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Effect of Organic Nutrient Management on Growth and Yield of Okra (*Abelmoschus esculentus* L.)

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ABSTRACT

A field experiment was conducted at research and demonstration block of Research Institute on Organic Farming, UAS, GKVK, Bengaluru during 2016 to study the combined effect of FYM and liquid organic manures on growth and yield of okra. The experiment was laid out in factorial randomised block design and replicated thrice. Application of FYM at 200 per cent N equivalent through FYM recorded significantly higher plant height (90.72 cm at harvest), leaf area (3434 cm^2 $plant^{-1}$ at 90 DAS), total dry matter accumulation (63.89 g $plant^{-1}$ at harvest), number of fruits (14.66 $plant^{-1}$), fruit weight (239.3 g $plant^{-1}$), fruit yield (9.59 t ha^{-1}) and stalk yield (1.54 t ha^{-1}) as compared to 100 per cent N equivalent through FYM (74.08 cm, 2568 cm^2 $plant^{-1}$, 52.70 g $plant^{-1}$, 11.20 $plant^{-1}$, 190.6 g $plant^{-1}$, 7.38 t ha^{-1} and 1.23 t ha^{-1}, respectively). Soil application of jeevamrutha (2000 L ha^{-1}) and foliar spray of panchagavya (5 %) recorded significantly higher plant height (89.64 and 86.66 cm), leaf area (3361 and 3231 cm^2 $plant^{-1}$), total dry matter accumulation (63.24 and 61.29 g $plant^{-1}$), number of fruits (14.43 and 13.79 $plant^{-1}$), fruit weight (235.4 and 227.6 g $plant^{-1}$), fruit yield (9.56 and 9.15 t ha^{-1}) and stalk yield (1.52 and 1.47 t ha^{-1}) compared to without application of jeevamrutha (76.07 cm, 2791 cm^2 $plant^{-1}$ at 90 DAS, 54.14 g $plant^{-1}$, 11.72 $plant^{-1}$, 198.5 g $plant^{-1}$, 7.64 t ha^{-1} and 1.28 t ha^{-1}, respectively) and without panchagavya (79.06 cm, 2920 cm^2 $plant^{-1}$, 56.09 g $plant^{-1}$, 12.36 $plant^{-1}$, 206.3 g $plant^{-1}$, 8.05 t ha^{-1} and 1.33 t ha^{-1}, respectively). Application of FYM and liquid organic manures *viz.*,Jeevamrutha & Panchagavya are beneficial in improving growth & yield of okra.

Keywords: FYM levels, N equivalent application, Jeevamrutha, Panchagavya, Organic okra

SOIL management is one of the important requirements for improving the agricultural productivity in tropics and sub-tropic soils. Organic manures constitute a dependable source of essential nutrients besides improving the soil physical, chemical and biological conditions. It is a challenging task for farmers as well as scientists to manage nutrients in organic farming systems since usage of inorganic fertilisers is strictly not permitted.

Okra (*Abelmoschus esculentus* L.) is one of the most well-known vegetable crop belongs to family *Malvaceae*. It is valued for its edible green pods. The okra originated in Ethiopian. The plant is cultivated in different regions all around the world *viz.*, tropical, subtropical and warm temperate climatic regions. It is one of the chief vegetable crop grown for its immature pods that can be consumed as a fried or boiled vegetable or may be added to salads, soups and stews (Kashif *et al*., 2008). It is a nutritious vegetable which can be grown in all types of soils starting from light sandy loam to clay soils and can be cultivated round the year in the country (Rana *et al*., 2009). Globally okra is cultivated on an area of 2.16 million hectares with an annual production of 8.9 million tones. It is mainly grown in India, Nigeria, Sudan, Pakistan, Ghana, Egypt, Benin, Saudi Arabia, Mexico and Cameroon. Largest area and production is in India followed by Nigeria. In India, it is cultivated in an area of about 0.485 million hectares with an annual production of 5.5 million tonnes (Anon., 2016). Major okra growing states in India are Maharashtra, Andhra Pradesh and Tamilnadu. However, it is grown in Karnataka mainly as vegetable purpose in all the districts.

