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Studies the Effect of Organic, Inorganic and Bio-fertilizers on the Growth and Yield of Okra cv. Arka Anamika

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ABSTRACT: The current study was conducted in 2021-2022 at CRC Farm, Department of Horticulture, ITM University Gwalior with Randomized Block Design along with 3 replications comprised of 12 treatments using organic manures likes *FYM, vermi-compost* and *poultry manure,* inorganic fertilizers and bio-fertilizers such as *Azotobacter* and *PSB* were applied in okra variety Arka Anamika. Integrated nutrient management (INM) is one of the most important methods to reduce input of chemical fertilizers and organic manure such as animal manures, crop residue and green manure neutralized soil acidity and supplied essential micronutrients. The different treatment combinations of organic manures like *FYM, vermi-compost* and *poultry manure,* inorganic fertilizers and bio-fertilizers like *Azotobacter* and *PSB* were significantly influenced the growth, yield and economic parameters of okra at different stages. The result revealed that the maximum growth, yield parameters and economic were observed in the treatment T_7 (100 % RDF + *Poultry manure* + *Azotobacter* + *PSB*) whereas minimum growth, yield parameters and economic were recorded in treatment T_1 (100 % RDF-100 Kg N, 60 Kg P_2O_5 and 50 Kg K_2O), respectively.

Keywords: Organic, Inorganic manures, Bio-fertilizers, Okra, growth, yield, economic parameter.

INTRODUCTION

Okra (*Abelmoschus esculentus* L.) belongs to the family of Malvaceae and is one of the economically important vegetable crop which can be easily grown in tropical and sub-tropical parts at the global level. Africa is the probably native place of okra. It is considering as a warm season vegetable crop and best suited in hot summer with temperature ranges of 18°C and 35°C (Rana *et al.,* 2020). Integrated nutrient management (INM) is one of the most important methods to reduce input of chemical fertilizers and organic manure such as animal manures, crop residues and green manures neutralized soil acidity and supplied essential micronutrients. At global level, India leads first in the area and production of okra followed by Nigeria. It can be grown in those types of the area where the average temperature is about 25-30 degree Celsius and having warm and humid hot climatic conditions but not too much hot. If we are talking about India, the largest growing states are Uttar Pradesh, West Bengal, Gujarat, Maharashtra, Andhra Pradesh, Uttar Pradesh, West Bengal, Assam, Punjab, Madhya Pradesh, Rajasthan, Haryana, Karnataka and Tamil Nadu. Okra is also known as lady's finger and bhindi.

Among all the various vegetables, okra is well responds to the fertilizers and manures, therefore, numerous types of experiment have been conducted to know about the effective approaches for overcome the problem of deficient nutrients in this crop to exploit its genetic potential for high productivity and economic yield. various practices like Intercropping (Singh *et al.*, 2014, 2015; Singh and Singh 2015), integrated nutrient management by using organic and inorganic sources of nutrients (Singh *et al.*, 2016a, Lallawmkima *et al.*, 2018a; Gorakh *et al.*, 2021), vermi-compost application (Singh *et al.*, 2016b), bio-fertilizer application (Lallawmkima *et al.*, 2018b; Singh *et al.*, 2018a; Tyagi *et al.*, 2022), ITK approach like panchgavya (Rohith *et al.*, 2022), fertigation approach (Bahadur *et al.*, 2021), protected cultivation (Singh and Singh 2019; Anmol *et al.*, 2021, 2022); hydroponics cultivation (Spehia *et al.*, 2019a, b, 2020) and micronutrient applications (Kaur *et al.*, 2018; Singh *et al.*, 2018b, c) are common for better growth or biomass production, enhanced productivity, quality produce and high income to the farmers by improving soil and plant nutrient status (Singh *et al.*, 2018d) among the different approaches which are being reported in production of horticultural crops. Singh and Lallawmkima (2018) had also advocated for multisource nutrient application in potato for high grade tuber production.

