Evaluation of the Use of Preemergence and Postemergence Herbicides Along With Cover Crop Residue for Control of Broadleaf Weeds in Watermelons

by

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Abstract

Field studies were conducted in the spring of 2011 and 2012 at Auburn University research facilities (AURF), Auburn, AL to evaluate the effectiveness of labeled herbicides with the addition of winter cover crops for controlling troublesome escape weed species. Herbicides included ethalfluralin, halosulfuron, carfentrazone, and glufosinate. A total of nine treatments were applied. Treatments included: non-treated (bareground); ethalfluralin at 1.7 lbs a.i./A (PRE) + halosulfuron at 0.048 lb a.i./A (POST); ethalfluralin at 1.7 lbs a.i./A (PRE) + glufosinate at 0.748 lb a.i./A (POST); ethalfluralin at 1.7 lbs a.i./A (PRE) + carfentrazone at 0.031 lb a.i./A (POST); ethalfluralin at 1.7 lbs a.i./A (PRE); halosulfuron at 0.048 lb a.i./A (POST); glufosinate at 0.748 lb a.i./A (POST); carfentrazone at 0.031 lb a.i./A (POST); and cover crop with no herbicide.

No differences were seen among treatments containing cover crop residue in 2011 or 2012 when comparing yellow nutsedge populations. In 2011, cover crop residue with ethalfluralin followed by halosulfuron had the highest control of yellow nutsedge. Ethalfluralin followed by carfentrazone had the highest percent of control in 2012. There were no differences between treatments containing cover crop residue when comparing amaranth populations in 2011 or 2012. In 2011, the treatment of cover crop residue with ethalfluralin followed by glufosinate had higher yields than all other treatments except for the treatment of cover crop residue with ethalfluralin followed by carfentrazone. The treatment of cover crop residue with ethalfluralin followed by glufosinate produced more fruit than all other treatments. In 2012, the cover crop and no herbicide treatment was similar in yields to all treatments except the nontreated treatment.

Field studies were conducted in the spring of 2011and 2012 at the AURF at Auburn University, AL to evaluate the effectiveness of polyethylene mulch with the addition of winter cover crops for controlling troublesome broadleaf weed species. Four treatments were evaluated. Treatments included: black polyethylene mulch on bare soil; rye/clover cover crop with no polyethylene mulch; cover crop tilled into soil covered with polyethylene mulch, and polyethylene mulch with rye not tilled in. This was a completely randomized block design study with four replications of each treatment. Data were collected to determine which treatment exhibits the greatest weed control.

Differences were observed in both 2011 and 2012 when comparing yellow nutsedge populations. In 2011, the plastic mulch and cover crop tilled into the soil treatment had fewer nutsedge than the treatment with cover crop residue without plastic mulch. In 2012, all treatments containing plastic mulch had lower yellow nutsedge per square yard than the cover crop residue alone treatment. No differences were observed when comparing amaranth populations in 2011 or 2012. In 2011and 2012, treatments containing plastic mulch on bare soil and plastic mulch on cover crop residue produced higher yields than the cover crop alone treatment. In both years, all treatments containing plastic mulch were comparable and were different from the treatment with cover crop residue alone.

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

The existence of weeds can have a considerable impact on the yield of vegetable crops. One of the most difficult situations faced by commercial vegetable growers worldwide is the control of weeds in vegetable crop production. Resources such as water, nutrients, space and light are taken away from vegetable crops by weed competition, which causes poor yields and malnourished plants (Gilreath and Santos, 2004). Sicklepod and morningglory are two of the most troublesome weeds to manage in vegetable crops in the southeastern United States (Jennings et al., 1997). A blend of chemical and cultural control is required for sufficient control of these weed species. A limited number of herbicides are registered in vegetable crops for sicklepod and morningglory control, which raises a significant problem.

Mechanical weed control in watermelons is complicated due to the vining growth habit of this crop. Control measures are difficult when combining wide row spacing and slow crop emergence. Good early season weed control is critical for profitable yield. Mechanical control is possible during early crop development, however, once the crop begins to produce runners mechanical control is not a viable option. Watermelons typically begin to produce runners 4 to 5 weeks after emergence (Terry et al., 1997).

With a limited number of herbicides labeled for broadleaf weed control in watermelons, a need exists for other chemical options to be evaluated. One potential method to reduce weed populations is the use of a cover crop. Cover crops have been used in the past to reduce water runoff and soil erosion, improve soil moisture retention, organic carbon, and nitrogen

(Mallory et al., 1998; Sainju and Singh, 1997; Teasdale, 1996; Varco et al., 1999; Yenish et al., 1996). In addition, cover crops have been used to suppress weed populations in many other crops including corn, soybean, and cotton (Johnson et al. 1993; White and Worsham, 1990; Yenish et al., 1996; Varco et al., 1999; Ateh and Doll, 1996; Liebel et al., 1992; Moore et al., 1994). Reduced weed populations by cover crops can be attributed to both physical and chemical interference. Winter cover crops are planted in the fall and are grown throughout the winter months. The cover crop is then desiccated by using a roller prior to crop planting in the spring. The rolled residue then acts as a mulch to suppress weed populations. Cover crops alter the environment causing unsuitable conditions for weed growth (Masiunas et al., 1995). By competing with weeds for elements such as water, light, soil nutrients, and space, cover crops may adequately control weed populations throughout the winter and spring months. Rye is commonly used as a cover crop to reduce density and biomass of several weed species in soybeans (Liebel et al., 1992; Moore et al., 1994). Annual legume species such as crimson clover have also been evaluated as a cover crop for weed control (Teasdale et al., 1991; White and Worshman, 1990; Yenish et al., 1996). Even though cover crops may rid areas of unmanageable winter annual weed species during early spring, cover crop residues do not provide total year round weed control in summer crops (Teasdale, 1996). Thus, elimination of herbicides in summer crops is not a practical option. Both preemergence (PRE) and postemergence (POST) herbicides are commonly used to achieve optimal weed control in vegetable production (Reddy, 2001).

The objective of using a winter cover crop for weed management is to create plant residue to supply adverse environmental conditions (i.e. reduction of light and space) for weed germination and establishment. Cover crop residues normally offer species-specific, partial weed control during early-season crop growth (Teasdale, 1996). The goal of using a cover crop is to replace an unmanageable weed population with a manageable cover crop. There are two types of cover crops. The first is an off season cover crop, usually a winter annual crop that decreases weed populations during non-cropping months. The other is a smother crop. This crop is planted in conjunction with the main crop to provide weed control during the growing season (Teasdale et al., 1991). A study was conducted by Walters in 2005 to determine weed populations when competing with winter rye as a cover crop. Weed data was collected at 28 and 56 days after transplanting. Without a cover crop, redroot pigweed density was 5.9 and 11.4 plants per square foot. Winter rye at 7.8 oz per square foot reduced weed densities down to 0.7 and 2.6 plants per square foot (Walters et al., 2005).

