GEORGIA WHEAT PRODUCTION GUIDE

2020-2021

UNIVERSITY OF GEORGIA
College of Agricultural & Environmental Sciences

Cooperative Extension
Crop and Soil Sciences

Edited by:

Corey Bryant

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Wheat Production

Corey Bryant and Dewey Lee

Planted wheat acreage in the 2019-2020 season (190,000) was up slightly compared to the 2018-2019 growing season. This acreage is relatively unchanged in the last five years where total planted wheat acreage has ranged from 150,000 to 200,000. Unchanged from the 2018-2019 growing season was the number of harvested acres where growers still only harvested 60,000 acres, tying the record for second least number of harvested acres.

Fall growing conditions in 2019 were favorable for planting; however, warmer temperatures throughout the winter presented some issues with vernalization, especially in later plantings. Overall, reports of disease and hessian fly infestations were relatively low last year and a cooler spring with timely rainfall aided in about average harvest levels.

As always there are a few critical points to consider when preparing for the upcoming 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. Remember, wheat responds best to some form of deep tillage.
2) Partition some of your nitrogen fertilizer for the early season (at or shortly after planting) to support fall tiller production. Approximately 85% of yield potential is from fall tillers. Approximately 30-40 lbs of N is adequate to support good tillering (less when following peanuts).
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. In addition, plant ~ 22 to 25 seeds per row foot.
4) Be prepared to control weeds early. Planting on time will enable you to apply your herbicides early and maximize control. Starting with a weed-free seed-bed is the best option for future weed control.
5) Scout early and often for aphid infestations. Pay special attention for Bird Cherry Oak aphids as they are the primary vector of Barley Yellow Dwarf Virus. Insecticide applications should be carefully considered when aphids reach threshold to help prevent BYDV infections.

LAND PREPARATION, TRAFFIC PATTERNS, AND SEED PLACEMENT

Corey Bryant and Dewey Lee

Optimization of wheat growth and development is largely dependent on soil environment at planting. Research from Alabama, Georgia, and South Carolina has consistently shown increased wheat yields with deep tillage. Root growth and penetration are eased and the potential for water and nutrient uptake is increased by tillage, in fields with a hard pan or compacted soils. Tillage also reduced surface residue which 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 South Georgia wheat production due to observed yield reductions ranging from 3-20%. With the understanding that no-till management often has a yield penalty in wheat, 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 soil layer. This is because the weight of the implement is concentrated in a very small area at the tip of the disk and, when repeated several times, can form a hardpan. 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. However, chiseling is also acceptable but not as thorough as V-ripping. 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.

Emergence uniformity, emerged plant stands, and potential wheat grain yield are all highly dependent on consistent and proper seed-placement. Rapid emergence and root development are best achieved with good seed to soil contact and adequate soil moisture. Uniform planting depth of 1 to 1.5-inches promotes uniform emergence as uncontrolled planting depth places some seed too shallow or too deep. While broadcasting is an option for planting wheat, using a properly calibrated seed-drill is preferred as seed distribution, seed to soil contact, and seeding depth are difficult to control when broadcasting. Studies conducted in the southeastern U.S. have demonstrated that greater wheat grain yields are more consistently achieved when a properly calibrated grain-drill is used to plant compared to broadcasting.

Establishing traffic row patterns, or tramlines, at planting or soon after emergence can be beneficial for all post-emergence field traffic. If all planting and post-emergence field equipment is the same size or divisible (i.e. 30-ft drill, 60-ft throw on fertilizer spreader, and 90-ft spray boom) then tramlines may be established at planting by closing off one or more row-units in the tire pattern. If the width of planting and post-emergence field equipment is not equivalent then tramlines may be established shortly after emergence by desiccating with glyphosate using hooded drop nozzles.

Using tramlines in intensively managed wheat enables uniform application of nutrients and pesticides with improved precision and timeliness, especially when precision guidance technology is used to establish tramlines. When precision agriculture technology such as light bars and GPS auto-steer systems are used to establish tramlines the error associated with overlapping post-emergence fertilizer and pesticide applications is reduced. Tramlines can also save on the cost of aerial applications and reduce the chance of disease development. Plant injury, caused by running over standing wheat, provides entry points for many pathogens that will reduce grain yields or require fungicide applications to maintain grain yield. Studies have demonstrated that plants bordering the tramlines will compensate up to 50 – 60% of grain yield lost to tramlines; whereas, plants damaged by equipment traffic rarely produce good yields.

Planting Dates

Corey Bryant and Dewey Lee

Planting date is another critical component of successful wheat production. Wheat grain yield potential is reduced by planting either too early or late. Late maturing varieties must always be planted first as these varieties typically have the longest vernalization requirements. With this being said, some medium maturing varieties may also have longer vernalization requirements, making them less suitable for later plantings.

Variation in vernalization requirements among wheat varieties can make determining exact planting dates difficult. Vernalization occurs when temperatures fall below a certain temperature for a specific amount of time. In the Southeast, vernalization requirements for commonly grown varieties can be as short as one day or as long as six weeks. Planting later maturing varieties early is critical as vernalization can begin as soon as the seed absorbs water and begins to swell. In the absence of sufficient chilling hours, 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 hot, dry periods such as May or June. When this occurs grain yield and weight will decrease as temperature increases.

If planting must occur later in the season, choose an early maturing variety because they will generally have 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 as they may reach the jointing and heading stages too early and be subject to winter kill or injury from late spring freezes.

Planting date effect on three popular varieties are shown in Table 1. 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 1. Effect of Planting Date on Yield (bu/a) of Soft Red Winter Wheat in Tifton, GA

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

The recommended planting dates for different regions in the state are listed in Table 2. 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 Hessian fly; however, in Georgia there is no such thing as a "fly-free date".

Table 2. General planting windows for most wheat varieties grown in Georgia by Region

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 Plain**	December 1 – December 15

** Only varieties with short vernalization requirements

The optimum window for wheat planting in Georgia is typically within one week before or after the average first frost date for a given region. 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 total 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 on 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 at GS 25 (i.e. 50-60 per square foot) then early N applications will be needed to support additional tiller production (additional information in fertility section).

Seeding Rates

Corey Bryant and Dewey Lee

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

In a normal year, wheat cultivars vary between 10,000 and 18,000 seeds/pound. This difference can impact the actual seeding rate if a grower seeds wheat in bushels/acre. For example, seeds/pound of variety 4 and variety 6 vary by 35%, as shown in Table 3. If a grower planted according to bushels/acre, they would plant 35% more seed of variety 6 than variety 4, potentially over-planting or under-planting one of the varieties. This illustrates the importance of purchasing wheat seed based on seeds/pound with a target of 30-35 seeds/square foot, rather than by bushels/acre.

Table 3. Example of seeds/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/Pound	**13,126**

Appropriate seeds/foot of row for various row widths are presented in Table 4. When planting on 7.5-inch rows each liner foot of row should contain 20-25 seeds depending on seed germination rate. This provides enough seed to achieve the target number of live plants/acre for high yields. If planting is delayed, seeding rates should be increased by 15-20%.

Table 4. Seeds/linear row foot needed to achieve certain seeds/square foot at different row widths.

	Seed/square foot			
Row Width in.	**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

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, if you do choose bin-run seed it is important to verify the germination rate prior to planting. Thorough seed cleaning will often increase the germination of a seed lot because it eliminates some non-viable seed.

Variation in pounds/acre between two varieties planted at various row widths and seeds per row foot are presented in Table 5. If a grower has a variety with approximately 12,000 seeds/pound and planted on a 7.5-inch row width with a target of 22 seeds/row foot, then you would need to purchase 128 pounds of seed/acre. If the seed were smaller and the variety had 15,000 seed/pound then the grower would need to purchase only 102 pounds/acre to achieve the same target population.

Table 5. Example of pounds of seed/acre as determined by row width, seeding rate, and seeds/pound.

	Row Width					
	6-inches		**7.5-inches**		**10-inches**	
Seed/row ft.	12,000	15,000	12,000	15,000	12,000	15,000
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

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/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 of seed 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.

Straw Utilization

Corey Bryant and Dewey Lee

Wheat straw utilization is a method of adding economic value to a wheat production system. While there are many potential uses for wheat straw, some of the most popular are; residue in conservation tillage systems, residue to reduce soil erosion during road or building construction, horse bedding, and hay feeding. Straw production will vary from variety to variety and even within a variety from year to year. In general, higher grain yield correlates to greater straw production. Table 6 demonstrates the range of straw heights and production across wheat varieties in Griffin, GA. Remember, if the straw is removed from the field the same amount of nutrients in the straw must be returned to the field for the subsequent crop. Straw nutrient contents are discussed more in the fertility chapter.

