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HYBRID REACTIONS TO PHYTOTOXIC EFFECTS OF THE CORN HERBICIDE, ERADICANE EXTRA

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Although corn hybrids are primarily evaluated only for yield performance in the Kentucky Hybrid Corn Performance Test, the 1984 test (Poneleit and Evans, 1985) provided a unique opportunity to evaluate hybrid reactions to an unusual hybrid-herbicide interaction. Of seven non-virus test locations, four were treated with Eradicane Extra[3] or Eradicane[4] for weed control. At the Princeton location Eradicane Extra, at 8 pints/acre, was used for johnsongrass rhizome suppression and seedling control. In late July, a routine check revealed that numerous plants had unusual appearances that were similar to abnormalities reported earlier as caused by Eptam[5] and Eradicane (Poneleit et al, 1975). Subsequent observations confirmed the severity of damage at the Princeton test site and reports of similar hybrid reactions from farmer fields prompted the collection of apparent herbicide damage data from the replicated Princeton test. The other performance test sites where Eradicane Extra or Eradicane was applied did not show significant plant abnormalities. Apparently the appearance of phytotoxic effects owing to Eradicane Extra are sporadic and strongly influenced by specific interaction of environmental factors. It was postulated that this injury occurrence in 1984 was the result of excessive rainfall four to six weeks after planting. Dichlormid (safener) is very water soluble and could have been leached away from the corn roots, and thus not available to protect the corn from EPTC.

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[3] Eradicane Extra, EPTC (S-ethyl dipropylcarbamothioate) + dichlormid safener (2,2-dichloro-N,N-di-2-propenylacetamide) + dietholote extender (O,O-diethyl O-phenyl phosphorothioate), Stauffer Chemical Company, Mountain View, CA.

[4] Eradicane, EPTC (S-ethyl dipropylcarbamothioate) + dichlormid safener, Stauffer Chemical Company, Mountain View, CA.

[5] Eptam, EPTC (S-ethyl dipropylcarbamothioate), Stauffer Chemical Company, Mountain View, CA.

One hundred thirty two hybrids were planted in an 11 x 12 rectangular lattice design on June 1, 1985 (Poneleit and Evans, 1985). Conventional tillage and recommended fertilization were employed. The herbicides used for weed control, 8 pints/acre of Eradicane Extra plus 4 pints/acre of Bladex[6], were preplant incorporated. The soil type was a Huntington silt loam and had been left fallow the previous year for weed control purposes.

The frequency and type of the plant and ear abnormalities were recorded in August, 1984 according to the following system:

Injury Type 1 (Minimal Injury) --

Incomplete husk covering, about 1/4 of the ear tip exposed, normal ear and kernel development.

Injury Type 2 (Severe Injury) --

Incomplete husk covering with more than 1/4 of the ear tip exposed, poor kernel fill and development, possibly crescent shaped ears with smut (Ustilago maydis) growth.

Injury Type 3 (Plant Growth Abnormalities) --

Twisting of stalk at the ear-node, stunting, absence of or extremely abnormal ear development.

Injury Type 4 (Other Abnormalities) --

Lodging or non-herbicide induced abnormalities.

The data for all hybrids (average of three replications) is reported in Table 1. Percent stand is the percent of planted seed (70 per plot) that emerged and developed into recognizable individual plants at the time of herbicide damage rating. Percent injury is the percent of those plants with visible abnormalities (Injury Types 1, 2, and 3) at the rating date. Poneleit (1974) reported that an extreme phytotoxic effect of EPTC would occur at germination or early seedling growth and result in death of plants (reduced percent stand) and twisted appearance of susceptible seedling genotypes. Such an effect was not evaluated in this study, since emergence stands were not collected. Also, routine observations, soon after emergence, did not detect abnormal seedling plants. Although a very low percent stand in Table 1 may suggest seedling phytotoxic effects, such a conclusion can not be verified. An "X" in the column for injury types 1 to 4 means that the injury type indicated was observed in at least one of the three replicated plots of that hybrid. More than one injury type may have been observed in a plot. Statistically significant differences for percent stand and percent injury were determined and indicate that the phytotoxic effects were genotype dependent and not a random function of spray overlap or micro-variations in soil type or soil preparations.

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[6] Bladex®, cyanazine {2-[4-chloro-(ethylamino)-s-triazine-2-yl]amino] - 2-methylpropanenitrile}, Shell Chemical Company, Houston, TX.

