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Herbicide-Soil Stabilizer Mulch Combinations For Weed Control Of Horticultural Crops

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EXPERIMENT STATION

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Field seeding of small seeded horticultural crops such as lettuce, petunias, peppers, tomatoes, etc. is not always successful. Some of the more common reasons for poor stands, other than poor seed, are excessive weed competition, lack of adequate soil moisture, and crusting of the soil prior to seed emergence. In addition, cool temperatures may delay germination so that pathological organisms in the soil have time to destroy the germinating seedlings. In cool, wet weather the effectiveness of pre-emergence herbicides often is dissipated by leaching or by decomposition before the seedling crop plants are strong enough to compete effectively with weed growth.

This bulletin reports results of a study to determine the effect of various pre-emergence herbicide-soil stabilizer mulch combinations[1] on weed growth and on the germination and seedling growth of several horticultural crops.

PRELIMINARY EXPERIMENTS

In a greenhouse study conducted at Stillwater during the spring of 1960, varying concentrations of a water-soluble asphaltic mulch[2], alone and in combination with dinitro-ortho-secondary butyl phenol (DNBP), were applied in a 70° F. greenhouse as pre-emergence sprays to seeded flats which contained aster, cantaloupe, periwinkle, petunia,

[1] All liquid herbicides used in these studies were compatable with the soil stabilizer mulch materials. Granular herbicides were mixed with a small quantity of water prior to adding to the prepared mulch spray to facilitate a more thorough mixing.

[2] Furnished courtesy Esso Research and Engineering Company, Linden, New Jersey.

Research reported herein was done under Oklahoma Agricultural Experiment Station Project Number 695.

phlox, poppy, scabiosa, snap bean, snapdragon, spinach, sweet pea, watermelon, and zinnia seed. The number of seedlings which emerged after 7 and 14 days was recorded.

Increasing the rate of a 50:50 asphalt-water mulch from 0 to 150 grams per square foot of soil surface had no appreciable effect on percent germination or speed of emergence of aster, cantaloupe, petunia, snap bean, snapdragon, spinach, sweet pea, watermelon, or zinnia seed. However, 75 grams per square foot or higher reduced percent emergence of the poppy seedlings.

The addition of 3.75 grams DNBP per square foot of soil surface to the 75 grams per square foot of 50:50 asphalt-water mulch had no effect on emergence of cantaloupe, periwinkle, scabiosa, snap bean, or watermelon. There was a marked reduction in the emergence of phlox, poppy, and spinach seed with this treatment.

OBSERVATIONAL TRIALS

Blackberry, strawberry, and tomato plants, gladiolus bulbs, and beet, cantaloupe, lettuce, lima bean, marigold, mustard, okra, pepper, periwinkle, petunia, snap bean, southern pea, spinach, squash, sweet corn, tomato, watermelon, and zinnia seeds were planted in rows three feet apart in observation trials at Stillwater. The soil surface was rolled after planting and then sprayed lightly with water. Various herbicide-asphalt, herbicide-resin[3], and herbicide-latex[4] mulch combinations were applied with a 3-gallon knapsack sprayer in bands, one foot wide by ten feet long over each row as shown in Figure 1. The herbicide was applied at the normally recommended rate of 1.0 X, one-half rate (0.5 X), double rate (2.0 X), and four times the normal rate (4.0 X). Irrigation was applied as needed. The number of emerged seedlings per plant was determined at different dates following planting (Table I). Grass and weeds from certain plots were harvested for dry weight determination.

Table I shows there was little difference between the speed of emergence of seedlings. Asphalt mulch plots covered with white sand, in general, tended to be slightly delayed in emergence, particularly with cantaloupe, periwinkle, petunia, and watermelon seedlings.

The total dry weight of grass and weeds per 1′ x 10′ plot in the 1960 experiment is shown in Table II. Asphalt mulch alone tended to

[3] Furnished courtesy Swift and Company, Chicago, Illinois.
[4] Furnished courtesy Alco Oil and Chemical Corp., Philadelphia, Pennsylvania.

