

EFFECT OF ORGANIC AND CHEMICAL FERTILIZERS ON VEGETABLE CULTIVATION IN UPCOUNTRY INTERMEDIATE ZONE

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ABSTRACT

A long-term field experiment was conducted over a period of 9 seasons to study the individual and combined effects of organic and chemical fertilizers on the performance of vegetable crops at Bandarawela. The organic fertilizers compost, cattle manure and poultry manure were evaluated for the cropping sequence, cabbage/tomato/garlic/pole bean/potato/cabbage/tomato/bush bean commencing from maha 1986/87. Irrespective of the crops the highest crop yield was obtained with 10t/ha poultry manure + recommended chemical fertilizers. The application of 10t/ha poultry manure gave higher yields compared to 10t/ha compost and 10t/ha cattle manure application. pH, available P and exchangeable K contents of soil samples collected at the end of each crop season were highest for poultry manure-treated plots. These findings demonstrate that application of 10t/ha poultry manure was beneficial for the achievement of higher productivity of vegetables in this region. However, maximum yield was obtained when 10t/ha poultry manure was applied in combination with the recommended chemical fertilizers. Both compost and cattle manure were found to be inferior to poultry manure as a source of organic fertilizer for growing vegetables.

KEY WORDS: Cattle manure, Chemical fertilizer, Compost, Poultry manure, Upcountry, Vegetables

INTRODUCTION

The upcountry intermediate zone of Sri Lanka refers to the region which lies between 600 to 1400 m above mean sea level and receives an annual rainfall ranging from 1100 to 1400 mm. The mean minimum and maximum temperatures are 15°C and 27°C, respectively. The landscape varies from undulating, rolling, topography to hilly, steeply dissected mountainous terrain. The soils are mainly Ultisols with a pH range of 4.0-5.5 (Panabokke, 1967).

The agriculture in the upcountry areas of Sri Lanka is characterized by intensive cultivation of potato and a range of vegetable crops throughout the year. Potato, tomato, cabbage and bean are the main vegetable crops which occupy a major part of the cropping sequence. Unlike the general pattern of low fertilizer use in

Sri Lanka, many farmers in this region use large amounts of cattle or poultry manure together with high rates of chemical fertilizers. This has resulted in the accumulation of high amounts of phosphorus and potassium in the soils of the region (J.D.H.Wijewardena, Unpubl.). Reasons for excessive applications of both organic and chemical fertilizers are their relatively low cost compared to the profits generated from cultivation of high value vegetable crops.

Poultry manure, which has to be transported over long distances is commonly used as an organic fertilizer at the rate of 10-15 t/ha per crop in the upcountry intermediate zone. Though cattle manure is available in large quantities in this region many farmers do not use it for vegetable cultivation except in the Nuwara Eliya district. Poultry manure is a good source of plant nutrients when compared with other organic manures and is recommended for the production of maximum crop yields (Gunasena and Ahmed, 1977). Poultry manure contains large amounts of many plant nutrients (Maraikar and Amarasiri, 1988; Japenga and Harmsen, 1990; Wijewardena, 1994). In general, poultry manure is considered to have fertilizing properties intermediate between mineral fertilizers and farmyard manure and therefore is beneficial for obtaining high yields (Giardini *et al.*, 1992) and improving crop quality (Pimpini *et al.*, 1992).

However, there is very little experimental data to indicate the relative benefits of organic and chemical fertilizers on vegetable cultivation in the region. This paper reports the findings of investigations carried out to quantify the suitability of various organic fertilizers and their combinations with chemical fertilizer on a long-term basis.

MATERIALS AND METHODS

A long-term non-replicated field experiment was conducted at the Regional Agricultural Research Centre, Bandarawela on a Red Yellow Podzolic (RYP) soil (Ultisol). The experiment began in maha 1986/87. The chemical analysis of soil from the experimental site at the beginning of the experiment is given in Table 1. The following treatments were included in the trial design during the period of maha 1986/87 to yala 1989: No fertilizer; Recommended N, P and K chemical fertilizers (Table 2); 10 t/ha compost; 10 t/ha cattle manure; 10 t/ha poultry manure; and 5 t/ha cattle manure + 5 t/ha poultry manure (with the exception of the first season). The chemical analysis of the organic manures is given in Table 3.

