 3.84 fl oz	0.015 0.015	24 hours/ H- 30 days G- 7 dyas	Treat when infestations are causing leaf discoloration in large areas of a field and mites are present. Infestations are usually associated with application of cattle manure or chicken litter. NOTE: Warrior II (formerly Karate) and Declare only provide mite suppression.
	<i>lambda cyhalothrin</i> Warrior II Zeon & others 2.08 Silencer, Lambda, & others 1.0	3A	1.92 fl oz 3.84 fl oz	0.03 0.03	24 hours/ H- 30 days G- 7 days	
	<i>lambda cyhalothrin & chloantraniliprole</i> Besiege	3 & 28	5.0-10.0 fl oz/A	0.02-0.03 + 0.04 – 0.06	24 hours/ H- 30 days G- 7 days	
Stink bugs	<i>alpha-cypermethrin</i> Fastac 0.83 (wheat, triticale only)	3A	3.2-3.8 fl oz	0.020-0.025	12 hours/ H- 14 days G- 14 days	Stink bugs rarely reach levels needing control in wheat. Treat if stinks bugs exceed 1 bug/sq ft at milk stage. Control during medium-hard dough stages is not justified, except to prevent movement of bugs to susceptible crops in nearby fields as wheat matures. NOTE: Fastac, Respect and Tombstone are not labeled for use on barley, oats, and rye.
	<i>beta-cyfluthrin</i> Baythroid XL 1EC	3A	1.8-2.4 fl oz	0.014-0.019	12 hours/ H- 30 days G- 3 days	
	<i>cyfluthrin</i> (wheat only) Tombstone Tombstone Helios 2.0	3A	1.8-2.4 fl oz	0.028-0.038	12 hours/ H- 30 days G- 3 days	
	<i>gamma cyhalothrin</i> Declare 1.25 Proaxis 0.5	3A	1.02-1.54 fl oz 2.56-3.84 fl oz	0.01-0.015 0.01-0.015	24 hours/ H- 30 days G- 7 days	
	<i>lambda cyhalothrin</i> Warrior II Zeon & others 2.08 Silencer, Lambda, & others 1.0	3A	1.28-1.92 fl oz 2.56-3.84 fl oz	0.02-0.03 0.02-0.03	24 hours/ H- 30 days G- 7 days	
	<i>zeta-cypermethrin</i> Mustang Maxx, Respect 0.8EC	3A	3.2-4.0 fl oz	0.02-0.025	12 hours/ H- 14 days G- 14 days	

DISEASE MANAGEMENT IN WHEAT

Alfredo D. Martinez-Espinoza

The most effective and economical method to control diseases of wheat is to plant disease resistant varieties. Resistance is the primary means to manage foliar diseases, which cause the greatest yield reduction each year. However, few recommended varieties have "good" or high resistance to all the major foliar diseases. In addition, populations of fungi causing leaf rust and powdery mildew are constantly changing. There are numerous strains or races of these fungi. When a new variety is released, it is usually resistant to the most commonly occurring races of the fungi prevalent at that time. The race population can change rapidly. Certain individual races or new races may become more common. If a variety is not resistant to these races of the fungus, it can become severely diseased. This may happen as quickly as a year after the release of a new variety. Varietal recommendations are modified each year, often as a result of changes in disease susceptibility. Refer to the most recent information about the best varieties to grow in this guide and in the annual variety performance bulletin located at <http://www.swvt.uga.edu/small.html>.

Weather conditions during the winter and spring can have a major effect on the incidence and severity of disease (Table 22). If the winter and spring are cool and/or dry, leaf diseases will usually be of little or no significance regardless of a variety's resistance. A warm, wet winter and spring are favorable for infection by disease-causing fungi. This results in more severe disease. New fungal races also increase more rapidly under such conditions. The combination of low resistance and warmer than normal winters and springs are favorable for severe powdery mildew, leaf rust, and *Stagonospora nodorum* leaf and glume blotch, the three most important fungal diseases. *Stagonospora nodorum* was formerly named *Septoria nodorum*. These conditions lead to an increased use of foliar fungicides to control diseases on susceptible varieties.

Seedborne and soilborne diseases are controlled primarily by seed treatment and crop rotation. Resistance is generally not available for these diseases. Following planting and fertility management recommendations all contribute to successful disease management for these and other diseases.

Among the diseases of wheat, viruses are often the most difficult to control. Three virus diseases occur on wheat in Georgia: soilborne mosaic, wheat spindle streak mosaic, and barley yellow dwarf. Most varieties have good tolerance to soilborne mosaic and wheat spindle streak. Tolerance or resistance to barley yellow dwarf is fair to low for most varieties.

Historically, Fusarium Head Blight (FHB) infections have been low in Georgia. However, FHB incidence and severity has been high throughout the state over the last three years (2014-2016). FHB also called scab, is a devastating and dangerous disease of wheat and barley with worldwide distribution. The disease causes yield loss, low-test weights, low seed germination, and contamination of grain with mycotoxins. A vomitoxin called deoxynivalenol (DON) is considered the primary mycotoxin associated with FHB. This mycotoxin is subject to regulatory limits by the U.S. Food and Drug Administration (FDA). In the 2016-2017 season FHB incidence throughout the state was lower than previous years.

LEAF DISEASES

Powdery Mildew. This disease may occur on any above ground plant part, but it is usually most prevalent on the upper surface of the lower leaves. The conspicuous white to gray patches of fungus appear early in the season. When powdery mildew is severe, the entire leaf turns yellow and dies. Black spore-producing structures develop in older lesions. Dense stands, high nitrogen fertility, and rapid growth increase susceptibility. Under such conditions a variety listed as having "good" resistance may become heavily infected. As the stem elongates and temperatures increase, conditions become less favorable for powdery mildew. This disease has the least effect on yields of any of the three diseases

discussed in this guide. On all but the most susceptible varieties, powdery mildew confined to the lower leaves has little or no effect on yield. Fungicides should not be applied until flag leaf emergence unless a variety is very susceptible. If fungicide is applied too early, the plant will not be protected during the latter half of the grain-filling period. A complete description, diagnosis and management is now available <http://extension.uga.edu/publications/detail.cfm?number=C1059> (circular 1059).

Leaf Rust. Reddish-brown pustules develop on leaves and sheaths. These pustules are filled with spores of the fungus. Rubbing an infected leaf will leave rusty colored areas on your fingers. Rust pustules may be very tiny, barely large enough to see with the naked eye, to 1/8 inch in length. Generally, varieties with higher levels of resistance will have smaller pustules than varieties with lower levels of resistance. Varieties with poor resistance will also have larger yellow halos around the pustules. Leaf rust has the greatest effect on yield of the diseases discussed here because it develops rapidly during favorable weather. A complete description, diagnosis and management is now available <http://extension.uga.edu/publications/detail.cfm?number=C1060> (circular 1060).

Stripe Rust. Also known as yellow rust. Pustules coalesce to produce long yellow stripes between veins of the leaf and sheath. Small yellow, linear lesions occur on floral bracts. These pustules are filled with spores of the fungus. In Georgia, the disease appears in late February early March during cool, overcast and wet weather. Stripe rust occurs well before leaf rust. Stripe rust is an emerging disease in Georgia and has been seen for two of the last three years. Stripe rust can have a potentially devastating effect on yield. Chemical options are available to control stripe rust however selection of fungicide should be made judiciously. Genetic resistance to stripe rust should be the best way to manage the disease. According to state breeders, there are several varieties or breeding lines than have higher levels of resistance to the disease. Work is in progress to release newer varieties with resistance to stripe rust. A complete description, diagnosis and management is now available at <http://extension.uga.edu/publications/detail.html?number=C960> (circular 960).

Leaf and Glume Blotch. Lesions (spots) are initially water-soaked and then become dry, yellow, and finally brown. Lesions are generally oblong, sometimes containing small black spore producing structures called pycnidia. The lesions are often surrounded by a yellow halo. Lower leaves are generally more heavily infected, with lesions joining together to cause entire leaves to turn brown and die. If pycnidia are present on lower leaves when the uppermost leaf and the head begin to emerge, infective spores will move to the top of the plant in splashing rain even after a brief shower. Symptoms may not appear for 10-15 days on the top leaves or glumes on the head. By the time lesions are seen on the head, it is too late for effective fungicide use. Therefore, it is important to examine the lower leaves for lesions when making decisions about fungicide application, not just the top leaves. Lesions are first tan or brown on the upper portion of the glume while the lower part remains green. As the head matures, it becomes purplish to black in appearance from glume blotch. Leaf and glume blotch can reduce yield as much as 20% and reduce test weight due to grain shriveling even when disease severity is low.

