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Techniques for improved Weed Control Efficiency In Cucumbers

Techniques for improved Weed Control Efficiency In Cucumbers

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Cover: Successful mechanical harvesting of cucumbers depends on good weed control from planting time until harvest.

INTRODUCTION

The cucumber is more susceptible to injury by several classes of selective herbicides than most other crops. All herbicides evaluated for weed control in cucumbers have a limited safety margin, and even at safe rates of application, the number of weeds they control varies with environmental conditions (1,4,5,-11,12,13,14,16,20).

The cultural practices for pickling cucumbers are changing rapidly with the transition from a multiple-hand harvest to a single destructive machine harvest. To obtain profitable yields from a single harvest of present varieties, the crop must be grown at high plant populations (18). This poses some basic changes in the available approaches to weed control, since with close row spacings cultivation is less feasible. Herbicide failure in high population plantings may result in a complete loss of the crop due to early weed competition.

A single harvest of most pickling cucumber varieties can be accomplished 50-55 days after seeding, whereas in the past, cucumbers were harvested for a 40-50 day period. Cucumbers grown at plant populations over 40,000 plants/A form a dense canopy of vines, which completely covers the soil surface 35-40 days after seeding. The plants compete well with seedling weeds at this time but effective weed control is needed until the canopy forms. The objective of our research program during the past 5 years has been to develop herbicide programs that will provide the best weed control during this 35-40 day period.

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EXPERIMENTAL METHODS

Preemergence Herbicides and Combinations

Field plots were established at the Horticultural Research Center, Sodus Experimental Farm and in several commercial cucumber fields during the 1966 to 1970 seasons. The soils included loamy sands (.96-1.88% organic matter), sandy loams (1.54-3.86% organic matter) and a Miami loam (2.57% organic matter).

Chemicals were applied in 30 or 36 gal. of water per acre. When incorporated prior to planting, the chemicals were worked into the surface 2-3 in. of soil with a rotary tiller immediately after spraying. Plot size was either 4′ x 25′ or 6′ x 20′ with 3 replications in a randomized block design. The herbicides used in these tests are described in Table 1.

The cucumbers (Varieties Pioneer, Crusader or Piccadilly) were grown at populations from 60,000-100,000 plants per acre. Stand counts were obtained after emergence. Control ratings on broadleaf and grassy weeds were obtained 30-35 days after seeding. Ratings were based on a scale from 1 indicating no control to 9 indicating complete weed control. Yield data were collected for a single destructive harvest, which simulated mechanical harvesting.

The Stale Seedbed Technique

A stale seedbed is produced by preparing the soil several days before planting, allowing the weeds to emerge. Contact herbicides are applied before the crop emerges. Two of these, paraquat and dinoseb, have given excellent knockdown of seedling annual weeds. This technique might be more dependable than preemergence herbicides to insure total control of early weed competition in cucumbers. Chemical seedbed preparation without tillage is commercially practiced with other crops (7).

During 1967-69, five field studies were conducted in 3 locations to determine how well this weed control method works. Each experiment was a split plot whose main plots were left undisturbed for 10-21 days or tilled immediately before planting. Fertilizer was broadcast and disked into the soil at the time of initial seedbed preparation, and supplemental nitrogen was applied as a top dressing before flowering.

Paraquat at 0.5 and 1.0 lb./A with X-77 surfactant at 0.5% (V/V) and dinoseb at 1.0 lb./A with 2 gal./A fuel oil were evaluated as contact herbicides. Several preemergence herbicides were used at 2 rates on both seedbeds. Piccadilly and Crusader cucumbers were seeded 1 in. deep in rows 1 ft. apart in the stale and freshly prepared seedbeds. The herbicides were applied in a volume equivalent to 36 gpa the same day of seeding. Weeds in the 5 stale seedbed areas varied from less than 1 in. to about 3 in. high.

Weed control, crop injury ratings and yield records were obtained as previously described. Weed counts were obtained on 3 random square foot areas per plot 30 days after treatment. All data were statistically evaluated using analysis of variance and Tukey's hsd test.

