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Impact of combination of different organic manures, bio-fertilizer and organic mulches on growth and yield of okra

S. BASFORE, R. CHATTERJEE AND S. SIKDER

Department of Vegetable & Spice Crops
Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar – 736156, West Bengal

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ABSTRACT

Present investigation was framed to study the effect of combination treatments of different organic manures, bio-fertilizer and organic mulches on growth and yield of okra (variety Arka Anamika) in total of sixteen treatment combinations. The results showed that combined application of poultry manure (14 t ha^{-1}) and bio-fertilizer as Azotobacter without any mulch recorded the maximum plant height (155.20 cm), number of fruits plant^{-1} (21.39), fruit length (18.28 cm), average fruit weight (14.01 g), fruit yield plant^{-1} (292.53 gm), fruit yield plot^{-1} (7.36 kg) and highest yield of 14.71 t ha^{-1}. It may be concluded that poultry manure and bio fertilizer may be a viable nutrient source for organic okra cultivation.

Keywords **:** Bio-fertilizer, okra, organic mulches, poultry manure and vermicompost

Okra (*Abelmoschus esculentus* L. Moench) belongs to the family Malvaceae, having chromosome number 2n =130, commonly known as Bhindi, is one of the most popular vegetable in tropics during spring summer and *kharif* seasons. Although India is the largest producer of okra with 6.35 million tonnes production (72.9% of total world production) from 0.53 million hectare area (Anon., 2015), its productivity potential is low. The major okra growing states in India are Andhra Pradesh or Telangana (20%), West Bengal (15%), Bihar (14%), Odisha (11%) and rest in other states (Godambe *et al*., 2016). Tender green fruit is bestowed with superior nutritional and medicinal properties. The composition of okra pods per 100 g edible portion (81% of the product as purchased, ends trimmed) is: water 88.6 g, energy 144.00 kJ (36 kcal), protein 2.10 g, carbohydrate 8.20 g, fat 0.20 g, fibre 1.70 g, Ca 84.00 mg, P 90.00 mg, Fe 1.20 mg, â-carotene 185.00 ìg, riboflavin 0.08 mg, thiamin 0.04 mg, niacin 0.60 mg, ascorbic acid 47.00 mg. The composition of okra leaves per 100 g edible portion is: water 81.50 g, energy 235.00 kJ (56.00 kcal), protein 4.40 g, fat 0.60 g, carbohydrate 11.30 g, fiber 2.10 g, Ca 532.00 mg, P 70.00 mg, Fe 0.70 mg, ascorbic acid 59.00 mg, â-carotene 385.00 ìg, thiamin 0.25 mg, riboflavin 2.80 mg, niacin 0.20 mg (Varmudy, 2011). Better growth and yield of okra depends on nutrient availability in soil, which is a consequence of judicious application of manures and fertilizers. However due to continuous and indiscriminate use of inorganic fertilizers, the natural fertility of soil has been deteriorated and rapidly leads to contamination of soil, water and food and very often associated with reduced crop yield, soil acidity and nutrient imbalance (Obi and Ebo, 1995; Ojeniyi, 2000). Use of organic manures to meet the nutrient requirement of crop would be an inevitable option in the years to come for sustainable agriculture. Organic manures generally improves the soil physical, chemical and biological properties along with conserving the moisture holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop produce. The presence of growth promoting substances like enzymes and hormones, besides plant nutrients make them essential for improvement of soil fertility and productivity (Bhuma, 2001). Thus, there is an increasing awareness throughout the world about the organic sustainable agricultural practice. Farmers are in need for replacement of inorganic fertilizer by organic sources of nutrients. Organic sources may comprise of animal wastes, vermicompost, organic mulches, bio-fertilizer *etc*. Due to changes in food habit, poultry farming is increasing in wider areas thus poultry manure is now become easily available and cheaper throughout the country. Organic mulches are efficient in reduction of nitrates leaching, improve soil physical properties, prevent erosion, supply organic matter, regulate temperature and water retention, improve nitrogen balance, take part in nutrient cycle as well as increase the biological activity of the soil (Hooks and Johnson, 2003; Muhammad *et al*., 2009; Sarolia and Bhardwaj, 2012). In recent year bio-fertilizer has become an important component in integrated nutrient supply system and holds a great promise to improve crop yields through better nutrient supplies. *Azotobacter* and *Azospirillum* are the two most important non symbiotic nitrogen fixing bacteria and considered to be very important for fixation of nitrogen in non leguminous crops. Keeping these in concern the research work was framed to evaluate the growth and yield of okra under different combination of organic sources and nutrients.