Table 6. Example of straw yield (lbs/a) of different soft red winter wheat varieties at Griffin, GA.

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	235
9	33	2478

Harvest Timing – Grain Quality

Corey Bryant and Reagan Noland

Harvesting a wheat crop with marketable grain quality continues to be a common challenge for many Georgia growers. The often-heavy spring rainfalls can keep combines out of the field well beyond grain maturity, imposing the risk of grain quality decreasing as the crop waits. Profitable management, production, and sale of wheat has been challenging in recent years due to weak markets and grain quality standards at buying points. Falling number is a common grain quality indicator that can often influence the marketability of wheat.

For many Georgia growers, falling number is one of the least understood quality parameters used by wheat buyers. As the grain sprouts, and even before sprout, enzymes are at work inside the seed, breaking down the starch to a more usable form for the plant to use when it germinates. Breaking down these starches decreases both the baking quality and shelf-life of the flour. Although falling number is not a direct measurement of enzyme levels, it does indicate enzymatic activity in the grain, and the breakdown of complex starches to more simple carbohydrates.

The falling number value is based on the viscosity (or thickness) of a slurry made with flour and water. The calculation is based on the amount of time it takes for a viscometer to fall a certain distance through the slurry. This has been demonstrated as a consistent indicator of the composition of starch in the wheat. A lower falling number due to a thinner slurry indicates starch breakdown and poor baking quality. A common threshold for buying wheat is 300. Falling numbers below 300 may be considered to have sprout damage and reduced quality; whereas, falling numbers above 300 indicate good baking quality and shelf life.

A major factor influencing sprout and falling number is how long the crop sits in the field under wet conditions prior to harvest. However, there is not a consistent relationship between sprout percentage and falling number. Susceptibility to sprout, starch composition, and rate of starch breakdown can vary by wheat variety and other conditions, making it very difficult to predict or estimate falling number. Environmental conditions are often not favorable for timely wheat harvest, but these quality standards emphasize the importance of harvesting as soon as possible, once the crop is mature. In addition to falling number, test weight also declines as the crop sits in the field after maturity, especially whenever it is rained on.

References

German, C.L. 2006. Understanding the falling number wheat quality test. University of Delaware Extension. ER06-02. Accessed at: http://www1.udel.edu/FREC/PUBS/ER06-02.pdf

Kweon, M. 2010. Falling number in wheat – How is it calculated and what does it mean to producers? USDA-ARS Soft Wheat Quality Lab. Accessed at: https://www.ars.usda.gov/ARSUserFiles/36070500/InfoDianehasuploaded/2010ResearchReviewAnnualReport/MKweon-FN-012810.pdf

Recommended Wheat Varieties: 2020-2021

Corey Bryant and Daniel Mailhot

Selecting the proper wheat variety for the region, field, and management practices is one of, if not the most, important decisions a grower will make with regards to profitable production. With the vast number of differences that exist among wheat varieties, 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 is provided to compare and understand the differences between each of the varieties recommended in Georgia (Table 7). Be sure to consider all notes regarding regional adaptation, disease, and insect susceptibilities.

Table 7. Recommended Wheat Varieties for 2019-2020

AGS 2024 (S)	Dyna-Gro 9811 (P)[3]	[*]Pioneer 26R10 (P)	USG 3329 (P)[2]
[*]AGS 2038 (C)	Dyna-Gro Blanton (S)	Pioneer 26R41 (P)[2]	USG 3536 (P)[2]
AGS 3000 (C)	Dyna-Gro Plantation (S)	Pioneer 26R45 (P)	USG 3640 (S)
AGS 3015 (S)[3]	Dyna-Gro Rutledge (S)	[*]Pioneer 26R59 (P)[3]	USG 3895 (P)[3]
AGS 3030 (S)	Go Wheat 2032 (C)[2]	Pioneer 26R94 (C)	#BERKELEY (C)[2]
AGS 3040 (S)	[*]Hilliard (P)[3]	SH 5550 (S)	#FURY (C)[2]
AgriMAXX 473 (P)	LW2026 (C)[3]	SY Viper (P)[3]	#TURBO (C)[2]
Dyna-Gro 9701 (P)[2]	[*]PGX 16-4 (C)[2]	[*]USG 3118 (C)[3]	

[1] P = Piedmont; C = Coastal Plain; S = Statewide
[2] Consider using a labeled fungicide; highly susceptible to owdery mildew, leaf rust, stripe rust, or crown rust.
[3] Susceptible to some Hessian fly; consider using an insecticide.
[*] Not tested in 2019-2020 but yields were comparable to those tested. To be dropped from the list in 2021.

Sources of Seed:

AGS varieties: AGSouth Genetics
Dyna-Gro: Dyna-Gro Seed
GoWheat: Stratton Seed Company
PGX and # varieties: Progeny Ag Products
Pioneer varieties: Dupont Pioneer
Southern Harvest 5550: Meherrin Agricultural Chemical and Supply
SS varieties: Southern States Coop
SY varieties: Syngenta Cereals
USG: UniSouth Genetics
Am 473: AgriMaxx Wheat

Table 8. Recommended what varieties regional yield performance summary: 2019-2020

Company or Brand Name	Variety	Normal Planting Dates North[1] 2020	North[1] 3-Yr Avg	South[2] 2020	South[2] 3-Yr Avg	Statewide[3] 2020	Statewide[3] 3-Yr Avg	Late Plantings South[4] 2020	Late Plantings South[4] 3-Yr Avg
AgriMAXX	AM473	**109.5**	100.0	.	.	.	.	.	.
AgriPro	SY Viper	88.9	**102.5**	55.2	86.0	63.6	91.2	.	.
AGSouth	AGS 2024	**103.8**	98.5	70.5	**95.6**	78.8	**96.5**	66.8	.
AGSouth	AGS 3000	.	.	62.0	79.4	.	.	62.1	**77.9**
AGSouth	AGS 3015	85.4	84.8	72.8	90.2	75.9	88.5	62.9	.
AGSouth	AGS 3030	96.8	85.8	60.3	86.0	69.4	85.9	54.7	72.1
AGSouth	AGS 3040	100.3	87.8	70.9	90.3	78.3	89.5	.	.
Dyna-Gro	9701	**108.0**	**103.9**	.	.	.	.	.	.
Dyna-Gro	9811	103.3	**104.6**	72.1	88.8	79.9	**93.7**	.	.
Dyna-Gro	Blanton	101.8	97.9	74.5	90.2	81.3	92.6	**74.8**	.
Dyna-Gro	Plantation	95.5	.	**86.2**	.	**88.5**	.	61.4	.
Dyna-Gro	Rutledge	94.1	84.4	73.2	**95.6**	78.4	92.2	**75.3**	.
Local Seed	LW2026	78.5	81.1	73.2	**95.6**	74.5	91.2	.	.
Pioneer	26R41	99.2	**103.0**	75.5	81.3	81.4	88.1	.	.
Pioneer	26R45	91.6	**109.5**	70.5	82.0	75.8	90.6	.	.
Pioneer	26R94	101.4	82.5	75.7	91.9	**82.1**	89.0	60.5	**75.3**
Progeny	#BERKELEY	92.8	.	80.1	**95.6**	**83.3**	.	60.0	.
Progeny	#FURY	103.1	.	67.0	**92.4**	76.0	.	56.9	.
Progeny	#TURBO	103.4	.	56.4	84.1	68.2	.	.	.
Southern Harvest	SH 5550	.	.	69.2	.	.	.	.	.
Stratton	Go Wheat 2032	**110.6**	93.3	72.3	89.4	**85.1**	90.7	51.2	**76.0**
UniSouth	USG 3329	84.2	97.8	.	.	.	.	.	.
UniSouth	USG 3536	102.3	**102.6**	.	.	.	.	.	.
UniSouth	USG 3640	91.0	88.0	80.1	**96.4**	**82.8**	93.9	**71.1**	.
UniSouth	USG 3895	102.6	**101.9**	.	.	.	.	.	.

[1] Calhoun (2018, 2019), Rome (2020), and Athens. Athens 2020 not included

[2] Plains (2 tests), Midville, and Tifton. Midville 2020 not included.

[3] Statewide averages exclude late plantings. Athens and Midville not included for 2020.

[4] Plains and Tifton.

Bolded yields are statistically not different from the highest yielding test entry.

Yields are calculated as 60 lbs/bu at 13.5% moisture.

Fertility Recommendations

Glen 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 9). 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 9. Nutrient uptake and nutrient removal by wheat at different yield levels.