RESULTS AND DISCUSSION

Preemergence Herbicides and Combinations

Preemergence herbicides tested for cucumbers can be roughly divided into two groups: those which control broadleaf weeds and not grasses and vice versa. Those giving good grass control are bensulide, DCPA and nitralin (Table 2). Chloramben-methyl ester (ME), dinoseb-alkanolamine salts (AS) and naptalam excel in control of broadleaf weeds. Chloramben ME and dinoseb AS also show fair to good activity on several grass species.

Table 1. Nomenclature, suppliers, and registration status of herbicides evaluated for pickling cucumbers

Common Name(a)	Trade Names	Suppliers	Registration(b) Status
Bensulide	Prefar	Stauffer	Yes
CDEC	Vegadex	Monsanto	Yes
Chloramben (methyl ester)	Amiben Methyl Ester	Amchem	No
DCPA	Dacthal	Diamond-Shamrock	Yes
Dinoseb (Alkanolamine Salts)	Premerge, Sinox PE	Dow, Uniroyal	Yes
Dinoseb	Dow General Weed Killer	Dow	Yes
Naptalam	Alanap	Uniroyal	Yes
Nitralin	Planavin	Shell	Yes
Paraquat	Paraquat CL, Dual Paraquat	Chevron	No
Trifluralin	Treflan	Elanco	No

(a) Name designated by Terminology Committee of Weed Science Society of America
(b) Registration status with Environmental Protection Agency (EPA) as of March 1, 1971.

Table 2. General effectiveness(a) of herbicides on common weeds in Michigan cucumber fields and their safety margin on seeded cucumbers.

Herbicide	Time of Application (Weeds-Crop)	Base Rate(b) (lb/A)	Pigweed (*Amaranthus retroflexus*)	Lambsquarters (*Chenopodium album*)	Purslane (*Portulaca oleracea*)	Ragweed (*Ambrosia artemisiifolia*)	Smartweed (*Polygonum pennsylvanicum*)	Foxtail (*Setaria glauca*)	Crabgrass (*Digitaria sanguinalis*)	Barnyard Grass (*Echinochloa crusgalli*)	Cucumber Tolerance
Bensulide	Pre-Pre	6	F	P	P	P	P	G	G	G	G
CDEC	Pre-Pre	4	F	F	F	P	P	F	F	F	F
Chloramben ME	Pre-Pre	2	G	G	G	G	F	G	G	G	F
DCPA	Pre-Pre	8	F	P	F	P	P	G	G	G	P
Dinoseb(c)	Post-Pre	1	G	G	G	G	G	F	G	G	G
Dinoseb AS	Pre-Pre	2	G	G	G	F	F	G	G	G	P
Naptalam	Pre-Pre	4	G	G	G	P	P	F	F	F	F
Nitralin	Pre-Pre	1	F	P	F	P	P	G	G	G	P
Paraquat(c)	Post-Pre	½	G	G	F	G	G	G	G	G	G

(a) G = good, F = fair, P = poor. In the case of cucumber tolerance, G indicates at least a 2x margin of safety, F indicates less than a 2x safety margin and P indicates damage on some soil types at the base rate.
(b) Rate usually required to control weeds on sandy loam soils.
(c) If applied before weeds are over 2 inches high.

Cucumber tolerance to these herbicides varies from questionable tolerance at labeled rates to a 2.5 x safety margin. In some instances tolerance is related to soil type with injury often occurring on loamy sands which are low (below 1.5%) in organic matter. Herbicides such as dinoseb AS, chloramben ME and nitralin must be kept away from the germinating cucumber seed to avoid injury. Heavy rainfall on sandy soils can readily leach these chemicals into the seed germination zone (2,8,9,10).

Overdoses of each herbicide produce typical signs of injury. Some herbicides cause early stunting of plants with curling, cupping or deformed leaves. Chloramben ME and naptalam may induce these symptoms when the cucumber has 1 or 2 leaves. However, these plants normally recover rapidly and produce a yield equal to that of hand-weeded check plots.

More serious forms of injury occur from improper placement of chemicals such as DCPA, dinoseb AS, nitralin or trifluralin. DCPA may cause injury on the stem of the cucumber at the soil level. Often, the stems crack open to expose callus tissue. The plants wilt rapidly under water stress and may break off at soil level during windy periods. This injury is often less severe if the herbicide is incorporated in the soil, but the safety margin is still limited.

Dinoseb AS, if leached into the germination zone, may kill the cucumber seedlings and reduce the stand (20). For this reason, it should not be used on sandy soils low in organic matter where leaching may occur.

