Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.11, 2015

Effect of Organic and Inorganic Fertilizers on Brinjal Cultivars under the Agro-Climatic Conditions of Mansehra

Adil Rehman Muhammad Shahid Ahmad Abbas Malik Shireen Khan Zakaria
Agricultural Research Station, Baffa, Mansehra Khyber Pakhtunkhwa Pakistan
PO BOX # 2110, Baffa, Mansehra, Pakistan
Email: adil_swati93@yahoo.com

Abstract
The effect of organic and inorganic fertilizers on Brinjal cultivars under the agro-climatic conditions of Mansehra was studied at Agricultural Research Station Baffa Mansehra, during crop season 2011. The experiment was laid out in Randomized Complete Block Design (RCBD) with two factors having split plot arrangement. There were three treatments which includes control (No fertilizer), inorganic regime (NPK @ 100:50:50 kg ha^{-1}) and organic regime (Farm yard manure + Poultry manure + Mashroom waste @ 25 t ha^{-1}, 5 t ha^{-1} and 10 t ha^{-1} respectively) were assigned to main plot. Four brinjal cultivars i.e. Pusa Long, Long Black, Black Beauty and Purple Long were used as sub plot factors. Both the growing regimes and cultivars significantly affected all the growth and yield parameters except the survival percentage of seedlings. Among the growing regimes the organic fertilizer significantly influenced most of growth and yield components of brinjal. However, minimum days to flowering (33.6), fruit set (46.6), fruit harvest (57.3) and the maximum fruit length (21.2 cm) and fruit diameter (7.0 cm) were recorded in plants grown under organic fertilizers. The brinjal cultivars also significantly influenced most of the parameters. The cultivar Pusa Long significantly resulted in the maximum plant height (82.9 cm) and also took less number of days to flowering (37.8). While the maximum fruit length (20.8 cm), less number of days to fruit set (48.1) and days to harvest (58.6) were recorded for cultivar Purple Long. Regarding to interaction of growing regimes and cultivars, the organic regime and cultivar Pusa Long showed the best performance for most of the growth and yield characteristics of brinjal. It is concluded from the present findings that brinjal cultivar Pusa Long should be cultivated under organic regime to obtain the higher yield and maximum profitability at Mansehra, Abbottabad- Pakistan.
Keywords: Brinjal, variety, organic, inorganic, fruit diameter.

I. INTRODUCTION

Brinjal or egg plant (*Solanum melongena* L.), a member of Solanacea family, is one of the most common vegetable crops grown in Pakistan. Brinjal is a staple vegetable. Its nutritive value varies among varieties. It contains vitamin A and B. It has been under cultivation in the sub-continent since ancient times and is available in the market year-around in these days (Malik, 1994). Brinjal as a summer vegetable is grown over 8.67 thousand hectares area in Pakistan with the annual production of 91.26 thousand tons ha^{-1} (MINFA, 2007).
Nitrogen is an essential part of proteins and nucleic acids, as well as of the chlorophyll molecule (Taiz and Zeiger, 2004). The absence of N in nutrient solution negatively affects stem and new leaves growth in brinjal (Haag and Homa, 1981). Phosphorus deficiency reduces productivity, as it induces flower abscission (Ribeiro *et al*., 1998). Phosphorus plays an important role in energy transfer in cells, respiration, and photosynthesis, besides being a structural component of nucleic acids, as well as of several coenzymes, phosphoproteins, and phospholipids (Grant *et al*., 2001).

Organic nutrition, although used for thousands of years in agricultural soils, has only recently been on the spot due to its positive effects over physical, chemical, and biological soil properties (Santos *et al*., 2001). The remarkable potential growth of organic production worldwide has also contributed to this momentum. Among the organic manures used in vegetable production, livestock manures stand out due to their positive effects on soil conditioning and nutrient availability, especially N (Almeida, 1991). The amount of livestock manure recommended for growing brinjal varies usually from 5 to 40 t ha^{-1} (Ribeiro *et al*., 1998 and Reis *et al*., 2007).

