EFFECT OF CATTLE AND POULTRY DUNG ADDITION ON AVAILABLE P AND EXCHANGEABLE K OF A RED—YELLOW PODZOLIC SOIL

SHIFAYA MARAIKAR and S. L. AMARASIRI[1]
Central Agricultural Research Institute, Gannoruwa

ABSTRACT

The data reported are from a laboratory incubation study comparing the effects of animal dung and chemical fertilizers on available P and exchangeable K content of a Red—Yellow Podzolic soil. Results showed that cattle dung was more effective than poultry dung but less effective than triple superphosphate (TSP) in increasing available soil P. A unit of P in TSP seems as effective as 2.5 and 3.5 units of P in cattle and poultry dung respectively. Both cattle and poultry dung seemed as effective as muriate of potash (MOP) in increasing exchangeable K of soil. Considerable savings in P and K chemical fertilizers can be effected when large amounts of animal dung are added to crops as in cultivation of vegetables.

KEY WORDS: Available P, Cattle dung, Exchangeable K, Poultry dung

INTRODUCTION

Continuous application of large amounts of cattle and poultry manure together with high rates of chemical fertiliezrs to vegetables in the upcountry region of Sri Lanka has resulted in the accumulation of excessive amounts of phosphorus and potassium in these soils. Available P and exchangeable K contents as high as 600 ppm have been recorded. In contrast the soil test values in the neighbouring tea growing lands are only about 12 ppm P and 140 ppm K (Division of Agricultural Chemistry, Central Agricultural Research Institute, Gannoruwa, 1989 unpubl.). Reasons for the large applications of chemical fertilizears could be their low cost compared to profits from vegetable cultivation, farmer ignorance of build—up of plant nutrients in soil and the absence of recommendations indicating the adjustments in chemical fertilizer rates when organics are also used. In order to arrive at such recommendations the quantities of plant nutrients in organic manures and their availability to plants in a given edaphic setting should be known.

[1]Present address: Research Division, Department of Agriculture, P. O. Box 5, Peradeniya.

The plant nutrient content of buffalo, cattle, goat, sheep, pig and poultry dung collected from different parts of Sri Lanka has been reported by Marajkar and Amarasiri (1988). Much of the plant nutrients contained in animal dung are not readily available and have to be converted into plant available forms by decomposition and mineralization. McAuliffe *et al.* (1949) and Bromfield (1961) have reported that a part of the phosphate in animal dung is organic and is only slowly available to plants. The inorganic fraction is made readily available when the dung is incorporated into soil (Gunary, 1968). Although several studies have indicated that the P contained in manures is available to plants, only a few studies have compared P availability from manures with that from chemical fertilizers. While some of these studies have shown that P, in manures was equally available as that in fertilizers, others have shown that it was less available (Elias-Azar *et al.*, 1980). Unlike P, information on the behaviour of K in manures is scarce. However, being one of the major cations in the inorganic fraction of animal dung, information on its behaviour in comparison to K chemical fertilizer is very desirable. This paper reports the effect of adding cattle dung, poultry dung and chemical fertilizers on the available P and exchangeable K content of a soil, in a laboratory incubation study conducted over a 10-week period.

MATERIALS AND METHODS

A Red—Yellow Podzolic soil from Bandarawela (pH 4.4, Olsen P 2.5 ppm, exchangeable K 27.3 ppm) and fresh cattle and poultry dung free of litter collected from the Animal Experimental Farm, Gannoruwa, were used in this study. The cattle and poultry dung were air—dried and ground by hand to a fine powder. One g of dung was digested with 5 ml of a 1:4 mixture of perchloric and nitric acids at about 250°C for approximately 30 minutes. The digest was diluted to 100 ml and analysed for P by the vanadomolybdate yellow method (Jackson, 1958) and for K by flame photometry. On dry—basis total P and K content of cattle dung was 1.09 and 0.85% and that of poultry dung 1.46 and 2.21% respectively.

