

1. Title:

Integrating Weed Management Options in Strawberries (Year 2)

2. Project Leader:

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4. Abstract:

Weed management in perennial strawberries is essential for long-term productivity. Particularly, management during the planting year is especially important to maximize stand establishment and minimize pressure in years to come. Reduction in weed populations can reduce disease and insect pressure and drastically reduce costly hand-weeding. Different studies have evaluated chemical, mechanical, and biological control measures separately. Whereas commercial growers integrate these tools into a program approach. This project evaluated seven different weed management systems for strawberries. Treatments included the use of broadcast and banded herbicides, cultivation equipment, and inter-seeding of fescue grass in a variety of combinations. A banded herbicide, which results in a 50% reduction in herbicide use, plus cultivation treatment and use of inter-seeded fescue with broadcast herbicide treatment both had the greatest reductions in weeds. Results suggest that cultivation equipment did not have a detrimental impact on plant development and establishment. Herbicide reductions strategies, i.e. banded herbicides and cultivation, treatments had similar yields when compared to broadcast herbicide treatments. Though, there was a varietal response to frequency of cultivation. This trial supports the conclusion that perennial strawberries can be produced under minimal herbicide input.

5. Background and justification:

Strawberries are an important component of New York State's total fruit production value. In 2004, berries were grown on 1,500 acres and the crop was valued at 10.4 million dollars; the third highest valued fruit crop in the state (NY NASS, 2005). Weed control can be a major limiting factor in strawberries and without proper management; they reduce yields through competition for water, nutrients and light. Additionally, weeds are hosts for insects and diseases that decrease fruit quality. A recent survey of growers determined that weed control was the #1 priority for research needs.

During the planting year, 75% of growers surveyed apply a broadcast pre-emergence herbicide followed by one to two post-emergence applications. 83% of growers follow the pre-emergence application with cultivation and 85% utilize hand-weeding when herbicide effectiveness is lost. The necessity for an additional one to two herbicide applications dramatically increases the pesticide load on the environment. Two-thirds of growers surveyed stated that they do not band herbicides, mostly due to lack of knowledge (2006 Grower Survey). Competition from in-row weeds during establishment can dramatically decrease yields. Banded

herbicides result in a reduction of 50% in herbicide use and can adequately maintain the row weed-free.

As previously stated, growers commonly rely on more than one type of weed control. The impact one control measure has on another has not been clarified in previous research. Despite utilizing a diversified management system, growers still have weed problems. The goal of this research was to determine the impact that integrated management practices have on the ability to minimize weeds. Through the monitoring of weed populations, strawberry plant development and establishment, and yields we intend to determine how more effectively these tools can be integrated.

6. Objectives:

- 1.) Compare seven different weed management systems for their impact on plant establishment, subsequent plant growth, daughter plant production/development, and yield.
- 2.) Evaluate the impact that these various systems have on weed populations and species diversity.
- 3.) This project will be evaluated through many avenues but will be most heavily weighed by its ability to provide strawberry growers with an immediate, effective way to reduce weed pressure and maintain yield quality. This will be determined through discussion with NY Berry Growers Association Board members, extension personnel, statewide growers, and researchers.

7. Procedures:

Objectives 1 and 2. The study was conducted at the H. C. Thompson Research Facility in Freeville, NY on a Howard Gravel Loam soil. Plants were transplanted on May 9, 2006 into plots containing one row each of 'Earliglow' and 'Jewel' varieties. The treatments were: A.) Standard Broadcast Herbicide, B.) Standard Broadcast Herbicide + Fescue, C.) Banded Herbicide + Cultivation(Between+In-row), D.) Banded Herbicide + Fescue, E.) Fescue + In-row cultivation, F.) Between + In-row cultivation only, and G.) Handweeded Check. All applications were made using a CO₂ sprayer that delivered 34 GPA. In-row cultivation was done with a Buddingh Finger Weeder (Buddingh Weeder Co., Dutton MI) and a torsion weeder (Bezerides Brothers, Orosoi, CA). An s-tine cultivator was used between rows. The fescue variety 'Firefly' was seeded at 200 lbs/A between rows sixteen days after transplanting and was maintained as needed throughout the trial. Each treatment had four replications setup in a randomized complete block design. All treatments received a hand-weeding on July 7, 2006. Four 0.25m² weed counts (June 8, 29, August 15, and September 6, 2006) by species were taken in all plots both in- and between-row and weed dry weights were collected on September 6, 2006. Runner number was separately counted for each variety in all treatments on August 15, 2006. On May 9, 2007, all plots that received herbicides in 2006 had a maintenance application of clopyralid (Stinger 0.13 lb ai/A). Frost protection was setup in early spring of 2007 throughout the bloom period. On May 18 2007 minor frost damage was noted on some of the blossoms. Harvest began on June 13, 2007 with 'Earliglow' and continued through June 29. All strawberries were counted and weighed individually by plot. All data were analyzed for both

varieties for treatment differences utilizing an ANOVA (PROC GLM, SAS Institute, 2007) and treatments were considered statistically significant if $p=0.05$.