One of the most problematic escape weeds for vegetable growers in the southeast is Sicklepod (*Cassia obtusifolia*), a leguminous weed species (Teem et al., 1980). Sicklepod is an annual weed that is able to germinate and establish throughout the season. High seed production is the primary reason sicklepod is such a problem. A single plant can yield up to 14,000 seeds when growing uninterrupted and 700 to 2,000 seeds when competing with vegetables (Bozsa et al., 1989; Senseman and Oliver, 1993). These seeds can maintain 10 – 25% viability after 2.5 years of burial (Eagley and Chandler, 1978). In some studies sicklepod emergence was greater than 50% at temperatures between 70 and 96 degrees Fahrenheit. Sicklepod is also capable of growing under wide ranges of soil pH and fertility levels (Bozsa et al., 1989; Senseman and Oliver, 1993). Relative tolerance to herbicides has contributed to the difficulty of controlling sicklepod (Bridges et al., 1985; Creel et al., 1968; Crowley et al., 1979; Isaacs et al., 1989; Teem et al., 1980). Several experiments have been conducted to evaluate which herbicides control sicklepod and other escape weeds best in certain vegetables. Because of the limited number of herbicides labeled for some crops, studies are being conducted on crops and herbicides not previously approved for use together.

Morningglory (*Ipomoea* spp.) is another of the most problematic weeds for southern vegetable growers (Elmore et al., 1990). Plant densities of 2 - 8 plants per 9 ft^2 can reduce soybean yield 25 – 43%. Reductions up to 90% have been observed in soybean yields due to morningglory infestation (Howe and Oliver, 1987; Stoller et al., 1987). In addition to reducing yield, morningglory can cause crop lodging, reduce harvesting efficiency, and increase foreign objects in the harvested crop (Barker et al., 1984; Stoller et al., 1987; Wilson and Cole, 1966). Controlling morningglory with soil applied herbicides is inconsistent and often inadequate (Vencill et al., 1995). Using postemergence herbicides to control morningglory is usually more effective than soil applied herbicides (Elmore et al., 1990). Producers often use soil applied herbicides in conjunction with postemergence herbicides to obtain satisfactory results (Reynolds et al., 1995). With only a limited amount of herbicides labeled for each crop, more and more studies are being performed to decide which herbicides work best especially if they are not labeled for that particular crop.

Palmer amaranth (*Amaranthus* spp.), commonly called pigweed, is an annual broadleaf weed that can be detrimental to crop yields. This weed is capable of growing more than 6 feet tall and can produce hundreds of thousands of seeds per plant (Rowland et al., 1999). These seeds can remain dormant for several years in the soil. Because of its large growth habit, palmer amaranth can easily compete with low growing crops for space, light, and nutrients (Rowland et al., 1999). Six smooth pigweed per square yards has been shown to reduce watermelon yields by 100% (Terry et al., 1997).

Nutsedge belongs to the family *Cyperaceae*. This plant has a triangular stem with three ranked leaves. The seedhead of this plant is yellowish-brown. This weed is a perennial which is spread by tubers and is one of the world’s worst weeds (Earl et al., 2004). Nutsedge species are a major problem in the southeastern United States due to the longevity and the prolific production of these tubers (Troxler et al., 2003). The Southern Weed Science Society published a survey by

Webster and Coble stating that yellow nutsedge (*Cyperus esculentus*) and purple nutsedge (*Cyperus rotundus*) are among the top three most problematic weeds in all vegetable crops in the United States (Webster and Coble, 1997). This is due to the fact that they are so well established and difficult to control (Warren and Coble, 1999).

Sufficient weed management in transplanted watermelons is not easy due to the limited number of registered herbicides (Elmstrom, 1976; Gilreath and Everett, 1983; Norton et al., 1990; Ogle, 1969; Porter and Johnson, 1986). Wide plant spacing for watermelons and reduced seedling vigor often results in a 6 to 10 week period before the crop canopy can develop enough to suppress weed populations (Elmstrom, 1976). Inadequately controlling these weeds can reduce watermelon yields significantly (Mitchem et al., 1997). Growers are more commonly choosing watermelon transplants rather than direct seeding due to more uniform plant stands and earlier harvest dates (Salter, 1985). According to Mitchem et al. (1997), ethalfluralin at 1.1 or 2.2 lbs a.i./A applied PPI or PRE produced severe crop damage (15 – 77%) at 2 and 6 weeks after treatment. In a study conducted by Macrae et al. (2008), halosulfuron can effectively control broadleaf weeds when applied preemergence without exhibiting substantial crop damage. However, postemergence applications of halosulfuron should be made after the watermelon plant has 10 inch runners and only used as a spot treatment when applied (Macrae et al., 2008).

Halosulfuron is a systemic herbicide belonging to the sulfonylurea class of herbicides. This herbicide was first developed for weed control in corn and grain sorghum. It is now being evaluated for use in several agricultural crops. Halosulfuron has both preemergence and postemergence activity on multiple species of weeds. Cucurbits have shown exceptional tolerance to halosulfuron in past studies (Vencill et al., 1995; Buker et al., 2004). The relationship between weed populations and crop yields has been studied with a limited number of weed species. Smooth pigweed at 6 plants per square yard can reduce yields 90% or greater (Monks and

Schultheis, 1998; Terry et al., 1997). Halosulfuron applied early post and late post in a study conducted by Macrae et al. (2008) caused 34 and 45% watermelon injury 2 weeks after treatment. Fruit number and weight were reduced 21 and 26% by early post treatments. Late post treatments reduced fruit weight by 18%, but had no effect on fruit number (Macrae et al., 2008).

Glufosinate is considered a nonselective contact postemergence (POST) herbicide and has traditionally been used to control weeds in orchards, vineyards, and noncropland sites and for control of emerged vegetation prior to planting of crops in minimum tillage systems (Lanie et al., 1994). Glufosinate also controls many weeds commonly found in agronomic row crops (Culpepper and York, 1998; Culpepper et al., 2000; Steckel et al., 1997; York and Coble, 1997). Glufosinate is a postemergence herbicide that inhibits glutamine synthetase (Wendler et al., 1990; Wild and Wendler 1991), the enzyme involved in the conversion of glutamic acid and ammonia into glutamine (Devine et al., 1993; Hinchee et al., 1993; Wild and Wendler, 1991). Inhibition of glutamine synthetase leads to a rapid accumulation of toxic levels of ammonia within the cell, cessation of photosynthesis, disruption of chloroplast structure, and vesiculation of stroma (Devine et al., 1993; Hinchee et al., 1993).

Carfentrazone is a postemergence broadleaf herbicide labeled for use in wheat (*Triticum aestivum* L.) and corn (*Zea mays* L.). Carfentrazone disrupts cell membranes through inhibition of protoporphyrinogen oxidase, so weed control is achieved primarily by contact action (Dayan et al., 1997). Injury to plant foliage is observed within hours after treatment, and complete plant death will occur within one week. Several broadleaf weeds, including common lambsquarter (*Chenopodium album* L.), velvetleaf, and wild buckwheat (*Polygonium convolvulus* L.) are effectively controlled by carfentrazone (Durgan et al., 1997).

Ethalfluralin is the most widely used preemergence herbicide for watermelons in the southeast. This herbicide can cause crop damage when applied preemergence or pre plant incorporated. Less injury occurs when the herbicide is applied postemergence to watermelon transplants immediately after planting (Darmstadt, 1979). Several studies have shown root damage to watermelons when ethalfluralin was applied preemergence. Seven percent root injury was reported when ethalfluralin was applied at 0.27 lbs. a.i./A (Darmstadt, 1979).