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Table 1. Some chemical characteristics of the experimental site

<i>Property</i>	<i>Content</i>
pH (1:1 H ₂ O)	5.1
Total N (%)	0.15
Organic matter (%)	2.4
Olsen's P (ppm)	19.0
Exchangeable K (me/100g)	0.29

Table 2. Plant spacing and level of N, P and K applied to different vegetable crops

<i>Crop</i>	<i>Spacing (cm)</i>	<i>N level (kg N/ha)</i>	<i>P level (kg P₂O₅/ha)</i>	<i>K level (kg K₂O/ha)</i>
Cabbage	50x50	200	150	100
Tomato	50x50	200	150	100
Garlic	10x10	60	120	60
P.bean	45x45	200	150	100
Potato	60x25	100	250	100
B.bean	15x10	80	75	80

P.bean = Pole bean; B.bean = Bush bean

Table 3. Composition of organic manures

<i>Manure</i>	<i>pH (1:1 H₂O)</i>	<i>Plant nutrient content (%)</i>			
		<i>N</i>	<i>P</i>	<i>K</i>	<i>Ca</i>
Poultry	8.2	3.07	1.54	2.41	3.82
Cattle	7.1	1.52	0.76	0.92	1.20
Compost	6.9	0.56	0.28	0.58	0.80

The plot size was 8m x 5m. Cabbage, tomato, garlic, pole bean and potato were grown sequentially, one crop per season until yala 1989. During maha 1988/89, crop was not planted due to civil disturbances in the country. However during the period of maha 1989/90 to yala 1991, each plot was divided into two equal plots (size 8 m x 2.25 m). Thereafter one part of the plots which were treated with compost, cattle manure, poultry manure, and cattle manure + poultry manure received the recommended chemical fertilizers for each crop until yala 1991. The other half of the plots continued to receive the same treatments as earlier. Cabbage, cabbage, tomato and bush bean were grown sequentially from maha 1989/90 onwards.

The plan of randomization was kept unchanged so that the same plot received the same treatment combination during the entire period of the experiment. The spacing and rates of N, P and K for each crop are given in Table 2. Chemical fertilizers were added according to the times recommended by the Department of Agriculture for each crop.

All crops were grown under rainfed conditions with supplementary irrigation whenever necessary. Plots were maintained weed-free throughout the experiment.

Soil samples were collected from each plot after each crop for chemical analysis except during maha 1987/88 and yala 1988.

RESULTS AND DISCUSSION

The effect of addition of organic and chemical fertilizers on the yield of each of the crops grown sequentially is given in Table 4.

All crops, except pole bean (yala 88) gave the highest yield response to addition of poultry manure. In general, the next best treatment was chemical fertilizer alone. Compost gave higher yield compared to cattle manure except in yala 90.

When organic manures were combined with chemical fertilizer the highest yield of crops was obtained for the combination, chemical fertilizer + poultry manure. The next best treatment was 5 t/ha poultry manure + 5 t/ha cattle manure in

Table 4. Effect of organic and chemical fertilizers on crop yield

Treatment	Crop yield (t/ha)								
	Cabbage maha 86/87	Tomato yala 87	Garlic maha 87/88	Pole bean yala 88	Potato yala 89	Cabbage maha 89/90	Cabbage yala 90	Tomato maha 90/91	Bush bean yala 91
Control	13.9	10.2	33.8	3.3	6.7	10.4	6.4	2.2	5.1
CF	52.7	18.7	48.8	10.4	14.0	55.0	33.0	7.2	10.7
CM	9.3	9.7	42.5	4.7	11.0	32.4	20.1	5.1	6.6
CP	22.2	11.4	52.5	6.1	13.0	33.8	16.9	6.9	8.2
PM	68.2	25.4	85.0	10.2	14.2	58.0	62.1	18.4	11.1
1/2 PM + 1/2 CM		16.5	27.5	4.5	13.7	49.0	34.9	12.1	8.8
CM + CF						55.3	44.4	9.3	9.3
CP + CF						57.9	44.3	8.4	11.4
PM + CF						88.1	81.8	24.6	15.8
1/2 PM + 1/2 CM + CF						68.9	74.2	19.1	13.0

PM = Poultry manure; CM = Cattle manure; CP = Compost; CF = Chemical fertilizer

combination with chemical fertilizer. Compost and cattle manure application in combination with chemical fertilizer gave almost similar yields. In general, all organic manures showed increased efficiency in combination with chemical fertilizer. Chemical fertilizer alone was inferior to the combination of organic and chemical fertilizer.