Figure 1. Various horticultural crops under test, Stillwater, Oklahoma.

increase the total amount of grass and weed growth over that of the check plots. The difference, in most instances, was reduced in favor of the asphalt mulch when it was covered by a reflectant material such as white sand. Adding a herbicide to the asphalt mulch tended to reduce grass and weeds in most plant species. Growth and development of all treated plants appeared to be normal except that of blackberry, watermelon, and squash, treated with 2.0 X and 4.0 X herbicide treatments.

The various herbicide-asphalt, herbicide-SEC Resin, and herbicide-latex mulch treated plots were rated on July 1 as to the relative amount of weed growth present. Average results from two independent ratings are shown in Table III. Fairly good weed control was obtained from the 1.0 X herbicide-asphalt and 1.0 X herbicide-SEC Resin mulch treatments. No measurable weed control was attained with the herbicide-latex mulch combination.

SPINACH AND SNAP BEAN YIELD TRIALS

Spinach and snap bean experiments were conducted at the Vegetable Research Station, Bixby, Oklahoma, during the fall of 1960 and

Table I. Effect of herbicide-asphalt mulch treatments on emerged seedlings, Stillwater, Oklahoma, 1960. (All seedlings were made between April 20 and April 23.)

Species (Days after Planting)	Herbicide*	Treatment** I	II	III	IV	V	VI	VII	VIII	IX
					Number of Seedlings					
Cantaloupe	NPA									
(9)		—	2	—	—	2	3	5	—	8
(16)		33	30	8	28	31	29	30	30	29
Lima Bean	DNBP									
(7)		—	2	2	7	4	3	16	8	12
(15)		23	54	47	52	48	49	41	54	48
Marigold	CEDC									
(9)		3	—	—	1	—	13	15	12	2
(15)		36	51	60	47	52	60	65	76	56
Mustard	CEDC									
(10)		33	91	122	115	108	138	113	129	127
(12)		66	143	162	195	173	221	202	174	177
Pepper	CEDC									
(15)		2	51	26	8	23	37	48	20	20
(19)		6	83	49	32	36	58	65	33	55
Periwinkle	CEDC									
(15)		—	—	—	—	5	4	1	8	5
(19)		—	8	—	2	18	5	1	8	11
Petunia	CEDC									
(12)		—	—	—	—	1	23	18	2	3
(19)		***	***	***	***	***	***	***	***	***
Snap Bean	DNBP									
(7)		—	10	7	10	1	6	8	2	21
(15)		58	59	64	42	45	55	47	44	41
Southern Pea	DNBP									
(7)		—	11	2	20	11	10	7	2	25
(13)		15	32	23	34	23	30	24	9	27
Squash	NPA									
(14)		9	5	—	—	5	—	—	—	2
(23)		24	13	20	4	5	3	—	—	2
Tomato	CEDC									
(12)		10	3	25	22	17	34	46	13	11
(22)		88	34	84	96	71	77	67	52	40
Watermelon	NPA									
(14)		—	16	—	17	26	21	13	5	6
(16)		1	17	—	17	31	21	14	6	7
Zinnia	CEDC									
(9)		2	2	8	13	17	8	6	2	15
(15)		109	140	105	111	107	94	75	51	92

Table continued on next page

Table I. Continued

Species (Days after Planting)	Herbicide*	Treatment**								
		I	II	III	IV	V	VI	VII	VIII	IX
Gladiolus†	Sesone									
(11)		5	17	6	10	10	2	13	13	13
(17)		21	29	27	34	29	21	27	33	37

*Herbicides: CEDC (Vegadex)—1.0 X rate = 3 lb/A; DNBP (Dow Gen.)—1.0 X rate = 3 lb/A; Sesone (2,4-DES)—1.0 X rate = 6 lb/A; NPA (Alanap No. 3)—1.0 X rate = 3 lb/A.

**Treatments: I — Check, not treated.
II — Asphalt-water mulch (75 gm/sq ft).
III — Asphalt-water mulch (75 gm/sq ft) plus white sand cover on top.
IV — Asphalt-water mulch (75 gm/sq ft) plus herbicide (0.5X) combination.
V — Asphalt-water mulch (75 gm/sq ft) plus herbicide (1.0X) combination.
VI — Asphalt-water mulch (75 gm/sq ft) plus herbicide (2.0X) combination.
VII — Asphalt-water mulch (75 gm/sq ft) plus herbicide (4.0X) combination.
VIII — Herbicide alone (1.0 X)
IX — Herbicide (1.0 X) plus asphalt-water mulch (75 gm/sq ft) on top.