Black polyethylene mulch has been used in commercial vegetable production since the 1960s. It is currently used on thousands of acres across the United States. Polyethylene is used early in the growing season to warm soil temperatures to promote seed germination and plant growth. Polyethylene is also very effective at reducing weed populations and aids in moisture retention. All of these qualities can significantly increase yields and fruit quality. Polyethylene also has negative aspects. Applying polyethylene mulch requires specialized equipment that can be too expensive for some growers. Polyethylene mulch also has to be removed and disposed of after use. This is usually done by hand. Recycling of polyethylene mulch is possible, however; plant and pesticide residues often make it difficult (Hochmuth, 1989).

Watermelon production

Watermelons (*Citrullus lanatus*) belong to the Cucurbitaceae family, also known as the gourd family or vine crops. Numerous melons belong to this family. Among the most important are muskmelons, honeydews, and watermelons (Swaider and Ware, 2002). The Cucurbitaceae family includes about 120 genera that consist of more than 800 species. Plants of this family often develop strong taproots with a network of shallow roots that spread to the surrounding soil. Leaves of most plants in the Cucurbitaceae family are simple, alternate, and palmately lobed. Tendrils can also be found in leaf axils. Bees are the most important pollinators for cucurbits because of their ability to transfer heavy sticky pollen (Rubatzky and Yamaguchi, 1999). Watermelons fall into three main classes: open pollinated, F1 hybrids, and triploid seedless. Open pollinated varieties have true to type seed and are less expensive. F1 hybrids are developed by crossing two inbred lines. These seeds are often more expensive and not always readily available. Triploid melons are a cross between a diploid and tetraploid melon and do not produce viable seed (Boyham et al., 2000).

Watermelons require warm temperatures for optimum growth. Soil temperatures should be between 70 and 95˚F for optimum seed germination. Under these temperatures seeds can germinate in three days. Air temperatures for optimum vegetative growth range from 65 to 90˚F. Watermelons are primarily monoecious. This means that they develop both male and female flowers separately. Male flowers appear first in leaf axils. Female flowers will appear several days later in different axils. There are many more male flowers than female flowers. Female flowers will only open for one day for insect pollination (Swaider and Ware, 2002).

Adequate moisture required for good melon production is 15 inches of water per growing season. Sandy loam soils are best for growing melons. One advantage of sandy soils is the ability to warm more rapidly in the spring for quicker seed germination. Sandy soils also have improved drainage which prevents waterlogging and reduces fruit rot diseases. In addition to fertilizer recommendations (Swaider and Ware, 2002), a sidedressing of 25-30 pounds of nitrogen is important for vegetative growth. Watermelons are more tolerant to acid soils than other members of the cucurbit family. They are able to be grown in soils with a pH between 5.5 and 6.8 (Swaider and Ware, 2002).

Watermelons are often grown from seed or transplants. Seeds should be planted 0.5 to 1.0 inch deep in heavy soils. Seeds can be planted 1.0 to 2.0 inches deep in lighter soils. Transplants should be grown with greenhouse temperatures between 65 and 75˚F during the day. Temperatures should be 10 degrees warmer for seedless varieties. Plants should be “hardened off” before being planted in the field. This means they should be acclimated to the outside temperatures and the wind (Swaider and Ware, 2002).

Weed populations can influence yields significantly. The upright growth of many broadleaf weeds can shade out young watermelon plants. Planting in fields with minimal weed populations can help increase yields. There are very few herbicides that are labeled for watermelon production. Using these labeled herbicides can provide control of selected weeds. Polyethylene mulch can also provide weed control. Using wide mulch and practicing cultivation in row middles can reduce weed numbers until the watermelons are mature enough to produce a crop canopy (Swaider and Ware, 2002). A combination of chemical and cultural weed control may be useful for managing troublesome escape weeds in watermelons. The objective of this study is to evaluate cover crop residue along with selected herbicides for escape weed control in watermelons. Cover crop residue will also be compared to black polyethylene mulch for watermelon production and weed management.

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CHAPTER 2

EVALUATION OF PRE AND POST APPLIED HERBICIDES COMBINED WITH RYE COVER CROP FOR WEED CONTROL IN WATERMELON

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Abstract: Field studies were conducted in the spring of 2011 and 2012 at Auburn University research facilities (AURF), Auburn, AL to evaluate the effectiveness of labeled herbicides with the addition of winter cover crops for controlling troublesome escape weed species. Herbicides included ethalfluralin, halosulfuron, carfentrazone, and glufosinate. A total of nine treatments were applied. Treatments included: non-treated (bareground); ethalfluralin at 1.7 lbs a.i./A (PRE) + halosulfuron at 0.048 lb a.i./A (POST); ethalfluralin at 1.7 lbs a.i./A (PRE) + glufosinate at 0.748 lb a.i./A (POST); ethalfluralin at 1.7 lbs a.i./A (PRE) + carfentrazone at 0.031 lb a.i./A (POST); ethalfluralin at 1.7 lbs a.i./A (PRE); halosulfuron at 0.048 lb a.i./A (POST); glufosinate at 0.748 lb a.i./A (POST); carfentrazone at 0.031 lb a.i./A (POST); and cover crop with no herbicide.

No differences were seen among treatments containing cover crop residue in 2011 or 2012 when comparing yellow nutsedge populations. In 2011, cover crop residue with ethalfluralin followed by halosulfuron had the highest control of yellow nutsedge. Ethalfluralin followed by carfentrazone had the highest percent of control in 2012. There were no differences between treatments containing cover crop residue when comparing amaranth populations in 2011 or 2012. In 2011, the treatment of cover crop residue with ethalfluralin followed by glufosinate had higher yields than all other treatments except for the treatment of cover crop residue with ethalfluralin

followed by carfentrazone. The treatment of cover crop residue with ethalfluralin followed by glufosinate produced more fruit than all other treatments. In 2012, the cover crop and no herbicide treatment was similar in yields to all treatments except the nontreated treatment.

Nomenclature: Halosulfuron; Ethalfluralin; Carfentrazone; Glufosinate; Yellow nutsedge (*Cyperus esculentus*); Amaranth (*Amaranthus* spp.); Morningglory (*Ipomoea* spp.); Sicklepod (*Senna obtusifolia*); Cover crop

INTRODUCTION

Growers are more commonly choosing watermelon transplants rather than direct seeding due to more uniform plant stands and earlier harvest dates (Salter, 1985). Sufficient weed management in transplanted watermelons is difficult due to the limited number of registered herbicides (Elmstrom, 1976; Gilreath and Everett, 1983; Norton et al., 1990; Ogle, 1969; Porter and Johnson, 1986). Wide plant spacing for watermelons `and reduced seedling vigor often results in a 6 to 10 week period before the crop canopy can develop enough to suppress weed populations (Elmstrom, 1976). Inadequately controlling these weeds can reduce watermelon yields significantly (Mitchem et al., 1997). A considerable portion of watermelon production in the United States takes place in the Southeastern states of Georgia, South Carolina, North Carolina, and Florida (NCDA and CS, 2004). In 2004, this region exceeded 64,000 acres in watermelon production with a total value of $107 million. The relationship between weed populations and crop yields has been studied with a limited number of weed species. Smooth pigweed at 6 plants per 9 square feet can reduce yields 90% or greater (Monks and Schultheis, 1998; Terry et al., 1997).