	Yield (bu/a)					
	40		70		100	
Nutrient	Uptake	Removal	Uptake	Removal	Uptake	Removal
	---------- pounds per acre ----------					
N	75	46	130	80	188	115
P_2O_5	27	22	47	38	68	55
K_2O	81	14	142	24	203	34
Mg	12	NA	21	NA	30	NA
S	10	NA	18	NA	25	NA

Removal based on grain only.

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:

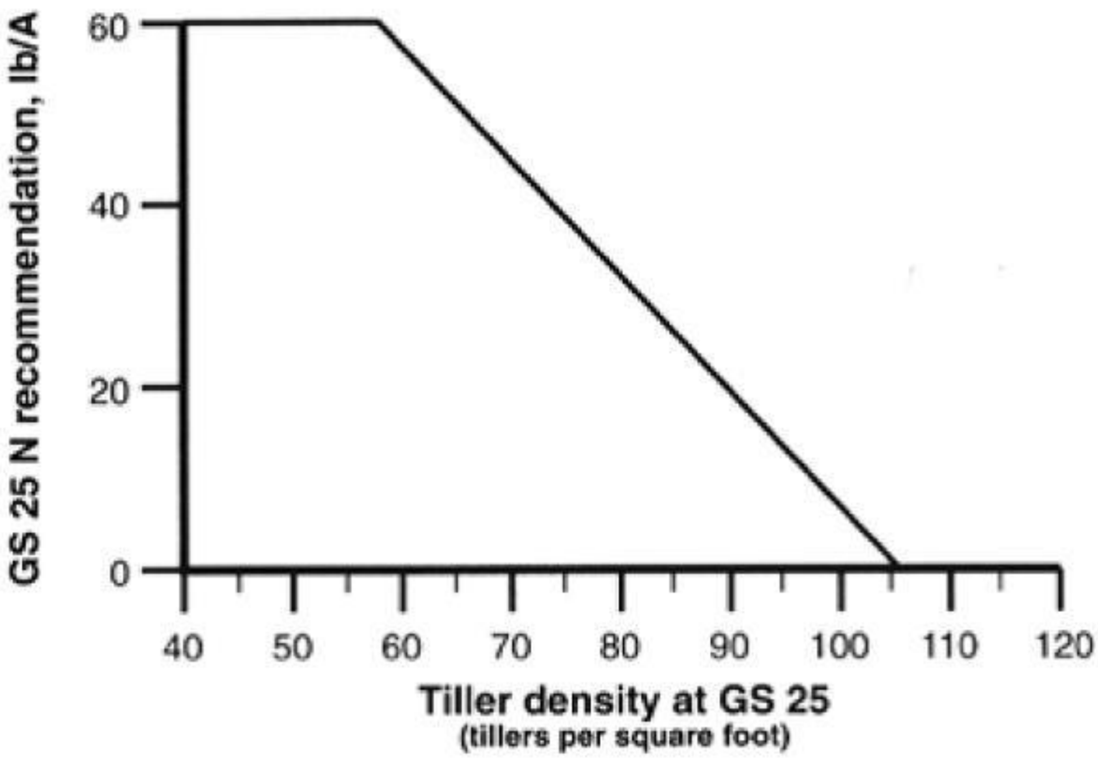
Cotton: 35 to 40 lbs ac   Soybeans: 15 to 20 lbs ac   Fallow: 25 to 30 lbs ac

Corn: 30 to 35 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.

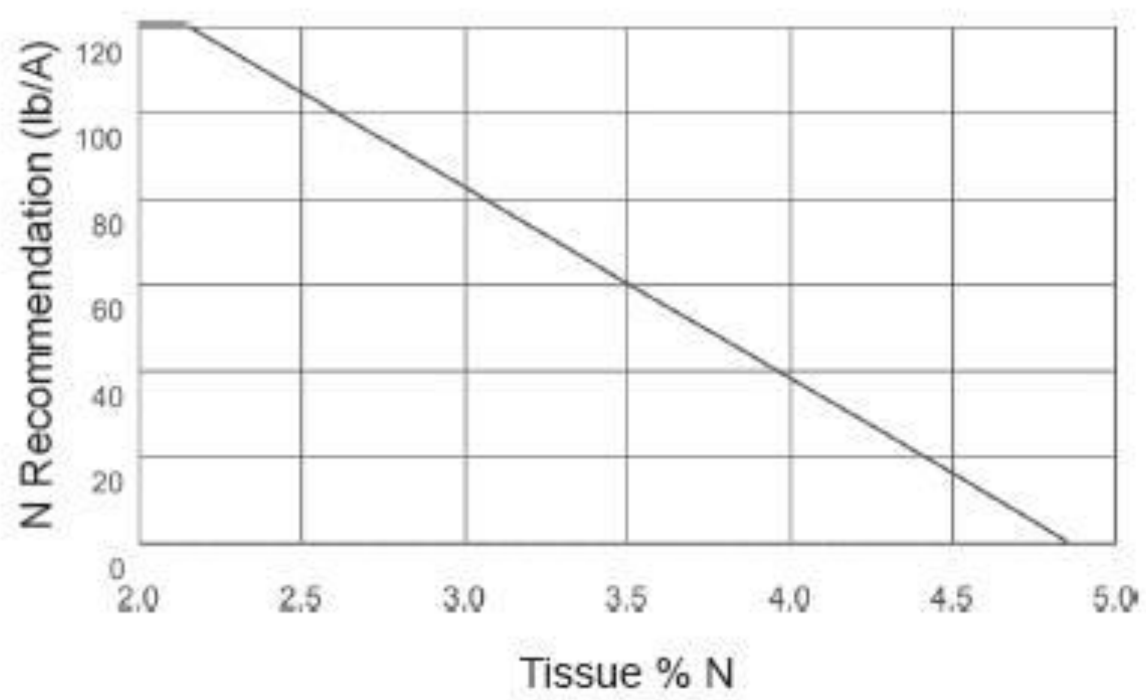
When the wheat crop reaches the growth stage Zadoks GS 25, begin counting tillers to determine the need for additional nitrogen applications for the proper tiller production prior to the onset of stem elongation. This stage of growth generally occurs during the mid to later week of January in south GA 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 midFebruary 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 ½ 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 suggests since it would exceed he 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 Culpepper

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, chickweed, and henbit; perennials such as wild garlic and curly dock; and annual ryegrass are often the most problematic weeds in wheat. Although each of these pests can be problematic, it is ryegrass that poses the greatest threat to the production of wheat and other grains in Georgia. Ryegrass populations have been confirmed to be resistant to all currently labeled effective postemergence herbicides. Growers must implement management programs to delay the development and spread of resistant ryegrass.

Cultural Control Methods

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

1) Planting certified seed (free of weed seeds and garlic bulblets)
2) Good seedbed preparation – free of weeds, clods, and plant debris
3) Proper fertilization
4) Seeding at the proper rate, planting depth, and time of year
5) Timely management of diseases and insects

Site selection can determine one's potential success. Growers are strongly encouraged to avoid fields heavily infested with herbicide-resistant ryegrass; rotate these fields into cropping systems that allow other effective herbicide chemistry's for at least three years. 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'.

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 potential herbicide carryover, how best to apply each herbicide, and having an in-depth understanding of 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; plants surviving through the winter and producing seeds in the spring will likely be the most popular weeds the following season. Knowing which weed species will appear allows one to develop a more effective management program.

Before-season and In-season Monitoring

As with all crops, there should be no weeds present when planting. Remove all weeds at least 10 days before planting with herbicides or tillage. Additionally, scout fields a few days prior to planting and control any plants that survived previous control tactics as well as any newly emerging weeds. Once the crop is planted, 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, to determine the need for additional control tactics, and to determine if there is a potential herbicide resistance issue. Identifying resistance early can be essential to long-term use of a given field. 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 if necessary.

Managing Weeds with Herbicides

If applying herbicides, read and follow all label recommendations. Information concerning weed response to herbicides, herbicide rates, and grazing restrictions for wheat are in Tables 13-15.

Larger weeds are usually 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 herbicide applications are restricted to certain growth stages to minimize crop injury and to ensure illegal pesticide residues are avoided (Tables 10 and 11). 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 impact crop tolerance.

Table 10. Wheat herbicides and their application window

Herbicide	Application Window in Wheat
2,4-D	Fully tillered only
Axial XL	2nd leaf through pre boot
Axial Bold	Emergence through pre-boot
Axiom	After spike through 2 leaf
Express	2nd leaf through flag leaf
Fierce	After spike through 2 leaf
Harmony Extra	2nd leaf through flag leaf
MCPA	2 tillers but before jointing
Osprey	Emergence through jointing
Peak	3rd leaf through 2nd detectable node
Powerflex	3rd leaf through jointing
Prowl H20	1st leaf through flag leaf visible
Quelex	Preplant through just before emergence AND 2 leaf through flag leaf
Zidua	Delayed PRE through 4 tiller

Table 11. The effect of Stage of Growth on Wheat Injury by Various POST Herbicides.

