

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, often reducing food and feed value.

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

Cultural Control Methods

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

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

Site selection can determine one's potential success. Growers are strongly encouraged to avoid fields heavily infested with herbicide-resistant ryegrass; rotate these fields into cropping systems that allow other effective herbicide chemistry's for at least three years. Additionally, so as to prevent weed spread from field to field during harvest, equipment should be cleaned when moving from infested areas. This precaution can be of significant consequence in preventing or minimizing the introduction of new weed species into 'clean areas'.

Planning a Herbicide Program

Before using herbicides, growers should know what weeds are present or expected to appear, soil characteristics (such as texture and organic matter content), capabilities and limitations including potential herbicide carryover, how best to apply each herbicide, and having an in-depth understanding of when to apply each herbicide relative to crop and weed stage of growth.

Weed Mapping

The first step in a weed management program is to identify the problem; this task is best accomplished by weed mapping. Surveys should be developed each spring to provide a written record of the species present and their population levels; plants surviving through the winter and producing seeds in the spring will likely be the most popular weeds the following season. Knowing which weed species will appear allows one to develop a more effective management program.

Before-season and In-season Monitoring

As with all crops, there should be no weeds present at time of wheat planting. Scout fields at least three weeks prior to planting and again a few days prior to planting implementing steps to remove all weedy plants prior to planting. Once the crop is planted, fields should be monitored periodically to identify the need for postemergence herbicides. Even after herbicides are applied, monitoring should be continued to evaluate the success of the weed management program, to determine the need for additional control tactics, and to determine if there is a potential herbicide resistance issue. Identifying resistance early can be essential to long-term use of a given field. Proper weed identification is necessary to ensure effective control since weed species respond differently to various herbicides. Contact your local Extension office for aid in weed identification if necessary.

Managing Weeds with Herbicides

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

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

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

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

Percent Injury by Stage of Wheat Growth^{1, 2}					
Herbicide	Pre-plant	0-1 tiller	2-3 tillers	full tiller	Jointing
2,4-D	>50%	>50%	20-35%	0-10%	>50%
MCPA	>25%	>30%	0-5%	0-5%	>40%
Harmony Extra	0-5%	0-5%	0-5%	0-5%	0-5%
Harmony + MCPA	>25%	>30%	10%	0-5%	>40%
Harmony + 2,4-D	>50%	>50%	20-35%	0-10%	>50%
Quelex	0-10%	0-10%	0-5%	0-5%	unknown
Osprey	unknown	0-15%	0-15%	0-15%	0-15%
PowerFlex	unknown	0-15%	0-15%	0-15%	0-15%

¹Refer to Figure 1 and the small grain production guide for growth stages.
²Percent injury (visual chlorosis, necrosis, tiller malformation, and/or stunting).

Herbicides for Controlling Broadleaf Weeds

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

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

Timing of application of 2,4-D is critical to avoid injury to wheat. The critical period for 2,4-D applications is after wheat is fully tillered but before jointing (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 and yield loss.

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

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

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

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

Harmony Extra controls many of the common winter annual broadleaf weeds including wild garlic and curly dock (Table 16). However, cornflower and wild radish are exceptions while henbit can be challenging to control depending on its physiological maturity. MCPA or 2,4-D at 0.375 ai/A

may be mixed with Harmony Extra for excellent wild radish control and improved control of cornflower; mixtures must follow the growth stage restrictions noted with 2,4-D or MCPA.

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

An advantage of Harmony Extra compared to 2,4-D or MCPA is the wide window of application; however, tank mixtures of these herbicides are suggested for wheat in the appropriate growth stage. See Table 17 for the appropriate rate depending on the formulation used.

Express (tribenuron) is a sulfonylurea herbicide and can be effective on many winter annual broadleaf weeds (Table 16). However, Harmony Extra is superior to Express in controlling most common weeds. Express can be applied after the wheat has two leaves but before the flag leaf is visible (Figure 1). 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 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.