The results clearly showed that poultry manure has a beneficial effect on crop growth compared to cattle manure and compost. Superiority of poultry manure for crop growth has been previously reported by Elsakow (1983), Giardini *et al.* (1992) and Wijewardena (1995).

Some possible reasons for the better performance of poultry manure are indicated below:

The beneficial effect of poultry manure on crop growth may be due to its high content of major plant nutrients (Maraikar and Amarasiri, 1988; Giardini *et al.*, 1992; Wijewardena, 1994). It is evident from Table 5 that total NPK contributed by 10 t/ha poultry manure is much higher than by cattle manure, compost or chemical fertilizers.

Table 5. Nutrient contribution from organic and chemical fertilizers

Source of fertilizer	Nutrient (kg/ha)		
	N	P ₂ O ₅	K ₂ O
PM 10 t/ha	307	353	289
CM 10 t/ha	152	174	110
CP 10 t/ha	56	64	59
CF Cabbage	200	150	100
Tomato	200	150	100
Garlic	60	120	60
Pole bean	200	150	100
Potato	100	250	100
Bush bean	80	75	80

PM = Poultry manure; CM = Cattle manure; CP = Compost; CF = Chemical fertilizer

The soil analysis after each crop showed that the available P (Olsen's) and exchangeable K content of poultry manure-treated plots were higher than those of chemical fertilizer -, compost- and cattle manure-treated plots (Figs. 1 and 2).

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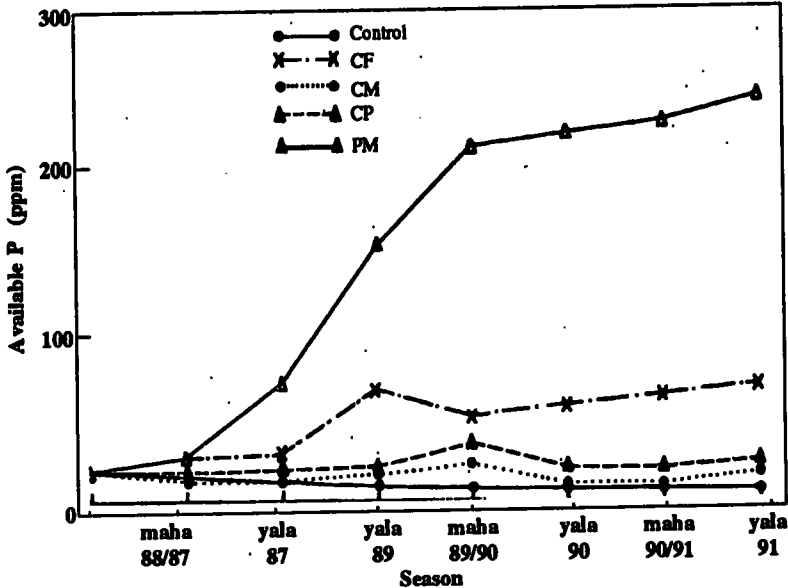