Phosphorus experiment: Triple superphosphate (TSP), cattle dung and poultry dung were added to 1 kg dry soil contained in plastic vessels at rates providing 0, 100, 200, and 400 ppm P. After mixing well the soils were incubated for 10 weeks in the laboratory at room temperature (25°C) and at about 60—70% field capacity. Each treatment was in three replications. A sheet of polythene was spread over the plastic vessels to minimize moisture loss. At periodic intervals the soils were sampled using an open-ended glass tube. Samples were air-dried and analysed for available P by extracting with 0.5M $NaHCO_3$ (Olsen *et al.*, 1954). Phosphorus measurements in the $NaHCO_3$ extracts were made colorimetrically by the ascorbic acid-reduced molybdate method (Murphy and Riley, 1962). The $NaHCO_3$ extraction has been used by Bowman and Cole (1978) to determine the mineralization of organic P compounds added to soil and by Elias-Azar *et al.* (1980) to estimate the availablity of P from manure and KH_2PO_4.

Potassium experiment : Muriate of potash (MOP), cattle dung and poultry dung were added to 1 kg dry soil at rates providing 0 ,100 200 and 400 ppm K. Each treatment was in three replications and incubated for 10 weeks as in the phosphorus experiment. Soil samples were taken periodically, air-dried and exchangeable K extracted using 1M NH_4OAc and K content in the extract was measured flame photometrically.

RESULTS AND DISCUSSION

The changes in available soil P from addition of TSP, cattle dung and poultry dung during the 10—week incubation period are shown in Fig. 1. With increasing rates of added material, available soil P increased for each source. Further, at all rates of added P the effect of TSP in increasing available P was much more pronounced than that of cattle and poultry dung. Similar results have been reported for a sandy loam soil by Elias-Azar *et al.* (1980) who compared P availability from two manure sources with that from KH_2PO_4. However, with a sandy soil they found no difference among the three sources of P. It is evident from Fig.1 that throughout the 10-week incubation period, cattle dung was more effective than poultry dung in increasing available soil P. This may be an indication that the P compounds in poultry dung are more resistant to breakdown than those in cattle dung.

When a P source is added to a soil it will react with it to form a number of phosphorus compounds of different solubilities. The available P content of a soil to which dung has been added is dependent on the balance between P released by the source and that fixed by the soil at a given time. Fig. 1 indicates that with TSP, especially at the higher rates of addition, the available

P content showed a decreasing trend with time of incubation. On the other hand, the available P content of peultry dung (400 ppm P level) reached the highest value at the end of the incubation period. Such contrasting behaviour may be partly due to a lowering of P fixation in soil in the presence of dung. In fact, During and Weeda (1973) have reported that cattle dung has reduced P sorption in soils of high P sorption capacities. Similar. effects due to poultry dung have also been observed (Singh and Jones, 1976).

Fig. 2 shows the changes in exchangeable K content of soil resulting from the addition of MOP, cattle dung and poultry dung. In all treatments exchangeable K content increased with increasing quantities of added material. Time of incubation did not bring about appreciable changes in exchangeable K content. The effect of poultry dung was very similar to that of MOP in increasing exchangeble K. Cattle dung was slightly less effective than poultry dung. These results seem to indicate that the potassium in cattle and poultry dung is present in a soluble form and its availability to plants is comparable to that in MOP.

The foregoing comparisons between chemical fertilizer and animal dung in increasing the available P and exchangeable K content of soil permit an approach towards the rationalization of adjustments in chemical fertilizer levels when organics are added. The relationship between addition of TSP and animal dung and the increase in available soil P at the 4-week incubation period (Fig.3) show that a unit of P in TSP is as effective as about 2.5 and 3.5 units of P in cattle and poultry dung respectively. These values can be used to estimate the relative effectiveness of P supplied in animal dung in terms of TSP. Considering potato cultivation in the upcountry for example, the common practice of adding nearly 40 t/ha cattle manure containing about 80% dung mixed with other materials and having a moisture content of 75%, will supply approximately 58 kg P and 60 kg K per hectare. Using the above stated effectiveness value for P and a 1:1 effectiveness for K with respect to MOP, the contribution from cattle manure will be equivalent to 23 kg P as TSP and 60 kg K as MOP. Thus when about 40 t/ha cattle manure is applied together with chemical fertilizers for potato, roughly 23 kg P and 60 kg K can be reduced from the amounts of chemical fertilizers recommended (112 kg P and 150 kg K, per hectare) for this crop, thereby effecting savings of approximately 20 and 40%, respectively of phosphorus and potassium.