Peak (prosulfuron) is a sulfonylurea herbicide that can be effective on many winter annual broadleaf weeds (Table 16). Peak is often the most effective option for controlling wild garlic but, a 10 month rotation restriction for soybeans, peanuts, and cotton exist for Peak at 0.75 oz of product per acre. Peak can be applied after wheat has reached the three-leaf stage but before the second detectable node of stem elongation (Figure 1).

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

The label claims control of common chickweed, Carolina geranium, henbit, horseweed, wild mustard, and volunteer soybean when the weeds are less than 4 inches tall. Initial UGA research with Quelex is very promising with early-season applications but not in controlling larger wild radish, contact your Extension agent for the latest details.

A non-ionic surfactant at up to 0.25% v/v or a crop oil concentrate at 0.5 to 1% v/v should be included with Quelex (UGA research has focused on 1% v/v of crop oil concentrate). It may be

applied in spray solutions containing liquid nitrogen fertilizer but in this case use only the non-ionic surfactant.

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

Wild Radish Control

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

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

Herbicide	Percent Control By Leaf Rosette Diameter			
	0-4 inches	4-8 inches	8-12 inches	Bolting/Flowering
2,4-D	>99%	>95%	>90%	80-90%
Dicamba	<50%	<40%	<20%	<20%
MCPA	>99%	>95%	>80%	70-80%
Peak	>90%	>85%	70-80%	<40%
Express	60-90%	50-70%	40-60%	<40%
Harmony Extra	70-90%	60-80%	40-70%	<40%
Express + MCPA or 2,4-D	>99%	>99%	>90%	70-85%
Harmony + MCPA or 2,4-D	>99%	>99%	>95%	80-95%
Quelex	>99%	>75%	50-75%	<60%
Osprey	>99%	90-95%	60-75%	40-65%
PowerFlex	>99%	>95%	>85%	75-90%

Wild Garlic

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

Harmony Extra with TotalSol (50 SG) at 0.75 to 0.9 oz/A is very effective. Wild garlic should be less than 12 inches tall and should have 2 to 4 inches of new growth (if treated in the spring) when Harmony Extra is applied. Temperatures of 50⁰ F or higher will enhance control. Peak will also control wild garlic very well. It is at least as effective on wild garlic as Harmony Extra, but it is less

effective than Harmony Extra on several other broadleaf weeds. Add a nonionic surfactant or crop oil according to label directions.

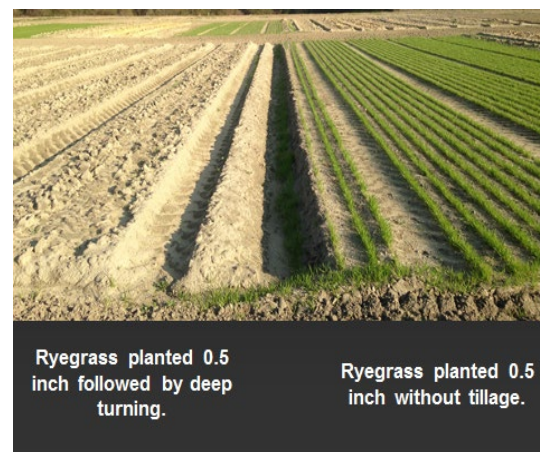
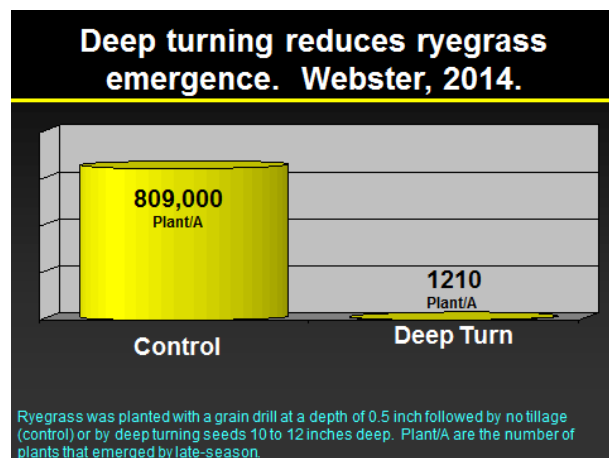
There are no rotational restrictions following wheat treated with Harmony Extra. There is a 10-month rotational restriction for all soybeans, cotton, peanuts, and tobacco following application of Peak. Soybeans should not be double-cropped behind small grains treated with Peak.

