POOR GRAIN SORGHUM PRODUCTION AFTER RICE IMPROVED BY PHOSPHORUS BANDED NEAR SEED

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Replicated field trials conducted in Colusa and Glenn Counties demonstrated that poor growth and production of grain sorghum (milo) the first year after rice may be improved by phosphorus banded near the seed. Treble super phosphate, 11-48-0, 8-24-0, and 10-50-0, improved seedling growth and grain yields when placed with or below seed. After four or more years of continuous rice, P banded near sorghum seed provided economic returns and striking seedling growth responses. Sorghum trials after only two years of rice showed fewer seedling growth differences and variable yield responses to banded P. Soil analysis using critical levels developed on soils with no rice history could not be used to successfully predict yield responses to banded P after rice. Further studies are necessary to answer such questions as: (1) Why are some soils P deficient after rice? (2) How can we predict situations where banded P is effective? (3) What are the optimum rates of P for highest economic returns?

Photo above shows the nearly normal sorghum growth (to left, as compared with check) as a result of treble super phosphate banded with the seed. The picture was taken at the Baker trial in Glenn County. The field had been in rice the previous four years.

MANY SORGHUM GROWERS in Colusa and Glenn counties have encountered poor crop growth on lands previously cropped to rice. A similar situation affecting safflower after rice was described in the September 1971 issue of CALIFORNIA AGRICULTURE (in this case improvement was achieved by placing phosphorus fertilizers near the seed). In addition, poor seedling growth has been observed in field corn, sudangrass and some other crops the first year after rice at several locations.

Grain sorghum is frequently grown in rotation with rice since it is one of the few crops suitable for heavy rice soils. Sorghum grown the first year after rice, develops normally the first two to three weeks after planting, and then becomes stunted and chlorotic. Symptoms also include a delayed development of the secondary roots and necrosis of the first leaves beginning at the leaf tip. Some stand loss may occur. Gradually the remaining plants develop secondary roots and resume growth, but maturity is delayed and yields may be reduced. Plant analyses show the stunted, chlorotic plants to be low in phosphorus. Many fields show nearly normal growth only on soil from the previous year's rice levees.

Greenhouse studies have been carried out with soils from areas of poor sorghum growth after rice. Sorghum has shown a striking response to fertilizer phosphorus banded with or near the seed. Little or no benefit resulted when phosphorus was mixed with soil in the greenhouse.

Field trials

Grain sorghum fertilizer trials were established in Colusa and Glenn counties in 1970 and 1971 to evaluate, under field conditions, the results of the greenhouse studies. In addition to evaluating the effect of banded P, the field trials helped determine the effect of rice history on the severity of the problem and the value of the bicarbonate soil phosphorus analysis for diagnosing possible problem fields.

Treatments utilized pelleted phosphorus fertilizers, 0-45-0 (treble super

phosphate), 8-24-0, 11-48-0, and 10-50-0 applied in a band 0.5 inch below or with the seed. An International Harvester model 150 drill, or a John Deere grassland drill, was used to plant seed and apply pelleted fertilizers. Liquid 8-24-0 was injected 1.5 inches directly below the seed.

Growth and maturity

The 1970 and 1971 tests verified earlier greenhouse studies. Within four to five weeks after planting, large seedling growth differences became apparent. Phosphorus banded near the seed produced relatively healthy, vigorous seedlings, while plants in untreated areas remained stunted and chlorotic. Seedling tissue samples were taken in trials about one month after planting to determine the PO_4-P content. Higher PO_4-P content was found in plants making good growth.

Banded P hastened maturity and generally lowered grain moisture content at harvest. The single harvest date necessitated by the nature of these field trials generally prevented measurement of the maximum moisture reduction at harvest.

After four or more years of continuous rice, yield responses to banded P could not be successfully predicted by soil analysis using the sodium bicarbonate P method. Previous sorghum trials on soils with no rice history indicated a critical soil level of 5 to 7 ppm bicarbonate P. Banded P significantly increased grain yields after rice even though bicarbonate P levels exceeded 10 ppm.