A blend of chemical and cultural control is needed for sufficient control of these weed species. A limited number of herbicides are registered in vegetable crops for sicklepod and morningglory control, which creates significant problems. Mechanical weed control in watermelons is complicated due to the vining growth habit of this crop. Control measures are difficult when combining wide row spacing and slow crop emergence. Good early season weed control is critical for profitable yields. Mechanical control is possible during early crop development. However, once the crop begins to produce runners, typically 4 to 5 weeks after emergence, mechanical control is not a viable option (Terry et al., 1997).

With the limited number of herbicides labeled for broadleaf weed control in watermelons, a need exists for other weed control options to be evaluated. One potential method to reduce weed populations is the use of a cover crop. Cover crops have been used in the past to reduce water runoff and soil erosion, improve soil moisture retention, organic carbon, and nitrogen (Mallory et al., 1998; Sainju and Singh, 1997; Teasdale 1996; Varco et al., 1999; Yenish et al., 1996). Cover crops have been used to suppress weed populations in many other crops including corn, soybean, and cotton (Johnson et al., 1993; White and Worsham, 1990; Yenish et al., 1996; Varco et al., 1999; Ateh and Doll, 1996; Liebel et al., 1992; Moore et al., 1994). Reduced weed populations by cover crops can be attributed to both physical and chemical interference. Winter cover crops are planted in the fall and are grown throughout the winter months. The cover crop is then desiccated by using a roller prior to crop planting in the spring. The rolled residue then acts as a mulch to suppress weed populations. Cover crops alter the environment causing unsuitable conditions for weed growth (Masiunas et al., 1995). By competing with weeds for elements such as water, light, soil nutrients, and space, cover crops can adequately control weed populations throughout the winter and spring months. Rye is commonly used as a cover crop to reduce density and biomass of several weed species in soybeans (Liebel et al., 1992; Moore et al., 1994). Annual legume species such as crimson clover have also been evaluated as a cover crop for weed control (Teasdale et al., 1991; White and Worshman, 1990; Yenish et al., 1996). Even though cover crops may rid areas of unmanageable winter annual weed species during early spring, cover crop residues do not provide total year round weed control in summer crops (Teasdale, 1996). Thus, elimination of herbicides in summer crops is not a practical option. Both preemergence (PRE) and postemergence (POST) herbicides are commonly used to achieve optimal weed control in vegetable production (Reddy, 2001). The objective of using a winter cover crop for weed management is to create plant residue to supply adverse environmental conditions (i.e. reduction of light and space) for weed germination and establishment. Cover crop residues normally offer species-specific, partial weed control during early-season crop growth (Teasdale, 1996). The goal of using a cover crop is to replace an unmanageable weed population with a manageable crop.

Halosulfuron is a systemic herbicide belonging to the sulfonylurea class of herbicides. This herbicide was first developed for weed control in corn and grain sorghum. It is now being evaluated for use in several agricultural crops. Halosulfuron has both preemergence and postemergence activity on multiple species of weeds. Cucurbits have shown exceptional tolerance to halosulfuron in past studies (Vencill et al., 1995; Buker et al., 2004). Halosulfuron applied early POST and late POST in a study conducted by Macrae et al. (2008) caused 34 and 45% watermelon injury 2 weeks after treatment. Fruit number and weight were reduced 21 and 26% by early post treatments. Late POST treatments reduced fruit weight by 18%, but had no effect on fruit number (Macrae et al., 2008).

Glufosinate is considered a nonselective postemergence herbicide and has traditionally been used to control weeds in orchards, vineyards, and noncropland sites and for control of emerged vegetation prior to planting of crops in minimum tillage systems (Lanie et al., 1994). Glufosinate also controls many weeds commonly found in agronomic row crops (Culpepper and York, 1998, 1999; Steckel et al., 1997; York and Coble, 1997). Glufosinate is a postemergence herbicide that inhibits glutamine synthetase (Wendler et al., 1990; Wild and Wendler, 1991), the enzyme involved in the conversion of glutamic acid and ammonia into glutamine (Devine et al., 1993; Hinchee et al., 1993; Wild and Wendler, 1991). Inhibition of glutamine synthetase leads to a rapid accumulation of toxic levels of ammonia within the cell, cessation of photosynthesis, disruption of chloroplast structure, and vesiculation of stroma (Devine et al., 1993; Hinchee et al., 1993).

Carfentrazone is a postemergence broadleaf herbicide labeled for use in wheat (*Triticum aestivum* L.) and corn (*Zea mays* L.). Carfentrazone disrupts cell membranes through inhibition of protoporphyrinogen oxidase, so weed control is achieved primarily by contact action (Dayan et al., 1997). Injury to plant foliage is observed within hours after treatment, and complete plant death will occur within one week. Carfentrazone provides effective control of several broadleaf weeds, including common lambsquarters (*Chenopodium album* L.), velvetleaf, and wild buckwheat (*Polygonum convolvulus* L.) (Durgan et al., 1997).

The first objective of this experiment was to evaluate rye and crimson clover as a weed suppressant when used as a winter cover crop. The second objective was to determine which herbicide combination exhibited the greatest weed control in watermelons. Broadleaf weeds and yellow nutsedge are difficult to control weeds in all cucurbits. Testing these herbicides in conjunction with a winter cover crop could provide the best overall control of these weeds without reducing crop yields due to excessive herbicide rates.

MATERIALS AND METHODS

Field studies were conducted in the spring of 2011 and 2012 at Auburn University research facilities (AURF) at Auburn University, AL to evaluate the effectiveness of selected herbicides with the addition of winter cover crops for controlling troublesome escape weed species in watermelon. Escape weeds in this area include sicklepod (*Senna obtusifolia*), morningglory (*Ipomoea* spp.), pigweed (*Amaranthus* spp.), and yellow nutsedge (*Cyperus* *esculentus*). Soil type at AURF was a Marvyn sandy loam.Winter cover crops were planted at both sites in the second week of September. Winter rye and crimson clover were planted in conjunction with one another to suppress winter weed populations and act as mulch during the spring growing season. Rye was broadcasted at the rate of 110 lbs/A while crimson clover was broadcasted at the rate of 15 lbs/A. The cover crop was burned down in the third week of March when rye was entering the first flowering stage (36 in. tall) with a tank mix of glyphosate (14 oz/A) and glufosinate (26 oz/A).

Herbicides used included ethalfluralin, halosulfuron, carfentrazone, and glufosinate. A total of nine treatments were applied. They included ethalfluralin as a preemergence application, halosulfuron (POST), glufosinate (POST), carfentrazone (POST), ethalfluralin followed by each of the three postemergence herbicides, a non-treated bareground plot, and a cover crop plot with no herbicide. Treatments included: non-treated (bareground); ethalfluralin at 1.7 lbs a.i./A (PRE) + halosulfuron at 0.048 lb a.i./A (POST); ethalfluralin at 1.7 lbs a.i./A (PRE) + glufosinate at 0.748 lb a.i./A (POST); ethalfluralin at 1.7 lbs a.i./A (PRE) + carfentrazone at 0.031 lb a.i./A (POST); ethalfluralin at 1.7 lbs a.i./A (PRE); halosulfuron at 0.048 lb a.i./A (POST); glufosinate at 0.748 lb a.i./A (POST); carfentrazone at 0.031 lb a.i./A (POST); and cover crop with no herbicide. Each treatment was replicated four times and arranged in a completely randomized block design. Treatments were applied with a battery powered backpack sprayer calibrated to deliver 24 gal/A. The sprayer was equipped with one Tee-Jet 11004 nozzle. PRE treatments were applied immediately after seeding. POST treatments were applied 4 weeks after seeding.

