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Impact of Organic Nutrient Management on Biometric Parameters of Rainy Season Okra (*Abelmoschus esculentus* (L.) Moench) under Jammu Agroclimate

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ABSTRACT

Fertility management in organic vegetables relies on a long-term integrated approach rather than the more short-term solutions common in conventional agriculture. Its management primarily through the use of various organic manures helps to ensure good soil structure and biological activity, important for nutrient supply, health and productivity of crops. Moreover, consumer demand for organically grown vegetables has increased dramatically over the past one decade, most likely because of persistent benefits to the environment and human health. A major component of organic production is providing organic sources of nutrients to promote plant growth as well as sustain soil quality. Okra, *Abelmoschus esculentus* (L.) Moench, which is an important warm season vegetable crop of Jammu region of Union territory of Jammu and Kashmir, was evaluated under organic nutrient management consecutively for two years during 2019 and 2020 for fruit and seed production. The experiment was conducted on okra variety SKUAST Jammu Okra -05 in Randomized Block Design, with three replicates and nine treatments including control viz., FYM@25 T/ha (T_1), Neem cake @ 2.0 T/ha (T_2), Poultry manure @5.0 T/ha (T_3) ,Bone meal@2.0 T/ha (T_4), Matka khad@T/ha(T_5), Multi nutrient mix@ 0.5 T/ha(T_6),Vermicompost @5T/ha ((T_7), FYM @ 20 T/ha+ Vermicompost @ 2.5T/ ha (T_8) and Control (No application) (T_9). Pooled results of two years showed that no single application of organic inputs are as effective as combined application of FYM @ 20T/ha+ Vermicompost @2.5T/ ha that resulted in maximum fruit and seed yield parameters of rainy season okra managed organically.

Keywords *Abelmoschus esculentus* (L.) Moench, Organic nutrients, Biometric parameters, Sub-tropical conditions.

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INTRODUCTION

Farmers of the Jammu region of J and K UT are engaged in both summer and rainy season okra production because of its lucrative nature and various potentials such as low cost of production, less managerial skills and ability, quick cash returns and turnover, high frequency of harvest, high land utili-

Table 1. Meterological parameters during crop period of rainy season okra at Chatha, Jammu during 2019. Average of all standard weeks in a month.

Month/Year	Temperature		Humidity		Rainfall
	Max (^{0}C)	Min (^{0}C)	Max (%)	Min (%)	(mm)
June 2020	40.43	24.00	50.19	28.82	0.79
July 2020	34.67	26.26	80.68	60.23	10.41
August 2020	33.73	25.93	86.61	64.87	5.57
September 2020	33.05	24.61	88.54	65.71	5.61
October 2020	29.39	17.19	86.97	52.52	0.99

zation during dry and wet summer season. But many times due to ignorance, indiscriminate and excessive use of inorganic synthetic chemicals especially at the time of harvesting has put forth a question mark on the quality and safety of this vegetable particularly on human and soil health. To fulfill and address social, ecological and economical issues together, organic farming plays a vital role. Promotion of health of the soil-plant-environment system is the key concern in organic farming (Ayala and Prakasa Rao 2002).It involves the use of organic nutrients and other eco-friendly systems for quality and sustainable production of vegetables.

Okra *Abelmoschus esculentus*(L.) Moench, 2n=2x=130 is one of the important vegetables belongs to Malvaceae family, is widely cultivated in the Jammu region of the UT covering an area of 2001 ha with a production of 34546.23 MT during 2019-20 (Anonymous 2021). Okra cultivation and production has been widely practiced because of its importance to the economy development and can be found in almost every market in Jammu but very few in Kashmir (Personal information). Okra is the most important fruit vegetable crop and a source of calorie (4550 Kcal/kg) for human consumption. It ranks first before other vegetable crops (Babatunde *et al*. 2007). Okra contains carbohydrate, protein and vitamin C in large quantities (Adeboye and Oputa 2006). The essential and non-essential amino acids that okra contains are comparable to that of Soybean. It was also reported by Eke *et al*. (2008) that fresh okra fruit is a good source of vitamins, minerals and plant proteins. It can be consumed boiled, fried or cooked for the young immature fruits.