Email: shibnathbckv@gmail.com

MATERIALS AND METHODS

Field experiments were conducted in the Instructional farm of UBKV, Pundibari Coochbehar during 1st week of February in 2014-15 and 2015-16. The soil of the experimental field was sandy loam in texture with pH 5.76, available N - 125 kg ha^{-1} (medium), available P- 32 kg ha^{-1} (medium), available K- 73 kg ha^{-1} (high) and organic matter – 0.92 %. There were 16 treatments (Table 1) involving different combination of animal wastes, organic mulches and bio-fertilizer along with no manure combination control. The experiment was conducted in Randomized Block Design and replicated thrice. The nutrient content of the organic manures *viz*., FYM, poultry manure, vermicompost were 0.4, 0.3 and 0.3; 1.0, 0.6 and 0.45; 0.5, 0.25 and 0.5 % N, P and K, respectively. Okra variety Arka Anamika was planted in a 60 x 60cm spacing of plots size 2 × 2.5 m^2. All the organic manures along with bio fertilizer as per the treatments were incorporated into the soil two week before seed sowing of okra. Different growth and yield attributes (Table 2) were recorded from each plot and two years data were analysed using SPSS statistical package and the means were compared between the treatments to identify the superior combinations.

RESULTS AND DISCUSSION

The statistically analyzed data (Table 2) indicated that all the treatments showed significant differences in relation to plant height. The maximum plant height (155.20 cm) was recorded by the treatment T_8 (Poultry manure @14 t ha^{-1} + bio fertilizer + no mulch). The minimum plant height (94.15 cm) was observed in treatment T_9 (FYM @20 t ha^{-1} + bio-fertilizer + wheat bran). Highest plant height by the poultry manure and bio-fertilizer containing treatment (T_8) may be attributed to readily available nutrients and in the best form for easy absorption by the plant roots, that enhanced the morphological growth of the plant (Onwu *et al*., 2014). The result is corroborated with the findings of Ajari *et al*. (2003) in okra where they reported that organic manure especially poultry manure had favorable effect on plant height. Significant differences between treatments were also observed for number of leaves/ plant. The maximum number of leaves (38 $plant^{-1}$) was recorded with T_6 treatment followed by T_9. Significant differences in treatments and maximum number of leaves by poultry manure and bio-fertilizer in presence of mulch material might have enhanced the decomposition and release of essential nutrients leading to more number of leaves in the plant.

The result (Table 3) revealed that all the treatments showed significant differences for number of fruits $plant^{-1}$, fruit length, fruit weight and fruit yield. Number of fruits $plant^{-1}$ was found maximum (21.39 in T_8 (poultry manure (14 t ha^{-1}) + bio-fertilizer + no mulch). The poultry manure and bio fertilizer combination might have enhanced the photosynthetic activity of the plant and resulted in more number of fruits. Abou-Elmagd *et al*. (2006) reported that poultry manure is rich in nitrogen and other plant nutrients and as a result it favours the growth and development of root system which reflects better growth, photosynthetic activity and dry matters accumulation. The maximum fruit length of 18.28 cm was recorded by the treatment (T_8) and the minimum value (13.55 cm) was observed in control treatment (T_{16}). This may be attributed due to application of poultry manures which might have improved the soil properties resulting in readily available of macro and micro nutrients for better growth of okra. The finding is corroborated with the result of Viharnaa *et al*. (2012) in okra. The superiority of poultry manure for crop growth has also been supported by Wijewardena and Yapa (1999). The highest fruit weight of okra was recorded by the treatment T_8 (14.01 g) followed by T_9 (13.66 g). Both these treatments (T_8 and T_9) were consisted of poultry manure along with bio-fertilizer and mulch material. The increase in fresh fruits weight of okra due to poultry manure in presence of bio fertilizer and mulch could be attributed to easy solubilization and release of plant nutrient leading to improve nutrient status and water holding capacity of the soil (Fagwalawa *et al*., 2016). The results obtained were in agreement with the findings of Sanwal *et al*. (2007) in turmeric and Premsekhar and Rajashree (2009) in okra, where they reported that higher yield response of crops due to organic manure application could be attributed to improved physical and biological properties of the soil resulting in better supply of nutrients to the plants. The maximum fruit yield was recorded in T_8 (292.53 g $plant^{-1}$, 7.36 kg $plot^{-1}$ and 14.71 t ha^{-1}, respectively) followed by T_6 (219.88 g $plant^{-1}$, 5.54 kg $plot^{-1}$ and 11.07 t ha^{-1}, respectively). Poultry manure is rich in organic matter and nitrogen as well as several macronutrients like potassium, calcium, magnesium and sodium (Onwu *et al.*, 2014). Gradual release of these essential nutrients helps better vegetative growth, more flowers and fruits and ultimately higher fruit yield. Again *Azotobacter* synthesizes and secretes considerable amount of biologically active substances like vitamin B, nicotinic acid, gibberellins, pantothenic acid, biotin, heteroxins etc. which enhances root growth of plants (Rao, 1986). These may be the reason that the treatment T_8 emerged as best for different growth and yield characters without any mulch materials. Adekunle (2013) also recorded non significant improvement of fruit number and yield in okra when poultry manure was combined with saw dust as mulch material.

