2013 - 2014 WHEAT PRODUCTION GUIDE

The University of Georgia

College of Agricultural and Environmental Sciences
Cooperative Extension Service

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2013-14 WHEAT MARKET SITUATION AND OUTLOOK

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Overview

Georgia harvested the same acres as last year but wheat production dropped compared to 2012 due to lower yields. Planted acreage rose 30,000 to 280,000 acres but a lower percentage was carried to harvest for grain. The average yield for Georgia was pegged at 44 bushels per acre, down 20% from 2011. Wheat prices dropping to below $6 per bushel discouraged more production as well as increasing costs.

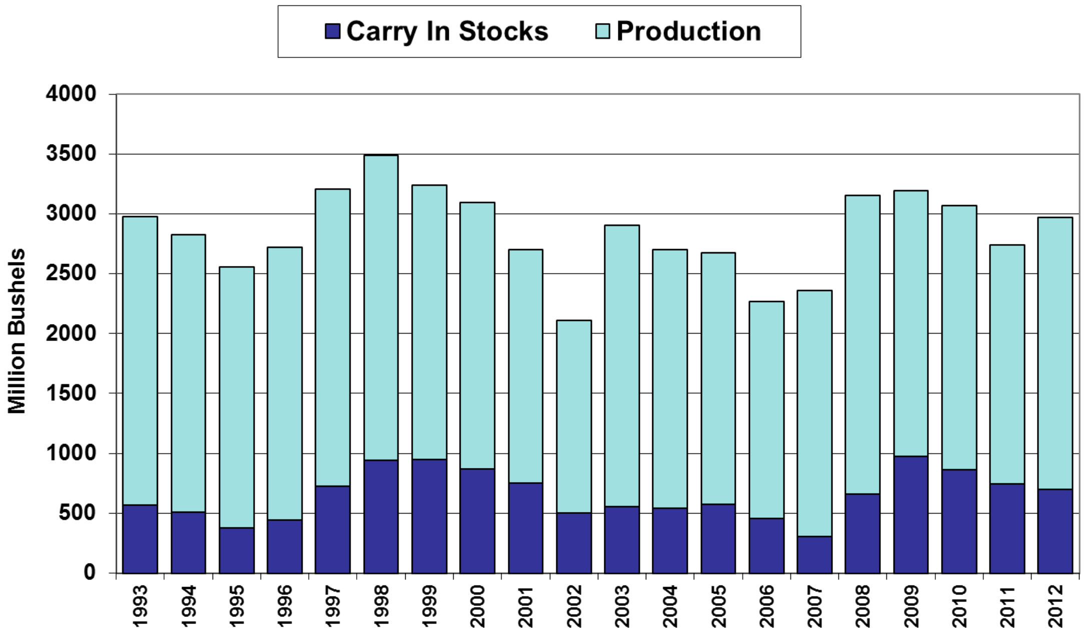
Total U.S. soft red winter (SRW) wheat production is lower in 2012 as both planted and harvested areas and yield are lower. Planted and harvested area for 2012 was down 3% while yield was down 1.2 bushels to 60.5 bushels per acre. Overall U.S. wheat production (all wheat types) is forecasted up 11.3%. Planted acreage rose 3% to 56 million and harvested acreage increased 6% to 48.8 million acres. The average U.S. yield for all wheat is forecast up 2.75 bushels to 46.6 bushels per acre. Prices were down over much of the year past until corn and soybeans price jumped and production problems surfaced in global exporting regions. Soft red winter wheat prices ranged between $5.25 and $6.00 during October 2011 after trading at $7 during harvest. Prices began a sharp run-up in mid-June breaking $8 in July. Prices appear stable as the price ratio of corn and wheat is returning to traditional relationship. Fundamentals are not bullish going into planting for 2012, however concern for global exports and moisture for winter seeding in the U.S. are supporting prices. Planting should increase over last year and particularly harvested acreage in Georgia.

Supply

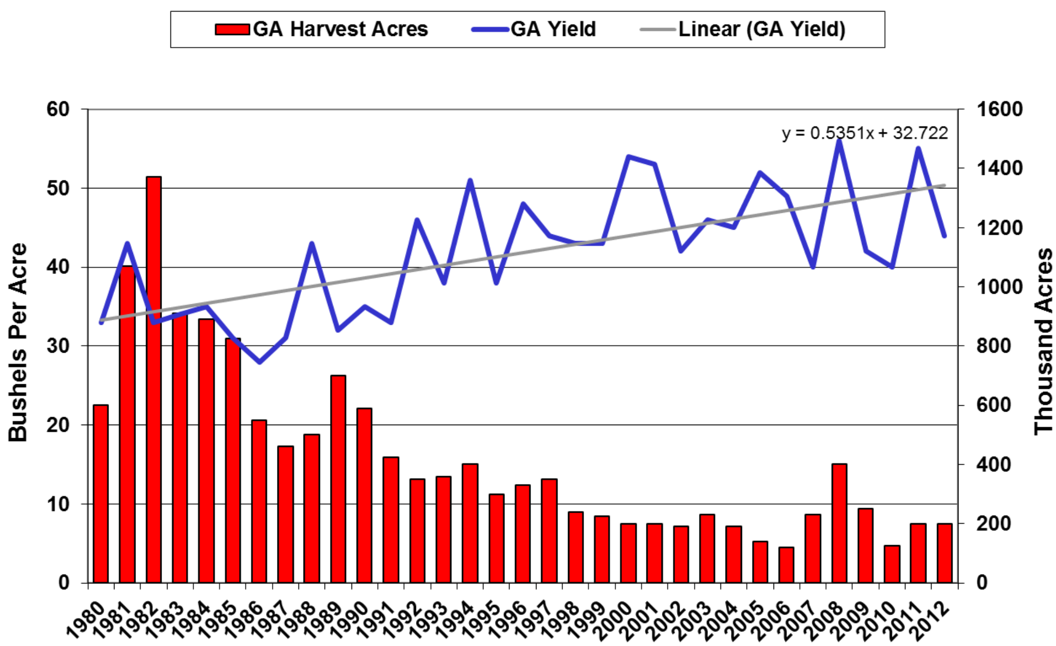
Total production for all wheat for 2012 is projected up 13.6% from last year at 2.27 million bushels. Soft red winter and white were decreased in size while hard red winter, hard red winter and durum jumped prior year’s poor yields. Hard red winter wheat is up 13.4%, hard red spring is up 18.2%, and durum is up 6%. Soft red winter is the third largest contributor to total production at 435 million bushels, nearly equaling hard red spring. The overall yield for wheat is up in 2012 at 46.5 bushels even with a decline in soft red winter wheat of 5% to 60.5 bushels per acre. For Georgia, planted acres were up 30,000 to 280,000 with 200,000 estimated harvested for a 44 bushel average yield. The trend yield for 2012 would be 51 bushels per acre. Georgia typically harvests 65% of wheat plantings for grain.

Total production of soft red winter is projected fall short of use shrinking ending stocks to 159 million bushels. Total supply including beginning stocks of 185 million bushels from 2012 starts out at 660 million bushels, same as last year. Total use is projected to increase 5% from 475 million in 2011/12 to 500 million in 2012/13. Domestic use and feed and residual use are projected to remain the same at 311 million and 140 million bushels respectively. Growth in exports by 25 million will push total use up. High corn prices don’t appear to have pushed feed use higher than previous year unless estimates are revised later in grain stocks report.

U.S.WHEAT - TOTAL SUPPLY



GA. WHEAT - HARVESTED ACRES & PRODUCTION



2013 Georgia Trend Yield = 50.9 bu./ac.

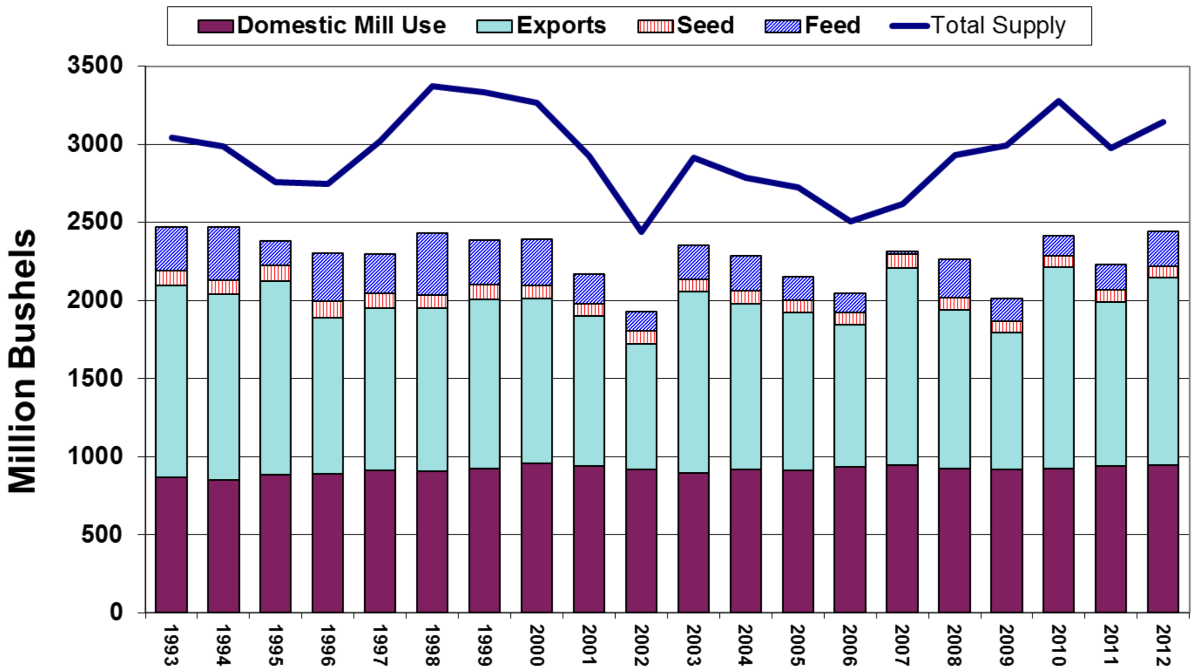
World wheat production is projected down over last year by 5% or 36 million metric tons to 659 million. Major wheat exporting countries have experienced shortfalls leading to a drop in the export trade. Export trade is expected to fall to 135 million metric tons with the U.S. capturing some of the market share as a result. The Former Soviet Union production is down according the USDA by 4.0 million tons with lower reported area and reduced yields due to additional drought and heat damage at harvest for both winter and spring wheat crops in the FSU. In addition to the FSU, Argentina (-23%), Australia (-12%), and the EU-27 (-3.3%) are having short production years. The FSU, Australia and EU-27 are the largest exporters of the ones experiencing production problems.

As a result of reduced supplies global wheat consumption for 2012/13 is lowered 14 million tons to 680 million. Imports are reduced12 million tons to 135 million. Ending stocks will fall to make up for the shortage to 177 million tons. As long as corn and soybean prices remain strong, there will be concern with wheat production so prices should remain strong for winter planting to keep acreage in wheat and alleviate the threat of greater shortage of wheat globally down the road.

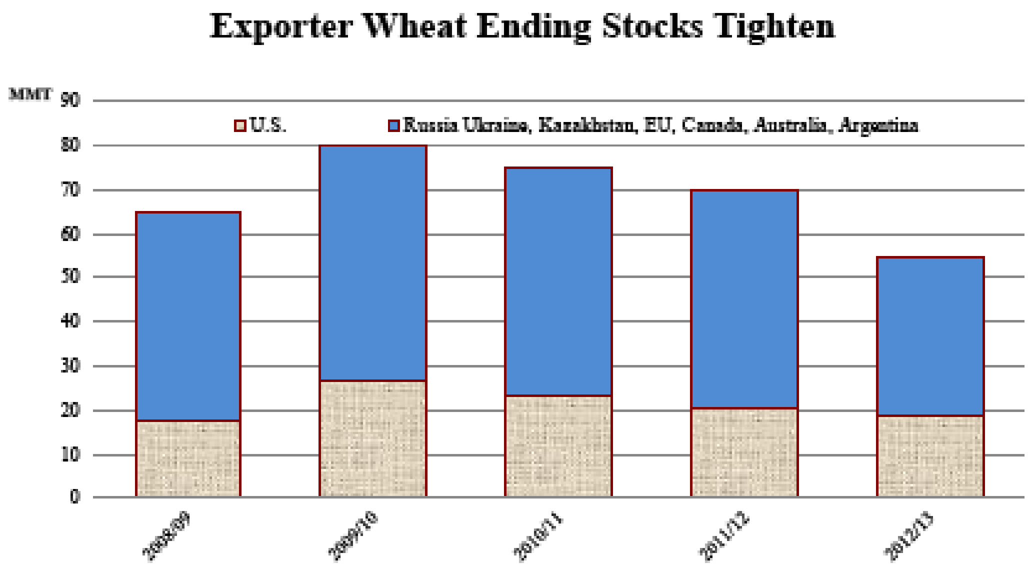
Disappearance

Total U.S. disappearance of wheat in 2011/12 fell to 2.23 million bushels in response to smaller crop and drop in exports with increased production in exporting nations other than the U.S. Total domestic food use rose to 926 million bushels, an increase of 1%. For 2012/13, the trend is forecast to reverse. Food use is expected to grow to 950 million bushels representing 76% of domestic use and 39% of total use. Feed use is forecast to jump to 220 million bushels, having substituted for corn in rations. This figure could grow more with higher corn prices. Exports will increase with a weaker dollar and a 7% drop in exporter nation production. The U.S. is expected to export 1.2 billion bushels.

