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Influence of biofertilizer, liquid organic manures along with RDF on growth and flowering of okra (*Abelmoschus esculentus* L. Moench)

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Abstract
An experiment was conducted at Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during *kharif* 2019 to study the influence of biofertilizer, liquid organic manures *Viz*., Panchagavya, Vermiwash, Jeevamrit and Cow urine on growth of okra in the open field condition. The experiment was laid in Randomized Block Design with fifteen treatments replicated twice by using the variety Parbhani Kranti. the various types of liquid organic solutions prepared from plant and animal origin are effective in promotion of growth in okra. Different concentration of liquid organic manures like Panchagavya (500 lit/ha), Vermiwash (100 lit/ha) and Cow urine (100 lit/ha) were given at 15, 45 and 75 DAS through foliar spray and Jeevamrit (500 lit/ha) and biofertilizer like *Azospirillium* (2.5 lit/ha) was applied through drenching at 15, 45 and 75 DAS along with Recommended dose of fertilizers (N:P:K::100:50:50]. The observations on growth and flowering parameters were recorded during the investigation. On the basis of observations recorded, the result revealed that the significantly highest plant growth and flowering was recorded with the application of T_{14} [RDF + Jeevamrit + Vermiwash + Panchagavya] and it was found to be significantly superior over other treatments and gives best results as compared to Control (100:50:50 N:P:K kg/ha).

Keywords: *Azospirillum*, cow urine, growth, Jeevamrit, okra, Panchagavya and Vermiwash

Introduction
Okra (*Abelmoschus esculentus* L. Moench) is a fast growing, erect, herbaceous annual and belongs to the family Malvaceae. Okra is an economically important vegetable crop grown in tropical and sub-tropical parts of world. It is a warm season vegetable crop and it grows best in hot summer with minimum and maximum temperature 18 ºC and 35 ºC for cultivation as a garden crop as well as on large commercial farms. It is one of the most popular vegetable cultivated in India, commonly called as *bhendi* or lady's finger. It is popularly grown during rainy and summer season throughout India. It contain 2n=2x=132 chromosome. It has an origin in tropical or subtropical Africa. It has multiple uses, okra fruits are used as vegetable in India, Brazil, West Africa and many other countries. It has good nutritional value as 100 g consumable unripe fruit contains moisture 89.6 g, carbohydrates 6.4 g, protein 1.9 g, fat 0.2 g, fibre 1.2 g, minerals 0.7 g, vitamin A 88 IU, thiamine 0.07 mg, riboflavin 0.10 mg, nicotinic acid 0.60 mg and vitamin C 13 mg. The dry seeds of okra contain 14-23% edible oil and 21-25% protein (Thamburaj and Singh, 2005) [16]. Oil from okra is used in soaps, cosmetic industry and as vanaspati, while protein is used for cattle feed preparation (Bini, 2003) [1].

The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable food production. The cost of inorganic fertilizers is increasing enormously to an extent that they are out of reach of small and marginal farmers. The use of organic liquid products such as beejamrit, jeevamrit and panchagavya results in higher growth, yield and quality of crops. Theses liquid organic solution are prepared form cowdung, urine, milk, curd, ghee, legume flour and jaggary. They contain macro nutrients, essential micro nutrients, many vitamins, essential micro nutrients, essential amino acids, growth promoting factors like IAA, GA and beneficial microorganisms (Palekar, 2006; Natarajan, 2007; Sreenivasa *et al*., 2010) [10, 9, 15].

Continuous use of inorganic fertilizers resulted in deficiency of micronutrients, imbalance in soil physiochemical properties and unsustainable crop production. The increase cost of inorganic fertilizers, application of recommended dose is difficult to be afforded by the small and marginal farmers. Hence renewable and low-cost sources of plant nutrients for supplementing and complementing chemical fertilizers should be substituted which can be afforded by majority of farming community. Integrated nutrient management would be a viable strategy for advocating judicious and efficient use of chemical fertilizers with matching

addition of fermented liquid organic manure and biofertilizers to meet the nutrient requirement of crop would be an inevitable practice in the years to come for sustainable agriculture. The result of this research was helpful to identify the best biofertilizer, fermented liquid organic manures and recommended dose of fertilizer combination for maximum growth, flowering and sustainable cultivation of okra.