Okra responses to organic fertilization have been observed by several researchers world wide (Oliveira *et al.* 2007, Omatoso and Shittu 2007, Abd El-Kader *et al.* 2010, Cardoso and Berni 2012). Its successful cultivation during rainy season is a challenge for organic farmers in the region, therefore the present study was conducted to provide recommendations of okra under organic management.The strategy was aimed to study the effect of various organic manures on fruit and seed yield parameters of rainy season okra grown organically.

MATERIALS AND METHODS

Two year field experiment was conducted atVegetable block, Organic Farming Research Center, SKUAST-Jammu,Main campus, Chatha on rainy season okra variety SKUAST-Jammu Okra-05 during 2019 and 2020.

Climate: Chatha, Jammu falls at an altitude of 300-330m amsl and is subtropical type with extreme summers (March-June), followed by warm and humid rainy season (July-September), pleasant autumn (October-November) and harsh winters (December-February).The climatic parameters during the crop period of rainy season okra have been compiled in Tables 1 and 2.

Soil: The soil of the experimental field was clayey loam in texture, having slightly alkaline soil reaction (pH of 7.3) with medium in nitrogen and phosphorus and low in potassium with cation exchange capacity of 17.82 mol/kg. The pH was measured in 1/10 (w/v) aqueous solution (de-ionized water) using digital pH meter. Nitrogen was measured by following mi-

Table 2. Meterological parameters during crop period of rainy season okra at Chatha,Jammu during 2020. Average of all standard weeks in a month. Source:Agro-meteorology section, Division of agronomy, SKUAST-Jammu.

Month/Year	Temperature		Humidity		Rainfall
	Max (^{0}C)	Min (^{0}C)	Max (%)	Min (%)	(mm)
June 2021	36.43	24.32	40.1	30.22	0.95
July 2021	35.40	25.98	75.50	59.30	2.56
August 2021	32.96	25.74	88.41	67.67	9.58
September 2021	34.27	24.59	90.45	69.55	0.46
October 2021	32.25	15.24	85.50	60.42	0.00

cro Kjeldahl method (Jackson 1975) and available phosphorus was measured following Olsen *et al.* (1954) method. Exchangeable K was determined after extracting the sample using ammonium acetate (Simard 1993) and analyzing under double beam atomic absorption spectrophotometer (AAS). The organic carbon content, determined by the partially-oxidation method (Walklay and Black 1934), was medium (0.52%) and electric conductivity was 0.41dS/m (Table 3).

Methodology: The field experiment consists of nine treatments namely FYM@25 T/ha(T_1), Neem-cake@2.0 T/ha (T_2), Poultry manure @ 5.0 T/ha(T_3) ,Bone meal @2.0 T/ha (T_4), Matka khad @1.0 T/ha (T_5), Multi nutrient mix @ 0.5 T/ha (T_6),Vermicompost @ 5T/ha (T_7), FYM @ 20 T/ha + Vermicompost @ 2.5T/ ha (T_8) and Control (no application) (T_9). The doses were established on the basis of their NPK status and the need of the crop. Nutrients sources were applied in two equal splits (at the time of planting and six weeks after planting) when thinning and first weeding was done. Prior to sowing, seed dormancy was broken by immersing the seeds in water for 24 h and subsequent drying in the shade. The sowing of okra variety SKUAST-Jammu okra-05 was done directly by drawing rows at a spacing of 60 cm with the help of liner in the plot size of 3.0×3.0m. Thinning was performed when plants were 5 to 10 cm tall, leaving a spacing of 60 cm between the plants in the row.The experiment was conducted in an irrigated plots receiving water from tube well.The area was weeded twice before rains set in,to avoid competition for water and nutrients, later on proper sanitation and drainage was maintained throughout the crop cycle. Ten plants were randomly selected from each plot to record biometric parameters observed at various stages of crop growth. Plant biometrical characters studied were days to 50% flower, plant height, number of pods per plant, pod weight, pod length, pod yield per plant, pod yield per hectare, seed yield per plant and per hectare. Data were subjected to analysis of variance (ANOVA) and means were separated by the least significance difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

The results indicated that all the vegetative and seed parameters of okra in rainy season were affected significantly by the application of various organic nutrients (Tables 4 and 5).The morphological parameters of okra have been discussed under following heads:

Days to 50 % flowering

The results indicated that all the treatments have a profound impact on the flowering of okra. Minimum number of days (40.0) were counted from the okra

Table 3. Physico-chemical analysis of the experimental field.

