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COTTON RESPONSE

TO LOW RATES OF 2,4-D AND OTHER HERBICIDES

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CONTENTS

SUMMARY

Use of hormone-type chemicals is essential in many instances to control perennial broadleaf weed species in grain sorghum. However, cotton may be damaged by spray drift when these herbicides are not properly applied. The objective of this research was to establish the relative toxicity of several hormone-type herbicides to cotton. Response of cotton to inadvertent spray drift was evaluated in simulated spray drift trials and by direct application of sub-lethal rates at various growth stages. Damage to cotton, in order of decreasing toxicity, was 2,4–D ester > 2,4–D amine >> dicamba > MCPA > picloram >> bromoxynil >> 2,3,6–TBA ≧ HRS–587. Application of 0.1 pound per acre of 2,4–D, dicamba or MCPA reduced lint yields 20 to 97 percent. Yield losses were most severe when cotton was sprayed before blooming. However, lint quality (micronaire and length) was not affected by herbicides. Midseason visual estimations of foliar damage did not provide reliable estimates of actual crop losses at harvest. Yield reductions were consistently higher than midseason injury estimates.

COTTON RESPONSE TO LOW RATES OF 2,4-D AND OTHER HERBICIDES

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PHENOXY HERBICIDES SUCH AS 2,4–D are highly effective and provide low-cost control of many annual weeds in grain sorghum (7) and other grass crops. In addition, they are highly effective in controlling deep-rooted broadleaf perennials (4,5,8). However, safe use of hormone-type chemicals in cotton production areas has been of concern because as little as 0.001 pound per acre (lb./A) of 2,4–D has injured cotton (1,2,3).

Perennial broadleaf weeds are becoming more prevalent in both cotton and grain sorghum in West Texas. This increase can be attributed to less frequent cultivation and reduced competition from annual weeds following herbicide use and elimination of hand hoeing.

Recently several herbicides have been developed that may be useful for annual weed control in sorghum grown near cotton. These compounds include dicamba, MCPA and bromoxynil. New herbicides useful for sterilizing small patches of perennial broadleaf weeds are 2,3,6–TBA, HRS–587 (9) and picloram. A previous study showed 2,3,6–TBA to be relatively safe near cotton (6). Amitrole has been effective as a foliage treatment for perennial broadleaf weeds. However, the potential hazard from spray drift from many of the newer chemicals in areas where cotton is produced has not been determined.

The objective of this research was (a) to establish the relative phytotoxicity and hazard to cotton from spray drift with these materials and (b) to evaluate the relationship between observable herbicide symptoms shortly after treatment and cotton yield later in the season.

MATERIALS AND METHODS

Cotton Response to Herbicide Spray Drift

Relative phytotoxicity from drift of several herbicides was evaluated under three environmental conditions in 1969 and 1970. Pots, containing two cotton seedlings each, were placed in duplicate at 0, 10 and 40 feet downwind from where chemicals were being applied in field plots. The cotton, grown in the greenhouse, was in an expanded cotyledon stage, with true leaves being initiated. Pots were placed in position immediately prior to spraying each treatment. Five minutes after spraying, pots were moved to the windward side of the field and later returned to a greenhouse where injury to cotton was visually estimated 3 weeks after treatment. Chemicals investigated in this trial were 2,4–D amine, 2,4–D ester, dicamba, MCPA, bromoxynil and amitrole (Appendix). All chemicals were applied at 1 pound per acre of active ingredient in 15 gallons of water, with 0.5 percent surfactant, at 28 pounds pressure, with a tractor-mounted plot sprayer. Wind velocities ranged from 3 to 10 miles per hour, and air temperature ranged from 68° to 80° F. Plots were 13.3 by 35 feet with three replications.

In a second experiment, cotton growing in a field was sprayed with 1 pound per acre of either 2,4–D amine or dicamba. At the time of application, cotton was 12 inches tall and squaring. Soil was dry, air temperature was 95° F and wind was 2 to 5 miles per hour. Chemicals, replicated three times, were applied to 30-foot sections of one 40-inch row in 30 gallons of water, at 40 pounds pressure. After maturity, cotton was hand-harvested in 20 feet of the treated row and in the three adjacent leeward rows to evaluate spray drift.