Excessive precipitation in the fall prevented grain harvest of the entire test. However, twenty-four plots in replication two were harvested and the data are presented in Table 2. These data are presented to illustrate the correspondence of the herbicide damage rating with yield performance. Additional information about yield reductions caused by EPTC can be obtained from a prior publication (Poneleit, 1974). Yield performance of the hybrids listed in Table 1 from other 1984 test sites can be obtained from the published performance test data (Poneleit and Evans, 1985). The 1984 Princeton yield observations are presented in four groups: No Injury, Injury Type 1, Injury Type 2, and Injury Type 3. No statistical evaluation was made since the 24 hybrid observations were not replicated.

Observations of the group means in Table 2, however, reveal that those hybrids grouped for Injury Type 3 had the least grain production and the highest frequency of injured plants. Hybrids in the Injury Type 1 group had the highest yield and the hybrids in the Injury Type 2 group had a mean yield equivalent to those hybrids in the no injury group. Several of the No Injury group hybrids had very low yields. These may have been caused by random environmental or soil conditions or by herbicide effects that produced no visual symptoms. It is not likely that the four groups of hybrids are inherently different for yield potential since the average yield for the four groups from five other 1984 performance test locations were 133.9, 129.0, 122.8, and 127.1 bu/acre, respectively. It is likely, therefore, that the data in Table 1, percent injury and injury type, adequately reflect the herbicide/hybrid interaction. Hybrids with a high frequency of injury, particularly Injury Type 3, have the highest potential yield loss from Eradicane Extra. Hybrids with Injury Type 2 are also a poor risk group since these hybrids should be considered susceptible to EPTC damage and might show a more severe reaction in a different situation. Hybrids with Injury Type 1 will probably experience little yield loss. Exposed ear tips, however, may invite invasions by pathogens, insects and birds.

Correlations of the measured variables are presented in Table 3. The low correlation of percent stand with percent injury superficially suggests that percent stands do not reflect herbicide injuries. However, if the phytotoxic effect for certain genotypes is expressed by killing newly germinated plants, and surviving plants are free of visual abnormalities, the correlation may not reflect the early herbicide damage. Seedling injuries resulting in reduced stand and yield reductions were reported by Poneleit, 1974, for Eptam and Eradicane but may represent a separate plant reaction that may or may not occur with Eradicane Extra. Percent injury is significantly correlated with yield (-0.74) and as discussed earlier should be a primary criterion for evaluation. Other correlations with percent injury were not significant and suggest that percent injury was not associated with hybrid maturity (percent moisture at harvest) or with lodging which may be used to evaluate adaptation of hybrids to the prevalent disease, insect and growth environment. Yield was also associated with maturity (percent moisture) but not with percent stand or percent lodged.

In summary, these data show that some hybrid corn genotypes are quite resistant to phytotoxic effects of Eradicane Extra. Other hybrids may be severely damaged and their use in combination with Eradicane Extra may result in severe economic losses to farmers. Presumably these phytotoxic effects are similar to those reported for EPTC in earlier publications (Poneleit, 1974; Poneleit et al., 1975). Combination of the active ingredient herbicide, EPTC,

with the dichlormid safener and dietholate extender, has provided a herbicide that is very useful for Kentucky farmers (Witt, 1983). However, the use of the Eradicane Extra formulation should be utilized with the understanding that it is not risk-free. The chemical formulations, plant genotype, soil variability, planting date, and weather may interact to create potential yield loss situations. Although the potential effect on yield may be severe, the appearance of phytotoxic effects is sporadic and relatively infrequent, depending upon undefined environmental factors. In 1984 Eradicane Extra damage occurred on only a few farmer fields (unpublished estimates by University personnel are that less than 2000 acres were significantly damaged in 1984). A corn grower, however, should be aware of potential herbicide/hybrid interactions when using the herbicide, Eradicane Extra. The risks can best be assessed by review of direct hybrid evaluations, as in this note, as well as by consultation with his seed corn and herbicide supplier.

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Table 1. Injury type and frequency for 132 hybrids treated with eight pints Eradicane Extra and four pints Bladex at Princeton, KY, in 1984. Data are averages of three replications.