Italian or Annual Ryegrass

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

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

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



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

Axial XL, active ingredient pinoxaden, at 16.4 fl oz/A can be applied postemergence to wheat having at least two leaves up to pre-boot stage (Figure 1). Ryegrass resistant to Hoelon may be cross resistant to Axial XL, although in many cases Axial XL is still effective in Georgia.

Apply in no less than 10 gallons of water per acre; preferably 15 gallons of water per acre. Rain falling after 30 minutes of application will not impact control. Axial can be applied only once per crop and will not offer residual control or control of broadleaf weeds.

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

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

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

If Axiom is activated prior to ryegrass emergence then control will be good, but if ryegrass emerges prior to Axiom being activated then control will be poor. Axiom will also provide fair to good control of several problematic broadleaf weeds, including wild radish and henbit. Axiom may be used as part of an herbicide resistance management program because it has an alternate mode of action for the control of ryegrass compared to typically used products such as Axial, Hoelon, Osprey and PowerFlex. Those wanting to use Axiom need to review the label very carefully regarding injury potential and use rates. Most Georgia growers will be using 6 oz of product/A (or maybe less in some environments), but, again this should be determined from your soil type, label restrictions, and expected rainfall/irrigation the week following application.

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

Fierce, containing the active ingredients flumioxazin plus pyroxasulfone, has obtained a Section 24 (c) Special Local Need label for Georgia wheat. Wheat must be planted between 1 and 1.5 inches deep; Fierce cannot be applied to wheat that has been broadcast and shallow incorporated. Fierce at 1.5 oz/A mixed with only water can be applied topically once 95% of the wheat is in the spike to 2-leaf stage of growth. ***Rainfall or irrigation of ½" must occur prior to ryegrass or radish reaching ½" in height for effective control.***

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

Hoelon, containing the active ingredient diclofop-methyl, can be applied in wheat to control annual ryegrass. Hoelon does not control broadleaf weeds, wild garlic, or annual bluegrass. Hoelon can be applied postemergence in wheat any time before the first node, or joint, develops (up to Feekes stage 6, Figure 1).

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

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

The Hoelon label allows for the addition of crop oil concentrate. Crop oil is usually not necessary, and it may increase the risk of crop injury under stressful conditions. However, a crop oil can improve control under dry conditions or when treating large ryegrass. Hoelon should NOT be applied postemergence in nitrogen or tank mixed with other herbicides. Either of these situations can reduce ryegrass control. Additionally, to avoid reduced ryegrass control, do not apply 2,4-D, MCPA, or dicamba within five days of applying Hoelon.

Ryegrass resistant to Hoelon is quite common throughout Georgia.

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

The two greatest uses for Prowl H₂O might be the following: First, a mixture of Prowl H₂O with a postemergence annual ryegrass herbicide. In theory with this application, the postemergence herbicide would control the emerged ryegrass and the Prowl H₂O would provide residual control of germinating ryegrass for a couple of weeks. However, it is worth mentioning that most of the ryegrass seen at harvest is not ryegrass that emerged after postemergence herbicide treatment, but rather is ryegrass that was not controlled with a postemergence herbicide because the ryegrass was too large or resistant when treated...Prowl H₂O will not help with this situation. A second use for Prowl H₂O would be in a situation where the wheat emerges while the ryegrass is late to emerge. In this situation, Prowl H₂O applied over one-leaf wheat and activated by rainfall or irrigation could

provide control of that later emerging ryegrass.