The above calculations have been made taking into consideration only the short term effects of manure. With prolonged contact with soil under field conditions, its effectiveness is likely to increase further, thereby permitting larger reductions in the use of chemical fertilizers. In fact several researchers have reported that manures in addition to supplying P, exert a long lasting effect on increasing available soil P as well (Pratt *et al.*, 1956; Abbot and Tucker, 1973; Meek *et al.*, 1979).

Long term field experiments need to be conducted in order to accurately assess the breakdown of manures in the presence of a growing crop under particular soil and climatic conditions. Such information will be helpful in making a better judgement on the amount of chemical fertilizer to be added when organics are in use. The results presented in this paper may help to design such experiments.

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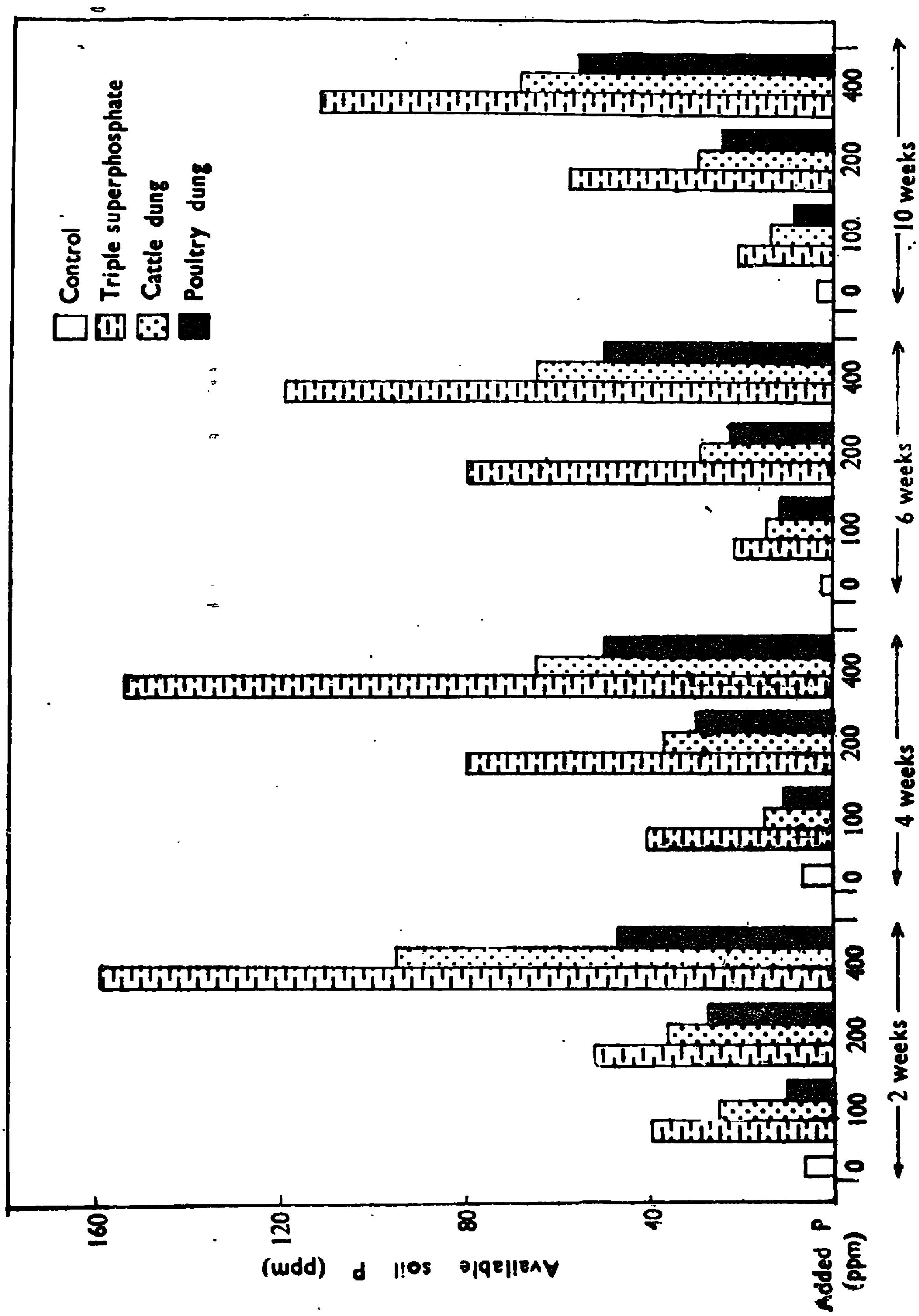