Texture	pH	Depth (cm)	CEC (mol kg^{-1})	N (g/kg)	P (g/kg)	K(g/kg)	EC (dSm^{-1})	OC (%)
Clayey loam	7.3	0-30	17.82	245.5	14.1	186.7	0.41	0.52

Table 4. Morphological parameters of rainy season okra as influenced by different organicnutrients.Pooled data of two years.

Sl.No.	Treatments	Days to 50 % flowering	Plant height (cm)	No. of fruits/ plant	Fruit weight (g)	Fruit length (cm)
T_1	FYM @25 T/ha	60.5	170	17.5	17.8	10.4
T_2	Neem cake @2 T/ha	51.5	165	16.3	14.5	11.5
T_3	Poultry manure @5T/ha	55.0	166	17.7	14.5	12.2
T_4	Bone meal @2 T/ha	55.0	160	18.4	14.0	10.1
T_5	Matkakhad @1T/ha	45.3	165	19.1	13.5	9.0
T_6	Multi nutrient mix @0.5 T/ha	55.2	172	18.7	15.0	11.3
T_7	Vermicompost@5 T/ha	58.4	175	16.4	16.0	13.7
T_8	FYM @20 T/ha+ Vermicompost @ 2.5T/ ha	62.0	180	21.3	16.5	12.0
T_9	Control-No application	40.0	155	10.5	12.6	8.50
	SEm+	1.30	4.98	1.04	1.48	1.12
	CD (0.05)	3.22	14.10	12.25	3.05	2.54

plants grown in the control plots having no application of organic nutrients but maximum number of days (62.0) were recorded in the treatment having joint application of FYM @ 20 T/ha + Vermicompost @ 2.5T/ ha (T_8) which was statistically at par with alone application of FYM@ 25 T/ha (T_1) but superior to all the other treatments (Table 4).The probable reason might be due to the fact that plants skip growth phases if they are under-nourished. In the same manner, treatments receiving low inputs skip vegetative growth, show stunted plant canopy and flower early as compared to other treatments where adequate nourishment was provided.

Plant height (cm)

The results indicated that all the treatments have a profound impact on the height of okra plants. Maximum height (180.0 cm) were recorded in the treatment having joint application of FYM @ 20 T/ha+ Vermicompost @ 2.5T/ ha (T_8) which was statistically superior to T_2 (Neem Cake @ 2T/ha), T_5(Matka khad @1T/ha) and T9 (Control-No application) but at par with T_1 (FYM @25 T/ha),T_6 (Multi nutrient mix @ 0.5T/ha) and T_7 (Vermicompost @ 5T/ha). Minimum height (55.0 cm) were however recorded from control plots. Poor nutrition has a direct negative impact on the growth and intermodal distance of the plant which was clearly depicted in the present study.

Number of fruits per plant

Data in Table 4 pointed out that maximum number of fruits (11.0) were recorded in the treatment having joint application of FYM @ 20 T/ha+ Vermicompost @ 2.5T/ ha (T_8) which was statistically at par with T_5 (Matka khad @1T/ha) with 19.10 fruits/plant butsuperior to rest of the other treatments. Minimum fruit count (10.50) was recorded from plants having no application of organic nutrients (Control).The reason might be that the effect of vermicompost was significant only when the dose was considerably improved or supplemented with different organic bulk nutrients like farm yard manure (Pradeep Kumar *et al.* 2017). Top-dressing fertilization in the rainy season maximized the yields of okra (Adekiya *et al*. 2017) support the present finding.

Fruit length (cm)

The results in Table 4 indicated that all the treatments showed profound impact on fruit length of okra. Maximum fruit length (13.70 cm) was recorded in the treatment having vermicompost at 5T/ha (T_7) which was at par with T_2 (Neem cake @ 2T/ha) ,T_3 (Poultry manure @ 5T/Ha), T_6 (Multi nutrient mix @ 0.5 T/ha) and T_8 (FYM @10 T/ha+ Vermicompost @ 2.5T/ ha). Minimum lengths (8.50 cm) were recorded from control plots where no application of organic nutrients was provided.