U.S. Wheat Use



Domestic Mill Use
Exports
Seed
Feed
Total Supply
Million Bushels
3500
3000
2500
2000
1500
1000
500
0
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012

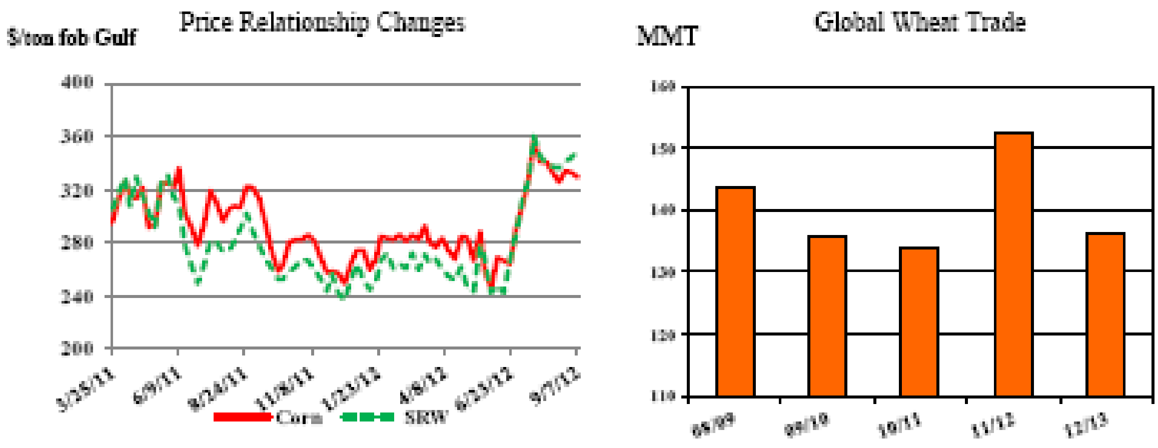


Source: FAS USDA Grain: World Markets and Trade, Circular Series, September 2012

Price Projections

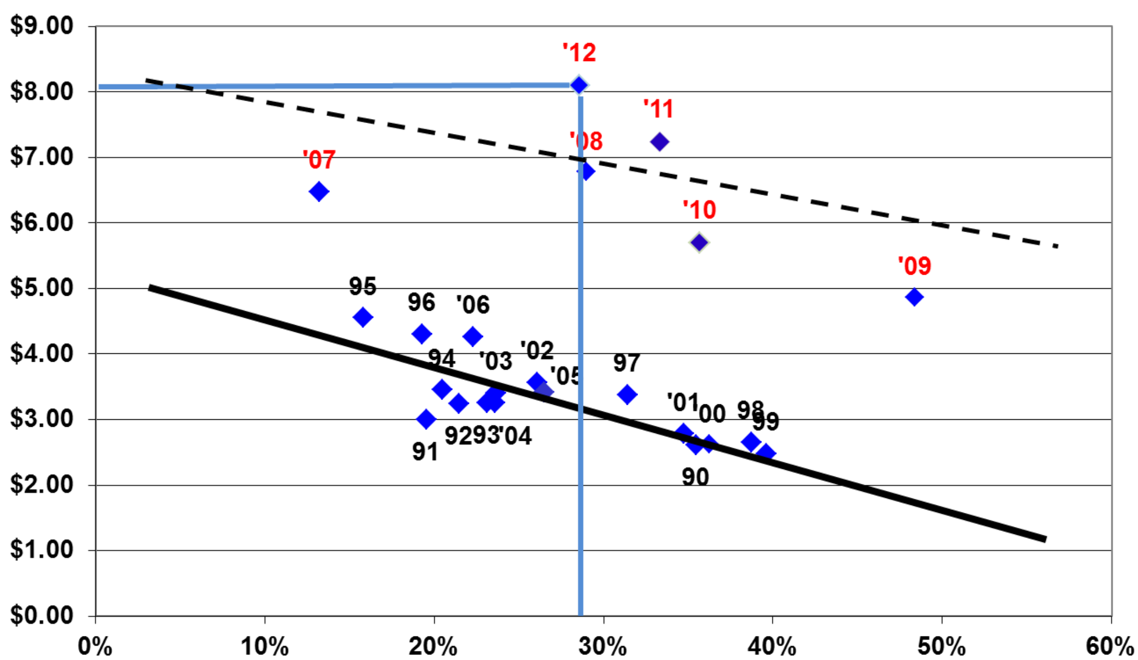
Local mills in Georgia and neighboring states are the main source of mill demand for Georgia wheat. Mill demand does not fluctuate as much as exports but the domestic mill use is also limited. Thus, exports can have a large influence on year-to-year price of soft red winter wheat. When exports are down, basis widens and prices fall in Georgia. Prices at planting will be much better for growers than last couple years. Basis has improved bid at 50-60 cents under under Chicago July futures for 2013. Contract prices will likely be around $8 per bushel. Corn and soybean prices have probably peaked in early September unless harvest suprises analysts with bigger drop in yields. These will likely be moderated with more acres planted than previously reported. Fundamental supply and demand estimates indicate supplies should be adequate for the U.S., exports will be key. Strong prices and basis at planting indicate going ahead and pricing some of 2013 production. Acreage should increase in Georgia and other wheat producing areas. Given the outlook for supply and demand, some price protection should be considered through either contracting, futures or options. The price election for soft red winter wheat in Georgia is be around $8.55 per bushel giving growers the opportunity to protect production costs and a higher level of revenue than in the past. Premiums will be higher but price risk protection can be purchased in the form of revenue insurance which allows you to go ahead and market some of the 2013 crop with confidence.

Wheat Prices Again Reflect Milling Value, Global Wheat Trade Drops with Less Wheat Feeding



Source: FAS USDA Grain: World Markets and Trade, Circular Series, September 2012

WHEAT PRICE vs STOCK-USE RATIO

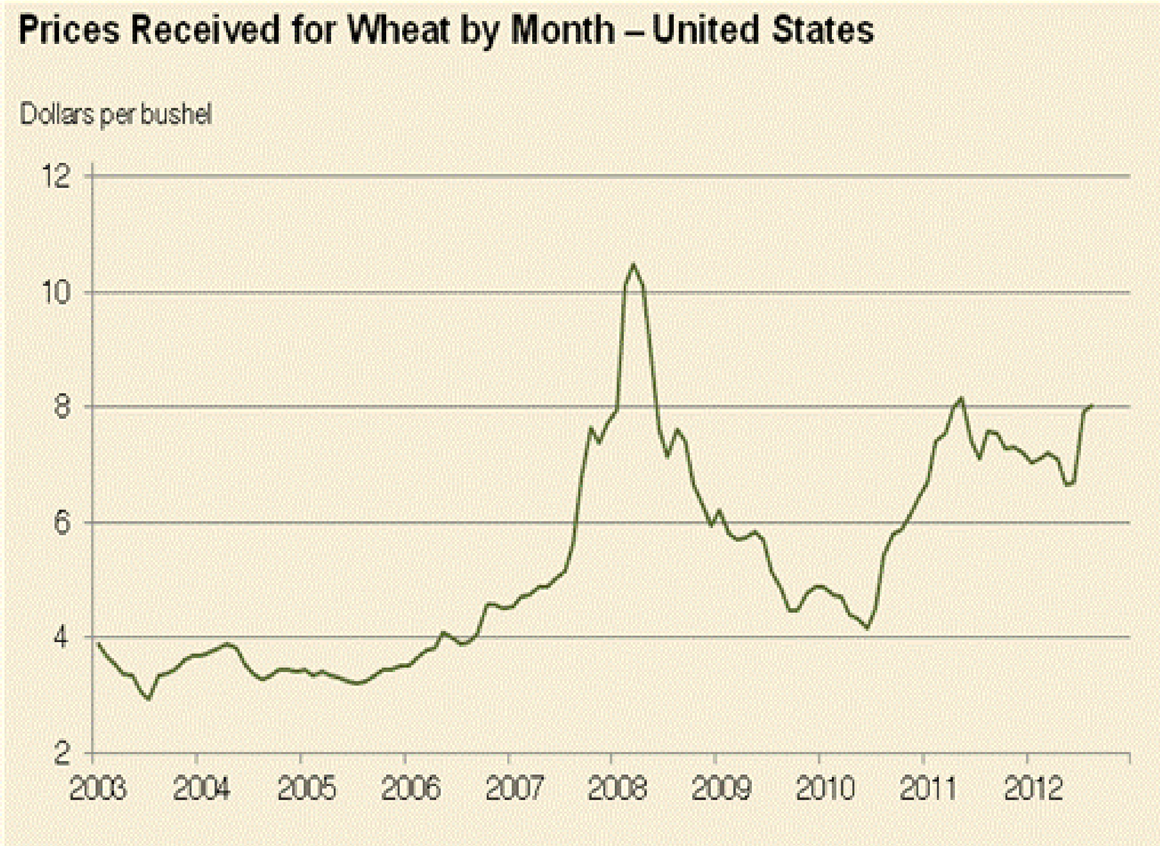


Outlook for the 2013 Crop Year

The U.S. wheat outlook depends on how well planting goes for winter wheat, particularly soil moisture in the drought stricken Midwest. There is an ample supply of U.S. wheat with export prospects improving due to drop in foreign production. Soft red winter wheat stocks are down but will grow in 2013 given normal yields and increased acreage in response to higher prices. However, relatively high corn and soybean prices will limit the increase of SRW acres (abandonment) come spring.

Cost of production is expected to increase attributed to all inputs. Opportunities to contract wheat for $8 per bushel should be available but done with protection. Revenue insurance should provide protection to contract early as the price election for yield and revenue protection is at least $8.50 per bushel for 2012 wheat. The deadline for signing up for crop insurance in September 30. Premiums will be higher due to the higher price but should represent 7-8 percent of the total revenue guarantee depending on coverage level chosen. Pricing a portion of expected wheat production for 2013 should also be considered with higher prices.

The bullish run in wheat prices should result in more acres of winter wheat planted. Georgia wheat growers are encouraged to watch for rallies during the seasonal period before planting. Spring rallies are also a time to watch due to corn and soybeans competing for spring acreage. Basis could improve between now and harvest, especially if futures prices begin to fall. Marketing is an important part of farming but it takes consistent monitoring of the market to take advantage of opportunities. In the long run, low cost producers will be successful in wheat production. Low cost producers are those who maximize yields while controlling costs. Knowing your costs and managing production are the key combination to profitable farming.



USDA – NASS
8/31/2012

Recommended Wheat Varieties for Fall Planting, 2013

One of the most important decisions that growers make in growing wheat is choosing the right variety or varieties to plant. Many differences exist among the varieties and therefore it is important to assess what characteristics are most important for their production area. Growers should choose several varieties to plant to reduce risk and improve their chances of success every season. The following information is provided to understand the differences in each of the varieties that are recommended in Georgia. Table 1-4 are included to provide comparative information on wheat.

AGS 2060 is one of a handful of early maturing varieties with excellent yield potential. It has very good leaf and stripe rust resistance and very good Hessian fly resistance and test weight but is susceptible to powdery mildew. It has a short vernalization requirement and matures earlier than most. It will lodge with high N rates.

AGS 2026 is marketed by AGS and is recommended statewide. While this variety lodges with high N rates, it is an excellent variety with very good disease resistance and Hessian fly resistance and excellent yield. In addition, it is one of a very few varieties with Biotype L Hessian fly resistance. It has good soil borne mosaic virus resistance. This variety requires more vernalization than other AGS lines.

AGS 2038 is a new high yielding variety that has excellent disease resistance and yield. It's straw strength is better than 2060 and 2026, but it is moderately resistant to Hessian fly.

AGS 2035 is a variety that was developed by the University of Georgia and has good leaf and stripe rust resistance, good test weight and yield, moderate Hessian fly resistance but is susceptible to powdery mildew. It is medium maturing with good soil borne virus resistance.

UniSouth Genetics (USG):

USG 3555 yields similar to AGS lines. It has a longer vernalization requirement than most. It is susceptible to leaf rust and hessian fly but has good yield and straw strength.

Dyna-Gro Seed:

Oglethorpe has above average yield in both north and south Georgia. It has good resistance to leaf and stripe rust but only fair tolerance to powdery mildew. This variety has Biotype L Hessian fly resistance. Care should be taken with nitrogen applications as it only has fair straw strength.

Baldwin has good Hessian fly resistance, good leaf and stripe rust resistance, good yield, test weight and soil borne virus resistance. It is moderately resistant to powdery mildew. It is medium late in maturity with a long vernalization requirement.

9171 is a shorter statured wheat with good disease resistance, but it is susceptible to hessian fly. Due to its longer vernalization requirement, it is recommended for the Piedmont and Mountain areas of Georgia.

Southern States Seeds:

Southern States (SS) 8641 is a good yielding wheat with excellent disease and Hessian fly resistance. It has good straw strength and test weight. It matures later than most varieties and should not be planted past the recommended planting window in Georgia.

Other varieties:

Fleming is the earliest maturing wheat in Georgia. It has very little vernalization requirement and, therefore, should be planted in the later ¼ portion of the recommended planting period. In late plantings in Georgia (after recommended planting periods), Fleming provides some of the highest yields of all the varieties tested. **Caution**: Fleming has a physiological spotting that is easily mistaken for leaf disease. All lesions should be carefully examined to make sure a proper diagnosis is made when considering a fungicide.

Jamestown is a variety with good yield but moderate susceptible to leaf rust, good resistance to powdery mildew and stripe rust. It is susceptible to Hessian fly. It is recommended that this variety be treated with an at-plant insecticide.

Roberts is one of the oldest public varieties still recommended however it is recommended for **forage production only.** It has good resistance to glume blotch but is susceptible to all other foliar diseases and requires a fungicide for adequate seed production. It is a late maturing variety that has a long vernalization requirement.

Terrall Seed:

LA754 is an early maturing wheat with a short vernalization requirement that has good leaf and rust stripe rust resistance. It is moderately resistant to hessian fly. It should be planted in the later portion of your recommended time period, for the Coastal Plains region.

TV8525, TV8535, TV8448, and TV8861 have vernalization requirements that are best suited for the Piedmont and Mountain areas of Georgia. Please see the variety characteristics for pest ratings.

Syngenta:

Arcadia is an early maturing, short vernalization wheat, that has good leaf rust resistance and good straw strength. It is susceptible to hessian fly, powdery mildew and stripe rust.