Percent Injury by Stage of Wheat Growth[1]					
Herbicide	Pre-plant	0-1 tiller	2-3 tillers	full tiller	Jointing
2,4-D	>40%	>40%	15-30%	0-10%	>50%
MCPA	>25%	>30%	0-10%	0-10%	>40%
Harmony Extra	0-5%	0-10%	0-10%	0-10%	0-5%
Harmony + MCPA	>25%	>30%	10-15%	5-10%	>40%
Harmony + 2,4-D	>40%	>40%	15-30%	5-10%	>50%
Quelex	0-10%	0-10%	0-10%	0-10%	unknown
Osprey	unknown	0-15%	0-15%	0-15%	0-15%
PowerFlex	unknown	0-15%	0-15%	0-15%	0-15%

[1]Percent 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, and wild radish (Table 17). However, 2,4-D often does not adequately control chickweed and henbit; thus, *mixtures with Harmony Extra are advised*.

This auxin 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 differences noted among formulations in Georgia. 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; ***Georgia research has shown nearly 90% less impact from volatility-drift of an amine formulation of 2,4-D when compared to an ester formulation 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. Applications to early 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 (too late) may result in malformed seed heads and yield loss.

Dicamba, an auxin herbicide, is labeled for use in wheat. It can be applied early-season as long as the application is complete prior to wheat jointing. Although dicamba has become an effective tool in agronomic crops, its value in wheat is much less because of the limited maximum use rate of 0.12 lb ai/A (ie Clarity = 4 oz/A; XtendiMax = 5.5 oz/A). This rate of dicamba is extremely low and of little value except in rare situations; little to no control of radish is observed.

MCPA, an auxin herbicide, controls a broad spectrum of broadleaf weeds similar to those noted with 2,4-D (Table 17). When compared to 2,4-D, MCPA is generally less injurious to wheat but also a little less effective on larger weed species. MCPA should be applied 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.

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. 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 13). 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 to 0.5 lb ai/A may be mixed with Harmony Extra for excellent wild radish control and improved control of cornflower; mixtures must follow the 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.

Express (tribenuron) is a sulfonylurea herbicide and can be effective on many winter annual broadleaf weeds if mixed with 2,4-D or MCPA (Table 13). Express alone can be applied after the wheat has two leaves but before the flag leaf is visible; if mixing with 2,4-D or MCPA follow their respective growth application restrictions. Express may 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.

Peak (prosulfuron) is a sulfonylurea herbicide that can be effective on many winter annual broadleaf weeds (Table 13). 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. Peak can be applied after wheat has reached the three-leaf stage but before the second detectable node of stem elongation.

Quelex (halauxifen-methyl + florasulam) is a mixture of an auxin herbicide and a sulfonylurea herbicide. The label allows it to be used as a preplant burndown treatment to wheat to control emerged weeds prior to, or shortly after planting (prior to emergence). It may also be used as a postemergence tool when wheat between 2 leaf and flag leaf. Do not apply more than 0.75 oz/A per growing season and no more than 2.25 oz/A per year for both burndown and in-season use.

The label claims control of common chickweed, Carolina geranium, henbit, horseweed, wild mustard, and volunteer soybean when the weeds are less than 4 inches tall. Initial UGA research with Quelex is promising with early-season applications with small weeds.

A non-ionic surfactant at up to 0.25% v/v or a crop oil concentrate at 0.5 to 1% v/v should be included with Quelex (UGA research has focused on 1% v/v of crop oil concentrate). It may be applied in spray solutions containing liquid nitrogen fertilizer but in this case use only the non-ionic surfactant.

Tank mixtures with other labeled rates of other herbicides can be made with a few restrictions: 1) cannot mix with glufosinate, 2) must read labels of products mixed, and 3) must perform a jar test to ensure compatibility.

Wild Radish Control

Wild radish can be controlled effectively with numerous herbicide options if applied timely (Table 12). Harmony Extra + MCPA or 2,4-D is an excellent option to control wild radish as well as most other commonly present broadleaf weeds. PowerFlex and Osprey, effective ryegrass herbicides, are also very good options for controlling wild radish.

Table 12. The effect of Stage of Growth on Wild Radish Control in Wheat.

	Percent Control By Leaf Rosette Diameter			
Herbicide	0-4 inches	4-8 inches	8-12 inches	Bolting/Flowering
2,4-D	>99%	>95%	>90%	80-90%
Dicamba	<50%	<40%	<20%	<20%
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%
Quelex	>99%	75-95%	50-75%	<60%
Osprey	>99%	90-95%	60-75%	40-65%
PowerFlex	>99%	>95%	>85%	75-90%

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 may receive a substantial discount.

Harmony Extra with TotalSol (50 SG) at 0.75 to 0.9 oz/A is very effective. 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 50^0 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 other broadleaf weeds. Add a nonionic surfactant or crop oil according to label directions.

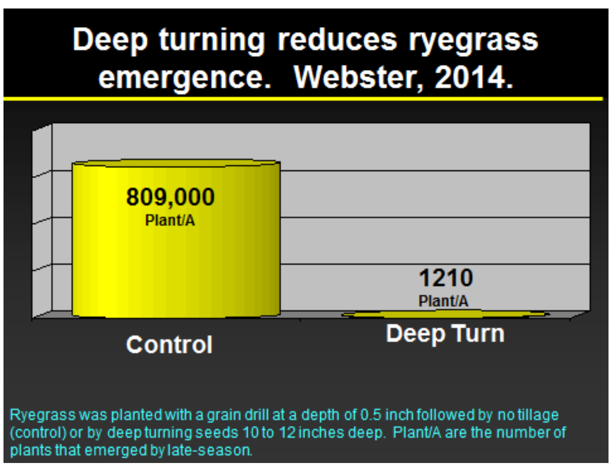
There are no rotational restrictions following wheat treated with Harmony Extra. There is a 10-month rotational restriction for all soybeans, cotton, peanuts, and tobacco following application of Peak.

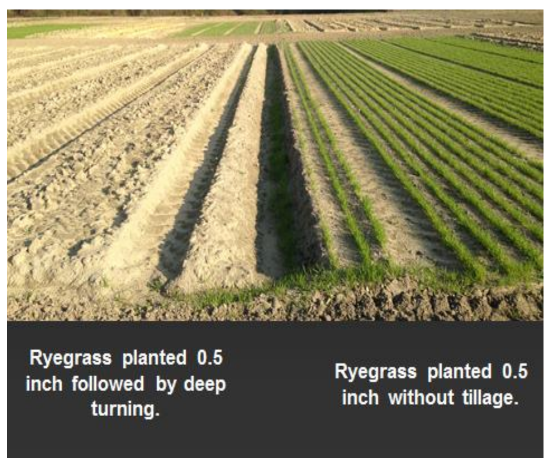
Italian or Annual Ryegrass

Georgia wheat production is challenged mightily by herbicide resistant ryegrass. Ryegrass resistant to all currently labeled postemergence herbicides has been confirmed and is spreading. Growers must implement management programs to delay the development and spread of resistant ryegrass.

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, rotating fields with heavy ryegrass populations into other crops allowing alternative control methods, 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 better 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.

Herbicides for Controlling Italian or Annual Ryegrass

Axial Bold, active ingredients pinoxaden and fenoxaprop-p-ethyl, at 15 fl oz/A can be applied postemergence to wheat between emergence and the pre-boot stage. Axial Bold is expected to replace Axial XL over the next year. Weed control and crop tolerance should be similar among the two products. Mixtures with Harmony Extra and Quelex are approved on the label. Only one application per year. See additional comments under Axial XL.

Axial XL, active ingredient pinoxaden, at 16.4 fl oz/A can be applied postemergence to wheat between 2 leaf and the pre-boot stage. Ryegrass resistant to Hoelon may be cross resistant to Axial XL, although in many cases Axial XL is still effective in Georgia. Apply in 10 gallons of water per acre. Rain falling after 30 minutes of application will not impact control. Axial can be applied only once per crop and will not offer residual control or control of broadleaf weeds.

Axial XL 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 against mixing Axial XL with nitrogen fertilizer because of the potential for reduced ryegrass control.*

Any crop can be planted after 90 days.

Axiom, active ingredients flufenacet and metribuzin, can be applied to wheat after the spike stage of growth up to the 2-leaf stage. 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 of product/A (or maybe less in some environments), but, again this should be determined from your soil type, label restrictions, and expected rainfall/irrigation the week following application.