Fruit weight (g)

Maximum weight (17.80 g) were recorded in the treatment having alone application of FYM @ 20 T/ ha (T_1) which was statistically at par with T_6 (Multi

Table 5. Fruit and seed parameters of rainy season okra as influenced by organic nutrient sources. Pooled data of two years.

Sl. No.	Treatments	Fruit yield /plant (g)	Fruit yield/hectare (q)	Seed yield per plant (g)	Seed yield per hectare (kg)
T_1	FYM @25 T/ha	312.60	121.04	65.10	260.45
T_2	Vermicompost @5T/ha	232.00	92.80	48.00	192.87
T_3	Neem cake @2T/ha	246.50	98.65	59.50	238.55
T_4	Poultry manure @5T/Ha	252.00	100.81	57.60	230.40
T_5	Bone meal @2T/ha	256.50	102.60	53.20	212.81
T_6	Matka Khad @1T/ha	270.00	108.55	52.20	208.80
T_7	Multi nutrient mix @0.5T/ha	256.00	102.43	54.40	217.60
T_8	FYM @20 T/ha+ Vermicompost @ 2.5T/ ha	351.50	138.63	68.00	272.45
T_9	Control-No application	189.00	75.61	28.50	114.00
	SEm+	5.99	6.87	7.12	8.59
	CD (0.05)	17.58	14.22	19.6	20.88

nutrient mix @ 0.5T/ha),T7(Vermicompost @ 5T/ha) and T_8 (FYM @ 20 T/ha+ Vermicompost @ 2.5T/ ha) and superior to all the other treatments including control where minimum fruit weight of (12.60g) were recorded (Table 4).The results of Oliveira *et al.* (2007), Abd El- Kader *et al*. (2010) confirmed the present finding.

Fruit yield per plant (kg) and per hectare (q)

The results showed in Table 5 showed that application of FYM @20 T/ha+ Vermicompost @ 2.5T/ ha recorded maximum fruit yield of 351.50g per plant and per hectare (138.63 q) which was statistically superior to all the other treatments under study. Lowest yield per plant and per hectare (189.00g and 75.61q) was recorded in control where no application of organic amendments were done.The results showed that without any application of nutrient sources, native soil nutrient was sub-optimal for normal vegetative growth of okra, as indicated by the low vegetative growth in terms of plant height, fresh/dry matter production in terms of fruit length and weight in the control plots.The observed increments in biometric parameters following application of organic amendments might be due to spontaneous response of native soil to applied organic nutrients (Cardoso and Berni 2012).The results of Omatoso and Shittu (2007) also confirmed the present finding.

Seed yield per plant (g) and per hectare (kg)

Data in Table 5 pointed out that application of FYM @20 T/ha+Vermicompost @ 2.5T/ ha recorded maximum seed yield per plant (68.00g) and per hectare (272.45kg) which was statistically superior to all the other treatments and control (28.50g and 114.0kg) except T_1 (FYM @ 25T/ha).The increased seed yield in combined application of FYM and vermicompost is an indication that organic matter accumulates more dry matter content in the fruits and its seed in the okra plants. This is because vermicompost showed synergistic effect on plants nutrients such as nitrates, exchangeable phosphorus and soluble potassium, calcium and magnesium and make them readily available to the plants for biomass accumulation (Edwards and Fletcher 1988).

CONCLUSION

Farmers of Jammu region are continually developing a stronger interest in okra production given its potential as an economic crop and its ability to grow optimally under low nutrient management and also its ability to produce promising yield within short period of time. However, for organic growers and home gardeners, no such recommendation of organic nutrients was suggested. Therefore the present experiment was conducted for two years and it can be concluded that no single source of organic nutrients can meet out the nutrient demandof okra for both fruit and seed production.Therefore, combined approach of FYM @20 T/ha applied at the time of final land preparation in combination with vermicompost @ 2.5T/ha, applied as top dressing i.e., after first weeding and thinning operation significantly increased all the biometric

parameters of organically maintained okra during rainy season under subtropical conditions of Jammu.

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