Barley Yellow Dwarf. Barley yellow dwarf virus (BYDV) is probably the most widely distributed virus in wheat. It is estimated to reduce yields by 5 to 25% each year. The symptoms are variable and resemble nutritional problems or frost damage. Usually the discoloration is characterized by various shades of yellow or reddening from the tips to the base and from the leaf margin to the midribs of the leaves. Some varieties have more yellow symptoms whereas others have red to purple discoloration. When infection begins early in the season, after heading, the uppermost leaf is often very upright. Severe infection usually causes some stunting and reduction in numbers of seeds per head. BYDV is transmitted by several aphid species. Aphids acquire the virus by feeding on infected plants for very short periods and then move to other uninfected plants. Infection can occur any time when viruliferous aphids multiply and migrate in fields. Crop rotation is less effective for barley yellow dwarf because aphids can transmit

the virus between fields, and many grasses on which the aphids feed also harbor the virus. Barley yellow dwarf can cause severe losses in many Georgia fields, most often following a mild fall and winter, which allows aphids to be active and transmit the virus early in plant development. BYDV is present in nearly all fields each year. Disease severity depends on aphid populations and the proportion of aphids that can transmit the virus. Control of volunteer wheat and grassy weeds during the summer and along the edges of fields may slow initial infection. Planting during the latter part of the recommended period can delay fall infection. Resistant varieties and insecticide application to control aphids can reduce damage from barley yellow dwarf (see Insect Management).

Table 22. Optimum temperature and moisture for the major diseases affecting wheat grown in Georgia

DISEASE	OPTIMUM MOISTURE	OPTIMUM TEMPERATURE
Powdery Mildew ¹	High Humidity	59-72°F ²
Leaf Rust	Free Moisture	59-72°F
Stripe Rust	Free Moisture	50-59°F
Leaf and Glume Blotch	Free Moisture	68-75°F
Take-All	Moist Soils	50-68°F
Fusarium Head Blight	High humidity at time of flowering	77-86°F

¹ Powdery mildew fungus does not need free moisture to develop.

² Temperatures above 77°F are not favorable for Powdery mildew fungal development.

SEEDBORNE AND SOILBORNE DISEASES

Seedling Blights. Several fungal pathogens infect the seed as it matures, particularly when rains are frequent during seed development. Seed quality is reduced significantly and germination is often problematic. Soil temperatures, which are higher early in the fall, also favor infection of the ungerminated seed and tissues of the germinating seedling by several species of soilborne *Pythium*. The combination of infection by both seedborne and soilborne fungi can result in severe pre- and post-emergence damping off. The result may be a substantially reduced stand that grows slowly or it may be necessary to replant. Seedling blights can be reduced by planting good-quality seed and by the use of fungicide-treated seed (Table 23).

Smut Diseases. There are two smut diseases that affect wheat in Georgia. They usually cause only minor problems, but they can increase rapidly and cause serious losses if not controlled. Loose smut causes the tissues in the head to be replaced by masses of powdery spores. The fungus spores invade the embryo of the developing seed and the fungus survives there until the seed germinates. Common bunt or stinking smut occurs rarely, but it can cause complete loss of a crop. The tissues of the head remain intact, but the seed is destroyed. The masses of smut spores are in ‘bunt balls’, which are held in the seed coat of the grain. Stinking smut gets its name from the foul odor it produces that is similar to rotting fish. The bunt balls are easily ruptured during harvest and millions of spores are deposited on the surface of healthy seeds. Spores germinate and invade the germinating seedling, and then the fungus grows systemically like loose smut. Smut spores are not toxic to animals or humans. These smut pathogens are only transmitted by seed. Planting certified seed is an effective method to control smut diseases because seed fields are carefully inspected. Seed treatment with systemic fungicides is an inexpensive way to achieve nearly complete control of loose smut and common bunt (Table 23).

Table 23. Seed Treatment Fungicides for Control of Seedborne and Soilborne Diseases of Wheat

FUNGICIDE	CROP	RATE/100 LB SEED	REMARKS AND PRECAUTIONS
captan Captan 400	Wheat, Barley, Oats, Rye	See label	Controls seedling blights. Does not control smuts.
carboxin + captan Enhance	Wheat, Barley, Oats	4.0 oz.	Controls loose smut, common and kernel bunt, seed rots and seedling diseases.
carboxin + thiram Vitavax 200 RTU-Vitavax-Thiram	Wheat, Barley, Oats, Triticale Wheat, Oats, Barley	2.0 oz. 2.0-4.0 oz.	Controls loose smut and stinking smut. Controls seedling blights. See label for specific rate for grains.
carboxin + PCNB + metalaxyl Prevail	Wheat, Oats, Barley	2.5 – 5.0 oz. wheat 1.6- 3.3 oz. oats	Controls loose smut, common and kernel bunt, seed rots and seedling diseases from Pythium and Rhizoctonia.
difenoconazole Dividend	Wheat	0.5-1.0 oz.	Controls loose smut and stinking smut.
difenoconazole + mefenoxam Dividend XL RTA Dividend XL Dividend Extreme	Wheat Wheat Wheat	5-10 oz. 1.0-.2.0 oz. 0.5-1.0 oz.	Controls loose smut, stinking smut, and Pythium damping-off. Grower and commercially applied.
fludioxonil Maxim 4FS	Barley, Millet, Oats, Rye, Sorghum, Triticale, Wheat	0.08-0.16 fl oz.	Controls Fusarium, Rhizoctonia, Helminthosporium and weakly pathogenic fungi such Aspergillus and Penicillium.
ipconazole Rancona 3.8 FS Rancona Apex	Wheat, Barley, Oats, Rye	3.8 FS =0.051 – 0.085 fl. oz. Apex= 5.0 – 8.3 fl. oz.	Controls loose smut, common and kernel bunt, seed rots and seedling diseases.
mefenoxan Apron XL, Apron XL-LS	Wheat, Barley, Millet, Oats, Rye, Sorghum, Triticale	0.042-0.08	Controls Pythium damping-off. Does not control smuts.
metalaxyl Allegiance	Wheat, Barley, Millet, Oats, Rye, Sorghum, Triticale	See label	Controls Pythium damping-off. Does not control smuts.
metalaxyl + metconazole + Clothianidin NipsIt SUITE	Wheat, Oats, Barley	5.0 – 7.5 fl oz	Controls common smut, flag smut loose smut, seed decay fungi, Fusarium seed scab, Pythium seed rot and seedling. Early season Fusarium seedling dieback, early season Rhizoctonia root rot and early season common rot
penflufen Evergol Prime	Wheat, Oats, Barley	0.32 fl. oz.	Controls loose smut, common and kernel bunt, seed rots and seedling diseases
prothioconazole + penflufen + metalaxyl Evergol Energy	Wheat, Oats, Barley	1.0 fl. oz.	Controls loose smut, common and kernel bunt, seed rots and seedling diseases along with early suppression of powdery mildew, rust and glume/leaf blotch
sedaxane Vibrance	Wheat, Barley, Oats, Rye, Triticale	0.08-0.16 fl oz	Controls Loose smut, Seed decay seedling blight and damping-off caused by <i>Rhizoctonia solani</i>

sedaxane + difenconazole + mefenoxam Vibrance Extreme	Wheat, Barley, Oats, Rye, Triticale	2.8-5.6 fl oz	Controls smuts and bunts, general seed rot, seedling blight, root rot and damping-off caused by seed or soilborne <i>Fusarium</i> spp or <i>Rhizoctonia</i> spp, Seedling blight and root rot and damping-off caused by <i>Pythium</i> spp, seed borne <i>Septoria</i> , Septoria leaf blotch, Fusarium seed scab
sedaxane + difenconazole + fludioxonil + mefenoxam Vibrance Quattro	Wheat, Barley, Oats, Rye, Triticale	5.0 fl oz	Controls smuts and bunts, general seed rot, seedling blight, root rot and damping-off caused by seed or soilborne <i>Fusarium</i> spp or <i>Rhizoctonia</i> spp, Seedling blight and root rot and damping-off caused by <i>Pythium</i> spp, seed borne <i>Septoria</i> , Septoria leaf blotch, Fusarium seed scab
tebuconazole Raxil (tebuconazole can be found in various combinations with other fungicides, look for Sativa, Foothold, Raxil)	Wheat, Oats, Barley	3.5 to 4.6 fl. oz.	Controls loose smut and stinking smut. Controls seedling blights. Commercially-applied and drill-box formulations available.
thiram	Wheat, Barley, Rye	See label	Controls seedling blights. Does not control smuts. Can be used for drill-box treatment.
triadimenol Baytan 30 RTU Baytan-Thiram	Wheat, Barley, Oats, Rye All	0.75-1.5 oz. 4.5-9.0 oz.	Controls loose smut and stinking smut. Controls smuts and seedling blights.
triticonazole + metconazole Charter F	Wheat, Barley, Oats, Rye	5.4 fl. oz.	Controls loose smut, common and kernel bunt, seed rots and seedling diseases.

