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RESEARCH PAPER

Studies on the impact and efficiency of integrated nutrient management on yield, major and secondary nutrient content of okra crop for sustainable agriculture

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Abstract : Combined use of animal wastes is necessary in order to obtain adequate amount of organic manure for use in crop production. Hence, field experiment was conducted in Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai to evaluate the response of okra (Arka anamika) with organic sources like goat manure and pig manure combined with inorganic fertilizers on yield, major and secondary nutrient content. There were ten treatment combinations replicated thrice in Randomized Block Design (RBD) in Maddukkur soil series (*Typic haplustalf*). The results revealed that application of 50 per cent RDF + goat manure @ 6.5 t ha^{-1} registered highest total nitrogen, phosphorus, potassium, calcium and magnesium content and yield (1.71%, 0.44%, 1.58%, 1.36% and 0.68% and 13.0 t ha^{-1}). The least value recorded in the untreated control (1.30%, 0.20%, 1.22%, 1.10% and 0.35%) and 11.90 t ha^{-1}, respectively.

Key Words : Animal manures, Okra, Total major, Secondary nutrients, Yield

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INTRODUCTION

India has a wide range of diverse agro-climatic conditions for growing different vegetables. Vegetables production in India has increased to a level of 146,554,000 metric tonnes from an area of about 84,95,000 hectares (Anonymous, 2011). Among vegetables, okra is the most sustainable vegetable crops grown in India. Okra [*Abelmoschus esculentus* (L.) Moench] is a multiple use crop. It is grown practically in all agro-ecological zones mainly for its immature fruits which are eaten as cooked vegetable or added to soups. In the country, okra are cultivated over an area of 4,98,000 hectares with an annual production of 57,84,000 metric tonnes, respectively (Anonymous, 2011). The fertilizers have played a prominent role in increasing the productivity of crops in the country. But continuous and imbalance use of fertilizers caused deterioration of soil health. Integrated nutrient management is in fact most important component of the production technology to sustain soil fertility and crop productivity in the future. The basic concept of integrated nutrient management system is the maintenance of plant nutrients supply to achieve a given level of crop production by optimizing the benefits from all possible sources of plant nutrients in an integrated manner, appropriate to each cropping system and farming system (Mahajan and Sharma, 2005). The advantage of combining organic and inorganic sources of nutrients in integrated nutrient management has been proved superior to the use of each component separately (Palaniappan

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and Annadurai, 2007). Organic manures improve soil physical, chemical and biological properties and thus, enhance crop productivity *vis-à-vis* maintain soil health. Organic manures contain plant nutrients though in small quantities, in comparison to the chemical fertilizers, the presence of growth hormones and enzymes make them essential for improvement of soil fertility and productivity. In addition to this, the organic manures help in improving the use efficiency of inorganic fertilizers (Singh and Biswas, 2000). Through the supply of essential micronutrients with organic manures also helps in plant metabolic activity especially in the early vigorous growth of plant (Anburani and Manivannan, 2002). The organic sources available presently in the country could meet nearly 1/3rd of total nutrients required to achieve the target of agricultural production. Given, the organic resources constraint, the use of organic is supplementary rather complimentary. Therefore, integrated use of organics and inorganics is a noble system of plant nutrient use for sustaining soil health and crop productivity. Focusing on this preview field experiment was conducted to study the impact and efficiency of integrated nutrient management on yield, major and secondary nutrient content of okra crop for sustainable agriculture.

