

Title:

Herbicide Weed Control in Annual Plasticulture Strawberries

Report Type:

Progress

Grant Code:

SFSFC Project # 2014-12

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Objectives:

- 1) To evaluate various combinations of labeled and soon to be labeled herbicides for weed control and safety to annual plasticulture strawberries.
- 2) To evaluate various combinations of labeled and soon to be labeled herbicides for efficacy to plug and bare-root annual plasticulture strawberry plant types.
- 3) To evaluate ways of feasibly applying those herbicides to bed tops with present equipment.

Justification and Description:

With the continued phase out of methyl bromide, more and more plasticulture strawberry growers are experiencing weed escapes through the planting holes in the plastic. These weeds compete with the strawberry plant for water, nutrition and sunlight. I have actually seen the weeds so bad that they “smother” the strawberry plant.

Most growers are fumigating with alternatives containing chloropicrin and Telone. However, weed control provided by these products appears to be less consistent than when using Methyl Bromide 98:2 or 67:33. Even Methyl Bromide 50:50 does not provide the consistent weed control of previous formulations.

In addition to the reduced efficacy with many of the alternative fumigation products, many small growers are refusing to deal with the requirements to prepare fumigant management plans when fumigating. Therefore, many smaller growers are opting to not fumigate at all. In non-fumigated situations, weeds in planting holes can be quite severe.

In the fall of 2012, a study was planted to evaluate various preemergence herbicides for weed control in planting holes, as well as phytotoxicity to the annual plasticulture strawberry plugs / plants. Herbicides evaluated, included: Chateau, Devrinol, Dual Magnum, Goal 2XL, Prowl, Reflex, Spartan and Ultra Blazer. Most of the products evaluated were safe to the newly planted

strawberry plugs. Chateau and Goal did cause some stunting soon after planting; however, by spring, no visual differences in plant growth or yield were observed among any of the preemergence herbicide treatments. All of the treatments provided better weed control than the UTC.

For the second objective of the first year proposal, plastic laying equipment was evaluated to determine if herbicides could be applied during the process of forming the beds and laying the plastic. The two main “bedders” used in our area are Rain-Flo and Reddick. With the design of the new Rain-Flo units, it is almost impossible to apply an herbicide during the bedding / plastic laying process. Therefore, if using a Rain-Flo bedder / mulch layer, the beds will have to be formed, herbicide applied in an additional application and plastic mulch laid with minimal soil disturbance.

On the other hand, using the Reddick bedder / plastic mulch layer we were able to apply herbicide as the beds were formed and the plastic mulch was laid. This was accomplished by installing two 80 degree flat fan nozzles to a piece of metal above the press pan. These two nozzles were positioned to cover the entire bed top. In the fall of 2013, a trial evaluating Prowl and Prowl plus Spartan was planted using the configuration. Early season evaluations show no phytotoxicity to the strawberry plugs / plants and excellent weed control.

Consistent with objectives of this project, we want to determine which herbicide combinations are safest to the strawberry plugs and bare-roots, as well subsequent strawberry plants, while providing the best weed control.

The first two objectives of this project will be to conduct replicated herbicide trials to tank mix combinations that are safe to the strawberry plants, while controlling the weeds in the plant holes. It appears that a combination of two or more products will be required to control spectrum of weeds experienced in annual plasticulture strawberry production. Tank mixes will focus on Devrinol, Dual Magnum and Prowl as the grass control components of the tank mix. Since Devrinol can be tricky, in that it can inhibit root formation in newly planted strawberries, care will have to be taken to make sure it is not mixed into the soil of the beds. Tank mix components such as Chateau, Reflex, Spartan and Ultra Blazer will be evaluated for broadleaf weed control. Therefore, the proposed treatment list will be as follows:

1. UTC
2. Devrinol @ 8 lb/A
3. Devrinol @ 8 lb/A plus Chateau @ 3 oz/A
4. Devrinol @ 8 lb/A plus Reflex @ 1.5 pints/A
5. Devrinol @ 8 lb/A plus Spartan 4F @ 8 fl oz/A
6. Devrinol @ 8 lb/A plus Ultra Blazer @ 2 pints/A
7. Dual Magnum @ 1.5 pints/A
8. Dual Magnum @ 1.5 pints/A plus Chateau @ 3 oz/A
9. Dual Magnum @ 1.5 pints/A plus Reflex @ 1.5 pints/A
10. Dual Magnum @ 1.5 pints/A plus Spartan 4F @ 8 fl oz/A
11. Dual Magnum @ 1.5 pints/A plus Ultra Blazer @ 2 pints/A
12. Prowl 3.3 EC @ 2 pints/A