Fig. 1. Changes in available soil P due to addition of animal dung and triple superphosphate during 10-week incubation period

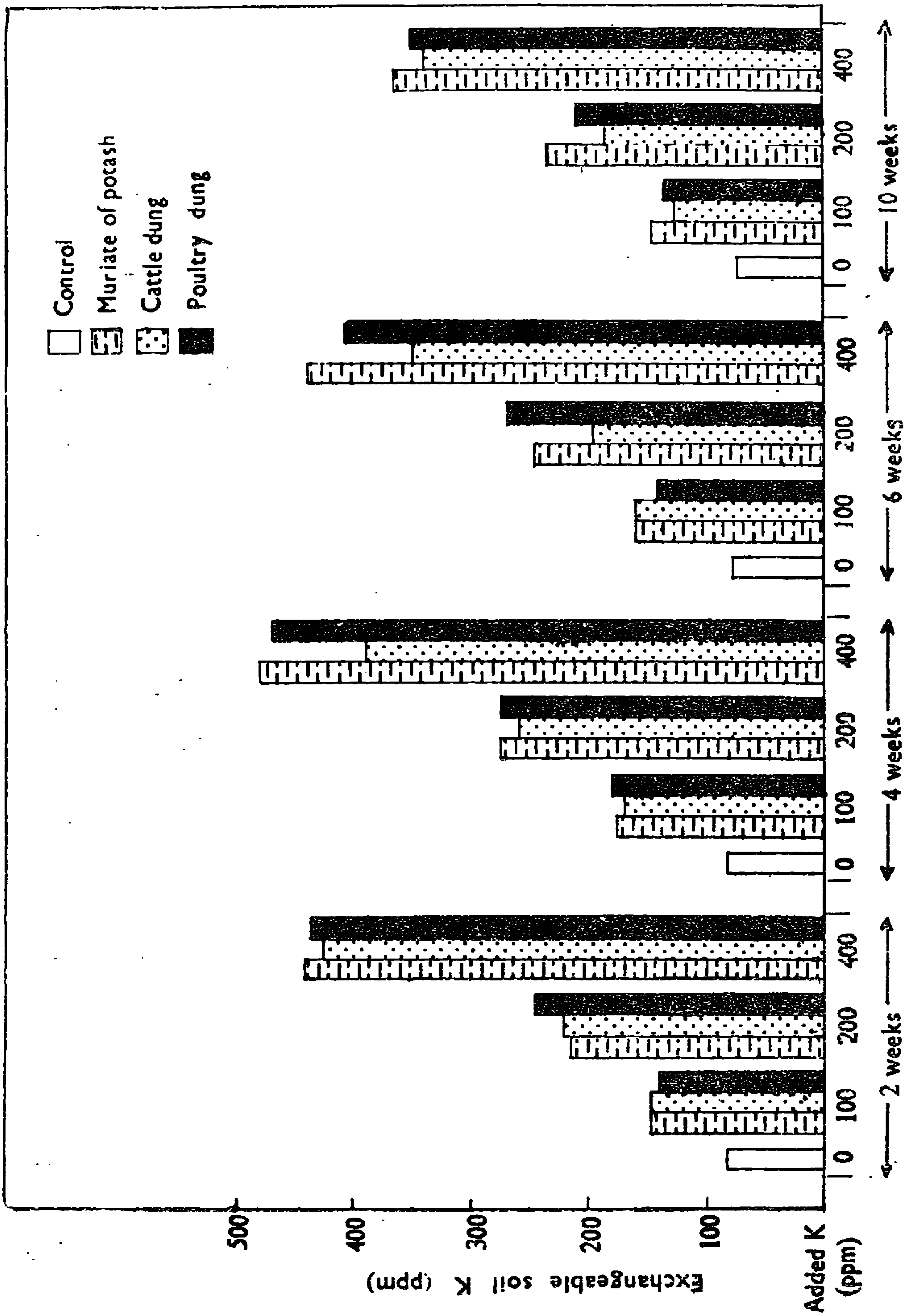

Fig. 2. Changes in exchangeable soil K due to addition of animal dung and muriate of potash during 10-week incubation period