Table 1. Characteristics of Recommended Varieties of Wheat													
		Resistance											
Variety	Planting Area[1]	Leaf Rust	Stripe Rust	Glume Blotch	Powdery Mildew	BYD	SBWM	Hessian Fly	Test Weight	Maturity	Straw Strength	Vernal Req	Awned
AGS 2060	C	good	good	good	poor	fair	fair	good	good	early	fair	short	Yes
AGS 2026	S	good	good	good	good	fair	good	good	good	medium	fair	medium	No
AGS 2035	S	good	good	fair	fair	fair	good	good	good	medium	good	medium	Yes
AGS 2038	S	good	good	fair	good	fair	good	fair	good	medium late	good	medium	Yes
Arcadia	C	good	fair	fair	fair	fair	good	poor	good	medium	fair	short	Yes
Dyna-Gro Baldwin	S	good	good	good	fair	fair	good	fair	good	medium late	good	medium	Yes
Dyna-Gro 9171	P, M	good	good	good	fair	fair	good	poor	fair	late	good	long	Yes
SS 8641	S	good	good	fair	good	fair	good	good	good	medium	good	medium	No
LA754	C	good	good	fair	poor	fair	good	fair	good	early	good	short	Yes
Oglethorpe	S	good	good	good	fair	fair	good	good	good	medium	fair	short	No
Pioneer 26R10	P, M	fair	good	good	fair	fair	good	good	good	late	good	long	Yes
Roberts**	P, M	poor	poor	good	good	fair	good	poor	good	late	fair	medium long	No
Jamestown	S	poor	good	fair	good	fair	good	poor	good	medium	good	short	Yes
TV8525	P, M	good	good	good	fair	fair	good	poor	good	late	good	long	Yes
TV8535	P, M	good	good	good	fair	good	good	poor	fair	late	good	long	Yes
TV8848	P, M	good	good	good	fair	good	good	good	fair	late	good	long	Yes
TV8861	P, M	fair	good	good	good	fair	good	good	good	late	good	medium long	Yes
USG 3555	P, M	poor	good	fair	good	fair	good	poor	good	medium	good	medium long	No

**Recommended for use as forage only. 1. S=statewide, C=coastal plains only, P,M= piedmont and mountains

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

Table 2. Yield and test weights of certain varieties tested at Tifton, Plains and Midville, Georgia, 2013

	Tifton				Plains				Midville			
	3-Yr	2-Yr	2013		3-Yr	2-Yr	2013		3-Yr	2-Yr	2013	
Brand/Variety	**Avg**	**Avg**	**Yield**	**Test Wt.**	**Avg**	**Avg**	**Yield**	**Test Wt.**	**Avg**	**Avg**	**Yield**	**Test Wt.**
	------------bu/Ac-----------			---lb/bu---	------------bu/Ac--------------			---lb/bu---	----------bu/Ac-------------			---lb/bu---
AGS 2060	73.8	72.6	65.9	58.4	71.2	70.9	72.4	58.0	63.2	68.4	78.5	59.0
AGS 2026	83.2	78.8	81.8	59.0	79.1	73.0	76.7	55.1	62.8	66.2	82.1	56.0
AGS 2035	84.5	83.1	82.2	60.5	78.9	74.1	66.3	58.0	70.2	70.6	83.3	58.0
AGS 2038	80.3	79.6	82.3	60.3	77.1	73.9	72.2	57.2	73.1	78.4	89.9	57.8
Arcadia	75.5	73.4	72.1	52.7	71.3	66.8	66.7	57.4	68.4	72.8	77.7	58.5
Dyna-Gro Baldwin	75.0	74.7	77.1	61.1	71.3	66.4	72.2	56.1	73.6	76.8	85.5	57.3
SS 8641	82.0	80.8	81.3	58.8	83.6	84.2	98.7	57.7	----	----	----	----
LA754	78.5	74.9	69.2	59.8	77.4	77.0	83.0	56.8	67.8	68.7	83.9	55.7
Oglethorpe	84.3	81.1	84.9	59.4	81.3	76.9	82.0	55.1	54.3	58.9	69.4	55.2
Jamestown	85.2	86.3	96.6	61.0	78.6	75.5	81.5	58.8	70.7	75.3	80.0	59.7
Average												
LSD @ 10% Level	**4.4**	**5.6**	**9.8**[2]	**2.5**	**6.5**	**10.2**	**11.2**[3]	**1.6**	**5.4**	**7.3**	**9.8**[4]	**3.8**

2. C.V. = 11.8%, and df for EMS = 237
3. C.V. = 12.5%, and df for EMS = 237
4. C.V. = 11.2%, and df for EMS = 237
5. The F-test indicated no statistical difference at the alpha = 0.10 probability level; therefore, a LSD value was not calculated.

Table 3. Yield and test weights of certain varieties tested at Griffin and Calhoun, Georgia

	Griffin				Calhoun			
	3-Yr	2-Yr	2013		3-Yr	2-Yr	2013	
	Avg	Avg	Yield	Test Wt.	Avg	Avg	Yield	Test Wt.
AGS 2026	101.6	103.1	97.9	56.4	71.6	61.8	37.6	44.5
AGS 2035	98.6	95.4	87.8	58.5	67.8	59.0	29.5	44.4
AGS 2038	99.5	96.5	93.6	56.6	70.5	60.4	34.8	44.5
Dyna-Gro Baldwin	96.7	97.1	97.7	59.0	72.4	60.8	29.6	42.6
Dyna-Gro 9171	101.4	100.5	112.9	56.5	93.6	83.9	66.9	47.2
SS 8641	107.0	115.1	129.3	59.0	80.5	78.5	63.6	48.4
Oglethorpe	105.0	101.8	98.7	56.7	65.2	57.2	37.1	44.2
Pioneer 26R10	102.6	104.0	120.1	57.8	83.2	71.1	61.1	48.1
Roberts	----	----	----	----	----	----	----	----
Jamestown	102.7	101.0	98.0	60.3	77.5	69.6	53.0	48.9
TV8525	97.3	101.3	113.5	58.5	77.6	70.8	57.1	48.4
TV8535	94.1	97.1	111.1	56.5	81.8	76.6	67.5	47.4
TV8848	99.6	95.6	107.4	58.0	75.2	67.1	67.6	48.2
TV8861	104.4	103.9	118.3	58.1	86.5	79.7	70.0	49.6
USG 3555	107.4	110.6	121.1	58.2	79.9	69.2	53.1	47.2
LSD @ 10% Level	**5.5**	**6.8**	**7.8**[2]	**1.0**	**7.8**	**N.S.**[3]	**11.2**[3]	**2.1**

2. C.V. = 6.4%, and df for EMS = 243
3. C.V. = 17.8%, and df for EMS = 243
4. The F-test indicated no statistical difference at the alpha = 0.10 probability level; therefore, a LSD value was not calculated

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

Consider using varieties tagged with an official certification tag. Certified seed ensures the highest quality seed available with good germination and freedom from noxious weeds. Contact the Georgia Crop Improvement Association regarding any questions with certified seed at 706/542-2351

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

LAND PREPARATION AND TRAFFIC PATTERNS

Tillage can greatly affect wheat yields. Alabama, Georgia and South Carolina research have consistently shown increased wheat yield with deep tillage. Deeper tillage allows for easier root penetration, burial of diseased debris, possible dilution of root pathogens and improved water infiltration. In wet years, low soil-oxygen conditions are compounded by compacted, dense soils. This condition will reduce yield of most small grains due to the detrimental effects of poor root production and nutrient uptake.

No-till is not used much in wheat production due to poorer yield production. Yield reductions range from 5-20%. Disking is a common tillage practice in wheat production. It can provide an excellent seedbed but may lead to the formation of a compacted layer of soil. The weight of the implement is concentrated in a very small area at the tip of the disk and when disking is repeated several times a hardpan can form. As far as wheat yields are concerned, deep tillage (bottom or paraplowing or V-ripping) is the best tillage option available. It is slower and more costly than disking, but the yield increase is usually cost effective. In situations where double-cropping makes it impractical to deep till, chiseling or subsoiling may be an acceptable alternative.

Establishing a row traffic pattern for all post-emergence field traffic can have merit for reducing injury to wheat and allowing for the crop following wheat to be planted no-till without stunting. No-tilling the crop after wheat can increase yield and soil/water conservation of the secondary crop.

Traffic patterns or tramlines can be established by closing one or more openings in the drill when planting the crop. This can be done by mechanically retrofitting the drill with clutches attached to the metering cup so as to close the opening to leave unplanted rows designed to fit the wheel spacing of your sprayer or tractor. Devices for drills can be purchased to establish tramlines on any tractor width in any multiple of drill widths.

Tramlines may also be formed after the crop has emerged by chemically killing the rows with glyphosate that match the width of the implement used to apply fertilizer or pesticides. Precision agriculture tools such as light bars and GPS guidance systems can help reduce the error of overlapping when attempting to chemically kill rows to produce a tramline. Chemically kill wheat early once the plant has one to two developed leaves.

Using tramlines in intensively managed wheat makes applying uniform sprays of nutrients and pesticides much easier. They improve the precision of applications. They can be used as guides for repeated applications and save on the cost of aerial applications. They reduce the chance of disease development when compared to plants that are crushed by running over standing wheat. Studies have shown that the border plants will compensate for yield losses whereas plants damaged by tires rarely produce good grain.

PLANTING DATES

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

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

If planting late in the season, choose an early maturing variety because they have, in general, very little vernalization requirements. This ensures the crop will vernalize properly even in a mild or warm winter. Caution should be taken to avoid planting these types of varieties too early in the season. Due to their short season growing abilities, these varieties may enter the jointing and heading phase too quickly and therefore be subject to severe winter kill or damage from late spring freezes.

In fact, varieties such with very short vernalization requirements such as Fleming etc., on average perform best when planted between December 1 and December 15th. In this case, the recommended planting dates are two weeks later than the recommended dates for most other varieties.

The effect of planting dates have on three popular varieties are shown in Tables 5 and 6. Notice the loss in yield at the late planting date with the late maturing variety. This variety requires longer vernalization and growing days than the early or medium maturing varieties. The effects of late planting can be severe depending on variety.

Table 5. Effect of Planting Date on Yield (bu/A) of Soft Red Winter Wheat, Tifton

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

Data in Table 6 illustrates how severely wheat yields are penalized as planting is delayed into the winter. It is important to plant within the recommended planting time for high yields.

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

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

The most recent data on the effects of planting dates in Alabama affirm the same trend as shown in tables 5 and 6. (*see http://www.aces.edu/pubs/docs/A/ANR-0992/ANR-0992-low.pdf) Table 7 lists the recommended planting dates for different regions of the state. These dates represent a tradeoff between planting early enough to allow for adequate tillering before cold weather begins and planting late enough to avoid excessive heat and moisture stress. In many parts of the country planting dates are set late in order to avoid problems with the Hessian fly, but in Georgia there is no such thing as a "fly-free date".

The optimum window for wheat planting in Georgia is typically one week before the average first frost date for a given area and one week after. 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 to apply two applications of N fertilizer in the spring. Fall produced tillers will have stronger root systems, larger heads with better capacity for high test weight and consequently, tolerate more stress.

Table 7. General planting times for most wheat varieties grown in Georgia.

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

**Only varieties with short vernalization requirements

SEEDING RATES

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

In a normal year, wheat cultivars vary between 10,000 and 18,000 seeds per pound. This difference can impact the actual seeding rate if a grower seeds wheat in bushels per acre. For example, in Table 8 seeds per pound of variety 4 and variety 6 vary by 35%. If a grower planted in bushels per acre, he would plant 35% more seed of variety 6 than variety 4, potentially over-planting or under-planting one of the cultivars. For that reason, it is important to focus attention on purchasing the amount of wheat for seeding not by bushels but ultimately that needed to give you the 30 to 35 seeds per square feet.

Table 8. Example of seeds per pound of wheat grown in one year in Georgia.

Variety	Seed/pound
1	9,610
2	11,340
3	14,823
4	12,064
5	11.172
6	16,316
7	12,741
8	14,538
9	15,534
Average # seeds per pound	**13,126**

Information in table 9 provides appropriate seeds per row foot for various row widths. When planting on 7.5 inch row widths each linear foot of row should contain 20-25 seeds depending on germination. This should give you enough seed to achieve the right amount of live plants per acre for high yield. If planting date is delayed, seeding rates should be increased by 15-20%.

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

Table 9. Seeds per linear row foot needed to achieve certain seeds per square foot at different seeding widths.

	Seeds /sq. ft.			
Row widths 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

Information in table 10, illustrates the differences in pounds per acre between two lots of seed planted at various row widths and seeds per row foot. If you had a variety that had approximately 12,000 seeds per pound and you planted in 7.5 inch row width and wanted to plant 22 seeds per row foot, then you would need to purchase 127.7 lbs of seed per acre. If the seed were small and the variety had 15,000 seed per pound, then the amount of lbs needed to purchase would only be 102.2 lbs per acre.

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

Table 10. Pounds of seed per acre as determined by row width, seeding rate and seeds per pound.

	Row width					
	6"		7.5"		10"	
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

Straw Utilization

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

Varieties vary in their ability to produce straw from year to year. Table 11 is provided to demonstrate differences found in varieties. In general the higher the grain yield, the greater the amount of straw produced. If the straw is removed from the field, remember to apply the same amount of nutrients to the subsequent crop that are removed by the straw.

Table 11. Example of Straw Yield of Different Soft Red Winter Wheat Varieties (lbs/A), Griffin.

Variety	Ht-in.	Griffin
1	38	2572
2	36	3149
3	38	2021
4	37	2777
5	40	2666
6	36	2173
7	34	2352
8	34	2235
9	33	2478

FERTILITY RECOMMENDATIONS

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 12). 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 12. Nutrient uptake and nutrient removal by wheat at different yield levels. Removal based on grain only.