Nitralin and trifluralin are other herbicides sensitive to placement. If incorporated into the soil, both may seriously damage the young roots of seedling cucumbers and stunt their growth (Table 3). Surface applications are less toxic in early stages of growth, but may cause some root injury later. Cucumber plants exposed to surface applications of nitralin or trifluralin sometimes exhibit reduced root growth when compared with control plants. This may appear even at harvest time.

Of all the preemergence materials tested for cucumbers, bensulide had the best safety margin. No injury symptoms occurred at rates 2-2.5x the labeled rate and no yield reductions were attributed to this material. Applying bensulide to the soil surface usually produces results equal to those obtained with soil incorporation providing there is rainfall or irrigation within a few days after application.

Herbicide performance data for 1966-1970 were summarized to determine the frequency of acceptable weed control (rating of 6.5 or above) and frequency of significant yield reduction (Table 4). Only treatments tested in at least 5 experiments were included.

Table 3. Effect of soil incorporation of several herbicides on weed control and cucumber injury on a Miami Loam soil

Herbicide	Rate (lb/A)	Method of Application(a)	Weed Control Rating		Injury Rating	Crop Stand (Plants/20' Row)
			Broadleaf	Grass		
None	—		1.0	1.0	1.0	46
Bensulide	6	S	2.3	8.7	1.0	40
		I	2.7	7.3	1.0	49
CDEC	4	S	2.3	2.3	1.3	47
		I	3.3	2.7	2.7	33
Chloramben ME	2	S	8.7	7.3	1.0	52
		I	6.0	6.3	3.5	38
DCPA	8	S	3.0	7.7	3.3	49
		I	4.3	7.7	2.3	46
Naptalam	4	S	6.7	4.0	1.0	48
		I	6.3	3.7	1.7	44
Nitralin	1	S	4.7	8.0	1.3	44
		I	5.0	7.0	3.7	40
Tukey's Test (hsd @ .05)			1.7	1.3	1.7	12

(a) S = Surface application after seeding, I = incorporated 2-3 inches prior to seeding.

Table 4. Summary of preemergence herbicide performance in Michigan from 1966 through 1970

Herbicide	Rate (lb/A)	Frequency	
		Acceptable Weed Control	Yield Reduction
Bensulide	6	4/18 (.22)	0/18 (.00)
Bensulide	8	3/6 (.50)	0/6 (.00)
Chloramben ME	1	8/14 (.57)	0/14 (.00)
Chloramben ME	2	11/13 (.85)	0/13 (.00)
Chloramben ME	3	16/17 (.94)	2/17 (.12)
Dinoseb AS	1	0/6 (.00)	0/6 (.00)
Dinoseb AS	2	2/8 (.25)	2/8 (.25)
Naptalam	4	7/18 (.39)	0/18 (.00)
Naptalam	6	3/5 (.60)	1/5 (.20)
Nitralin	0.5	1/6 (.17)	0/6 (.00)
Nitralin	1	5/9 (.56)	2/9 (.22)
Nitralin	2	4/6 (.67)	4/6 (.67)
Chloramben ME + bensulide	1 + 6	10/11 (.91)	0/11 (.00)
Naptalam + bensulide	4 + 6	19/22 (.86)	1/22 (.04)
Naptalam + dinoseb AS	4 + 1	7/13 (.54)	2/13 (.15)
Naptalam + dinoseb AS	4 + 2	14/16 (.88)	4/16 (.25)
Chloramben ME + nitralin	1.5 + 0.5	4/6 (.67)	0/6 (.00)
Naptalam + nitralin	4.0 + 0.5	4/8 (.50)	0/8 (.00)

Except for chloramben ME (Figure 1), good weed control was not obtained unless combinations of herbicides were used. Failure was often due to a lack of precipitation after herbicide application. The effectiveness of several of these herbicides was increased with a light irrigation after application (3).

Complementary combinations improved weed control even when irrigation was applied (Table 5). By combining a good grass killer (bensulide) with either chloramben ME or naptalam, the frequency of success was increased to about 90% (Table 4).