Table 1: Treatment details

Treatments	
T_1	Vermicompost (8 t ha^{-1}) + wheat bran
T_2	Vermicompost (8 t ha^{-1}) + wheat straw mulch
T_3	Vermicompost (8 t ha^{-1}) + water hyacinth mulch
T_4	Vermicompost (8 t ha^{-1}) + no mulch
T_5	Poultry manure (14 t ha^{-1}) + bio-fertilizer + wheat bran mulch
T_6	Poultry manure (14 t ha^{-1}) + bio-fertilizer + wheat straw mulch
T_7	Poultry manure (14 t ha^{-1}) + bio-fertilizer + water hyacinth mulch
T_8	Poultry manure (14 t ha^{-1}) + bio-fertilizer + no mulch
T_9	FYM (20 t ha^{-1}) + bio-fertilizer + wheat bran mulch
T_{10}	FYM (20 t ha^{-1}) + bio-fertilizer + wheat straw mulch
T_{11}	FYM (20 t ha^{-1}) + bio-fertilizer + water hyacinth mulch
T_{12}	FYM (20 t ha^{-1}) + bio-fertilizer + no mulch
T_{13}	FYM (20 t ha^{-1}) + wheat bran mulch
T_{14}	FYM (20 t ha^{-1}) + wheat straw mulch
T_{15}	FYM (20 t ha^{-1}) + water hyacinth mulch
T_{16}	FYM (20 t ha^{-1}) + no mulch (control)

Table 2: Different growth and yield attributes of okra as influenced by different treatments (pooled)

Treatment	Plant height (cm)	No. of leaves $plant^{-1}$	No. of fruit $plant^{-1}$	Fruit length (cm)	Fruit wt.(g)	Fruit yield (g $plant^{-1}$)	Fruit yield (kg $plot^{-1}$)	Fruit yield (t ha^{-1})
T_1	99.21	26.50	9.05	14.68	12.35	110.85	2.80	5.61
T_2	104.14	19.23	9.01	13.98	11.61	104.44	2.63	5.25
T_3	121.02	20.51	9.50	16.83	12.45	119.25	3.00	6.00
T_4	116.12	26.43	11.51	14.90	12.89	146.83	3.70	7.40
T_5	99.06	28.26	9.52	14.50	11.67	110.20	2.77	5.54
T_6	118.13	38.15	18.48	17.40	11.84	219.88	5.54	11.07
T_7	131.07	21.39	9.03	15.55	13.27	120.17	3.03	6.06
T_8	155.20	25.33	21.39	18.28	14.01	292.53	7.36	14.71
T_9	94.15	21.29	6.24	15.33	13.66	81.96	2.06	4.12
T_{10}	113.03	27.46	6.42	13.78	12.28	73.96	1.86	3.73
T_{11}	126.17	26.19	10.16	17.28	12.17	121.36	3.05	6.10
T_{12}	134.09	24.53	11.53	14.98	11.06	126.27	3.17	6.34
T_{13}	96.22	23.49	5.49	15.88	11.44	98.55	2.48	4.96
T_{14}	116.19	26.22	10.37	16.35	11.25	112.50	2.83	5.65
T_{15}	114.17	29.31	8.29	16.13	12.96	111.27	2.79	5.58
T_{16}	117.22	22.19	8.33	13.55	12.34	98.72	2.48	4.96
SEm (±)	**0.43**	**0.11**	**0.08**	**0.07**	**0.03**	**0.45**	**0.01**	**0.02**
LSD (0.05)	**1.24**	**0.33**	**0.22**	**0.21**	**0.08**	**1.30**	**0.03**	**0.05**

Fagwalawa *et al*. (2016) also reported higher yield of okra with the application of poultry manure compared to other sources of organic manures.

The findings of the present work shown that poultry manure in combination with *Azotobacter* bio-fertilizer can fulfill the nutrient requirement of organically grown okra which is manifested by more number of fruits, greater fruit weight and higher fruit yield, hence this nutrient combination can be recommended for further study for wider cultivation of organic okra at farmer's field level.

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