	Yield bu/A					
	40		70		100	
Nutrient	Uptake	Removal	Uptake	Removal	Uptake	Removal
	------------------------------pounds per acre------------------------------					
N	75	46	130	80	188	115
P_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

Nitrogen (N)

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

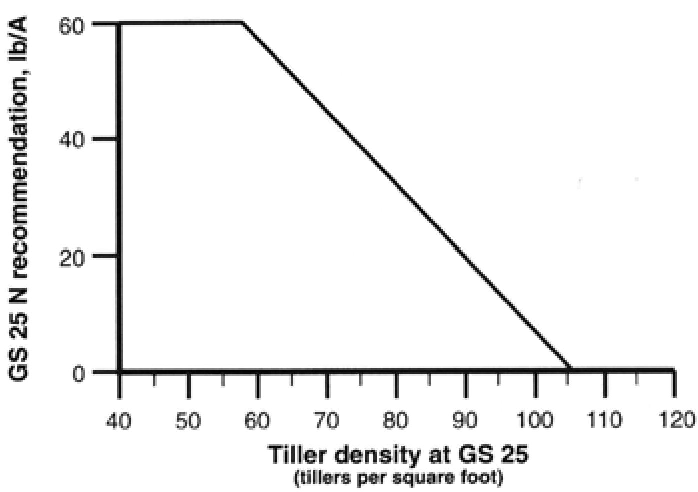
Apply nitrogen in the fall is critical to encourage good tiller production prior to the onset of winter. Adjust this rate based on the preceding crop. In general, apply N (based on the previous crop rotation) as follows:

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

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

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

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

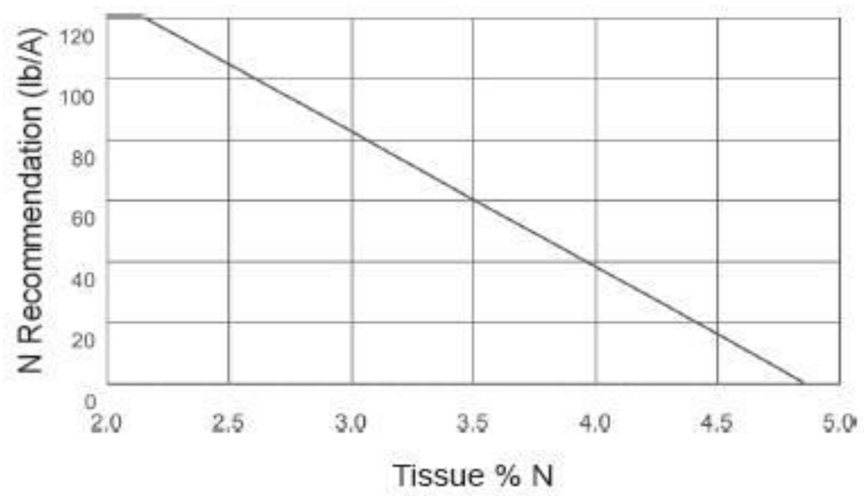


Splitting spring nitrogen applications can improve yields when N leaching conditions occur. Although yields may not always be improved, this practice can also reduce the amount of N released into the environment, and offers the chance to adjust N rates downward if climatic or economic conditions do not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

The graph below is a guide used by growers in North Carolina and Virginia to determine the need for nitrogen at GS 30 (or Feekes 5). It assumes that the average tiller count will be above 100 per square foot. GS 30 is when the leaf sheaths of the wheat plant are strongly erected and splitting the stem shows a hollow internode area about 1/4 to 1/2 inch in length. It is important to have an accurate assessment of the nitrogen content at the right growth stage prior to completing the final N applications. Obtain a representative tissue sample from about 20 areas in the field. Cut the samples about 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 suggest since it would exceed the upper limit of 130 lbs N in the season (20 +40 = 60; 60 +70 =130).

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

Other Nutrients

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

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

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

Poultry Litter

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

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

WEED CONTROL IN WHEAT

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 that commonly reduce both food and feed value.

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

Cultural Control Methods

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

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

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

Planning a Herbicide Program

Before using herbicides, growers should know what weeds are present or expected to appear, soil characteristics (such as texture and organic matter content), capabilities and limitations including carryover of the various herbicides, and how best to apply each herbicide.

Weed Mapping

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

In-season Monitoring

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

Managing Weeds with Herbicides

If applying herbicides, read and follow label recommendations. Information concerning weed response to herbicides, herbicide rates, and grazing restrictions for wheat are provided in Tables 15, 16 and 17. Refer to product labels for up-to-date suggestions and restrictions.

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

All wheat herbicides are restricted to certain stages of development to avoid crop injury (Table 13). Although the stage of development provides a good indicator for application timing, factors such as environmental conditions, health of the crop, and variety (early vs. late maturity) also have an impact on crop tolerance.

Table 13. The Effect of Stage of Growth on Wheat Injury by Various Herbicides.

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

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

[2]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, wild mustard, and wild radish (Table 15). However, 2,4-D often does not adequately control chickweed and henbit; thus, mixtures with Harmony or Express are advised.

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

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

MCPA is similar to 2,4-D in that it is a phenoxy herbicide controlling a broad spectrum of broadleaf weeds (Table 15). In general MCPA is less injurious to wheat but also less effective on larger weed species. Application of MCPA is after wheat tillers (preferably 2+ tillers) at a rate of 12 to 16 oz/A (3.7 to 4.0 lb ai material) up to just before jointing; if wheat is fully tillered a rate of 1 to 1.5 pt/A may be applied (Figure 1).

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

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

Harmony Extra controls many of the common winter annual broadleaf weeds including wild garlic and curly dock (Table 15). However, cornflower and wild radish are exceptions while henbit can be challenging to control depending on its physiological maturity. MCPA or 2,4-D at 0.375 pound active ingredient per acre may be mixed with Harmony Extra for excellent wild radish control and improved control of cornflower; these mixtures must follow the application growth stage restrictions noted with 2,4-D or MCPA.

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

An advantage of Harmony Extra compared to 2,4-D or MCPA is the wide window of application; however, tank mixtures of these compounds are encouraged when wheat is at the appropriate stage of growth.

See Table 16 for the appropriate rate depending on the formulation used.

Express (tribenuron) and **Peak** (prosulfuron) are sulfonylurea herbicides that are effective on many winter annual broadleaf weeds (Table 15). Harmony Extra is superior to Express in controlling henbit, shepherd's-purse, and wild garlic. Peak is often the most effective option for controlling wild garlic but, a 10 month rotation restriction for soybeans, peanuts, and cotton exist for Peak at 0.75 oz of product per acre.

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

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

Wild Radish Control

Wild radish can be controlled effectively with numerous herbicide options (Table 14). Harmony Extra + MCPA or 2,4-D as well as Express + MCPA or 2,4-D are suggested to control wild radish as well as most other commonly present broadleaf weeds. PowerFlex, an effective ryegrass herbicide, is also a very good option for controlling wild radish.

Table 14. The Effect of Stage of Growth on Wild Radish Control in Wheat.

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

[1]Wild radish size in diameter of leaf rosette.

Wild Garlic

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

Harmony Extra with TotalSol (50 SG) at 0.75 to 0.9 ounce per acre is very effective on wild garlic. Wild garlic should be less than 12 inches tall and should have 2 to 4 inches of new growth (if treated in the spring) when Harmony Extra is applied. Temperatures of 50^0 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 broadleaf weeds. Add a nonionic surfactant or crop oil according to label directions.

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

Italian Ryegrass

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

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

Axial XL, active ingredient pinoxaden, at 16.4 fl oz/A can be applied postemergence to wheat having at least two leaves up to pre-boot stage (Figure 1). Do not confuse Axial XL with Axial, the older pinoxaden product, as the application rates differ. Ryegrass resistant to Hoelon may be cross resistant to Axial XL, although in many cases Axial XL is still effective in Georgia.

Apply in no less than 10 gallons of water per acre. Rain falling 30 minutes after application will not impact control. Axial can be applied only once per crop and will not offer residual control.

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

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

Axiom, active ingredients flufenacet and metribuzin, can be applied to wheat after the spike stage of growth up to the 2 leaf stage (Figure 1). Preemergence applications can cause severe crop injury, especially on sandier soils when conditions are wet during crop emergence. 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 control 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 (lighter soils) to 8 oz (heavier soils) of product per acre, but, again this should be determined from your soil type and label restrictions.

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

Hoelon, containing the active ingredient diclofop-methyl, can be applied in wheat to control annual ryegrass. Hoelon does not control broadleaf weeds, wild garlic, or annual bluegrass. Hoelon is an aryloxyphenoxy propionate-type herbicide. Herbicides of this type work slowly often taking up to 8 weeks to kill the ryegrass. Hoelon can be applied postemergence in any variety of wheat any time before the first node, or joint, develops (up to Feekes stage 6, Figure 1).

Timely application of Hoelon to annual ryegrass is essential for good control. Best control is obtained when treating one- to three-leaf ryegrass (about 2 to 3 inches tall), which most often occurs prior to Christmas. Higher rates are required for larger ryegrass, and even then control decreases. Better activity is obtained under warmer temperatures; night-time temperatures should be above 35^0 F for three days before and three days after application.

Postemergence Hoelon rates for ryegrass

Ryegrass growth stage	Hoelon rate (pints per acre)
1 to 3 leaves	1.33
3 to 4 leaves	1.33 to 2.0
5 leaves to 2 tillers	2.0 to 2.67

Postemergence Hoelon effectiveness

Ryegrass height	Percent control
2 inches	100
4 inches	80-90
6 inches	50

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

Hoelon should NOT be applied postemergence in nitrogen or tank mixed with other herbicides. Either of these situations can reduce ryegrass control. Additionally, to avoid reduced ryegrass control, do not apply 2,4-D within five days of applying Hoelon. Hoelon may be tank mixed with fungicides, but fungicides are typically applied in the spring, which is after the optimum timing of Hoelon application.

Ryegrass resistant to Hoelon is quite common throughout Georgia.

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 the 1^{st} leaf stage and the flag leaf being visible (Figure 1). Prowl does not control emerged weeds, but can provide residual control of sensitive weed species if the herbicide is activated by rainfall or irrigation in a timely manner. For ryegrass, Prowl can provide 60 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 does allow for mixtures with any labeled wheat postemergence herbicide.

The two greatest uses for Prowl H_20 would include 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 seen at harvest is not ryegrass that emerged after postemergence herbicide treatment, but rather is ryegrass that was not controlled with a postemergence herbicide because the ryegrass was too large or resistant when treated…Prowl H_20 will not help with this.

A second use for Prowl H_20 in wheat 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. However, a timely postemergence application of an effective herbicide with the ability to control emerged plants will still be needed.

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

From 2011 through 2013, there is a transition period of PowerFlex formulations from a 7.5 WDG to a 13.13 WDG; therefore, it is critical that growers apply the appropriate rate. For the 7.5 WDG formulation (old formulation) the application rate of 3.5 oz/A was in order while 2.0 oz/A is in order for the new 13.13 WDG formulation. Applications should be made in 12 to 15 gallons per acre and include a crop oil concentrate at 1 to 1.25% v/v (1 to 1.25 gal crop oil per 100 gal spray solution). Four hours is needed prior to the first rain.

In addition to ryegrass, the PowerFlex label claims control of several broadleaf weeds including Carolina geranium, common chickweed, hairy vetch, wild mustard and suppression of henbit. The label does not mention wild radish but numerous Georgia studies suggest excellent control of radish up to 8 inches in height (Table 13).

For additional broadleaf control, PowerFlex may be mixed with Harmony Extra. Do not mix with dicamba, 2,4-D, or MCPA. Also, do not mix with organo-phosphate insecticides.

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

PowerFlex is a 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.
Ryegrass resistance to Osprey has been documented in Georgia and is becoming more common rapidly. Ryegrass resistant to Osprey is almost certainly resistant to PowerFlex since both Osprey and PowerFlex are ALS herbicides. Growers should rotate PowerFlex OR Osprey with alternative chemistry; never treat the same piece of land more than once in a two year time period with either of these herbicides.

Labeled rotational restrictions include 1 month for wheat and triticale, 3 months for cotton, soybean, grain sorghum, and sunflower, 9 months for grasses including barley, field corn, millet, oats, popcorn, seedcorn, 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.

Do not apply a product containing organophosates for five days before or five days after and application of PowerFlex.

Osprey, active ingredient mesosulfuron-methyl, is a postemergent herbicide applied at 4.75 oz per acre in wheat from emergence up to the jointing stage (Figure 1). For annual ryegrass control, applications must be made between 1-leaf and 2-tillers. If applied properly and timely, Osprey controls ryegrass very well and very consistently, including Hoelon-resistant ryegrass.

Osprey is a sulfonylurea-type herbicide, and similar to other sulfonylureas, Osprey works slowly. Symptoms appear three to four weeks after application but eight weeks may pass before ryegrass dies. Four hours is needed prior to the first rain event.

An adjuvant is required with Osprey. The manufacturer is currently recommending a nonionic surfactant containing at least 80% surface-active agents plus an ammonium nitrogen source for wheat in Georgia. The nonionic surfactant should be used at a rate of 0.5% by volume (2 quarts per 100 gallons spray solution). In addition to the nonionic surfactant, also include 1 to 2 quarts per acre of urea ammonium nitrogen fertlizer (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 topdressed shortly after an Osprey application. Separate Osprey and 2,4-D applications by at least 5 days.

Osprey may be mixed with Harmony Extra to improve control of broadleaf weeds. The label also allows a mixture with MCPA; however, antagonism (reduced ryegrass control) with Osprey/MCPA mixtures has been noted in several Georgia trials.

Osprey will also provide good control of henbit, wild radish, and common chickweed if applied when these weeds are small ($\leq$2 inch) at time of application. 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 is quite common throughout Georgia and is rapidly becoming more common. Ryegrass resistant to Osprey is almost certainly resistant to PowerFlex since both Osprey and PowerFlex are ALS herbicides. Growers should rotate PowerFlex OR Osprey with alternative chemistries; never treat the same piece of land more than once in a two year time period with either of these herbicides.

Herbicide Resistance Management

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

Hoelon-resistant Italian (annual) ryegrass has been a problem in Georgia for years. These resistant populations are a response to repeated use of Hoelon. Osprey-resistant ryegrass is now becoming quite common because of repeated use of Osprey. With Osprey and PowerFlex having the same mode of action, some Georgia growers developed ryegrass resistant to PowerFlex before PowerFlex was ever commercialized because of the over use of Osprey.

During 2009, ryegrass with resistance to Hoelon, Osprey, and PowerFlex was confirmed. In 2011, ryegrass populations with resistance to Hoelon, Osprey, Axial, and PowerFlex were confirmed.

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

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

1) improper herbicide choice or rate
2) poor/improper application
3) POOR TIMING OF APPLICATION
4) unfavorable weather
5) later weed flushes
6) antagonism by other pesticides

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

Additional Considerations for No-Till Wheat Production

In no-till production systems, weed control at planting is critical because many winter annual weeds such as chickweed, henbit, annual bluegrass, and Italian ryegrass are already established at planting time. Paraquat (Gramoxone, etc) or glyphosate may be applied after planting **but before wheat emerges** (Tables 15 and 16) for control of emerged weeds.