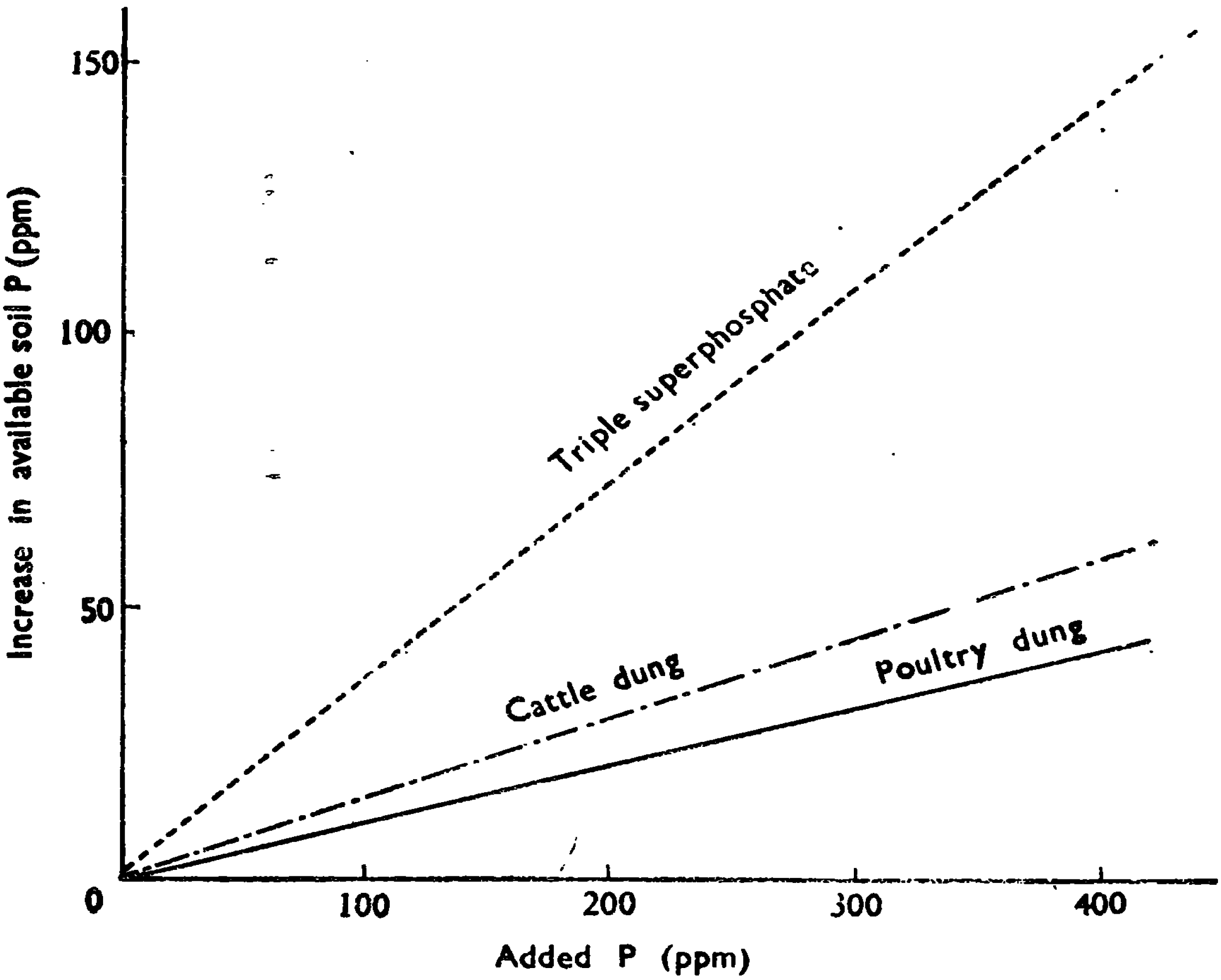

Fig. 3. Relationship between increase in available soil P and quantity of P added as animal dung and TSP at 4-week incubation period