Cotton Response to Foliar-Applied Herbicides

Relative phytotoxicity and drift hazard were evaluated by applying low sublethal rates of several herbicides at various stages of cotton growth (Table 1). Herbicides applied were 2,4–D amine, dicamba, MCPA, picloram, bromoxynil, 2,3,6–TBA and HRS–587. Chemicals were applied in 36 gallons per acre, at low pressure (15 pounds) with three replications.

TABLE I. STAGE OF COTTON GROWTH AND APPLICATION DATES WHEN LOW RATES OF HERBICIDE WERE SPRAYED ON COTTON

Year	Stage of cotton growth when treated		
	Presquare	Square	Bloom
1965		June 14	Aug 11
1966		July 8	
1969	July 18	July 25	July 30

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TABLE 2. PERCENTAGE INJURY FROM SIMULATED HERBICIDE DRIFT TO COTTON SEEDLINGS LOCATED 0, 10 AND 40 FEET DOWNWIND, UNDER THREE ENVIRONMENTAL CONDITIONS[1]

Herbicide	Rate (lb./A)	1969 – 73° F 3.4 to 7.9 MPH				1970 – 68° F 8 to 10 MPH				1970 – 80° F 4 to 6 MPH				Average – 3 experiments		
		0	10	40	mean	0	10	40	mean	0	10	40	mean	0	10	40
Untreated control		0	0	0	0[c]	0	0	0	0[d]	0	0	0	0[d]	0	0	0
2,4–D amine[2]	1	100	50	20	57[a]	90	37	7	45[a]	95	45	15	52[a]	95	44	14
2,4–D ester	1					82	25	17	42[a]	82	40	22	48[ab]	82	33	20
Dicamba[2]	1	75	15	5	32[b]	82	20	0	34[ab]	85	30	7	41[bc]	81	22	4
MCPA	1	50	15	0	22[bc]	47	20	0	22[c]	80	10	5	32[c]	59	15	2
Bromoxynil	1					100	22	2	42[a]	95	27	5	42[ab]	97	24	3
Amitrole	8	100	0	0	33[b]									100	0	0
Mean		65[a]	16[b]	5[b]		67[a]	21[b]	5[c]		73[a]	25[b]	9[c]				

[1]Injury was visually estimated on plants grown in 1-gallon cans in a greenhouse after seedlings were exposed while spraying field plots. Means with the same letter are not different, and herbicide-drift distance interactions were significant in all instances ($P<0.05$).

[2]Applied at 0.5 pound per acre in 1969.

Plots were one row by 30 feet with two untreated rows between plots, in three replications. Injury to cotton was estimated visually at two dates in 1969. Lint yield and fiber quality (length and micronaire) were determined after cotton was killed by frost in the fall. Plots were furrow-irrigated twice in 1965 but were not irrigated in 1966 or 1969.

RESULTS AND DISCUSSION

Cotton Response to Herbicide Spray Drift

Damage from herbicides to crop plants was readily apparent when cotton seedlings were evaluated in the greenhouse (Table 2). In all three trials cotton was most severely damaged by all chemicals when cotton was directly sprayed (0 feet downwind). The degree of injury to the seedlings diminished or became nonexistent as their distance from plots being sprayed increased.

Damage to cotton depended on the distance from the sprayed area and the chemical used. Damage to cotton, in order of decreasing injury, was 2,4–D ester > 2,4–D amine >> dicamba ≧ MCPA > bromoxynil > amitrole.

2,4-D

When cotton was sprayed with 2,4–D amine, plant damage ranged from 90 to 100 percent. Damage was most severe in low wind since the chemical was not displaced and diluted by wind. High wind (8 to 10 miles per hour) decreased the effect of 2,4–D sprayed directly on cotton since some of the chemical was blown away. Plants located 10 feet away were damaged 37 to 50 percent, and plants 40 feet away were damaged 7 to 20 percent. Injury was lower when wind diluted and displaced more of the 2,4–D spray. Damage from 2,4–D ester to cotton 0 and 10 feet downwind was comparable to that observed with 2,4–D amine. However, the ester formulation resulted in more damage to cotton located 40 feet away than did 2,4–D amine. The difference in phytotoxicity between the formulations was particularly evident when wind velocity was 8 to 10 miles per hour. It was concluded that damage to cotton from 2,4–D was directly related to wind velocity. Severe damage from 2,4–D could be confined to the immediate area of application when winds were low (3 to 5 miles per hour). However, with increased wind speeds, damage in the immediate area was lower since more chemical was blown away and distributed over a wide area.