Osprey, active ingredient mesosulfuron-methyl, is a postemergent herbicide applied at 4.75 oz per acre in wheat from emergence up to the jointing stage (Figure 1). For annual ryegrass control, applications must be made between 1-leaf and 2-tillers. If applied properly and timely, Osprey controls ryegrass very well and very consistently, including Hoelon-resistant ryegrass, as long as it is not ALS-resistant ryegrass. Osprey is a sulfonyleurea-type herbicide and works slowly. Symptoms appear three to four weeks after application but eight weeks may pass before ryegrass dies. Four hour rain fastness required.

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

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

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

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

Resistance to Osprey and PowerFlex is now common. Growers should rotate PowerFlex OR Osprey with alternative chemistries every year; only 1 application of either Osprey or PowerFlex should be made in a field over a two-year period.

PowerFlex HL, active ingredient pyroxsulam, can be applied from the three-leaf stage until jointing (Figure 1). Apply after ryegrass has emerged but before it exceeds the two-tiller stage which means most applications should occur prior to Christmas. The current formulation of PowerFlex HL should be a 13.13 WDG where 2.0 oz/A is the appropriate rate. Applications should be made in 12 to 15 gallons of water 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 hour rain fast is required.

In addition to ryegrass, the PowerFlex HL label claims control of several broadleaf weeds including Carolina geranium, common chickweed, hairy vetch, wild mustard and suppression of henbit. The label does not mention wild radish but numerous Georgia studies suggest excellent

control of wild radish up to 8 inches in height (Table 15).

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

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

PowerFlex is a sulfonyleurea-type herbicide, and similar to other sulfonyleureas, PowerFlex works slowly. Symptoms appear three to four weeks after application with up to eight weeks passing before the ryegrass actually dies. Ryegrass resistance to PowerFlex and Osprey are now common. Growers should rotate PowerFlex OR Osprey with alternative chemistry every year; only 1 application of either Osprey or PowerFlex should be made in a field over a two-year period.

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

Zidua, active ingredient pyroxasulfone, can be applied as a delayed preemergence or early postemergence treatment in wheat that is planted between 0.75 to 1.25 inches deep. Delayed preemergence applications can occur when 80% of the germinated wheat seeds have a shoot at least ½ inch long up until spiking; applications of 0.7 to 1.0 oz/A (coarse soils) are appropriate for most Georgia fields while the rate can be increased to 1.25 oz/A on medium to fine soils. Do not irrigate fields treated with a delayed preemergence application until wheat spiking *and DO NOT apply delayed preemergence applications to broadcast-seeded wheat.*

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

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

Greatest potential for injury occurs when open/cracked seed furrow allows herbicides to directly contact the seed, when seed are planted too shallow, or when seed are planted in a deep furrow that allows herbicide concentration after a rain/irrigation event during wheat germination.

Herbicide Resistance Management

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

Ryegrass with resistance to Hoelon has been a problem in Georgia for decades. Osprey and PowerFlex-resistant ryegrass are now common because of repeated use of Osprey and/or PowerFlex. During 2009, ryegrass with resistance to Hoelon, Osprey, and PowerFlex was confirmed. And in 2011, several ryegrass populations with resistance to Hoelon, Osprey, Axial, and PowerFlex were confirmed. Additional locations with ryegrass resistance to multiple herbicide modes of action have been confirmed each year since then as well.

