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Table 1. Chemicals used in interaction studies in 1965 and 1966.

Common name	Trade Name[1]	Chemical composition
Fungicides:		
captan	Captan	N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboximide
chloroneb	Demosan	1,4-dichloro-2,5-dimethoxybenzene
hexachlorophene	Nabac	2,2′-methylenebis(3,4,6-trichlorophenol)
Olin 2424	Terrazole	3-trichloromethyl-5-ethoxy-1,2,4-thiadiazole
PCNB	Terrachlor	pentachloronitrobenzene
Herbicides:		
fluometuron	Cotoran	3-(m-trifluromethylphenyl)-1,1-dimethylurea
propachlor	Ramrod	2-chloro-N-isopropylacetanilide
CP 50144	Lasso	2-chloro-2′,6′-diethyl-N-(methoxymethy) acetanilide
diuron	Karmex	3-(3,4-dichlorophenyl)-1,1-dimethylurea
EPTC	Eptam	ethyl N,N-dipropylthiocarbamate
nitralin	Planavin	4-(methysulfonyl)-2,6-dinitro-N,N-dipropylaniline
trifluralin	Treflan	alpha, alpha, alpha-trifluro-2,6-dinitro-N,N-dipropyl-p-toluidine
Insecticides:		
DuPont 1179	Lannate	methyl N-[(methylcarbamoyl)oxy] thioacetimidate
NIA 10242	Furadan	2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate
phorate	Thimet	O,O-diethyl-S-(ethylthio)methyl phosphorodithioate
UC 21149	Temik	2-methyl-2-(methylthio)propionaldehyde O-(methylcarbamoyl)oxime

[1]Mention of a trade name or a proprietary product does not constitute a guarantee or warranty of the product by the United States Department of Agriculture, and does not imply its approval to the exclusion of other products of a similar nature.

STUDIES OF INTERACTIONS AMONG CHEMICALS APPLIED TO COTTON AT PLANTING

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Since 1961 studies have been conducted at the Delta Branch Experiment Station to evaluate possible interactions among chemicals commonly used at planting. Our intentions in reporting these studies are, to point out the benefit of multiple chemical treatment, and to identify any combinations that might be deleterious.

Most of the combinations of chemical treatments have resulted in excellent pest control, increased stand uniformity, and increased yields. However, a number of deleterious interactions have been noted (3,4,5).

To reduce the possibility of economic loss, new materials are tested in various combinations with chemicals now used, to insure that the new combinations will not reduce stands or yield. It is essential that possible occurrence of damaging interactions be understood before materials are selected for use. This report summarizes studies conducted in 1965 and 1966.

Methods and Materials

Tests were established in a split-plot design to determine both main effects of (and interactions between) chemical treatments. Individual plots were two rows at least 55 feet long. Plantings on 40 - inch rows were hill-dropped on 20-inch centers, with 20 lbs. per acre of Stoneville 7A cottonseed treated with 3 oz. per cwt of 2.2% cyano (Methylmercuri) guanidine (Panogen 15). The chemicals used in these studies are listed in Table 1.

Fungicide treatments were applied as a seed treatment or as a planter - box dust (2). Chloroneb was applied as a slurry, at the rate of 10 ounces of a 65% formulation, to the Panogen 15 treated seed. The other fungicides were mixed with the seed and applied through the planter seedhopper.

Herbicide treatments were applied on a 20-inch band. Trifluralin and nitralin were incorporated with a rolling cultivator in 1965 and Experiment 1 in 1966. A ground-driven double - reel device was used to incorporate nitralin in Experiment 2 in 1966. EPTC-diuron was applied as a 6-8-6 triband treatment (1). Diuron was applied in the center 8-inch band, and EPTC was injected 1-inch deep into the soil to form a 6-inch band on either side of the center diuron band. Other herbicides were applied as preemergence treatments to the soil surface in a 20-inch band after planting

Insecticides were applied with a gravity flow granule applicator, except DuPont 1179 which was applied as a seed treatment. In the 1965 study, insecticide granules were applied through the planter hill-drop unit. In 1966 the granules were applied in the seed drill.

