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RESEARCH ARTICLE Agricultural Science Digest, Volume Issue : ()

Evaluation of Fertilizer-manure Blocks as a Slow Release Fertilizer Formulation for Okra [*Abelmoschus esculentus* (L.) Moench]

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10.18805/ag.D-5668

ABSTRACT

Background: Fertilizer use efficiency is the output of any crop per unit of the nutrient applied under a specified set of soil and climatic conditions and slow/ ccontrolled release fertilizer formulations offer agricultural producers the opportunity to increase fertilizer/ nutrient use efficiency, especially in soils with very low cation exchange capacity.

Methods: In pot culture study, fertilizer-manure blocks consisting of selected proportions of different organic manures and fertilizers were prepared in two dimensions (100 g and 25 g) with three different dosages of fertilizers (100% POP, 50% POP, 25% POP) and were evaluated in a pot culture experiment using Okra variety Arka Anamika.

Result: Fertilizer-manure blocks showed significant effect on growth and yield of okra. The use of fertilizer-manure blocks of proportion; Coirpith-35%, Cowdung-25%, Vermicompost-13%, Groundnutcake-10%, Neem cake 10%, Zeolite-2%, Humic acid-5%, 100 g size containing 25% of the recommended dose of nutrients placed 5cm below the level of planting and top dressing of 50% of KAU POP recommendation was identified as the best treatment (B:C ratio-1.26 and nutrient use efficiency-28.12) for enhancing the productivity of okra in grow bags. Days to flowering, number of fruits per plant, fruit yield per plant, length of fruits, girth of fruits and number of seeds per fruit were significantly influenced by the treatments. The selected treatment had recorded highest value for number of fruits per plant (20.70), fruit yield per plant (457.9 g), fruit length(17.90 cm), fruit girth (6.326 cm) as well as number of seeds per fruit (58.67). The general application of the recommended fertilizers and soil test based recommendation were found to be on par with the placement of slow release fertilizer- manure blocks with respect to fruit yield per plant.

Key words: Fertilizer use efficicency, Fertilizer-manure blocks, Okra, Slow release fertilizers.

INTRODUCTION

Kerala is a state with tropical humid climate and heavy rain fall leading to leaching of bases and results poor soil fertility. Thus adequate quantities of nutrients have to be supplied through appropriate nutrient delivery techniques. There are different nutrient delivery techniques for ensuring adequate plant nutrition which include soil application, foliar application of nutrients and nutrient mixtures, fertigation by using water soluble fertilizers etc. Effective fertilizer use is the key factor that determine agricultural production. Direct application of fertilizer nutrients to the soil cannot ensure high nutrient use efficiency (NUE) and nutrient security for the crops due to the physico-chemical properties of the soil as well as the environmental factors which may lead to nutrient loss from the system. Loss of applied nutrients from the site of application not only cause harmful effect on the environment but also affect the socio-economic situation of the farmers because fertilizers are one of the costliest inputs in agriculture. To overcome this, targeted application of plant nutrients is necessary and this can be ensured by using slow or controlled release fertilizers.

According to Morgan *et al*. (2009) slow/ controlled release fertilizer formulations offer agricultural producers the opportunity to increase nutrient use efficiency, especially in soils with very low cation exchange capacity. Incorporation of organic manures have some additional advantages like improving the physical, chemical and biological properties of soil. Kumar *et al*. (2012) developed a customized formulation, organic matrix entrapped urea in granular form by mixing natural materials such as cow dung, rice bran, neem leaf powder and clay in 1:1:1:1 along with half of the recommended dose of commercially available soluble for rice (*Oryza sativa* L. cv. Basmati) and it was found effective method for improving growth, productivity and nutritional status of rice and enrichment in soil fertility. They suggested that organic matrix entrapped urea, a biodegradable slow

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How to cite this article: Induja, M., Thulasi, V., Santhosh, P.P. and Moossa, P.P. (2023). Evaluation of Fertilizer-manure Blocks as a Slow Release Fertilizer Formulation for Okra [*Abelmoschus esculentus* (L.) Moench]. Agricultural Science Digest. doi: 10.18805/ag.D-5668.