FYM consist of partially rotted straw of plants, urine and feaces. It improves soil physical properties such as water holding capacity, erosion stability and gas exchange (Nyangani, 2010). Due to the high costs of commercial fertilizers the importance of farm yard manure as organic fertilizer is being realized. FYM not only supplies a lot of macro and micro nutrients to the soil, but also improve the soil physical, chemical and biological properties. Conventional FYM contains about 0.73% N, 0.18% P and 0.71% K (Tolessa and Friesen, 2001). In Pakistan, farm yard manure is the most important organic manure. It is estimated that about 1.5 million tones of nutrients are available from farmyard manure (Bari, 2003).

The latest estimates showed a population of about 290 million of poultry birds. The droppings of poultry birds contains high amount of essential nutrients and it can provide about 101 thousand tones of nitrogen, 58 thousand tones of P_20_5 and 26 thousand tones of K_20 (Bari, 2003). The efficiency of cultivars, in regards to

nutrients (NPK) uptake in the form of organic and inorganic fertilizers, varies with respect to location. Hence before the recommendation of a variety for commercial cultivation and for organic farming, determination of nutrients (NPK) requirements of the varieties for particular agro-ecological zone is of prime importance. Thus a study was under taken to monitor the effect of organic and inorganic fertilizers on the performance of different brinjal cultivars with the following objectives.

- To observe the brinjal production under organic and inorganic regimes.
- To select the best performing cultivar for both the organic and inorganic regimes under the agro-climatic conditions of Mansehra.

II. METHOD AND MATERIAL

To study the ‘‘Effect of organic and inorganic fertilizers on Brinjal cultivars under the agro-climatic conditions of Mansehra” an experiment was conducted at Agricultural Research Station Baffa Mansehra during crop season 2011.

II.I Experimental Design

The experiment was laid out in Randomized Complete Block Design (RCBD) with two factors. The experiment was carried out in split plot arrangement with growing regimes (fertilizers) as main plot factor and brinjal cultivars as sub plot factor. There were 3 main plots and 4 sub plots having 3 rows of each cultivar per treatment. The length of each row was 5 m long. The area of each sub plot was 9 m^2. The plant to plant and row to row distance was kept at 60 cm. The experiment consists of the following two main factors.

II.III Factor A (Fertilizers)

The inorganic fertilizers (NPK) were applied at the rate 100:50:50 kg ha^{-1} and the organic fertilizers at the rate of FYM 25 t ha^{-1}, Poultry Manure at the rate of 5 t $ha^{-1}$and spent mushroom compost at the rate of 10 t ha^{-1} were mixed together and then applied.

II.IV Factor B (Cultivars)

The experiment consists of four different brinjal cultivars i.e. Pusa Long, Long Black, Black Beauty and Purple Long.

II.V Soil Analysis

Before fertilizers application soil samples up to 25 cm depth were taken randomly from five different parts of the field and analyzed for Physico-chemical properties of soil. After the harvest of the crop the soil samples up to 25 cm were taken from each treatment in each replication and analyzed for Physico-chemical properties of soil and then their average was calculated. The soil analysis was done in the Soil Science Laboratory at Agricultural Research Station Baffa Mansehra for chemical characters.

Table A. Physico-chemical Analysis of Experimental Soil at depth 25 cm

Before sowing		After harvest		
Determination	**Quantity**	**Control**	**Inorganic**	**Organic**
Nitrogen (%)	0.042	0.031	0.048	0.060
Phosphorus (mg kg^{-1})	9.00	6.00	11.67	13.33
Potassium (mg kg^{-1})	110	90	120	130
Organic matter (%)	0.83	0.61	0.96	1.20
pH	7.3	7.2	7.1	6.9
Textural class	Clay Loam	Clay loam	Clay loam	Clay loam

Table B. Chemical Analysis of FYM, Poultry Manure and Mushroom Compost

Determination	FYM	PM	M C
Nitrogen (%)	0.73	2.14	0.7
Phosphorus (%)	0.18	1.09	0.3
Potassium (%)	0.71	1.23	0.3

II.VI Nursery Raising

Seeds of four cultivars were collected from local Market of Peshawar. Raised bed for nursery raising of each cultivar was prepared in the green house. The seedbeds were irrigated through sprinklers and when soil came in field condition, lines were drawn in the direction of North and South. Line to line distance was 5 cm. These beds were irrigated weekly, hoeing and weeding were done according to the requirement. After one month the seedlings were ready to transplant.