Materials and Methods

The investigation was carried out at the Department of Horticulture, Vansantrao Naik Marathwada Krishi vidyapeeth, Parbhani, during the year 2019 in the month of July – October to know the effect of biofertilizers, liquid organic manures along with RDF on growth and flowering parameters of okra. The experiment was laid out in randomized block design with 15 treatments and each replicated twice. The treatments involved were T_1 [Control (100:50:50 kg/ha)], T_2 [RDF + Vermiwash], T_3 [RDF + Jeevamrit], T_4 [RDF + Cow urine], T_5 [RDF + Panchagavya], T_6 [RDF + Biofertilizer], T_7 [RDF + Jeevamrit + Vermiwash], T_8 [RDF + Jeevamrit + Cow urine], T_9 [RDF + Jeevamrit + Panchagavya], T_{10} [RDF + Jeevamrit + Biofertilizer], T_{11}[RDF + Jeevamrit + Cow urine + Panchagavya], T_{12} [RDF + Jeevamrit + Cow urine + Biofertilizer], T_{13} [RDF + Jeevamrit + Vermiwash + Cow urine], T_{14} [RDF + Jeevamrit + Vermiwash + Panchagavya] and T_{15} [RDF + Jeevamrit + Vermiwash + Cow urine + Panchagavya + Biofertilizer]. The plot size was 3.0 m × 2.0 m and spacing followed by 60 cm × 30 cm. the land was brought to a fine tilth through ploughing and tillage. Irrigation channels and bunds were maintained properly.

The dibbling of seed directly in the open field condition, before dibbling the seed were treated with Beejamrit by dipping for 5 hrs. Light irrigation was given after sowing. Recommended dose of fertilizer (NPK) was applied before dibbling of seed. Recommended dose Nitrogen, phosphorus and potash were applied through urea, single superphosphate and muriate of potash, respectively at 100 kg N/ha, 50 kg P_2O_5/ha and 50 kg K_2O/ha. Application of full dose of Phosphorous & Potassium and half dose of Nitrogen were applied just before the dibbling of seed and remaining half dose of Nitrogen was just 30 days after sowing. Application of liquid organic manures *Viz.,* vermiwash (100 lit/ha), panchagavya (500 lit/ha) and cow urine (100 lit/ha) was applied through spraying at 15, 45 and 75 DAS, jeevamrit (500 lit/ha) was applied through drenching at 15, 45 and 75 days after sowing and application of *Azospirillum* (2.5 lit/ha) through drenching at 15, 45 and 75 days after sowing. All cultural practices were followed regularly during crop growth and observations were recorded on growth parameters i.e. height of plant, number of branches, stem girth, number of leaves, number of nodes per plant and internal nodal length; flowering parameters i.e. days to 1st flowering, days to 50% flowering and nodal position of 1st flower.The data generated during the investigation was subjected to statistical analysis to test the significance among the treatments on various characters of okra under study was done according to the procedure given by Panse and Sukhatmane (1985) [11].

Results and Discusion

In the present study, both the growth (Table 1.) and flowering parameters (Table 2.) were significantly higher with the application of T_{14} [RDF + Jeevamrit + Vermiwash + Panchagavya], which might due to the increased availability of nutrient at initial stage through recommended dose of fertilizer (100:50:50 NPK/ha) in addition to nutritional & other benefits from liquid organic manures.

The vegetative growth parameters like hight of plant, number of branches, stem girth, number of leaves, number of nodes, inter nodal length were influenced significantly due to different treatments as shown in Table 1.

Overall vegetative parameters were influenced due to application of nutrient through combination of organic liquid manures, biofertilizer and RDF were proved beneficially for increasing growth of okra crop. Application of above combination improved vegetative growth significantly. The maximum vegetative growth in terms of hight of plant at 60DAS (84.85 cm) and 90 DAS (138.40 cm), number of branches per plant at 60 DAS (3.15) and 90 DAS (4.55), stem girth (2.70 cm) and number of leaves per plant (45.45) were recorded in the treatment T_{14} receiving combination of [RDF + Jeevamrit + Vermiwash + Panchagavya]. The maximum number of nodes per plant (26.67) were recorded in treatment T15 receiving combination T_{15} [RDF + Jeevamrit + Vermiwash + Cow urine + Panchagavya + Biofertilizer] followed by treatment T_{14}, T_{11}, T_{12} & T_{13}. The minimum values for all above vegetative parameters were found in T_1 [control]. These results are closely confined with findings of Gore and Sreenivasa (2011) [4], Sahu (2014) [14], Kumar and Devakumar (2016) [7], Rakesh *et al.,* (2017) [13], Kumar *et al.* (2018a) and Kumar *et al.* (2018c) [8].

The minimum inter nodal length of okra (6.87 cm) is a desirable character which was noticed in treatment T_{11} receiving combination of [RDF + Jeevamrit + Cow urine + Panchagavya] which was at par with the treatment T_{14} (6.92 cm). While, the maximum inter nodal length of okra plant (8.42 cm) was recorded in the treatment T_1 [control]. The results obtained corroborated with the reports of Tharmaraj *et al.* (2011) [17] and Choudhary *et al.* (2017) [2].

The flowering parameters like days to initiation of 1st flowering, days to 50% flowering and nodal position of 1st flower was influenced significantly as presented in Table 2. The minimum number of days to initiation of 1st flowering (39.00), days to 50% flowering (41.37) and nodal position at which 1st flower appear (5.20) were recorded in the treatment T_{14} receiving combination of [RDF + Jeevamrit + Vermiwash + Panchagavya]. While, maximum number of days to initiation of 1st flowering (42.90), days to 50% flowering (47.33) and nodal position at which 1st flower appear (7.05) were recorded under the treatment T_1 [control]. These results are in close conformity with the findings of Patel (2012) [12], Dutta *et al.* (2018) [3] and Kumar *et al.* (2018b) [6]. The above results indicated that increase the level of nutrients significantly affect the flowering parameters.