Submitted: 07-09-2022 **Accepted:** 01-02-2023 **Online:** 18-03-2023

release fertilizer, can be attempted to replace the conventional use of soluble urea in rice.

Okra, *Abelmoschus esculentus* (L.) Moench is an important vegetable crop widely grown in tropical, subtropical and warm temperate regions of the world. The fruits or pods are harvested when immature and are used as vegetables. Okra is a fertilizer responsive vegetable crop. Since okra is a vegetable crop with indeterminate growth pattern it has simultaneous vegetative as well as reproductive growth. Abbasi *et al*. (2010) found that foliar application of multinutrients supplement plant nutrition in integration with soil applied chemical fertilizers improved growth traits of okra such as days to flowering, plant height, number of branches per plant, number of fruits per plant, fruit length *etc*.

This study is mainly focused on the effect of fertilizer-manure blocks of different sizes and varying dosage of fertilizers on yield and yield characteristics of okra plant.

MATERIALS AND METHODS

The fertilizer-manure blocks of proportion- Coirpith- 35%, Cowdung- 25%,Vermicompost-13%, Groundnut cake- 10%, Neem cake 10%, Zeolite- 2%, Humic acid- 5% showed slow release pattern of nutrients as compared to sole use of fertilizers in a laboratory incubation study conducted at Regional Agricultural Research Station, Pattambi. No adhesive was used for formulating the blocks. The nutrient contents of various component materials used for formulating the fertilizer-manure blocks are given in Table 1. The best proportion (Treatment) selected based on the laboratory incubation experiment was used for the pot culture study conducted at Regional Agricultural Research Station, Pattambi during the year 2017-18; to investigate the efficiency of fertilizer-manure blocks on growth and yield of okra (variety Arka Anamika).

For pot culture study fertilizer- manure blocks was prepared in two dimensions (100g and 25 g blocks) using three different dosages (100 per cent POP (Package of Practices, Kerala Agricultural University), 50 per cent POP and 25 per cent POP) of fertilizers for the crop. The per plant dosage of fertilizers was calculated based on the POP and *ad hoc* POP recommendations of primary, secondary and micro nutrients and were used for formulating single block. Combinations of the various dosages of recommendations and sizes of the blocks were taken as T_1-T_6. Hence the experiment consisted of a total of 11 treatments with 3 replications such as T_1: Blocks of size 100 g with nutrients as per 100per cent POP @ 1 block per grow bag, placed below the level of planting, T_2: Blocks of size 100 g with nutrients as per 50per cent POP @ 1 block per grow bag, placed below the level of planting, T_3: Blocks of size 100 g with nutrients as per 25 per cent POP @ 1 block per grow bag, placed below the level of planting, T_4: Blocks of size 25 g with nutrients as per 100 per cent POP @ 4 blocks per grow bag, placed on 4 sides of the plant at soil surface, T_5: Blocks of size 25 g with nutrients as per 50 per cent POP @ 4 blocks per grow bag, placed on 4 sides of the plant at soil surface, T_6: Blocks of size 25 g with nutrients as per 25 per cent POP @ 4 blocks per grow bag, placed on 4 sides of the plant at soil surface, T_7: T_3 + 50 per cent POP recommendation as top dressing, T_8: Nutrients as per general POP of KAU, T_9: Nutrients as per soil test based POP recommendation, T_{10}: Control(Organic manure as per POP of KAU) and T_{11}: Absolute control.

The experiment was laid out in a completely randomized design with 11 treatments and three replications. Five pots were maintained in each replication. Days to flowering, plant height, number of leaves per plant, number of branches per plant, total number of fruits per plant, fruit length, fruit girth, total fruit yield per plant and number of seeds per plant are the observations recorded during pot culture study.

