Table III. Postemergence and Preemergence Applications of DPX 4189

		% control or injury							
application	rate, g/ha	wheat	barley	black grass[a]	kochia[b]	false chamomile[c]	wild mustard[d]	dog fennel[e]	wild buckwheat[f]
postemergence	16	0				100	100	90	100
postemergence	31	0	0	80	100	100	100	100	100
postemergence	62	0	0	90	100	100	100	100	100
postemergence	0	0	0	0	0	0	0	0	0
preemergence	16	0				100	90	90	90
preemergence	31	0	30	80	90	100	90	100	100
preemergence	62	10	40	90	100	100	100	100	100
preemergence	0	0	0	0	0	0	0	0	0

[a] *Alopecurus myosuroides.* [b] *Kochia scoparia.* [c] *Matricaria inodora.* [d] *Brassica* sp. [e] *Eupatorium* sp. [f] *Polygonum convolvulus.*

Table IV. Postemergence Treatment of Water Hyacinth[b]

	% chlorotic or necrotic tissue	
rate, g/ha	10 days	45 days
8	30[a]	100
0	0	0

[a] Plant growth strongly retarded. [b] These data indicate that DPX 4189 may be useful for the control of water hyacinth, an aquatic plant that infests many bodies of water in tropical and subtropical areas. This pattern of activity (rapid growth retardation followed by chlorosis and gradual decline) should permit control with minimal side effects on the ecosystem.

Test Procedure IV. DPX 4189, dissolved as in test procedure I, was applied as an overall spray to small ponds containing water hyacinth (*Eichornia crassipes*) plants typically 18 cm tall with five leaves per plant. Treated plants and controls were maintained in a greenhouse, and visual observations, which were taken 10 and 45 days after application, are presented in Table IV.

The data from the above-described tests were an early indication that DPX 4189 held promise for selective weed control in cereal crops such as wheat and barley, especially when applied postemergence. This compound provides control of a large number of weeds as either a pre- or postemergence treatment. Injury symptons are somewhat slow to develop, and a typical effect of DPX 4189 is almost complete inhibition of plant growth frequently followed by chlorosis and death. These data indicate weed control at extremely low application rates under greenhouse conditions. In field tests, DPX 4189 is effective against weeds at application rates considered extremely low.

Subsequent greenhouse and field tests have contributed much to our knowledge of this novel herbicide. The results of these studies will be reported in future publications.

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Constituents of Mustard, Goldenrod, and Croton—Three Host Plants of the Tarnished Plant Bug

The volatile compounds of three plants, mustard [*Brassica juncea* (L.)], goldenrod (*Solidago nemoralis* Ait.), and croton (*Croton capitatus* Michx.), were examined. Though all three are hosts of the *Lygus* bug, there is little similarity in the compounds found in the volatile extracts.

The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is a pest of cotton, *Gossypium hirsutum* L., and many other crops. Although cotton is damaged by the *Lygus*, it is not a preferred host. Mustard, *Brassica juncea* (L.) Czern. E Coss., for instance, will attract *Lygus* to cotton fields when the mustard is interplanted with cotton. As a result, such interplanting is used to attract *Lygus* to experimental cotton lines that are to be assessed for resistance to *Lygus* (Laster and Meredith, 1974). During the growing season, *Lygus* are found on many hosts, perhaps 20–25 varied species of plants. In late summer and early fall, croton, *Croton capitatus* Michx., and goldenrod, *Solidago nemoralis* Ait., are hosts, as well as domesticated mustard plants, though other weeds are also hosts at this time of year.