A personal sized watermelon was chosen for this study. The variety ‘Darkstar’ was selected because of its desirable fruit. Watermelons were direct seeded and maintained according to commercial practices (Swaider and Ware 2002). Fertilizer was applied at 50 lbs/A (20-20-20) prior to planting followed by another 50 lbs/A throughout the growing season. Seeds were spaced

3 ft apart in parallel rows with 6 plants per plot. Seeds were planted 3 to a hill and thinned to one plant per hill 14 days after planting. Four rows were formed with a total of 9 plots per row. Plots were 20 ft long with a 6 ft buffer between plots and rows were spaced 20 ft apart.

Weed counts were taken weekly of individual species from a 9 ft^2 section of each plot. Crop yields were also recorded. Data were collected to determine which herbicide combination exhibits the greatest weed control when combined with a cover crop. Fruit size, soluble solids, and overall quality were evaluated. Data were also collected to determine if winter cover crops suppressed weed populations in watermelons. An overall evaluation was made to determine which herbicide had the best weed control when combined with a winter cover crop. Statistical analysis was conducted using a general linear model with the PROC GLM procedure of SAS Version 9.1 (SAS Institute, Cary, NC).

RESULTS AND DISCUSSION

Analysis of variance (ANOVA) revealed no differences among treatments in 2011 or 2012 when comparing yellow nutsedge populations ($P=0.2144$, $P=0.8268$) (Table 1). In 2011, cover crop residue with ethalfluralin followed by halosulfuron had the highest control of yellow nutsedge (95%) when compared to the nontreated treatment (0%) (Table 1). When a two-way comparison (LSD) was conducted in 2011, the nontreated treatment had higher nutsedge populations than the treatments of: cover crop residue with glufosinate POST; cover crop residue with carfentrazone POST; cover crop residue with ethalfluralin followed by glufosinate; cover crop residue with ethalfluralin followed by carfentrazone; and cover crop residue with ethalfluralin followed by halosulfuron (Table 1).

No differences were observed between treatments when comparing amaranth populations in 2011 or 2012 ($P=0.3143$, $P=0.2870$) (Table 2). In 2011 and 2012, cover crop residue with ethalfluralin followed by glufosinate had the greatest control of amaranth (96 and 100%) (Table

2). In 2012, the treatment containing cover crop residue with no herbicides had better amaranth control (93%) than the nontreated treatment. In 2011, LSD revealed that the nontreated treatment had higher amaranth populations than the treatments of cover crop residue with glufosinate POST; cover crop residue with carfentrazone POST; cover crop residue with ethalfluralin followed by halosulfuron; and cover crop residue alone (Table 2). In 2012, LSD revealed that the nontreated treatment had higher amaranth populations than all other treatments (Table 2).

ANOVA revealed yield differences in both 2011 (P=0.0163) and 2012 (P=0.0365) (Table 3). In 2011, the treatment of cover crop residue with ethalfluralin followed by glufosinate had higher yields (194.6 lbs/plot) than all other treatments except for the treatment of cover crop residue with ethalfluralin followed by carfentrazone (123.7 lbs/plot) (Table 3). The treatment of cover crop residue with ethalfluralin followed by glufosinate produced more fruit (17.00 fruit/plot) than all other treatments (Table 3). In 2012, the cover crop and no herbicide treatment was similar in yields to all treatments except the nontreated treatment (Table 3). ANOVA revealed no differences in fruit numbers between treatments in 2012 (P=0.1668) (Table 3). However, when a two-way comparison (LSD) is performed, cover crop residue with ethalfluralin followed by carfentrazone produced more fruit per plot than cover crop with glufosinate POST alone, cover crop with carfentrazone POST alone, and the nontreated treatment (Table 3).

In both years, cover crop residue with ethalfluralin followed by glufosinate had the highest percent control of amaranth at 96 and 100%. In 2011, all treatments containing a postemergence application had 80% control of amaranth or higher. In 2012, all treatments other than the nontreated had 93% control or higher. Lower amaranth numbers may be due to a more uniform cover crop. Cover crop stands can be attributed to rainfall and temperature. Yellow nutsedge numbers were much higher in 2012 than in 2011. This could be due to the temperature and timing of the rolling of the cover crop. Also, the study in 2012 was performed on a different field but was adjacent to the field used in 2011. Postemergence control of yellow nutsedge is difficult to accomplish in watermelons due to herbicide damage to the crop. Herbicide placement is important when using postemergence herbicides in watermelons. Preemergence herbicides may not be useful when using a cover crop because the herbicide may not reach the soil surface. Further research should be done to determine which preemergence herbicides have the greatest weed control when applied over cover crop residue.

In both years, cover crop residue with ethalfluralin followed by glufosinate produced the highest yields. This treatment also had the greatest percent control of amaranth. This study shows that controlling amaranth had an impact on watermelon yields. The cover crop with ethalfluralin followed by halosulfuron treatment had similar weed control to the cover crop residue followed by glufosinate treatment but did not produce comparable yields. Lower yields may be due to herbicide damage caused by herbicide drift onto the watermelon plants. Halosulfuron, a systemic herbicide, can cause total vine death if contact is made with the plant. Glufosinate is a contact herbicide. Contact with the crop can result in crop damage but will not translocate throughout the plant. If weeds are present when using a cover crop, postemergence herbicides are needed for sufficient weed control. Cover crops can be effective at producing high yields without the use of herbicides. Growers with lower weed pressure may benefit from using a cover crop without the use of herbicides. However, if weed populations are high, postemergence herbicides may be needed for sufficient weed management.

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Table 1. Effects of PRE or POST applied herbicides and cover crop residue on yellow nutsedge suppression for watermelon production in the summer of 2011 and 2012 at the Auburn University research facilities.

Treatment			Yellow nutsedge (2011)		Yellow nutsedge (2012)	
			Total number (#/9ft²)	Control %	Total number (#/9ft²)	Control %
Cover crop	PRE	POST				
Yes	Ethal	None	9.0ab	53ab	72.5a	29a
Yes	None	Glufos	3.3a	83a	51.5a	28a
Yes	None	Carfen	4.5a	76a	89.0a	12a
Yes	None	Halo	8.0ab	58ab	63.3a	38a
Yes	Ethal	Glufos	7.8ab	59ab	73.0a	28a
Yes	Ethal	Carfen	13.5ab	29ab	16.0a	84a
Yes	Ethal	Halo	1.0a	95a	74.3a	27a
Yes	None	None	5.5a	71a	24.0a	76a
No	None	None	19.0b	0b	101.5a	0a
Probability			0.1380		0.8268	
lsd 0.05			10.9		123.3	

Treatment differences followed by the same letter are not different according to Least Significant Difference (LSD) Test ($p \leq 0.05$). Ethal = ethalfluralin at 1.7 lb a.i./a. ; Glufos = glufosinate at 0.748 lb a.i./a ; Carfen = carfentrazone at 0.031 lb a.i./a ; Halo = halosulfuron at 0.048 lb a.i./a. % control = % control relative to the nontreated treatment. % control = 1-(trt/nontrt).

