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Kenneth L. Wells
University of Kentucky

Dennis B. Egli
University of Kentucky, degli@uky.edu

C. E. Wyatt
University of Kentucky

John Kavanaugh
University of Kentucky

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UNIVERSITY OF KENTUCKY
COLLEGE OF AGRICULTURE
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FOLIAR FERTILIZATION OF SOYBEANS

K.L. Wells, D.B. Egli, C.E. Wyatt, and John Kavanaugh

Research reported by Iowa State University during the winter of 1975-76 suggested that a means of increasing soybean yields by use of a specific foliar fertilizer had been demonstrated (1976). Theory proposed to explain the reported responses was as follows: Up to the seed filling period in soybean growth, soybean roots and activity of nitrogen-fixing bacteria contained in root nodules are capable of supplying the necessary nutrients to meet the plants demands. However, as seed filling begins root growth stops and nodule activity declines. This results in nutrients being redistributed from leaves to seeds and a reduction in rate of photosynthesis. Consequently, studies were conducted to evaluate methods of foliar fertilization in an attempt to maintain photosynthetic rate and nutrient supply during seed filling, the objective being to increase yields.

The limitation to developing such a method was in formulating a fertilizer material which was concentrated enough to supply the necessary nutrients and yet not so concentrated that foliage would be unduly damaged (burned).

The research reported from Iowa State indicated success in formulating such a fertilizer and in developing rates and a time sequence for its application. The fertilizer developed contained N-P-K-S in a ratio similar to that found in soybean seed. Absence of any one of these elements was reported to result in lower yields than could be obtained when all four elements were present in the proper ratio. Formulation of the fertilizer centered on the use of urea for all nitrogen, potassium polyphosphate, and potassium sulfate. Key to success of this formulation reportedly was the use of potassium polyphosphate.

Results reported indicated that soybean yields had been increased 10-20 bushels per acre by 3-4 applications of this formulation, beginning just as pods start to fill. Successive applications were made at 10-14 day intervals with the objective of supplying the crop an additional 75-18-27-4 lbs/A of N-P_2O_5-K_2O-S respectively. Three foliar treatments each supplying 25-6-9-1.5 lbs/A of N-P_2O_5-K_2O-S in approximately 20 gallons of water were suggested in addition to the routine soil fertilization program. It was emphasized that this procedure was more likely to be successful when used in addition to all other

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good production practices and that it would not likely be a substitute for them.

Following announcement of these results, the Tennessee Valley Authority's National Fertilizer Development Center formulated enough of the fertilizer material for wide-spread field evaluation during the 1976 growing season. We obtained a supply of the product for field testing in Kentucky. This product was a clear liquid containing 10-2.2-4.0-0.6 percent of N-P_2O_5-K_2O-S respectively, and was recommended for direct foliar application at the rate of 25 gal/acre. We conducted several studies as reported below to evaluate the effect of this fertilization method on soybean yields. A surfactant (TWEEN 80) was used at a 0.1% concentration. These foliar applications were made in addition to routine soil fertilization practices.

FIELD STUDIES CONDUCTED DURING 1976

I. Small plot, replicated field comparisons.

a. U.K. Agricultural Experiment Station South Farm

Cutler 71 soybeans were planted May 20, 1976 in 30-inch rows in Maury silt loam soil. Foliar applications were made as shown in footnotes below between 5 and 7 p.m. using a CO_2 - powered hand sprayer. Treatments were replicated 4 times. Results obtained are as follows:

No. Applic's	Total Applied(lbs/A) N	P_2O_5	K_2O	S	bu/A Yield	Maturity[1]	(ins.) Height[2]	Lodging[3]	(g/100 seed) Seedsize
-	0	0	0	0	38.2	9/15	39	3.1	16.8
3	0	0	0	0 [4/5]	37.6	9/15	42	3.4	16.8
3	66	16	26	4 [6/]	35.0	9/16	41	3.8	16.5
2	44	11.5	18	3 [7/]	37.2	9/18	41	3.1	17.0
3	66	0	0	0 [7/]	34.4	9/13	40	2.8	15.9
				L.S.D(.05)	N.S.	N.S	N.S	N.S	0.8

1/ Date when 95% of pods were brown.

2/ Height from ground level to tip of main stem.

3/ Rated on scale 1-5. All plants standing = 1; all plants lodged = 5.

4/ Sprayed with water and TWEEN 80 on dates shown below.

5/ Applied in 3 equal applications beginning at seed fill (stage R5) which occured 8-11; 8-23; and 9-2.

6/ Applied in 2 equal applications 8-11; and 8-23.

7/ Prepared from chemical grade Urea at the same concentration as in the TVA material; applied 3 times as shown above.

b. Three paired comparisons (3 replications each conducted on double-cropped soybeans (var. Williams) no-till planted in 18-inch rows into wheat stubble on a Lowell silt loam soil on Briar Hill Stock Farm, Fayette County. Results obtained were as follows:

Total Applied (lbs/A)				Yield (bu/A)		
N	P_2O_5	K_2O	S	Test 1	Test 2	Test 3
0	0	0	0	39.5	41.4	34.7
75	16.5	30.0	4.5 1/	40.9	38.1	31.2

1/ Applied in 3 equal applications with a CO_2-powered hand sprayer on 8-31; 9-9; and 9-20.

c. Small plot study (3 reps per treatment) conducted in Graves County.

No. Applic's	Total Applied (lbs/A)				Yield (bu/A)
	N	P_2O_5	K_2O	S	
-	0	0	0	0	30.7
1	25	5.5	10	1.5	30.8
2	50	11.0	20	3.0	25.4
3	75	16.5	30	4.5	31.8

d. Small plot study (3 reps per treatment) conducted in Ohio County on Mitchell soybeans.

No. Applic's	Total Applied (lbs/A)				Yield (bu/A)	
	N	P_2O_5	K_2O	S	Test 1	Test 2
0	0	0	0	0	55.6	46.0
2	50	11.0	20	3.0	--	47.3
3	75	16.5	30	4.5 1/	54.8	--

1/ Material was diluted with water before spraying.

II. Large plot comparisons (sprayed a total of 0.75 - 1.0 acre) by farmers. Enough material was supplied to farmers at the following locations to make 3 foliar applications (total application of 75-16.5-30-4.5 lbs/A of N-P_2O_5-K_2O-S, respectively). The liquid fertilizer was applied either by airplane or by use of a hi-boy, depending on location. Yields reported are from field combine harvest within treated and adjacent untreated areas of the field.

	Yield (bu/A)	
Location (County)	treated	untreated
Calloway	49.1	48.4
Fayette	30.0	28.5
Livingston	20.0	19.3
McCracken	34.3	34.0
McCracken	29.0	27.1

SUMMARY

Field tests (small plot and large plot) were conducted at several sites in Kentucky during 1976 to determine the effect of a foliar fertilization technique developed at Iowa State University on yield of soybeans. Under conditions tested in Kentucky during 1976, yield of soybeans was not increased by use of this method of fertilization. It was of additional interest that while mild to moderate foliage damage (burn) was reported from most sites, the effect on yield was judged to be negligible.

REFERENCE

Garcia, L.R., and J.J. Hanway. 1976. Foliar fertilization of soybeans during the seed filling period. Agron. J. 68:653-657.

Kenneth L. Wells, Extension Specialist
in Agronomy

Kenneth L. Wells