For information on CruiserMaxx Cereals (thiamethoxam + mefenoxam + difenconazole), CruiserMaxx Vibrance Cereals (sedaxane + thiamethoxam + mefenoxam + difenconazole), Cruiser Vibrance Quattro (thiamethoxam + mefenoxam + difenconazole + sedaxane + fludioxonil), and Gaucho XT (Imidacloprid + metalaxyl + tebuconazole), see the Insect Management Section of this Guide. Commercial treatment of small grain seed is preferred, but a drill box treatment can be used with many formulations. Drill-box treatment may not give control to commercial treatment

Take-all Root and Crown Rot. The fungus responsible for this disease builds up in the soil when wheat is planted in the same field two or more years. Roots are damaged progressively during the winter and early spring. Shortly after heading infected plants wilt and die due to poor water movement from the rotted roots to the stems. The crown and lower stem turn black and plants are easily pulled from the soil. Areas of dead plants are circular or follow tillage patterns indicating movement of infested crop debris. Take-all is reduced by rotation with oats, fallow, or other non-cereal winter crops such as canola. Rotation with barley, rye, or triticale maintains the fungus in roots of these crops although they may not exhibit symptoms as severe as on wheat. Sorghum as a summer crop will reduce the disease in a subsequent wheat crop, whereas soybeans favor take-all. Other control measures include planting near the end of the recommended period to reduce fall infection and avoiding soil pH above 6.5.

Soilborne Mosaic and Spindle Streak Mosaic. The symptoms of soilborne mosaic range from mild green to a prominent yellow leaf mosaic. Plants may be stunted or rosette in shape. Symptoms are usually seen in late winter and early spring. New leaves may be mottled or exhibit streaks or flecking. Wheat spindle streak mosaic virus causes stunting and poor growth with yellow mottling and numerous elongated streaks on leaves. Leaf streaks are usually a light green to yellow. The discontinuous streaks

run parallel to the leaf veins and taper to form a spindle shape. Both viruses are transmitted by a fungus, which survives in the soil and transmits the virus into the wheat roots. These diseases are typically a problem when soils remain wet during the late fall and winter. Spindle streak mosaic and soilborne mosaic are most common in fields planted to wheat for two or more years. Both viruses may occur together and symptoms may intermingle. Crop rotation is an effective control method.

OTHER DISEASES

Fusarium Head Blight (FHB) or Head Scab. *Fusarium* Head Blight is caused by the pathogen *Fusarium* spp /teleomorphs *Gibberella* spp and *Microdochium nivale*. Severe infections of *Fusarium* head blight have been registered in 2014, 2015 and 2016 in Georgia. FHB is a devastating and dangerous disease of wheat and barley with worldwide distribution. The disease causes yield loss, low-test weights, low seed germination, and contamination of grain with mycotoxins. A vomitoxin called deoxynivalenol (DON) is considered the primary mycotoxin associated with FHB. This mycotoxin is subject to regulatory limits by the U.S. Food and Drug Administration (FDA). The fungus requires warm (78-86 F consistently), humid/wet weather coinciding with wheat at flowering stages for infection to occur. *Fusarium* conidia and/or ascospores infection are most common at wheat anthesis. *Fusarium* Head Blight is best recognized on emerged immature heads where one or more or the entire head appears prematurely bleached (see image to right). Usually a pinkish/orange mycelium is present, which will develop dark fruiting bodies (perithecia). Diseased, bleached spikelets are sterile or contain shriveled/discolored seed (usually with a tint of pink or orange). For control, avoid rotation with other cereal crops, specifically corn (*Fusarium graminearum* also causes ear and stalk on corn) or sorghum. For more information on FHB visit <http://www.scabusa.org>. For FHB risk and /or prediction information visit <http://www.wheatcab.psu.edu>. A complete description, diagnosis and management is now available at <http://extension.uga.edu/publications/detail.cfm?number=C1066> (circular 1066).

FUNGICIDE USE

The decision about whether or not to use a fungicide needs to be made carefully. Fungicides do not increase yield. They only help preserve yield and test weight. If yield potential is low or there is no disease present at the critical time for fungicide application or conditions are not favorable for disease, there will be little benefit from fungicide application. If the price of wheat is low, there will be less profit from the use of fungicides. For these reasons, a decision guide has been developed to help you determine if fungicides will be beneficial. This guide makes no guarantee for an economic return on the fungicide investment. It will simply allow you to determine if fungicide treatment might help maintain yields.

To use this guide effectively, you must scout your wheat fields and be able to recognize the three major foliage diseases likely to reduce yields. Consult the UGA Extension publications Plant Pathology section at <http://extension.uga.edu/publications.html> Or the field crops section of the UGA Plant Pathology Extension site <http://www.caes.uga.edu/departments/plant-pathology/extension/educational-materials/plant-disease-library.html> for information on these and other wheat diseases. Some fungicide manufacturers have a color booklet on small grain diseases, which is helpful in disease identification. Begin scouting soon after the plants tiller and the stem begins to elongate. The leaves of plants should be observed at least once per week when jointing begins. Inspect plants twice each week from the time the flag (uppermost) leaf begins to emerge until flowering is complete. This is the most critical time to consider fungicide application. Inspect all the leaves, especially the lower leaves. Early in the season the lowest leaves may have symptoms while the younger upper leaves do not. Symptoms on the lower leaves are a good indication that the upper leaves will become infected, especially if rain or heavy dews occur during the next several weeks. Because disease symptoms may not appear until 7-12 days after infection begins, upper leaves that appear healthy may already be infected.

Fungicides can only be effective when you carefully select the fungicide with good activity against the disease(s) present (Table 24). They should be applied at the correct rate and time according to the label.

Fungicides should be applied with enough water to get good coverage: 5-7 gal/acre for aerial and 20-30 gal/acre for ground application. Use of a spreader-sticker will help improve leaf retention and fungicide performance. When applying fungicides always read the label and comply with the instructions and restrictions listed.

Generally, the most effective time to apply fungicides is from flag leaf emergence to completion of heading but be certain to follow any label restrictions concerning time of application, the number of applications, and total amount of fungicide that can be applied per season.

Infectious fungi sometimes develop resistance to particular fungicides, especially when a product is used repeatedly without alternating with chemically unrelated fungicides. When fungicide resistance develops, there is no value in increasing rates, shortening intervals between sprays, or using other fungicides with similar modes of action. Several general strategies are recommended to minimize the risk of fungicide resistance. First, don't rely on fungicides alone for disease control. Avoid using wheat varieties that are highly susceptible to common diseases. Follow good disease management practices to reduce the possibility of fungicide resistance. Limit the number of times at-risk fungicides are used during a growing season. Alternate at-risk fungicides with different fungicide groups. These are general principles that can help to reduce but not eliminate risk. A fungicide-resistant pathogen population can still develop when these principles are practiced.

Table 24. Fungicides for Wheat Foliar Diseases

DISEASE	CHEMICAL AND FORMULATION	RATE PRODUCT PER ACRE	REMARKS AND PRECAUTIONS	FRAC	REI
Stagonospora Leaf and Glume Blotch, Leaf Rust, Stripe Rust, Powdery Mildew, Tan Spot	azoxystrobin** Quadris Equation Satori	6.2-10.8 oz. 4.0-12.0 fl oz	Apply after Feekes 6 but not later than Feekes 10.5. Do not harvest treated wheat for forage. A crop oil concentrate adjuvant may be added at 1.0% v/v to optimize efficacy	11	4 hrs
	azoxystrobin + cyproconazole Azure Xtra	3.5 -6.8 fl oz	Apply product at 3.5 oz /A in the spring at @ Feekes 5. Apply at 5-6.8 fl oz/A between Feekes 8-10.51.	11+3	12 hrs
	azoxystrobin + propiconazole Quilt, QuiltXcel, Avaris, Trivapro B	7-14 oz	Applications may be made no closer than a 14-day interval. Quilt and QuiltXcel can be applied up to Feekes growth stage 10.5. QuiltXcel has a higher rate of azoxystrobin. Low rates of Quilt and QuiltXcel are used for spring suppression of early season diseases. 10.5 fl oz and above are used for flag leaf protection and maximizing yield potential. Trivapro A + Trivapro B= Trivapro co-pack. Do not apply more than 28 fl oz /A of Trivapro B per year	11+3	12 hrs
	azoxystrobin + tebuconazole Custodia	6.4-8.6 fl oz	Should be applied prior to disease development up to late head emergence (Feekes 10.5). Do not apply after this stage	11+3	12 hrs
	benzovindiflupyr Trivapro A	4.0 fl oz	Combining Trivapro A and Trivapro B co-pack. Apply in spring for early disease control or Feekes 8 through Feekes 10.5.4 for disease control on flag leaf. Make applications no closer than 14 days apart. Do not apply more than 14 fl oz/A of Trivapro A per year.	7	12 hrs
	benzovindiflupyr + azoxystrobin + propiconazole Trivapro SE	9.4 -13.7 fl oz	For disease control on the flag leaf, apply from Feekes 8 (Zadoks 37) through Feekes 10 (Zadoks 45). Protecting the flag leaf is important for maximizing the potential yield. Highest yields are normally obtained Trivapro Fungicide is applied when the flag leaf is 50% to fully emerged. Trivapro Fungicide can be applied through full head emergence (Feekes growth stage 10.5.4). Do not apply after this stage to avoid	7+11+3	12 hrs

