EVALUATION OF NEW HERBICIDES FOR USE IN STRAWBERRIES

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Two field trials were established in 1999 at the North Willamette Research and Extension Center (NWREC) on a Quatama silt loam soil with 4% organic matter. Treatments were applied using a CO_2 backpack sprayer equipped with a 4-nozzle boom (TeeJet 8002, flat fan) at 40 psi, at a rate of 40 gallons of water per acre.

1. Establishment Trial. 'Totem' strawberries were planted into raised beds on May 13, 1999. Plots four rows wide and 30 feet long were arranged in a complete randomized block design with four replications. Soil was lightly raked over the strawberry crowns immediately after planting (to ensure that no green growth was visible) then irrigated. Treatments were applied May 15, 1999 then incorporated with one inch of irrigation. Treatments applied at planting were again applied during winter dormancy (similar to the program developed for the use of oxyfluorfen). Because most herbicides began to lose effectiveness by late summer, all plots received a maintenance application of simazine (1 lb/A) and napropamide (2 lb/A) on September 29, 1999, after being hoed free of weeds. All rates are expressed as lb ai/acre.

Weed control was evaluated approximately every 30 days, beginning one month after applications. Plots were hand-weeded after each evaluation. Phytotoxicity was evaluated two days after application then periodically throughout the season. Plant vigor was evaluated July 14, 1999. Yield data was collected in June 2000.

Table 1. Treatments in Establishment Trial

Treatments	Rate at planting lb/A	Winter Rate lb/A
Azafenidin	0.2	0.3
Dimethenamid	1	1.25
Fluamide	0.25	Fluamide (0.25) + Sulfentrazone (0.125)
Oxyfluorfen	0.25	0.5
Rimsulfuron	0.0117	0.0187
Sulfentrazone	0.0625	0.25
Thiazopyr	0.5	0.5
Hand-weeded control [a]	- - - -	- - - -
Weedy control [a]	- - - -	- - - -

[a] Included in trial to provide a basis for comparison when evaluating plant vigor and yield.

Table 2. Dominant weeds present during growing season, 1999.

Date	Primary Weeds	Other Weeds
June 28	Nightshade	Shepherd's purse, henbit, pineappleweed, chickweed, pigweed, annual bluegrass, barnyard grass.
July 21	Pigweed Crabgrass	Shepherd's purse, sowthistle, pineappleweed, chickweed, nightshade, annual bluegrass, barnyard grass.
August 18	Pigweed	Shepherd's purse, pineappleweed, sowthistle, groundsel, annual bluegrass, crabgrass, barnyard grass. (Heavy grass pressure)
September 20	Annual bluegrass	Shepherd's purse, pineappleweed, sowthistle, groundsel.

Azafenidin provided the longest lasting control of all weeds (Table 3). Thiazopyr provided excellent control of grasses through September and excellent control of broadleaves through August; by September, broadleaf control in the thiazopyr plots had become marginal, with pressure from pineappleweed and groundsel. Sulfentrazone provided good control of broadleaves through August and virtually no control of grasses. Oxyfluorfen, the chemical standard provided excellent control of broadleaves and grasses through August. Dimethenamid provided excellent control of broadleaves through July and excellent control of grasses through August. Fluamide provided excellent control of grasses all season and virtually no control of broadleaves. Rimsulfuron provided only fair-good control of broadleaves through July and little control of grasses.

Table 3. Weed control in establishment trial (express as percent control compared to the weedy check plots) on four dates.

	Broadleaf Weed Control				**Grass Weed Control**			
Treatment	6/28	7/21	8/18	9/20	6/28	7/21	8/18	9/20
	———		%	———	———		%	———
Azafenidin	99.7	96.5	97.0	96.2	97.2	96.2	92.5	97.5
Dimethenamid	97.0	93.7	71.8	60.6	100.0	98.3	93.8	75.0
Fluamide	66.5	62.0	54.5	56.9	100.0	100.0	97.0	100.0
Oxyfluorfen	93.7	95.0	85.5	66.9	96.0	91.4	93.3	80.0
Rimsulfuron	74.0	86.2	51.0	61.9	56.2	64.2	41.8	62.5
Sulfentrazone	90.8	90.2	89.5	70.0	29.2	50.0	57.9	50.0
Thiazopyr	99.3	98.9	92.2	75.0	100.0	100.0	100.0	97.5
Significance	*	***	***	**	**	***	***	***
LSD (≤ 0.05)	19.7	9.4	14.6	14.3	29.5	15.0	15.3	18.0

*, **, *** = Significance at P ≤ 0.05, 0.01, 0.001, respectively

There were no statistically significant differences among treatments in number of leaves, number of runners, or plant size (Table 4). However, there was a trend for more runners in the azafenidin, dimethenamid, fluamide, and hand weeded plots when compared to the weedy check plots or other treated plots.