INM is one of the holistic approaches that consider all the available farm resource that can be used as plant nutrients. The combined application of inorganic and organic manures are better utilized than singly inorganic, besides reducing cost of production and maintaining the soil health (Anmol and Singh 2018). Organic manure directly improves the physical, biological and chemical conditions of the soil and also

provides adequate amount of essential plant nutrients along with improves soil productivity (Singh, 2018). It also improves the soil organic C, total NPK status and increase the soil microbial growth (Singh *et al.*, 2018e). Vermi-compost consists worm casting, organic extract, humus, living earth-worms along with their cocoons and other organisms (Singh and Sharma 2016). It is slow releasing organic manure, which is odorless, pathogen free and rich in plant nutrients (Singh and Sharma 2016). Bio-fertilizers (Component of INM) are cost effective, eco-friendly and the most important these are renewable and non bulky plant nutrient supplementing fertilizers in sustainable agriculture system in India (Siddiqui *et al.* 2014, Kumar *et al.*, 2018; Ramandeep *et al*., 2018).

MATERIAL AND METHODS

Field investigation was carried out during kharif season 2021-2022 at experimental field of ITM School of Agriculture, Gwalior. The experimental soil (0-15 cm) had clay, texture, uniform topography and slightly alkaline in reaction (pH 7.6), normal in salt content (0.32 dSm^{-1}), low in available N (197.58kg ha^{-1}), medium in available P_2O_5 (19 kg ha^{-1}) and high in available K_2O (241 kg ha^{-1}). The current experiment was conducted with Randomized Block Design along with 3 replications comprised of 12 treatment combinations (T_1 – 100 % RDF, T_2 – 100 % RDF + Vermi compost, T_3 – 100 % RDF + FYM, T_4 – 100 % RDF + Poultry manure, T_5 – 100 % RDF + Vermicompost + *Azotobacter* + *PSB*, T_6 – 100 % RDF + FYM + *Azotobacter* + *PSB*, T_7 – 100 % RDF + Poultry manure + *Azotobacter* + *PSB*, T_8 – 70 % RDF + Vermicompost, T_9 – 70 % RDF + FYM, T_{10} – 70 % RDF + Vermicompost + *Azotobacter* + *PSB*, T_{11} – 70 % RDF + FYM + *Azotobacter* + *PSB* and T_{12} – 70 % RDF + Poultry manure + *Azotobacter* + *PSB*) using organic manures likes *FYM, vermi-compost* and *poultry manure,* inorganic fertilizers and bio-fertilizers such as *Azotobacter* and *PSB* were applied in okra variety Arka Anamika. RDF *i.e.* 100:60:50 kg NPK per ha was applied in the form of urea, single super phosphate and muriate of potash, respectively. 1/3 part of nitrogen and full dose of phosphorus and potassium were applied at basal dose, while nitrogen was applied in two split doses; 1/3 part 30 days after sowing and 1/3 part after 30 days of first application. The plots were kept free from weeds by periodic hand weeding. Protective irrigation was given at an interval of 6-7 days or as per requirement. After 30 days of sowing, earthing up operation was carried out in the main field to keep the plants in the upright position. The schedule of different plant protection measures taken against pests and diseases during the period of investigation. The fully developed green fruits were harvested at 3-4 days, totally 4-5 pickings were taken. The harvested green fruits were further used for recording different observations data recorded on various parameters were subdivided into four categories during the period of experimentation. The data were recorded as per standard procedure. For different treatments total cost was calculated on the basis of prevailing market rates of fertilizer, field preparation, sowing of seeds, labour charges, cultural and intercultural operations etc. Gross returns were calculated by multiplying yield with sale rate of produce. Sale rate was depicted on the basis of prevailing market rate of produce. It was calculated treatment wise. The cost of cultivation per hectare was subtracted from the gross income for computing net returns of each treatment. Net return (₹/ha) = Gross return (₹/ha) - Cost of cultivation (₹/ha). B:C ratio is the ratio of gross returns to cost of cultivation. It is expressed as returns per rupee invested. The data obtained from set of observation for each character were subjected to "Analysis of Variance" as advocated by Panse and Sukhatme (1985). The experiment was laid with following objectives:

- To find out effect of organic and inorganic fertilizers on growth of okra.
- To evaluate the effect of organic and inorganic fertilizers on yield and yield attributes of okra.
- To find out the cost of cultivation.