Dicamba

Foliar damage from dicamba was more related to air temperature than to wind velocity at application. Damage to directly sprayed cotton foliage was 75 to 85 percent. Cotton located 10 feet away was damaged 15 to 30 percent, and cotton 40 feet away was damaged 0 to 7 percent. Injury to cotton was more severe when dicamba was sprayed at 80° F than at 68° or 73° F. Response of cotton to dicamba, due to temperature differences, was particularly evident on plants located 10 and 40 feet away from where the chemical was applied. However, drift of dicamba (10 to 40 feet) was consistently less detrimental to cotton than that of 2,4–D amine or ester. The relative safety of dicamba, in relation to 2,4–D, was also evident in another field trial (Table 3). Both 2,4-D and dicamba killed cotton when the crop was sprayed.

TABLE 3. LINT YIELD OF COTTON, 1 TO 3 ROWS DOWNWIND WHEN AN ADJACENT ROW OF COTTON WAS SPRAYED WITH 2,4–D OR DICAMBA

Herbicide	lb./A	Lint, lb./A Treated row	Rows downwind from treated row 1	2	3
Untreated control		224	208	246	230
2,4–D amine	1	0	160	244	218
Dicamba	1	0	205	260	253

However, dicamba did not reduce lint yield in the adjacent row, as did 2,4–D.

MCPA

Although MCPA is chemically very similar to 2,4–D, this chemical was consistently less toxic to cotton than 2,4–D (Table 2). Furthermore, MCPA was less damaging than dicamba. Damage to cotton directly sprayed with MCPA ranged from 47 to 80 percent and appeared to be related to air temperature at the time of application. Only minor damage (10 to 20 percent) occurred on cotton located 10 feet downwind, and no significant damage was observed 40 feet downwind from the sprayed area. Of the hormone-type herbicides investigated, MCPA appeared to be the least hazardous for use around cotton fields.

Bromoxynil and Amitrole

Bromoxynil was highly toxic if sprayed directly on cotton. Foliage and stems were completely desiccated. Foliage on cotton located 10 feet downwind was only slightly damaged (22 to 27 percent) while injury did not occur on plants 40 feet downwind. In contrast, injury from amitrole was limited to those plants directly sprayed. There was no evidence of any damaging drift from amitrole.

Cotton Response to Foliar-Applied Herbicides

Damage to cotton increased as application rates increased; however, a fivefold or tenfold increase in rates did not result in a fivefold or tenfold increase in cotton damage (Table 4). Yield losses were generally most severe from herbicides applied when cotton was in a vegetative state and actively growing (presquare and square stages). Less herbicide damage occurred after cotton bloomed when bolls were developing and plants were less vegetative and not growing rapidly.

Herbicide toxicity was in the same relative order in reducing cotton yields as it was in damaging cotton in simulated drift trials (Table 4). Herbicides that decreased lint yield, in order of decreasing toxicity, were 2,4–D >> dicamba > MCPA > picloram >> bromoxynil >> 2,3,6–TBA ≅ HRS–587.

2,4–D

Application of 0.05 and 0.1 pound per acre of 2,4–D on cotton foliage caused significant yield losses each year. Yield reductions ranged from 32 to 81 percent, averaging all application dates. Spraying 0.01 pound per acre of 2,4–D did not cause losses that were statistically significant; however, yields were consistently 7 to 32 percent lower than those of untreated controls. The earlier the cotton was sprayed

TABLE 4. LINT YIELD OF COTTON FOLLOWING FOLIAR APPLICATION OF LOW RATES OF HERBICIDES AT VARIOUS GROWTH STAGES[1]

