EFFECTS OF THE SOYBEAN CROP ON SOIL PRODUCTIVITY

O. H. Sears and W. L. Burlison

University of Illinois, Urbana, Illinois

Soybeans have gained in popularity among Illinois farmers more rapidly than any other legume crop. In 1914 only 2,000 acres were grown in the state, whereas the last four-year average production (1936-1939) was more than 2,000,000 acres. This acreage exceeds that of all other important legumes in Illinois.

As early as 1903, a rotation experiment including soybeans was begun at Urbana. This rotation, consisting of one year of soybeans and three years of corn (soybeans, corn, corn, corn), has been unchanged, and there are now data for thirty-six consecutive years.

One-half the plots are harvested for seed and the other half harvested for hay. On the plots where seed is harvested, the threshed straw is returned to the land and, on the plots harvested for hay, manure is applied at the rate of one pound for each pound of crop harvested. In addition, some plots in each half series receive rock phosphate treatment. Cornstalks are returned to the land on all plots.

At the beginning of the experiment, a rotation of soybeans, corn, corn, corn was believed not to be a good one. It was used for the purpose of comparison with two other four-year rotations having one and two years of corn in these respective rotations.

Curiously enough, the yields of soybeans have increased slowly but gradually. This fact is shown by Fig. 1.

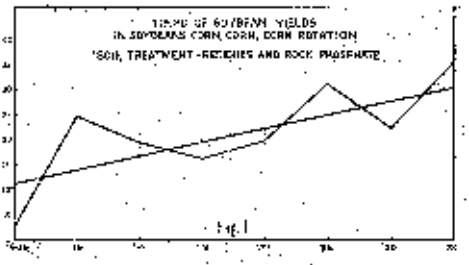

Fig. 1

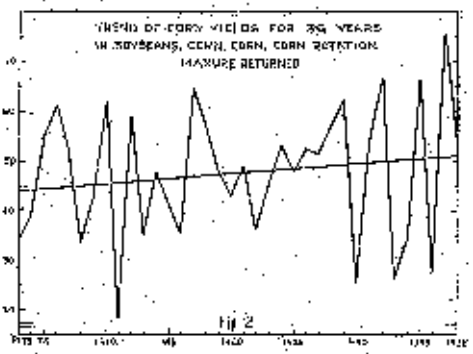

Fig. 2

The increase in yields of soybeans during the early years of the rotation is due in part to the gradual development of an active nodule bacteria flora. Good commercial inoculants were not available in 1903 and, as a result, nodulation of the soybean crop was dependent upon "natural" inoculation. Consequently, several years were required before maximum nodulation was obtained.

TABLE 1—CORN YIELDS AFTER SOYBEANS, COWPEA-CORN, CORN, ROTATION ON SOILS RECEIVING DIFFERENT FERTILIZER TREATMENTS, URBANA

(Averages for 38 years, 1908-1930)

Year after soybeans	Yields from plots treated with *				Average, all treatments
	R+P	R	M	MrP	
	bu.	bu.	bu.	bu.	bu.
First	60.8	46.6	51.6	58.3	50.7
Second	43.3	42.7	47.6	49.7	48.3
Third	43.3	39.6	41.6	44.8	42.8

* R = crop residues—cornstalks and threshed bean straw.
M = livestock manure—one ton for each ton of crops grown.
rP = rock phosphate.

The yields of corn have been consistently highest the first year after soybeans, and have been lowest the third year after the soybeans. These yields are given in Table 1.

Undoubtedly the physical condition of the soil is a factor affecting these yields. The tilth of the soil is much better after soybeans than after corn. The first year after soybeans the land is pulverized easily and a good seedbed may be prepared without difficulty, whereas in the third year after soybeans, the land appears cloddy and a good seedbed is difficult to prepare.

The biological activity of the soil is another factor affecting the yields of corn after soybeans. This fact is shown in Table 2.

The average number of microorganisms of the soil is highest the first year after soybeans and lowest in the third year. By referring to Table 1, it may be seen that the highest corn yields are secured on the plots having the highest number of microorganisms and vice versa. Either the same factors which are responsible for high corn yields are responsible also for large numbers of organisms, or else the large number of microorganisms affect the productivity of the soil. There is reason to believe the latter is the case.

One of the functions of soil microorganisms is the production of available

TABLE 2—AVERAGE MILLIONS OF MICROORGANISMS PER GRAM OF AIR-DRY SOIL IN A SOUTHERN CORN, COWPEA-CORN, ROTATION ON SOILS RECEIVING DIFFERENT FERTILIZER TREATMENTS, URBANA, 1928

Year after soybeans	Millions of microorganisms per gram of air-dry soil from plots treated with *				Average, all treatments
	R	R+P	M	MrP	
First	12.6	15.1	14.7	15.3	13.6
Second	9.1	13.9	10.4	13.1	11.2
Third	5.2	10.2	8.5	10.9	9.5

* R = crop residues—cornstalks and threshed bean straw.
M = livestock manure—one ton for each ton of crops grown.
rP = rock phosphate.

TABLE 3—AVERAGE AMOUNT OF NITRATE NITROGEN PER ACRE IN SOIL IN A SOUTHERN CORN, COWPEA-CORN ROTATION, ON SOILS RECEIVING DIFFERENT FERTILIZER TREATMENTS, URBANA 1928

Year after soybeans	Pounds of nitrate nitrogen per acre in soil of plots treated with *				Average, all treatments
	R	MrP	M	MrP	
First	21.9	30.2	30.2	29.3	27.4
Second	17.8	19.4	14.6	18.9	15.4
Third	14.7	18.4	13.1	15.1	13.5

* R = crop residues—cornstalks and threshed bean straw.
M = livestock manure—one ton for each ton of crops grown.
rP = rock phosphate.

nitrogen—an element limiting crop yields in many soils. An examination of Table 3 shows that there are 27.7 pounds

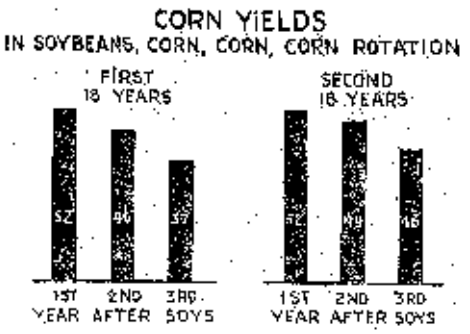

Fig. 3

per acre of nitrate-nitrogen the first year after soybeans, as an average for all treatments. With the same soil treatments the nitrate-nitrogen average is 16.4 and 12.3 pounds for the second and third years after soybeans, respectively.

The general trend of corn yields has been slightly downward where the soybeans are harvested for seed, and definitely upward where they are harvested for hay. The latter trend is shown in Fig. 2.

By grouping the yields in two 18-year periods this upward trend of corn yields is found to be due to increased yields in the second and third years after soybeans, rather than in the first year (Fig. 3).