			possibly illegal residues.		
fluoxapyroxad pyraclostrobin Priaxor	+	4-8 fl oz.	Apply no later than the beginning of flowering (Feekes 10.5, Zadok's 59). Maximum number of applications per season=2	7+11	12 hrs
fluoxapyroxad pyraclostrobin propiconazole Nexicor	+ +	7-13 fl oz	For optimal disease control, begin applications of Nexicor prior to disease development. To maximize yield potential it is important to protect the flag leaf. Apply Nexicor immediately after flag leaf emergence, no later than the beginning of flowering (Feekes 10.5, Zadok's 59).	7+11+3	12 hrs
fluoxastrobin Evito		2-4 fl oz.	For optimum results, begin applications preventatively and continue on a 14 to 21 day interval. Do not make more than two sequential applications. Apply prior to disease development from Feekes 5 (Zadok's 31) up to late head emergence at Feekes 10.5 (Zadok's 59)	11	12 hrs
fluoxastrobin + tebuconazole Evito T		4-6 fl oz	Apply a maximum of two applications per season. Apply no later than Feekes growth stage 10.5. For optimum results, apply the first application at approximately Feekes growth stage 5 (Zadok's 31) (shooting-pseudostem erected) and a second application no later than Feekes growth stage 10.5 (Zadok's 54) (heading completed)	11 + 3	12 hrs
fluoxastrobin + flutriafol Fortix		2-3 fl oz. 4-6 fl oz	For early season control Apply Fortix when flag leaf is 50% to fully emerged. Apply preventatively when conditions for disease are favorable for development. *Supplemental labeling	11 + 3	12 hrs
metconazole Caramba		10-14 oz.	Maximum number of applications per season=2; Minimum time from application to harvest=30 days	3	12 hrs
picoxystrobin Approach		3-4 fl oz 6-12 fl oz	For early season preventive disease control. Begin applications of Approach prior to disease development and continue on a 7- to 14-day interval, depending on the targeted disease. Use higher rate and shorter interval when disease pressure is high.	11	12 hrs
picoxystrobin cyproconazole Approach Prima	+	3.4 fl oz 3.4 -6.8 fl oz	For early season preventive disease control. Begin applications of Approach-Prima prior to disease development and continue on a 7- to 14-day interval, depending on the targeted disease. Use higher rate and shorter interval when disease pressure is high	11+3	12 hrs
propiconazole Tilt Propimax		4 oz.	Tilt can be applied until heading stage (Feekes 10.5). Do not apply Tilt after this growth stage to avoid possible illegal residues.	3	12 hrs
propiconazole trifloxystrobin Stratego	+	10 oz	Do not apply more than 2 applications of Stratego per season. Do not apply after Feekes 10.5	3+11	12 hrs
prothioconazole Proline		4.3-5 fl oz.	For optimum disease control, the lowest labeled rate of a spray surfactant should be tank mixed with Proline. Up to two applications of Proline can be made per year.	3	12 hrs
prothioconazole tebuconazole Prosaro	+	6.5 - 8.2 fl. oz.	Begin applications of Prosaro preventatively when conditions are favorable for disease development. For optimum disease control, the lowest labeled rate of a spray surfactant should be tank mixed with Prosaro	3+3	12 hrs
prothioconazole trifloxystrobin	+	4 fl oz	Begin applications preventatively when conditions are favorable for disease	3+11	12 hrs

	Stratego YLD		development. Do not apply more than 2 applications per season. Do not apply after Feekes growth stage 10.5. Do not apply within 35 days of harvest		
	pyraclostrobin Headline	6-9 oz	Apply no later than Feekes 10.5	11	12 hrs
	pyraclostrobin metconazole Twinline	+ 7-9 fl oz.	Do not apply more than 2 applications per season. Do not apply after Feekes 10.5	11+3	12 hrs
	tebuconazole Folicur, several other with tebuconazole as active ingredient. Check label of specific products	4 fl oz.	Folicur is not longer manufactured (2009). No end-user restrictions for disease control. Use until supply lasts. Not labeled for Powdery mildew control. For all tebuconazole products, a maximum of 4 fl oz may be applied per acre per season	3	12 hrs
	tebuconazole trifloxystrobin, Absolute	+ 3-5 fl oz.	Begin applications preventively when conditions are favorable for disease development. For optimum disease control apply 5 fl oz at flag leaf stage (Feekes 8-9). For early season suppression of Tan Spot, Leaf Blight and Powdery Mildew, apply at 3-4 oz. Do not apply more than 5 fl oz per season. Do not apply after Feekes growth stage 10.5.2. Do not apply within 35 days of harvest. Do not use with adjuvants.	3+11	12 hrs

Economic yield response to control wheat diseases is most likely to occur in fields with yield potentials of more than 50 bu/A and varieties with fair to poor resistance. *Always follow label instructions, recommendations and restrictions.*

Table 25: Fungicides for Fusarium Head Blight

Active ingredient	Product	Rate/A (fl. oz)	Head scab	Harvest Restriction
Metconazole 8.6%	Caramba 0.75 SL	13.5 - 17.0	G	30 days
Propiconazole 41.8%	Tilt 3.6 EC	4.0	P	Feekes 10.5
Prothioconazole 41%	Proline 480 SC	5.0 - 5.7	G	30 days
*Tebuconazole 38.7%	Folicur 3.6 F	4.0	F	30 days
Prothioconazole 19% Tebuconazole 19%	Prosaro 421 SC	6.5 - 8.2	G	30 days

Efficacy categories; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent. Timing of fungicide application is crucial for the control of FHB. Research indicates that products within the triazole class of fungicides are most effective if applied at early flowering (Feekes 10.5.1). **Strobilurin fungicides are not recommended for management of FHB. Data from other states indicate that Strobilurin fungicides can increase the DON content of FHB-infected grain.**

*A maximum of 4 fl. oz. of tebuconazole-containing products may be applied per acre per crop season.

Table modified from 2016 fungicide table produced by “The North Central Regional Committee on Management of Small Grain Diseases (NCERA-184)”. **This information is provided only as a guide. By law, it is the responsibility of the pesticide applicator to read and follow all current label directions. No endorsement is intended for any products listed, nor is criticism meant for products not listed. The University of Georgia and members or participants in the NCERA-184 committee assume no liability resulting from the use of these products. Always check the label before application for the most current rates and application restrictions.**

2017/18 WHEAT MARKET SITUATION AND OUTLOOK

Adam N. Rabinowitz

Overview

Georgia: Wheat production in Georgia in 2017 dropped 35 percent to 3.29 million bushels. Planted acreage dropped from 180,000 to 160,000 while harvested acreage is estimated to be 70,000 acres or just 43.8 percent of planted area. Yields are projected slightly up in 2017, increasing from 46 to 47 bushels per acre. Wheat prices continued to fall for the fifth year in a row. The 2016 marketing year crop average is estimated at \$4.05 per bushel compared to \$4.60 and \$5.35 per bushel for the 2015 and 2014 crops, respectively. Prices for 2017 are looking to be just slightly better, moving back towards 2014 prices but not quite reaching that level.

