

**WASHINGTON STATE COMMISSION ON PESTICIDE REGISTRATION
FINAL PROJECT REPORT**

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TITLE: Evaluation of various herbicides applied to cauliflower using a prototype shielded sprayer

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SUMMARY OF INITIAL REQUEST:

Postemergence (POST) weed control in cole crops is severely limited. The only herbicide currently registered for POST use in cole crops is Lantagran (pyridate), and that product is registered for use only in cabbage. Even in cabbage, however, crop injury from Lantagran may exceed 20% depending on variety and environmental conditions immediately before and after application. Broadcast application of liquid fertilizer (such as 28% aqua ammonia) is sometimes used in broccoli to burn young weeds, but cauliflower leaves are more tender than broccoli leaves and cauliflower seedlings are severely injured or killed by these applications. Consequently, hand weeding is the only POST option in cauliflower for controlling weeds that were not adequately controlled by preemergence herbicides. Hand weeding costs would be cut drastically if a POST herbicide could be identified that is either (a) very selective in cauliflower (and therefore in other, less tender, cole crops), or (b) not usually selective in cauliflower but applied in such a way that weed leaves, but not crop leaves, are sprayed.

A prototype sprayer has been constructed by Mike & Jean's Berry Farm of Mount Vernon in an attempt to apply non-selective products to cauliflower in a selective manner. As the sprayer is driven slowly through the field (2 to 3 mph), the stems of the cauliflower plants slip continuously through the slot in the PVC-shield. Because weeds are normally not as tall as 2- to 3-leaf cauliflower seedlings, cauliflower foliage is protected from the POST herbicide by the PVC-shield while most weed foliage within the 6-inch band does not enter into the shield and is sprayed.

In this project, non-selective products applied POST using the PVC-shield were Aim (carfentrazone), Rely (glufosinate), Gramoxone (paraquat), Scythe (pelargonic acid), Roundup (glyphosate), Blackberry & Brush Blocker (acetic + citric acid), aqua ammonia, Milestone (azafenidin), Cobra (lactofen), Goal (oxyfluorfen), and Valor (flumioxazin). In a separate study, non-registered selective herbicides were applied POST, over-the-top of cauliflower seedlings. These products were Stinger (clopyralid, POST), Spartan (sulfentrazone, POST), Dual Magnum (s-metolachlor, PRE and POST), and Frontier (dimethenamid, PRE and POST).

FINDINGS:

Objective: To test several selective and non-selective POST herbicides either broadcast over-the-top of cauliflower seedlings or applied using a prototype PVC-shield sprayer.

Materials and methods:

Two separate experiments were established in 2002: the shielded sprayer trial and the selective broadcast herbicide trial.

Shielded sprayer trial: Plots were established at a Mike & Jean's cauliflower field approximately three miles west of Mount Vernon, WA. Plots were 50 feet long and each contained four rows of cauliflower. Cauliflower plants were sprayed using the grower's prototype shielded sprayer June 21, 2002; cauliflower plants were 3- to 4-leaf and shepherd's-purse plants (*Capsella bursa-pastoris*) were to 3 inches tall at the time of herbicide application. Four liters of herbicide solution was poured into the tank and applied in a spray volume of 70.2 gal/a. Early crop injury and weed control was visually estimated just prior to cultivation on June 27 (6 days after treatment, DAT), and again on August 8 (late season, 48 DAT). Cauliflower plots were harvested on August 14, and marketable heads were counted and weighed. The experimental design was a randomized complete block with four replicates (one row per rep). A general linear models procedure was used to analyze the data. Means were separated using Fisher's Protected LSD ($P = 0.05$).

Selective broadcast herbicide trial: Plots were established at WSU Mount Vernon. Cauliflower was seeded June 12 into 10- by 15-foot plots using a four-row seeder (from Mike & Jean's Berry Farm). Treflan (trifluralin) was applied pre-plant incorporated (PPI) on June 6, prior to cauliflower seeding. Preemergence (PRE) and POST treatments were applied June 15 and July 3, respectively. Cauliflower plants were in the 3- to 4-leaf stage of growth at the time of POST application while weeds were 3 to 5 inches tall. Weeds included shepherd's-purse, pale smartweed (*Polygonum lapathifolium*), ladythumb (*P. persicaria*) and common lambsquarters (*Chenopodium album*). Weed control was visually estimated July 2, (early PPI and PRE) and July 13 (early season), and August 8 (late season) while crop injury was estimated on July 13 (0 = no control/injury, 100 = weed/crop death). Cauliflower heads in plots with 70% or higher weed control at the August 8 evaluation were harvested on August 23, and all heads were counted and weighed. The experimental design was a randomized complete block with four replicates (one row per rep). A general linear models procedure was used to analyze the data. Means were separated using Fisher's Protected LSD ($P = 0.05$).