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

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

- 1) improper herbicide choice or rate
- 2) poor/improper application
- 3) POOR TIMING OF APPLICATION
- 4) unfavorable weather such as excessively cold, wet, dry, etc....
- 5) later weed flushes
- 6) antagonism by other pesticides
- 7) time of day in which the herbicide was applied
- 8) weed covered by dirt
- 9) rainfall/irrigation prior to postemergence herbicide uptake
- 10) lack of rainfall or irrigation to activate residual herbicides

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

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

Liquid Nitrogen Tank Mixes

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

Additional Considerations for No-Till Wheat Production

In no-till production systems, weed control at planting is critical because many winter annual weeds such as chickweed, henbit, annual bluegrass, and Italian ryegrass are already established at planting time. Paraquat (Gramoxone, etc) or glyphosate may be applied after planting **but before wheat emerges** (Tables 16 and 17) for control of emerged weeds. Other herbicides such as Select, Harmony Extra, 2,4-D, Quelex and Valor may be applied preplant. However with the exception of Harmony Extra and Quelex, significant plantback intervals must be followed (Tables 16 and 17).

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

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

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

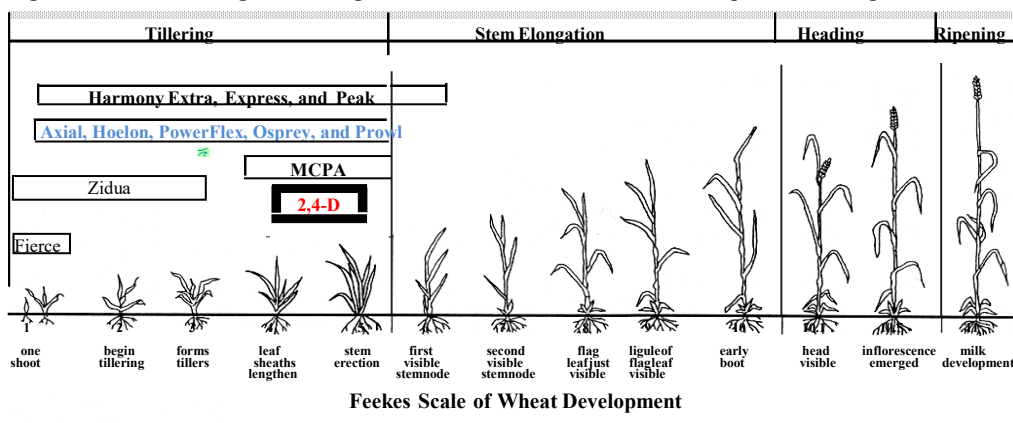


Table 16. Weed Responses to Broadleaf Herbicides Used in Wheat.

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

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

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

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

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

¹ Timely postemergence application.

² Applied spike to wheat.

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

⁴ Will not control Hoelon-resistant ryegrass.