Herbicide	Rate (lb./A)	1965 Square	1965 Bloom	1965 Mean	1966 Square	1969 Presquare	1969 Square	1969 Bloom	1969 Mean
Lint yield (lb./A) of untreated control		805	912	859^{a}	149^{b-e}	103	203	93	133^{a}
		Percent reduction in yield—compared to untreated controls above							
2,4–D	0.01	25	7	15^{abc}	28^{ef}	32	25	10	22^{a-d}
	0.05	57	10	32^{cd}	81^{g}	94	76	54	75^{f}
	0.10	78	23	49de	79^{g}	97	79	49	77^{f}
Dicamba	0.01	+4	7	3^{a}	+107^{a}	79	38	+46	69^{a-d}
	0.05	24	14	19^{abc}	5^{b-e}	84	55	11	53^{c-f}
	0.10	61	27	43de	20^{ef}	91	76	69	78^{f}
MCPA	0.01				+15^{cd}	+4	70	+31	27^{a-d}
	0.05				+12^{b-e}	75	57	+46	38^{b-e}
	0.10				49^{fg}	75	62	16	50^{d-f}
Picloram	0.01	4	14	8^{a}	+16^{cd}				
	0.05	16	15	16^{abc}	52^{fg}				
	0.10	56	24	44de	81^{g}				
Bromoxynil	0.01				+4^{b-e}	+9	25	27	22^{abc}
	0.05				+20^{bc}	56	48	66	54^{d-f}
	0.10				24^{def}	38	78	68	65^{ef}
2,3,6–TBA	0.01	+2	19	9^{a}		+30	29	6	8^{ab}
	0.05	6	14	10^{ab}		3	19	+1	11^{ab}
	0.10	10	11	11^{ab}	+34^{b}	32	40	3	69^{b-d}
HRS–587	0.10	+2	8	3^{a}	17^{c-f}				
	0.20	6	11	8^{a}					
Stage mean		24^{a}	15^{b}			45^{b}	51^{a}	20^{b}	

[1]Positive values (+) indicate yield increase above untreated controls; all other values are % loss. Interactions between herbicide treatments and time of application were significant in 1965 and 1969 ($P<0.05$). Means followed by the same letter are not different ($P<0.05$).

the more severe was its damage. The increased susceptibility of seedling cotton to 2,4–D was readily apparent in the 1969 trial. There was no indication of increased cotton yield due to low rates of 2,4–D since the rates investigated were probably above the ultra-low levels required for beneficial growth stimulation.

Dicamba

Application of 0.1 pound per acre of dicamba consistently reduced cotton yields, and losses generally ranged from 27 to 91 percent. Reduction in lint production was greatest in 1969. As in results with 2,4–D, yields were reduced most when cotton was sprayed early in the year. However, losses occurred when the highest application rate (0.1 pound per acre) of dicamba was applied at cotton bloom. In three instances yields appeared to be enhanced from dicamba applied at 0.01 pound per acre. However, this rate also reduced yields 3 to 79 percent at other times.

MCPA

The visual response of cotton to MCPA was similar to that of 2,4–D, although yields were not as drastically reduced by MCPA. Damage to cotton decreased with increased plant age. Seedlings sustained the most damage, but injury was insignificant on older plants. In five of eight instances, yields were not decreased at all by MCPA at 0.01 or 0.05 pound per acre. The sodium salt of MCPA was less toxic to cotton than the formulation of 2,4–D or dicamba used in these tests.

Picloram

This herbicide is highly effective on many perennial broadleaf weeds since the chemical persists and moves in the soil. Picloram at 0.01 pound per acre did not reduce yields compared to the untreated check. However, yields were consistently lowered following application of 0.1 pound per acre regardless of the growth stage. Legume, solanaceous and other crops are considerably more sensitive to picloram than is cotton. Consequently, picloram should be used with extreme caution around soybeans, peas, beans, tomato, potato, pepper, egg plant, cucumber, watermelon, cantaloupe and other crops. Sensitive crops should not be planted in fields where runoff or tailwater from treated fields may flow. Direction and flow of runoff water should be determined before picloram application.

Bromoxynil

Bromoxynil, a contact-type herbicide, was highly toxic to cotton in 1969 when applied at 0.05 or 0.1 pound per acre. The chemical tended to cause more damage on old than on young plants. However, bromoxynil would be safe to use around cotton fields since damage would be limited to plants in direct contact with the spray.

2,3,6-TBA and HRS-587

These chemicals had little or no adverse effect on cotton. In 1969, 2,3,6–TBA reduced yields when applied at 0.1 pound per acre on cotton before blooming. However, these chemicals could generally be used with adequate safety for perennial weed control around fields without danger to cotton.

Lint Micronaire and Length

In contrast to yields, application of herbicides generally had little or no effect on lint quality (Table 5). However, some differences between stages of application and between herbicides were apparent. Lint quality was suppressed most when chemicals were applied before blooming–in the presquare or square stages. This was most apparent in micronaire values in 1969.

In most instances, all application rates of 2,4–D at all stages tended to lower micronaire. The exception was in high-yielding irrigated cotton in 1965. The low rate of 2,4-D (0.01 pound per acre) was as detrimental as 0.1 pound per acre. However, 2,4–D did not affect fiber length.