MATERIAL AND METHODS

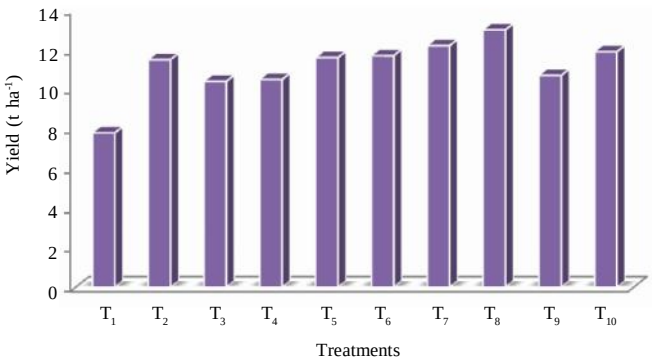
A field experiment was conducted in Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai. The test crop was okra (Arka anamika). The experimental soil was sandy loam texture and belongs to madukkur soil series (*Typic haplustalf*). The initial soil sample collected from the experimental site before the commencement of experiment was analyzed for the various physico-chemical properties. From the textural composition of soil it was inferred that the soil was sandy loam. The cation exchange capacity of the soil was 22.50 C mol (P^+) kg^{-1}. The pH was 7.5 with EC of 0.42 dSm^{-1}. The organic carbon content was 0.49 per cent. The available nitrogen, phosphorus and potassium content of the soil was 266.5, 12.3 and 265.3 kg ha^{-1}, respectively recording low, medium and medium status in soil fertility. Goat manure and pig manure collected from cattle shed from Agricultural College and Research Institute, Madurai, Tamil Nadu Agricultural University. Collected animal waste were composted in compost shed. The composted goatmanure has the nutrient content of N(0.75%), P (0.50%) and K(0.45%) and pigmanure N(0.65%), P (0.50%), K (0.40%), respectively. Composted animal manures and recommended dose of fertilizers applied basally in the field. There were 10 treatments which included T_1-Control, T_2-Recommended dose of fertilizer (RDF), T_3-100% Pig manure @ 7.5t ha^{-1}, T_4-100% goat manure @ 6.5t ha^{-1}, T_5-75% RDF + pig manure @ 7.5 t ha^{-1}, T_6-50% RDF + pig manure @ 7.5 t ha^{-1},T_7-75% RDF + goat manure @ 6.5 t ha^{-1}, T_8- 50 % RDF + goat manure @ 6.5 t ha^{-1}, T_9- pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1}, T_{10}-50% RDF + pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1} were replicated thrice in a Randomised Block Design. The crop was raised and grown up to 130 days and harvested. The nutrient uptake of okra crop were recorded and statistically scrutanised. Plant samples were collected at four stages, *viz.*, vegetative, flowering, fruiting and post harvest stage, dried in shade and then in air oven at 60°C and were ground in a Willey mill using stainless steel grinder and stored in labeled containers for chemical analysis. Total nitrogen was analysed by Micro kjeldahl method (Jackson, 1973), Total phosphorus: Pemberton's method (Pemberton, 1945), Total potassium: Flame photometer method (Jackson, 1973), Total calcium and total magnesium: by versenate titration in HCl extract (Jackson, 1973). Yield: The yield of fruits per plot was recorded for individual harvest and expressed in kg ha^{-1}. Statistical analysis: The data obtained from the investigation were subjected to statistical scrutiny to determine the effects of treatments. The data were analyzed adopting Randomized Block Design and simple correlations were worked out to determine the possible relationships as described by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Yield of okra :

The plots which received the 50 per cent RDF combined with goat manure @ 6.5 t ha^{-1}showed the highest number of fruits and highest yield of okra (Fig. 1). There is a possibility to save fertilizer input for NP and K by substituting the goat manure. The beneficial effect of nutrients on okra fruits may be due to increased supply of nutrients to the crop.



(T_1: Control, T_2: Recommended dose of fertilizer (RDF), T_3: pig manure @ 7.5 t ha^{-1}, T_4: goat manure @ 6.5 t ha^{-1}, T_5: 75% RDF + pig manure @ 7.5 t ha^{-1}, T_6: 50% RDF + pig manure @ 7.5 t ha^{-1}, T_7: 75% RDF + goat manure @ 6.5 t ha^{-1}, T_8: 50 % RDF + goat manure @ 6.5 t ha^{-1}, T_9: pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1}, T_{10}: 50%RDF + pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1}).

