Recycle Solid Animal Wastes

by T. C. Tucker & J. L. Abbott[1]

This is an era of ecological preservation, concern over environmental pollution, inflation, energy crises, and fertilizer shortages. Conversion of the problem of animal wastes disposal to systematic utilization on crop land relates to these contemporary topics. For example, diminishing supplies of fossil-derived energy sources, along with generally spiraling price increases, have resulted in higher fertilizer prices and critical shortages. The fixation of light energy by green plants is the only process of energy renewal of major importance at the present time functioning on Planet Earth. For plants to accomplish this remarkable feat, carbon dioxide must be present at the leaf surfaces as well as an adequate supply of mineral nutrients and water in a well-aerated root environment.

Manure contributes to the nutrition of the plants as well as a favorable root environment. The National environment with respect to manure is threatened with the possible contamination of water supplies and the nuisance problems such as odors and flies associated with large stockpiles of manure. The feeder or dairyman is faced with an increasingly difficult physical problem of handling and disposal as the manure accumulates.

Animal manure has long been recognized as a source of nitrogen for plants along with its beneficial effects on soil physical condition. However, the contribution of manure to the phosphorus and micronutrient nutrition of plants has not been emphasized.

Experiments with manure were conducted at the Cotton Research Farm beginning in 1960 and continued through 1970. Although emphasis in studies was on the contributions to the available nitrogen (N) and phosphorus (P) for crop plants, other effects also were observed. In the initial experiment cotton yields were higher from 1960 through 1964 when manure was applied at the rate of 10 tons per acre per year when compared with the application of adequate amount of fertilizer N. The P content of the cotton leaves was much higher with manure application than with the application of commercial fertilizer N and P as shown in Figure 1.

Beneficial effects of manure other than the contribution of N were shown by the fact that yields were higher with manure than with only N application (Table 1). These effects of manure on cotton are shown to persist for three years after a single application of 10 tons per acre although additional N was needed after the first year. With annual applications of 10 tons per acre, N fertilizer was not necessary.

After cotton harvest in the fall of 1968, soil samples were taken from each treatment and analyzed for P. These results (Table 2) show increasing amounts of extractable P corresponding to increasing rates of manure application during the preceding four-year period. Barley followed the cotton in 1968 and the residual manure effects are reflected in the data (Table 3). The P concentration in barley tissue samples follow the same pattern as the soil P values and reflect a residual P contribution from past manure applications. Yields were higher on plots treated with the highest rates of manure.

The P uptake by alfalfa planted in 1969 after barley continued to show the persistence of manure P availability by increased P content of the hay in 1970 (Table 4). This continued effect of the past manure applications was shown by phosphorus uptake data for 1971.

The long-recognized value of manure for its contribution to the N nutrition of crops and the not-so-generally recognized fact that manure is an excellent source of P, as shown in this study. These data indicated that manure is an effective source of P as was shown by increased P content of cotton, barley, and alfalfa as well as soil analysis. These effects were shown to last for several years after the last manure application. At a given location, the duration of the effects of manure application on P availability will probably depend upon the quantity of manure applied and the nature of the soil.

Organic matter and nutrients in manure stimulate microbiological activity in the soil. Microbial cycling of manure P probably is the key to the length of time manure P will persist, and the fact that manure P appears more effective than commercial P fer-

[1] *Professor and Assistant Agricultural Chemist, respectively, Department of Soils, Water and Engineering.*

Table 1. Manure Treatments and Corresponding Lint Yields for Cotton 1965-1968.

Manure Applied				*Manure*		*Lint Yield*			
1965	1966	1967	1968	*Total*	*N*	1965	1966	1967	1968
— — — — — — T/A — — — — — —					lbs./A	— — — — — — lbs./A — — — — — —			
0	0	0	0	0	0	662a*	572a	470a	552a
					75	712a	723b	566ab	782b
10	0	0	0	10	0	946b	823bc	548ab	569a
					75	1011b	1004de	768d	919c
10	0	10	0	20	0	909b	823bc	730cd	738b
					75	996b	912cd	740cd	926c
10	5	5	6	26	0	922b	888cd	641bc	829b
					75	959b	902cd	652c	963c
10	10	10	12	42	0	961b	1032e	792d	946c
					75	925b	984de	775d	974c

* *Values within a given column followed by the same letter are not significantly different at the* 0.05 *probability level.*

Table 2. Sodium bicarbonate soluble P in soil sampled December 1968.

*Manure** T/A	*$NaHCO_3$ Ext. P* ppm
0	4.8a
10	6.9ab
20	8.4b
26	10.4b
42	19.3c

* *Manure applications indicated in Table* 1.

Means followed by the same letter belong to the same population (0.05 probability level).

tilizers. Beneficial effects of manure on soil physical condition — tilth, aeration, and water relationships — probably contribute appreciably to increased productivity and are associated with this microbial activity.

Although not evaluated in this study, it is quite probable that micronutrients from manure can provide an additional advantage on soils deficient in these nutrients.

Table 3. Phosphorus Concentration in Barley Tissue and Yields for the First Crop of Residual Study, 1969.

Manure T/A	*P Concentration* %	*Grain Yield* lbs./A
0	0.22a*	3207a
10	0.26ab	3671ab
20	0.30bc	3654ab
26	0.36c	3904b
42	0.46d	3861b

* *Means followed by the same letter belong to the same population.*

Rates of manure application of the order of 5 to 10 tons per acre annually will provide adequate N and P for most crops without excessive land loading to the point of creating a pollution hazard. Sufficient data are not available to determine the long-term effects of appreciably higher rates under Arizona conditions.