Table 4. Strawberry plant vigor evaluated 7/14/99 (plants est. on 5/13/99, treatments applied 5/15/99).

Treatment	# Leaves per plant	# Runners per plant	Plant Size (cm^2)
Azafenidin	7.95	1.85	498.5
Dimethenamid	7.05	1.85	517.6
Fluamide	7.45	1.85	613.6
Oxyfluorfen	6.75	1.30	483.1
Rimsulfuron	6.10	1.20	423.8
Sulfentrazone	7.05	1.55	534.8
Thiazopyr	6.70	1.00	464.4
Hand-weeded control	6.55	1.95	541.6
Weedy control	5.95	1.05	507.7
Significance (P ≤ 0.05)	ns	ns	ns

ns = not significant.

Most of the treatments did not cause significant phytotoxicity. The oxyfluorfen-treated plants exhibited many red spots on the first flush of leaves after application and well into early June. By late June, plants treated with oxyfluorfen showed no signs of phytotoxicity. Azafenidin-treated plants had a few red spots on newly emerged leaves. Rimsulfuron-treated plants had some yellowish coloration in the newly emerged leaves and the plants remained a greenish-yellow color throughout the growing season.

Herbicides were applied at the winter rates listed in Table 1 on January 29, 2000. At that time, the fluamide treatment was changed to fluamide (0.25) + sulfentrazone (0.125) to broaden the spectrum of control. There was little weed pressure in all plots during winter and spring so only one weed evaluation was conducted prior to harvest.

Table 5. Weed control in establishment trial, winter application (expressed as percent control compared to weedy check plots) on May 17, 2000.

Treatment	% Weed Control [a]
Azafenidin	100
Dimethenamid	81.25
Fluamide + Sulfentrazone	79.25
Oxyfluorfen	86
Rimsulfuron	82.5
Sulfentrazone	99
Thiazopyr	97.25
Significance	**
LSD ($\leq$ 0.05)	5.88

** = Significance at P$\leq$ 0.01.

[a] Weeds present: Pineappleweed, groundsel, shepherds purse, chickweed, annual bluegrass.

Azafenidin, thiazopyr, and sulfentrazone applied at the 0.25 lb rate provided the best weed control. Dimethenamid and rimsulfuron tended to give better control of grass than broadleaf weeds, while oxyfluorfen provided better broadleaf than grass weed control. The mixture of fluamide + sulfentrazone provided excellent annual bluegrass control, however, sulfentrazone used at the 0.125lb rate, performed poorly against broadleaf weeds.

Table 6. Yield, percent rot, and adjusted berry size

Treatment	Yield* (lbs/5 ft. row)	% Rot*	Adjusted Berry Size* (g)
Azafenidin	7.63	6.22	14.68
Dimethenamid	7.97	5.79	14.22
Fluamide + Sulfentrazone	8.15	3.68	14.65
Oxyfluorfen	7.03	7.25	14.41
Rimsulfuron	8.09	7.98	14.89
Sulfentrazone	7.13	10.10	14.57
Thiazopyr	8.64	4.25	14.20
Hand-weeded control	7.97	8.46	15.58
Weedy control	7.53	5.12	14.43
Significance	ns	ns	ns

*Fruit was harvested four times between June 5 and June 19, 2000.

There were no differences among treatments in yield, percent rot or adjusted berry size. Two weeks following harvest the planting was renovated (e.g. mowed, cultivated, fertilized). Treatments were applied on July 7, 2000. Evaluations of weed control from fall 2000 to summer 2001 will be made on a regular basis and yield data collected in June 2001.

2. Fall Timing Trial. This planting was established on raised beds at NWREC on May 13, 1999. It was used to evaluate herbicide treatments made in the fall to strawberries planted in May. Plots four rows wide and 30 feet long were arranged in a complete randomized block design with four replications. To achieve weed control throughout the summer, napropamide, at 4 lb ai/A, was applied after planting and incorporated with one inch of irrigation. Treatment applications were made on September 29, 1999 and immediately irrigated. As of early November, weed control was good and there were no signs of phytotoxicity in any of the plots.