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. 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/A 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" must occur prior to ryegrass or radish reaching ½ inch in height for effective control.***

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

Hoelon, containing the active ingredient diclofop-methyl, is still labeled for controlling ryegrass in wheat; however, the product does not appear to be available in our area. Resistance to this herbicide is widespread.

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 to control ryegrass with less than 2-tillers. If applied properly and timely, Osprey controls ryegrass well as long as it is not ALS-resistant. Osprey is a sulfonylurea-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. The manufacturer is currently recommending a nonionic surfactant containing at least 80% surface-active agents (0.5% by volume; 2 quarts per 100 gallons spray solution) plus 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 or MCPA 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 a huge concern; thus, if treating a field with either Osprey or PowerFlex this year, do not apply either product to that field next year.

PowerFlex HL, active ingredient pyroxsulam, can be applied to wheat between three leaf and jointing to control ryegrass with less than two tillers. 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 of water per acre and include a crop oil concentrate at 1 to 1.25% v/v (1 to 1.25-gal crop oil per100 gal spray solution). Four-hour rain fast period is needed.

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 wild 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. *The University of Georgia recommends against mixing PowerFlex with nitrogen fertilizer as a carrier because of the potential for reduced ryegrass control.*

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

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.

Resistance to Osprey and PowerFlex is a huge concern; thus, if treating a field with either Osprey or PowerFlex this year, do not apply either product to that field next year.

Prowl H_20, active ingredient pendimethalin, at 1.5 to 2.5 pt/A can be applied postemergence to wheat as long as the wheat is between one leaf and flag leaf. 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 H_20 label allows for mixtures with any labeled postemergence wheat herbicide.

The two greatest uses for Prowl H_20 might be the following: First, a mixture of Prowl H_20 with a postemergence annual ryegrass herbicide. In theory with this application, the postemergence herbicide would control the emerged ryegrass and the Prowl H_20 would provide residual control of germinating ryegrass for a couple of weeks. However, it is worth mentioning that most of the ryegrass observed 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 H_20 will not help with this situation. A second use for Prowl H_20 would be in a situation where the wheat emerges while the ryegrass is late to emerge. In this situation, Prowl H_20 applied over one-leaf wheat and activated by rainfall or irrigation could provide control of that later emerging ryegrass.

Zidua, active ingredient pyroxasulfone, can be applied as a delayed preemergence or early postemergence treatment 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 (or less 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 decades. 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, several ryegrass populations with resistance to Hoelon, Osprey, Axial, and PowerFlex were confirmed. Additional locations with ryegrass resistance to multiple herbicide modes of action have been confirmed each year since then as well.

One effective way to avoid or delay buildup of herbicide-resistant ryegrass populations is to rotate herbicides with different modes of action within the wheat crop. Of even more importance may be the need of rotating out of wheat and into other cropping systems allowing for the use of herbicide chemistries not used in small grains. Additionally, integration of non-chemical controls, such as crop rotations and cultural control methods including deep turning of the land, can delay resistance.

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 such as excessively cold, wet, dry, etc….
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 application
9) rainfall prior to postemergence herbicide uptake
10) lack of rainfall or irrigation to activate residual herbicides

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

Liquid Nitrogen Tank Mixes

Although several herbicides used in wheat may be mixed with liquid nitrogen, herbicide and nitrogen timing for wheat applications likely do 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 (often before or around Christmas). Stretching the window for effective weed control to accommodate nitrogen fertilization may result in poor weed control and greater wheat injury. *Additionally, it is encouraged to not use nitrogen fertilizers as a carrier for 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 13 and 14) for control of emerged weeds. Other herbicides such as Select, Harmony Extra, 2,4-D, Quelex and Valor may be applied preplant; however, with the exception of Harmony Extra and Quelex, significant plantback intervals must be followed (Tables 13 and 14).

A burndown herbicide is recommended in every case of no-till wheat production. Without a burndown, winter annuals can quickly get too large to control 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 especially ryegrass and wild radish.

Table 13. Weed Responses to Broadleaf Herbicides Used in Wheat.

Weeds	2,4-D[1]	MCPA[1]	Harmony Extra[1]	Harmony Extra + MCPA or 2,4-D[1]	Express + MCPA or 2,4-D[1]	Quelex[1]	Express[1]	Buctril[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
c. chickweed	P	P	G	GE	GE	GE	G	PF		G
c. ragweed	G	F	PF	FG				E	E	
cornflower	G		P	F				GE		F
cudweed	GE	GE	E	E	E			G		
curly dock	P	P	E	E	P			PF		
dandelion	E	E		GE	GE			E		
dogfennel	G	F	E	E				GE		
evening primrose	E	E	F	E	E			F	FG	
field pennycress	G		G	GE				G		G
geranium	F	F	FG	GE		G				
goldenrod	F	G						F		
hairy vetch	FG	FG	P	F				F		
henbit	P	P	G	GE	G	GE	F	F	FG	G
horsenettle	F	F						F		
horseweed	F	F	FG	FG				F		
knawel	P		G	G				P		
lambsquarters	G	G	E	E				E	G	
plantains	E	E	E	E	E			E		
shepherd's-purse	GE	GE	E	E	E			G	G	G
swinecress	G	G	E	E	GE			GE		
thistles	G	G	FG	G				G	FG	
vetch	G		P					F		
VA pepper-weed	E		G	GE	E			FG		
wild garlic	F	P	GE	GE				P	E	P
wild mustard	E	GE	FG	E	E		F	G	G	G
wild radish	E	GE	FG[3]	E	E	GE[3]	F	FG	G	G

[1]Timely postemergence application. [2]Applied preemergence. [3] Must be less than 3 inches when treated in good growing conditions.

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

Table 13. 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	F			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	G	GE	PF	N	N	G	GE
wild radish	G	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 14. Chemical Weed Control in Wheat.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Categlory[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	U.S. EPA has restricted the use of paraquat to certified applicators ONLY; applicators must take a specialized training before use. Apply before crop emerges. Rate depends on weed size. Add nonionic surfactant at 2 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; use full rate for ryegrass	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. Cool temperatures, including at night, may slow or even reduce the level of control observed.
Control of most weeds; full glyphosate rate for ryegrass	glyphosate + 2,4-D amine (3.8 L) MOA 9 + 4	see glyphosate + 12 to 16 fl oz	0.75 to 1.13 + 0.36 to 0.48	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; full glyphosate rate for ryegrass	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 0.0187 + 0.0047 to 0.0094	May be used as a burndown treatment prior to or shortly after planting, but prior to wheat emergence.
Volunteer Roundup Ready Corn and ryegrass; full rates for ryegrass	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 0.13 0.05 to 0.07	**Do not plant wheat for 30 days** after application. Rainfall after application and before planting of 0.5" advised. 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 0.064	For Valor, **a minimum of 30 days 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.
Chickweed, C. geranium, henbit, horseweed, soybean, wild radish; use full glyphosate rate for ryegrass	glyphosate + halauxifen-methyl + florasulam (Quelex) 0.2 WG MOA 4 + 2	see glyphosate + 0.75 oz	0.75 to 1.13 + 0.0048 + 0.0047	Apply as a preplant burndown treatment prior to, or shortly after planting prior to emergence; suggest at least 3 days prior to emergence. Label requires addition of non-ionic surfactant or crop oil concentrate. An application can be made for burndown and again in-crop, see below. Rotation to cotton and soybean is 3 months. UGA research shows excellent crop tolerance with 2 years of data.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Categlory[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 (<u>Finesse, Report Extra</u>) 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.
		DELAYED PREEMERGENCE		
Ideal use is for residual control of ryegrass resistant to POST herbicides	Pyroxasulfone (<u>Zidua</u>) 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 soils. Do not irrigate until wheat is emerged. Avoid application if a long period of rain is expected prior to wheat emergence. **To minimize resistance:** *If treating a field with <u>either</u> Zidua or Fierce this year, do not apply either product on that field next year.*
		POSTEMERGENCE: SPIKE TO EARLY POST		
Ryegrass resistant to POST herbicides, radish, henbit and annual bluegrass; must be activated before emergence	flufenacet + metribuzin (<u>Axiom</u>) 68 WDG MOA 15 + 5	4 to 8 oz	0.136 to 0.027 + 0.034 to 0.068	Wheat seed should be planted at least 1 inch deep. Apply to wheat between spike and 2 leaf. Preemergence applications can cause severe injury on light soils. For most GA soils, $\leq$6 oz/A of product is ideal. Heavy rains following application can cause wheat stunting. Rotation: soybean = 0 months, cotton = 8 months, many other crops = 18 months.
Residual control of annual ryegrass; will not control emerged plants and must be activated before ryegrass emergence	pyroxasulfone (<u>Zidua</u>) 85 WG MOA 15	0.7 to 1.5	0.037 to 0.079	Apply to wheat (drilled or broadcast) between spiking and 4 tiller. *Sequential applications may be made as to not exceed 2.5 oz/A per crop.* More effective than Prowl. May mix with Axial XL to control emerged ryegrass plants (those not resistant to Axial) and apply between 2-leaf and 4-tiller wheat. **To minimize resistance:** *If treating a field with <u>either</u> Zidua or Fierce this year, do not apply either product on that field next year.*
Residual control of annual ryegrass, wild radish, and other weeds Fierce must be activated prior to weeds being ¼" for excellent control.	pyroxasulfone + flumioxazin (<u>Fierce</u>) 76 WDG MOA 15 + 14	1.5 oz	0.04 + 0.031	Plant seed 1 to 1.5 inch deep; cannot treat broadcast seedings. Apply to wheat when 95% of wheat is in the spike to 2-leaf stage of growth; DO NOT apply preemergence. Apply only in water! Visual leaf tip burn and minor chlorosis is expected. Ideally, Fierce is activated after wheat is up but before weed emergence. No rotational concern following wheat with cotton, peanut, soybean or corn. **To minimize resistance:** *If treating a field with <u>either</u> Zidua or Fierce this year, do not apply either product on that field next year.*