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

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

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

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

Table 17. Chemical Weed Control in Wheat.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Category ¹	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
PREPLANT NO-TILL				
Emerged annual weeds; volunteer corn	paraquat (Gramoxone) 2 SL (Firestorm, Parazone) 3 SL MOA 22	2 to 4 pt 1.33 to 2.7 pt	0.5 to 1.0	Apply before crop emerges. Rate depends on weed size. Add nonionic surfactant at 1 pt per 100 gal of spray or crop oil concentrate at 1 gal per 100 gal of spray. Control of 12" corn at 1.5 pt/A is about 80% but may provide acceptable control until frost.
Emerged annual weeds, control or suppression of perennial weeds	glyphosate 3.57 SL (3 lb a.e.) 4 SL (3 lb a.e.) 5 SL (3.7 lb a.e.) 5.5 SL (4.5 lb a.e.) 6 SL (5 lb a.e.) MOA 9	32 to 48 fl oz 24 to 36 fl oz 23 to 34 fl oz 22 to 32 fl oz 19 to 29 fl oz	0.75 to 1.13	Apply before crop emerges. Adjuvant recommendation varies by glyphosate brand used.
Control of most winter weeds	glyphosate + 2,4-D amine MOA 9 + 4	see glyphosate + 12 to 16 fl oz	0.75 to 1.13 + 0.38 to 0.5	Check brand of 2,4-D used as some labels prohibit planting within 29 days of application. Research suggests plantback intervals of 24 days and 1 inch of rain between application and planting may be needed. Without required rainfall, serious injury can occur.
Summer and winter annual weeds including wild radish, henbit, chickweed	glyphosate + thifensulfuron-methyl + tribenuron-methyl (Harmony Extra SG with Total Sol) 50 SG MOA 9 + 2	see glyphosate + 0.45 to 0.9 oz	0.75 to 1.13 + 0.0094 to 0.0188 + 0.0047 to 0.0094	May be used as a burndown treatment prior to or shortly after planting, but prior to wheat emergence. Improves control of wild radish and chickweed; greatly improves henbit control.
Volunteer Roundup Ready Corn	glyphosate + clethodim (Select) 2 EC (Select Max) 0.97 EC MOA 9 + 1	see glyphosate + 4 to 8 fl oz 6 to 9 fl oz	0.75 to 1.13 + 0.06 to 0.12 0.05 to 0.07	Do not plant wheat for <u>30 days</u> after applying clethodim. Corn < 12 inch: Select 4 to 6 oz; Select Max 6 oz. Corn 12-24 inch: Select 6 to 8 oz; Select Max 9 oz.
Summer and winter annual weeds including wild radish, henbit, chickweed; residual control of numerous weeds with ryegrass suppression	glyphosate + flumioxazin (Valor SX) 51 WDG MOA 9 + 14	see glyphosate + 1 to 2 oz	0.75 to 1.13 + 0.032 to 0.063	For Valor, a <u>minimum of 30 days</u> must pass, and 1 inch of rainfall/irrigation must occur, between application and planting of wheat. On sands, a plant back interval of 40 days is suggested. Significant injury is likely if required rainfall does not occur.
Common chickweed, C. geranium, henbit, horseweed, soybean, wild radish	glyphosate + halauxifen-methyl + florasulam (Quelex) 0.2 WG MOA 4 + 2	see glyphosate + 0.75 oz	0.75 to 1.13 + 0.0048 + 0.0047	Apply as a preplant burndown treatment to wheat to control emerged weeds prior to, or shortly after planting (prior to emergence). Weeds should be less than 4". Label requires addition of non-ionic surfactant or crop oil concentrate. An application can be made for burndown and again in-crop, see below. Try on limited acres as it is a new tool; UGA research shows excellent crop tolerance but only with 1 data year.