*** Small size plants and great number made counting impractical.

† 45 corms planted per plot.

Table II. Effect of herbicide-asphalt mulch combinations on dry weight of grasses and weeds, Stillwater, Oklahoma, 1960.

Species	Date of Planting	Herbicide*	Treatment**								
			I	II	III	IV	V	VI	VII	VIII	IX
						(Grams)					
Cantaloupe Seed	4/23	NPA	333	502	395	130	19	1	1	1	16
Lima Bean Seed	4/22	DNBP	424	553	345	266	225	29	7	14	142
Marigold Seed	4/20	CEDC	527	662	413	251	280	124	23	156	271
Tomato Seed	4/20	CEDC	552	612	141	315	285	239	100	301	418
Gladiolus Corms	4/22	Sesone	431	506	421	8	5	3	2	15	14
Blackberry Plant	4/22	Sesone	327	454	323	0	1	1	2	17	14
Marigold Plant	4/29	CEDC	583	306	253	200	197	179	141	223	191
Tomato Plant	4/23	Niag. 4512	26	15	20	1	16	8	6	14	1

* Herbicide Used: CEDC (Vegadex) — 1.0 X rate = 3 lb/A; DNBP (Dow Gen.) — 1.0 X rate = 3 lb/A; Sesone (2,4-DES) — 1.0 X rate = 6 lb/A; NPA (Alanap No. 3) — 1.0 X rate = 3 lb/A; Niag. 4512 (Soldan) — 1.0 X rate = 3 lb/A.

**Treatments: See Table 1.

Table III. Effect* of herbicide-asphalt, herbicide-S.E.C. Resin, and herbicide-latex mulch combinations on weed control of various horticultural crops. (Seedings and treatments were made first week in April, 1961.)

Species	Herbicide**	Treatment***							
		I	II	III	IV	V	VI	VII	VIII
		(Weed Rating)							
Beet	CEDC	3.0	0.0	2.0	3.0	1.0	1.5	3.0	2.5
Lettuce	CEDC	2.5	0.0	2.0	2.0	5.0	1.0	3.0	2.0
Lima Bean	DNBP	3.0	0.0	__	2.5	1.0	1.0	3.0	__
Marigold	CEDC	3.0	0.0	__	2.0	1.0	0.5	2.5	__
Okra	CEDC	3.0	0.0	__	2.0	0.5	0.5	3.0	__
Pepper	Niag. 4512	3.0	0.0	__	3.0	1.0	2.5	3.0	__
Periwinkle	CEDC	3.0	0.0	__	3.0	1.0	3.0	3.0	__
Petunia	CEDC	3.0	0.0	__	3.0	1.0	3.0	3.0	__
Snap Bean	DNBP	1.5	0.0	__	2.0	1.0	0.5	3.0	2.0
Southern Pea	DNBP	3.0	0.0	__	1.5	1.0	1.0	3.0	3.0
Spinach	CEDC	3.0	0.0	2.5	2.5	1.0	2.0	3.0	3.0
Sweet Corn	Simazin	2.0	0.0	__	2.0	1.0	1.0	1.0	__
Tomato	Niag. 4512	3.0	0.0	__	3.0	1.0	3.0	3.0	__
Zinnia	CEDC	3.0	0.0	__	1.5	1.0	1.0	3.0	__
Gladiolus Corm	Sesone	3.0	0.5	3.0	2.5	0.5	0.5	3.0	3.0
Tomato Plant	Niag. 4512	1.5	0.0	__	2.0	1.0	1.0	3.0	__

* Ratings: 0 = no weeds, 1 = few weeds, 2 = many weeds, 3 = no apparent weed control.

** Herbicides: CEDC (Vegadex) — 1.0 X rate = 3 lb/A; DNBP (Dow Gen.) — 1.0 X rate = 3 lb/A; Niag. 4512 (Soldan) — 1.0 X rate = 3 lb/A; Simazin — 1.0 X rate = 3 lb/A; Sesone (2,4-DES) — 1.0 X rate = 6 lb/A.