II.VII Land Preparation
The experimental plot was ploughed thoroughly before sowing and divided into main plots and then to subplots. Ridges of uniform size were made for sowing.

II.VIII Transplantation
Raised beds measuring 5 meters long were prepared. The seedlings of 1 month age of each cultivar were transplanted on these raised beds. During the growing season of the crop, normal cultural practices of the area were followed.
The following different growth and yield parameters were studied during the course of the experiment.

III. RESULTS AND DISCUSSION
The research project on the "Effect of organic and inorganic fertilizers on Brinjal cultivars under agro-climatic conditions of Mansehra" was carried out at Agricultural Research Station Baffa Mansehra during crop season 2011. Data collected on different growth, development and yield parameters were analyzed statistically. The results of the study are presented in the following order.

III.I Days to Flowering
Mean value for number of days taken to flowering of brinjal cultivars showed that the maximum days taken to flowering (41.1) were recorded for cultivar Black Beauty, which is non significantly different from cultivar Long Black took (40.7) days to flowering. Cultivar Pusa Long and Purple Long were at par with each other took the least days to flowering i.e. 37.8 and 38.8 respectively. Mean values for the effect of growing regimes showed that the more days to flowering (44.1) were noted in control treatment. Whereas, the plants growing under organic regime took minimum days to flowering (36.3 days) which was at par with the plants grown under inorganic regime, took 38.4 days to flowering. The interaction between growing regimes and cultivars showed that highest number of days to flowering (46.3) was found in control treatment for cultivar Black Beauty. While less days to flowering (34.0) was noted in organic regime for cultivar Pusa Long. The early flowering in cultivar Pusa Long might be due to genetic variations, which play an important role in flowering. The induction of early flowering in organic regime by all cultivars may be due to the better nutritional status of plants, which increased the production of photosynthates (carbohydrates) needed for flower induction (Sharma, 1995). The present results are in line with the findings of Ambre and Comadug (2010) who found that early flowering in organic fertilizer treatment were observed in egg plant, also similar to those of Sutagundi (2000) in chilii and as well to Khan (2004) in okra.

III.II Days to fruit set
According to the mean values of table regarding days to fruit set for different cultivars, more number of days taken to fruit set (52.4) was observed in cultivar Long Black, closely followed by (51.8) for cultivar Black Beauty. While the cultivars Purple Long and Pusa Long were at par with each other took less number of days to fruit set i.e. 48.1 and 48.8 days respectively. Observing the mean values for the effect of growing regimes indicated that the more number of days to fruit set (55.3) was observed in control treatment. While plants growing under organic regime showed the minimum number of days to fruit set (46.6) but had a non significant difference with plants grown under inorganic regime which took 48.9 days to fruit set. The interaction between growing regimes and cultivars stated that more number of days taken to fruit set (57.3) was recorded in control treatment for cultivar Long Black. While the minimum days to fruit set (43.7) was noted in organic regime for cultivar Pusa Long, closely followed by (45.3) for cultivar Purple Long. The earliest fruit set in cultivar Purple Long could be due to fact that it utilizes the existing resources efficiently due to its compatibility with local environment. The reduction of the days to fruit set in organic regime by all cultivars might be due to the presence of increased microbial activity which improves the availability of soil phosphorus and nitrogen, ultimately enhanced the uptake of nitrogen in plant leading to increase chlorophyll content and carbohydrate synthesis which faster the process of fruit development (Shashidhara, 2000). The present conclusions are in resemblance with the findings of Sutagundi (2000) who stated that the chilli plants gave earliest fruit set under organic regime.