Farm yard manure is a decomposed organic matter obtained by the action of microbial population in a warm and moist aerobic environment using cow dung, cow urine and other waste materials available from

backyard cattle (Ramprasad *et al.,* 2009). Usage of liquid organic manures such as jeevamrutha and panchagavya results in increased growth and yield of crops and improve the soil physico-chemical and biological properties. They contain micro and macro nutrients, many vitamins, essential amino acids, beneficial microorganisms and growth promoting substances *viz*., IAA, GA (Devakumar *et al*., 2008 and Tharmaraj *et al*., 2011). Panchagavya and jeevamrutha are eco-friendly organic preparations made from cow products. The products from cow have the ability to bring the flow of cosmic energy which in turn can revitalize the growth process. Use of farm yard manure (FYM) and liquid organic formulations like panchagavya and jeevamrutha are potential sources of organic nutrients. Hence, the present investigation was conducted to study the combined effect of FYM, jeevamrutha and panchagavya on growth and yield of okra.

Material and Methods

A field experiment was conducted at research and demonstration block of Research Institute on Organic Farming, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru which is situated in Eastern dry zone of Karnataka at a latitude of 12° 582 North, longitude of 75° 352 East and at an altitude of 930 m above mean sea level. The experiment was conducted to study the combined effect of FYM, jeevamrutha and panchagavya on growth and yield of okra during *kharif* - 2016 with irrigated condition. The experiment was laid out in factorial Randomised Block Design and treatments were replicated thrice. The net plot size was 2.9 m × 2.6 m (7.54 m²). Recommended dose of nutrients for okra is 125:75:63 $N:P_2O_5:K_2O$ kg ha^{-1} and nutrients were supplied through FYM on the basis of nitrogen equivalent. Treatment combinations consisted of three FYM levels (F_1:100%, F_2: 150 % and F_3: 200 % N equivalent through FYM), two jeevamrutha levels (J_0:0 and J_1: 2000 L ha^{-1}) and panchagavya (P_0 : 0 and P_1 : 5 %). FYM was incorporated into the soil, three weeks prior to sowing. Soil of the experimental site was red sandy loam with a pH of 6.73, EC (0.22 dSm^{-1}), low in organic carbon (0.42 %) and medium in available nitrogen (298 kg ha^{-1}), P_2O_5 (29 kg ha^{-1}) and K_2O (237 kg ha^{-1}).

Preparation of jeevamrutha and panchagavya

Jeevamrutha was prepared by mixing 10 kg of cow dung, 10 litre of cow urine, 2 kg of jaggery, 2 kg of pigeon pea flour and hand full of soil collected from farm. All these were put in 200 litres plastic drum and mixed thoroughly and volume was made up to 200 litres by adding water. The mixture was stirred well in clock wise direction thrice a day and plastic drum was kept in shade covered with wet jute bag. Jeevamrutha was fermented for 10 days and applied to the plants manually at of 20, 40, 60 and 80 days after sowing (DAS) as per treatments (Palekar, 2006).

Panchagavya was prepared by mixing 7 kg fresh cow dung and 1 kg ghee and incubated in a container for 2 days and it was mixed daily once. On the third day, 10 litres cow urine and 10 litres water were added, mixed thoroughly and incubated for fermentation for 13 days. Further, 3 litres of milk, 2 litres of curd, 3 litres of tender coconut water, 3 kg jaggery and 12 well ripened Cavendish banana were added and contents were incubated for 6 days. The mixture was stirred thoroughly thrice a day at morning, afternoon and evening. Plastic drum was kept in shade and it was covered with wet jute bag. After 21 days of fermentation mixture was filtered through a cotton cloth and used for spraying. Three litres of filtrate was taken and diluted to 100 litres using water and sprayed to the crop during the 15, 30 and 45 day after sowing when the soil is moist (Natarajan, 2002).

Experimental data collected was subjected to statistical analysis by adopting Fisher's method of analysis of variance (ANOVA) as outlined in Gomez and Gomez (1984). Critical difference (CD) values were calculated whenever the "F" test was significant at 5 per cent level.