Dicamba reduced micronaire most when sprayed at 0.1 pound per acre or at presquare or square growth stages. There was little or no reduction in micronaire when dicamba was sprayed when cotton was blooming. In contrast, MCPA affected micronaire most when applied to seedling cotton (presquare), regardless of the rate applied.

Picloram had little or no influence on fiber quality, except when applied at 0.1 pound per acre when cotton was squaring. Micronaire was reduced, but fiber length was not affected. Bromoxynil differed from other herbicides in that it decreased micronaire with later stages of application. Micronaire was lowered following application of 0.1 pound per acre of bromoxynil at squaring or blooming in 1969. The safest compounds investigated, 2,3,6–TBA and HRS–587, did not reduce fiber quality except when 2,3,6–TBA was applied at 0.1 pound per acre in 1969.

Relationship Between Estimated Injury and Crop Yield

Since fiber quality was affected to only a minor extent by chemicals, the primary economic loss imposed by herbicide drift was yield reduction. In 1969 foliar damage to cotton was estimated visually on July 30 and August 15 following application. Yield losses in 1969, due to chemical treatments, were greater than in other years. Injury estimates were not made in 1965 and 1966.

The highest estimates of crop damage with 2,4–D, MCPA and dicamba were in cotton evaluated 12 days after chemicals were sprayed on seedling (presquare) cotton (Table 6). Chemical injury ranged from 2 to

TABLE 5. MICRONAIRE AND LENGTH OF COTTON LINT FOLLOWING APPLICATION OF LOW RATES OF HERBICIDES AT VARIOUS GROWTH STAGES[1]

Herbicide	Rate (lb./A)	Micronaire 1965 Square	Micronaire 1965 Bloom	Micronaire 1966 Square	Micronaire 1969 Presquare	Micronaire 1969 Square	Micronaire 1969 Bloom	Micronaire 1969 Mean	Length (32nds of an inch) 1965 Square	Length (32nds of an inch) 1965 Bloom	Length (32nds of an inch) 1966 Square
Untreated control		3.2	3.7	4.1	4.2	4.3	4.0	4.2^{a}	30	29	30
2,4-D amine	0.01	3.3	3.0	3.0	3.7	4.2	4.1	4.0^{a-d}	29	30	33
	0.05	3.2	3.6	3.8	3.5	3.6	3.7	3.6^{a-e}	29	30	32
	0.10	3.4	3.7	4.2	2.9	3.6	3.9	3.5^{a-e}	30	29	31
Dicamba	0.01	3.0	3.7	4.2	2.6	4.1	4.0	3.6^{a-e}	30	30	32
	0.05	3.2	3.4	3.8	2.4	4.2	4.0	3.5^{a-e}	30	30	32
	0.10	2.9	3.6	3.7	2.1	3.5	3.8	3.2^{e}	29	29	32
MCPA	0.01			4.2	4.0	4.0	3.9	4.0^{a-d}			34
	0.05			4.5	3.6	4.5	4.2	4.1^{a-c}			30
	0.10			4.1	3.7	4.3	4.2	4.1^{a-c}			33
Picloram	0.01	3.2	3.4	4.0					29	30	32
	0.05	3.3	3.6	3.8					30	30	32
	0.10	2.7	3.8	3.8					29	30	32
Bromoxynil	0.01			4.1	4.4	4.3	4.1	4.2^{a}			32
	0.05			3.9	4.0	4.2	3.8	4.0^{a-d}			32
	0.10			4.2	4.6	3.9	3.8	4.1^{a-c}			34
2,3,6-TBA	0.01	3.5	3.6		4.3	4.2	4.0	4.1^{ab}	29	30	
	0.05	3.8	4.0		4.2	4.2	4.3	4.2^{a}	29	29	
	0.10	3.4	3.7	4.5	3.8	4.0	3.7	3.8^{a-e}	29	30	32
HRS-587	0.10	3.4	3.5	4.3					30	29	32
	0.20	3.4	3.4						30	29	
Mean					3.5^{b}	4.0^{a}	4.0^{a}				

[1]Statistics available only for 1969. Means with the same letter are not different ($P<0.05$).

