STARTER EFFECTS ON CORN GROWN ON PREVIOUSLY FLOODED SOILS

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The devastating floods of 1993 prompted a great deal of concern about crop production in those areas the following year. These concerns were prompted both by scientific information (Fixen et al. 1984: Vivekanandan and Fixen, 1991) and by farmer observations from prior flood experience. In response to these concerns, projects, observations, and experiments were undertaken. These included collection of soil samples for chemical analysis in the fall of 1993, observations of corn grown in 1994 on flood affected soils, and experiments on both starter and foliar fertilizers in 1994.

EXPERIMENTAL PROCEDURES

Soil sampling: In an attempt to characterize chemical properties of flood affected soils, samples were collected to a 7-inch depth on one acre grids from five fields in the fall of 1993 and analyzed for pH, P, and K. Two additional samples collected from each field - one to the depth of silt deposition and another to a 7-inch depth in an area of the field that had not received any apparent deposition - were analyzed for atrazine and trifluralin. Samples were collected from sites in Stephenson and Whiteside Counties in Northern Illinois, Pike County in West Central Illinois, and Monroe and Alexander Counties in Southwestern Illinois. Each field had been sampled for soil analysis in the previous two years, although the earlier sampling was less extensive than the one we made following flooding. Fields selected for sampling had to be drained by fall to allow for sampling. Silt and sand deposition was significant in only two of the fields.

Observations on corn grown following soil flooding: An informal survey was made concerning early-season growth of corn grown in 1994 on soils that had been flooded in the summer of 1993. Notes were made on possible nutrient (especially P) deficiency problems, and on the recovery of plants in affected fields.

N and P starter fertilizer experiments: Starter fertilizer experiments were conducted in two farm fields, one with Wakeland silt loam soil near Hull in Pike County, and the other with Blackoar silt loam soil near Ursa in Adams County - both fields are in the western extremity of Illinois near the Mississippi River. Crops in both of these fields had been destroyed by flooding in 1993. The Hull location was planted on May 18, 1994 following the destruction of a thin stand of wheat that had been planted in the fall of 1993. The Ursa location was planted on May

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5. Soil samples taken at the time of planting showed pH of 6.7, P of 51 lb/acre, and K at 155 lb/acre at Ursa, and pH 6.1, P = 119, and K = 361 at Hull.

The 12 treatments in this experiment consisted of factorial combinations of two application methods - broadcast and sidebanded (2 x 2 placement near the row); 2 N rates - 0 and 25 lb N/acre as ammonium nitrate; and 3 P rates - 0, 25, and 50 lb P_2O_5/acre as CSP (0-46-0). Treatments were arranged in an RCB design with four reps. Plots consisted of four, 30" rows 30 feet long.

Plant dry weight and N and P content were measured on plants samples at about the 7-leaf stage (June 20) at Hull and at the 5-leaf stage (May 31) at Ursa. Yields were calculated from hand-harvested samples, but are not yet available.

Foliar fertilizer: In the second week in May, a foliar fertilizer experiment was established in a Wakeland silt loam soil in a field located near Hull, Illinois, in which corn had been planted very early (March 31), and where plants showed severe P deficiency (leaf purpling) symptoms. The crop in this field was destroyed by the 1993 flood. Soil test levels were pH = 6.3, P = 45 lb/acre, and K = 187 lb/acre.

There were ten treatments: control; 2.5 or 5.0 gal/acre of 10-34-0 applied foliarly either all at once (on May 18, 1994), split (to minimize potential leaf damage) into two applications 8 days apart, or directed at the base of the plants; 5.0 gallons of 10-34-0 dribbled on the soil surface near the row; and 1.94 gal/acre of 28-0-0 either broadcast or dribble-applied. This amounts of 28-0-0 provided 5.8 lb N/acre, and the 5-gallon rate of 10-34-0 provided 5.8 lb N and 19.7 lb P_2O_5/acre. Plants were sampled at about the 6-leaf stage (June 1) for dry weight and N and P concentration, and grain yield was determined from hand-harvested samples.