Fig. 1 : Effect of organic and inorganic plant sources on yield of okra crop (t ha^{-1})

The increase in yield might be due to enhanced shoot growth of plant and increased number of flowers and fruits. This is in clear because of the direct relationship between leaf area, foliage, number of nodes and height of the plant with yield. Increased foliage might have resulted in more photosynthesis which enhanced the yield potential of the crop. The lowest yield was recorded in control plot. It could be possible due to available nutrients in soil insufficient and there by affected the metabolism of plant. Similar findings were observed by Sable *et al*. (2007). Prabu *et al*. (2002) reported that significant increase in yield of okra fruit with integrated use of chemical fertilizers alone or in conjunction with organic manures may be due to vigorous vegetative growth and increased chlorophyll content, which together accelerate the photosynthetic rate and thereby increased the supply of carbohydrate to plants. The beneficial role in improving soil physical, chemical and biological role is well known, which in turn helps in better nutrient absorption by plant and resulting in higher yield.

Total nitrogen :

Application of organic manures along with recommended dose of fertilizers showed significant among the various treatments. Among the various treatments the total nitrogen value ranges from 1.30-1.72 per cent (Table 1). The treatment received (T_8) 50 % RDF + goat manure @ 6.5 t ha^{-1} registered highest total nitrogen content in okra crop (1.72%), and it was followed by the application of (T_7) 75 % RDF + goat manure @ 6.5 t ha^{-1} (1.675) and (T_{10}) 50 % RDF + pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1} (1.64%). The least value recorded in the untreated plot (1.30%). It might be due to the combined supply of organic with inorganic increased the total nitrogen content in the plant. Similar result were emanated by Tolanur and Badanur (2003).

Total phosphorus :

The results indicate that organic source of nutrients combined with inorganic fertilizer had increased the total phosphorus nutrient content of the plant and it ranged from

Table 1 : Effect of organic and inorganic plant sources on major nutrient content (%) of okra crop at post harvest stage

Treatments	Total N (%)	Total P (%)	Total K (%)
T_1: Control	1.30	0.20	1.22
T_2: Recommended dose of fertilizer (RDF)	1.55	0.32	1.47
T_3: Pig manure @ 7.5 t ha^{-1}	1.45	0.27	1.29
T_4: Goat manure @ 6.5 t ha^{-1}	1.50	0.29	1.40
T_5: 75% RDF + pig manure @ 7.5 t ha^{-1}	1.59	0.32	1.43
T_6: 50% RDF + pig manure @ 7.5 t ha^{-1}	1.62	0.34	1.49
T_7: 75% RDF + goat manure @ 6.5 t ha^{-1}	1.67	0.40	1.53
T_8: 50 % RDF + goat manure @ 6.5 t ha^{-1}	1.72	0.44	1.58
T_9: Pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1}	1.38	0.24	1.25
T_{10}: 50 % RDF + pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1}	1.64	0.38	1.51
S.E. ±	0.021	0.013	0.020
C.D. (P=0.05)	0.045	0.027	0.043

Table 2 : Effect of organic and inorganic plant sources on secondary nutrient content (%) of okra crop at post harvest stage

Treatments	Ca (%)	Mg (%)
T_1: Control	1.10	0.35
T_2: Recommended dose of fertilizer (RDF)	1.28	0.57
T_3: Pig manure @ 7.5 t ha^{-1}	1.22	0.50
T_4: Goat manure @ 6.5 t ha^{-1}	1.25	0.54
T_5: 75% RDF + pig manure @ 7.5 t ha^{-1}	1.28	0.58
T_6: 50% RDF + pig manure @ 7.5 t ha^{-1}	1.29	0.59
T_7: 75% RDF + goat manure @ 6.5 t ha^{-1}	1.32	0.64
T_8: 50 % RDF + goat manure @ 6.5 t ha^{-1}	1.36	0.68
T_9: Pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1}	1.19	0.48
T_{10}: 50 % RDF + pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1}	1.30	0.60
S.E. ±	0.073	0.015
C.D. (P=0.05)	0.154	0.031

0.20-0.44 per cent. In this field experiment various levels of treatment combinations were tried. Among them, the plot that received (T_8) 50 per cent RDF combined with goat manure @ 6.5 t ha^{-1} registered higher total phosphorus nutrient than other levels of treatment and it was followed by (T_7) 75 per cent recommended dose of fertilizers along with goat manure @ 6.5 t ha^{-1} (0.40%) (Table 1). This might be due to strong interaction between fertilizer N and soil P fertility that influenced higher total P content in okra crop.