Table 7. Treatments in fall timing trial.

Treatment	Rate
	lb/A
Azafenidin	0.2
Dimethenamid	1.25
Fluamide + Isoxaben	0.25 + 0.75
Fluamide + Sulfentrazone	0.25 + 0.125
Isoxaben	0.75
Sulfentrazone	0.125
Thiazopyr	1
Simazine + Propionamide	1 + 2
Hand-weeded control	- - - -
Weedy control	- - - -

Weed pressure was moderate in early March. Weed evaluations were conducted on March 15 (168 DAT) and May 18, 2000 (232 DAT). There were differences in control of certain broadleaf weeds among treatments.

Table 8. Broadleaf weed control in fall trial (expressed as percent control compared to weedy check plots) on March 15, 2000.

Treatment	Groundsel	Little bittercress	Chickweed	Speedwell
Azafenidin	100	100	97.50	98.75
Dimethenamid	83.75	88.75	93.75	96.25
Fluamide + Isoxaben	98.75	100	98.75	100
Fluamide + Sulfentrazone	93.75	96.25	55	96.25
Isoxaben	100	100	100	100
Simazine	95	97.5	90	56.25
Sulfentrazone	100	73.75	20	100
Thiazopyr	100	100	100	100
Significance	***	**	***	*
LSD ($\leq$ 0.05)	3.26	6.91	5.84	11.45

*, **, *** = Significance at P $\leq$0.05, 0.01, 0.001, respectively

Although sulfentrazone gave excellent control of groundsel, speedwell, shepherds purse, and pineappleweed (shepherds purse and pineappleweed data not shown), it provided only marginal control of little bittercress and no control of common chickweed. Simazine performed well against all broadleaf weeds except speedwell.

Table 8. Weed control in fall trial (expressed as percent control compared to the weedy check) on two dates.

Treatment	Broadleaf 3/15	Broadleaf 5/15	Annual Blue 3/15	Annual Blue 5/15	Overall 3/15	Overall 5/15
Azafenidin	98.96	96.87	98.25	96.25	97.75	97
Dimethenamid	90.83	67.5	96.25	92.50	90.75	75
Fluamide + Isoxaben	98.96	86.25	88.75	65	94.5	82.5
Fluamide + Sulfentrazone	88.75	86.25	96.25	90	86.25	83.75
Isoxaben	100	72.5	40	35	77.5	78.75
Simazine	88.67	76.25	77.5	60	81.25	81.25
Sulfentrazone	80.62	83.12	68.75	37.5	70	77.5
Thiazopyr	98.75	80.5	100	100	96.5	88.75
Significance	***	ns	***	***	***	***
LSD ($\leq$ 0.05)	2.35		6.82	12.43	4.75	3.79

***, ns = Significance at P $\leq$ 0.001, not significant, respectively.

Azafenidin provided the best control of both broadleaf and grass weeds from March to May. Although thiazopyr provided excellent weed control in March, broadleaf weed control (particularly pineappleweed) had declined to a point that overall weed control was reduced by May. Broadleaf weed control by May was also a concern in dimethenamid-treated plots. Poor annual bluegrass control in isoxaben, simazine, and sulfentrazone-treated plots reduced overall effectiveness, suggesting that these herbicides would be best applied in the fall in combination with a grass herbicide.

Table 9. Yield, Percent Rot, and Adjusted Berry Size

Treatment	Yield* (lb/5 ft row)	%Rot*	Adj. Berry Size* (g)
Azafenidin	7.7	1.97	13.47
Dimethenamid	7.97	4.57	14.39
Fluamide + Isoxaben	6.87	3.29	15.19
Fluamide + Sulfentrazone	7.51	4.37	14.63
Isoxaben	8.68	2.22	13.7
Simazine	6.97	4.93	13.55
Sulfentrazone	6.85	3.10	14.72
Thiazopyr	7.27	2.55	14.85
Hand-weeded control	7.22	2.47	14.44
Weedy control	7.18	3.3	14.46
Significance	ns	ns	ns

ns = not significant.

* Fruit was harvested four times between June 5 and June 19, 2000.

There were no differences among treatments in yield, percent rot, or adjusted berry size. Two weeks following harvest the planting was renovated. Treatments were applied October 4, 2000. Evaluations of weed control from fall 2000 through summer 2001 will be made on a regular basis. Yield data will be collected June 2001.