Results

1965 Study — On April 30, 1965, we established a test to evaluate the possible interactions between two preemergence herbicides, a systemic insecticide, and three fungicides applied at planting time on Bosket silt loam.

Stand data indicate that two of the fungicide treatments significantly increased plant populations (Table 2).

The use of these fungicide combinations, PCNB + captan or PCNB + Olin 2424, resulted in plant stand increases of over 10,000 plants per acre. Stand differences due to herbicide or insecticide

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treatments were not significant. None of the interactions among the treatments were significant. While yield increases were associated with the use of multiple pesticide treatments, none were significant.

The grass infestation, evaluated on May 25, was primarily annual grasses and trifluralin provided considerably better control than diuron.

1966 Studies — Two experiments were established to evaluate possible interactions among chemicals applied at planting time.

In the first experiment, on May 10, 1966, we applied two fungicides, four herbicides, and two insecticides on Bosket silt loam.

Stand data (Table 3) indicate that the herbicide trifluralin and the insecticides UC 21149 and phorate significantly reduced plant stands. Stands with UC 21149 treatment were significantly better than those treated with phorate. Both insecticide treatments gave significant reductions in thrips population. However, control with UC 21149 was significantly better than that obtained with the phorate treatment. Yield data (Table 3) indicate that the use of either of the systemic insecticides resulted in significant increases in yield.

Cotton in all plots treated with UC 21149, regardless of the other pesticides used, was generally delayed in emergence and showed some injury. Injury was most severe where UC 21149 was used in combination with the diuron + EPTC herbicide treatment. However, injury was only temporary and the cotton quickly recovered. During the week after planting there was .5 inch of rainfall and three successive nights with minimum soil temperatures in the 60s at the 2-inch depth. During the 2nd week after planting, moderate cotton injury developed in all plots treated with a combination of phorate and diuron. The injury symptoms were not the typical chlorosis usually associated with diuron toxicity, but started as a mottled green coloration in the leaf tissue and progressed very rapidly to a necrotic condition. The cotyledons had a silvery appearance with necrotic margins.

Weed control was very good to excellent, regardless of the herbicide used. Differences were small, but weed control ratings indicated that fluometuron and diuron + EPTC were superior to trifluralin and diuron.

Table 2. Studies on possible interactions between chemicals used at planting time, 1965. None of the possible interactions among chemicals were significant.

Treatment Chemical Concentration	Rate/A lbs.	Stand Plants/a[1]	Seed cotton, lbs/a	% Weed control
Fungicides:				
None	-0-	17,291 b	2,666	76
Hexachlorophene + captan .75 +7%	3	21,749 b	2,654	89
PCNB + captan 10 + 10%	3	28,804 a	2,958	82
PCNB + Olin 2424 10 + 5%	3	29,368 a	3,084	81
Herbicides:[2]				
None	-0-	24,431 a	2,788	68
Diuron	1.0	23,978 a	2,840	78
Trifluralin	1.0	24,501 a	2,892	98
Insecticides:				
None	-0-	24,651 a	2,838	82
Phorate 10%	3.6	23,953 a	2,842	81

[1] Means followed by the same letter within pesticide groups are not significantly different at the .01 level of probability as measured by Duncan's New Multiple Range Test.

[2] Rate per acre of active ingredient on a broadcast basis.

Table 3. Studies on possible interactions between chemicals used at planting, Experiment 1, 1966. The herbicide x insecticide interaction on plants per acre and yield of seed cotton were significant at the .01 level.