RESULT AND DISCUSSION

Growth parameters. Result reported that the different treatment combinations of organic, inorganic as well as bio-fertilizers were significantly influenced the different growth parameters of okra at different stages of growth and the treatment T_7 (100 % RDF + Poultry manure + *Azotobacter* + PSB) was found superior than the others treatments (Table 1) and it gave the maximum growth parameters *viz*., plant height (38.46 cm at 45 DAS and 70.21 cm at 90 DAS), number of branches/plant (3.10 at 45 DAS and 3.35 at 90 DAS) and number of leaves/plant (17.41 and 35.40 at 45 and 90 DAS, respectively), whereas minimum days to flowering (39.42 Days) and days to 50 % flowering (47.40 Days) was observed in treatment T_7 (100 % RDF + Poultry manure + *Azotobacter* + PSB). However, the minimum growth parameters *viz*., plant height (27.40 cm at 45 DAS and 54.13 cm at 90 DAS), number of branches/plant (2.30 at 45 DAS and 3.10 at 90 DAS) and number of leaves/plant (12.10 and 29.42 at 45 and 90 DAS, respectively) and maximum days to flowering (45.40 Days) and days to 50 % flowering (55.40 Days) were recorded in treatment T_1 (100 % RDF). This probably due to directly associated with the increased availability of nitrogen and phosphorus through biological fixation of N and solubilization of P in soil in readily utilizable form by the plants. Further, the beneficial effect of organic manures like FYM and vermi-compost on plant growth might be due to attributed to the fact that the higher level of microbial population mineralized the macro and micronutrients during vermi-composting and made available to crop plants for longer period. The similar finding were also supported by Sahu *et al.* (2014); Sharma *et al.* (2014); Ghimire *et al.* (2015); Ghuge *et al.* (2015); Sindhya *et al.* (2015); Singh (2015); Tyagi *et al.* (2016); Kumar *et al.* (2017); Muhammad *et al.* (2020); Singh *et al.* (2020).

Yield parameters. It has been noticed that the maximum yield parameters *viz*., fruit length (8.90 cm),

fruit girth (1.80 cm), number of pod/ plant (18.00), yield/ plant (542.88 g), yield/ plot (10.86 kg) and yield/ hectare (190.01 q) were noted in the treatment T_7 (100 % RDF + Poultry manure + *Azotobacter* + PSB) and result revealed that treatment T_7 was found superior than the rest of the treatments (Table 2). Whereas, the minimum yield parameters *viz*., fruit length (6.70 cm), fruit girth (1.70), number of pods/plant (13.00), yield/plant (392.08 g), yield/plot (7.84 kg) and yield/hectare (137.23 q) were recorded in treatment T_1 (100 % RDF). The significant increase in number of fruits/plant, fruit yield and fruit length under the influence of *azotobactor* and PSB was largely a function of improved growth and consequently increases in different yield parameters in okra. This probably due to the application of *azotobactor* and PSB enhances the utility of added chemical fertilizers in soil and increased rate of humification. The increased availability of N and P due to vermi-compost inoculation might have increased the growth, yield attributes and ultimately the yield due to increased photosynthetic rate, nitrogenase reductase activity, glumatine synthetase activity and solubilization of phosphate. These observations were also supported by the findings of Ray *et al.* (2005); Singaravel *et al.* (2008); Sajid *et al.* (2012); Achebe *et al.* (2013); Molik *et al*. (2016); Kumar *et al*. (2017); Okee (2020); Singh *et al.* (2020).

Economics of okra cultivation under INM. During the economic data of okra, it has been observed that the maximum gross returns (₹ 285012 /ha), net returns (₹ 191612 /ha) and B:C ratio (3.1) were recorded in treatment T_7 (100 % RDF + Poultry manure + *Azotobacter* + PSB) and was found statistically superior than rest of the treatments (Table 3). However, the minimum gross returns (₹ 205842 /ha) and net returns (₹ 123842 /ha) was noted in treatment T_1 (100 % RDF), wheras the minimum B:C ratio (2.4) was noticed in treatment T_8 (70 % RDF + Vermi-compost). The increasing demands of quality vegetables may be fulfilled by integrated use of organic manures and bio-fertilizers in most of vegetable crops. The similar findings were also reported by Ghimire *et al.* (2015); Singh *et al.* (2020). The highest net return and benefit-cost ratio due to simultaneously approaches of nutrient management could be showed the high and quality production of okra fruits with having well market price (Singh *et al*., 2015; Singh and Singh 2015; Singh *et al*., 2018b, e).

Table 1: Effect of organic, inorganic and bio-fertilizers on growth parameters of okra.