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

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

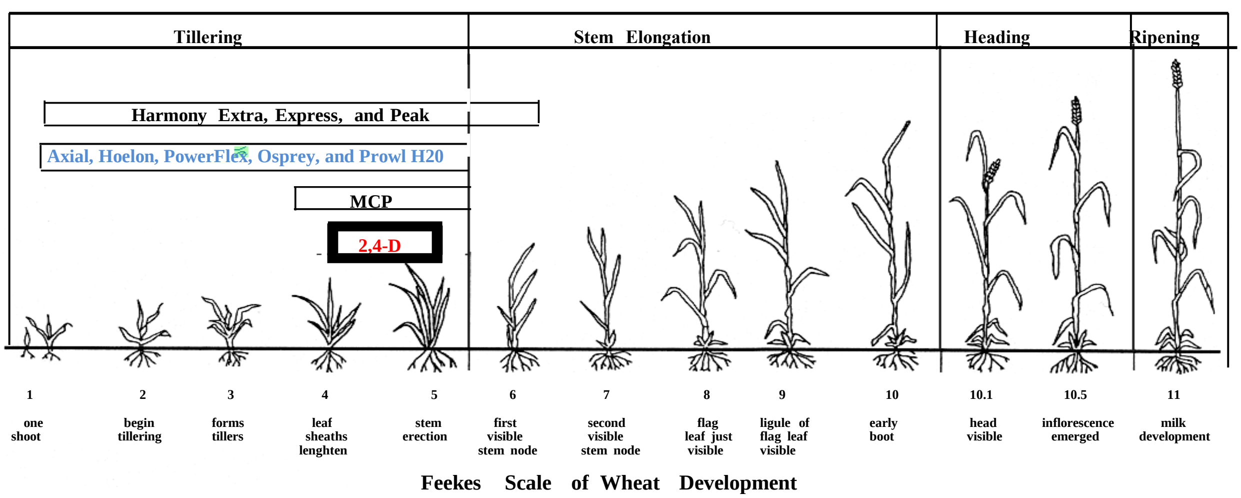


Table 15. Weed Responses to Broadleaf Herbicides Used in Wheat.

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

[1] Timely postemergence application.
[2] Applied preemergence.

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

Table 15. Weed Responses to Grass and Broadleaf Herbicides Used in Wheat.

Weeds	Axiom[2]	Hoelon[1]	Axial XL[1]	Osprey[1]	PowerFlex[1]
Annual bluegrass	G	N	N	GE	PF
Annual ryegrass	PG[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		N	N	P	P
field pennycress		N	N		
goldenrod		N	N		
hairy vetch		N	N		
henbit	GE	N	N	GE[7]	FG
horsenettle		N	N		
horseweed		N	N		
knawel		N	N		
Lambs-quarters		N	N		
plantains		N	N		
shepherd's-purse		N	N		
swinecress		N	N	E	
thistles		N	N		
vetch		N	N	PF[7]	
VA pepper-weed		N	N		
wild garlic		N	N	P	
wild mustard	GE	N	N	G	GE
wild radish	GE	N	N	G	GE

[1] Timely postemergence application.
[2] Applied spike to wheat.
[3] Provides good control if Axiom is activated prior to ryegrass germination, poor control if ryegrass emerges prior to Axiom activation.
[4] Will not control Hoelon-resistant ryegrass.
[5] Axial XL and Hoelon have similar modes of action. Axial XL may not control Hoelon-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 16. 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 broadleaf and grass weeds; volunteer Roundup Ready corn	paraquat (Gramoxone Inteon) 2 SL (Firestorm, Parazone) 3 SL MOA 22	 2 to 4 pt 1.33 to 2.7 pt	0.5 to 1.0	Apply before crop emerges. Rate depends on weed size. Add nonionic surfactant at 1 pt per 100 gal of spray or crop oil concentrate at 1 gal per 100 gal of spray. Control of 12" corn at 1.5 pt/A is about 80% but may provide acceptable control until frost. See label for application directions.
Emerged annual broadleaf and grass weeds, control or suppression of perennial weeds	glyphosate 3.57 SL (3 lb a.e.) 4 SL (3 lb a.e.) 5 SL (3.7 lb a.e) 5.5 SL (4.5 lb a.e.) 6 SL (5 lb a.e.) MOA 9	 1 to 3 pt 1 to 3 pt 0.8 to 2.4 pt 11 to 32 fl oz 10 to 28 fl oz	0.38 to 1.13	Apply before crop emerges. Rate depends upon weed size; see label. Adjuvant recommendation varies by glyphosate brand used.
Summer and winter annual weeds including wild radish, henbit, chickweed	glyphosate + thifensulfuron-methyl + tribenuron-methyl (Harmony Extra SG with Total Sol) 50 SG MOA 9 + 2	see glyphosate + 0.45 to 0.9 oz	0.38 to 1.13 + 0.0094 to 0.0188 + 0.0047 to 0.0094	May be used as a burndown treatment prior to or shortly after planting, but prior to wheat emergence. Greatly improves henbit control.
Summer and winter annual weeds including wild radish, henbit, chickweed; residual control of numerous weeds.	glyphosate + flumioxazin (Valor SX) 51 WDG MOA 9 + 14	see glyphosate + 1 to 2 oz	0.38 to 1.13 + 0.032 to 0.063	May be used as a burndown treatment for control of most weeds. Also provides residual control of numerous weeds including radish and ryegrass if the herbicide contacts the soil and is activated. For Valor, a minimum of 30 days must pass, and 1 inch of rainfall/irrigation must occur, between application and planting of wheat.
Volunteer Roundup Ready Corn	glyphosate + clethodim (Select) 2 EC (Select Max) 0.97 EC MOA 9 + 1	see glyphosate + 4 to 8 fl oz 6 to 9 fl oz	0.75 to 1.13 + 0.06 to 0.12 0.05 to 0.07	Do not plant wheat for 30 days after applying clethodim. Corn < 12 inch: Select 4 to 6 oz; Select Max 6 oz. Corn 12-24 inch: Select 6 to 8 oz; Select Max 9 oz.
PREEMERGENCE				
Annual ryegrass and annual broadleaf weeds	chlorosulfuron + metsulfuron-methyl (Finesse, Report Extra) 75 WDG MOA 2 + 2	0.5 oz	0.0195 + 0.0039	Ryegrass control is variable; expect suppression. May stunt wheat on sandy soils. **Plant only STS soybeans following wheat harvest.** Crop injury may result if organophosphate is used. SEE rotational restrictions. If ryegrass is not the target weed present then a lower rate may be used, see label.
SPIKE				
Wild radish, henbit, annual ryegrass, and annual bluegrass	flufenacet + metribuzin (Axiom) 68 WDG MOA 15 + 5	4 to 10 oz	0.136 to 0.034 + 0.34 to 0.085	Apply to wheat in the spike stage (up until the 2 leaf stage). Wheat seed should be planted at least 1 inch deep. Preemergence applications can cause severe injury. For most Georgia soils, 6 to 8 oz/A of product is ideal. Heavy rains following application can cause stunting even with a spike application. If Axiom is activated prior to ryegrass emergence then control will be good but if ryegrass emerges prior to Axiom activation then control will be poor. Rotation to soybean is 0 months, cotton 8 months, many other crops 18 months.

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		
Annual ryegrass	diclofop-methyl (Hoelon) 3 EC MOA 1	1.33 to 2.67 pt	0.5 to 1.0	Apply before wheat begins to joint. Apply 1.33 pt/A on 2-leaf ryegrass, 2 pt/A on 2-leaf to initial tillering ryegrass; and 2.67 pt/A on 1- to 2-tiller ryegrass. Make only one application per season. Do not tank mix with broadleaf herbicides or use liquid nitrogen as the carrier. May add 1 to 2 pt per acre of crop oil concentrate when conditions are dry or when ryegrass is large. Crop oil usually not necessary. Crop injury may result if organophosphate is used. ***Ryegrass resistant to Hoelon is* common**. **To minimize resistance:** Make only one application of Hoelon **OR** Axial in a field every two years. Adding Axiom or Prowl H_20 to a program is beneficial.
Annual ryegrass, small wild radish, and other broadleaf weeds	mesosulfuron-methyl (Osprey) 4.5 WDG MOA 2	4.75 oz	0.013	Apply to ryegrass between 1-lf and 2-tiller and before wheat is jointing. Add a nonionic surfactant (at least 80% active) at 2 qts per 100 gallon spray solution plus ammonium nitrogen fertilizer (28-0-0, 30-0-0, 32-0-0) at 1 to 2 qt per acre. DO NOT topdress within 14 days of Osprey application or mix with 2,4-D or MCPA. Do not use liquid nitrogen as the carrier. May mix Osprey with Harmony Extra. Cotton/soybean can be planted 90 days after application. ***Ryegrass resistant to Osprey or PowerFlex is* common.** **To minimize resistance:** Make only one application of Osprey **OR** PowerFlex in a field every two years. Adding Axiom or Prowl H_20 to a program is beneficial.
Annual ryegrass	pinoxaden (Axial XL) 0.42 EC MOA 1	16.4 fl oz	0.053	Apply to ryegrass prior to two tillers while wheat is between 2 leaf and pre-boot. No adjuvant required. Mix with Harmony Extra for broadleaf control. UGA suggest not mixing with nitrogen but label allows water/nitrogen mixtures containing up to 50% liquid nitrogen by volume. Add water to tank, then add Axial; then mix thoroughly and add nitrogen. Make only one application per crop and any crop can be planted 90 days after application. Axial and Hoelon have the same mode of action. Research in Georgia has shown Axial to kill about 50% of the Holeon-resistant populations studied. **To minimize resistance:** Make only one application of Hoelon **OR** Axial in a field every two years. Adding Axiom or Prowl H_20 to a program is beneficial.
Annual ryegrass, wild radish, and other broadleaf weeds	pyroxsulam (PowerFlex) 7.5 WDG (PowerFlex) 13.13 WDG MOA 2	3.5 oz 2.0 oz	0.0164	Apply to ryegrass prior to two tillers while wheat is between 3-lf and jointing. Add crop oil concentrate at to 1.25 gal per 100 gal spray solution. May tank mix with Harmony Extra but NOT dicamba, 2,4-D, or MCPA. UGA suggest not mixing with nitrogen but label allows water-nitrogen mixture containing up to 50% liquid nitrogen by volume (< 30 lb/A of nitrogen). If applying in liquid nitrogen, use a nonionic surfactant at 0.25% v/v, instead of crop oil. An independent liquid ammonium nitrogen fertilizer application should not be made within 7 days of application; do not apply organophosphate within 5 days of application. Minimum rotation for soybean and cotton planted after winter wheat harvest is 3 months. ***Ryegrass resistant to Osprey or PowerFlex is* common.** **To minimize resistance:** Make only one application of Osprey **OR** PowerFlex in a field every two years. Adding Axiom or Prowl H_20 to a program is beneficial.

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 1.18	Apply from 1st leaf stage of wheat up to flag leaf. Prowl does not control emerged weeds. May tank mix with any postemergence herbicide labeled for use in wheat.
Wild garlic, curly dock, and most winter annual broadleaf weeds. Not an effective option for controlling WILD RADISH larger than 1.5 inches in diamater when applied alone.	thifensulfuron-methyl + tribenuron-methyl (Harmony Extra SG with TotalSol) 50 SG (Harmony Extra, Nimble) 75 WDG MOA 2 + 2	 0.45 to 0.9 oz 0.3 to 0.6 oz	0.0094 to 0.0188 + 0.0047 to 0.0094	Apply after two-leaf stage of wheat but prior to flag leaf. Most annuals can be controlled with 0.6 to 0.75 oz/A of Harmony Extra 50 SG; however, 0.75 to 0.9 oz/A is needed for wild garlic or wild radish. Apply when weeds are 2- to 4-lf, temps are above 50 F, and not stressed. Garlic should be < 12 inches tall and should have 2- to 4-inches of new growth. Make no more than 2 applications per year applying a max of 1.5 oz/A per season of Harmony Extra Total Sol. A nonionic surfactant at the rate of 1 quart per 100 gal of spray solution is suggested when applied in water. Liquid nitrogen may be used as the carrier; in this case, premix the herbicide in water and add the mixture to nitrogen with agitation; add 0.5 to 1.0 pint nonionic surfactant per 100 gallons spray solution. *For timely wild radish control,* tank mix with MCPA or 2,4-D at 0.375 lb ai/A (12 oz/A of 4 lb ai material). Add 0.5 to 1.0 pint nonionic surfactant per 100 gallons spray solution. If mixing 2,4-D or MCPA with Harmony and using nitrogen as the carrier, eliminate surfactant. Follow wheat stage of growth restrictions for 2,4-D or MCPA with mixtures.
Wild mustard, chickweed, field pennycress; provides only partial control of most weeds	tribenuron-methyl (Express SG with TotalSol) 50 SG (Express) 75 WDG MOA 2	 0.25 to 0.5 oz 0.167 to 0.33 oz	0.008 to 0.0155	Apply after two-leaf stage of wheat but prior to flag leaf. Add 1 qt of nonionic surfactant per 100 gal of spray solution. Apply when weeds are small and not stressed. May be applied in mixture with some liquid fertilizers; however, some discoloration and stunting may occur; see label. If applying in liquid nitrogen; add 0.5 to 1 pint nonionic surfactant per 100 gallons of spray solution. Suggest mixtures with 0.375 lb active ingredient of 2,4-D or MCPA for improved control of wild radish (add 0.5 to 1.0 pint nonionic surfactant per 100 gallons spray solution). If mixing 2,4-D or MCPA with Express and using nitrogen as the carrier, use at most 0.5 pt of nonionic surfactant per 100 gallons of spray solution. Follow wheat stage of growth restrictions for MCPA or 2,4-D when using these mixtures.
Most winter annual broadleaf weeds except chickweed, henbit, and knawl	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 (stages 4 and 5 on Feekes scale) but before jointing. Spraying wheat too young or after jointing may reduce yields. Better results obtained when day-time temps are above 50 F. Increase rate by 50% to control corn cockle. For wild onion or wild garlic, increase rate according to respective labels. GA research has shown greater injury by 2,4-D 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 Express or Harmony, see above. Only 1 in crop application of 2,4-D allowed.
	MCPA (various brands) 4.0 L (various brands) 3.7 L MOA 4	 0.5 to 1.25 pt 0.5 to 1.25 pt	 0.25 to 0.625 0.23 to 0.58	Apply 12 to 16 oz/A when wheat has at least 2 tillers and 16 to 20 oz/A when wheat is fully tillered. Do not apply after wheat is jointing. Weeds should be less than two inches in height or diameter. No spray additive required. STRONLGY suggest mixtures with Express or 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	 1 to 2 pt 1 to 2 pt 0.8 to 1.6 pt 11 to 22 fl oz 10 to 20 fl oz	0.38 to 0.75	Apply after hard dough stage of grain (30% or less grain moisture) but at least 7 days before harvest. Do not apply to wheat grown for seed.
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. 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 17. Forage, Feed, and Grazing Restrictions for Wheat Herbicides.	
Trade Name	**Restrictions** (see specific label of product used as label restrictions do vary by product)
Axial	Do not graze livestock or harvest forage for hay for at least 30 days after application. Do not harvest grain or feed straw to livestock for at least 60 days after application.
Axiom	Do not graze within 30 days of application.
Express or Harmony Extra Total Sol	Allow 7 days between application and grazing treated forage or feeding forage to livestock. Allow 30 days between application and feeding hay to livestock. Harvested straw may be used for bedding and/or feed. Allow at least 45 days before harvesting grain.
Hoelon	Do not allow livestock to graze treated fields for 28 days after treatment. Do not harvest forage, hay, or straw from treated fields prior to grain harvest.
Finesse	No grazing restrictions.
MCPA	Do not forage or graze meat animals or dairy cattle within 7 days of slaughter.
Osprey	Do not apply within 30 days of harvesting wheat forage, and 60 days for hay, grain, and straw.
PowerFlex	Do not graze treated crop within 7 days following application. Do not cut the treated crop for hay within 28 days after application.
Prowl H20	Do not apply within 28 days of harvest of hay; within 11 days of harvest of forage; or within 60 days before harvest of grain or straw.
Roundup WeatherMax	Stubble may be grazed immediately after harvest.
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

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. True armyworm and other insects also occasionally damage cereal grain crops. Damage symptoms and economic thresholds are found in table 19.