RESULTS AND DISCUSSION

Soil sampling: With differences in the intensity and sites of sampling, we can draw few statistically sound conclusions about possible flooding-induced changes in soil test values: the following are observations only. At the two locations where significant sand deposition occurred, P tests decreased from 30 to 60 lb P/acre (Table 1). In contrast, two of the locations that had received little deposition increased in P test by about 30 pounds. Soil pH tended to increase slightly at those locations (Monroe and Alexander Counties) below the confluence of the Mississippi and the Missouri, while pH tended to decrease slightly in fields above that point. Changes in soil test K levels decreased in two locations and appeared to have increased in one location following the flood.

Despite possible changes due to flooding, pH, P, and K levels after flooding were at or above those recommended for optimum production. This was especially true for P, which averaged 114 lb P/acre over the five sites. Atrazine was not detected in deposited materials any of these fields, while trifluralin was found in three fields, at less than 0.05 ppm in each case. Based on the 1993 soil test results, concern about adverse affects of the flood on the 1994 crop was lessened.

Table 1. Soil test values before and after the 1993 flooding in five fields in Illinois.

County	Cooperator	Before flooding			After flooding				
		pH	P	K	pH	P	K	Atr.[1/]	Tri.[2/]
			-----lb/acre------			-----lb/acre------		---------ppm--------	
Stephenson	Rigney	7.1	103	355	7.0	100	382	nd	0.047
Whiteside	Young	6.9	96	256	7.1	128	343	nd	nd
Pike	Lundberg	6.4	124	444	6.3	99	255	nd	nd
Monroe	Reichman	5.9	43	430	6.4	68	476	nd	0.030
Alexander	Teflinger	6.6	127	455	6.8	60	345	nd	0.026

[1/] Atr. = atrazine: [2/] Tri. = trifluralin. nd = not detected.

Observations of Corn Grown on Flood Affected Soil: Following are some qualitative observations recorded from the informal survey of early-season corn growth in the flood-affected areas of western illinois:

1. The beginning of the 1994 season was quite cool and dry, and leaf purpling was very widely observed, on both flooded and non-flooded soils in Illinois. Plants with purple leaves usually started to started to green up within a week of so after the appearance of the symptoms.
2. Corn in fields where weeds had been allowed to grow until just prior to planting appeared to have less purpling than those in fields where tillage was used to prevent weed growth. Farther south in the state, where winter annual weeds had established in most fields (and, presumably, where soils were warmer), purple corn was not a problem even on early planted fields.
3. Corn growing in areas that had once been used as feedlots showed no adverse affects of the flood compared to corn growing just a few yards out of the feedlot area but otherwise treated the same.
4. While there were differences in the intensity of the purple color formation among hybrids, virtually all exhibited some symptoms.
5. The intensity of the problem was not consistent within most fields. Some areas of fields appeared to be developing at a normal rate, while most of the rest of the field was stunted and purple. This differential did not appear to be related to soil type or topography.

While these observations seem to indicate some sort of effect of flooding on P nutrition of small corn plants, so much corn purpling occurred throughout Illinois in the spring of 1994 that singling out the effect of flooding as a primary cause is difficult. Hints that the flood-induced purpling may have been different than that in non-flooded soils include the rather uniform and rapid disappearance of the problem in flooded soils, and what appeared to be greater influence of tillage and planting conditions in fields that had not been flooded.