Weeds Controlled	Herbicide, Formulation, and Mode of Action Categlory[1]	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
POSTEMERGENCE				
Non-resistant annual ryegrass	diclofop-methyl (Hoelon) 3 EC MOA 1	1.33 to 2.67 pt	0.5 to 1.0	Product availability is a concern. Apply before wheat joints; 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. Do not mix with other herbicides or nitrogen.
Common chickweed, C. geranium, henbit, horseweed, soybean, small wild radish	halauxifen-methyl + florasulam (Quelex) 0.2 WG MOA 4 + 2	0.75 oz	0.0048 + 0.0047	Apply to wheat between 2-leaf and flag leaf. Weeds should be less than 4”. Weeds stressed from cold or drought may not be controlled. Include crop oil concentrate (0.5 to 1% v/v). See label regarding mixing with liquid nitrogen. Rotation of 3 months for cotton, corn, and soybean and 9 months for peanut. UGA research shows excellent control of small radish but less effective on larger plants.
Non-resistant 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 wheat between emergence and jointing to control ryegrass with less than 2 tillers. 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/A. 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 with Harmony Extra. Cotton/soybean can be planted 90 day after application. **To minimize resistance:** *If treating a field with either Osprey or PowerFlex this year, do not apply either product on that field next year.*
Non-resistant emerged annual ryegrass	pinoxaden (Axial XL) 0.42 EC MOA 1	16.4 fl oz	0.054	Apply to wheat between 2 leaf and pre-boot to control ryegrass with less than 2 tillers. No adjuvant required. May 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 later. **To minimize resistance:** *If treating a field with either Axial or Hoelon this year, do not apply either product on that field next year.*
Non-resistant emerged annual ryegrass	pinoxaden + fenoxaprop-p-ethyl (Axial Bold) 0.685 EC MOA 1 + 1	15 fl oz	0.054 + 0.027	Apply to wheat between emergence and pre-boot to control ryegrass with less than 2 tillers. No adjuvant mentioned on label. May 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. One application per crop and any crop can be planted 90 days later. **To minimize resistance:** *If treating a field with either Axial or Hoelon this year, do not apply either product on that field next year.*
Non-resistant annual ryegrass, also very effective on wild radish and several other broadleaf weeds	pyroxsulam (PowerFlex HL) 13.13 WDG MOA 2	2.0 oz	0.0164	Apply to wheat between 3 leaf and jointing to control ryegrass with less than 2 tillers. Add crop oil concentrate at 1 to 1.25 % v/v. May tank mix with Harmony Extra. 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 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 April assuming application was made before February. ***Ryegrass resistant to Osprey or PowerFlex is* common.** **Minimize resistance:** *Apply either Osprey or PowerFlex only once on the same field over a two year period.*

Weeds Controlled	Herbicide, Formulation, and Mode of Action Categlory[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 H20) 3.8 AS MOA 3	1.5 to 2.5 pt	0.71 to 1.19	Apply to wheat between 1 leaf and flag leaf. Prowl does not control emerged weeds. May tank mix with any postemergence herbicide labeled for use in wheat. *Zidua is more effective on ryegrass.*
Wild garlic, curly dock, and most winter annual broadleaf weeds except wild radish should be less than 1"	thifensulfuron-methyl + tribenuron-methyl (Harmony Extra SG with TotalSol) 50 SG (Harmony Extra, Nimble, others) 75 WDG MOA 2 + 2	 0.45 to 0.9 oz 0.3 to 0.6 oz	0.0094 to 0.0187 + 0.0047 to 0.0094	Apply to wheat between 2 leaf and flag leaf. Most annuals can be controlled with 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 to non-stressed weeds with less than 4 leaves when temperatures are above 50 F. 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 wild radish,** tank mix with MCPA or 2,4-D at 0.375 to 0.5 lb ai/A (12-16 oz/A of 3.8 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 growth restrictions for 2,4-D or MCPA.
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 to wheat between 2 leaf and flag leaf. Add 1 qt of nonionic surfactant per 100 gal of spray solution. Suggest mixtures with 0.375 to 0.5 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, knawl, red sorrel, and geranium	2,4-D amine (various brands) 3.8 L 2,4-D ester (various brands) 3.8 L 2,4-D ester (various brands) 5.7 L 2,4-D acid/ester (Weedone 638) 2.8 L MOA 4	 1.0 to 1.25 pt 1.0 to 1.25 pt 0.67 to 0.84 pt 1.0 to 1.25 pt	0.48 to 0.6 0.48 to 0.6 0.48 to 0.6 0.35 to 0.43	Apply to fully tillered wheat only. 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.*** **STRONLY suggest mixtures with Harmony Extra, see above.** One in-season application only.
	MCPA (various brands) 4.0 L (various brands) 3.7 L MOA 4	 0.75 to 1.25 pt 0.75 to 1.25 pt	 0.375 to 0.625 0.347 to 0.58	Apply to wheat with at least 2 tillers but before jointing. Consider 12 to 16 oz/A when wheat has at least 2 tillers and 16 to 20 oz/A when wheat is fully tillered. Safer on wheat than 2,4-D; slightly less effective on large weeds when applied alone. Amine formulation suggested to help minimize drift. No spray additive required. **STRONLGY suggest mixtures with Harmony Extra, see above.**

Weeds Controlled	Herbicide, Formulation, and Mode of Action Categlory[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	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	 2.6 pt 2 pt 1.6 pt 22 fl oz 20 fl oz	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	2,4-D amine (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 for reduced volatility and off-target movement. Pre-harvest interval of 14 days required.

[1]Mode 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.

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.

Table 15. Forage, Feed, and Grazing Restrictions for Wheat Herbicides.	
Trade Name	**Restrictions** (see label of product used as label restrictions vary by product)
Axial XL	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.
Axial Bold	Do not harvest grain or feed straw to livestock for at least 70 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.
Quelex	Do not apply closer than 21 days before cutting of hay. Do not allow livestock to graze on treated crops for 7 days following application. Do not compost any plant material from treated area.
RU PowerMax	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.

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 invert 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 complete destroy a seedling stand of cereal grains. Field should be scouting 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 sample 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 16). 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 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 16. 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/head to include flag
Hessian fly	Vegetative plants – tillers stunted dark green, tiller death; Jointed stems – 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/2 plants Spring: 1 adult/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 appears 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.

Disease Management in Wheat

Alfredo 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 17). 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.

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). While the incidence and severity of FHB (Fusarium Head Blight) was low in 2018. FHB incidence and severity has been high throughout the state from 2014 to 2017.

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 17. Optimum temperature and moisture for the major diseases affecting wheat grown in GA

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 18).

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 18).