These treatments were always safe for the crop. The combination of naptalam + dinoseb AS was more effective than either herbicide applied singly, but at 2.0 lb./A dinoseb AS injury occurred in 4 tests on soils low in organic matter. Nitralin at 0.5 lb./A improved results when combined with chloramben ME or naptalam. However, this did not give as high a frequency success as bensulide combined with these materials.

When chloramben ME is combined with bensulide, it is possible to decrease the rate to 1-1.5 lb./A providing an improved margin of safety on the crop. Clearance for chloramben ME on cucumbers is expected during 1971.

Fig. 1. Excellent weed control obtained from Chloramben ME applied preemergence on a Miami Loam Soil. Note the weedy check plot on the left.

Table 5. A comparison of single herbicides and herbicide combinations followed by sprinkler irrigation on an Oshtemo Loamy sand containing .96% organic matter

Herbicide	Rate (lb/A)	Weed Control Ratings		Yield (Bu/A)
		Broadleaf	Grass	
Chloramben ME	1.5	8.7	7.7	319
Bensulide	6.0	6.0	8.0	323
Naptalam	4.0	5.0	5.0	368
Nitralin	0.5	6.0	7.3	340
Naptalam + bensulide	4.0+6.0	8.3	8.0	376
Chloramben ME + bensulide	1.5+6.0	9.0	8.7	324
Naptalam + nitralin	4.0+0.5	8.7	7.3	354
Chloramben ME + nitralin	1.5+0.5	8.7	8.3	314
Tukey's Test (hsd @ .05)		0.8	0.9	NS

The Stale Seedbed Technique

The initial weed knockdown must be complete to assure success with the stale seedbed technique. Weeds over 2 in. high were not always eliminated with paraquat or dinoseb (Table 6).

Larger lambsquarters (*Chenopodium album* L.) seedlings were injured but survived paraquat treatment; larger individual grass plants survived treatment with dinoseb. Purslane (*Portulaca oleracea* L.), which developed 2-3 leaves, was also not completely killed with paraquat (Table 2). For complete kill of emerged weeds, 10-14 days seems to be an adequate interval between seedbed preparation and treatment.

No injury was seen on the germinating cucumber seedlings from either contact herbicide. The expected safety margin for paraquat is very high since it is tightly adsorbed to most mineral soils (6). Current label registrations allow the use of dinoseb as a contact herbicide before cucumber emergence. It is hoped that label clearance with paraquat for this purpose will also be obtained.

Very few weeds germinated in the stale seedbed plots unless the planter shoe disturbed the soil and brought new weed seeds to the surface. All of the weeds (8.3/sq. ft.) in the plot receiving only paraquat were in the crop row (Table 7). Paraquat alone on the stale seedbed gave weed control comparable to 6.0 lb./A naptalam, 1.0 lb./A chloramben or 4.0 + 2.0 lb./A naptalam + dinoseb on a conventional seedbed.

Using preemergence herbicides at low rates along with paraquat provided excellent weed control. In fact, the results with half rates were equal or superior to those obtained with double rates on a conventional seedbed (Figure 2). Destroying emerged weeds without soil disturbance decreased subsequent germination of weed seedlings. Contact herbicides killed a higher percentage of rapidly germinating weeds than most preemergence treatments.

Table 6. Effect of interval from seedbed preparation to spraying on effectiveness of contact herbicides

Test	Interval from soil preparation to spraying (Days)	Height of largest Weeds (Inches)	% Kill(a)	
			Paraquat	Dinoseb
1	10	0.50	100	99
2	12	0.75	99	100
3	14	1.50	100	96
4	19	2.25	97	91
5	21	3.50	88	74

(a) Calculated from counts of dead and surviving weeds 5-7 days after application.

Table 7. Weed populations 30 days after spraying as influenced by seedbed preparation and herbicides

Preemergence herbicide	Rate (lb/A)	Weeds Per Square Foot			
		Stale Seedbed		Conventional Seedbed	
		Broadleaf	Grass	Broadleaf	Grass
None		3.5	4.8	12.7	7.3
Naptalam	3.0	1.7	1.4	9.2	5.8
Naptalam	6.0	1.2	3.2	4.5	5.5
Chloramben ME	1.0	1.2	0.9	5.8	2.0
Chloramben ME	2.0	0.2	0.2	0.9	2.8
Naptalam +					
dinoseb AS	2.0+1.0	0.0	2.7	9.5	3.0
dinoseb AS	4.0+2.0	0.5	1.5	3.9	4.2
	Mean(a)	1.2	2.1	6.6	4.4
Tukey's Test (hsd @ .05)		1.3	1.8	3.2	2.3

(a) Means for stale vs conventional seedbed differ significantly at .01 level.