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. For the most part, beneficial insects such as lady beetles are not active during the winter and only exert some control over aphids during the spring in wheat.

Aphids also vector 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. BYD is present in most fields in most years throughout Georgia. Yield losses of 5-15% are common but losses 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 generally have greater aphid numbers and greater BYD incidence than late plantings.

Systemic seed treatments, imidacloprid (Gaucho, Attendant, Axcess), thiamethoxam (Cruiser), and clothianidin (NipsIt Inside), 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 expensive and 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 (Karate Zeon, 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 at full tiller also may be beneficial. In southern Georgia, the best treatment time usually is at full-tiller stage in early 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. 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 8 to 16 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 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 weed hosts. 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 spring 2013 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.

Table 18. Wheat variety rating for Hessian fly resistance in spring 2013.

Poor (Susceptible)	Fair	Good (Resistant)
AGS 2031, 2020, 2040 **Croplan** 8302 **Dyna-Gro** 9053, 9171 **Pioneer Brand** 26R12, 26R15, 26R22, 26R24, 26R87 **Progeny** 117, 125, 130, 136, 185, 308, 357, 870 **Public:** Roberts, Neuse, Pat, Chesapeake, NC-Cape Fear, NC-Yadkin **SS** 520, 560, 5205, 8340, 8404, 8412 **Syngenta AgriPro** Panola, Gore, Magnolia, Arcadia **Syngenta Coker** 9184, 9295, 9553, 9663, 9700, 9804 **Terral** LA821, LA841, LA842, TV8525, TV8526, TV8535, TV8626 **USG** 3153, 3201, 3244, 3251, 3295, 3438, 3477, 3555, 3562, 3725, 3933	**AGS** 2000, 2035, 2038 **Dyna-Gro** **Pioneer Brand** 26R12, 26R31 **Progeny** 122, 166 **Public:** Fleming, Jamestown **SS** 8308 **Syngenta AgriPro** **Syngenta-Coker** 9152 **Terral** **USG** 3209, 3592, 3665, 3833	**AGS** 2026*, 2060 **Dyna-Gro/CPS** Baldwin, Oglethorpe* **Pioneer Brand** 26R10, 26R20, 26R38, 26R41, 26R61* **Public:** Roane **Progeny** **SS** 8641 **Syngenta AgriPro** **Syngenta-Coker** **Terral** TV8558, TV8589, TV8848, TV8861, LA754 **USG** 3120 * Resistant to Biotype L.

For susceptible varieties, systemic seed treatments, such as Gaucho, Cruiser, or NipsIt Inside, when applied at a **high rate (see Table 20) will suppress fall infestations but will not prevent Hessian fly infestation** in winter or spring. In February through mid-March with a properly-timed foliar application of lambda cyhalothrin also may suppress spring infestation but control may be inconsistent. 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 extensively 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. But, lambda cyhalothrin (Karate Zeon, Silencer, and similar products) and gamma cyhalothrin (Declare) also can be applied early when egg hatch is occurring, which may coincide with an application of foliar fungicide for leaf rust control.

***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 en-mass out of defoliated wheat fields to continue feeding on crops in nearby fields. Treatment should be considered if 4 or more worms per square foot are found before pollen-shed stage and if 8 or more worms per square foot are found after pollen-shed stage. Insecticides listed are effective but coverage of dense foliar and lodged plants sometimes makes control difficult.

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

Sampling for Insect Pests

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

Insecticides generally are not widely used in wheat in the Southeast. Except for the Hessian fly, most other insect pests can be controlled by applying foliar insecticides when population densities exceed economic thresholds (Table 19). Granular insecticides at planting, such as Thimet / Phorate 20G, are no longer registered for use on wheat. Systemic seed treatments such as Gaucho 600 or Cruiser 5FS may control aphids, suppress BYD infection and at high rates control Hessian fly in fall. Consult the Georgia Pest Control Handbook and Table 20 for specific chemical recommendations for wheat. Most insecticides registered for use on wheat also can be used on oats, rye, and barley with the exception of Mustang MAX, Tombstone and similar products. For current insecticide recommendations for oats, rye, and barley see the most recent edition of the Georgia Pest Management Handbook, Commercial Edition.

Summary of Management Practices for Insect Pest Control

1. If possible, avoid continuous planting of wheat in the same field. Also avoid using wheat as a cover crop year after year in the same field.
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. A rescue foliar treatment of lambda cyhalothrin based on egg sampling also may provide partial control of the spring infestation.
8. Scout wheat for aphids at 25 - 35 days after planting and at top dress in early February in south Georgia and early March in north Georgia. Scout at boot and heading stages for aphids, true armyworms, and cereal leaf beetles. Apply a foliar insecticide if numbers exceed treatment thresholds.

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

Insect	Damage Symptoms	Treatment threshold
Aphids	Suck plant sap and may cause yellowing and death of leaves. Reduce grain size when grain heads infested. Transmit barley yellow dwarf virus.	Seedlings: 2/row ft., 6-10 inch plants: 5/row ft., Stem elongation: 2 per stem, Flag leaf - head emergence: 5/stem, Full heading: 10 per 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: 1adult per 2 plants, Spring: 1 adult per stem.
True armyworm	Primarily occur in late winter and spring from stem elongation to maturity; chew foliage and seed head glumes, also clip awns and seed heads.	Before pollen shed: 4 or more worms/sq. ft. After pollen shed: 8 or more worms/sq. ft.
Fall armyworm, beet armyworm & yellow-striped armyworm	Primarily occurs in the fall; small larvae cause "window pane" feeding on leaves; larger larvae consume leaves and plants and destroy stands	Do not treat unless seedling damage exceeds 50% defoliation and 2 or more armyworms per sq. ft. are present.
Grasshoppers	Destroy leaves of seedlings during fall. Damage common along field margins.	Do not treat unless damage exceeds 50% defoliation and 3 or more grasshoppers/sq. yd. are present.
Flea beetles	Destroy leaves of seedlings in fall. Damage common along field margins.	Do not treat unless seedling damage exceeds 50% defoliation and 2 beetles /row ft. are present.
Lesser corn stalk borer	Larvae bore into base of seedlings in fall. Usually only in early plantings for grazing.	Not established.
European corn borer	Small larvae chew holes in leaves; large larvae tunnel	Control almost never practical; Treat when larvae are small and borer numerous and

	in stem killing developing grain head.	before they bore into stems.
Mites, winter grain mite	Suck plant sap; cause leaf discoloration.	Treat when leaf discoloration appears over large areas of a field.
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.	Almost never require control in wheat. Treat if 1 or more bugs per sq. ft. at milk stage. Do not treat in dough stage.

Table 20. Insecticide recommendations for wheat insect pests.

PEST	INSECTICIDE[1]	AMOUNT OF FORMULATION PER ACRE	LBS. ACTIVE INGREDIENT PER ACRE	REMARKS
Aphids	Seed Treatments			
	Gaucho, Attendant, Axcess 600	0.8 fl. oz./100 lb. seed	0.03 lb./100 lb. seed	**NOTE:** Gaucho XT formulation also contains Raxil and Apron fungicides.
	Gaucho XT	3.4 fl. oz./100 lb. seed	0.03 lb./100 lb. seed	
	Cruiser 5FS	1.0 fl. oz./100 lb. seed	0.04 lb./100 lb. seed	**NOTE:** Cruiser 5FS is available as a commercial seed treatment. CruiserMaxx Cereal also contains two fungicides.
	CruiserMaxx Cereals plus Cruiser 5FS	5.0 fl. oz./100 lb. seed plus 0.5 fl. oz./100 lb. seed	0.04 lb./100 lb. seed (total)	
	NipsIt Inside	0.75 fl. oz./100 lb. seed	0.03 lb./100lb. seed	**NOTE:** OP insecticides, like dimethoate, control aphids but are not effective at suppressing barley yellow dwarf disease.
	Foliar Treatments			
	Baythroid XL (1EC)	2.4 fl. oz.	0.019	
	Dimethoate 4EC, 400	0.5 to 0.75 pt.	0.25 to 0.375	
	Dimethoate 2.67EC	0.75 to 1 pt.	0.25 to 0.375	
	Methyl 4EC	0.5 to 1.5 pt.	0.25 to 0.75	**NOTE: Methyl parathion / Penncap-M cannot be legally used after December 31, 2013.**
	Penncap-M	2 to 3 pt.	0.5 to 0.75	
	Karate Zeon, Lambda (2.08)	1.28 to 1.92 fl. oz.	0.02 to 0.03	
	Silencer, others (1.0)	2.56 to 3.84 fl. oz.	0.02 to 0.03	
	Declare (1.25)	1.02 to 1.54 fl. oz.	0.01 to 0.015	
	Proaxis (0.5)	2.56 to 3.84 fl. oz.	0.01 to 0.015	
Armyworm	Baythroid XL (1EC)	1.8 to 2.4 fl. oz.	0.014 to 0.019	True armyworm usually in late winter and spring at boot/head stage. Treat when larval numbers exceed 4 larvae per square foot before pollen shed and 8 larvae per square foot after pollen shed.
	Lannate 2.4LV	1.5 pt.	0.45	
	Lannate 90SP	0.5 lb.	0.45	
	Methyl 4EC	1.5 pt.	0.75	
	Penncap-M	2 to 3 pt.	0.5 to 0.75	
	Mustang MAX, Respect (0.8EC) (wheat only)	3.2 fl. oz.	0.025	**NOTE:** Tracer and Radiant are most effective against small larvae.
	Tracer 4SC	2 fl. oz.	0.062	
	Karate Zeon, Lambda (2.08)	1.6 fl. oz.	0.025	**NOTE: Methyl parathion / Penncap-M cannot be legally used after December 31, 2013.**
	Silencer, others (1.0)	3.2 fl. oz.	0.025	
	Declare (1.25)	1.28 fl. oz.	0.0125	
	Proaxis (0.5)	3.2 fl. oz.	0.0125	
	Radiant 1SC	3 to 6 fl. oz.	0.0234 – 0.0469	
	Tombstone (2.0) (wheat only)	1.8 to 2.4 fl. oz.	0.028 to 0.038	
Fall armyworm, beet armyworm, Yellowstriped armyworm, and Cutworms	Lannate 2.4LV	1.5 pt.	0.45	Usually in fall on seedling plants. Treat when larval populations of any one or any combination of these insects exceed 3 larvae (1/2 inch long or larger) per square foot.
	Lannate 90SP	0.5 lb.	0.45	
	Mustang MAX, Respect (0.8EC) (wheat only)	3.2 to 4.0 fl. oz.	0.025	
	Tracer 4SC	1.5 to 3.0 fl. oz.	0.047 to 0.094	
	Karate Zeon, Lambda (2.08)	1.6 fl. oz.	0.025	**NOTE:** Tracer and Radiant are more effective against small larvae. Tracer is not labeled for cutworm control.
	Silencer, others (1.0)	3.2 fl. oz.	0.025	
	Declare (1.25)	1.28 fl. oz.	0.0125	
	Proaxis (0.5)	3.2 fl. oz.	0.0125	
	Radiant 1 SC	3 to 6 fl. oz.	0.0234 – 0.0469	
	Tombstone (2.0) (wheat only)	2.4 fl. oz.	0.038	