The nodal position of 1st flower is desirable character and earliness is good might due to the effect of spraying and drenching of biofertilizer, organic liquid manures along with recommended dose of fertilizer.

The treatment T_{14} observed early flowering in the 5th node this is due to better availability of nutrients at early stage of crop through RDF along with liquid organic manures and higher production of photosynthesis might lead to early flowering in this treatment followed by treatments T_{11}, T_{13}, T_{12} and T_{10}.

Table 1: Influence of biofertilizer, liquid organic manures along with RDF on growth parameters of okra.

	Plant height (cm)		Number of branches/plants		Stem girth (cm)	Number of leaves/plants	Number of nodes/plant	Inter nodal length (cm)
Treatment no	60 DAS	90 DAS	60 DAS	90 DAS				
T_1	71.40	106.06	1.13	2.15	2.18	26.58	18.13	8.42
T_2	76.83	115.90	1.26	2.40	2.39	34.65	22.52	8.26
T_3	74.70	114.10	1.47	2.47	2.31	32.15	22.03	8.31
T_4	75.13	111.15	1.26	2.90	2.28	30.94	20.85	8.37
T_5	75.55	117.60	1.53	2.75	2.39	33.60	22.80	8.24
T_6	75.40	115.85	1.90	2.53	2.34	32.15	22.77	8.26
T_7	78.40	126.35	2.35	3.91	2.47	38.61	24.27	7.65
T_8	77.30	123.30	2.04	2.97	2.42	42.45	23.69	8.11
T_9	79.00	124.59	2.10	3.40	2.49	35.60	24.65	7.63
T_{10}	78.15	125.84	2.05	3.66	2.48	37.20	24.33	7.85
T_{11}	81.90	137.65	3.07	4.51	2.58	45.05	25.97	6.87
T_{12}	80.90	135.87	2.43	4.15	2.56	43.65	25.59	7.11
T_{13}	83.35	136.55	2.39	4.07	2.68	44.75	25.82	7.13
T_{14}	84.85	138.40	3.15	4.55	2.70	45.45	26.25	6.92
T_{15}	82.70	137.43	2.62	4.40	2.54	42.80	26.67	7.15
SE ±	1.267	1.796	0.138	0.159	0.015	0.883	0.370	0.042
CD at 5%	3.879	5.499	0.442	0.487	0.045	2.706	1.132	0.130

Table 2: Influence of biofertilizer, liquid organic manures along with RDF on flowering parameters of okra

Tr. No.	Treatments	Days for initiation of 1st flower	Days to 50% flowering	Nodal position of 1st flower
T_1	Control (100:50:50 Kg/ha)	42.90	47.33	7.05
T_2	RDF + Vermiwash (100 lit/ha) 3 application (spraying at 15, 45 & 75 DAS)	41.67	46.90	6.80
T_3	RDF + Jeevamrit (500 lit/ ha) 3 application (drenching at 15, 45 & 75 DAS)	42.37	47.00	6.90
T_4	RDF + Cow urine (100 lit/ha) 3 application (spraying at 15, 45 & 75 DAS)	42.32	46.52	7.00
T_5	RDF + Panchagavya (500 lit/ha) 3 app -lication (spraying at 15,45 &75 DAS)	41.13	45.80	6.40
T_6	RDF + Biofertilizer (2.5 lit/ ha) 3 application (drenching at 15, 45 & 75 DAS)	40.77	45.47	6.90
T_7	RDF + Jeevamrit + Vermiwash	40.70	44.37	6.57
T_8	RDF + Jeevamrit + Cow urine	40.50	44.53	6.33
T_9	RDF + Jeevamrit + Panchagavya	40.23	43.73	6.67
T_{10}	RDF + Jeevamrit + Biofertilizer	39.90	43.36	6.30
T_{11}	RDF + Jeevamrit + Cow urine + Panchagavya	39.67	42.27	5.23
T_{12}	RDF + Jeevamrit + Cow urine + Biofertilizer	40.00	43.13	5.90
T_{13}	RDF + Jeevamrit + Vermiwash + Cow urine	39.60	42.20	5.40
T_{14}	RDF + Jeevamrit + Vermiwash + Panchagavya	39.00	41.37	5.20
T_{15}	RDF + Jeevamrit + Vermiwash + Cow urine + Panchagavya + Biofertilizer	40.13	43.57	7.00
	SE±	0.329	0.482	0.075
	CD at 5% level	1.008	1.476	0.231

Conclusion

The liquid organic manures are rich source of different plant growth hormones and beneficial micro-organism and was applied in combination of RDF gives highest growth and flowering in okra. The study clearly revealed that there was significant improvement in growth and flowering with the combined application of liquid organic manures and recommended dose of fertilizer as compared to RDF alone.

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