Treatment						
Chemical – concentration	Rate/A lbs.	Stand plants/a[1]	Thrips/10 plants[1] 6/8/66	6/16/66	Seed Cotton lbs/A[1]	% Weed control 6/21/66
Fungicides:						
Captan + PCNB 10 + 10%	3.0	20,958 a	106 a	38 a	3,130 a	91
Chloroneb 65%	0.125	20,424 a	112 a	43 a	3,130 a	89
Herbicides[2]:						
Diuron + EPTC	1.0 + 1.5	21,567 a	108 a	38 a	3,049 a	90
Fluometuron	1.0	21,332 a	105 a	45 a	3,269 a	95
Diuron	1.0	20,988 a	118 a	36 a	2,997 a	88
Trifluralin	1.0	18,877 b	106 a	42 a	3,205 a	86
Insecticides:						
None	-0-	22,540 a	240 c	58 c	2,498 c	89
UC 21149 10%	5.0	20,679 b	15 a	22 a	3,754 a	90
Phorate 10%	6.0	18,857 c	72 b	40 b	3,118 b	90

[1]Means followed by the same letter within pesticide groups are not significantly different at the .01 probability level as measured by Duncan's New Multiple Range Test.

[2]Per acre amount of active material on a broadcast basis.

Table 4. Studies on possible interactions between chemicals used at planting time, Experiment 1, 1966. Numerical illustration of herbicide x insecticide interaction on plants per acre.

Herbicide	Insecticide None	UC 21149	Phorate	Average[1]
Trifluralin	19,501	17, 879	19,252	18,877 b
Diuron	24,615	23,409	14,927	20,988 a
Diuron + EPTC	22,952	21,497	20,249	21,567 a
Fluometuron	23,077	19,917	20,998	21,332 a
Average[1]	22,540 a	20,679 b	18,857 c	

[1]Averages followed by the same letter are not significantly different at the .01 probability level as measured by Duncan's New Multiple Range Test.

Table 5. Studies on possible interactions between chemicals used at planting time, Experiment 1, 1966. Numerical illustrations of herbicide x insecticide interaction on pounds of seed cotton per acre.

Herbicide	Insecticide None	UC 21149	Phorate	Average[1]
Trifluralin	2468	3795	3347	3205 a
Diuron	2426	3864	2700	2997 a
Diuron + EPTC	2373	3681	3090	3049 a
Fluometuron	2743	3701	3358	3269 a
Average[1]	2498 c	3754 a	3118 b	

[1]Averages followed by the same letter are not significantly different at the .01 probability level as measured by Duncan's New Multiple Range Test.

The herbicide x insecticide interactions on plant stands and yield of seed cotton per acre were significant.

The interactions between herbicides and insecticides on plant stand are summarized in Table 4. The diuron-phorate, and the trifluralin - UC 21149 treatments resulted in reduced stands. The diuron UC 21149, diuron+EPTC-UC 21149 and trifluralin - phorate treatments had less effect on stands than any of the other combinations.

The interactions between herbicides and insecticides on yield of seed cotton per acre are summarized in Table 5. The diuron - phorate treatment reduced yield more than the other herbicide - insecticide combinations. However, the yield was higher than that obtained where diuron alone was used.

In the second experiment, planted on May 5, two fungicides, three herbicides and three insecticides were applied at planting time on Bosket silt loam.

Data in Table 6 indicate that nitralin significantly reduced stands. The data indicate that the use of a systemic insecticide significantly increased yields. Population counts of thrips on June 8 indicate that nitralin gave some control of thrips. However, the UC 21149 - treated plots had significantly fewer thrips than the check or either of the other insecticide treatments. On June 16, UC 21149 did not differ from the check, but both had significantly fewer thrips than the other insecticide treatments. Plots treated with DuPont 1179 had significantly higher thrips counts than the check plots on both June 8 and 16.

The herbicide X insecticide interactions on thrips infestation on June 16 and on yield of seed cotton were significant. The data are summarized in Table 7. The following herbicide - insecticide combinations resulted in reduced insecticidal effectiveness: propachlor - DuPont 1179, propachlor - UC 21149, nitralin - NIA 10242, and CP - 50144 - DuPont 1179.

The interactions between herbicides and insecticides on yield of seed cotton are summarized in Table 8. The Nitralin-UC 21149, and the CP 50144-UC 21149

Table 6. Studies on possible interactions between chemicals used at planting, Experiment 2, 1966. The herbicide x insecticide interaction on thrips infestation at 6/16/66 and yield of seed cotton per acre were significant.