Name	Color	Percent Stand	Percent Injured	Injury Type 1	2	3	4
Adlers 88X	Yellow	91.4	3.9	x	x	-	-
Adlers 6100	Yellow	86.7	38.4	-	x	x	-
Adlers 3015	Yellow	87.1	4.6	-	x	x	-
AgraTech GK868	Yellow	88.6	26.9	-	x	x	-
AgraTech GK900	Yellow	84.8	3.5	x	-	-	-
AgraTech GK925	Yellow	91.0	16.5	x	x	-	-
AgriGold A-6910	Yellow	89.0	17.7	-	x	x	-
AgriGold A-6865	Yellow	88.1	22.7	x	x	-	-
AgriGold A-6795W	White	93.8	40.2	-	x	x	x
Asgrow RX962W	White	85.2	0.0	-	-	-	x
Asgrow RX777	Yellow	82.4	23.6	-	x	x	-
Asgrow RX114	Yellow	85.7	14.1	x	x	x	x
Beck's 90X	Yellow	93.3	4.0	x	x	-	-
Beck's 85XA	Yellow	83.3	36.7	x	x	x	-
Ring Around RA3605W	White	81.0	0.0	-	-	-	-
Bo-Jac 674	Yellow	90.0	30.1	x	x	x	-
Bo-Jac 5623	Yellow	73.8	51.1	-	x	x	-
Bo-Jac 7021	Yellow	83.3	26.5	-	x	x	x
Select Seed 5177	Yellow	87.1	27.2	x	x	x	-
USS Ag-Chem USS1218	Yellow	85.2	10.2	x	x	x	-
Campbell C960	Yellow	84.3	11.1	x	-	-	-
Campbell C755	Yellow	89.0	29.9	-	x	x	-
Cargill 967	Yellow	89.5	12.9	x	x	-	-
Cargill 980	Yellow	84.8	32.3	-	x	x	-
Cargill 955	Yellow	88.1	19.3	x	x	x	-
Caverndale CF 6065	Yellow	88.1	12.5	x	x	x	-
Coker 19A	Yellow	91.0	11.2	x	x	-	-
Coker 21	Yellow	92.9	19.1	x	x	-	-
Coker 833W	White	97.6	46.2	-	x	x	-
Colbert 315	Yellow	86.7	0.0	-	-	-	-
Colbert 340	Yellow	86.7	3.5	x	x	-	-
Colbert 345	Yellow	93.8	12.6	x	x	x	-
Colbert 326	Yellow	89.0	11.6	-	x	-	-

Name	Color	Percent Stand	Percent Injured	Injury Type 1	2	3	4
Crow's SL75	Yellow	91.4	21.5	x	x	x	-
Crow's 688	Yellow	86.7	22.2	-	x	x	-
Crow's 690	Yellow	82.0	12.4	x	x	-	-
Custom Farm Seed CFS8000	Yellow	88.1	42.4	x	x	x	-
Custom Farm Seed EW98000	Yellow	78.6	40.3	x	x	x	-
Custom Farm Seed W4100	Yellow	81.0	35.3	x	x	x	-
D & H DH7183	Yellow	91.0	4.6	x	x	-	-
D & H DH9120	Yellow	73.8	14.6	x	x	x	-
D & H DH9113	Yellow	91.9	24.9	x	x	x	-
DeKalb-Pfizer DK747	Yellow	86.7	14.0	-	x	x	-
DeKalb-Pfizer DK789	Yellow	84.8	0.0	-	-	-	-
DeKalb-Pfizer XL71	Yellow	87.1	19.7	x	x	x	-
DeKalb-Pfizer T1230	Yellow	90.0	14.6	x	x	-	-
Dekalb-Pfizer XL390B	White	82.4	0.0	-	-	-	-
Dennis DS42	Yellow	84.3	16.4	-	x	x	-
Dennis DS49	Yellow	74.8	19.4	x	x	x	-
Dennis DS37A	Yellow	82.4	13.1	x	x	-	-
Funk's G-4522	Yellow	93.8	21.7	x	x	x	-
Funk's G-4733	Yellow	86.7	2.7	x	-	-	-
Funk's 6024X	Yellow	90.5	15.6	-	x	x	-
Funk's G-4779W	White	83.3	0.0	-	-	-	-
Golden Acres T-E 6995	Yellow	84.8	33.0	x	x	x	-
Golden Acres T-E 6998	Yellow	91.4	28.5	x	x	x	-
Golden Acres T-E 6996	Yellow	87.6	23.1	-	x	x	-
Golden Harvest H2680	Yellow	91.0	33.8	-	x	x	-
Golden Harvest H2675	Yellow	85.7	21.3	x	x	x	-
Golden Harvest H2686	Yellow	83.8	44.3	-	x	x	-
Golden Harvest H2775A	Yellow	78.6	30.6	x	x	x	x
Gold Tag GT4022	Yellow	91.0	18.8	x	x	-	-
Jacobi 6600	Yellow	82.9	9.1	x	x	-	-
Jacobi 8870	Yellow	91.9	25.1	x	x	x	-
Jacobi 6700	Yellow	81.0	1.3	x	-	-	-
Jacques 8220	Yellow	91.4	21.1	x	x	-	-
Jacques 8400	Yellow	86.2	9.0	x	x	x	-
Jacques 8100	Yellow	90.0	14.0	x	x	x	-
Leader SX717	Yellow	85.2	8.2	-	x	-	-
McCurdy 84AA	Yellow	91.4	13.4	x	-	-	-
McCurdy 8150	Yellow	91.0	16.0	x	x	x	-
McCurdy 7372	Yellow	86.7	12.1	-	x	-	-