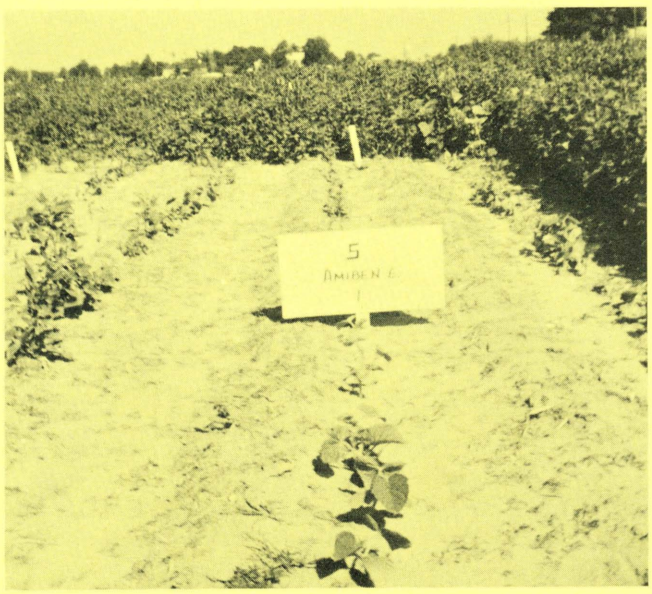

Fig. 2. Experimental plot where paraquat at 0.5 lb./A was utilized with 1.0 lb./A Chloramben ME on a stale seedbed. Note weeds in background and on right where preemergence herbicides were utilized without irrigation.

Cucumber yields were not adversely affected by use of the stale seedbed technique. In fact, in 6 out of the 7 comparisons, yields were higher in the stale seedbed (Table 8). This may be due partly to less early weed competition, but in the two tests, the emergence and stand of cucumbers was superior in the stale seedbed as compared to the freshly prepared seedbed.

Available soil moisture may have been higher in the stale seedbed area. There were no nutritional differences apparent in the foliage of plants grown under the two systems. One recent report indicates successful use of this method on cucumbers using dinoseb as a contact herbicide (15). The stale seedbed technique is also successful in soybeans where different herbicides are used (17).

Table 8. Yields of cucumbers from two locations as influenced by seedbed preparation and herbicides

Location	Chemical	Rate (lb/A)	Yield (Bu/A)	
			Stale Seed-bed(a)	Conven-tional Seedbed
Test 1 (Sandy Loam)	Weeded check	—	223	207
	Naptalam	4	184	196
	Chloramben ME	1	267	198
	Chloramben ME	2	256	185
	Mean(b)		232	197
Tukey's Test (hsd @ .05)			41	NS
Test II (Miami Loam)	Weeded check	—	116	102
	Naptalam	4	97	79
	Naptalam +			
	dinoseb AS	2 + 1	139	116
	Mean(c)		117	99
Tukey's Test (hsd @ .05)			20	18

(a) With 0.5 lb./A paraquat.
(b) F value for interaction of herbicide x seedbed preparation method is significant at .05 level.
(c) F value for seedbed preparation method is significant at .05 level.

SUMMARY

Herbicides for use on seeded cucumbers have a narrow safety margin and control only a limited number of weeds effectively. Field experiments conducted from 1966 through 1970 showed selected combinations of herbicides can be used with great success. Naptalam + bensulide and chloramben ME + bensulide gave consistent results without crop injury on all soil types. Naptalam + dinoseb, naptalam + nitralin and chloramben + nitralin were promising on some soil types, but the safety margin was minimal on loamy sands and sandy loams with low organic matter content.

A stale seedbed approach with an interval of 10-14 days from seedbed preparation to application of a contact herbicide was also evaluated. The contact herbicides paraquat and dinoseb gave excellent knockdown of seedling weeds less than 2 in. high. When used with low rates of preemergence herbicides, excellent weed control was maintained from planting to harvest. The growth and yield of cucumbers may be somewhat improved using this system.

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