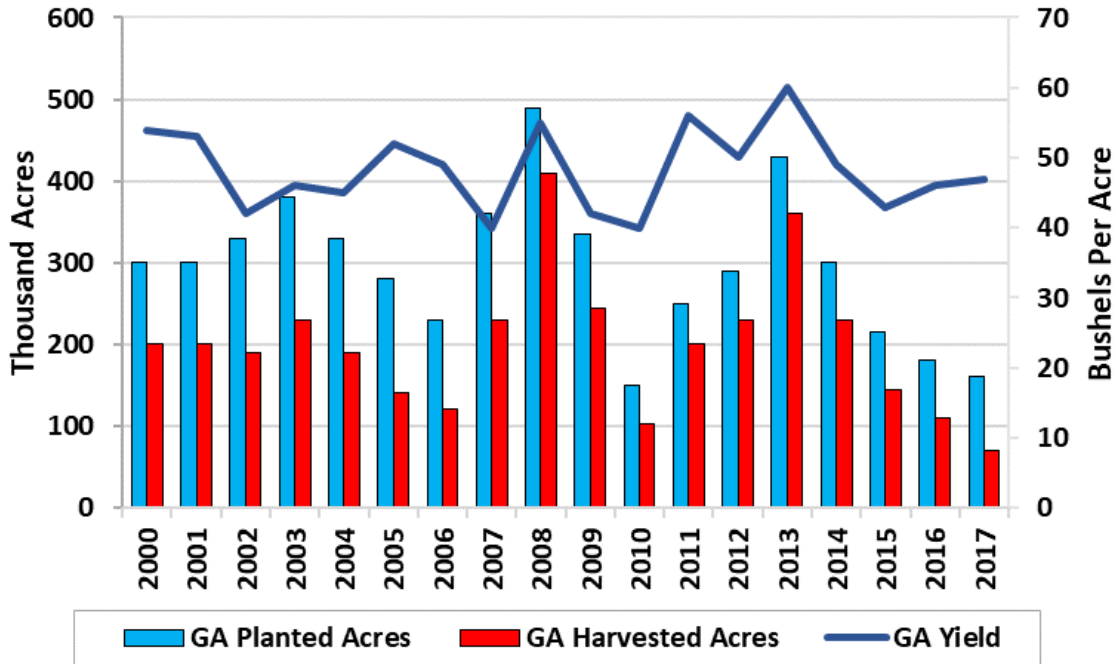
United States: Total wheat acreage planted in the U.S. is estimated to fall 8.2 percent to 46 million acres for 2017. Harvested acreage also is projected to decrease over 6 million acres to 37.6 million acres. Winter wheat acreage is projected to drop 9.6 percent to 32.7 million acres in 2017. The U.S. average winter wheat yield is estimated to drop from a record high 55.3 bushels per acre in 2016 to 50.2 bushels per acre in 2017. Seventy-seven percent of the winter wheat planted was harvested. The U.S. all wheat production is projected at 1.7 billion bushels of which 1.3 billion bushels are winter wheat, both significant decreases in production compared to last year. Meanwhile, total U.S. soft red winter (SRW) production fell 3.9 percent to 345.2 million bushels in 2016 and is projected to fall another 15.4 percent to 292,156 in 2017.

The July 2018 Chicago futures price for wheat was around \$5 per bushel in the fall of 2016 and while there was a spike in July 2017 to \$6 per bushel, there has been a steep decline since back to \$5.00. Monthly SRW wheat prices dropped below \$4 per bushel in the late 2016 but have since rebounded to around \$4.50 per bushel by mid-2017.

Supply

Georgia: Georgia planted acres dropped again in the 2017 to 160,000 acres while harvested acres dropped 36 percent to 70,000 acres. The crop was far below the ten-year average crop of 280,000 acres planted and 210,200 acres harvested. While the average yield increased 1 bushel per acre from the prior year, to 47 bushels per acre, this too was below the ten-year average of 49 bushels per acre. Producers were slightly ahead of the 5-year average harvest rate at the end of May, with almost all harvest completed by the end of June. Total production in Georgia in 2017 dropped by 35 percent to 3.29 million bushels. This level of production represents a 84.8 percent decrease from the recent high in 2013 and a 70.8 percent decline from 2014. The figure below shows the number of acres planted and harvested for Georgia wheat as well as the annual yield for 2000-2017.

GEORGIA WHEAT ACRES AND YIELD

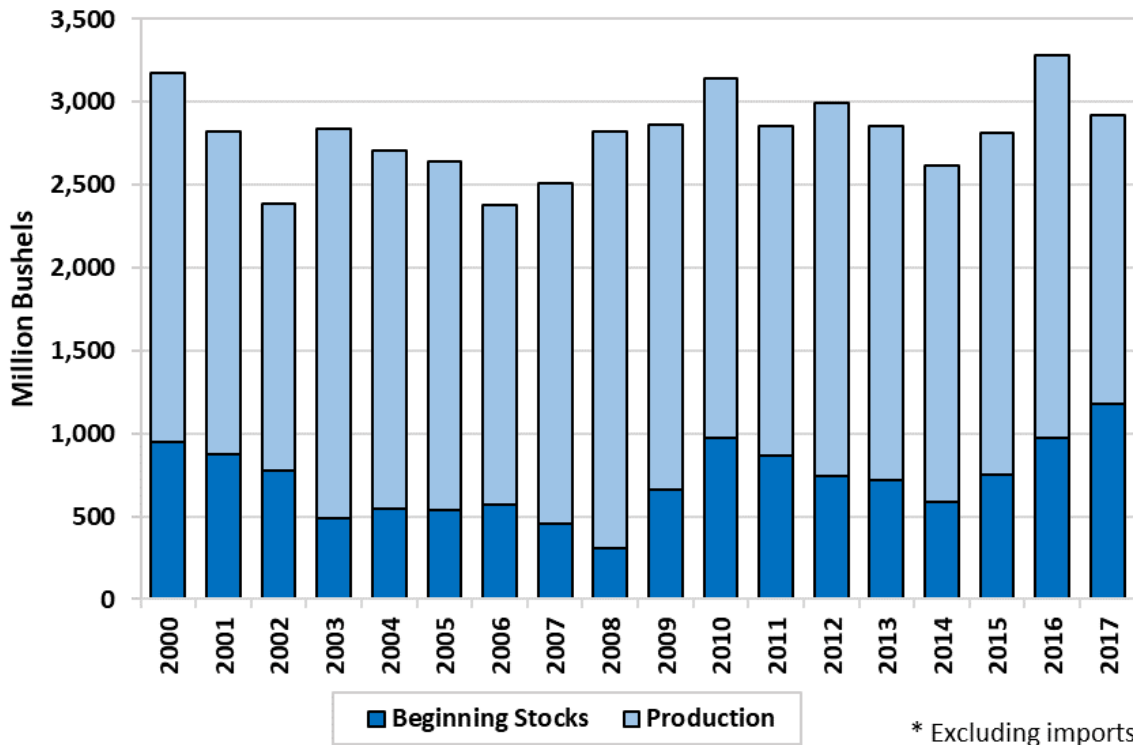


United States Winter Wheat: For 2017/18 the soft red winter wheat production is projected to decrease by 53 million bushels to 292 million bushels, well below hard red winter wheat and just 17 percent of all wheat. Total winter wheat acreage is estimated in 2017 to be down 3.4 million acres to 32.7 million planted acres. With yields back down from record levels, production of all winter wheat is projected to decrease by 24 percent to 1.3 billion bushels.

United States All Wheat: Total U.S. wheat production decreased in 2017 with a drop in acreage and a decrease in yields. Total supply has dropped with the decline in production, however, there is still a very substantial buildup of stocks. Total production of all U.S. wheat for 2016/17 is down 25 percent to 1.7 billion. This level of production is the lowest since 2002.

The carryover U.S. wheat supply grew in 2016/17 to reach 1.2 billion bushels by the end of the marketing year. With the decreased production estimated in 2017/18, ending stocks will drop but are still forecast to be above most recent years. The figure below shows the total supply for U.S. wheat, including beginnings stocks and production for 2000-2017. Note that imports are not included.