Although it was expected that vast differences in volatile

Table I. Volatiles of Host Plants of Tarnished Plant Bug

compd	molecular wt	retention time	fragment ions in order of abundance	%
		Mustard		
allyl 3-isothiocyanate	99	11.6	41, 39, 99, 72, 44, 45	43.87
a	?	12.2	no scan	11.44
a	?	12.5	*b*	13.84
butyl isothiocyanate	115	12.8	41, 29, 39, 57, 56, 115	14.78
a	99	14.7	43, 67, 41, 82, 29, 39	4.09
3-butenyl isothiocyanate	113	16.8	72, 113, 55, 39, 41, 43	7.02
a	129	20.0	29, 41, 43, 55, 39, 57	0.20
phenylacetaldehyde	120	22.0	91, 65, 39, 92, 29, 51	1.20
a	127	22.6	41, 39, 29, 91, 67, 72	0.30
acetophenone	120	23.8	29, 77, 44, 41, 43, 105	0.09
a	135	38.6	91, 65, 39, 51, 27, 29	1.28
a	?	42.0	41, 29, 101, 27, 61, 72	0.12
a	149	45.6	91, 29, 41, 39, 43, 27	0.10
a	177	48.1	29, 43, 41, 29, 55, 39	0.01
a	163	52.7	65, 51, 39, 77, 105, 91	1.66
		Goldenrod		
terpene hydrocarbon	136	8.8	93, 29, 91, 77, 39, 41	trace
α-pinene	136	9.3	93, 91, 92, 77, 79, 41	8.48
camphene	136	10.1	93, 41, 39, 79, 91, 27	0.17
sabinene	136	11.4	93, 41, 77, 91, 79, 39	17.40
terpene hydrocarbon	136	12.0	41, 69, 93, 39, 27, 91	
terpene hydrocarbon	136	13.4	41, 93, 39, 69, 27, 77	0.02
limonene	136	14.3	68, 67, 93, 79, 39, 41	17.10
β-thujene	136	14.6	93, 77, 91, 41, 79, 39	
terpene hydrocarbon	136	16.0	93, 41, 91, 39, 77, 43	0.13
α-terpinolene	136	17.7	93, 41, 39, 91, 79, 121	0.19
terpene hydrocarbon	136	19.3	41, 43, 71, 39, 55, 29	0.08
terpene alcohol?	154?	19.9	29, 41, 45, 57, 27, 55	0.05
terpene alcohol	154	21.4	43, 29, 41, 39, 93, 27	trace
terpene alcohol	154	24.2	29, 41, 43, 39, 27, 55	trace
terpinen-4-ol	154	25.5	71, 43, 41, 93, 55, 27	0.67
myrcenol	154	27.2	59, 43, 29, 41, 67, 93	0.12
terpene alcohol	154	31.9	41, 29, 43, 69, 93, 27	trace
terpene alcohol	154	32.4	43, 95, 41, 93, 55, 121	5.48
sesquiterpene hydrocarbon	204	34.2	43, 41, 29, 93, 95, 39	trace
sesquiterpene hydrocarbon	204	34.7	43, 41, 29, 93, 105, 55	0.12
sesquiterpene hydrocarbon	204	35.8	41, 43, 29, 81, 80, 31	0.07
sesquiterpene hydrocarbon	204	36.2	41, 161, 29, 91, 105, 43	0.52
β-elemene	204	36.5	41, 81, 93, 68, 67, 29	0.63
sesquiterpene hydrocarbon	204	38.1	29, 41, 43, 27, 55, 93	trace
sesquiterpene hydrocarbon	204	38.9	41, 69, 93, 55, 39, 79	1.46
β-selinene	204	41.7	93, 41, 29, 39, 80, 55	0.52
sesquiterpene hydrocarbon	204	43.0	41, 29, 93, 43, 55, 79	trace
α-copaene	204	44.4	105, 91, 41, 81, 79, 161	42.50
sesquiterpene hydrocarbon	204	46.8	41, 105, 161, 119, 81, 91	0.81
sesquiterpene hydrocarbon	204	49.8	41, 93, 121, 55, 67, 39	1.55
sesquiterpene	222	54.5	43, 55, 95, 29, 81, 109	0.87
sesquiterpene alcohol	222	56.0	43, 41, 29, 55, 81, 39	0.20
sesquiterpene alcohol	222	57.6	43, 41, 29, 55, 161, 81	0.19
sesquiterpene alcohol	222	59.2	43, 41, 59, 95, 29, 55	0.63
		Croton		
benzene	78	5.0	28, 78, 52, 77, 51, 39	trace
a	98	6.6	29, 41, 44, 27, 39, 51	trace
a	82	9.2	27, 43, 56, 57, 39, 41	0.13
camphene	136	10.6	41, 93, 27, 39, 43, 77	trace
terpene hydrocarbon	136	13.6	29, 41, 27, 43, 39, 55	trace
limonene	136	14.0	29, 68, 41, 43, 67, 39	0.04
a	?	14.6	29, 43, 41, 39, 55, 67	trace
1,8-cineole	154	15.0	43, 41, 55, 81, 71, 39	0.76
1,2-dimethoxybenzene	122	16.7	122, 77, 39, 107, 91, 51	0.26
a	138	18.0	41, 29, 69, 43, 39, 55	0.07
a	?	18.8	29, 43, 71, 41, 27, 39	0.24
a	?	19.5	45, 41, 43, 29, 55, 69	4.32
a	142	20.0	43, 41, 57, 55, 56, 39	0.27
methyl octanoate	158	20.6	74, 43, 41, 87, 29, 55	1.46
a	120	23.6	29, 43, 55, 41, 27, 39	trace
a	128?	25.0	29, 55, 41, 39, 87, 43	0.23
a	154?	25.6	43, 29, 41, 71, 59, 27	0.09
a	112	26.2	29, 43, 27, 57, 55, 73	0.13
α-terpineol	154	27.2	59, 43, 41, 93, 81, 39	0.45
terpene alcohol	154	31.4	45, 43, 41, 29, 55, 31	0.23
2-undecanone	170	32.2	43, 58, 59, 41, 71, 29	6.63
a	196?	33.4	43, 79, 41, 108, 39, 67	1.82