Name	Color	Percent Stand	Percent Injured	Injury Type 1	2	3	4
AgriPro HP470	Yellow	91.9	33.5	-	x	x	x
AgriPro HP771	Yellow	91.4	15.9	x	x	x	-
AgriPro HP555	Yellow	87.1	16.4	-	x	x	-
Northrup-King PX95	Yellow	89.0	9.7	-	-	x	x
Northrup-King PX9581	Yellow	94.8	35.7	x	x	x	x
Northrup-King PX9692	Yellow	86.2	32.9	x	x	x	-
O's Gold 2570	Yellow	89.0	0.5	x	-	-	-
O's Gold 2545	Yellow	83.3	33.0	-	x	x	-
P.A.G. SX351	Yellow	91.4	27.8	x	x	x	-
P.A.G. SX354	Yellow	84.8	55.1	-	x	x	x
P.A.G. XL383	Yellow	86.2	25.8	x	x	x	-
Paymaster 8990	Yellow	76.2	42.9	x	x	x	-
Pioneer Brand 3320	Yellow	94.3	0.0	-	-	-	-
Pioneer Brand 3184	Yellow	91.9	12.5	x	x	x	-
Pioneer Brand 3192	Yellow	82.4	1.2	x	-	-	-
Pioneer Brand 3358	Yellow	90.0	0.0	-	-	-	-
Prairie Stream SX730	Yellow	81.0	10.6	x	x	x	-
Prairie Stream SX720	Yellow	94.8	13.0	x	x	x	-
Premier SX636	Yellow	94.3	20.5	x	x	x	-
Princeton SX860	Yellow	84.3	56.7	-	x	x	-
Princeton SX870	Yellow	75.2	39.9	x	x	x	x
Ring Around RA1502	Yellow	88.6	47.0	-	x	x	-
Ring Around RA1604	Yellow	93.3	38.9	x	x	x	-
Ring Around RA1404	Yellow	88.6	43.5	-	x	x	x
Ring Around RA2606W	White	87.1	0.0	-	-	-	-
Ruff's R334A	Yellow	84.8	3.4	x	-	-	-
Ruff's R230	Yellow	74.8	27.0	x	x	x	-
Scott Seed LR880	Yellow	86.7	15.9	x	x	x	-
Scott Seed LR220	Yellow	85.7	57.5	-	x	x	x
Scott Seed LR3589	Yellow	73.3	21.9	x	x	x	-
Select Seed 8400	Yellow	91.0	2.5	x	-	-	-
Select Seed 8900	Yellow	87.1	30.2	-	x	x	-
Select Seed 9122	Yellow	91.9	16.6	x	x	-	-
Select Seed 9131	Yellow	88.1	0.5	x	-	-	-
Southern States SS950W	White	90.0	2.1	x	-	-	-
Southern States SS811	Yellow	83.8	6.5	x	x	-	-
Southern States SS910	Yellow	93.8	42.8	x	x	x	-
Southern States SS915	Yellow	91.4	11.5	x	x	-	-

