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EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON THE GROWTH AND YIELD OF OKRA UNDER SUB-TROPICAL REGION

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ABSTRACT

An experiment was conducted at Chatha (Jammu) to find out the effect of organic and inorganic fertilizers on the growth and seed yield of okra under sub-tropical areas during the spring- summer seasons of 2008 and 2009. The experiment was laid out in split plot design with four levels of organic fertilizers (control, Azospirillum, farmyard manure and vermicompost) and five levels of inorganic fertilizers (0, 25, 50, 75 and 100% of RDF). Application of 60: 30: 30 kg NPK ha^{-1} significantly increased plant height (55.29 cm), stem diameter (5.71 cm), branches per plant (5.77), average fruit weight (15.55 g), marketable yield per plant (1.73 kg) and seed yield (12.78 q ha^{-1}) except than internodal length as compared to other treatments. Azospirillum inoculation produced significantly higher plant height (54.16 cm), stem diameter (4.83 cm), branches per plant (5.44), fruit weight (14.75 g), marketable yield per plant (1.67 kg) and seed yield (12.46 q ha^{-1}) over control. All the organics proved superior to control in respect of growth, yield attributes yield and net returns.The interaction between organic x inorganic fertilizers had significant beneficial effect on internodal length and yield of okra. Among fertilizer doses, 75 % RD NPK gave maximum net returns (₹ 71441 ha^{-1}) and B:C ratio (2.26) and minimum in control. Inoculation of Azospirillm proved superior to other organics in respect of net return (₹ 69030 ha^{-1}) and B:C ratio (2.25).

Kewords: FYM, vermicompost, biofertilizer, *Azospirillum*, seed yield, okra.

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench), 2n = 2x = 130) commonly known as Bhindi or Lady's finger belongs to family Malvaceae. It is a fast growing annual vegetable crop grown in tropical and sub-tropical regions of the world. In India, okra occupies an area of about 3,70, 000 ha with production of 3550 million tones and productivity of 95.94 q/ha. In Jammu and Kashmir, okra occupies a prominent position among vegetables and its commercial cultivation is limited to Jammu division, where it is grown during summer and rainy seasons covering an area of 2680 ha with an annual production of 43147 metric tones. Okra is an important fruit vegetable of high commercial and food values. It is primarily valued for its tender, immature green pods in fresh form; however its curry, soups, stews and edible young leaves are also popular. To a limited extent it finds use in canned, dehydrated or frozen forms for off-season consumption by the army at high altitudes and export. High iodine content of fruit helps to control goiter, while leaves used in inflammation and dysentery. The fruits also help in cases of renal colic, leucorrhoea and general weakness.Increasing energy crises, rapid depletion of non-renewable sources like naptha and natural gas and release of pollutants during fertilizers production has necessitated the development of alternate or supplemental technologies to reduce the use of chemical fertilizers. Biofertilizer increases soil fertility and crop yield by rendering unavailable sources of elemental nitrogen bound phosphate and decomposed plant reside into available form in order to facilitate the plant to absorb the nutrients of these bio fertilizers. Therefore, the present investigation was initiated to evaluate the effect of organic and inorganic fertilizers on the growth and seed yield of okra under sub-tropical areas of Jammu.

MATERIALS AND METHODS

The present investigation was conducted during summer season of 2008 and 2009 at Vegetable Research Farm, Division of Vegetable Science and Floriculture, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Main Campus Chatha. Chatha (Jammu) situated at 33^{O}-55′N latitude and 74^{O}-58′ East longitude with altitude of 332 meters above mean sea level. The climate of Chatha is subtropical with hot dry summer, hot humid rainy and cold winter months. The experiment was laid out in split plot design with four levels of organic fertilizers (control and *Azospirillum*, farmyard manure (FYM) and vermicompost) and five levels of inorganic fertilizers (0, 25, 50, 75 and 100% of RDF, 60:30:30:: N: P: K) having three replications with spacing 45 x 30 cm, plot size 4.05 x 2.70 m.

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The source of N, P and K were urea, diammonium phosphate and muriate of potash respectively. The soil was inoculated with *Azospirillum* @2 kg ha^{-1} mixing with 40 kg FYM ha^{-1}. *To maintain uniformity* in the quantity of FYM the control plots were also supplied with 40 kg FYM ha^{-1}. *The FYM 25 tones ha^{-1} and vermicompost 6 tones ha^{-1}*. The observations on plant height, stem diameter, internodal length, branches per plant, fruit weight, marketable yield and seed yield were recorded at maturity.