Results:

Shielded sprayer trial: Several products caused excessive injury (20% or greater) to cauliflower seedlings by June 27 (6 DAT) (Table 1). These included Scythe, Rely, Gramoxone Extra, Cobra, Goal, Milestone, and Valor. Aim caused moderate injury (14%) while Blackberry & Brush Block (B&BB), Organic Interceptor, and Roundup Ultra caused only slight injury (<10%). Plants showed considerable recovery by August 8 (48 DAT), but injury from Roundup Ultra, Goal, Scythe, and Valor was moderate to high (14 to 34%). Shepherd's-purse control was generally low at both evaluation dates (Table 1). Weed control with Valor, Goal, Rely, or Cobra was rated good at 6 DAT, however (71 to 83%). At 48 DAT, the best control ranged from 70 to 81% from Aim, Milestone, Roundup, Rely, Gramoxone, or Cobra. While number or weight of cauliflower heads did not statistically differ between treatments, average head weight was marginally improved in plots treated with Scythe, Rely, Roundup, Gramoxone, Goal, or Valor (Table 2). There was a trend toward higher average head weights resulting when head number was numerically low, indicating that perhaps plant spacing was playing a larger role in head production than did herbicide application.

Taken together, it appears from these data that the shielded sprayer did not provide adequate protection to cauliflower leaves when treated at the 3- to 4-leaf stage, and weed control from this system alone was generally inadequate. Since the percentage control of weeds was generally higher than the percentage injury to cauliflower, however, there is still potential for this system to improve a weed control program. Perhaps crop injury can be reduced and weed control improved if these POST applications are made at the 1- to 2-leaf stage when more complete crop shielding will occur and weeds are smaller and more easily controlled. Even at current settings, the shielded sprayer may provide more cost effective weed control than hand labor.

Selective broadcast herbicide trial:

Initial weed control (July 2) was spotty and rather variable, as evidenced by the range of weed control for the same PPI or PRE treatments and on the rather wide least significant difference of 32 (Table 3). For example, control from Treflan alone ranged from 71 to 84%, while Treflan + Dual Magnum or Treflan + Outlook provided 45 and 73%, respectively. By the July 13 and August 8 evaluations, however, that weed control was much more consistent within treatments (LSDs of 17 and 20, respectively). By July 13, only those treatments with Spartan applied POST and Treflan + Stinger were still providing weed control similar to the hand weeded check. These Spartan applications caused speckling of cauliflower leaves at level of approximately 10%, however. By August 8, crop injury from Spartan was not evident, but only three treatments were still providing greater than 70% weed control: the Treflan, Dual Magnum, or Outlook followed by sequential Spartan. These treatments, plus the hand weeded check, did not differ in their harvest parameters, indicating that all three were safe for use in cauliflower (Table 4).

Based on these data, Dual Magnum or Outlook (PRE) followed by Stinger or Spartan (POST) was safe to early season cauliflower foliage. Combinations of all these products were also safe to cauliflower foliage when used sequentially with Treflan (PPI). Depending on species, weed

control may be better than experienced in these plots, where heavy populations of pale smartweed, ladythumb, and common lambsquarters overwhelmed most treatments except Treflan, Dual Magnum, or Outlook followed by Spartan. Harvest data also indicate that Treflan, Dual Magnum, Outlook, and Spartan are safe for use in cauliflower, although not all treatments were evaluated.

STATUS: Treflan is currently registered for PPI use in cole crops, and Goal is registered for pre-transplant use only. No other treatments tested in these trials are currently labeled. FMC is expected to label Spartan for use in cabbage during 2004 (except California) and other cole crops should follow. Stinger (Dow AgroSciences) may likewise become available in the near future (2004?). DuPont has discontinued work with Milestone.

RECOMMENDATIONS FOR FUTURE ACTIVITY: The shielded sprayer may offer better selectivity if used when cauliflower plants are smaller and can more easily be shielded from overspray with non-selective herbicides or nitrogen-based fertilizers. Testing should continue to determine whether this prototype can be refined for improved performance. In addition, the initial testing in Washington and across the US have indicated that broadcast Spartan, Dual Magnum, Outlook, and Stinger can improve weed control in cauliflower. It is hoped that these products move quickly through IR-4 and EPA testing/registration process.