Results and Discussion

Effect of FYM levels on growth and yield of okra

Application of varied levels of farm yard manure showed significant effect on growth and yield attributes

of okra. Growth parameters differed significantly due to treatments effect at all the stages of crop growth except at 30 DAS. Application of 200 per cent N equivalent through FYM recorded significantly higher growth parameters *viz.,* plant height (44.67, 82.08 and 90.72 cm at 60, 90 DAS and at harvest, respectively), leaf area (2143, 3434 and 2017 cm^2 $plant^{-1}$ at 60, 90 DAS and at harvest, respectively**)** and total dry matter accumulation (26.84, 54.13 and 63.89 g $plant^{-1}$ at 60, 90 DAS and at harvest, respectively) as compared to those with 100 per cent N equivalent through FYM. However, it was at par with the application of 150 per cent N equivalent through FYM *i.e.*, plant height (40.65, 75.31 and 83.77 cm at 60, 90 DAS and at harvest, respectively), leaf area (1950, 3434 and 1878 cm^2 $plant^{-1}$ at 60, 90 DAS and at harvest, respectively**)** and total dry matter accumulation (24.43, 49.50 and 59.48 g $plant^{-1}$ at 60, 90 DAS and at harvest, respectively) (Table 1, 2 and 3). Similarly, yield and yield attributes *viz.,* number of fruits (14.66 $plant^{-1}$), fruit length (14.03 cm), fruit weight (239.3 g $plant^{-1}$), fruit diameter (2.01 cm), fruit yield (9.59 t ha^{-1}) and stalk yield (1.54 t ha^{-1}) were recorded significantly higher with higher level of FYM *i.e.,* 200 per cent N equivalent as compared to 100 per cent N equivalent (11.20 $plant^{-1}$, 10.62 cm, 190.6 g $plant^{-1}$, 1.55 cm, 7.38 t ha^{-1} and 1.23 t ha^{-1}, respectively) and it was found at par with 150 per cent N equivalent through FYM application (13.38 $plant^{-1}$, 13.03 cm, 221.0 g $plant^{-1}$, 1.85 cm, 8.83 t ha^{-1} and 1.43 t ha^{-1}, respectively) (Table 4 and 5).

The higher growth and yield of these treatments might be due to FYM besides supplying N, P and K also improved the physical condition of soil, which make the unavailable forms of elemental nitrogen, bound phosphates, micronutrients and decomposed plant residues into an available form of nutrients which facilitate the plants to absorb more nutrients, which ultimately enhances higher dry matter accumulation and their translocation. Hence, improvement in the growth and yield attributes of okra was noticed. All these factors had cumulative effect on improvement in the final total yield of okra. These results are in agreement with findings of the Guriqbal singh *et al.* (2012) in chickpea, Siddappa (2015) in field bean, Basavaaraj Kumbar and Devakumar (2016) in frenchbean, Boraiah *et al*. (2017) in organic capsicum and Siddappa *et al*., 2017 in fieldbean. According to Basavaraj Kumbar and Devakumar (2016), application of FYM at 200 per cent N equivalent recorded significantly higher growth, pod yield and haulm yield of frenchbean over application of FYM at 100 per cent N equivalent.

Effect of jeevamrutha on growth and yield of okra

The growth and yield of okra were varied significantly with application of jeevamrutha. Growth parameters showed significant difference due to application of jeevamrutha at all the stages of crop growth except at 30 DAS. Soil application of jeevamrutha (2000 L ha^{-1}) had significantly increased *viz.,* plant height (44.33, 80.54 and 89.64 cm at 60, 90 DAS and at harvest, respectively), leaf area (2127, 3361 and 1952 cm^2 $plant^{-1}$ at 60, 90 DAS and at harvest, respectively**)** and total dry matter accumulation (26.59, 53.25 and 63.24 g $plant^{-1}$ at 60, 90 DAS and at harvest, respectively) (Table 1, 3 and 3). Whereas, yield and yield attributes recorded similar trend *viz*., number of fruits (14.43 $plant^{-1}$), fruit length (13.68 cm), fruit weight (235.4 g $plant^{-1}$), fruit diameter (2.01 cm), fruit yield (9.56 t ha^{-1}) and stalk yield (1.52 t ha^{-1}) as compared to without application of jeevamrutha (35.80, 67.15 and 76.07 cm at 60, 90 DAS and at harvest, 1717, 2791 and 1654 cm^2 $plant^{-1}$ at 60, 90 DAS and at harvest, 21.46, 44.57 and 54.14 g $plant^{-1}$ at 60, 90 DAS and at harvest, 11.72 $plant^{-1}$, 11.43 cm, 198.5 g $plant^{-1}$, 1.60 cm, 7.64 t ha^{-1} and 1.28 t ha^{-1}, respectively) (Table 4 and 5). The possible reason for this might be due to that cow dung in jeevamrutha acts as a media for the growth of beneficial microorganisms and cow urine provides nitrogen which is essential for crop growth upon fermentation with other ingredients in jeevamrutha. These results are in consonance with findings of Siddappa (2015) in field bean, Basavaraj Kumbar (2016) in frenchbean. Siddappa *et al.* (2017) reported that significantly higher growth and yield parameters were recorded in application of jeevamrutha at 1500 L ha^{-1} over 1000 and 500 L ha^{-1} in fieldbean.