Cereal leaf beetle	Baythroid XL (1EC) Lannate 2.4LV Lannate 90SP Malathion 5EC Malathion 8EC Mustang MAX, Respect (0.8EC) (wheat only) Karate Zeon, Lambda (2.08) Silencer, others (1.0) Declare (1.25) Proaxis (0.5) Tombstone (2.0) (wheat only)	1.0 to 1.8 fl. oz. 0.75 to 1.5 pt. 0.25 to 0.5 lb. 1.5 pt. 1.25 pt 2.6 to 3.2 fl. oz. 1.28 to 1.6 fl. oz. 2.56 to 3.2 fl. oz. 1.02 to 1.28 fl. oz. 2.56 to 3.2 fl. oz. 1.0 to 1.8 fl. oz.	0.008 to 0.014 0.225 to 0.45 0.225 to 0.45 0.94 1.25 0.02 to 0.025 0.02 to 0.025 0.02 to 0.025 0.01 to 0.0125 0.01 to 0.0125 0.016 to 0.028	Treat when an average of 1 larva and adult per 4 stems are found. Karate, Silencer, Declare and similar products can be applied at 50% egg hatch. Other materials should not be applied until after 90% egg hatch.
Grasshoppers	Baythroid XL (1EC) Malathion 57EC, 5EC Malathion 8EC Mustang MAX, Respect (0.8EC) (wheat only) Karate Zeon, Lambda (2.08) Silencer, others (1.0) Declare (1.25) Proaxis (0.5) Tombstone (2.0) (wheat only)	1.8 to 2.4 fl. oz. 1.5 to 2 pt. 1.25 pt. 3.2 to 4.0 fl. oz. 1.28 to 1.92 fl. oz. 2.56 to 3.84 fl. oz. 1.02 to 1.54 fl. oz. 2.56 to 3.84 fl. oz. 1.8 to 2.4 fl. oz.	0.014 to 0.019 0.94 to 1.25 1.25 0.02 to 0.025 0.02 to 0.03 0.02 to 0.03 0.01 to 0.015 0.01 to 0.015 0.028 to 0.038	Treat when populations exceed 3 hoppers per square yard and are causing excessive (greater than 50%) defoliation.
Chinch bug	Baythroid XL (1EC) Mustang MAX, Respect (0.8E) (wheat only) Karate Zeon, Lambda (2.08) Silencer, others (1.0) Declare (1.25) Proaxis (0.5)	2.4 fl. oz. 4.0 fl. oz. 1.92 fl. oz. 3.84 fl. oz. 1.54 fl. oz. 3.84 fl. oz.	0.019 0.025 0.03 0.03 0.015 0.015	Gaucho and Cruiser seed treatments may provide control for a few weeks after planting. Chinch bugs are difficult to control in headed wheat.
Hessian fly	<u>Seed Treatments</u> Gaucho, Attendant, Axcess 600 Gaucho XT plus Gaucho 600 Cruiser 5FS CruiserMaxx Cereals plus Cruiser 5FS NipsIt Inside <u>Foliar application</u> Karate Zeon, similar products 2.08CS Declare (1.25)	 1.6 fl. oz./100 lb. seed 3.4 fl. oz./100 lb. seed 0.8 fl. oz./100 lb. seed 1.33 fl. oz./100 lb. seed 5.0 fl. oz./100 lb. seed plus 1.0 fl. oz./100 lb. seed 1.79 fl. oz./100 lb. seed 1.92 fl. oz./acre 1.54. fl. oz.	 0.06 lb./100 lb. seed 0.06 lb./100 lb. seed (total) 0.06 lb./100 lb. seed 0.07 lb./100 lb. seed (total) 0.07 0.03 0.015	Consider use on susceptible varieties. Systemic seed treatments, **Gaucho** and **Cruiser**, need highest rates for effective suppression. Gaucho XT alone may not provide good control. **NOTE:** Apply Karate when adults are actively laying eggs. Apply based on egg sampling for best results.
Mites, Winter grain mite	Methyl 4EC Penncap-M Mustang MAX. Respect (0.3E) Karate Zeon, Lambda (2.08)	1 to 1.5 pt. 2 to 3 pt. 4.0 fl. oz. 1.92 fl. oz.	0.5 to 0.75 0.5 to 0.75 0.025 0.03	**NOTE:** Karate for suppression only. **NOTE: Methyl parathion / Penncap-M cannot be legally used after December 31, 2013.**

Stink bugs	Baythroid XL (1EC)	1.8 to 2.4 fl. oz.	0.014 to 0.019	See Table 19 for comments. **NOTE: Methyl parathion / Penncap-M cannot be legally used after December 31, 2013.**
	Methyl 4EC Penncap-M	1 to 1.5 pt. 2 to 3 pt.	0.5 to 0.75 0.5 to 0.75	
	Mustang MAX, Respect (0.8E) (wheat only)	3.2 to 4. 0 fl. oz.	0.02 to 0.025	
	Karate Zeon, Lambda (2.08) Silencer, others (1.0)	1.28 to 1.92 fl. oz. 2.6 to 3.84 fl. oz.	0.02 to 0.03 0.02 to 0.03	
	Declare (1.25) Proaxis (0.5)	1.02 to 1.54 fl. oz. 3.2 fl. oz.	0.01 to 0.015 0.0125	
	Tombstone (2.0) (wheat only)	1.8 to 2.4 fl. oz.	0.028 to 0.038	

Table 21. Forage, feed, and grazing restrictions for wheat insecticides.

Insecticide	Brand Name	Days From Last Application To:		Restricted Entry Interval (hours)	Maximum Amount Allowed Per Acre Per Crop	Precautions
		Harvest	Grazing			
beta-cyfluthrin	Baythroid XL (1.0EC), generics	30	7	12	4.8 fl. oz. or 2 applications	
cyfluthrin	Tombstone (2.0)	30	7	12	4.8 fl. oz. or 2 applications	Wheat only
clothianidin	NipsIt Inside	-	-	12	Seed treatment; 6 oz ai per acre per crop	See label for crop plant-back restrictions.
dimethoate	Dimethoate, others	35	14	48	2 applications	
imidacloprid	Gaucho, Attendant, Axcess	45	45	12	Seed treatment	Gaucho XT formulation also contains Raxil and Apron fungicides.
lambda-cyhalothrin	Karate Zeon, Silencer others	30	7	24	0.06 lb ai.	Same active ingredient as gamma-cyhalothrin
gamma-cyhalothrin	Prolix (1.25) Proaxis (0.5)	30	7	24	0.19 pt. 0.48 pt.	Same active ingredient as lambda-cyhalothrin
malathion	Malathion, others	7	7	12	Not listed	Apply as needed.
methomyl	Lannate	7	10	48	1.8 lbs. ai	Maximum of 4 applications per crop.
methyl parathion	Methyl 4EC, Penncap-M	15	15	96	4EC: 3 pts. Penncap-M: 6 pts.	Use protective equipment. **Methyl parathion / Penncap-M cannot be legally used after December 31, 2013.**
spinetoram	Radiant 1SC	21	3	4	28 fl. oz.	
spinosad	Tracer 4SC	21		4	9 fl. oz.	
thiamethoxam	Cruiser 5FS	-	-	12	Seed treatment	See label for crop plant-back restrictions.
zeta-cypermethrin	Mustang MAX, Respect (0.8EC)	14	14	12	21.5 fl. oz.	Do not make applications less than 14 days apart. Wheat only

DISEASE MANAGEMENT IN WHEAT

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.

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

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

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

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.

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.

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://pubs.caes.uga.edu/caespubs/pubcd/C960/C960.htm (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 more red to purple discoloration. When infection begins early in the season, after heading, the uppermost leaf is often very upright. Severe infection usually causes some stunting and reduction in numbers of seeds per head. BYDV is transmitted by several aphid species. Aphids acquire the virus by feeding on infected plants for very short periods and then move to other uninfected plants. Infection can occur any time when viruliferous aphids multiply and migrate in fields. Crop rotation is less effective for barley yellow dwarf because aphids can transmit the virus between fields, and many grasses on which the aphids feed also harbor the virus. Barley yellow dwarf can cause severe losses in many Georgia fields, most often following a mild fall and winter, which allows aphids to be active and transmit the virus early in plant development. BYDV is present in nearly all fields each year. Disease severity depends on aphid populations and the proportion of aphids that can transmit the virus. Control of volunteer wheat and grassy weeds during the summer and along the edges of fields may slow initial infection. Planting during the latter part of the recommended period can delay fall infection. Resistant varieties and insecticide application to control aphids can reduce damage from barley yellow dwarf (see Insect Management).

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

DISEASE	OPTIMUM MOISTURE	OPTIMUM TEMPERATURE
Powdery Mildew[1]	High Humidity	59-72°F[2]
Leaf Rust	Free Moisture	59-72°F
Stripe Rust	Free Moisture	50-59°F
Leaf and Glume Blotch	Free Moisture	68-75°F
Take-All	Moist Soils	50-68°F

[1] Powdery mildew fungus does not need free moisture to develop.
[2] Temperatures above 77°F are not favorable for 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 the use of seed treatment fungicides (Table 22).

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

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

FUNGICIDE	CROP	RATE/100 LB SEED	REMARKS
Captan Captan 400	Wheat, Barley, Oats, Rye	See label	Controls seedling blights. Does not control smuts.
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.
Difenoconazole Dividend	Wheat	0.5-1.0 oz.	Controls loose smut and stinking smut.
Difenoconazole-Metalaxyl 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
Mefenoxan Apron XL, Apron XL-LS	Wheat, Barley, Millet, Oats, Rye, Sorghum, Triticale	0.042-0.08	Controls Pythium damping-off. Does not control smuts.
Metalaxyl Allegiance	Wheat, Barley, Millet, Oats, Rye, Sorghum, Triticale	See label	Controls Pythium damping-off. Does not control smuts.
Metalaxyl –Metconazole-Clothianidin NipsIt SUITE	Wheat, Oats, Barley	5.0 – 7.5 fl oz	Controls common smut, flag smut loose smut, seed decay fungi, Fusarium seed scab, Pythium seed rot and seedling. Early season Fusarium seedling dieback, early season Rhizoctonia root rot and early season common rot
Tebuconazole Raxil (in various combinations with other fungicides)	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.

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

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

Soilborne Mosaic and Spindle Streak Mosaic. The symptoms of soilborne mosaic range from mild green to a prominent yellow leaf mosaic. Plants may be stunted or rosette in shape. Symptoms are usually seen in late winter and early spring. New leaves may be mottled or exhibit streaks or flecking. Wheat spindle streak mosaic virus causes stunting and poor growth with yellow mottling and numerous elongated streaks on leaves. Leaf streaks are usually a light green to yellow. The discontinuous streaks run parallel to the leaf veins and taper to form a spindle shape. Both viruses are transmitted by a fungus, which survives in the soil and transmits the virus into the wheat roots. These diseases are typically a problem when soils remain wet during the late fall and winter. Spindle streak mosaic and soilborne mosaic are most common in fields planted to wheat for two or more years. Both viruses may occur together and symptoms may intermingle. Crop rotation is an effective control method.

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 Field Crops section of the UGA Plant Pathology Extension site (http://plantpath.caes.uga.edu/extension/DiseaseLibrary.html) for information on these and other wheat diseases. Some fungicide manufacturers have a color booklet on small grain diseases, which is helpful in disease identification. Begin scouting soon after the plants tiller and the stem begins to elongate. The leaves of plants should be observed at least once per week when jointing begins. Inspect plants twice each week from the time the flag (uppermost) leaf begins to emerge until flowering is complete. This is the most critical time to consider fungicide application. Inspect all the leaves, especially the lower leaves. Early in the season the lowest leaves may have symptoms while the younger upper leaves do not. Symptoms on the lower leaves are a good indication that the upper leaves will become infected, especially if rain or heavy dews occur during the next several weeks. Because disease symptoms may not appear until 7-12 days after infection begins, upper leaves that appear healthy may already be infected.

Fungicides can only be effective when you carefully select the fungicide with good activity against the disease(s) present (Table 24). They should be applied at the correct rate and time according to the label. Fungicides should be applied with enough water to get good coverage: 5-7 gal/acre for aerial and 20-30 gal/acre for ground application. Use of a spreader-sticker will help improve leaf retention and fungicide performance. When applying fungicides always read the label and comply with the instructions and restrictions listed.

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

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

Table 24. Fungicides for Wheat Foliar Diseases

DISEASE	CHEMICAL AND FORMULATION	RATE PER ACRE	REMARKS AND PRECAUTIONS
Stagonospora Leaf and Glume Blotch, Leaf Rust, Stripe Rust, Powdery Mildew, Tan Spot	Azoxystrobin Quadris	6.2-10.8 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.
	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
	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 to late head emergence at Feekes 10.5 (Zadok's 59)
	Metconazole Caramba	10-14 oz.	Maximum number of applications per season=2; Minimum time from application to harvest=30 days
	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.
	Propiconazole-azoxystrobin Quilt, QuiltXcel	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.
	Propiconazole-trifloxystrobin Stratego	10 oz.	Do not apply more than 2 applications of Stratego per season. Do not apply after Feekes 10.5
	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.
	Prothiconazole + tebuconazole Prosaro	6.5 - 8.2 fl. oz.	Begin applications 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.
	Prothioconazole + trifloxystrobin Stratego YLD	4 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.
	Pyraclostrobin Headline	6-9 oz.	Apply no later than Feekes 10.5
	Pyraclostrobin + metconazole Twinline	7-9 fl oz.	Do not apply more than 2 applications per season. Do not apply after Feekes 10.5
	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
	Tebuconazole + trifloxystrobin, Absolute	3-5 fl oz.	Begin applications preventively when conditions are favorable for disease development. For optimum disease control apply 5 fl oz at flag leaf stage (Feekes 8-9). For early season suppression of Tan Spot, Leaf Blight and Powdery Mildew, apply at 3-4 oz. Do not apply more than 5 fl oz per season. Do not apply after Feekes growth stage 10.5.2. Do not apply within 35 days of harvest. Do not use with adjuvants.

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***.

Effectiveness of Foliar Fungicides for Control of Wheat Diseases

Trials have been conducted at Plains and Griffin during the past 25 years to test the efficacy and timing of fungicide application on disease-susceptible wheat cultivars. During this period there has been a shift from protectant fungicides that only prevented new infections to systemic fungicides that can eliminate an existing infection and provide protection for three weeks or more. Conditions of the tests represent a range of cultivar susceptibility and yield potential, timing of fungicide application (from flag leaf emergence to full heading), and environmental conditions favoring disease. They give an accurate estimate of the full range of crop conditions that might be encountered in Georgia. All were in high yield potential management systems.

Thirty-five fungicide treatments over a span of 17 years resulted in statistically significant yield increases in response to leaf rust, and sometimes to powdery mildew and Stagonospora blotch. The average yield of controls was 67 bu/A and the average yield increase due to fungicide treatment above the controls was 9.2 bu/A or an average increase of 14.1%. In 54% of the cases, test weight was maintained at a higher level than the controls with disease. The average return was 1.5-2.5 times the cost of fungicide application.

Assuming $15.00/A cost of fungicide application:

Yield increase	X Price/bu	= Return	Profit/A
9.2	$2.50	$23.00	$ 8.00
9.2	$3.00	$27.60	$12.60
9.2	$3.50	$32.20	$17.20
9.2	$4.00	$36.80	$21.80

If yield was not increased significantly, mostly due to weather conditions unfavorable for disease after fungicide application, there was still an average 3.9 bu/A yield increase above the control for leaf rust and Stagonospora blotch. These results are based on 41 control and 168 fungicide treatments over 16 years.

Yield increase	X Price/bu	= Return	Profit/A
3.9	$2.50	$ 9.75	-$5.25
3.9	$3.00	$11.70	-$3.30
3.9	$3.50	$13.65	-$1.35
3.9	$4.00	$15.60	$0.60

Test weight was improved 11.7% of the time. Even in years when disease develops only moderately or fungicide application is less than optimal, increased yield and some protection of test weight will pay most or all the cost of fungicide application on a disease susceptible cultivar.