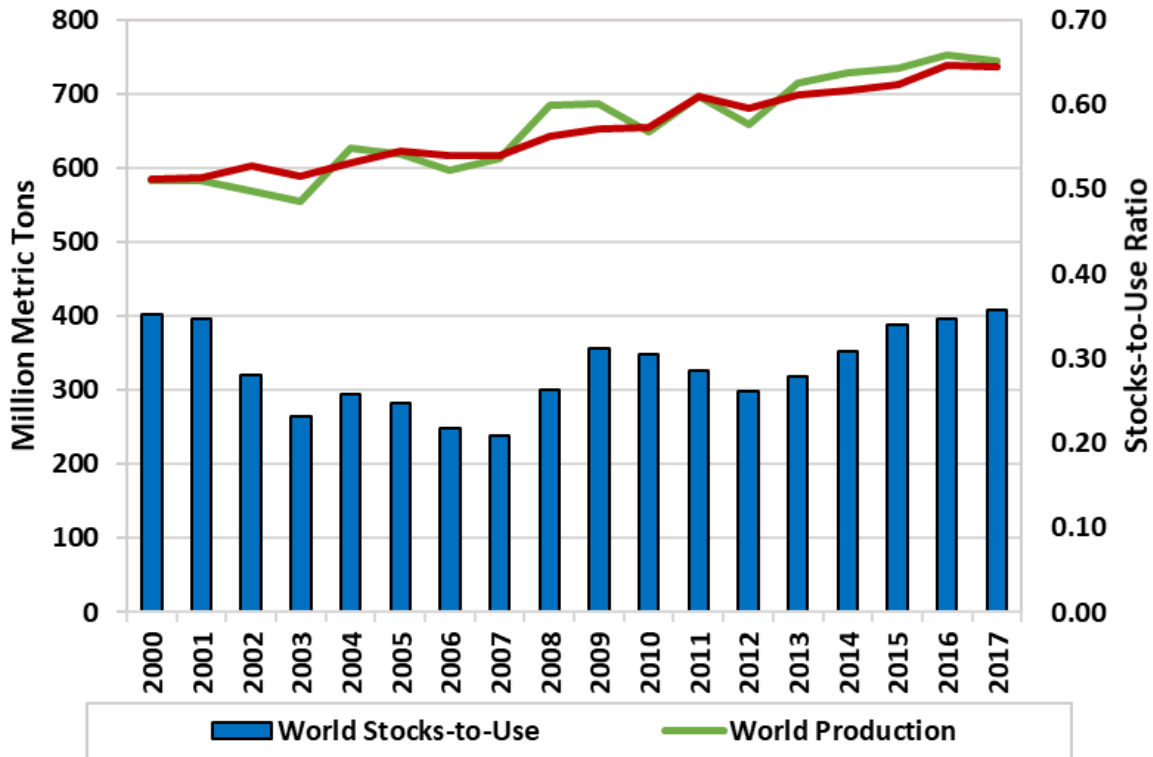
U.S. WHEAT - TOTAL SUPPLY*



World Wheat: The 2016/17 global wheat production set a record of 753.3 million tons. While projections are slightly down from that record for 2017/18, total world wheat production is forecast to be 744.9 million tons and has recently been revised upwards. In particular, Russia is projecting a record 81-million-ton crop based on very favorable weather and updated harvest numbers that have exceeded initial optimistic yield expectations. Wheat production, however, is lower in Australia. A combination of bad weather in various parts of Australia have affected the crop which is projected to decrease 11 million tons from the record crop produced last year. The European Union crop is projected to be up about 4 million tons, after having dropped 15 million tons from the prior year.

The figure below shows the world wheat production and disappearance from 2000-2017. Also included is the world stocks-to-use ratio showing 2017 at record levels, having increased every year for five years in a row.

WORLD WHEAT PRODUCTION: DISAPPEARANCE AND STOCKS

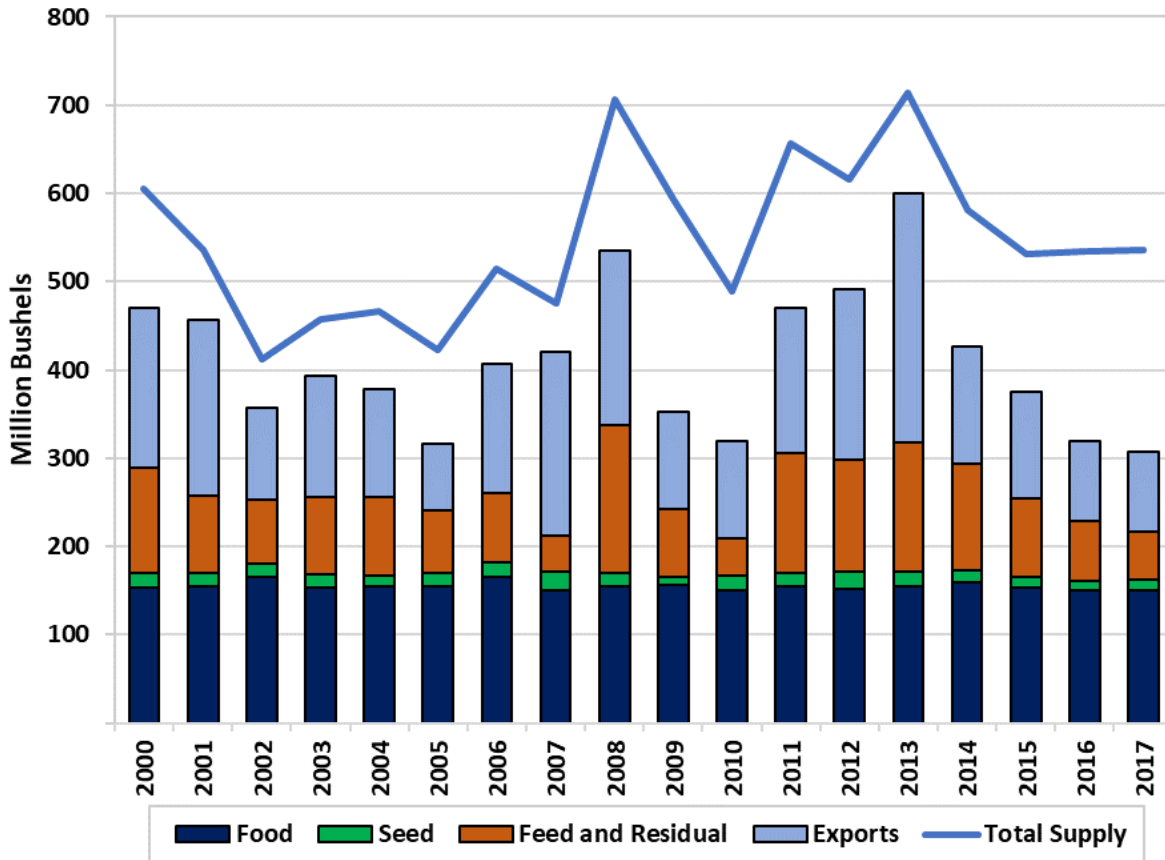


Disappearance

Close to record global wheat production is projected for 2017/18 and foreign domestic wheat use is projected to stay stable at 737 million metric tons. Total use of all wheat in the U.S. increased in 2016/17 to 2.219 million bushels. Projections for 2017/18, however, show a slight decline to 2.141 million bushels. The decrease is expected to mainly be in exports as a result of increased global competition. Recent hurricanes in the Gulf Coast region have also caused transportation issues for exports. These are expected to be only temporary and should have no lasting impacts on export projections. Other uses remain stable or slightly increasing. The percentage breakdown of major U.S. wheat use includes food use (44.4 percent), exports (45.5 percent), feed and residual use (7 percent), and seed use (3.1 percent).

Total use of soft red winter wheat is projected to be 307 million bushels in 2017/18. This represents a 4 percent decrease from the 320 million bushels in 2016/17. The decrease is attributed to a 18.5 percent decrease in feed and residual use. Food use is projected to stay the same while exports are expected to drop 1.8 percent. The percentage breakdown of major U.S. soft red winter wheat use includes food use (48.9 percent), exports (29.3 percent), feed and residual use (17.9 percent), and seed use (3.9 percent). The figure below displays the total supply and major category use for U.S. soft red winter wheat from 2000-2017.