13. Prowl 3.3 EC @ 2 pints/A plus Chateau @ 3 oz/A
14. Prowl 3.3 EC @ 2 pints/A plus Reflex @ 1.5 pints/A
15. Prowl 3.3 EC @ 2 pints/A plus Spartan 4F @ 8 fl oz/A
16. Prowl 3.3 EC @ 2 pints/A plus Ultra Blazer @ 2 pints/A

The beds will be formed and herbicides applied to the bed tops and plastic applied with minimal soil disturbance. The preliminary work has shown very good crop safety to plug plants. However, we need to determine if bare-root fresh dug plants will behave similarly. Therefore 10 to 20 plants of each type; plugs and bare-root fresh dugs will be planted in each treatment.

Data collected will include plant survival, phytotoxicity (plant vigor), fruit yield and weed control. All data will be analyzed utilizing ANOVA at the 0.05 level of probability. Treatments found to be significant at the 0.05 level of probability will be subjected to Mean Separation Techniques.

Application Equipment

In recent years, some growers have applied herbicides prior to bed formation. However, they usually saw less than favorable results and often caused injury to the strawberry plus due to “hot spots” created during the bedding process. Because of the nature of the herbicides and the issue with non-uniform soil flow through the bedder during the bedding process, most of the herbicides need to be applied to the bed top after bed formation with little or no soil disturbance. This is difficult to do with many of the small single pass bedder/plastic mulch layers used by producers.

Also of concern is the ability to apply the herbicide to the bed top and avoiding application to the row middles. This is especially critical if establishing a cover crop like annual ryegrass in the middles.

Therefore, to complete the third objective of this proposal commonly used bedder / plastic mulch layers will be examined and evaluated for ways of applying herbicides after bed formation, but prior to application of the plastic. This will need to be done with little or minimal soil movement.

Methodologies

Replicated Trial of Herbicides

In the fall of 2012, a study was planted to evaluate various preemergence herbicides for weed control in planting holes, as well as phytotoxicity to the annual plasticulture strawberry plugs / plants. Herbicides evaluated, included: Chateau, Devrinol, Dual Magnum, Goal 2XL, Prowl 3.3EC, Reflex, Spartan 4F and Ultra Blazer. Beds were formed and drip tape was installed.

Herbicide treatments were applied to the bed tops on September 30, 2012. Other pertinent application parameters are listed in Table 1. Plastic was applied to the beds with as little soil disturbance as possible. ‘Chandler’ strawberry plants were planted on October 17, 17 days after

herbicide application. Strawberry plants were spaced 12 inches in-row and 15 inches between double rows on 6 foot bed centers. Each experimental unit was 15 feet long and contained approximately 30 plants.

Plant injury ratings were taken on November 17, 2012, 48 days after herbicide application and 31 days after planting. Plant injury rating was a percentage vigor reduction as compared to the untreated check plot for the replication. Weed control ratings were taken on May 13, 2013 and consisted of percentage weed control as compared to the untreated check plot for the replication. Yields were collected from mid-May through mid-June and consisted of pounds of fruit harvested from each experimental unit.

The experimental design was a randomized complete plot with 4 replications. All data was subjected to ANOVA techniques. Means of variables found to be significant at the 0.05 level of probability were subjected to SNK means separation techniques at the 0.05 level of probability.

Table 1. Application parameters for preemergence herbicide treatments made to strawberry beds, September 30, 2012.