*** Treatments: I = Check, not treated.
II = Black plastic cover on ground.
III = Asphalt-water mulch (75 gm/sq ft).
IV = " + Herbicide (0.5 X) combination.
V = " + " (1.0 X) "
VI = S.E.C. Resin-water mulch (20 gal/A) + " " "
VII = Latex-water mulch (20 gal/A) + " " "
VIII = Herbicide alone (1.0 X).

spring of 1961. Hybrid No. 7 spinach was seeded at a rate of 100 seeds per 14-foot row in plots 1½ feet wide and 14 feet long. Each plot contained three rows, six inches apart. Topcrop snap beans were seeded at a rate of 80 seeds per 14-foot row in plots 3½ feet wide and 14 feet long. These plots contained only one row.

After planting and immediately before application of the different treatments, the soil surface of each plot was sprayed with water. The various mulch treatments were then applied in bands, either 1½ feet wide (spinach) or 1 foot wide (snap beans) using 3-gallon knapsack sprayers as shown in Figure 2.

Asphalt mulch[2], diluted 50:50 with water, was applied at a rate of 75 grams per square foot of soil (21.1 gallons per 1000 square feet). The two resin mulches, S.E.C. Resin[3] and Organic Soil Stabilizer (O.S.S.)[3], diluted 50:50 with water, were applied at a rate of 20 gallons per 1000 square feet. Liquid forms of the herbicide were mixed directly with the diluted mulch materials. Vegadex (CEDC) herbicide was applied to spinach and DNBP to snap beans. Three pounds of actual herbicide was designated as the 1.0 X concentration. The herbicide alone treatment was applied in water at a rate of 40 gallons per acre. There were four replications of each treatment. Irrigation was applied as needed.

Figure 2. Mulch treatments were sprayed in bands over each row.

The middle ten feet of the center row in the spinach plots were harvested for yield. Harvested spinach was graded U. S. No. 1 processing spinach. The middle ten feet of the row in the snap bean plots were harvested for yield. Harvested snap beans were graded sieve size No. 4, U.S. No. 1 grade beans.

Table IV shows the average percent emergence and average yields per acre of spinach and the relative infestation of grass and weeds at harvest. In the fall, spinach seedlings in the S.E.C. Resin mulch plots emerged at an earlier date than did those in the asphalt mulch plots. In the spring planting, the opposite was true; seedling emergence occurred earlier in the asphalt mulch treated plots than in the S.E.C. Resin mulch plots, the O.S.S. mulch plots, or the check plots. However, there was little difference in total emergence from any of the treatments—fall or spring.

Average yields from the S.E.C. Resin mulch plots were approximately two tons per acre greater than yields from the asphalt mulch plots in the fall spinach crop. In contrast, spring yields from asphalt mulch treated plots were, in general, higher than those from the Resin mulch plots.

Increased concentrations of herbicides reduced total yields both in the fall and spring crops. There was little difference in weed and grass infestation from any of the treatments in both the fall and spring crops. The effect of time of planting and herbicide mulch treatment on the relative content of grass and weeds in spinach is shown in Table V. There was little difference between treatments. However, as the planting dates progressed, there was less overall weed growth.

Average percent emergence and average yield per acre of snap bean seedlings and the relative infestation of grass and weeds are shown in Table VI. Snap bean seedlings emerged earlier in the S.E.C. Resin mulch plots than in the asphalt mulch plots. On August 10 plant stand counts for the S.E.C. Resin treated plots averaged 52 percent as compared to 21 percent for the asphalt treated plots. Average yields were slightly greater from the asphalt treated plots than from the S.E.C. Resin plots. Increased concentrations of DNBP in both the S.E.C. Resin and asphalt mulch plots reduced total yields of marketable snap beans. There tended to be slightly less infestation of grass in the S.E.C. Resin treated plots.

Effect of herbicide-mulch treatment and time of planting on average yields of snap beans are shown in Figure 3. The mulch treatments had no marked effect on yields. Earlier planting apparently in-

Table IV. Effect of various herbicide-asphalt, herbicide-S.E.C. Resin, and herbicide-O.S.S. mulch combinations on spinach, Bixby, Oklahoma, 1960-61. (Each figure an average of 4 replications.)