A more widespread use of animal manure on crop land can ease the problem of critical fertilizer shortages created by the energy crisis and convert the disposal problem into a utilization program without severe environmental hazard. By this utilization, nutrients and a more favorable root environment are provided for the green plants that trap the energy from the abundant Arizona sun.

Table 4. Phosphorus Uptake by Alfalfa in Residual Study, 1970.

Manure T/A	*P Uptake* lbs./A
0	5.45a*
10	6.82b
20	7.38bc
26	8.22c
42	10.00d

* *Means followed by this same letter belong to the same population.*

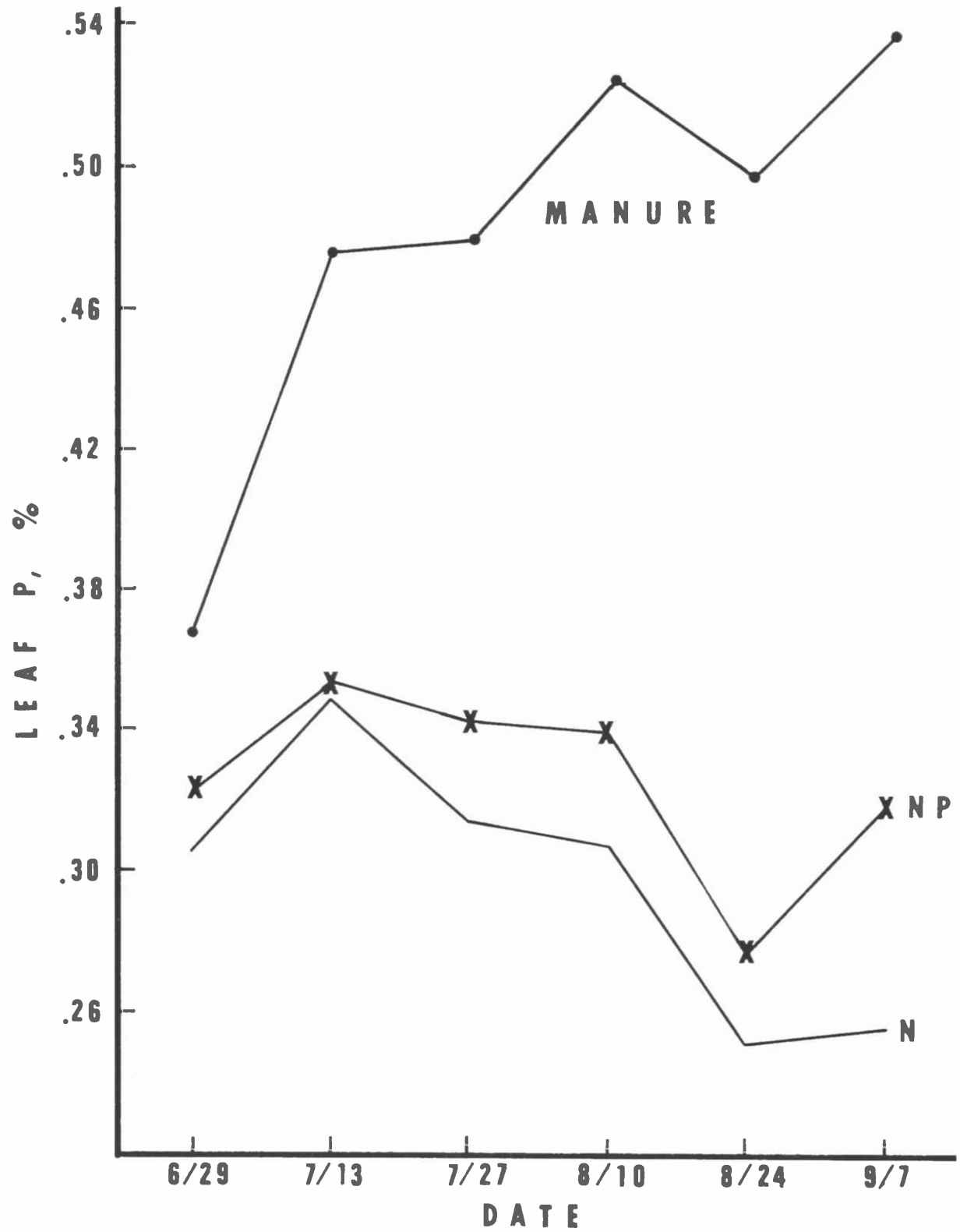

Figure 1. Effect of Manure on the P Concentrations in Cotton Leaves After Six Annual Treatments.

References

Abbott, J. L. 1968. *Use animal manure effectively! Bull. A-35. Agr. Exp. Sta. and Coop. Ext. Serv., The University of Arizona, Tucson.*

Abbott, J. L., and J. C. Lingle. 1968. *Effect of soil temperature on the availability of phosphorus in animal manures. Soil Sci.* 105: 145-152.

Abbott, J. L. 1973. *Persistence of manure phosphorus availability in calcareous soil. Soil Sci. Soc. Amer. Proc.* 37:60-63.

Hannapel R. J., W. H. Fuller, Shirley Bosma, and J. S. Bullock. 1964. *Phosphorus movement in a calcareous soil: I. Predominance of organic forms of phosphorus in phosphorus movement. Soil Sci.* 97:350-357.

Hannapel, R. J., W. H. Fuller, and R. H. Fox. 1964. *Phosphorus movement in a calcareous soil: II. Soil microbial activity and organic phorphorus movement. Soil Sci.* 97:421-427.

Olsen, R. J., R. F. Hensler, and O. J. Attoe. 1970. *Effect of manure application, aeration, and soil pH on soil nitrogen transformations and on certain soil test values. Soil Sci. Soc. Ameri. Proc.* 34: 222-225.