Starter fertilizer: Statistical analyses showed that plant dry weight, N concentration, and P concentration of young corn plants was significantly affected by P rate, application method, and by the P rate × application method interaction at both locations. In addition, the N rate, N rate × P rate, N rate × application effects were significant for N and P concentrations, and N rate × P rate × application effect was significant for P concentration at Ursa. Higher P rates increased plant dry weight substantially when the fertilizer was sidebanded, but not when it was broadcast (Table 2). The effect of application method on N and P concentrations differed at the two locations, with sidebanding causing decreases at Hull and increases at Ursa. It appears that the faster growth of the much larger plants at Hull simply diluted the amount of nutrient taken up: total plant N and P content were higher where P had been sidebanded at both locations. The fact that the much smaller plants at Ursa also took up more N and P, and grew faster, indicates that the growth increase from fertilizer near the seed can initiate a cumulative effect on growth. We have no basis to evaluate whether the previous flooding had any effect on this phenomenon.

Table 2. Effects of N and P fertilizer applied at planting time on dry weight and N and P concentration of young corn plants grown in previously-flooded soils in Illinois, 1994.

Treatment			Hull			Ursa		
N	P_2O_5	Application	Plant dry wt.	Plant N conc.	Plant P conc.	Plant dry wt.	Plant N conc.	Plant P conc.
-------lb/acre--------			g/plant	%	%	g/plant	%	%
0	0	broadcast	9.0	3.54	0.41	0.50	3.18	0.17
0	0	sideband	9.8	3.42	0.41	0.48	3.15	0.18
0	25	broadcast	10.5	3.28	0.43	0.54	3.10	0.19
0	25	sideband	13.0	2.92	0.35	0.95	3.84	0.36
0	50	broadcast	10.5	3.49	0.45	0.51	2.96	0.17
0	50	sideband	15.2	2.78	0.34	0.98	3.39	0.37
25	0	broadcast	10.5	3.25	0.45	0.48	3.28	0.18
25	0	sideband	9.2	3.70	0.44	0.49	3.53	0.17
25	25	broadcast	8.6	3.49	0.44	0.50	3.08	0.18
25	25	sideband	14.7	2.95	0.34	1.00	4.10	0.43
25	50	broadcast	9.7	3.56	0.44	0.45	3.14	0.18
25	50	sideband	16.3	3.13	0.35	1.28	4.66	0.53
	LSD 0.10		2.4	0.30	0.05	0.18	0.46	0.04

Foliar fertilizer: Statistical analysis showed no effect of fertilizer treatment on plant weight. N concentration, or grain yield (Table 3). The effect on P concentration of young plants was significant, with the broadcast split applications of 10-34-0 and the 28-0-0 giving higher P concentrations than the other treatments. It is not at all clear why the N-only treatments produced higher plant P concentrations than did equivalent rates of N along with P. These results do show clearly that plants with purple leaves were able to recover and grow normally without added P. and that addition of P as a "rescue" treatment was therefore not justified. One additional benefit from this experiment was that a number of farmers in the area waited to see whether the additional P was beneficial, and so delayed destroying their first-planted crop until after it had recovered with no additional treatment.

Table 3. Effect of liquid fertilizer applied post-emergence on corn grown in a previously flooded soil near Hull, Illinois in 1994.

Treatment			Plant	Plant	Plant	Grain
Material	Rate	Application	dry wt.	N conc.	P conc.	yield
	gal/acre		g/plant	%	%	bu/acre
None - control			2.27	4.42	0.39	142
10-34-0	2.5	broadcast	2.17	4.19	0.38	158
10-34-0	5.0	broadcast	2.21	4.31	0.35	139
10-34-0	2.5	broadcast-split	2.15	4.39	0.43	121
10-34-0	5.0	broadcast-split	2.34	4.20	0.45	157
10-34-0	2.5	directed	1.99	4.15	0.35	140
10-34-0	5.0	directed	2.25	4.27	0.36	143
10-34-0	5.0	dribbled	1.72	4.27	0.36	144
28-0-0	1.9	broadcast	2.39	4.28	0.42	137
28-0-0	1.9	dribbled	2.02	4.51	0.43	137
LSD 0.10			NS	NS	0.03	NS

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