Treatment	Emergence*				Yields		Grass**		Weeds**	
	Fall		Spring		Fall	Spring	Fall	Spring	Fall	Spring
	(Percent)				(Tons Per Acre)					
Check (no cultivation)	61	90	20	55	12.1	8.5	5.8	4.8	5.0	5.0
Check (clean cultivation)	66	94	23	61	12.2	9.8	5.8	5.0	5.8	5.0
1.0 X Herbicide***	30	79	20	51	12.0	8.4	5.3	4.8	5.0	5.0
Asphalt-Water Mulch alone†	36	76	37	50	10.0	7.5	5.0	5.0	5.0	5.0
" + 0.5 X Herb.	46	84	25	47	10.9	7.6	5.3	5.0	5.3	5.0
" + 1.0 X Herb.	45	80	41	55	9.8	9.8	4.8	4.8	5.8	5.0
" + 2.0 X Herb.	40	84	28	41	7.3	8.5	5.0	5.0	5.5	4.8
S.E.C. Resin-Water Mulch alone†	60	85	29	60	12.2	7.9	5.8	5.0	5.3	4.8
" + 0.5 X Herb.	64	94	15	36	12.8	5.5	5.5	5.0	5.5	5.0
" + 1.0 X Herb.	54	85	18	49	10.5	8.2	6.0	5.0	5.3	5.0
" + 2.0 X Herb.	51	85	24	42	9.6	6.2	6.0	5.0	5.3	4.8
O.S.S.-Water Mulch alone†			47	59		8.7		4.8		5.0
" + 0.5 X Herb.			18	43		7.7		4.8		5.0
" + 1.0 X Herb.			23	53		5.3		5.0		5.0
" + 2.0 X Herb.			27	41		6.0		5.0		5.0

* Reading left to right, percent emergence of spinach seedlings was determined on October 1 and October 4, 1960, and March 6 and March 17, 1961, respectively.

** Ratings: 1 = heavy infestation, ... 5 = light infestation, 6 = none.

*** Vegadex (CEDC) — 1.0 X = 3 lb/A.

† Asphalt-Water Mulch @ 75 gm/sq ft (21.1 gal/1000 sq ft).
S.E.C. Resin-Water Mulch @ 20 gal/1000 sq ft.
O.S.S.-Water Mulch @ 20 gal/1000 sq ft.

Table V. Effect of herbicide alone, herbicide-asphalt mulch, and herbicide-S.E.C. Resin mulch on grass and weed infestation in spinach, Bixby, Oklahoma, 1960.* All ratings were made at time of harvest.

Date of Planting	Weeds			Grass		
	A	B	C	A	B	C
				(Rating)**		
August 4, 1960	3.0	5.0	3.5	4.0	4.5	3.5
August 11, 1960	4.0	5.5	4.0	5.0	4.5	3.5
August 19, 1960	3.5	4.5	3.0	2.0	1.0	3.5
August 25, 1960	6.0	5.5	5.5	5.0	5.0	5.0
September 1, 1960	5.5	5.5	5.5	5.0	4.5	4.5

* Treatment A = Herbicide alone; Treatment B = Herbicide plus asphalt-water mulch (75 gm/sq ft); Treatment C = Herbicide plus S.E.C. Resin mulch (20 gal/1000 sq ft). Herbicide used was Vegadex (CEDC) at 3 lb/A.

**Ratings: 1 = heavy infestation, ... 5 = light infestation, 6 = none.

Table VI. Effect of various herbicide-asphalt and herbicide-S.E.C. Resin mulch combinations on emergence of snap beans, yield per acre, and infestation of grass and weeds. Planted August 4, 1960 and harvested September 28 and October 7. (Each figure an average of 4 replications.)