Table 2. Effects of PRE or POST applied herbicides and cover crop residue on amaranth suppression for watermelon production in the summer of 2011 and 2012 at the Auburn University research facilities

Treatment			Amaranth (2011)		Amaranth (2012)	
			Total number (#/9ft²)	Control %	Total number (#/9ft²)	Control %
Cover crop	PRE	POST				
Yes	Ethal	None	54.5ab	43ab	4.3a	94a
Yes	None	Glufos	10.0a	90a	0 .5a	99a
Yes	None	Carfen	13.3a	86a	0.8a	98a
Yes	None	Halo	19.5ab	80a	1.5a	98a
Yes	Ethal	Glufos	3.5a	96a	0.0a	100a
Yes	Ethal	Carfen	7.5a	92a	2.0a	97a
Yes	Ethal	Halo	5.5a	94a	0.0a	100a
Yes	None	None	31.5ab	67ab	4.8a	93a
No	None	None	95.0b	0b	71.5b	0b
Probability			0.3143		0.2304	
lsd 0.05			65.8		56.7	

Treatment differences followed by the same letter are not different according to Least Significant Difference (LSD) Test ($p \leq 0.05$). Ethal = ethalfluralin at 1.7 lb a.i./a.; Glufos = glufosinate at 0.748 lb a.i./a; Carfen = carfentrazone at 0.031 lb a.i./a; Halo = halosulfuron at 0.048 lb a.i./a.
% control = % control relative to the nontreated treatment. % control = 1-(trt/nontrt).

Table 3. . Effects of PRE or POST applied herbicides and cover crop residue on yields of watermelon in the summer of 2011 and 2012 at the Auburn University research facilities.

Treatment			2011		2012	
			Total number (#/plot)	Total weight (lbs/plot)	Total number (#/plot)	Total weight (lbs/plot)
Cover crop	PRE	POST				
Yes	Ethal	None	1.8c	13.5c	18.0abc	162.5abc
Yes	None	Glufos	8.8bc	83.5bc	12.0ab	174.0ab
Yes	None	Carfen	6.3bc	52.8bc	10.5bc	110.3bc
Yes	None	Halo	3.5bc	31.3bc	19.0ab	192.8ab
Yes	Ethal	Glufos	17.0a	194.5a	25.5a	273.3a
Yes	Ethal	Carfen	9.8ab	123.8ab	27.8a	253.5ab
Yes	Ethal	Halo	6.5bc	67.8bc	21.5ab	223.8ab
Yes	None	None	1.5c	15.5c	21.5ab	196.0ab
No	None	None	8.0bc	70.5bc	2.3c	18.3c
Probability			0.0104	0.0163	0.1668	0.0365
lsd 0.05			6.3	79.7	15.6	145.3

Treatment differences followed by the same letter are not different according to Least Significant Difference (LSD) Test ($p \leq 0.05$). Ethal = ethalfluralin at 1.7 lb a.i./a.; Glufos = glufosinate at 0.748 lb a.i./a ; Carfen = carfentrazone at 0.031 lb a.i./a ; Halo = halosulfuron at 0.048 lb a.i/ a. Plot = 400 ft^2

CHAPTER 3

EVALUATION OF COVER CROPS AND POLYETHYLENE MULCH FOR BROADLEAF WEED CONTROL IN WATERMELONS

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Abstract: Field studies were conducted in the spring of 2011and 2012 at the Auburn research facilities (AURF) at Auburn University, AL to evaluate the effectiveness of polyethylene mulch with the addition of winter cover crops for controlling troublesome broadleaf weed species. Four treatments were evaluated. Treatments included: black polyethylene mulch on bare soil; rye/clover cover crop with no polyethylene mulch; cover crop tilled into soil covered with polyethylene mulch, and polyethylene mulch with rye not tilled in. Seeds were spaced 3 feet apart in parallel rows with 6 plants per plot. This was a completely randomized block design study with four replications of each treatment. Data were collected to determine which treatment exhibits the greatest weed control. Differences were observed in both 2011 and 2012 when comparing yellow nutsedge populations. In 2011, the polyethylene mulch and cover crop tilled into the soil treatment had fewer nutsedge than the treatment with cover crop residue without polyethylene mulch. In 2012, all treatments containing polyethylene mulch had lower yellow nutsedge per square yard than the cover crop residue alone treatment. No differences were observed when comparing amaranth populations in 2011 or 2012.

In 2011, treatments containing polyethylene mulch on bare soil and polyethylene mulch on cover crop residue produced higher yields than the cover crop alone treatment. Studies in 2012 showed similar results. Plastic mulch on bare soil produced higher yields than the cover

crop residue without polyethylene mulch treatment and the treatment with cover crop residue not tilled in with polyethylene mulch. Polyethylene mulch on bare soil had comparable yields with the treatment of polyethylene mulch over a cover crop tilled into the soil. All three treatments containing polyethylene mulch had higher yields than the treatment without polyethylene mulch. In 2011, differences in fruit number were observed between treatments with or without polyethylene mulch. Treatments containing polyethylene mulch on bare soil and polyethylene mulch with cover crop tilled in had higher yields than the cover crop alone treatment. Similar results were observed in 2012. All treatments containing polyethylene mulch were comparable and were different from the treatment with cover crop residue alone.

Nomenclature: Yellow nutsedge (*Cyperus esculentus*); Amaranth (*Amaranthus* spp.); Morningglory (*Ipomoea* spp.); Sicklepod (*Senna obtusifolia*); Cover crop; Polyethylene mulch.

INTRODUCTION

Sufficient weed management in transplanted watermelons is not easy due to the limited number of registered herbicides (Elmstrom, 1976; Gilreath and Everett, 1983; Norton et al., 1990; Ogle 1969; Porter and Johnson, 1986). Wide plant spacing for watermelons and reduced seedling vigor often results in a 6 to10 week period before the crop canopy can develop enough to suppress weed populations (Elmstrom, 1976). Inadequately controlling these weeds can reduce watermelon yields significantly (Mitchem et al., 1997). Growers are more commonly choosing watermelon transplants rather than direct seeding due to more uniform plant stands and earlier harvest dates (Salter, 1985).

A blend of chemical and cultural control is needed for sufficient control of these weed species. A limited number of herbicides are registered in vegetable crops for sicklepod and morningglory control, which raises significant problems. Mechanical weed control in watermelons is complicated due to the vining growth habit of this crop. Control measures are difficult when combining wide row spacing and slow crop emergence. Good early season weed control is critical for profitable yields. Mechanical control is possible during early crop development, however, once the crop begins to produce runners mechanical control is not a viable option. Watermelons typically begin to produce runners 4 to 5 weeks after emergence (Terry et al., 1997).