Three trials established where sorghum followed 2 to 3 years of rice produced variable results on soils containing 9.6 and 13.1 ppm bicarbonate P. Banded P corrected seedling "after rice" symptoms and advanced grain sorghum maturity in some trials but significantly increased yields at only one location. These trials indicate that the "after rice" problem is usually less severe following 2 or 3 years of continuous rice.

Economic value

One important advantage of banded P after rice is earlier maturity of sorghum. Earlier maturity lowers grain moisture content at harvest which can facilitate earlier harvest and lower grain drying costs. Lower grain moisture content from banded P, illustrated in tables 1 and 2, resulted in a grain drying cost savings of 7 to 9 dollars per acre.

Increased yields from P banded or mixed with the seed improved net returns from grain sorghum following 4 or more years of continuous rice.

Value

The value of increased yields ranged from $15.98 per acre to $31.92 per acre. The cost of phosphorus fertilizers to obtain these yield increases ranged from $2.91 per acre to $8.54. To determine net returns, roadside grain sorghum was valued at $2.10 per cwt. The following per-ton costs of fertilizers, excluding application costs, were used for comparisons: 0-45-0 (treble super phosphate) @ $90/ton; 8-24-0 @ $74/ton; 11-48-0 @ $100/ton; and 10-50-0 @ $120/ton.

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TABLE 1. RESPONSE OF GRAIN SORGHUM TO BANDED P AFTER 4 YEARS IN RICE, GLENN COUNTY*

Material applied	Total	Banded nutrients N	Banded nutrients P_2O_5	Banded nutrients P	Seedlings PO_4-P	Advanced† maturity	Moisture at harvest	Yield‡	Yield increase	Value of increased yield @ $2.10/cwt	Approximate fertilizer cost
	lbs/A		lbs/A		ppm	days	%	lbs/A	lbs/A	$/acre	$/acre
None (30" rows)	0	0	0	0	511	.....	28.4	4,898	....	....	...
None (12" rows)	0	0	0	0	661	.....	23.1	4,914	16	....	...
8-24-0 (30" rows). Liquid injected 1.5" below seed @ $74/ton	200	16	48	21	2624	15–20	16.7	5,659	761	15.98	7.40
0-45-0 (with seed in 12" rows) @ $90/ton	108	..	49	22	1597	15–20	16.0	5,841	943	19.80	4.86
10-50-0 (with seed in 12" rows) @ $120/ton	110	11	55	24	1917	15–20	15.7	6,051	1,153	24.21	6.60
LSD 5%					397			576			
Coefficient of Variability					17.6%			6.8%			

* Grower: Baker—Soil Test: 16.9 ppm Bicarbonate P—pH: 5.3—Variety: DeKalb C-48A—Soil Type: Plaza silt loam, Arbuckle gravelly loam—Preplant: 160 lbs. N/A.
† The Advanced Maturity column indicates the reduced number of days needed to reach flowering in banded P treatments.
‡ All yields adjusted to 14% moisture.

TABLE 2. RESPONSE OF GRAIN SORGHUM TO BANDED P AFTER 15 YEARS IN RICE, COLUSA COUNTY*

Material applied	Total	Banded nutrients N	Banded nutrients P_2O_5	Banded nutrients P	Advanced† maturity	Moisture at harvest	Yield‡	Yield increase	Value of increased yield @ $2.10/cwt	Approximate fertilizer cost
	lbs/A		lbs/Acre		days	%	lbs/A	lbs/A	$/acre	$/acre
None	0	0	0	0	....	21.7	2740	....	....	...
11-48-0 @ $100/ton	60	7	28	12	10–16	15.3	3680	940	19.74	2.91
11-48-0 @ $100/ton	115	13	55	24	6–17	14.8	3720	980	20.58	5.58
11-48-0 @ $100/ton	176	19	83	36	10–18	14.5	4260	1520	31.92	8.54
LSD .05						2.57	346			
Coefficient of Variability						7.6%	4.6%			

* Grower: LaGrande—Soil Test: 10.0 ppm Bicarbonate P—pH: 6.3—Variety: NK 125—Soil Type: Willows clay—Preplant: 180 lbs. N/A. (Rowspacing, 20 inches).
† The Advanced Maturity column indicates the reduced number of days needed to reach flowering in banded P treatments.
‡ All yields adjusted to 14% moisture.