III.III Days to harvest
According to the mean values of days to harvest for different cultivars, the maximum days taken to harvest (64.6) was recorded in cultivar Black Beauty, while the cultivar Purple Long had taken least days to harvest i.e. 58.6 days. A non significant variation was recorded for cultivar Pusa Long and Long Black, took 62.2 and 62.9 days respectively. The mean values for the effect of growing regimes showed that the maximum days to harvest (66.9) was noted in control treatment. Whereas, the plants grown under organic regime took the least days to harvest i.e. 57.3 as compared to plants grown under inorganic regime (61.9). The interaction between the growing regimes and cultivars revealed that more number of days to harvest (70.7) was found in control treatment for cultivar

Black Beauty. Whereas, the less number of days taken to harvest (54.7) recorded in organic regime for cultivar Pusa Long, closely followed by (55.7) by Purple Long. The earliest harvest of cultivar Purple Long might be due to its rapid growth habits and its compatibility with locality. The least number of days to fruit harvest in organic regime by all cultivars could be due to the fact that the application of organic fertilizer (FYM) contains appreciable quantities of magnesium, helped in chlorophyll synthesis which increased the rate of photosynthesis. This in return increase the process of fruit development and minimize the days taken to ready the fruit for harvest (Jeevansab, 2000). The present findings are in line with Goo *et al*., (2000) and Gu and Theresa (2008) who found that the egg plant took least days to harvest grown under organic regimes and similarly by Khan (2004) obtained in okra.

III.IV Fruit length (cm)

Mean values regarding the fruit length for different cultivars showed that the highest fruit length (20.8 cm) was noted in cultivar Purple Long, closely followed by cultivar Pusa Long (18.9 cm) which was at par with the fruit length (18.4 cm) of cultivar Long Black. While the cultivar Black Beauty produced the fruit having the minimum length of 16.6 cm. The mean values of Table 5 indicated that the growing regimes significantly influenced the fruit length of brinjal cultivars. However, the highest fruit length (21.2 cm) was noted in plants grown under organic regime. While the plants grown in the control treatment produced fruit having the minimum fruit length (16.3 cm) but it was at par with the plants grown under the inorganic regime, produced 18.5 cm long fruit. The interaction between growing regimes and cultivars revealed that maximum fruit length (24.1 cm) was found in plants grown under organic regime for cultivar Purple Long. Whereas, the minimum fruit length (15.4 cm) noted in control treatment for cultivar Black Beauty. The reason of the maximum fruit length of the cultivar Purple Long might be due to its genetic potential, vigorous growth and fruit habit of the cultivar. The increase in the fruit length in organic regime by all cultivars might be due to the fact that the organic fertilizers provide the available nutrients (macro and micro) which increased the production of leaves, ultimately increased the process of photosynthesis, higher amount of carbohydrates were produced and translocated from source (leaves) to sink (reproductive parts) resulted in increase in fruit length (Jeevansab, 2000). The findings are in line with Ambre and Comadug (2010), Gu and Theresa (2008) who found that the length of brinjal fruits were increased when grown under organic growing condition. Similar results were also given by Nirmala and Vadivel (1999) in cucumber and Khan (2004) in okra.

III.V Fruit diameter (cm)

A significant variation was recorded for fruit diameter of brinjal cultivars. The mean values of fruit diameter for different cultivars showed that the maximum fruit diameter (6.6 cm) was recorded in cultivar Long Black, closely followed by (6.4 cm) in cultivar Black Beauty. Whereas, a non significant variation was recorded for fruit diameter of cultivars Purple Long (5.6 cm) and Pusa Long (5.6 cm), producing the fruit having minimum diameter which was at par with each other. The mean values for growing regimes revealed that the maximum fruit diameter (7.0 cm) was recorded in plants grown under organic regime condition, which significantly varied from the rest of treatments. While the minimum fruit diameter (5.1 cm) was recorded in control treatment. The reason for producing fruits of maximum diameter by cultivar Long Black could be the genetic makeup and the fruit habit of the cultivar. The increased fruit diameter in organic regime by all cultivars might be due to fact that the organic fertilizers improved the available nutrient status of soil which resulted in vigorous plants and also increased the leaves production. More food production and vigorous growth of plant resulted in an increase in fruit diameter (Shashidhara, 2000). The present conclusions are similar to that of Nirmala and Vadivel (1999) who reported that organic regimes increased the fruit diameter in cucumber. Similar results were also obtained by Khan, 2004 in okra.