75 percent and was highest where 2,4-D or MCPA at 0.1 pound per acre was applied. The apparent foliar injury decreased considerably by 28 days after presquare cotton was sprayed. When cotton was sprayed at square or blooming stages, estimates of crop injury were substantially lower (generally 0 to 38 percent) than following treatment of presquare cotton. Injury and yield reduction with bromoxynil were about

TABLE 6. ESTIMATED INJURY TO COTTON FOLLOWING HERBICIDE APPLICATION IN 1969 IN RELATION TO LOSSES IN LINT YIELD AT HARVEST[1]

Herbicide	Rate (lb./A)	Presquare % injury 12 days	Presquare % injury 28 days	Presquare % loss in yield	Square % injury 5 days	Square % injury 20 days	Square % loss in yield	Bloom % injury at 16 days	Bloom % loss in yield
Untreated control		0	0	0	0	0	0	0	0
2,4-D amine	0.01	7	5	32	0	2	25	5	10
	0.05	35	17	94	5	8	76	8	54
	0.10	70	28	97	7	13	79	17	49
Dicamba	0.01	8	8	79	3	7	38	0	+46
	0.05	25	8	84	3	8	55	0	11
	0.10	18	23	91	8	8	76	0	69
MCPA	0.01	5	12	+4	12	7	70	0	+31
	0.05	33	30	75	7	17	57	0	+46
	0.10	75	40	75	13	27	62	10	16
Bromoxynil	0.01	32	3	+9	15	15	25	10	27
	0.05	45	45	56	23	23	48	38	66
	0.10	50	48	38	38	35	78	72	68
2,3,6-TBA	0.01	2	5	+30	5	0	29	0	6
	0.05	8	5	3	2	2	19	0	+1
	0.10	7	10	32	5	3	40	0	3
Mean		25	18	45	8	10	51	9	20

[1]Treatment dates for presquare, square and bloom applications were July 18, July 25 and July 30, respectively. Injury was visually estimated July 30 (presquare and square stages) and August 15 (presquare, square and bloom). Positive values (+) indicate yield increases above untreated controls.

equal. Estimated injury and yield loss were low with 2,3,6–TBA.

There was no consistent relationship between visual estimates of percentage injury to cotton and actual yields. In some instances low estimates of injury (40 percent or less) were followed by high reduction (60 percent or more) in crop yield. This was particularly true for dicamba, 2,4–D and MCPA applied at 0.05 pound per acre or more to cotton in the presquare or square stages. With this rate at the square stage of treatment, all estimates of crop damage were low (less than 27 percent) while actual yield losses were generally high (55 percent or more). For example, injury from 0.05 pound per acre was estimated at 8 percent, but yield loss was 76 percent.

These data show that it is extremely difficult to predict accurately the extent of crop loss from herbicide drift prior to the time of actual harvest. Therefore, portions of cotton fields that appear to be damaged from inadvertent chemical drift should be clearly marked and identified. Then "damaged" and known untreated areas should be harvested separately to accurately assess the magnitude of actual crop loss. In most instances cotton could be harvested by hand from different areas in the same field for comparison to determine whether economic crop damage actually occurred.

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APPENDIX

SUMMARY OF HERBICIDES INVESTIGATED FOR SPRAY DRIFT DAMAGE TO COTTON IN WEST TEXAS FROM 1965 TO 1970

Common name	Trade name[1]	Supplier	Chemistry and Formulation
2,4–D amine	Formula 40	Dow	isopropanol–ethanol amine of 2,4–dichlorophenoxyacetic acid
2,4–D ester	Weedone LV4	Amchem	butoxyethanol ester of 2,4–dichlorophenoxyacetic acid
Dicamba	Banvel	Velsicol	dimethylamine salt of 2–methoxy–3,6–dichlorobenzoic acid
MCPA	Chiptox	Rhodia	sodium salt of 2–methyl–4–chlorophenoxyacetic acid
Bromoxynil	Buctryl	Rhodia	3,5–dibromo–4–hydroxybenzonitril
Amitrole	Amitrol–T	Amchem	3–amino–*s*–triazole + ammonium thiocyanate
Picloram	Tordon 22K	Dow	potassium salt of 4–amino–3,5,6–trichloropicolinic acid
2,3,6–TBA	Trysben 200	Dupont	2,3,6–trichlorobenzoic acid
HRS–587	Tritac	Hooker	2,3,6–trichlorobenzyloxypropanol

[1]2,4–D also sold as Weedar, Dacamine and numerous other trade names. MCPA, bromoxynil and amitrole also sold as Weedar MCPA (Amchem), Brominal (Amchem) and Cytrol (American Cyanamid).