Table 18. Seed Treatment Fungicides for Control of Seedborne and Soilborne Diseases of Wheat

FUNGICIDE	CROP	RATE/100 LB SEED	REMARKS AND PRECAUTIONS
azoxystrobin Dynasty	Wheat and Barley	0.153-0.882 fl oz	For protection against common bunt and partial control of dwarf bunt. Where appropriate use in combination with Dividend extreme
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 + ipconazole Rancona V100	Wheat, Barley, Oats, Rye	0.9 -1.5 fl oz	For control of seedborne and soilborne fungi
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.
ipconazole + metalaxyl Rancona Pinnacle	Wheat, Barley, Oats, Rye	5.0 – 8.33 fl oz	Controls seed rot, damping off seed and soil borne fungi, loose smut, common and kernel bunt,
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 Sebring Dyna-shield Belmont	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 *Rhizoctonia solani*
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 *Fusarium* spp or *Rhizoctonia* spp, Seedling blight and root rot and damping-off caused by *Pythium* spp, seed borne *Septoria*, 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 *Fusarium* spp or *Rhizoctonia* spp, Seedling blight and root rot and damping-off caused by *Pythium* spp, seed borne *Septoria*, 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 (Imidaclorpid + metalaxyl + tebuconazole), Rancona Crest (ipconazole + metalaxyl + imidacloprid). 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*. 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). While the incidence and severity of the infections of Fusarium head blight in 2018 were low due to weather patterns, high incidence and severity causing severe losses were registered in in previous years in Georgia. 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.wheatscab.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 19). 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 19. 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 QuiltxXcel 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 oa /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
	azoxystrobin + flutriafol Topguard EQ	4.0-7.0 fl oz	Apply preventatively or when conditions are favorable for disease development. Repeat as necessary if conditions are favorable for disease development. Do not apply past Feekes 10.54..An adjuvant may be added at recommended rates.	3+11	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 possibly illegal residues.	7+11+3	12 hrs
	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 appli-cations of Nexicor prior to disease development. To maximize yield potential it is important to protect the flag leaf. Apply Nexico**r** 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 make more than two sequential applications. Apply prior to disease development from Feekes 5 (Zadok's 31) up	11	12 hrs

			to late head emergence at Feekes 10.5 (Zadok's 59)		
	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 rst application at approximately Feekes growth stage 5 (Zadoks 31) (shooting- pseudostem erected) and a second application no later than Feekes growth stage 10 5 (Zadoks 54) (heading completed)	11 + 3	12 hrs
	fluoxastrobin + flutriafol Fortix Preemtor SC	2-3 fl oz. 4-6 fl oz	For early season control Apply Fortix when flag leaf is 50% to fully emerged. Apply preventative 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 Aproach	3-4 fl oz 6-12 fl oz	For early season preventive disease control. Begin applications of Aproach 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 Aproach Prima	3.4 fl oz 3.4 -6.8 fl oz	For early season preventive disease control. Begin applications of Aproach-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 made per year.	3	12 hrs
	prothiconazole + tebuconazole Prosaro	6.5 - 8.2 fl. oz.	Begin applications of Prosaro preventively 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 Stratego YLD Delaro 325 SC	4 fl oz 8.0 fl oz	Begin applications preventively when conditions are favorable for disease 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	3+11	12 hrs
	pydiflumetofen propiconazole Miravis Ace	13.7 fl oz	Protecting flag leaf is important for maximizing the potential yield	7 + 3	12 hrs
	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 Absolute Maxx	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 20. 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
Pydiflumetofen 13.7% Propiconazole 11.4%	Miravis Ace SE	13.7	G	Feekes 10.5.4

Efficacy categories; P = Poor, F = Fair, 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. Strobilurin fungicides can increase the DON content of FHB infected grain.** * A maximum of floz of tebuconazole containing products may be applied per acre per crop season.

Table modified from 2018 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.**

Management of Small Grain Diseases
Fungicide Efficacy for Control of Wheat Diseases-2020

The North Central Regional Committee on Management of Small Grain Diseases (NCERA-184) has developed the following information on fungicide efficacy for control of certain foliar diseases of wheat for use by the grain production industry in the U.S. Efficacy ratings for each fungicide listed in the table were determined by field testing the materials over multiple years and locations by the members of the committee. Efficacy is based on proper application timing to achieve optimum effectiveness of the fungicide as determined by labeled instructions and overall level of disease in the field at the time of application. Differences in efficacy among fungicide products were determined by direct comparisons among products in field tests and are based on a single application of the labeled rate as listed in the table. Table includes most widely marketed products, and is not intended to be a list of all labeled products.

Fungicide(s)												
Class	**Active ingredient**	**Product**	**Rate/A (fl. oz)**	**Powdery mildew**	**Stagonospora leaf/glume blotch**	**Septoria leaf blotch**	**Tan spot**	**Stripe rust**	**Leaf rust**	**Stem rust**	**Head scab[4]**	**Harvest Restriction**
Strobilurin	**Picoxystrobin 22.5%**	**Aproach SC**	**6.0 – 12.0**	G[1]	VG	VG[2]	VG	E[3]	VG	VG	NL	Feekes 10.5
	Pyraclostrobin 23.6%	**Headline SC**	**6.0 - 9.0**	G	VG	VG[2]	E	E[3]	E	G	NL	Feekes 10.5
Triazole	**Metconazole 8.6%**	**Caramba 0.75 SL**	**10.0 - 17.0**	VG	VG	--	VG	E	E	E	G	30 days
	Tebuconazole 38.7%	**Folicur 3.6 F[5]**	**4.0**	NL	NL	NL	NL	E	E	E	F	30 days
	Prothioconazole 41%	**Proline 480 SC**	**5.0 - 5.7**	--	VG	VG	VG	VG	VG	VG	G	30 days
	Prothioconazole19% Tebuconazole 19%	**Prosaro 421 SC**	**6.5 - 8.2**	G	VG	VG	VG	E	E	E	G	30 days
	Propiconazole 41.8%	**Tilt 3.6 EC[5]**	**4.0**	VG	VG	VG	VG	VG	VG	VG	P	Feekes 10.5.4
Mixed modes of action[6]	**Tebuconazole 22.6% Trifloxystrobin 22.6%**	**Absolute Maxx SC**	**5.0**	G	VG	VG	VG	VG	E	VG	NL	35 days
	Cyproconazole 7.17% Picoxystrobin 17.94%	**Aproach Prima SC**	**3.4 - 6.8**	VG	VG	VG	VG	E	VG	--	NR	45 days
	Prothioconazole 16.0% Trifloxystrobin 13.7%	**Delaro 325 SC**	**8.0**	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 35 days
	Pydiflumetofen 13.7% Propiconazole 11.4%	**Miravis Ace SE**	**13.7**	VG	VG	VG	VG	VG	VG	VG	G[7]	Feekes 10.5.4
	Fluxapyroxad 2.8% Pyraclostrobin 18.7% Propiconazole 11.7%	**Nexicor EC**	**7.0 - 13.0**	VG	VG	E	E	E	E	VG	NL	Feekes 10.5
	Fluoxastrobin 14.8% Flutriafol 19.3%	**Preemptor SC**	**4.0 - 6.0**	--	--	VG	VG	E	VG	--	NL	Feekes 10.5 and 40 days
	Fluxapyroxad 14.3% Pyraclostrobin 28.6%	**Priaxor**	**4.0 - 8.0**	G	VG	VG	E	VG	VG	G	NL	Feekes 10.5
	Propiconazole 11.7% Azoxystrobin 13.5%	**Quilt Xcel 2.2 SE[5]**	**10.5 - 14.0**	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5.4
	Prothioconazole 10.8% Trifloxystrobin 32.3%	**Stratego YLD**	**4.0**	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 35 days
	Benzovindiflupyr 2.9% Propiconazole 11.9% Azoxystrobin 10.5%	**Trivapro SE**	**9.4 - 13.7**	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5.4

	Flutriafol 18.63% Azoxystrobin 25.30%	**Topguard EQ**	**4.0-7.0**	VG	NL	VG	VG	E	E	VG	NL	Feekes 10.5.4 30 days

[1]Efficacy categories: NL=Not Labeled; NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent; -- = Insufficient data to make statement about efficacy of this product.

[2] Product efficacy may be reduced in areas with fungal populations that are resistant to strobilurin fungicides.

[3]Efficacy may be significantly reduced if solo strobilurin products are applied after stripe rust infection has occurred.

[4]Application of products containing strobilurin fungicides may result in elevated levels of the mycotoxin Deoxynivalenol (DON) in grain damaged by head scab.

[5]Multiple generic products containing the same active ingredients also may be labeled in some states.

[6]Products with mixed modes of action generally combine triazole and strobilurin active ingredients. Miravis Ace, Nexicor, Priaxor, and Trivapro include carboxamide active ingredients.

[7]Based on application timing at the beginning of anthesis (Feekes 10.5.1).