With the limited number of herbicides labeled for broadleaf weed control in watermelons, a need exists for a supplement for chemical control to be evaluated. One potential method to reduce weed populations is the use of cover crop residues. Cover crops have been used in the past to reduce water runoff and soil erosion, improve soil moisture retention, organic carbon, and nitrogen (Mallory et al., 1998; Sainju and Singh, 1997; Teasdale, 1996; Varco et al., 1999; Yenish et al., 1996). Cover crops have been used to suppress weed populations in many other crops including corn, soybean, and cotton (Johnson et al., 1993; White and Worsham, 1990; Yenish et al., 1996; Varco et al., 1999; Ateh and Doll, 1996; Liebel et al., 1992; Moore et al., 1994). Reduced weed populations by cover crops can be attributed to both physical and chemical interference. Winter cover crops are planted in the fall and are grown throughout the winter months. The cover crop is then desiccated by using a roller prior to crop planting in the spring. The rolled residue then acts as a mulch to suppress weed populations. Cover crops alter the environment causing unsuitable conditions for weed growth (Masiunas et al., 1995). By competing with weeds for elements such as water, light, soil nutrients, and space, cover crops can adequately control weed populations throughout the winter and spring months. Rye (*Secale cereal*) is commonly used as a cover crop to reduce density and biomass of several weed species in soybeans (Liebel et al., 1992; Moore et al., 1994). Annual legume species such as crimson clover have also been evaluated as a cover crop for weed control (Teasdale et al., 1991; White and Worshman, 1990; Yenish et al., 1996). Even though cover crops may rid areas of unmanageable winter annual weed species during early spring, cover crop residues do not provide total year round weed control in summer crops (Teasdale, 1996). Thus, elimination of herbicides in summer crops is not a practical option. Both preemergence (PRE) and postemergence (POST) herbicides are commonly used to achieve optimal weed control in vegetable production (Reddy, 2001). The objective of using a winter cover crop for weed management is to create plant residue to supply adverse environmental conditions (i.e. reduction of light and space) for weed germination and establishment. Cover crop residues normally offer species-specific, partial weed control during early-season crop growth (Teasdale, 1996). The goal of using a cover crop is to replace an unmanageable weed population with a manageable cover crop.

Black polyethylene mulch has been used in commercial vegetable production since the 1960s. It is currently used on thousands of acres across the United States. Polyethylene mulch is used early in the growing season to warm soil temperatures to promote seed germination and plant growth. Polyethylene mulch is also very effective at reducing weed populations and aids in moisture retention. All of these qualities can significantly increase yields and fruit quality (Hochmuth, 1989). Polyethylene mulch also has negative aspects. Applying mulch requires specialized equipment that can be too expensive for some growers. Polyethylene mulch also has to be removed and disposed of after use. This is usually done by hand. Recycling of polyethylene mulch is possible, however, plant and pesticide residues often make it difficult (Hochmuth, 1989).

The first objective of this experiment was to evaluate rye and crimson clover as a weed suppressant when used as a winter cover crop. The second objective was to determine if cover crop residues can produce overall yields comparable to polyethylene mulch.

MATERIALS AND METHODS

Field studies were conducted in the spring of 2011 and 2012 at the Auburn University research facilities (AURF) at Auburn University, AL to evaluate the effectiveness of polyethylene mulch with the addition of winter cover crops for controlling troublesome broadleaf weed species. Soil type at AURF was a Marvyn sandy loam. Winter cover crops were planted the second week of September in 2011 and 2012. Winter rye (*Secale cereal*) and crimson clover (*Trifolium incarnatum*) were planted in conjunction with one another to suppress winter weed populations and act as a mulch during the spring growing season. Rye was broadcasted at the rate of 110 lb/A while crimson clover was broadcasted at the rate of 15 lb/A. The cover crops were burned down with a combination of glyphosate (Makaze 41%)(0.43 lb a.i./A)and glufosinate (Ignite 280SL)(0.475 lb a.i./A).

Watermelons were direct seeded on April 21, 2011 and April 23, 2012. A personal sized watermelon was chosen for this study. The variety ‘Darkstar’ was selected because of its desirable fruit. Four treatments were evaluated. Treatments included: polyethylene mulch on bare soil, rye/clover cover crop with no polyethylene mulch, cover crop tilled into soil covered with polyethylene mulch, and polyethylene mulch with rye in the row-middles not tilled in. For the latter treatment polyethylene mulch was applied prior to seeding the rye and clover in September. The cover crop was rolled along the edge of the polyethylene without damaging the polyethylene. Watermelons were direct seeded, maintained according to commercial practices, and fertilized according to soil test recommendations. Seeds were planted 3 to a hill and thinned to 1 plant per hill 14 days after planting. This was a completely randomized block design study with four replications of each treatment. Each plot consisted of a single-row 20 ft long with a total of 6 plants per plot. Rows were spaced 20 ft apart.

Data gathered included: weed evaluation, watermelon quality and yields. Individual weed ratings were taken weekly from a 9 ft^2 section of each plot. Crop yield was recorded. Data were collected to determine which herbicide combination exhibits the best weed control. Fruit size and soluble solids were evaluated. Soluble solid content showed no differences between treatments (Data not shown). Data were also collected to determine whether or not winter cover crops suppressed weed populations in watermelons. Hobo V2 data loggers (Onset computer corp. Bourney, MA) were placed at the soil surface and 4 inches below the soil surface on all treatments. These instruments record soil temperature constantly throughout the season. An overall evaluation was made to determine if cover crop residues can produce yields comparable to conventional polyethylene mulch. Statistical analysis was conducted using a general linear model with the PROC GLM procedure of SAS Version 9.1 (SAS Institute, Cary, NC).

RESULTS AND DISCUSSION

ANOVA revealed differences in both 2011 (P=0.0219) and 2012 (P=0.0064) when comparing yellow nutsedge populations (Table 1 and Table 2). In 2011, the black polyethylene mulch and cover crop tilled into the soil treatment had fewer nutsedge (9.5 nutsedge/9 ft^2) than the treatment with cover crop residue without polyethylene mulch (21.0 nutsedge/9 ft^2) (Table 1). In 2012, all treatments containing polyethylene mulch had lower yellow nutsedge per 9 ft^2 than the cover crop residue alone treatment. No differences were observed when comparing amaranth populations in 2011 (P=0.1143) or 2012 (P=0.0772) (Table 1). However, in two-way LSD comparisons differences were observed when comparing the black polyethylene mulch and cover crop residue tilled treatment (2.3 amaranth/9 ft^2) and the cover crop residue alone treatment (9.5 amaranth/9 ft^2) (Table 1).