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

Weeds Controlled	Herbicide, Formulation, and Mode of Action Category ¹	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
POSTEMERGENCE				
Annual ryegrass not resistant to Hoelon	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. One application per season; do not tank mix with broadleaf herbicides or use liquid nitrogen as the carrier. May add 1 to 2 pt/A of crop oil concentrate when conditions are dry or when ryegrass is large. Crop injury may result if organophosphate is used. Ryegrass resistant to Hoelon is common. Minimize resistance: Apply <i>either</i> Hoelon or Axial only once on the same field over a two year period.
Common chickweed, C. geranium, henbit, horseweed, soybean, wild radish	halauxifen-methyl + florasulam (Quelex) 0.2 WG MOA 4 + 2	0.75 oz	0.0048 + 0.0047	Apply to actively growing wheat from the 2-leaf to flag leaf stage. Weeds should be less than 4". Weeds stressed from cold or drought may not be controlled. Include crop oil concentrate (0.5 to 1% v/v). Try on limited acres as it is a new tool; UGA research shows excellent control of small radish (4" or less) but much less effective on larger radish.
Annual ryegrass, small wild radish, and other broadleaf weeds Very effective on annual bluegrass	mesosulfuron-methyl (Osprey) 4.5 WDG MOA 2	4.75 oz	0.013	Apply to ryegrass between 1-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/A. DO NOT top-dress within 14 days of Osprey application or mix with 2,4-D or MCPA. Do not use liquid nitrogen as the carrier. May mix with Harmony Extra. Cotton/soybean can be planted 90 day after application. Ryegrass resistant to Osprey or PowerFlex is common. Minimize resistance: Apply <i>either</i> Osprey or PowerFlex only once on the same field over a two year period.
Annual ryegrass	pinoxaden (Axial XL) 0.42 EC MOA 1	16.4 fl oz	0.053	Apply to ryegrass prior to 2 tillers while wheat is between 2 leaf and pre-boot. No adjuvant required. May mix with Harmony Extra for broadleaf control. UGA suggest not mixing with nitrogen but label allows water/nitrogen mixtures containing up to 50% liquid nitrogen by volume. Add water to tank, then add Axial; then mix thoroughly and add nitrogen. May mix with Zidua for residual control. Make only one application per crop and any crop can be planted 90 days later. Ryegrass resistant to Hoelon or Axial is common. Minimize resistance: Apply <i>either</i> Hoelon or Axial only once on the same field over a two year period.
Annual ryegrass, wild radish, and other broadleaf weeds	pyroxsulam (PowerFlex HL) 13.13 WDG MOA 2	2.0 oz	0.0164	Apply to ryegrass prior to 2 tillers while wheat is between 3-lf and jointing. Add crop oil concentrate at 1.25 gal per 100 gal spray solution. May tank mix with Harmony Extra but NOT dicamba, 2,4-D, or MCPA. UGA suggest not mixing with nitrogen but label allows water-nitrogen mixture containing up to 50% liquid nitrogen by volume (< 30 lb/A of nitrogen). If applying in liquid nitrogen, use a nonionic surfactant at 0.25% v/v, instead of crop oil. An independent liquid ammonium nitrogen fertilizer application should not be made within 7 days of application; do not apply organophosphate within 5 days of application. Soybeans or cotton can be planted after the following April. Ryegrass resistant to Osprey or PowerFlex is common. Minimize resistance: Apply <i>either</i> Osprey or PowerFlex only once on the same field over a two year period.