2020-2021 Wheat Production Budgets

Amanda R. Smith

WHEAT FOR GRAIN, CONVENTIONAL
GEORGIA, 2020/21

Estimated Costs and Returns

Expected Yield: **55** bushel Your Yield ____________

Variable Costs	Unit	Amount	$/Unit	Cost/Acre	$/bushel	Your Farm
Seed	pounds	90	$ 0.37	$ 33.30	$ 0.61	______
Lime	ton	0.25	$ 45.00	$ 11.25	$ 0.20	______
Fertilizer						
Nitrogen	pounds	80	$ 0.40	$ 32.00	$ 0.58	______
Phosphate	pounds	40	$ 0.35	$ 14.00	$ 0.25	______
Potash	pounds	40	$ 0.30	$ 12.00	$ 0.22	______
Weed Control	acre	1	$ 12.85	$ 12.85	$ 0.23	______
Insect Control	acre	1	$ 2.18	$ 2.18	$ 0.04	______
Disease Control	acre	1	$ 4.20	$ 4.20	$ 0.08	______
Preharvest Machinery						
Fuel	gallon	3.7	$ 2.00	$ 7.37	$ 0.13	______
Repairs and Maintenance	acre	1	$ 8.40	$ 8.40	$ 0.15	______
Harvest Machinery						
Fuel	gallon	3.0	$ 2.00	$ 6.06	$ 0.11	______
Repairs and Maintenance	acre	1	$ 5.62	$ 5.62	$ 0.10	______
Labor	hours	0.7	$ 13.50	$ 10.07	$ 0.18	______
Irrigation*	applications		$ 8.00	$ -	$ -	______
Crop Insurance	acre	1	$ 12.00	$ 12.00	$ 0.22	______
Land Rent	acre	1	$ -	$ -	$ -	______
Interest on Operating Capital	percent	$ 85.65	6.00%	$ 5.14	$ 0.09	______
Drying - 2 Points	bushel	60	$ 0.09	$ 5.43	$ 0.10	______
Total Variable Costs:				**$ 181.87**	**$ 3.31**	
Fixed Costs						
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery	acre	1	$ 22.98	$ 22.98	$ 0.42	______
Harvest Machinery	acre	1	$ 26.47	$ 26.47	$ 0.48	______
Irrigation	acre	0	$ 130.00	$ -	$ -	______
General Overhead	% of VC	$ 181.87	5%	$ 9.09	$ 0.17	______
Management	% of VC	$ 181.87	5%	$ 9.09	$ 0.17	______
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	______
Other ______________	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 67.64**	**$ 1.23**	
Total Costs Excluding Land				**$ 249.51**	**$ 4.54**	
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/appl when diesel costs $2/gal.

Sensitivity Analysis of WHEAT FOR GRAIN, CONVENTIONAL

Net Returns Above Variable Costs Per Acre

Varying Prices and Yields (bushel)

	-25%	-10%	Expected	+10%	+25%
Price \ bushel/Acre	41	50	55	61	69
$4.00	**-$16.87**	**$16.13**	**$38.13**	**$60.13**	**$93.13**
$4.25	**-$6.56**	**$28.50**	**$51.88**	**$75.25**	**$110.32**
$4.50	**$3.75**	**$40.88**	**$65.63**	**$90.38**	**$127.50**
$4.75	**$14.07**	**$53.25**	**$79.38**	**$105.50**	**$144.69**
$5.00	**$24.38**	**$65.63**	**$93.13**	**$120.63**	**$161.88**
$5.25	**$34.69**	**$78.00**	**$106.88**	**$135.75**	**$179.07**
$5.50	**$45.00**	**$90.38**	**$120.63**	**$150.88**	**$196.25**

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) MFWD 190	16.3	1	0.08	0.60	$ 1.77	$ 5.13
Chisel Plow-Rigid 24' with Tractor (180-199 hp) MFWD 190	13.0	1	0.10	0.75	$ 1.29	$ 3.62
Grain Drill 15' with Tractor (180-199 hp) MFWD 190	8.0	1	0.16	1.23	$ 3.11	$ 8.74
Spray (Broadcast) 60' with Tractor (180-199 hp) MFWD 190	35.5	4	0.14	1.10	$ 2.24	$ 5.49
Total Preharvest Values			0.47	3.69	$ 8.40	$ 22.98

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	$ 3.79	$ 21.43
Grain Cart Wht/Sor 500 bu with Tractor (180-199 hp) MFWD 190	10.6	1	0.12	0.92	$ 1.83	$ 5.04
Total Harvest Values			0.28	3.03	$ 5.62	$ 26.47

** 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.

WHEAT FOR GRAIN, INTENSIVE MANAGEMENT
GEORGIA, 2020/21
Estimated Costs and Returns

Expected Yield: **75** bushel Your Yield ____________

Variable Costs	Unit	Amount	$/Unit	Cost/Acre	$/bushel	Your Farm
Treated Seed	pounds	125	$ 0.47	$ 58.75	$ 0.78	______
Lime	ton	0.25	$ 45.00	$ 11.25	$ 0.15	______
Fertilizer						
Nitrogen	pounds	120	$ 0.40	$ 48.00	$ 0.64	______
Phosphate	pounds	50	$ 0.35	$ 17.50	$ 0.23	______
Potash	pounds	60	$ 0.30	$ 18.00	$ 0.24	______
Weed Control	acre	1	$ 35.42	$ 35.42	$ 0.47	______
Insect Control	acre	1	$ 2.18	$ 2.18	$ 0.03	______
Disease Control**	acre	1	$ 7.80	$ 7.80	$ 0.10	______
Preharvest Machinery						
Fuel	gallon	8.0	$ 2.00	$ 16.02	$ 0.21	______
Repairs and Maintenance	acre	1	$ 16.96	$ 16.96	$ 0.23	______
Harvest Machinery						
Fuel	gallon	3.0	$ 2.00	$ 6.06	$ 0.08	______
Repairs and Maintenance	acre	1	$ 5.62	$ 5.62	$ 0.07	______
Labor	hours	1.3	$ 13.50	$ 17.54	$ 0.23	______
Irrigation*	applications		$ 8.00	$ -	$ -	______
Crop Insurance	acre	1	$ 11.00	$ 11.00	$ 0.15	______
Land Rent	acre	1	$ -	$ -	$ -	______
Interest on Operating Capital	percent	$ 136.05	6.00%	$ 8.16	$ 0.11	______
Drying - 2 Points	bushel	82	$ 0.09	$ 7.41	$ 0.10	
Total Variable Costs:				**$ 287.66**	**$ 3.84**	

Fixed Costs	Unit	Amount	$/Unit	Cost/Acre	$/bushel	Your Farm
Machinery Depreciation, Taxes, Insurance and Housing						
Preharvest Machinery	acre	1	$ 48.55	$ 48.55	$ 0.65	______
Harvest Machinery	acre	1	$ 26.47	$ 26.47	$ 0.35	______
Irrigation	acre	1	$ 130.00	$ 130.00	$ 1.73	______
General Overhead	% of VC	$ 287.66	5%	$ 14.38	$ 0.19	______
Management	% of VC	$ 287.66	5%	$ 14.38	$ 0.19	______
Owned Land Cost, Taxes, Cash Payment, etc.	acre	1	$ -	$ -	$ -	______
Other ______________	acre	1	$ -	$ -	$ -	
Total Fixed Costs				**$ 233.79**	**$ 3.12**	
Total Costs Excluding Land				**$ 521.45**	**$ 6.95**	
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/appl when diesel costs $2/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

Net Returns Above Variable Costs Per Acre

Varying Prices and Yields (bushel)

	-25%	-10%	Expected	+10%	+25%
Price \ bushel/Acre	56	68	75	83	94
$4.00	**-$62.66**	**-$17.66**	**$12.34**	**$42.34**	**$87.34**
$4.25	**-$48.60**	**-$0.79**	**$31.09**	**$62.96**	**$110.77**
$4.50	**-$34.54**	**$16.09**	**$49.84**	**$83.59**	**$134.21**
$4.75	**-$20.48**	**$32.96**	**$68.59**	**$104.21**	**$157.65**
$5.00	**-$6.41**	**$49.84**	**$87.34**	**$124.84**	**$181.09**
$5.25	**$7.65**	**$66.71**	**$106.09**	**$145.46**	**$204.52**
$5.50	**$21.71**	**$83.59**	**$124.84**	**$166.09**	**$227.96**

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) MFWD 190	2.3	1	0.54	4.20	$ 7.52	$ 22.68
Disk Harrow 32' with Tractor (180-199 hp) MFWD 190	16.3	2	0.15	1.20	$ 3.54	$ 10.26
Grain Drill 15' with Tractor (180-199 hp) MFWD 190	8.0	1	0.16	1.23	$ 3.11	$ 8.74
Spray (Broadcast) 60' with Tractor (180-199 hp) MFWD 190	35.5	5	0.18	1.38	$ 2.79	$ 6.87
Total Preharvest Values			1.02	8.01	$ 16.96	$ 48.55

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	$ 3.79	$ 21.43
Grain Cart Wht/Sor 500 bu with Tractor (180-199 hp) MFWD 190	10.6	1	0.12	0.92	$ 1.83	$ 5.04
Total Harvest Values			0.28	3.03	$ 5.62	$ 26.47

** 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.