The per cent P contribution from soil increased with increasing nitrogen rates. The effect of nitrogen fertilizer in influencing phosphorus supply to plants due to better root proliferation and by mining more soil volume was evident. Application of N, P and K along with organic sources increased the P content and it might be due to the effect of soils, P levels and interaction between soils and phosphorus on dry matter and P uptake and was also reported by Laxminarayanan (2007). The lowest value recorded in the untreated check (0.20%).

Total potassium :

The total potassium content of okra crop was significantly influenced by the combined application of organic and inorganic sources. The highest total potassium nutrient content was observed in the treatment which received (T_8) 50 per cent RDF combined with goat manure @ 6.5 t ha^{-1} (1.58%) and it was followed by the application of (T_7) 75 % RDF + goat manure @ 6.5 t ha^{-1} (1.53%) and (T_{10}) 50 % RDF + pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1} (1.51%). It might be due to very low accumulation of K in fruits and more accumulation in plant parts (Table 1). This is mainly because K remains mostly in cell sap and with low translocation to the reproductive parts. Similar trend emanated by Dahama (2003). The least value of total potassium nutrient content of okra was registered in control plot (1.22%). Higher potassium content may be due to increase in uptake of this nutrient when organic and inorganic fertilizers combination along with recommended dose of N, P and K fertilizers emanated by Najnappa *et al*. (2001).

Total calcium and magnesium :

Total calcium and magnesium nutrient content was increased by the application of both organic manures along with inorganic fertilizers and proved statistically significant among various treatments. Total calcium nutrient content ranged between 1.10 -1.36 per cent (Table 2). The plot received (T_8) 50 per cent RDF combined with goat manure @ 6.5 t ha^{-1} showed superior than other treatments and registered highest total calcium nutrient content (1.36%) and it was at par with application of (T_7) 75% RDF + goat manure @ 6.5 t ha^{-1} (1.32%) and T_{10}) 50 % RDF + pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1} (1.30%) and followed by the treatment received (T_6) 50 % RDF + pig manure @ 7.5 t ha^{-1} (1.29%).

Total magnesium content:

The results showed that application of (T_8) 50 % RDF combined with goat manure @ 6.5 t ha^{-1} recorded highest total magnesium nutrient content in okra crop (0.68%) and it was followed by the plot received (T_7) 75 % RDF + goat manure @ 6.5 t ha^{-1} (0.64%) and (T_{10}) 50% RDF + pig manure @ 7.5 t ha^{-1} + goat manure @ 6.5 t ha^{-1} (0.60%) (Table 2). The least value of total calcium and magnesium nutrient was recorded in untreated check (1.10% and 0.35%), respectively. It might be due to high Ca content of single super phosphate and also lower yield might be the reason for high available Ca content in grain and straw while Mg content lower than Ca based on the uptake efficiency. Kaur and Brar (2008) reported that end product of organic matter decomposition to form complexes with metal ion by ion exchange like surface adsorption, chelation coagulation and peptization reaction in the soils there by availability of micronutrients increased. This may probably due to favourable conditions emanated after the decomposition of organic matter which enhance the formation of chelates.

Conclusion :

The results obtained from the study had shown that application of 50 per cent RDF combined with goat manure @ 6.5 t ha^{-1} showed superior than other treatments. Hence, integrated use of organics along with inorganic fertilizers could be a worthwhile management skill for attaining economic yield and that could not only resulted in an adequate productivity of okra crop but would also give maximum net return and enhance the sustainability of soil fertility status for long term basis.

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