RESULTS AND DISCUSSION

Growth parameters

A significant linear increase in plant height was noticed with the increase in inorganic fertilizers and maximum value (55.29cm) was recorded with 100 % RDF while the minimum in control. The increase in plant height may be due to the fact that application of NPK showed synergetic effect by accelerating the synthesis of chlorophyll and amino acids which are associated with major plant processes (Dar *et al.* 2010). Azospirillum inoculation produced taller plants (54.16 cm) over control which might be due to the reason that biofertilizers are known to synthesis the growth promoting substances besides N-fixation which results in luxurious growth of plants (Dar *et al.* 2010). The maximum stem diameter (5.71cm) was recorded with 100 % NPK application which may be due to better utilization of NPK by the plants, resulting in better growths. The results are in accordance with the findings of Singh and Mohan (2007) in pointed gourd and Sharma *et al.* (2010) in okra. The maximum stem diameter was recorded with *Azotobactor* (4.83cm) and the minimum (4.03cm) in control (Table 1).

Table 1: Effect of organic and inorganic fertilizers on growth and yield attributes and yield of okra (Pooled data for 2 years)

Treatments	Plant height (cm)	Stem diameter (cm)	Internodal length (cm)	branches per plant	Fruit weight (g)	Marketable yield per plant (kg)	Seed yield q/ha
NPK Fertilizers							
Control	51.32	3.99	6.35	3.45	10.43	1.27	10.15
25% RD	52.40	4.14	6.10	4.34	12.05	1.53	11.44
50% RD	53.51	4.19	5.50	5.48	13.80	1.68	11.90
75% RD	53.87	4.44	5.14	5.53	14.78	1.69	12.48
100 % RD	55.29	5.71	4.24	5.77	15.55	1.73	12.78
C.D.(p=0.05)	1.40	0.44	0.40	0.93	1.33	0.09	0.68
Organic fertilizers							
Control	52.11	4.03	6.35	3.86	10.45	1.43	10.87
Azospirillum	54.16	4.83	4.37	5.44	14.75	1.67	12.46
FYM	53.33	4.27	5.67	4.50	12.50	1.52	11.91
Vermicompost	53.52	4.39	5.46	4.81	12.72	1.61	11.62
C.D.(p=0.05)	0.98	0.24	1.06	0.45	0.71	0.10	0.70

Internodal length

The data in Table 3 showed that inorganic fertilizers were statistically significant for internodal length. The maximum (6.35cm) internodal length was found in control (C_0) and minimum internodal length was recorded with C_4 (4.24cm). The decrease in internodal length might probably be due to the fact that NPK at recommended dose of fertilizers showed better performance than other treatments. Similar, results have been reported by Naidu *et al.* (1999). The soil application of *Azospirillum* significantly reduced the internodal length among organic fertilizers. The best result was with T_2 treatment (4.37cm) over all the organic fertilizers. The interaction between inorganic fertilizers x organic fertilizers was found significant on internodal length and the lowest (3.49cm) internodal length was observed with C_3T_2 treatment combination. Similar, results have been reported by Dar *et al.* (2010). The interactions between inorganic fertilizers x organic fertilizers were also statistically significant. The combination C_3 T_2 (Soil treatment with *Azospirillum* + 75 per cent RDF) gave minimum (3.49cm) internodal length while as the treatment combination C_0 T_1 gave maximum (7.28cm) internodal length. The maximum number of branches per plant (5.77) was recorded in 100% NPK treatment, whereas minimum (3.45) in control which may be due to sufficient and readily availability of N, P and K fertilizers during crop growth. These results are in close conformity with the findings of Naidu *et al.* (1999). The soil application of organic fertilizers significantly increased the number of branches per plant than control treatment. The soil application of *Azospirillum*, recorded the maximum number of branches per plant (5.44) which might be due to the role of *Azospirillum* in nitrogen fixation as well as producing plant growth hormones. The increase in activity of plant growth substances like GA and IAA might be responsible for increase in number of branches per plant (Ray *et al.* 2010, Narayanamma *et al.* 2010).