TABLE 1

Plant height (cm) at different stages of okra as influenced by FYM, jeevamrutha and panchagavya application

Treatments	Plant height (cm)											
	30 DAS			60 DAS			90 DAS			At harvest		
	J_0	J_1	Mean	J_0	J_1	Mean	J_0	J_1	Mean	J_0	J_1	Mean
FYM (F)												
F_1	13.66	14.70	14.18	31.19	38.56	34.87	57.72	70.54	64.13	66.93	81.22	74.08
F_2	14.34	15.52	14.93	35.81	45.49	40.65	67.47	83.16	75.31	77.32	90.21	83.77
F_3	15.49	16.67	16.08	40.39	48.95	44.67	76.25	87.91	82.08	83.95	97.50	90.72
Mean	14.49	15.63		35.80	44.33		67.15	80.54		76.07	89.64	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
F	0.53	NS		1.48	4.35		2.49	7.32		3.10	9.10	
J	0.43	NS		1.21	3.55		2.04	5.97		2.53	7.43	
F x J	0.75	NS		2.10	NS		3.53	NS		4.39	NS	
	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean
F_1	13.87	14.48	14.18	32.52	37.22	34.87	60.78	67.47	64.13	70.95	77.20	74.08
F_2	14.59	15.27	14.93	37.86	43.45	40.65	70.47	80.16	75.31	79.73	87.80	83.77
F_3	15.92	16.23	16.08	42.22	47.11	44.67	78.29	85.87	82.08	86.48	94.96	90.72
Mean	14.80	15.33		37.53	42.60		69.85	77.83		79.06	86.66	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
P	0.43	NS		1.21	3.55		2.04	5.97		2.53	7.43	
F x P	0.75	NS		2.10	NS		3.53	NS		4.39	NS	
	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean
J_0	14.22	14.76	14.49	33.56	38.03	35.80	63.38	70.91	67.15	72.56	79.57	76.07
J_1	15.37	15.89	15.63	41.50	47.16	44.33	76.32	84.75	80.54	85.55	93.74	89.64
Mean	14.80	15.33		37.53	42.60		69.85	77.83		79.06	86.66	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
J x P	0.61	NS		1.71	NS		2.88	NS		3.58	NS	
Interaction F x J x P	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean
F_1 J_0	13.33	13.98	13.66	28.82	33.56	31.19	53.74	61.69	57.72	64.07	69.79	66.93
J_1	14.41	14.98	14.70	36.22	40.89	38.56	67.82	73.25	70.54	77.83	84.61	81.22
F_2 J_0	13.99	14.68	14.34	33.71	37.91	35.81	62.33	72.61	67.47	72.53	82.12	77.32
J_1	15.19	15.86	15.52	42.01	48.98	45.49	78.62	87.70	83.16	86.93	93.49	90.21
F_3 J_0	15.34	15.63	15.49	38.15	42.62	40.39	74.06	78.44	76.25	81.08	86.81	83.95
J_1	16.50	16.84	16.67	46.29	51.61	48.95	82.51	93.31	87.91	91.89	103.1	97.50
F x J x P	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
	1.06	NS		2.97	NS		4.99	NS		6.20	NS	

Note: CD at 5 %, NS- Non-significant, DAS-Days after sowing RDF: 125:75:63 $N:P_2O_5:K_2O$ kg ha^{-1} for N equivalent calculation

Factor - I: FYM levels

F_1- 100 % equivalent N through FYM

F_2- 150 % equivalent N through FYM

F_3- 200 % equivalent N through FYM

Factor - II: Jeevamrutha levels

J_0- Without Jeevamrutha

J_1- Jeevamrutha 2000 L ha^{-1}

Factor - III: Panchagavya levels

P_0- Without panchagavya

P_1- Panchagavya at 5 %

TABLE 2

Leaf area (cm^2 $plant^{-1}$) at different stages of okra as influenced by FYM, jeevamrutha and panchagavya application