Treatments: Chemical – concentration	Rate/A lbs.	Stand, plants/A[1]	Thrips/100 plants[1] 6/8/66	Thrips/100 plants[1] 6/16/66	Seed Cotton lbs/A[1]
Fungicides:					
Chloroneb 65%	0.125	22,650 a	203 a	94 a	3817 a
Captan + PCNB 10 + 10%	3.0	21,676 a	200 a	84 a	3700 a
Herbicides[2]:					
Propachlor	4.0	23,223 a	217 b	98 a	3716 a
CP 50144	1.0	23,099 a	240 b	98 a	3736 a
Nitralin	0.5	20,170 b	148	91 a	3823 a
Insecticides:					
DuPont 1179 90%	0.075	22,675 a	312 c	113 b	3739 b
Niagara 10242 10%	5.0	22,540 a	190 b	112 b	3742 b
None	-0-	22,400 a	201 b	72 a	3476 c
UC 21149 10%	5.0	21,043 a	103 a	59 a	4075 a

[1]Means followed by the same letter are not significantly different at the .05 probability level as measured by Duncan's New Multiple Range Test.
[2]Per acre amount of active material on a broadcast basis.

Table 7. Studies on possible interactions between chemicals used at planting time, Experiment 2, 1966. Numerical illustrations of herbicide x insecticide interaction on thrips counts on June 16, 1966.

Insecticide	Herbicide: Propachlor	CP 50144	Nitralin	Average[1]
DuPont 1179	131	121	87	113 b
Niagara 10242	76	100	160	112 b
None	77	57	83	72 a
UC 21149	108	34	34	59 a
Average[1]	98 a	78 a	91 a	

[1]Averages followed by the same letter are not significantly different at the .05 probability level as measured by Duncan's New Multiple Range Test.

combinations resulted in significantly increased yields, as compared to other herbicide - insecticide combinations. The Nitralin - DuPont 1179, the CP 50144-DuPont 1179, and the CP 50144 - NIA 10242 combinations resulted in reduced yields compared to other combinations. Propachlor - treated plots yielded well with any of the insecticide treatments, but better with an insecticide than without.

Discussion

The use of a fungicide treatment at planting time resulted in improved stands. The use of any commercially available systemic insecticide at planting time resulted in reduced stands. However, use of the systemic insecticides phorate and UC-21149 resulted in increased yields. Of the herbicides tested, only trifluralin and nitralin reduced stands. Yields were not reduced by any of the herbicide treatments.

Several herbicide - insecticide combinations resulted in reduced stands and yields. The combinations of diuron-phorate and trifluralin - UC 21149 were responsible for stand reductions. The following combinations resulted in reduced yields, as compared to other herbicide-insecticide combinations:

Diuron — phorate
Nitralin — DuPont 1179
CP 50144 — DuPont 1179
CP 50144 — NIA 10242

While several combinations of chemical treatments were found to be deleterious, most resulted in increased production. The results clearly show that several fungicide - herbicide - insecticide combinations reduce stand losses, give effective weed and thrips control without damage to the crop, and contribute to maximum yields.

This is a report on the current status of research on best control practices. It does not contain recommendations for the use of pesticides, nor does it imply that the uses discussed have been registered. All uses of pesticides must be registered by appropriate State and Federal agencies before they can be recommended.

Table 8. Studies on possible interactions between chemicals used at planting time, Experiment 2, 1966. Numerical illustrations of herbicide x insecticide interaction on yield of seed cotton, pounds per acre.

Insecticide	Herbicide			Average[1]
	Propachlor	CP 50144	Nitralin	
DuPont 1179	3891	3669	3659	3739 b
Niagara 10242	3726	3665	3837	3742 b
None	3419	3443	3564	3476 c
UC 21149	3829	4166	4231	4075 a
Average[1]	3716 a	3736 a	3823 a	

[1] Averages followed by the same letter are not significantly different at the .05 probability level as measured by Duncan's New Multiple Range Test.

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