Objective 3. After data was analyzed, the project was evaluated for its ability to reduce weed populations and maintain yields. Information on weed management methods was presented as part of the NY Berry Notes (March 2007), Lake Ontario Fruit Program (November 2007), and the Empire Expo (February 2007 & 2008). Discussion with 30+ growers on this trial occurred at the Lake Ontario Fruit Program. Growers were asked about their adoption of such herbicide reduction practices.

8. Results and discussion:

2006 was one of the wettest on record which resulted in extremely heavy weed pressure in even the standard herbicide plots. A hand-weeding event was needed across all treatments during the wettest portion of the summer. Plant development was also slowed because of the excessive moisture and cooler than normal temperatures in May. Inter-seeded fescue germinated poorly because of cooler temperatures immediately after seeding, and was re-seeded a week later.

Banded herbicides, which decreased herbicide use 50%, in combination with cultivation and the broadcast herbicide combined with fescue treatments, had the greatest reduction of total weeds when compared to the other treatments. By mid-season (July), the broadcast herbicide treatment combined with fescue reduced weed populations compared to broadcast without fescue. This resulted in a reduction in between-row and total weeds and weed dry weights for the season. These reductions can be attributed to competition from the fescue. Fescue suppressed between-row weeds as well as between-row cultivation. Some treatments, i.e. banded herbicide + cultivation, had fewer numbers of weeds, but those that escaped tended to be larger. Subsequently, there was no difference between in-row weed dry weights (Table 1).

Horticultural data suggests that cultivation equipment did not have a detrimental impact on plant development and establishment. Fescue treatments reduced the number of established (rooted) runners by both varieties; although were only significantly lower than the hand weeded treatment (Table 2).

Harvest data in 2007 outlined different varietal responses to treatments. In 'Earliglow', in-row and between-row cultivation maintained similar yields as a broadcast program, whereas in 'Jewel' cultivation resulted in higher yields and fruit size. When herbicides were banded in conjunction with between-row cultivation, yields were similar to a standard broadcast herbicide. In 'Earliglow' plots containing fescue, regardless of other activities, a significant reduction in total yield occurred when compared to a standard broadcast program. In 'Jewel' when herbicides were broadcast in addition to fescue, yields were not significantly reduced as compared to a standard broadcast. Other fescue treatments in 'Jewel' did significantly reduce yields. This reduction can be attributed to management practices (weed whacking) in 2006 which injured plants (Table 3).

Results suggest that adequate weed control and improved plant establishment occurred when herbicides were banded and combined with cultivation. Yields for both varieties were similar to the hand weeded treatment. This resulted from a decrease in weed competition. The adoption by growers to band herbicides could halve the amount of herbicides used and subsequently lower herbicide costs during the establishment year. This practice could be used by all growers who utilize a matted-row system (about 80% of growers surveyed used the matted-

row system, 2006 Grower Survey). Additionally, results suggest that the use of well-timed cultivation can effectively reduce weed populations and also maintain quality yields. A single operator can cover more land in less time than a group of workers hand weeding. Previous studies determined that weed pressure during the establishment year resulted in a 50% yield reduction during the first fruiting year (Vézina and Bouchard, 1989). Growers can directly benefit from decreased weeds, improved plant growth, and increased yields. High weed densities can increase disease pressure by altering the microclimate around the strawberry plants. As a result, growers will indirectly benefit from more effective weed control through a reduction in disease incidence (i.e. gray mold).

Project evaluation determined that it is feasible to reduce weed pressure and maintain yields while simultaneously reducing herbicide input. Grower response to these methods were very supportive and resulted in the requesting of a presentation (Empire Expo 2008) dedicated to covering reduced herbicide input weed management. Grower adoption of such management practices will require further education through demonstration and printed materials.

Further refinement of the techniques described herein is needed. First, testing the effectiveness of banded herbicides in a commercial field will further validate these findings. Secondly, further testing of inter-seeding of fine leaf fescue is necessary. The use of a permanent inter-seeded crop has many benefits to strawberries including increased soil health, reduction of between-row cultivation, and potential for weed reduction. Casual observations suggest planting fescue the year prior to planting and killing off in-row fescue prior to transplanting berries would result in better weed control between-row.