Treatments	Leaf area (Cm^2 $plant^{-1}$)											
	30 DAS			60 DAS			90 DAS			At harvest		
	J_0	J_1	Mean	J_0	J_1	Mean	J_0	J_1	Mean	J_0	J_1	Mean
FYM (F)												
F_1	805	867	836	1496	1850	1673	2293	2844	2568	1346	1684	1515
F_2	829	898	864	1718	2183	1950	2912	3539	3225	1739	2016	1878
F_3	896	965	931	1938	2348	2143	3168	3700	3434	1876	2157	2017
Mean	844	910		1717	2127		2791	3361		1654	1952	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
F	29.43	NS		72.55	212.8		91.69	268.9		68.04	199.5	
J	24.03	NS		59.24	173.7		74.86	219.6		55.56	162.9	
F x J	41.62	NS		102.60	NS		129.67	NS		96.23	NS	
	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean
F_1	818	854	836	1560	1786	1673	2420	2717	2568	1427	1603	1515
F_2	844	883	864	1816	2084	1950	3040	3411	3225	1793	1962	1878
F_3	922	939	931	2026	2260	2143	3302	3565	3434	1933	2101	2017
Mean	861	892		1801	2044		2920	3231		1718	1889	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
P	24.03	NS		59.24	173.7		74.86	219.6		55.56	162.9	
F x P	41.62	NS		102.60	NS		129.67	NS		96.23	NS	
	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean
J_0	828	859	844	1610	1824	1717	2641	2941	2791	1581	1726	1654
J_1	895	925	910	1991	2263	2127	3200	3521	3361	1854	2051	1952
Mean	861	892		1801	2044		2920	3231		1718	1889	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
J x P	33.98	NS		83.78	NS		105.87	NS		78.57	NS	
Interaction F x J x P	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean
F_1 J_0	786	825	805	1382	1610	1496	2129	2457	2293	1289	1404	1346
J_1	850	884	867	1738	1962	1850	2711	2976	2844	1566	1802	1684
F_2 J_0	809	849	829	1617	1819	1718	2734	3090	2912	1643	1835	1739
J_1	879	917	898	2015	2350	2183	3345	3732	3539	1943	2089	2016
F_3 J_0	888	904	896	1830	2045	1938	3061	3275	3168	1812	1940	1876
J_1	956	974	965	2221	2476	2348	3543	3856	3700	2054	2261	2157
F x J x P	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
	58.86	NS		145.10	NS		183.38	NS		136.08	NS	

Note: CD at 5 %, NS- Non-significant, DAS-Days after sowing RDF: 125:75:63 $N:P_2O_5:K_2O$ kg ha^{-1} for N equivalent calculation

Factor - I: FYM levels

F_1- 100 % equivalent N through FYM

F_2- 150 % equivalent N through FYM

F_3- 200 % equivalent N through FYM

Factor - II: Jeevamrutha levels

J_0- Without Jeevamrutha

J_1- Jeevamrutha 2000 L ha^{-1}

Factor - III: Panchagavya levels

P_0- Without panchagavya

P_1- Panchagavya at 5 %

TABLE 3

Total dry matter accumulation (g plant^{-1}) at different stages of okra as influenced by FYM, jeevamrutha and panchagavya application