Table I (*Continued*)

compd	molecular wt	retention time	fragment ions in order of abundance	%
sesquiterpene hydrocarbon	204	35.0	105, 41, 119, 43, 55, 81	4.78
sesquiterpene hydrocarbon	204	36.0	81, 41, 80, 43, 29, 39	0.27
sesquiterpene hydrocarbon	204	36.4	41, 161, 105, 91, 55, 81	2.34
sesquiterpene hydrocarbon	204	37.2	41, 55, 108, 81, 39, 93	1.46
sesquiterpene hydrocarbon	204	38.0	41, 93, 55, 69, 29, 119	0.43
α-bergamotene	204	39.0	41, 93, 69, 109, 55, 39	9.00
sesquiterpene hydrocarbon	204	41.0	105, 41, 119, 91, 69, 55	8.43
sesquiterpene hydrocarbon	202	43.2	159, 41, 105, 43, 55, 145	14.66
sesquiterpene hydrocarbon	204	45.0	105, 81, 41, 91, 79, 93	14.04
sesquiterpene hydrocarbon	204	46.5	41, 69, 55, 93, 42, 39	0.29
sesquiterpene hydrocarbon	204	47.2	41, 105, 161, 119, 81, 91	5.95
sesquiterpene hydrocarbon	204	49.1	41, 43, 93, 55, 69, 121	0.22
sesquiterpene hydrocarbon	204	50.4	41, 93, 121, 67, 55, 39	2.87
sesquiterpene alcohol	222	52.2	43, 41, 81, 55, 69, 39	2.59
sesquiterpene alcohol	222	54.4	43, 41, 55, 69, 81, 67	0.33
sesquiterpene alcohol	222	55.0	41, 43, 55, 81, 69, 95	2.05
sesquiterpene alcohol	222	58.2	43, 41, 95, 55, 161, 81	3.36
sesquiterpene alcohol	222	60.0	43, 95, 41, 121, 55, 81	7.05
sesquiterpene alcohol	222	64.8	41, 69, 43, 55, 29, 81	2.74

[a] Unknown. [b] Strong interference from previous peak(s).

compounds would be found between mustard, goldenrod, and croton, it seemed possible that there might be attractive compounds common to all three.

The volatile constituents of cotton have been studied and shown to contain many terpenoids (Hedin et al., 1973, 1975), a class generally considered to be secondary plant metabolites and to have diverse functions that are "ecological rather than physiological" (Robinson, 1975). For example, terpenoids inhibit the growth of competing plants (Rice, 1974) and microorganisms (Morris et al., 1979). Also, mustard volatiles have been studied recently by Wallbank and Wheatley (1976), and allyl isothiocyanate, a common constituent of mustard and other crucifers, was found to be attractive to the cabbage root fly [*Delia brassicae* (Bouché)] (Wallbank and Wheatley, 1979). The glucosinolate precursors of mustard volatiles were shown to be quantitatively related to the feeding response of the diamondback moth [*Plutella xylostella* (L.)] (Fraenkel, 1959).

EXPERIMENTAL SECTION

The plant materials were collected in Oct 1974, a time when all three plants would be hosts, in Oktibbeha County, MS. The leaves of the mustard, the flower buds of croton, and the buds and blossoms of goldenrod, plant parts with the highest frequency of *Lygus* bugs, were separately steam distilled. Each distillate was extracted with pentane. The pentane extracts were concentrated to ~50% oil and injected into a Hewlett-Packard 5930 quadrupole mass spectrometer via the gas–liquid chromatograph (GLC) equipped with a 250 ft × 0.03 in. stainless steel capillary column coated with OV-17. The GLC oven was programmed from 80 to 180 °C at 2 °C/min; the He flow 8 was mL/min. The mass spectra were obtained at 70 eV. GLC peak identities were determined by comparison with reference spectra (Stenhage et al., 1974). Peak areas were quantitated by triangulation.

RESULTS AND DISCUSSION

As expected, mustard volatiles did not contain terpenoids (see Table I). Further, there were no compounds common to all three plants. In croton and goldenrod only, camphene and limonene were shown to be present in both plants, and these were at low levels. Although there are many terpenoids in croton and goldenrod, the typical terpenoid mass spectra did not allow the same identity to be given to peaks with similar retention times. It is noteworthy that α-copaene (42.5%) is the major constituent of goldenrod volatiles. Unlike goldenrod, croton contains a number of nonterpenoid compounds. Each plant, therefore, appears to be unique in its volatile constituents. The response of the *Lygus* bug may be a general response to the presence of volatile compounds associated with plants and not a specific response to individual compounds. This view is consistent with the wide range of crop and weed plants that are hosts for the *Lygus* bug.

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