Table 1. Results From a Trial Evaluating Integrated Weed Management in Strawberries

Weed Count	1	2	3	4	Season			Weed Dry Weights		
Weed Location	Total ^a	Total	Total	Total	IR	BR	Total	IR	BR	Total
Treatment	-----weeds/0.25m ² -----									
Standard Broadcast	51.8 b	50.6 a	24.4 a	22.4 bc	18.4 abc	19.0 ab	37.3 a	65.3 a	29.1 ab	94.3 a
Standard Broadcast + Fescue	54.4 b	30.4 ab	10.2 b	11.4 c	13.6 bdc	10.8 b	24.4 bc	16.1 a	10.9 cd	27.0 b
Banded + Cultivation	44.5 b	9.8 c	7.5 b	14.0 bc	8.9 d	10.0 b	18.9 c	42.3 a	18.3 bcd	60.5 ab
Banded + Fescue	35.0 b	41.0 ab	23.4 a	21.0 bc	11.0 cd	19.1 ab	30.1 ab	26.4 a	33.6 ab	60.0 ab
Fescue + Cultivation (In-row only)	36.6 b	43.4 ab	27.0 a	44.6 a	21.5 ab	16.5 ab	37.9 a	25.7 a	25.2 abc	51.0 ab
Cultivation	71.0 ab	26.8 b	10.6 b	21.2 bc	19.0 abc	13.5 ab	32.4 ab	59.4 a	3.2 d	62.5 ab
Handweeded	99.8 a	36.8 ab	25.4 a	24.4 ab	23.9 a	22.7 a	46.6 a	22.0 a	19.2 abc	41.3 ab

^aTotal = In-row + Between-row

^bNumbers followed by different letters are considered statistically significant ($p=0.05$)

Table 2. Comparison of the Impact of Weed Management Treatments on Plant Establishment

Treatment	Number of Established (Rooted) Runners Per Plant	
	Jewel	Earliglow
Standard Broadcast	4.6 abc ¹	3.9 b
Standard Broadcast + Fescue	2.8 dc	3.8 b
Banded + Between-Row Cultivation	3.4 bdc	6.1 a
Banded + Fescue	2.8 dc	3.3 b
Fescue + In-Row Cultivation	2.2 d	2.7 b
In- & Between-Row Cultivation	5.2 ab	4.0 b
Handweeded	5.6 a	6.0 a

¹Means followed by different letters are considered statistically significant ($p = 0.05$)

Table 3. Yield Data of 'Earliglow' and 'Jewel' from a Trial Comparing Weed Management Options in Strawberries Freeville, NY 2007.

	'EARLIGLOW' HARVEST			'JEWEL' HARVEST		
	WT (G)	# Fruit	WT (G)/FRT	WT (G)	# Fruit	WT (G)/FRT
1 STD BRDCHEM	7156 ab ¹	1037 a	6.96 abc	4711 bcd	529 ab	9.08 c
2 STD BRDCHEM + FESCUE	3275 c	575 bc	5.66 d	3802 cd	353 bc	10.64 abc
3 BANDED + CULTIVATION	6462 ab	889 a	7.64 ab	5690 abc	547 ab	10.30 abc
4 BANDED + FESCUE	2752 c	470 c	5.88 cd	2925 d	254 c	11.78 a
5 FESCUE + IN-ROW CULT	2668 c	400 c	6.64 bcd	2403 d	248 c	9.56 bc
6 BTWN + IN-ROW CULTIV	6142 b	777 ab	7.86 ab	7831 a	695 a	11.14 ab
7 HANDWEEDED	8247 a	1038 a	7.96 a	7258 ab	682 a	10.60 abc
LSD (P=.05)	1984	287.3	1.24	2637.1	228.6	1.81
Standard Deviation	1516.2	219.5	0.95	2015.3	174.7	1.39

¹Means followed by a different letter are considered statistically significant ($p = 0.05$).

Literature Cited

Vézina, L. and C.J. Bouchard. 1989. Competition de la petite oseille (*Rumex acetosella* L.) avec le fraisier cultivé (*Fragaria ananassa* Dcne). *Naturaliste Can.* 116:237-243.

9. Project location(s):

Tompkins County, Freeville, NY
Particularly in the Northeast but also Nationally

10. Samples of resources developed:

See below



Banded Herbicides + Cultivation
Early Summer, 2006



Broadcast Herbicides
Early Summer, 2006



Fescue Inter-seeded in Strawberries
Fall, 2006

WEED MANAGEMENT UPDATE FOR STRAWBERRIES

Robin Bellinder and Chris Benedict, Dept. of Horticulture, Cornell University, Ithaca, NY

Late winter always bring about thoughts of the upcoming growing season. We decided that this would be an opportune time to jump-start the weed management generator. Included here are some important chemical management updates along with some very simple ideas to help manage your weed populations through an integrated approach.