Weeds Controlled	Herbicide, Formulation, and Mode of Action Category ¹	Amount of Formulation (broadcast rate/acre)	Pounds Active Ingredient (broadcast rate/acre)	REMARKS AND PRECAUTIONS (read all labels)
POSTEMERGENCE (continued)				
Fair residual suppression of annual ryegrass	pendimethalin (Prowl H20) 3.8 AS MOA 3	1.5 to 2.5 pt	0.71 to 1.18	Apply from 1 st leaf stage of wheat up to flag leaf. Prowl does not control emerged weeds. May tank mix with any postemergence herbicide labeled for use in wheat. <i>Zidua is more effective on ryegrass.</i>
Wild garlic, curly dock, and most winter annual broadleaf weeds except wild radish should be less than 1"	thifensulfuron-methyl + tribenuron-methyl (<u>Harmony Extra SG with TotalSol</u>) 50 SG (<u>Harmony Extra, Nimble, others</u>) 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 2-lf stage of wheat but prior to flag leaf. Most annuals can be controlled with 0.6 to 0.75 oz/A of Harmony Extra 50 SG; however, 0.75 to 0.9 oz/A is needed for wild garlic or wild radish. Apply when temps are above 50 F, and plants are not stressed. Garlic should be < 12" tall and should have 2-4" of new growth. Make no more than 2 applications per year applying a max of 1.5 oz/A per season of Harmony Extra Total Sol. A nonionic surfactant at the rate of 1 quart per 100 gal of spray solution is suggested when applied in water. Liquid nitrogen may be used as the carrier; in this case, premix the herbicide in water and add the mixture to nitrogen with agitation; add 0.5 to 1.0 pint nonionic surfactant per 100 gallons spray solution. For timely wild radish control , tank mix with MCPA or 2,4-D at 0.375 lb ai/A (12 oz/A of 4 lb ai material). Add 0.5 to 1.0 pint nonionic surfactant per 100 gallons spray solution. If mixing 2,4-D or MCPA with Harmony and using nitrogen as the carrier, eliminate surfactant. Follow wheat stage of growth restrictions for 2,4-D or MCPA with mixtures.
Partial control of most weeds including wild radish Harmony Extra is usually more effective	tribenuron-methyl (<u>Express SG with TotalSol</u>) 50 SG (<u>Express</u>) 75 WDG MOA 2	0.25 to 0.5 oz 0.167 to 0.33 oz	0.008 to 0.0155	Apply after 2-lf stage of wheat but prior to flag leaf. Add 1 qt of nonionic surfactant per 100 gal of spray solution. Apply when weeds are small and not stressed. May be applied in mixture with some liquid fertilizers; however, some discoloration and stunting may occur; see label. If applying in liquid nitrogen; add 0.5 to 1 pint nonionic surfactant per 100 gallons of spray solution. <u>Suggest mixtures</u> 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, knawl, red sorrel, and geranium	<u>2,4-D amine</u> (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 labels. Greater injury by 2,4-D can occur when using liquid nitrogen as the carrier. Ester formulations can be added directly into nitrogen. If using amine formulation, premix in water (1 part 2,4-D to 4 parts water) and add mixture to nitrogen with strong agitation. Amine formulations give less burn than ester formulations in nitrogen. Ester formulations are far more volatile and should be avoided if possible. STRONGLY suggest mixtures with Harmony Extra, see above. Only 1 in-crop application of 2,4-D allowed.
	<u>MCPA</u> (various brands) 4.0 L (various brands) 3.7 L MOA 4 MOA 4	0.75 to 1.25 pt 0.75 to 1.25 pt	0.375 to 0.625 0.347 to 0.58	Amine formulation suggested to help minimize off-target movement. Apply 12 to 16 oz/A when wheat has at least 2 tillers and 16 to 20 oz/A when wheat is fully tillered. Do not apply after wheat is jointing. Weeds should be less than two inches in height or diameter. No spray additive required. STRONGLY suggest mixtures with Harmony Extra, see above.

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

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

Trade Name	Restrictions (see label of product used as label restrictions vary by product)
Axial	Do not graze livestock or harvest forage for hay for at least 30 days after application. Do not harvest grain or feed straw to livestock for at least 60 days after application.
Axiom	Do not graze within 30 days of application.
Express or Harmony Extra Total Sol	Allow 7 days between application and grazing treated forage or feeding forage to livestock. Allow 30 days between application and feeding hay to livestock. Harvested straw may be used for bedding and/or feed. Allow at least 45 days before harvesting grain.
Hoelon	Do not allow livestock to graze treated fields for 28 days after treatment. Do not harvest forage, hay, or straw from treated fields prior to grain harvest.
Fierce	Do not graze until wheat has reached 5 inches in height.
Finesse	No grazing restrictions.
MCPA	Do not forage or graze meat animals or dairy cattle within 7 days of slaughter.
Osprey	Do not apply within 30 days of harvesting wheat forage, and 60 days for hay, grain, and straw.
PowerFlex	Do not graze treated crop within 7 days following application. Do not cut the treated crop for hay within 28 days after application.
Prowl H20	Do not apply within 28 days of harvest of hay; within 11 days of harvest of forage; or within 60 days before harvest of grain or straw.
Quelex	Do not apply closer than 21 days before cutting of hay. Do not allow livestock to graze on treated crops for 7 days following application. Do not compost any plant material from treated area.
RU PowerMax	Stubble may be grazed immediately after harvest.
Zidua	Wheat forage and hay can be fed or grazed 7 or more days after application.
2,4-D	Do not graze dairy animals within 7 days of application. Do not cut treated grass for hay within 7 day of applications. Remove meat animals from treated areas 3 day prior to slaughter.