RESULTS AND DISCUSSION

Effect of treatments of fertilizer-manure block on yield and yield characteristics (Table 2)

Fruit yield, fruit number, fruit length, fruit diameter and number of seeds per fruit were recorded from the Okra crop and the data is presented in the table II. Highest fruit number was recorded by the treatment T_7 where in 25 % of the recommended nutrients based on KAU POP recommendation was given as fertilizer-manure block and 50% as top dressing. However it was found to be on par with the treatments T_8 (Nutrients as per KAU POP recommendation) and T_9 (Nutrients as per soil test based recommendation) *i.e.* savings of 25% recommended fertilizers is obtained where fertilizer-manure blocks was used. This can be attributed to reduced loss of nutrients from the fertilizer-manure block owing to its slow release of nutrients and hence fertilizer use efficiency (FUE) is improved to a greater extent. Kiran *et al*. (2010) also suggested such improvement in FUE on use of slow release fertilizer technology.

Table 1: Nutrient content of component material used for formulating fertilizer-manure block.

Components	N%	P%	K%	Ca%	Mg%	S%	Zn ppm	Cu ppm	B ppm
Vermi compost	0.987	0.100	0.3045	0.5010	0.1540	0.2700	62.0	28.25	19.975
Coir pith	0.330	0.0752	0.9749	0.3215	0.2330	0.2100	10.2	22.25	16.20
Cow dung	0.70	0.3997	0.2542	0.3080	0.1840	1.5200	38.0	10.50	9.450
Zeolite	0.530	0.0074	0.0445	11.430	3.0155	0.0100	0.80	15.90	6.150
Neem cake	0.990	0.4565	0.4749	0.2019	0.8900	0.2900	42.0	9.00	6.975
Groundnut cake	6.40	0.5000	0.3277	0.2000	0.2430	0.3500	50.0	9.75	5.900
Humic acid	0.17	0.0012	0.2400	0.0046	0.0033	0.0025	2.50	3.75	0.105

More over the slow release nature of the fertilizer-manure block can supply the nutrients in accordance with the crop growth resulting in reduced leaching and increased plant uptake. Venkadeswaran and Sundaram, (2016). conducted an experiment on nutrient uptake of hybrid okra under drip fertigation plot receiving daily fertigation of water soluble fertilisers recorded higher fruit N, P and K uptake than the crop receiving daily fertigation of conventional fertilizers. Akter *et al*. (2017) reported that the use of fertilizers and organic manures in combination improved crop growth and yield in tomato. Similar results of use of fertilizers and organic manures were reported by Sharma and Singh (2011) in *Brassica juncea*. Singh *et al*. (2013) recorded the parity of yield between full recommended dose of urea and diammonium phosphate (DAP) and organic matrix entrapped urea and DAP containing ¼th of the recommended dose.

The yield attributes such as number of fruits per plant, fruit length and girth showed the similar trend as that of the fruit yield. Treatments T_4, T_9 and T_7 were having highest number of seeds per fruit, which can be attributed to the graded supply of all nutrients for seed filling and yield. (Table 2).

Effect of fertilizer-manure blocks on Biometric parameters (Table 3)

The fertilizer-manure blocks made with different fertilizer dosages and in different size placed in grow bags of Okra crop showed significant difference in biometric parameters and the data is presented in theTable 2. Pant height, number of leaves per plant and number of branches per plant showed significant difference among treatments. The results revealed that biometric parameters are in general higher for the treatment T_7 where 25% of the recommended nutrients was applied in the form of 100 g fertilizer manure block as basal and 50% of the recommended nutrients was applied as fertilizer as top dressing at 1 month after planting.

The comparison of size and placement of the different fertilizer-manure blocks revealed the superiority of the 100 g block placed below the planting depth over 4 numbers of 25 g blocks placed around the plant just below the surface (Plate 1). This may be due to the fact that leaching of nutrients from

Table 2: Effect of treatments on yield and yield attributing characteristics of Okra.