Treatments	Plant height (cm)		Number of branches/plant		Number of leaves/plant		Days to flowering	Days to 50 % flowering
	45 DAS	90 DAS	45 DAS	90 DAS	45 DAS	90 DAS		
T_1	27.40	54.13	2.30	3.10	12.10	29.42	45.40	55.40
T_2	35.64	63.92	2.78	3.26	15.70	33.54	42.46	50.40
T_3	33.26	61.09	2.69	3.26	15.31	33.13	42.92	51.39
T_4	36.42	65.21	2.81	3.27	16.34	33.86	41.42	49.59
T_5	37.17	69.49	3.05	3.33	17.02	34.69	40.51	48.38
T_6	36.95	67.00	2.94	3.30	16.85	34.04	40.95	49.00
T_7	38.46	70.21	3.10	3.35	17.41	35.40	39.42	47.40
T_8	30.49	56.23	2.44	3.16	13.03	30.95	44.04	54.67
T_9	29.46	55.49	2.35	3.12	12.90	30.51	44.69	55.00
T_{10}	31.86	58.01	2.59	3.18	14.24	32.46	43.54	52.85
T_{11}	31.13	57.60	2.56	3.18	13.64	31.42	43.86	53.73
T_{12}	32.47	59.37	2.61	3.22	14.76	32.92	43.13	52.09
SEm ±	0.924	0.896	0.031	0.028	0.158	0.445	0.524	0.510
CD 5%	2.709	2.628	0.091	0.082	0.464	1.304	1.538	1.495

Table 2: Effect of organic, inorganic and bio-fertilizers on yield parameters of okra.

Treatments	Fruit length (cm)	Fruit girth (cm)	Number of pods per plant	Yield per plant (g)	Yield per plot (kg)	Yield per hectare (q)
T_1	6.70	1.70	13.00	392.08	7.84	137.23
T_2	8.09	1.76	16.67	502.87	10.06	176.00
T_3	7.88	1.76	16.25	490.10	9.80	171.54
T_4	8.36	1.77	16.81	506.99	10.14	177.45
T_5	8.76	1.79	17.71	534.23	10.68	186.98
T_6	8.62	1.78	17.23	519.56	10.39	181.84
T_7	8.90	1.80	18.00	542.88	10.86	190.01
T_8	6.92	1.72	14.27	430.48	8.61	150.67
T_9	6.80	1.71	13.63	411.08	8.22	143.88
T_{10}	7.38	1.74	15.02	453.00	9.06	158.55
T_{11}	7.20	1.73	14.88	448.88	8.98	157.11
T_{12}	7.66	1.75	15.76	475.22	9.50	166.33
SEm ±	0.067	0.020	0.133	4.022	0.080	1.408
CD 5%	0.197	0.058	0.391	11.798	0.236	4.129

Table 3: Effect of organic, inorganic and bio-fertilizers on economical parameters of okra.

Treatment detail	Gross returns (₹/ha)	Net returns (₹/ha)	B:C ratio
T_1	205842	123842	2.5
T_2	264006	168006	2.8
T_3	257303	168303	2.9
T_4	266170	174170	2.9
T_5	280473	182073	2.9
T_6	272767	182367	3.0
T_7	285012	191612	3.1
T_8	226004	131904	2.4
T_9	215817	129717	2.5
T_{10}	237827	142327	2.5
T_{11}	235663	148163	2.7
T_{12}	249491	158991	2.8

CONCLUSIONS

Result concluded that the different treatment combinations of organic like FYM, vermi-compost and poultry manure, inorganic and bio-fertilizers like *Azotobacter* and PSB were significantly influenced the growth, yield and economic parameters of okra at different stages. Furthermore, they reviewed the maximum growth, yield parameters and economic were noticed in the treatment T_7 (100 % RDF + Poultry manure + *Azotobacter* + PSB) and statistically found significant than the rest of the treatments, whereas the lowest were noted in treatment T_1 (100 % RDF). On the basis of the result obtained after completion of present investigation we can also say that using integrated nutrient management not only increase the production but reduce the consumption of chemical fertilizers and may also improve the soil health. But the further research work is needed to confirm the findings of the present investigation.

FUTURE SCOPE

INM in the present research may be either used to improve the growth and development in the vegetable crops or other cereal crops.

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Conflict of Interest. None.

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