Fig.1. Available P content after each season

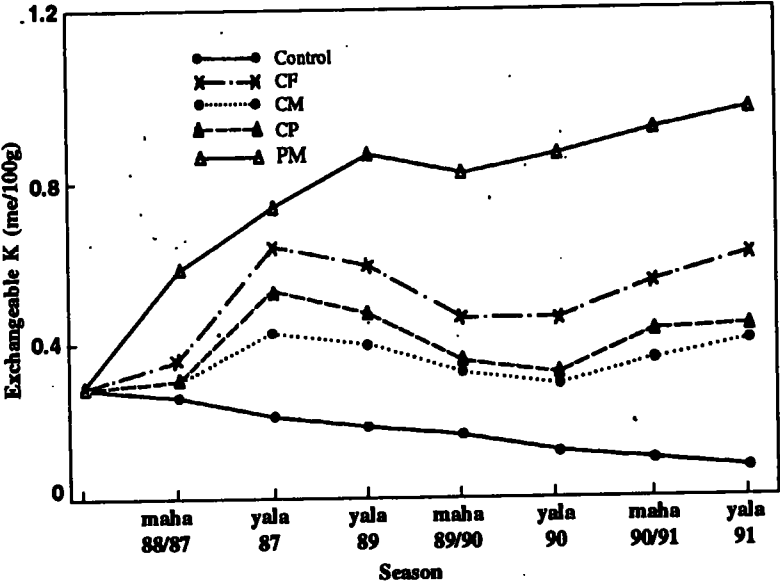


Fig. 2. Exchangeable K content after each season

This may also be an indication that the plant nutrients in poultry manure are more available than those in compost and cattle manure. In an incubation study, Maraïkar and Amarasiri (1989) found that cattle dung was more effective than poultry dung in increasing available P content of a Red Yellow Podzolic soil. The exchangeable K of the soil however, was increased to the same extent by both these organic manures. It is relevant to note that there were major differences in the types of cattle and poultry manure used in the two studies which could be the reason for the different results obtained. In the present study cattle manure was mixed bedding material while poultry manure which was obtained from the deep litter, contained decomposed rice husk. On the other hand, Maraïkar and Amarasiri used fresh cattle and poultry dung free of litter for their experiment. According to Awad and Al-Obaidy (1989) the degree of decomposition rate of poultry manure is very much higher than other organic manures.

Poultry manure also contains more secondary and micronutrients when compared to other organic manures such as cattle manure and compost (CRI, 1994). This could be another reason for the high yield of vegetable crops with the addition of poultry manure.

Poultry manure may also produce other beneficial effects other than chemical effects; it can improve the physical and biological properties of the soil (Kononova, 1966; Gaur *et al.*, 1971). It is well known that root-knot nematode is a common problem for potato and vegetable cultivation in this region. Studies conducted in the region showed that poultry manure incorporation to nematode - infested soils controlled root-knot nematode in tomato (Wahundeniya, 1991).

Fig.3 shows that with poultry manure application soil pH gradually increased reaching a plateau at the end of the fifth season. The pH value reached was around 6.5 which is generally considered ideal for most nutrients to become available to plants. Such an increase of pH was not observed with the application of cattle manure or compost. Since soils of this region are acidic, liming is often practised by farmers. Thus if poultry manure is used then there is no need to apply lime separately and this will result in a big saving for the vegetable growers of the upcountry region.

Although compost had much lower nutrient content than cattle manure (Table 5) it gave higher yields than cattle manure (Table 4). This could be because

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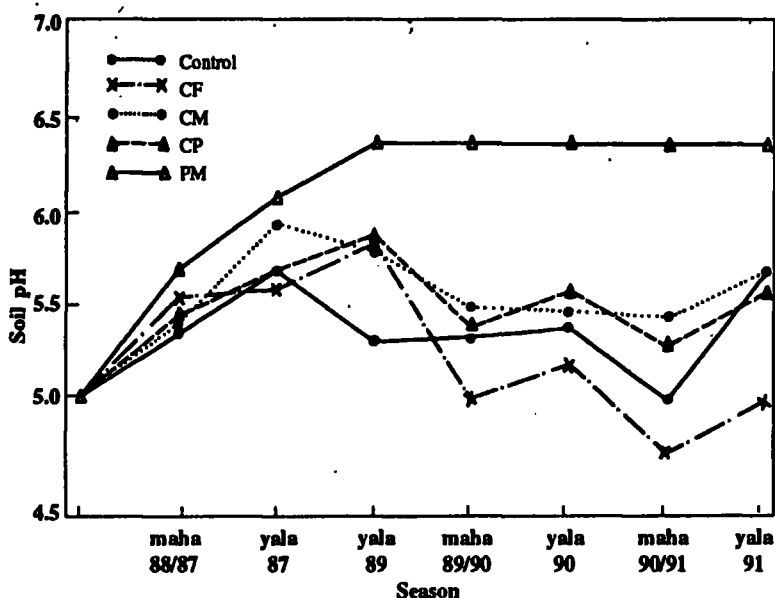


Fig. 3. Soil pH after each season

compost is well-decomposed organic manure and therefore its nutrients are readily available. On the other hand, cattle manure had to undergo decomposition before its nutrients become available to the crop. Furthermore, only a part of the nutrients is released through decomposition of the cattle manure.

The results also demonstrated that high crop yields could be obtained when organic manures are combined with chemical fertilizers. The best combination however was poultry manure + chemical fertilizer.

CONCLUSIONS

The results suggest that poultry manure is the most suitable organic manure for vegetable cultivation, compared to compost and cattle manure. This is so even when it is combined with chemical fertilizers. Available P and exchangeable K contents in the soil are increased by the addition of poultry manure at 10 t/ha. Results also revealed that poultry manure application over several seasons could lead to an increase in soil pH. Therefore, lime application could be avoided if poultry manure is used.

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