Treatments	Days to flowering (DAP)	Number of fruits per plant	Fruit yield per plant (g)	Fruit length (cm)	Fruit girth (cm)	Number of seeds per fruit
T_1	31.25^{b}	11.29^{d}	238.5^{d}	15.17^{e}	5.880^{cde}	53.66^{c}
T_2	29.92^{bcd}	10.37^{e}	254.0^{c}	17.03^{b}	5.973^{bcd}	47.33^{d}
T_3	30.67^{bcd}	8.930^{f}	167.9^{f}	15.90^{d}	5.840^{de}	43.33^{e}
T_4	30.77^{bc}	10.38^{e}	348.2^{b}	16.65^{bc}	6.066^{bc}	60.66^{a}
T_5	30.00^{bcd}	7.666^{g}	209.7^{e}	16.27^{cd}	5.720^{ef}	46.33^{d}
T_6	29.50^{cd}	6.625^{h}	164.1^{f}	15.87^{d}	6.010^{bcd}	46.33^{d}
T_7	29.50^{cd}	20.70^{a}	457.9^{a}	17.90^{a}	6.326^{a}	58.67^{ab}
T_8	29.08^{d}	17.98^{c}	456.6^{a}	16.33^{cd}	6.110^{b}	56.33^{b}
T_9	29.75^{bcd}	19.14^{b}	452.6^{a}	17.90^{a}	6.326^{a}	59.00^{a}
T_{10}	34.83^{a}	4.470^{i}	81.60^{g}	13.80^{f}	5.513^{f}	41.67^{e}
T_{11}	36.33^{a}	2.550^{j}	39.83^{h}	10.70^{g}	5.266^{g}	25.00^{f}
CD (0.05)	1.597	0.603	14.237	0.590	0.211	2.559

Table 3: Effect of fertilizer-manure blocks on biometric parameters in Okra.

Treatments	Plant height (cm)					Number of leaves per plant					Number of branches per plant
	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP	15 DAP	30 DAP	45 DAP	60 DAP	75 DAP	75 DAP
T_1	26.52^{ab}	52.06^{a}	94.93^{a}	115.3^{b}	132.1^{de}	7.250^{d}	10.87^{b}	12.12^{cd}	13.50^{cd}	16.75^{d}	1.583^{b}
T_2	26.26^{b}	52.42^{a}	95.87^{a}	106.3^{c}	136.8^{d}	10.750^{a}	11.33^{b}	13.62^{b}	17.25^{b}	23.00^{b}	1.333^{bc}
T_3	27.57^{ab}	51.31^{a}	80.10^{b}	104.6^{c}	135.7^{de}	8.083^{bc}	10.62^{b}	11.33^{d}	13.50^{cd}	17.12^{d}	1.083^{cd}
T_4	24.16^{c}	24.16^{e}	70.52^{cd}	102.5^{c}	129.6^{e}	7.625^{cd}	10.37^{b}	12.62^{bc}	17.17^{b}	20.12^{c}	1.450^{b}
T_5	21.41^{de}	21.41^{f}	62.00^{e}	85.31^{d}	102.9^{g}	7.333^{d}	7.750^{c}	9.500^{c}	14.23^{c}	15.25^{e}	1.083^{cd}
T_6	20.09^{e}	20.08^{f}	49.64^{f}	67.50^{e}	112.0^{f}	6.375^{e}	7.250^{c}	9.500^{e}	13.00^{d}	14.87^{ef}	1.000^{d}
T_7	28.06^{a}	51.22^{a}	84.00^{b}	125.6^{a}	183.4^{a}	8.250^{b}	13.33^{a}	16.58^{a}	26.92^{a}	37.08^{a}	2.416^{a}
T_8	21.02^{de}	39.21^{c}	67.37^{d}	115.1^{b}	164.6^{b}	7.125^{d}	13.33^{a}	16.25^{a}	26.58^{a}	37.00^{a}	2.166^{a}
T_9	22.42^{d}	42.70^{b}	74.08^{c}	119.5^{b}	157.6^{c}	7.250^{d}	11.25^{b}	17.12^{a}	26.87^{a}	36.25^{a}	2.333^{a}
T_{10}	17.91^{f}	26.81^{d}	36.26^{g}	49.08^{f}	80.75^{h}	5.500^{f}	6.416^{cd}	7.500^{f}	11.62^{e}	13.75^{g}	0.000^{e}
T_{11}	17.59^{f}	27.25^{d}	34.36^{g}	46.75^{f}	62.06^{i}	4.633^{f}	5.750^{d}	6.500^{f}	9.250^{f}	11.42^{f}	0.000^{e}
CD (0.05)	1.621	2.208	4.923	5.908	6.741	0.535	1.411	1.129	0.814	1.135	0.282