Treatments	Total dry matter accumulation (g plant^{-1})											
	30 DAS			60 DAS			90 DAS			At harvest		
	J_0	J_1	Mean	J_0	J_1	Mean	J_0	J_1	Mean	J_0	J_1	Mean
FYM (F)												
F_1	7.61	8.34	7.97	18.58	23.01	20.80	38.72	47.50	43.11	47.89	57.51	52.70
F_2	8.10	8.67	8.38	21.52	27.34	24.43	44.70	54.29	49.50	55.10	63.87	59.48
F_3	8.33	8.94	8.64	24.27	29.41	26.84	50.28	57.97	54.13	59.43	68.34	63.89
Mean	8.01	8.65		21.46	26.59		44.57	53.25		54.14	63.24	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
F	0.29	NS		0.87	2.55		1.71	5.01		2.16	6.34	
J	0.24	NS		0.71	2.08		1.40	4.09		1.77	5.18	
F x J	0.41	NS		1.23	NS		2.42	NS		3.06	NS	
	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean
F_1	7.81	8.14	7.97	19.54	22.06	20.80	40.74	45.48	43.11	50.24	55.16	52.70
F_2	8.24	8.52	8.38	22.75	26.11	24.43	46.66	52.33	49.50	56.80	62.17	59.48
F_3	8.56	8.71	8.64	25.37	28.31	26.84	51.62	56.63	54.13	61.23	66.55	63.89
Mean	8.20	8.46		22.55	25.49		46.34	51.48		56.09	61.29	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
P	0.24	NS		0.71	2.08		1.40	4.09		1.77	5.18	
F x P	0.41	NS		1.23	NS		2.42	NS		3.06	NS	
	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean
J_0	7.87	8.15	8.01	20.16	22.75	21.46	42.31	46.82	44.57	51.61	56.67	54.14
J_1	8.54	8.76	8.65	24.94	28.23	26.59	50.37	56.14	53.25	60.57	65.91	63.24
Mean	8.20	8.46		22.55	25.49		46.34	51.48		56.09	61.29	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
J x P	0.34	NS		1.00	NS		1.97	NS		2.50	NS	
Interaction F x J x P	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean
F_1 J_0	7.43	7.78	7.61	17.31	19.85	18.58	36.10	41.34	38.72	45.36	50.41	47.89
J_1	8.18	8.50	8.34	21.76	24.26	23.01	45.38	49.62	47.50	55.11	59.90	57.51
F_2 J_0	7.90	8.29	8.10	20.26	22.78	21.52	41.99	47.41	44.70	52.06	58.14	55.10
J_1	8.58	8.76	8.67	25.24	29.43	27.34	51.33	57.26	54.29	61.55	66.19	63.87
F_3 J_0	8.27	8.38	8.33	22.92	25.61	24.27	48.84	51.72	50.28	57.40	61.46	59.43
J_1	8.85	9.03	8.94	27.81	31.01	29.41	54.41	61.53	57.97	65.06	71.63	68.34
F x J x P	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
	0.58	NS		1.74	NS		3.42	NS		4.33	NS	

Note: CD at 5 %, NS- Non-significant, DAS-Days after sowing RDF: 125:75:63 N:P_2O_5:K_2O kg ha^{-1} for N equivalent calculation

Factor - I: FYM levels

F_1- 100 % equivalent N through FYM

F_2- 150 % equivalent N through FYM

F_3- 200 % equivalent N through FYM

Factor - II: Jeevamrutha levels

J_0- Without Jeevamrutha

J_1- Jeevamrutha 2000 L ha^{-1}

Factor - III: Panchagavya levels

P_0- Without panchagavya

P_1- Panchagavya at 5 %

TABLE 4

Yield parameters at harvest stage of okra as influenced by FYM, jeevamrutha and panchagavya application