Treatment	Emergence 8/10	Emergence 8/12	Yield	Grass	Weed
	(Percent)		(T/A)	(Rating)*	
Check (no cult.)	61	81	2.9	4.8	4.8
Check (clean cult.)	40	70	3.5	4.8	5.0
1.0 X Herbicide**	46	74	3.1	4.0	4.8
Asphalt-Water Mulch alone***	27	75	4.3	3.5	4.3
" + 0.5 X Herb.	15	63	2.6	3.0	5.0
" + 1.0 X "	19	64	3.3	3.3	5.3
" + 2.0 X "	22	69	2.8	4.3	5.5
S.E.C. Resin-Water Mulch alone	58	83	3.1	4.8	5.0
" + 0.5 X Herb.	65	90	3.2	5.3	5.0
" + 1.0 X "	44	71	2.8	4.5	3.5
" + 2.0 X "	41	64	2.7	4.8	4.5

* 1 = heavy infestation, ... 5 = light infestation, 6 = none.

** Dow General (DNBP) — 1.0 X = 3 lb/A.

*** Asphalt-Water Mulch @ 75 gm/sq ft (21.1 gal/1000 sq ft).
S.E.C. Resin-Water Mulch @ 20 gal/1000 sq ft.

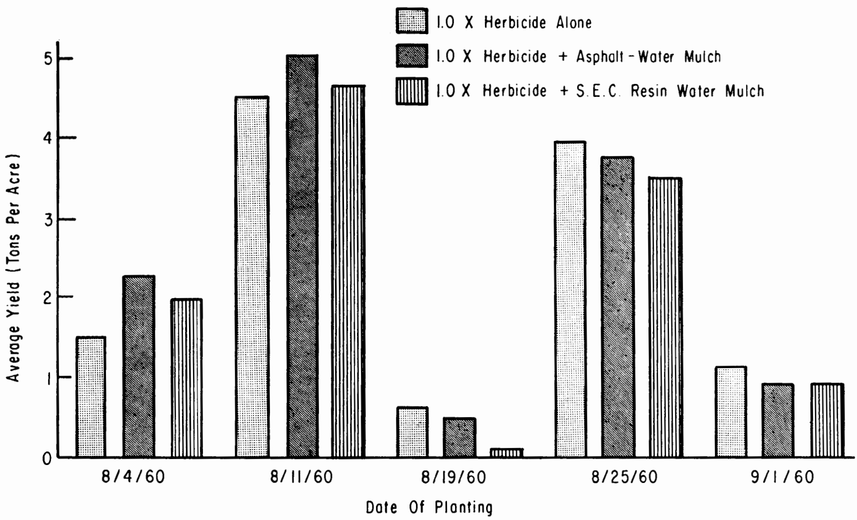

Figure 3. Effect of time of planting and herbicide-mulch combinations on yield of snap beans in 1960.

creased yields, with the highest over-all yields occurring from the August 11 planting. The August 19 planting produced a very low yield of beans from all treatments. Heavy rain, occurring immediately after the August 19 planting, caused excessive packing of the soil and a poor stand of beans.

DISCUSSION AND CONCLUSIONS

This study suggests the feasibility of applying soil stabilizer-mulch materials to the soil surface to aid in the establishment of certain horticultural crops. In acting as soil stabilizers, these materials appear to facilitate seedling emergence, thus resulting in better plant stands with higher yields. In most instances, using a herbicide to control grass and weeds appears to be desirable or necessary due to the increased grass and weed growth caused by mulches.

Spinach plots treated in the fall with asphalt mulch combinations resulted in lower yields. This was due probably to the fact that spinach, a cool season crop, was not especially benefited by the soil temperature buildup. Early spring seeded spinach, on the other hand, responded favorably to the asphalt mulch treatment. Clear soil stabilizers, such as

S.E.C. Resin mulch and O.S.S. mulch, which do not result in a soil temperature buildup, probably would be more beneficial to the growth of summer or fall seeded crops.

Oklahoma's Wealth in Agriculture

Agriculture is Oklahoma's number one industry. It has more capital invested and employs more people than any other industry in the state. Farms and ranches alone represent a capital investment of four billion dollars—three billion in land and buildings, one-half billion in machinery and one-half billion in livestock.

Farm income currently amounts to more than $700,-000,000 annually. The value added by manufacture of farm products adds another $130,000,000 annually.

Some 175,000 Oklahomans manage and operate its nearly 100,000 farms and ranches. Another 14,000 workers are required to keep farmers supplied with production items. Approximately 300,000 full-time employees are engaged by the firms that market and process Oklahoma farm products.

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