ANOVA revealed differences in yield in 2011 (P=0.0040) and (P=<0.0001) (Table 2). In 2011, treatments containing black polyethylene mulch on bare soil (149.8 lbs/plot) and polyethylene mulch on cover crop residue (121.5 lbs/plot) produced higher yields than the cover crop alone treatment (44.5 lbs/plot) (Table 2). Studies in 2012 showed similar results (P=<0.0001) (Table 2). Polyethylene mulch on bare soil produced higher yields (187.8 lbs/plot) than the cover crop residue without polyethylene mulch treatment (39 lbs/plot) and the treatment with cover crop residue not tilled in with polyethylene mulch (129 lbs/plot) (Table 2). Polyethylene mulch on bare soil had comparable yields with the treatment of polyethylene mulch over a cover crop tilled into the soil (182.3 lbs/plot). All three treatments containing polyethylene mulch had higher yields than the treatment without polyethylene mulch (Table 2). In 2011, differences in fruit number were observed (P=0.0036) between treatments with or without polyethylene mulch. Treatments containing polyethylene mulch on bare soil (15.0 fruit/plot) and polyethylene mulch with cover crop tilled in (13.8 fruit/plot) had higher yields than the cover crop alone treatment (4.3 fruit/plot) (Table 2). Similar results were observed in 2012 (P=0.0042) (Table 2). All treatments containing polyethylene mulch were comparable and were different from the treatment with cover crop residue alone (Table 2).

Differences in weed populations can be attributed to the presence of polyethylene mulch treatments. Cover crop alone treatment had the lowest percent control of both amaranth and nutsedge in 2011 and 2012. Also, the cover crop alone treatment had the lowest yields in both years. All treatments containing plastic mulch had comparable fruit yields. Cost of polyethylene mulch for watermelons is approximately $185/acre. This does not include other expenses, equipment costs, and time applying the mulch. Planting a rye cover crop will cost approximately $25/acre. Polyethylene mulch can be very effective at producing high yields and earlier yields which is important for growers. Early yields can be attributed to warm soil temperatures under the plastic mulch. It was determined that soil temperatures underneath a cover crop top out around 90°F while soil temperatures underneath plastic mulch top out around 105°F during the time of seed germination when using HOBO temperature data loggers. Although polyethylene mulch is more expensive and can be troublesome to apply, it can drastically improve crop yields. Plants can mature quicker and provide fruit up to several weeks earlier than fields with cover crop residue. Polyethylene mulch can be very efficient at controlling weed populations and producing high yields without the use of herbicides.

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Table 1. Effects of cover crop residues along with black polyethylene mulch on yellow nutsedge and amaranth suppression for watermelon production in the summer of 2011 and 2012 at the Auburn University research facilities.

Treatment		Yellow nutsedge control				Amaranth control			
		2011		2012		2011		2012	
Cover crop	Polyethylene mulch	#/ 9 ft²	Control %	#/ 9 ft²	Control %	#/ 9 ft²	Control %	#/ 9 ft²	Control %
No	Yes	14.2ab	32ab	11.2a	41a	4.2ab	55ab	2.7ab	8ab
Yes (tilled)	Yes	9.5a	54a	12.5a	34a	2.5a	76a	1.7ab	42ab
Yes (not tilled)	No	21.0b	0b	19.0b	0b	9.5b	0b	3.0b	0b
Yes (not tilled)	Yes	- x	- x	10.7a	43a	- x	- x	1.2a	58a
Probability		0.0219		0.0064		0.1143		0.0772	
lsd 0.05		7.6		4.5		5.4		1.6	

Treatment differences followed by the same letter are not different according to least significant difference (lsd) test ($p \leq 0.05$).

x—Data were not collected in 2011.
% control = % control relative to the nontreated treatment. % control = 1-(trt/nontrt).
Plot = 400 ft²

Table 2. Effects of cover crop residue along with black polyethylene mulch on watermelon yield in the summer of 2011 and 2012 at the Auburn University research facilities.

Treatment		2011		2012	
Cover crop	Plastic mulch	Fruit number (#/plot)	Total weight (lbs/plot)	Fruit number (#/plot)	Total weight (lbs/plot)
No	Yes	15.0a	149.7a	21.2a	187.7a
Yes (tilled)	Yes	13.7a	121.5a	19.5a	182.2a
Yes (not tilled)	No	4.2b	44.5b	4.0b	39.0c
Yes (not tilled)	Yes	-x	-x	14.0a	129.5b
Probability		0 .0036	0.0040	0.0042	<0.0001
lsd 0.05		4.2	47.2	8.6	41.3

Treatment differences followed by the same letter are not different according to least significant difference (lsd) test ($p \leq 0.05$).
x—Data were not collected in 2011.
% control = % control relative to the nontreated treatment. % control = 1-(trt/nontrt).
Plot = 400 ft^2

CHAPTER 4

FINAL DISCUSSION

Cover crops can effectively suppress broadleaf weed populations. Previous research has shown that rye cover crop residue can reduce weed populations. Treatments containing postemergence herbicides along with cover crop residue had the greatest overall weed control and highest yields. Ethalfluralin followed by carfentrazone and ethalfluralin followed by glufosinate produced the highest number of fruit in 2011 and 2012. No differences were observed between treatments containing cover crop residues when controlling amaranth populations. However, all treatments containing a post emergence application had lower weed populations than the nontreated treatment. Yellow nutsedge populations were much higher in 2012 than in 2011. In 2011, ethalfluralin followed by halosulfuron provided the greatest control of yellow nutsedge. Results from this study show that greater weed control can be accomplished when preemergence and postemergence herbicides were combined.

Early season weed control is important for producing high yields. Early season broadleaf weed control is accomplished when using cover crop residue. However, yellow nutsedge populations are not as greatly affected when using cover crop residue. Nutsedge must be controlled with polyethylene mulch or preemergence herbicides for optimum fruit yields. When using cover crop residues, preemergence herbicides may not be effective because the chemical cannot reach the soil surface. Preemergence herbicides require soil contact to effectively control weeds. In 2011, the bareground treatment had yields comparable to the cover crop treatments while having significantly higher weed populations. Higher yields could be due to earlier crop emergence in the bareground treatment. Soil temperatures were cooler under cover crop residue than bareground soil. This results in slower crop emergence.

Both years ethalfluralin followed by glufosinate produced the highest yields. This may be due to glufosinate's ability to target broadleaf weeds along with grasses and sedges. In 2012, cover crop residue alone produced yields comparable with ethalfluralin followed by any post treatment. This reveals that a good cover crop residue can be beneficial when trying to control weed population without the use of preemergence or postemergence herbicides.

Herbicide applications were made 4 weeks after planting when weed populations began to interfere with watermelon growth. Herbicide application timing is important when applying a postemergence material. Further research would be useful to determine what kind of effect application timing has on weed control when using a cover crop residue. This experiment showed that cover crop residues are effective at reducing broadleaf weed populations. However, escape weeds were present later in the growing season. By applying postemergence herbicides, escape weeds can be controlled later in the season.

Using black polyethylene mulch is very effective at controlling weed populations. However, it can be very expensive. The cost of polyethylene mulch for watermelons is approximately $185/acre. This does not include other expenses such as equipment costs and labor. Planting a rye cover crop will cost around $25/acre. Treatments containing cover crop residues had the greatest control of amaranth species. The treatment with polyethylene mulch on bare ground had the least control of amaranth. Plastic mulch is needed for adequate control of nutsedge without the use of preemergence herbicides. All treatments containing polyethylene mulch produced higher yields than the cover crop alone treatment. Further research should be done to determine if transplants can produce better yields than direct seeding when using cover crop residues. If yellow nutsedge populations are high in an area, using a cover crop may not adequately control these weeds for optimum watermelon yields. However, cover crops can be effective at controlling amaranth and other broadleaf weeds. Growers trying to control broadleaf weeds without using herbicides may benefit from using cover crops.