Treatments	Yield Parameters											
	No. of Fruits per Plant			Fruits length (cm) at 2nd picking			Fruits weight (g plant^{-1})			Fruits diameter (cm) at 2nd picking		
	J_0	J_1	Mean	J_0	J_1	Mean	J_0	J_1	Mean	J_0	J_1	Mean
FYM (F)												
F_1	10.04	12.36	11.20	9.36	11.88	10.62	171.2	210.0	190.6	1.38	1.72	1.55
F_2	11.87	14.88	13.38	12.09	13.97	13.03	202.0	240.0	221.0	1.63	2.08	1.85
F_3	13.26	16.07	14.66	12.85	15.20	14.03	222.3	256.3	239.3	1.80	2.22	2.01
Mean	11.72	14.43		11.43	13.68		198.5	235.4		1.60	2.01	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
F	0.48	1.42		0.48	1.42		7.64	22.40		0.07	0.20	
J	0.40	1.16		0.39	1.16		6.24	18.29		0.06	0.17	
F x J	0.69	NS		0.68	NS		10.80	NS		0.10	NS	
P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	
F_1	10.67	11.72	11.20	9.99	11.24	10.62	180.1	201.0	190.6	1.45	1.65	1.55
F_2	12.55	14.20	13.38	12.44	13.62	13.03	210.7	231.3	221.0	1.74	1.97	1.85
F_3	13.86	15.46	14.66	13.46	14.59	14.03	228.2	250.3	239.3	1.87	2.15	2.01
Mean	12.36	13.79		11.96	13.15		206.3	227.6		1.69	1.92	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
P	0.40	1.16		0.39	1.16		6.24	18.29		0.06	0.17	
F x P	0.69	NS		0.68	NS		10.80	NS		0.10	NS	
P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	
J_0	11.05	12.39	11.72	10.81	12.06	11.43	190.0	207.0	198.5	1.51	1.70	1.60
J_1	13.67	15.20	14.43	13.12	14.24	13.68	222.7	248.2	235.4	1.87	2.14	2.01
Mean	12.36	13.79		11.96	13.15		206.3	227.6		1.69	1.92	
	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
J x P	0.56	NS		0.56	NS		8.82	NS		0.08	NS	
Interaction F x J x P	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean	P_0	P_1	Mean
F_1 J_0	9.46	10.61	10.04	8.75	9.96	9.36	159.6	182.7	171.2	1.28	1.48	1.38
J_1	11.89	12.82	12.36	11.23	12.52	11.88	200.6	219.4	210.0	1.62	1.82	1.72
F_2 J_0	11.18	12.57	11.87	11.46	12.72	12.09	194.5	209.6	202.0	1.55	1.71	1.63
J_1	13.93	15.83	14.88	13.42	14.52	13.97	226.9	253.1	240.0	1.94	2.22	2.08
F_3 J_0	12.52	13.99	13.26	12.21	13.50	12.85	215.9	228.7	222.3	1.69	1.92	1.80
J_1	15.19	16.94	16.07	14.71	15.69	15.20	240.5	272.0	256.3	2.06	2.39	2.22
F x J x P	S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.		S.Em±	C.D.	
	0.97	NS		0.97	NS		15.28	NS		0.14	NS	

Note: CD at 5 %, NS- Non-significant, DAS-Days after sowing RDF: 125:75:63 N:P_2O_5:K_2O kg ha^{-1} for N equivalent calculation

Factor - I: FYM levels

F_1- 100 % equivalent N through FYM

F_2- 150 % equivalent N through FYM

F_3- 200 % equivalent N through FYM

Factor - II: Jeevamrutha levels

J_0- Without Jeevamrutha

J_1- Jeevamrutha 2000 L ha^{-1}

Factor - III: Panchagavya levels

P_0- Without panchagavya

P_1- Panchagavya at 5 %

TABLE 5

Fruit yield and stalk yield of okra as influenced by FYM, jeevamrutha and panchagavya application

Treatments	Fruit yield (t ha^{-1})			Stalk yield (t ha^{-1})		
	J_0	J_1	Mean	J_0	J_1	Mean
FYM (F)						
F_1	6.58	8.19	7.38	1.10	1.35	1.23
F_2	7.76	9.90	8.83	1.30	1.55	1.43
F_3	8.59	10.59	9.59	1.43	1.65	1.54
Mean	7.64	9.56		1.28	1.52	
	S.Em±	C.D.		S.Em±	C.D.	
F	0.30	0.89		0.046	0.134	
J	0.25	0.73		0.037	0.109	
F x J	0.43	NS		0.064	NS	
	P_0	P_1	Mean	P_0	P_1	Mean
F_1	6.92	7.85	7.38	1.16	1.30	1.23
F_2	8.30	9.36	8.83	1.36	1.49	1.43
F_3	8.93	10.25	9.59	1.47	1.61	1.54
Mean	8.05	9.15		1.33	1.47	
	S.Em±	C.D.		S.Em±	C.D.	
P	0.25	0.73		0.037	0.109	
F x P	0.43	NS		0.064	NS	
	P_0	P_1	Mean	P_0	P_1	Mean
J_1	7.18	8.10	7.64	1.23	1.33	1.28
J_2	8.92	10.20	9.56	1.44	1.60	1.52
Mean	8.05	9.15		1.33	1.47	
	S.Em±	C.D.		S.Em±	C.D.	
J x P	0.35	NS		0.053	NS	
Interaction	P_0	P_1	Mean	P_0	P_1	Mean
F x J x P						
F_1 J_0	6.11	7.04	6.58	1.03	1.18	1.10
J_1	7.73	8.66	8.19	1.29	1.41	1.35
F_2 J_0	7.38	8.15	7.76	1.25	1.35	1.30
J_1	9.22	10.57	9.90	1.46	1.63	1.55
F_3 J_0	8.04	9.13	8.59	1.39	1.47	1.43
J_1	9.81	11.37	10.59	1.55	1.75	1.65
F x J x P	S.Em±	C.D.		S.Em±	C.D.	
	0.61	NS		0.091	NS	