Table 1. Crop injury and weed control in cauliflower treated with postemergence herbicides using a prototype shielded sprayer (2002).

Treatment	Rate product/a	Crop injury		Weed control	
		June 27 %	August 8 %	June 27 %	August 8 %
Blackberry & Brush Block	25%	4	0	5	38
Organic Interceptor	10%	6	0	29	61
Scythe	4%	29	29	40	15
Rely	4 pt	33	8	71	70
Roundup Ultra	0.75 pt	8	14	60	74
Gramoxone Extra	0.8 pt	20	5	65	70
Cobra	1 pt	29	0	70	69
Goal	1 pt	44	28	79	35
Milestone	3 oz	28	3	63	75
Aim	4 oz	14	0	53	81
Valor	2.24 oz	44	34	83	58
LSD _{0.05}	---	19	19	14	16

Table 2. Cauliflower yield following postemergence herbicide applications using a prototype shielded sprayer (2002).

Treatment	Rate	Head number	Head weight	Average head weight
	product/a	number/plot	kg/plot	kg/head
Blackberry & Brush Block	25%	7.3	2.4	0.3
Organic Interceptor	10%	9.5	3.5	0.4
Scythe	4%	4.0	1.8	0.5
Rely	4 pt	5.8	2.8	0.5
Roundup Ultra	0.75 pt	7.0	3.3	0.5
Gramoxone Extra	0.8 pt	7.3	3.6	0.5
Cobra	1 pt	9.8	4.0	0.4
Goal	1 pt	5.0	2.4	0.5
Milestone	3 oz	7.3	2.7	0.4
Aim	4 oz	7.0	3.2	0.4
Valor	2.24 oz	3.4	1.8	0.5
LSD _{0.05}	---	ns	ns	0.1

Table 3. Crop injury and weed control in cauliflower treated with various herbicide combinations (2002).

Treatment	Rate	Timing ^a	Crop injury	Weed control		
			July 13	Jul. 2 ^b	Jul. 13	Aug. 8
	product/a		%	%	%	%
Treflan	1.5 pt	PPI	0	84	79	40
Treflan + Stinger	1.5 pt + 0.67 pt	PPI + POST	1	80	83	49
Treflan + Spartan	1.5 pt + 4.3 oz	PPI + POST	10	71	98	84
Treflan + Dual Magnum	1.5 pt + 0.78 pt	PPI + PRE	0	45	48	6
Treflan + Outlook	1.5 pt + 0.67 pt	PPI + PRE	0	73	69	20
Dual Magnum + Stinger	0.94 pt + 0.67 pt	PRE + POST	0	0	68	0
Dual Magnum + Spartan	0.94 pt + 4.3 oz	PRE + POST	10	0	96	70
Outlook + Stinger	0.87 pt + 0.67 pt	PRE + POST	1	18	68	8
Outlook + Spartan	0.87 pt + 4.3 oz	PRE + POST	11	21	96	79
Hand weeded	---	---	100	100	100	100
LSD _{0.05}	---	---	2	32	17	20

^aPPI = preplant incorporated, PRE = preemergence, POST = postemergence.

^bOnly PPI and PRE applications had been applied prior to this evaluation.

Table 4. Cauliflower yield following treatment with various herbicide combinations (2002).

Treatment	Rate	Timing ^a	Head number	Head weight	Average head weight
	product/a		no./plot	kg/plot	kg/head
Treflan	1.5 pt	PPI	--	--	--
Treflan + Stinger	1.5 pt + 0.67 pt	PPI + POST	--	--	--
Treflan + Spartan	1.5 pt + 4.3 oz	PPI + POST	10.8	6.6	0.6
Treflan + Dual Magnum	1.5 pt + 0.78 pt	PPI + PRE	--	--	--
Treflan + Outlook	1.5 pt + 0.67 pt	PPI + PRE	--	--	--
Dual Magnum + Stinger	0.94 pt + 0.67 pt	PRE + POST	--	--	--
Dual Magnum + Spartan	0.94 pt + 4.3 oz	PRE + POST	10.0	4.9	0.5
Outlook + Stinger	0.87 pt + 0.67 pt	PRE + POST	--	--	--
Outlook + Spartan	0.87 pt + 4.3 oz	PRE + POST	9.8	6.1	0.6
Hand weeded	---	---	7.3	4.1	0.6
LSD _{0.05}	---	---	ns	ns	ns

^aPPI = preplant incorporated, PRE = preemergence, POST = postemergence.