U.S. SOFT RED WINTER WHEAT: SUPPLY AND DISAPPEARANCE

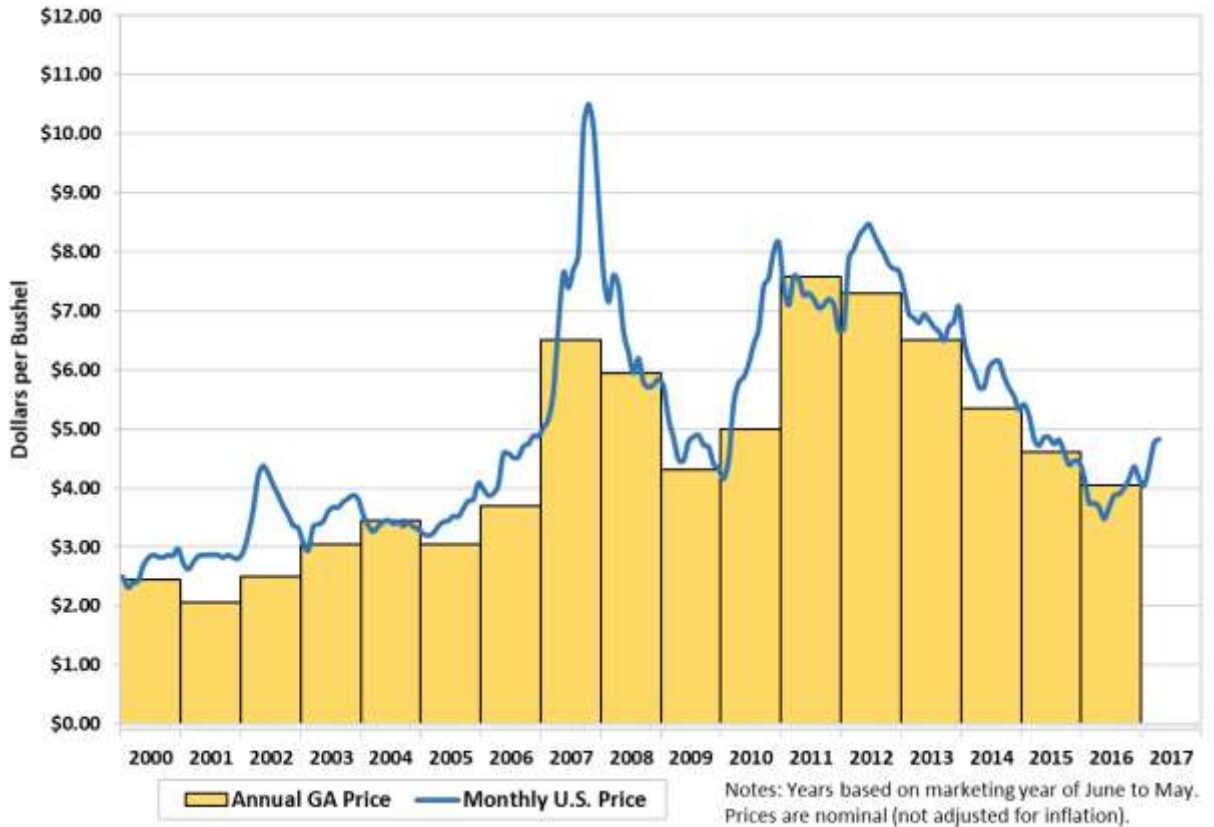


Price Projections

Prices for all wheat in the U.S. have been on a steady decline in recent years, falling almost \$1 per bushel each of the last four years. The marketing year annual price in 2016/17 averaged \$3.89 per bushel, the lowest price since 2005. Since mid-2016/17 marketing year, the price of all wheat has started to increase, with the September 2017 price at \$4.83 per bushel. Local cash prices in Georgia for soft red winter wheat ranged from \$3.84 to \$4.38 per bushel in October 2017 with no cash prices posted for any forward months.

The top figure below shows the annual Georgia price received for wheat and the monthly U.S. all wheat price from 2000-2017. The bottom figure is a chart of the July 2018 futures price for wheat from October 2016 to October 2017.

US AND GEORGIA WHEAT PRICES RECEIVED



Source: Barchart.com

Data Sources:

USDA ERS Wheat Outlook, September 14, 2017, available at

<http://www.ers.usda.gov/publications/whs-wheat-outlook/>.

USDA WAOB World Agricultural Supply and Demand Estimates, September 12, 2017, available at

<http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1194>.

USDA NASS Small Grains Annual Summary, September 29, 2017, available at:

<http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1268>.

Additional data accessed from USDA NASS QuickStats, available at:

<https://quickstats.nass.usda.gov/>.

**WHEAT FOR GRAIN, CONVENTIONAL
GEORGIA, 2017/18**

Estimated Costs and Returns

Expected Yield: **55 bushel** Your Yield _____

Variable Costs	Unit	Amount	\$/Unit	Cost/Acre	\$/bushel	Your Farm
Seed	pounds	90	\$ 0.26	\$ 23.40	\$ 0.43	_____
Lime	ton	0.25	\$ 45.00	\$ 11.25	\$ 0.20	_____
Fertilizer						
<i>Nitrogen</i>	pounds	80	\$ 0.39	\$ 31.20	\$ 0.57	_____
<i>Phosphate</i>	pounds	40	\$ 0.38	\$ 15.20	\$ 0.28	_____
<i>Potash</i>	pounds	40	\$ 0.30	\$ 12.00	\$ 0.22	_____
Weed Control	acre	1	\$ 39.64	\$ 39.64	\$ 0.72	_____
Insect Control	acre	1	\$ 3.90	\$ 3.90	\$ 0.07	_____
Disease Control	acre	1	\$ 4.80	\$ 4.80	\$ 0.09	_____
Preharvest Machinery						
<i>Fuel</i>	gallon	3.7	\$ 2.15	\$ 7.93	\$ 0.14	_____
<i>Repairs and Maintenance</i>	acre	1	\$ 8.79	\$ 8.79	\$ 0.16	_____
Harvest Machinery						
<i>Fuel</i>	gallon	3.0	\$ 2.15	\$ 6.51	\$ 0.12	_____
<i>Repairs and Maintenance</i>	acre	1	\$ 5.42	\$ 5.42	\$ 0.10	_____
Labor	hours	0.7	\$ 13.00	\$ 9.70	\$ 0.18	_____
Irrigation*	applications		\$ 8.30	\$ -	\$ -	_____
Crop Insurance	acre	1	\$ 12.00	\$ 12.00	\$ 0.22	_____
Land Rent	acre	1	\$ -	\$ -	\$ -	_____
Interest on Operating Capital	percent	\$ 95.87	6.0%	\$ 5.75	\$ 0.10	_____
Drying - 2 Points	bushel	60	\$ 0.09	\$ 5.43	\$ 0.10	_____
Total Variable Costs:				\$ 202.91	\$ 3.69	
Fixed Costs						
Machinery Depreciation, Taxes, Insurance and Housing						
<i>Preharvest Machinery</i>	acre	1	\$ 23.92	\$ 23.92	\$ 0.43	_____
<i>Harvest Machinery</i>	acre	1	\$ 25.12	\$ 25.12	\$ 0.46	_____
<i>Irrigation</i>	acre	0	\$ 130.00	\$ -	\$ -	_____
General Overhead	% of VC	\$ 202.91	5%	\$ 10.15	\$ 0.18	_____
Management	% of VC	\$ 202.91	5%	\$ 10.15	\$ 0.18	_____
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	\$ -	\$ -	\$ -	_____
Other _____	acre	1	\$ -	\$ -	\$ -	_____
Total Fixed Costs				\$ 69.32	\$ 1.26	
Total Costs Excluding Land				\$ 272.24	\$ 4.95	
Your Profit Goal				\$ _____	/bushel	
Price Needed for Profit				\$ _____	/bushel	

*Average of diesel and electric irrigation application costs. Electric is estimated at \$7/appl and diesel is estimated at \$9.60/appl when diesel costs \$2.15/gal.

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Developed by Amanda Smith.

Sensitivity Analysis of WHEAT FOR GRAIN, CONVENTIONAL

Net Returns Above Variable Costs Per Acre					
Varying Prices and Yields (bushel)					
Price \ bushel/Acre	-25%	-10%	Expected	+10%	+25%
	41	50	55	61	69
\$3.75	-\$48.23	-\$17.29	\$3.34	\$23.96	\$54.90
\$4.00	-\$37.91	-\$4.91	\$17.09	\$39.09	\$72.09
\$4.25	-\$27.60	\$7.46	\$30.84	\$54.21	\$89.27
\$4.50	-\$17.29	\$19.84	\$44.59	\$69.34	\$106.46
\$4.75	-\$6.98	\$32.21	\$58.34	\$84.46	\$123.65
\$5.00	\$3.34	\$44.59	\$72.09	\$99.59	\$140.84
\$5.25	\$13.65	\$56.96	\$85.84	\$114.71	\$158.02

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use** (hrs/ac)	Fuel Use (gal/ac)	Repairs (\$/ac)	Fixed Costs (\$/ac)
Disk Harrow 32' with Tractor (180-199 hp) CB MFWD 190	16.3	1	0.08	0.60	\$ 1.73	\$ 5.04
Chisel Plow-Rigid 24' with Tractor (180-199 hp) CB MFWD 190	13.0	1	0.10	0.75	\$ 1.36	\$ 3.82
Grain Drill 15' with Tractor (180-199 hp) CB MFWD 190	8.0	1	0.16	1.23	\$ 3.21	\$ 9.04
Spray (Broadcast) 60' with Tractor (180-199 hp) CB MFWD 190	35.5	4	0.14	1.10	\$ 2.48	\$ 6.01
					\$ -	\$ -
					\$ -	\$ -
Total Preharvest Values			0.47	3.69	\$ 8.79	\$ 23.92

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor Use** (hrs/ac)	Fuel Use (gal/ac)	Repairs (\$/ac)	Fixed Costs (\$/ac)
Header Wheat/Sorghum 22' Rigid with Combine (300-349 hp) 325 hp	7.9	1	0.16	2.11	\$ 3.56	\$ 19.97
Grain Cart Wht/Sor 500 bu with Tractor (180-199 hp) CB MFWD 190	10.6	1	0.12	0.92	\$ 1.86	\$ 5.15
Total Harvest Values			0.28	3.03	\$ 5.42	\$ 25.12

** Includes unallocated labor factor of 0.25. Unallocated labor factor is percentage allowance for additional labor required to move equipment and hook/unhook implements, etc.