Cultural

Establishment year in strawberries is very difficult because commonly used production systems lend themselves to be out-competed by weeds (particularly the matted row system). One of the most effective means by which to reduce weed (and overall pest) pressure is to rotate your production fields. Three key ingredients for rotations include: 1) rotate out of berries for as long as possible between plantings, 2) avoid rotating with crops that host strawberry pests, and 3) include cover crops in the rotation (Grubinger, 2005). First, rotations break a static growing environment and place pressure on weeds through competition. Secondly, benefits from cover crop use have been well documented in research and a recent trial has demonstrated that inter-seeding a cover crop has competed well with weeds (Pritts & Kelly, 2001). **Avoid allowing weeds to go to seed should be the underlying goal of any long-term management decision.**

Mechanical

Use of cultivation is a very effective tool in reducing weed populations. Research tells us that the first 2 months after planting is the critical weed-free period (Pritts & Kelly, 2001). Sole reliance on cultivation equipment during this time period is difficult (especially in a wet spring), but possible. A 2006 field trial determined that integrating mechanical cultivation combined with banded herbicides can be more effective in reducing weed pressure than reliance on broadcast herbicides alone (Bellinder & Benedict, unpublished, NYSIPM Grant). To see some photos and descriptions of a variety of cultivation equipment check out: <http://www.hort.cornell.edu/department/faculty/bellinder/new%20cultivation%20mech.pdf>

Chemical

There are some promising new chemistries that will be available to New York Growers in the next couple of years. We have tested these products in our field trial that was planted in the spring of 2006. For 2007, the grass herbicide Select[®] will now be registered as Select Max[®] and will not need to be applied with a crop oil concentrate. A new product Chateau[®] WDG may be available in the second half of the 2007 growing season after the DEC reviews the product.

In a 2006 field trial, we evaluated several herbicides that are not currently registered for strawberries to expand available products for producers. We were able to

test Chateau® WDG and observed very good control of hairy galinsoga and shepherd's purse. Chateau® will most likely be registered as a 30 day pre-transplant, fall/spring dormant, and hooded between-row application. We tested Chateau and applied it within 24-hours of transplanting and observed good crop tolerance. Table 1 outlines the spectrum of control of registered products and how Chateau® may fit into your herbicide program.

Table 1.^a

Product	Broadleaf							
	Lambsquarters	Purslane	Ragweed	Pigweed	Galinsoga	Mustards	Nightshades	Velvetleaf
Pre-emergent								
Dacthal	G-E	G-E	P	F-G	P	P	F	P
Devrinol	E	G-E	P-F	G-E	F	P	P	P
Sinbar	F-G	F	F	P	P	G	F	P
Chateau	E	E	F*	E	P	G	E	F*
Post-emergent								
2-4,D	G	G	G	G	G	G	E	E
Stinger	P	P	E	P	P	P	E	P
Select	P	P	P	P	P	P	P	P
Fusilade	P	P	P	P	P	P	P	P
Roundup	E	E	E	E	E	E	E	E
Gramoxone Max	E	E	E	E	E	E	G	G
Scthye	E	E	E	E	E	E	G	G
Poast	P	P	P	P	P	P	P	P

Product	Annual grasses				Perennials
	Barnyardgrass	Crabgrass	Fall Panicum	Foxtail sp.	Y. nutsedge
Pre-emergent					
Dacthal	F-G	E	F-G	F-E	P
Devrinol	E	E	E	E	P
Sinbar	P	G	F	F	P-F
Chateau	F*	F*	F*	F*	P
Post-emergent					
2-4,D	P	P	P	P	P
Stinger	P	P	P	P	P
Select	E	G	E	E	P
Fusilade	G	G	G-E	G-E	P
Roundup	E	E	E	E	F
Gramoxone Max	E	E	E	E	G*
Scthye	G	G	G	G	G*
Poast	G	F	G	G	P

*Suppressed

^a This table is based on applications made under varying conditions and does not necessarily outline results under all conditions.

References

Colquhoun, J. and R.R. Bellinder. 1997. New Cultivation Tools for Mechanical Weed Control in Vegetables. <http://www.hort.cornell.edu/department/faculty/bellinder/new%20cultivation%20mech.pdf>

Grubinger, V. 2005. Proceedings New England Vegetable and Fruit Conference.

Pritts, M. and M.J. Kelly. 2001. Early Season Weed Competition Reduces Yield of Newly Planted Matted Row Strawberries. HortSci 36(4): 729-731.