Table 1. Number of days to flowering of brinjal cultivars as affected by organic and inorganic regimes.

	Growing regimes			
Cultivars	**Control**	**Inorganic regime**	**Organic regime**	**Mean**
Pusa Long	42.3	37.3	34.0	37.8 B
Long Black	42.3	40.3	39.3	40.7 A
Black Beauty	46.3	39.3	37.7	41.1 A
Purple Long	45.3	36.7	34.3	38.8 B
Mean	44.1 A	38.4 B	36.3 B	

LSD value for growing regimes at alpha level 0.01 = 3.153, LSD value for cultivars at alpha level 0.01 = 1.805 and LSD value for interaction at alpha level 0.05 = 3.205

Table 2. Number of days to fruit set for brinjal cultivars as affected by organic and inorganic regimes.

	Growing regimes			
Cultivars	**Control**	**Inorganic regime**	**Organic regime**	**Mean**
Pusa Long	54.3	48.3	43.7	48.8 B
Long Black	57.3	50.3	49.7	52.4 A
Black Beauty	56.3	51.3	47.7	51.8 A
Purple Long	53.3	45.7	45.3	48.1 B
Mean	55.3 A	48.9 B	46.6 B	

LSD value for growing regimes at alpha level 0.01 = 3.604, LSD value for cultivars at alpha level 0.01 = 1.179 and LSD value for interaction at alpha level 0.05 = 2.042

Table 3. Number of days to harvest of brinjal cultivars as affected by organic and inorganic regimes.

	Growing regimes			
Cultivars	**Control**	**Inorganic regime**	**Organic regime**	**Mean**
Pusa Long	66.7	65.3	54.7	62.2 B
Long Black	67.0	61.3	60.3	62.9 B
Black Beauty	70.7	64.3	58.7	64.6 A
Purple Long	63.3	56.7	55.7	58.6 C
Mean	66.9 A	61.9 B	57.3 C	

LSD value for growing regimes at alpha level 0.01 = 3.049, LSD value for cultivars at alpha level 0.01 = 1.519 and LSD value for interaction at alpha level 0.01 = 2.631

Table 4. Fruit length (cm) of brinjal cultivars as affected by organic and inorganic regimes.

	Growing regimes			
Cultivars	**Control**	**Inorganic regime**	**Organic regime**	**Mean**
Pusa Long	16.2	18.0	22.5	18.9 B
Long Black	16.4	18.8	20.1	18.4 B
Black Beauty	15.4	16.3	18.1	16.6 C
Purple Long	17.3	20.9	24.1	20.8 A
Mean	16.3 B	18.5 B	21.2 A	

LSD value for growing regimes at alpha level 0.01 = 2.438, LSD value for cultivars at alpha level 0.01 = 1.125 and LSD value for interaction at alpha level 0.05 = 1.948

Table 5. Fruit diameter (cm) of brinjal cultivars as affected by organic and inorganic regimes.

	Growing regimes			
Cultivars	**Control**	**Inorganic regime**	**Organic regime**	**Mean**
Pusa Long	4.8	5.6	6.5	5.6 B
Long Black	5.5	6.7	7.6	6.6 A
Black Beauty	5.5	6.4	7.2	6.4 A
Purple Long	4.5	5.7	6.5	5.6 B
Mean	5.1 C	6.1 B	7.0 A	

LSD value for growing regimes at alpha level 0.01 = 0.7337 and LSD value for cultivars at alpha level 0.01 = 0.3179

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