MAKING SPRAY JUDGEMENTS

Scout each individual field beginning at growth stage 5 on a weekly basis. At, or just before stage 7, make a disease evaluation. Then use the point guide to determine the need to spray.

If a "zero" is indicated in any major category (I-VII), then it will probably not be profitable to spray.

Total Points		Chances of Economic Return
575 +	=	Good
425 - 574	=	Fair
Below 425	=	Poor

When to spray: Generally the most effective time for fungicide application is at flag leaf emergence (Feekes stage 8-9). Applications through stage 10.5 (heading complete) may be beneficial, particularly for control of Stagonospora glume blotch. Refer to the fungicide label for timing of application.

WHEAT FOLIAR FUNGICIDE POINT SYSTEM

This system should be used only as a guide to determine the need for application of foliar fungicide. It does not guarantee an economical return.

I.	**YIELD POTENTIAL**				
	1. 40 bu/A or more	=	150		
	2. 35-39 bu/A	=	50		
	3. Less than 35 bu/A	=	0	I.	________
II.	**NITROGEN FERTILIZATION**				
	1. Applied 90-120 lbs N/A	=	100		
	2. Applied 60-90 lbs N/A	=	50		
	3. Applied no nitrogen	=	0	II.	________
III.	**SEEDING RATE**				
	1. 2 or more bu/A	=	75		
	2. 1.5 - 2.0 bu/A	=	50		
	3. Less than 1.5 bu/A	=	25	III.	________

IV.	**DISEASE AT STAGE 7 (Second Node Just Visible)**		
	1. Severe (rust, powdery mildew or Stagonospora on all leaves)	=	100
	2. Moderate (bottom and middle leaves diseased)	=	75
	3. Light (disease on bottom leaves only)	=	50
	4. No visible foliage disease	=	25
	If rust, or two or more diseases are present, add	=	25
		IV.	________

V.	**SEASONAL RAINFALL PRIOR TO TODAY**				
	1. Above normal	=	100		
	2. Normal	=	75		
	3. Below normal	=	25	V.	________
VI.	**FIVE DAY RAINFALL FORECAST**				
	1. 40% probability (1 or more days)	=	100		
	2. Less than 40% probability (1 or more days)	=	50		
	3. No rainfall forecast	=	25	VI.	________

VII. DISEASE RESISTANCE OF VARIETY GROWN (Enter a value for each disease)

	Good	Fair	Poor	
1. Leaf Rust	0	50	100	1.________
2. Powdery Mildew	0	25	50	2.________
3. *Stagonospora nodorum* Leaf Blotch	0	25	75	3.________
			VII.	________

VIII. PRICE OF WHEAT

$2.50/bu	= 25		
$3.00/bu	= 50		
$3.50/bu +	= 75	VIII.	________

TOTAL POINTS ________

WHEAT FOR GRAIN, CONVENTIONAL
GEORGIA, 2013

ESTIMATED COSTS AND RETURNS

Expected Yield **55** Bushels YIELD: YOUR FARM ________

Variable Costs:*	Unit	Number of Units	$/Unit	Cost/Acre	$/Bushels	Your Farm
Seed	Bushel	1.50	$ 21.00	$ 31.50	$ 0.57	________
Lime	Tons	0.25	$ 40.00	$ 8.25	$ 0.15	________
Fertilizer						
Nitrogen	Lbs	80.00	$ 0.72	$ 48.00	$ 0.87	________
Phosphate (P2O5)	Lbs	40.00	$ 0.50	$ 18.00	$ 0.33	________
Potash (K2O)	Lbs	40.00	$ 0.50	$ 22.00	$ 0.40	________
Weed Control	Acre	1.00	$ 15.11	$ 15.11	$ 0.27	________
Insect Control	Acre	1.00	$ -	$ -	$ -	________
Disease Control	Acre	1.00	$ -	$ -	$ -	________
Machinery: Preharvest						
Fuel	Gallon	2.77	$ 4.00	$ 11.09	$ 0.20	________
Repairs & Maintenance	Acre	1.00	$ 5.59	$ 5.59	$ 0.10	________
Machinery: Harvest						________
Fuel	Gallon	2.77	$ 4.00	$ 11.10	$ 0.20	________
Repairs & Maintenance	Acre	1.00	$ 4.30	$ 4.30	$ 0.08	________
Labor	Hrs	0.62	$ 12.00	$ 7.46	$ 0.14	________
Crop Insurance	Acre	1.00	$ 15.00	$ 15.00	$ 0.27	________
Land Rental	Acre	1.00	$ -	$ -	$ -	________
Interest on Operating capital	Percent	$ 98.70	6.50%	$ 6.42	$ 0.12	________
Drying - 2 points	Bushel	56.65	$ 0.09	$ 5.10	$ 0.09	________
Total Variable Costs				**$ 208.91**	**$ 3.80**	
Fixed Costs:						
Machinery: Depreciation, Taxes, Insurance, and Housing						
Preharvest	Acre	1.00	$ 15.81	$ 15.81	$ 0.29	________
Harvest	Acre	1.00	$ 20.53	$ 20.53	$ 0.37	________
General Overhead	% of VC	$ 208.91	5.00%	$ 10.45	$ 0.19	________
Management	% of VC	$ 208.91	5.00%	$ 10.45	$ 0.19	________
Owned Land Costs; Taxes, Cash Payment, Etc.	Acre	1.00	$ -	$ -	$ -	________
Other ____________________						
Total Fixed Costs				**$ 57.24**	**$ 1.04**	
TOTAL COSTS AND PROFIT GOAL						
Total Costs Excluding Land				**$ 266.15**	**$ 4.84**	
**** YOUR PROFIT GOAL ****				$ __________/Bu.		
$$-PRICE NEEDED FOR PROFIT-$$				$ __________/Bu.		

FOOTNOTES
*Seed, fertilizer, chemical and fuel costs could vary as much as +/- 15 to 20% from estimates shown. The estimates are based on "normal" or typical growing conditions and pest pressure. Abnormal weather, weed/grass problems, insects, and diseases would alter the estimates shown above.

Sensitivity Analysis of WHEAT FOR GRAIN, CONVENTIONAL

NET RETURNS ABOVE VARIABLE COSTS PER ACRE Varying Prices and Yield (Bushels)					
	-25% 41.25	-10% 49.5	Average 55	+10% 60.5	+25% 68.75
$ 6.00	$ 38.59	$ 88.09	$ 121.09	$ 154.09	$ 203.59
$ 6.50	$ 59.21	$ 112.84	$ 148.59	$ 184.34	$ 237.96
$ 7.00	$ 79.84	$ 137.59	$ 176.09	$ 214.59	$ 272.34
$ 7.50	$ 100.46	$ 162.34	$ 203.59	$ 244.84	$ 306.71
$ 8.00	$ 121.09	$ 187.09	$ 231.09	$ 275.09	$ 341.09

ESTIMATED LABOR AND MACHINERY COSTS PER ACRE

PREHARVEST OPERATIONS						
Operation	Acres/Hour	Number Times Over	Labor Use (Hr.)	Fuel Use (Gal./Ac)	Machinery Repairs ($/Ac)	Fixed Costs ($/Ac)
Disk Harrow32' with Tractor (180-199 hp)-MFWD 190	16.291	1.00	0.06	0.60	1.48	4.29
Chisel Plow(Rigid)24' with Tractor (180-199 hp)-MFWD 190	12.982	1.00	0.08	0.75	1.18	3.33
Grain Drill15' with Tractor (180-199 hp)-MFWD 190	7.955	1.00	0.13	1.23	2.65	7.50
Spray (Broadcast)60' with Tractor (120-139 hp)-2WD 130	35.455	1.00	0.03	0.19	0.29	0.70
Total Preharvest Fuel, Repairs, Fixed Costs, & Labor			**0.292**	**2.77**	**$ 5.59**	**$ 15.81**

HARVEST OPERATIONS						
Operation	Acres/Hour	Number Times Over	Labor Use (Hr.)	Fuel Use (Gal./Ac)	Machinery Repairs ($/Ac)	Fixed Costs ($/Ac)
Header Wheat/Sorghum22' Rigid with Combine (300-349 hp)-325hp	9.015	1.000	0.111	1.86	$ 3.07	$ 16.08
Corn Grain Cart 8R36500 bu with Tractor (180-199 hp)-MFWD 190	10.642	1.000	0.094	0.92	$ 1.23	$ 4.46
Total Harvest Fuel, Repairs, Fixed Costs, and Labor			**0.205**	**2.77**	**$ 4.30**	**$ 20.53**

Prepared and Reviewed By: Nathan B Smith and Amanda R Smith, UGA Extension Economists, Department of Agricultural & Applied Economics, Dewey Lee, UGA Extension Agronomist, Department of Crop and Soil Sciences.

WHEAT FOR GRAIN, INTENSIVE MANAGEMENT
GEORGIA, 2013

ESTIMATED COSTS AND RETURNS

Expected Yield **75** Bushels YIELD: YOUR FARM ___________

Variable Costs:*	Unit	Number of Units	$/Unit	Cost/Acre	$/Bushels	Your Farm
Seed	Bushel	2.25	$ 22.00	$ 49.50	$ 0.66	
Lime	Tons	0.25	$ 40.00	$ 10.00	$ 0.13	
Fertilizer						
Nitrogen	Lbs	120.00	$ 0.72	$ 86.40	$ 1.15	
Phosphate (P2O5)	Lbs	50.00	$ 0.50	$ 25.00	$ 0.33	
Potash (K2O)	Lbs	60.00	$ 0.50	$ 30.00	$ 0.40	
Weed Control	Acre	1.00	$ 25.65	$ 25.65	$ 0.34	
Insect Control	Acre	1.00	$ -	$ -	$ -	
Disease Control	Acre	1.00	$ 15.00	$ 15.00	$ 0.20	
Machinery: Preharvest						
Fuel	Gallon	7.18	$ 4.00	$ 28.74	$ 0.38	
Repairs & Maintenance	Acre	1.00	$ 13.43	$ 13.43	$ 0.18	
Machinery: Harvest						
Fuel	Gallon	2.77	$ 4.00	$ 11.10	$ 0.15	
Repairs & Maintenance	Acre	1.00	$ 4.30	$ 4.30	$ 0.06	
Labor	Hrs	1.17	$ 12.00	$ 14.09	$ 0.19	
Crop Insurance	Acre	1.00	$ 17.00	$ 17.00	$ 0.23	
Land Rental	Acre	1.00	$ -	$ -	$ -	
Interest on Operating capital	Percent	$ 165.10	6.50%	$ 10.73	$ 0.14	
Drying - 2 points	Bushel	77.25	$ 0.09	$ 6.95	$ 0.09	
Total Variable Costs				**$ 347.89**	**$ 4.64**	

Fixed Costs:	Unit	Number of Units	$/Unit	Cost/Acre	$/Bushels	Your Farm
Machinery: Depreciation, Taxes, Insurance, and Housing						
Preharvest	Acre	1.00	$ 39.24	$ 39.24	$ 0.52	
Harvest	Acre	1.00	$ 20.53	$ 20.53	$ 0.27	
General Overhead	% of VC	$ 347.89	5.00%	$ 17.39	$ 0.23	
Management	% of VC	$ 347.89	5.00%	$ 17.39	$ 0.23	
Owned Land Costs; Taxes, Cash Payment, Etc.	Acre	1.00	$ -	$ -	$ -	
Other ____________________						
Total Fixed Costs				**$ 94.57**	**$ 1.26**	

TOTAL COSTS AND PROFIT GOAL		
Total Costs Excluding Land	**$ 442.46**	**$ 5.90**
**** YOUR PROFIT GOAL ****	$ ___________/Bu.	
$$-PRICE NEEDED FOR PROFIT-$$	$ ___________/Bu.	

*Seed, fertilizer, chemical and fuel costs could vary as much as +/- 15 to 20% from estimates shown. The estimates are based on "normal" or typical growing conditions and pest pressure. Abnormal weather, weed/grass problems, insects, and diseases would alter the estimates shown above.

Sensitivity Analysis of WHEAT FOR GRAIN, INTENSIVE MANAGEMENT

NET RETURNS ABOVE VARIABLE COSTS PER ACRE Varying Prices and Yield (Bushels)					
	-25% 56.25	-10% 67.5	Average 75	+10% 82.5	+25% 93.75
$ 6.50	$ 17.73	$ 90.86	$ 139.61	$ 188.36	$ 261.48
$ 6.75	$ 31.80	$ 107.73	$ 158.36	$ 208.98	$ 284.92
$ 7.00	$ 45.86	$ 124.61	$ 177.11	$ 229.61	$ 308.36
$ 7.25	$ 59.92	$ 141.48	$ 195.86	$ 250.23	$ 331.80
$ 7.50	$ 73.98	$ 158.36	$ 214.61	$ 270.86	$ 355.23

ESTIMATED LABOR AND MACHINERY COSTS PER ACRE

PREHARVEST OPERATIONS						
Operation	Acres/Hour	Number Times Over	Labor Use (Hr.)	Fuel Use (Gal./Ac)	Machinery Repairs ($/Ac)	Fixed Costs ($/Ac)
Plow 4 Bottom Switch6' with Tractor (180-199 hp)-MFWD 190	2.327	1.00	0.43	4.20	6.92	20.81
Disk Harrow32' with Tractor (180-199 hp)-MFWD 190	16.291	2.00	0.12	1.20	2.95	8.58
Grain Drill15' with Tractor (180-199 hp)-MFWD 190	7.955	1.00	0.13	1.23	2.65	7.50
Spray (Broadcast)60' with Tractor (180-199 hp)-MFWD 190	35.455	2.00	0.06	0.55	0.90	2.36
Total Preharvest Fuel, Repairs, Fixed Costs, & Labor			**0.735**	**7.18**	**$ 13.43**	**$ 39.24**

HARVEST OPERATIONS						
Operation	Acres/Hour	Number Times Over	Labor Use (Hr.)	Fuel Use (Gal./Ac)	Machinery Repairs ($/Ac)	Fixed Costs ($/Ac)
Header Wheat/Sorghum22' Rigid with Combine (300-349 hp)-325hp	9.015	1.000	0.111	1.86	$ 3.07	$ 16.08
Corn Grain Cart 8R36500 bu with Tractor (180-199 hp)-MFWD 190	10.642	1.000	0.094	0.92	$ 1.23	$ 4.46
Total Harvest Fuel, Repairs, Fixed Costs, and Labor			**0.205**	**2.77**	**$ 4.30**	**$ 20.53**

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