Plate 1: Fertilizer-manure blocks prepared 1b. Layout of the pot culture experiment.

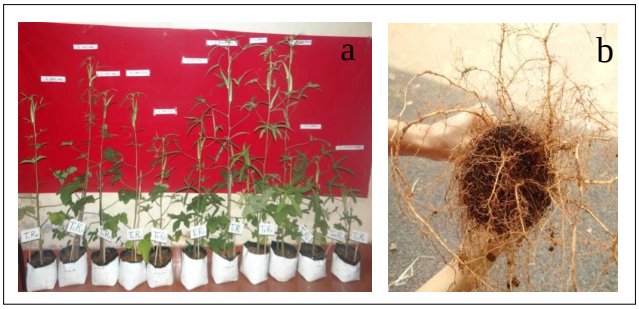

Plate 2: Comparison of the different treatments 2b. Root penetratin through 100g ferrti-manure block.

the 25 g blocks placed just below the surface occurred before the complete establishment of the root system. However the root system might have entered directly in to the 100 g blocks resulting in effective utilization of the nutrients entrapped inside the fertilizer-manure blocks. This is very clearly visible in the Plate 2.

The use of organic components along with fertilizers slow down the release of nutrients which can be taken as a point to explain the reduction in fertilizer recommendation needed when the fertilizer manure blocks was used. Trinh Thi Ben *et al*. (2022) significant studied the effect of organic Fertilizer and planting type on growth and yield of *Curcuma aromatica*. Puri (1999) reported the effect of neem on inhibition of nitrification. Neem cake is a component in fertilizer-manure block formulated in the study.

The treatments showed significant influence on number of days taken to flowering. Shubham Chawla *et al*. (2018) conducted a field study on effect of dates of sowing and nitrogen levels on growth and yield of okra and reported remarkable significant influence on all growth attributes, flower characters and yield parameters. Significantly early flowering was observed in the treatment T_8 which received nutrients as per KAU POP recommendations and it was on par with all treatments except T_4, T_1 and control. Shukla *et al*. (2018) also reported that, the occurrence of days to flowering in okra is directly related to the fertility status of the soil.

The control and absolute control treatments T_{10} and T_{11} had took more days to flowering (34.83 and 36.33 days) and this may be due to in adequate nutrient availability in these treatments.

CONCLUSION

The results of the pot culture study revealed that fertilizer manure blocks showed significant influence on the growth and yield of okra. Fertilizer-manure blocks can be used in Okra as an efficient and sustainable nutrient management technique. Twenty five per cent reduction in the recommended dose of nutrients is achieved by using fertilizer-manure blocks. Among various treatment, treatment with 25% of the recommended nutrients applied in the form of 100 g fertilizer-manure block and 50% as topdressing 1 month after planting was the best treatment which recorded highest yield (457.9 g), high nutrient use efficiency, B:C ratio greater than 1(1.26) and saves 25% of the recommended nutrients. Thus fertilizer-manure block is a slow release fertilizer capable of ensuring long term nutrient availability and by adopting this technique we can reduce the fertilizer load in the soil and hence improve nutrient use efficiency and productivity. In future, studies can be undertaken to standardize controlled release fertilizer-manure formulations in open field conditions and in various crops including long duration crops.

Conflict of interest: None.

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