Name	Color	Percent Stand	Percent Injured	Injury Type 1	2	3	4
Stauffer S8818	Yellow	91.0	10.2	x	x	-	-
Stauffer S7759	Yellow	87.6	39.9	-	x	x	-
Stauffer S8500	Yellow	88.6	23.4	-	x	x	-
Stewarts SX77	Yellow	93.3	25.0	-	x	x	-
Stewarts S-6973	Yellow	73.8	27.8	-	x	x	-
Stewarts S-7324	Yellow	79.0	17.0	-	x	x	-
Stewarts S-8430	Yellow	69.5	33.3	-	x	x	-
Super Crost 6762	Yellow	92.9	19.7	-	x	x	-
Super Crost 5438	Yellow	87.6	33.1	x	x	x	-
Super Crost 6340	Yellow	88.1	44.3	-	x	x	-
USS Ag-Chem USS2020	Yellow	79.5	25.7	-	x	x	-
USS Ag-Chem USS7001	Yellow	85.2	33.0	x	x	x	-
Vineyard Seed MV48	White	81.9	3.3	x	-	-	-
Vineyard Seed MV58	White	80.0	6.5	x	x	-	-
Vineyard Seed MV68	White	81.4	0.0	-	-	-	-
Vineyard Seed MV78	White	54.8	0.0	-	-	-	x
Voris Seeds V2641	Yellow	89.0	20.0	x	x	x	-
Voris Seeds V2631	Yellow	90.5	14.2	x	-	-	-
Zimmerman Z11W	White	90.0	0.0	-	-	-	-
Zimmerman Z14W	White	67.1	0.0	-	-	-	-
Zimmerman Z23Y	Yellow	91.0	62.4	-	x	x	x
Zimmerman Z27Y	Yellow	87.6	16.7	x	x	-	-
Average		86.4	20.0				

Table 2. Yield, percent injury, injury type of 24 hybrids treated with eight pints Eradicane Extra and four pints Bladex at Princeton, KY, in 1984. One replication of data only.

Entry	Color	Bu/Ac	Percent Moisture	Percent Stand	Percent Lodged	Percent Injured	Injury Type 1	2	3	4
15	White	141.6	22.9	84.3	11.9	0.0	-	-	-	-
6	Yellow	137.6	21.1	94.3	0.0	0.0	-	-	-	-
35	Yellow	108.2	21.3	85.7	11.7	0.0	-	-	-	-
125	White	107.4	22.6	82.9	3.4	0.0	-	-	-	-
33	Yellow	73.4	20.1	85.7	5.0	0.0	-	-	-	-
40	Yellow	44.3	23.8	88.6	0.0	0.0	-	-	-	-
		102.1	22.0	86.9	5.3	0.0				
52	Yellow	143.3	22.0	88.6	3.2	3.2	x	-	-	-
87	Yellow	127.6	22.1	81.4	0.0	3.5	x	-	-	-
108	Yellow	123.6	22.7	71.4	10.0	4.0	x	-	-	-
		131.5	22.3	80.5	4.4	3.6				
1	Yellow	119.0	24.3	85.7	6.7	11.7	x	x	-	-
13	Yellow	95.8	22.9	94.3	0.0	12.1	x	x	-	-
12	Yellow	93.6	22.6	85.7	16.7	25.0	x	x	-	-
		102.8	23.3	88.6	7.8	16.3				
94	Yellow	104.5	22.1	91.4	1.6	31.3	-	x	x	-
120	Yellow	100.1	21.1	87.1	0.0	32.8	-	x	x	-
22	Yellow	98.4	19.5	85.7	1.7	50.0	-	x	x	-
116	Yellow	81.0	24.8	67.1	0.0	51.1	-	x	x	-
118	Yellow	70.5	21.0	95.7	1.5	47.8	-	x	x	-
2	Yellow	65.4	20.8	87.1	0.0	80.3	-	x	x	-
78	Yellow	63.1	23.0	84.3	1.7	49.2	-	x	x	-
43	Yellow	56.2	20.5	88.6	3.2	41.9	-	x	x	-
9	White	50.2	23.3	90.0	7.9	66.7	-	x	x	-
92	Yellow	34.1	22.9	84.3	0.0	81.4	-	x	x	-
37	Yellow	25.4	26.2	85.7	8.3	66.7	-	x	x	-
117	Yellow	12.3	28.3	64.3	2.2	68.9	-	x	x	-
		63.4	22.8	84.3	2.3	55.7				
Grand Mean		86.5	22.6	85.0	4.0	30.3				
Range Low		12.3	19.5	71.4	0.0	0.0				
High		143.3	28.3	95.7	16.7	81.4				

Table 3. Correlations

Correlated Characters			N	r
Percent Injury	with	Percent Stand	396	.04
	with	Bu/Ac	24	-.74**
	with	Percent Moisture	24	.26
	with	Percent Lodged	24	-.23
Bu/Ac	with	Percent Stand	24	.18
	with	Percent Moisture	24	-.44*
	with	Percent Lodged	24	.18

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