Note: CD at 5 %, NS- Non-significant, DAS-Days after sowing RDF: 125:75:63 N:P_2O_5:K_2O kg ha^{-1} for N equivalent calculation

Factor - I: FYM levels

F_1- 100 % equivalent N through FYM

F_2- 150 % equivalent N through FYM

F_3- 200 % equivalent N through FYM

Factor - II: Jeevamrutha levels

J_0- Without Jeevamrutha

J_1- Jeevamrutha 2000 L ha^{-1}

Factor - III: Panchagavya levels

P_0- Without panchagavya

P_1- Panchagavya at 5 %

Effect of panchagavya on growth and yield of okra

Application of panchagavya showed significant variation in the growth and yield of okra. Growth parameters showed significant difference due to application of panchagavya at all the stages of crop growth except at 30 DAS. Foliar spray of panchagavya recorded significantly increased *viz.,* plant height (42.60, 77.83 and 86.66 cm at 60, 90 DAS and at harvest, respectively), leaf area (2044, 3231 and 1889 cm^2 $plant^{-1}$ at 60, 90 DAS and at harvest, respectively) and total dry matter accumulation (25.49, 51.48 and 61.29 g $plant^{-1}$ at 60, 90 DAS and at harvest, respectively) (Table 1, 2 and 3). Whereas, yield and yield attributes recorded similar trend *viz*., number of fruits (13.79 $plant^{-1}$), fruit length (13.15 cm), fruit weight (227.6 g $plant^{-1}$), fruit diameter (1.92 cm), fruit yield (9.15 t ha^{-1}) and stalk yield (1.47 t ha^{-1}) as compared to without application of panchagavya (37.53, 69.85 and 79.06 cm at 60, 90 DAS and at harvest, 1801, 2920 and 1718 cm^2 $plant^{-1}$ at 60, 90 DAS and at harvest, 22.55, 46.34 and 56.09 g $plant^{-1}$ at 60, 90 DAS and at harvest, 12.36 $plant^{-1}$, 11.96 cm, 206.3 g $plant^{-1}$, 1.69 cm, 8.05 t ha^{-1} and 1.33 t ha^{-1}, respectively) (Table 4 and 5). This might be due the fact that panchagavya acts as growth promoter, pest repellent and resistance against disease. These triple roles of panchagavya helped in profuse growth of okra. Apart from this, tender coconut water ingredient was also being used for preparation of panchagavya and it contains kinetin which has role in enhancing chlorophyll content and leaf size in plant, thus in turn enhanced photosynthetic activity, growth and yield of okra. Fermented liquid organic manures also contain plant growth promoting substances like IAA and GA (Selvaraj *et al*., 2007; Devakumar *et al*., 2008 and Nileema & Sreenivasa, 2011). These might have stimulated the necessary growth and development in plants, leading to better growth and yield of okra. Similar results were also found by Sharma and Thomas (2010), Basavaraj Kumbar and Devakumar (2017) in black gram and organic frenchbean, respectively.

Interaction effect of FYM levels, jeevamrutha and panchagavya on growth and yield of okra

The statistically non-significant interaction effect among different levels of FYM (F), jeevamrutha (J) and panchagavya (P) was observed. Numerically higher and lower fruit yield (11.37 and 6.11 t ha^{-1}, respectively) and stalk yield (1.75 and 1.03 t ha^{-1}, respectively) were observed in the treatment combinations of application of 200 per cent FYM along with the application of jeevamrutha (2000 L ha^{-1}) and panchagavya (5 %) and application of 100 per cent FYM along without the application of jeevamrutha (0 L ha^{-1}) and panchagavya (0 %), respectively.

From this study it can be concluded that application of FYM and liquid organic manures (jeevamrutha and panchagavya) are beneficial in improving growth and yield of okra by providing better availability of nutrients, improved microbial activity and availability of growth promoting substances.

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