Developed by Amanda Smith.

**WHEAT FOR GRAIN, INTENSIVE MANAGEMENT, IRRIGATED
GEORGIA, 2017/18**

Estimated Costs and Returns

Expected Yield: **75 bushel** Your Yield _____

Variable Costs	Unit	Amount	\$/Unit	Cost/Acre	\$/bushel	Your Farm
Treated Seed	pounds	125	\$ 0.30	\$ 37.50	\$ 0.50	_____
Lime	ton	0.25	\$ 45.00	\$ 11.25	\$ 0.15	_____
Fertilizer						
<i>Nitrogen</i>	pounds	120	\$ 0.39	\$ 46.80	\$ 0.62	_____
<i>Phosphate</i>	pounds	50	\$ 0.38	\$ 19.00	\$ 0.25	_____
<i>Potash</i>	pounds	60	\$ 0.30	\$ 18.00	\$ 0.24	_____
Weed Control	acre	1	\$ 39.64	\$ 39.64	\$ 0.53	_____
Insect Control	acre	1	\$ 3.90	\$ 3.90	\$ 0.05	_____
Disease Control**	acre	1	\$ 12.00	\$ 12.00	\$ 0.16	_____
Preharvest Machinery						
<i>Fuel</i>	gallon	8.0	\$ 6.00	\$ 48.07	\$ 0.64	_____
<i>Repairs and Maintenance</i>	acre	1	\$ 17.57	\$ 17.57	\$ 0.23	_____
Harvest Machinery						
<i>Fuel</i>	gallon	3.0	\$ 2.15	\$ 6.51	\$ 0.09	_____
<i>Repairs and Maintenance</i>	acre	1	\$ 5.42	\$ 5.42	\$ 0.07	_____
Labor	hours	1.3	\$ 13.00	\$ 16.89	\$ 0.23	_____
Irrigation*	applications	0.5	\$ 8.30	\$ 4.15	\$ 0.06	_____
Crop Insurance	acre	1	\$ 11.00	\$ 11.00	\$ 0.15	_____
Land Rent	acre	1	\$ -	\$ -	\$ -	_____
Interest on Operating Capital	percent	\$ 148.85	6.0%	\$ 8.93	\$ 0.12	_____
Drying - 2 Points	bushel	82	\$ 0.09	\$ 7.41	\$ 0.10	_____
Total Variable Costs:				\$ 314.03	\$ 4.19	
Fixed Costs						
Machinery Depreciation, Taxes, Insurance and Housing						
<i>Preharvest Machinery</i>	acre	1	\$ 50.07	\$ 50.07	\$ 0.67	_____
<i>Harvest Machinery</i>	acre	1	\$ 25.12	\$ 25.12	\$ 0.33	_____
<i>Irrigation</i>	acre	1	\$ 130.00	\$ 130.00	\$ 1.73	_____
General Overhead	% of VC	\$ 314.03	5%	\$ 15.70	\$ 0.21	_____
Management	% of VC	\$ 314.03	5%	\$ 15.70	\$ 0.21	_____
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	\$ -	\$ -	\$ -	_____
Other _____	acre	1	\$ -	\$ -	\$ -	_____
Total Fixed Costs				\$ 236.59	\$ 3.15	
Total Costs Excluding Land				\$ 550.62	\$ 7.34	
Your Profit Goal				\$ _____	/bushel	
Price Needed for Profit				\$ _____	/bushel	

*Average of diesel and electric irrigation application costs. Electric is estimated at \$7/appl and diesel is estimated at \$9.60/appl when diesel costs \$2.15/gal.

** If disease is expected to be a problem, add an additional \$12-15/acre for chemical and application costs.

Sensitivity Analysis of WHEAT FOR GRAIN, INTENSIVE MANAGEMENT, IRRIGATED

Net Returns Above Variable Costs Per Acre

Varying Prices and Yields (bushel)

Price \ bushel/Acre	-25%	-10%	Expected	+10%	+25%
	56	68	75	83	94
\$3.75	-\$103.09	-\$60.90	-\$32.78	-\$4.65	\$37.53
\$4.00	-\$89.03	-\$44.03	-\$14.03	\$15.97	\$60.97
\$4.25	-\$74.97	-\$27.15	\$4.72	\$36.60	\$84.41
\$4.50	-\$60.90	-\$10.28	\$23.47	\$57.22	\$107.85
\$4.75	-\$46.84	\$6.60	\$42.22	\$77.85	\$131.28
\$5.00	-\$32.78	\$23.47	\$60.97	\$98.47	\$154.72
\$5.25	-\$18.72	\$40.35	\$79.72	\$119.10	\$178.16

Estimated Labor and Machinery Costs per Acre

Preharvest Operations

Operation	Acres/Hour	Number of Times Over	Labor			
			Use** (hrs/ac)	Fuel Use (gal/ac)	Repairs (\$/ac)	Fixed Costs (\$/ac)
Plow 4 Bottom Switch with Tractor (180-199 hp) CB MFWD 190	2.3	1	0.54	4.20	\$ 7.79	\$ 23.43
Disk Harrow 32' with Tractor (180-199 hp) CB MFWD 190	16.3	2	0.15	1.20	\$ 3.47	\$ 10.08
Grain Drill 15' with Tractor (180-199 hp) CB MFWD 190	8.0	1	0.16	1.23	\$ 3.21	\$ 9.04
Spray (Broadcast) 60' with Tractor (180-199 hp) CB MFWD 190	35.5	5	0.18	1.38	\$ 3.10	\$ 7.52
					\$ -	\$ -
					\$ -	\$ -
Total Preharvest Values			1.02	8.01	\$ 17.57	\$ 50.07

Harvest Operations

Operation	Acres/Hour	Number of Times Over	Labor			
			Use** (hrs/ac)	Fuel Use (gal/ac)	Repairs (\$/ac)	Fixed Costs (\$/ac)
Header Wheat/Sorghum 22' Rigid with Combine (300-349 hp) 325 hp	7.9	1	0.16	2.11	\$ 3.56	\$ 19.97
Grain Cart Wht/Sor 500 bu with Tractor (180-199 hp) CB MFWD 190	10.6	1	0.12	0.92	\$ 1.86	\$ 5.15
Total Harvest Values			0.28	3.03	\$ 5.42	\$ 25.12

** Includes unallocated labor factor of 0.25. Unallocated labor factor is percentage allowance for additional labor required to move equipment and hook/unhook implements, etc.

Developed by Amanda Smith.

ATTENTION!

Pesticide Precautions

1. Observe all directions, restrictions and precautions on pesticide labels. It is dangerous, wasteful and illegal to do otherwise.
2. Store all pesticides in original containers with labels intact and behind locked doors. "KEEP PESTICIDES OUT OF THE REACH OF CHILDREN."
3. Use pesticides at correct label dosage and intervals to avoid illegal residues or injury to plants and animals.
4. Apply pesticides carefully to avoid drift or contamination of non-target areas.
5. Surplus pesticides and containers should be disposed of in accordance with label instructions so that contamination of water and other hazards will not result.
6. Follow directions on the pesticide label regarding restrictions as required by State and Federal Laws and Regulations.
7. Avoid any action that may threaten an endangered species or its habitat. Your County Extension Agent can inform you of endangered species in your area, help you identify them, and through the Fish and Wildlife Service Field Office, identify actions that may threaten endangered species or their habitat.

Trade names are used only for information. The Cooperative Extension Service, University of Georgia College of Agriculture does not guarantee nor warrant the standard of any product mentioned, neither does it imply approval of any product to the exclusion of others which may also be suitable.

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AN EQUAL OPPORTUNITY EMPLOYER

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- ◆ Certified seed can only be conditioned in an approved facility.
- ◆ Certified seed must meet High Quality standards as to germination and purity.
- ◆ Free of noxious seeds.

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