Application Date	9/30/12
Application Time	12:50 to 1:15 p.m.
Air Temperature	69 degrees F
Relative Humidity	62%
Cloud Cover	50%
Wind Speed	0 – 2 mph
Wind Direction	From the Southeast
Soil Temperature at 4 inches	71 degrees F
Soil Moisture	Moist
Soil Condition	Freshly Worked and Bedded / Firm Middles
Soil Texture	Loam
Application Pressure	30 psi
Gallons per Acre (GPA)	17
Nozzles	XR TeeJet 11002

In the fall of 2014, a study was planted to evaluate various preemergence herbicides combinations (see list above) for weed control in planting holes, as well as phytotoxicity to the annual plasticulture strawberry plugs / plants. Herbicides evaluated, included: Devrinol, Dual Magnum and Prowl 3.3EC as “grass” herbicides. These products were applied alone and in combination with Chateau, Reflex, Spartan 4F and Ultra Blazer.

Beds were formed and drip tape was installed. Herbicide treatments were applied to the bed tops on September 16, 2014. Other pertinent application parameters are listed in Table 2. Plastic was applied to the beds with as little soil disturbance as possible. ‘Chandler’ strawberry plants were planted on September 26 and 27, 10 and 11 days after herbicide application. Strawberry plants were spaced 14 inches in-row and 15 inches between double rows on 6 foot bed centers. Each experimental unit was 12 feet long and contained approximately 20 plants. Plants were observed for injury several times during the fall.

Table 2. Application parameters for preemergence herbicide treatments made to strawberry beds, September 16, 2014.

Application Date	9/16/14
Application Time	2:30 to 4:00 p.m.
Air Temperature	79 degrees F
Relative Humidity	67%
Cloud Cover	90% - Showered during application
Wind Speed	1 – 5 mph
Wind Direction	From the West
Soil Temperature at 4 inches	74 degrees F
Soil Moisture	Moist – However, some clods
Soil Condition	Freshly Worked and Bedded / Firm Middles
Soil Texture	Clay Loam
Application Pressure	30 psi
Gallons per Acre (GPA)	17
Nozzles	XR TeeJet 11002

Application Equipment

Two models of Rain-Flo bedder / plastic mulch layers (Model 2550 and Model 2600) and an older version of a Reddick bedder / plastic mulch layer were inspected for the possibility of applying an herbicide to the top of the bed as the bed was being formed.

With the design of the new Rain-Flo units, it is almost impossible to apply an herbicide during the bedding / plastic laying process. Therefore, if using a Rain-Flo bedder / mulch layer, the beds will have to be formed, herbicide applied in an additional application and plastic mulch laid with minimal soil disturbance.

On the other hand, using the Reddick bedder / plastic mulch layer we were able to apply herbicide as the beds were formed and the plastic mulch was laid. This was accomplished by installing two 80 degree flat fan nozzles to a piece of metal above the press pan. These two nozzles were positioned to cover the entire bed top.

A grower with the Reddick bedder agreed to let us trial this application process. On August 26, 2013, a 15 gallon spray tank with a 12 volt motor was attached to the Reddick bedder. The apparatus was calibrated and found to be applying 30 GPA. Two different preemergence herbicide treatments were applied. The first half of the field was treated with Prowl 3.3EC at 2 pints/A. The remainder of the field was treated with Prowl 3.3EC at 2 pints/A plus Spartan 4F at 8 fl oz/A. A few areas of the field were left untreated as comparisons.

Field observations have shown great grass and winter annual control with Prowl. However, Prowl does not provide good control of some broadleaf weeds and wild brassicas. Experience has shown that Spartan does not control grass weeds, but does provide control of many broadleaf weeds. Therefore, we felt this would be a good combination.

Plant injury ratings were taken on 9/22, 10/26 and 12/01; and consisted of percentage vigor reduction as compared to the untreated check plots. Weed control ratings were taken 9/22, 10/26 and 12/01; and consisted of percentage of plant holes exhibiting weed growth.

Results

Replicated Trial of Herbicides

All of the products evaluated were safe to the newly planted strawberry plugs. Chateau and Goal did cause some stunting soon after planting; however, by spring, no visual differences in plant growth or yield were observed among any of the preemergence herbicide treatments (Table 3). All of the treatments provided better weed control than the UTC. Transplants were planted approximately 2 months later than recommended for this area, therefore yields were low. However, there were no significant differences in yield among herbicide treatments.

Table 3. Plant injury ratings, weed control ratings and yield of ‘Chandler’ strawberry plants receiving various preemergence herbicide applications, 2012 - 2013.