Table 2: Interaction effect of fertilizers and manures on yield of okra (Pooled data for 2 years)

Chemical fertilizers	**Organic fertilizers**			
	Control	***Azospirillum***	**FYM**	**Vermicompost**
Control	9.62	10.38	10.44	10.54
25 %	10.77	12.10	11.44	11.12
50 %	10.78	12.95	11.97	11.43
75 %	11.13	13.68	12.62	12.27
100 %	12.03	13.21	13.09	12.74
C.D.(p=0.05)	0.46	0.45	0.56	0.49

Yield

Linear increase in fruit weight was observed as the inorganic fertilizers increased from 0 to 100 % of RDF and highest fruit weight (15.55g) was recorded with 100 % RDF. The enhancement in fruit weight may be due to synthesis of more photosynthates due to larger leaf area. The results are in conformity with Singh *et al.* (2005) in okra and Rahul and Singh (2010) in cucumber. The higher fruit weight was recorded with *Azospirillum* treatment (14.75g). The produced hormones increase cell division and elongation which led to better growth of plants. The increased root growth of plants helped in increasing assimilation of nutrients thereby producing more fruit weight. The marketable yield per plant was significantly influenced by the inorganic fertilizer levels and the maximum value (1.73 kg) was recorded with 100 % and minimum (1.27kg) in control. These nutrients play an important role in root development which leads to increased branching, leaves, stem diameter, plant spread, height, number of flowers and fruit set. Cumulative effect of yield contributing characters was reflected on marketable yield (Singh *et al.* 2005; Kour *et al.* 2006). *Azotobacter* showed a significant role in increasing the marketable yield per plant (1.67kg) which might be due to better translocation of food material from roots to the shoots, rapid elongation and multiplication of cells as fixed atmospheric nitrogen concentration was increased in cell sap in the form of proteins, amides and amino acids in growth region of merismatic tissues. The results are in conformity with the findings of Rahul *et al.* (2010) in cucumber and Dhawale *et al.*(2011). The maximum yield per plant (1.86 kg) was recorded in 75% RDF x *Azospirillum* combination.. This might be due to more balanced C: N ratio, more supply of nutrients from the soil, faster enhancement of reserve food material to the buds (Dar *et al.*2010, Dhawale *et al.* 2011).

Table 3: Effect of organic and inorganic fertilizers on economics of seed yield of okra (Pooled data for 2 years)

Treatments	**Cost of cultivation (`₹. ha^{-1})**	**Gross return (`₹. ha^{-1})**	**Net return (₹.ha^{-1})**	**B:C ratio**
Fertility levels				
Control	30460	81962.5	51502.5	1.69
25% RD	30853	90861.6	60008.6	1.94
50% RD	31246	94238.3	62992.3	2.02
75% RD	31639	103080.0	71441.0	2.26
100% RD	32032	98460.8	66428.8	2.07
Organics				
Control	32605	95286.6	62681.6	1.92
Azospirillum	30670	99700.6	69030.6	2.25
FYM	32605	92962.6	60702.6	1.88
Vermicompost	31460	86932.6	55472.6	1.76

Inorganic fertilizers had significant effect on seed yield and maximum value was recorded in 100% NPK treatment (12.78 q ha^{-1}) which was at par with 75% NPK (12.48 q ha^{-1}). Minimum seed yield was obtained in control. The increase in yield may be due to promotion of vegetative growth thereby resulting in more yields. Phosphorus and K help in better growth, maturity, quality of the seed and ultimately seed yield. These nutrients have a good effect on yield contributing traits obtaining higher seed yield.

This finding has the support of Dalal and Nandkar (2010). Application of organic fertilizers had significant effect on the seed yield of okra. The Azospirillum inoculation produced the highest seed yield (12.46 q ha^{-1}) whichwas at par with FYM (11.91q ha^{-1}). The increase in seed yield might be due to higher vegetative growth which accumulated more photosynthates in the plants and these resulted into seed yield contributing traits. This finding is in line with Dalal and Nandkar (2010). Interaction effect of inorganic fertilizers x organic fertilizers was found significant for seed yield (Table 2). The data showed maximum seed yield (13.68 q ha^{-1}) with 75% NPK+ Azospirillum. This increase in seed yield might be due to improved physical structure, soil fertility and soil microbial properties that ultimately produced higher yield. This finding is in accordance with the findings of Dalal and Nandkar (2010) and Chattopadhyay *et al.* (2011).

Economics

Among the treatment, 75 % NPK resulted in higher gross returns of ₹. 1,03,080 ha^{-1} net returns ₹. 71,441 ha^{-1} and cost: benefit ratio (2.26) and minimum gross returns, net return and cost : benefit ratio in control. Among organics soil application of *Azospirillum* gave higher gross returns of `.99700.6, net returns ₹. 69030.6 ha^{-1} and cost: benefit ratio (2.25). The fertility levels and organic fertilizers when applied individually or in combination gave significantly highest net returns as well as B: C ratio. Both these treatments gave highest B: C ratio. Similar findings have been reported by Sharma *et al.* (2010).

On the basis of results it may be concluded that the 100 % RDF significantly influenced the growth and yield of okra. The results clearly show that the inoculation with *Azospirillum* performed better with respect to growth attributes and seed yield of okra.

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