Product	Application Rate (amount/A)	Plant Injury Ratings (%)^x	Weed Control Ratings (%)^y	Fruit Yield (quarts/A)
UTC	---	0 c ^z	0 d	1,732
Chateau	3 oz/A	15 b	94 a	1,636
Devrinol 50WP	8 lb/A	0 c	80 b	1,482
Dual Magnum	1.5 pints/A	0 c	74 c	1,440
Goal 2XL	2 pints/A	21 a	93 a	1,802
Prowl 3.3EC	2 pints/A	0 c	74 c	1,448
Reflex	1.5 pints/A	0 c	74 c	1,394
Spartan 4F	8 fl oz/A	0 c	78 bc	1,874
Ultra Blazer	2 pints/A	0 c	78 bc	1,780

^x Plant injury ratings were taken on 11/19/12 and consisted of percentage vigor reduction as compared to the untreated check plots.

^y Weed control ratings were taken 5/13/13 and consisted of control as compared to the untreated check plots.

^z Means within a column followed by the same letter are not statistically different at the 0.05 level of probability. Means separated utilizing SNK Multiple Range Test at the 0.05 level of probability. Absence of letters indicates no significant difference at the 0.05 level of probability.

2014

No injury was observed in the fall. Yield and weed control evaluations will be taken in the spring.

Application Equipment

The treatments containing Prowl and Prowl plus Spartan caused no visible injury to either ‘Camarosa’ or ‘Sweet Charlie’ strawberry plants (Table 4). On 9/22, both herbicide treatments were providing 100% control of weeds in the plant holes, while about 20% of the plant holes in the UTC areas were showing weeds. By 10/26, the Prowl and Spartan treatment was still providing 99 to 100% control of weed in the plant holes. At the same time, the Prowl alone treatment was beginning to show more weeds (10-20% of the holes) and the UTC area was showing 25% of the plant holes with weeds. At the final rating data (12/01), Prowl and Spartan was still providing 95 to 100% control of weeds, while Prowl alone was still providing 75 to 80% control of the weeds. The untreated check areas were generally weedier than the treated areas (50%) , while in some areas of the field, every plant hole that was not treated with a herbicide had weeds in the hole.

Table 4. Plant injury ratings and weed control ratings of ‘Camrosa’ and ‘Sweet Charlie’ strawberry plants receiving various preemergence herbicide applications, 2013.

Product	Application Rate (amount/A)	Plant Injury Ratings (%) ^y			Weed Control Ratings (%) ^z		
		9/22	10/26	12/01	9/22	10/26	12/01
UTC	---	0	0	0	80	100	100
Prowl 3.3EC	2 pints/A	0	0	0	75	80 - 90	99 - 100
Prowl 3.3EC Spartan 4F	2 pints/A 8 fl oz/A	0	0	0	0 - 50	75 - 80	95 - 100

^y Plant injury ratings were taken on 9/22, 10/26 and 12/01; and consisted of percentage vigor reduction as compared to the untreated check plots.

^z Weed control ratings were taken 9/22, 10/26 and 12/01; and consisted of the percentage of plant holes exhibiting weed growth.

Conclusions

Replicated Trial of Herbicides

All herbicides appeared to be safe for use under plastic in annual plasticulture strawberry production. Chateau and Goal, did appear to cause some preliminary stunting; however, the plants were able to grow through the initial injury. Some products evaluated provided good control of grass and winter annual weeds, while others provided better control of broadleaf weeds. Therefore, a combination of products will likely provide the best control. A good example of this will be Prowl plus Spartan.

Application Equipment

In the fall following the application of Prowl and Prowl plus Spartan, there was no visible plant injury. Prowl plus Spartan provided the best weed control (almost 100%). Prowl alone

controlled grass weeds and suppressed broadleaf weeds for about a month. However, 2 months after planting, 20 to 25% of plant holes were exhibiting weeds like wild mustard / turnip. In the areas left untreated, 50 to 100% of all holes exhibited weed growth by December 1.

Impact Statement

With the phase-out of MeBr, several herbicide options appear to provide acceptable weed control in annual plasticulture strawberry production. A good example is the combination of Prowl and Spartan, which provides excellent weed control, with no plant injury.