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Integration effect of NPK with vermicompost & boron on yield and economics of brinjal (*Solanum melongena* L.)

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Abstract
An experiment was conducted to the study of "Integration effect of NPK with Vermicompost and Boron on Yield and Economics of Brinjal *(Solanum melongena* L.)" during *Kharif* season 2017 at Horticulture Farm, S.K.N. College of Agriculture, Jobner (Jaipur). The experiment consisted of 18 treatments *viz.*, INM levels (control, 100% NPK, 75% NPK + 25% vermicompost, 50% NPK + 50% vermicompost, 25% NPK + 75% vermicompost and 100% vermicompost) and boron levels (control, 100 ppm and 200 ppm). The total 18 treatment combinations were tested in randomized block design (RBD) with three replications. The application of 50% NPK + 50% vermicompost increased fruit girth (14.75cm), number of fruit plant^{-1} (11.06), fruit yield plant^{-1} (0.91kg), as compared to control but statistically at par with 25% NPK + 75% vermicompost. The application of boron (200 ppm) significantly increased fruit girth (14.33 cm), number of fruit plant^{-1} (10.99), fruit yield plant^{-1} (0.89kg), as compared to control and boron (100 ppm). The application of 50% NPK + 50% vermicompost or boron (200 ppm) gave maximum net return of 246634 Rs. ha^{-1} and 246660 Rs. ha^{-1} respectively but significantly higher B: C ratio observed under treatment N_1(100% NPK) or boron (200 ppm) 3.16 and 3.07 respectively.

Keywords: NPK, boron, vermicompost, brinjal, yield and economics

Introduction
The brinjal is cultivated as one of the leading and the second major vegetable crop next to tomato. It is also known as eggplant or aubergine. Brinjal or Guinea squash is one of the non-tuberous species of the family Solananceae (Kantharajah and Golegaonkar), 2004 [12]. The green leaves of plant are the main resource of the supply of anti-ascorbic acid (vitamin- C). It is used in Ayurveda as appetizer, fruit exhibits laxative property and provides relief from inflammation. The unripe fruit of brinjal primarily used as cooked vegetable for the preparation of various dishes. It has got much potential as raw material in pickle making and dehydration industry. The white brinjal is said to be good for diabetic patients. It can also cure toothache and liver complains (Chouhan, 1981) [5]. Brinjal is also used for the treatment of bronchitis, asthma, dysentery, *etc*. it is also helpful for decreasing the level of blood cholesterol. Brinjal is low in energy (30 kcal/100g), protein (1.4%) and vitamin C (5 mg/100g), but is a very good source of dietary fiber, potassium, calcium, manganese, copper and vitamin A and B also possess antioxidant ability (Anonymous, 2012). The foremost challenge to the existence of mankind has always been to produce adequate quantity of food from the available acreage to meet the requirements of ever expending world population. It can be grown in wide range of agro-climatic zones, which provides a tremendous scope and potential for cultivation of this crop. However, low productivity of this crop has created the necessity developing high yielding varieties with improved technique, which may fulfill the needs of the growers and enhance the productivity**.**

The combination of organic and inorganic sources of nutrient in a specific crop and cropping system to achieve the more yield and improve the soils properties. Macro and micro nutrients play an important role in production of vegetable crops. The green revolution in India promoted the unsystematic use of chemical fertilizer and pesticides to obtain a better crop yield. Recent investigations have shown that N and P and K requirement of brinjal are quite high for the most of plant life *i.e.* for fruit growth and development the significant role of nitrogen nutrition in plant production is universally accepted N and K fertilizers are considered to be closely associated having well marked cumulative and individual effects on the quality and production of different vegetable crops. Application of nitrogenous fertilizer promotes more vegetative growth that provided more photosynthetic area which in turn helps in flowering and fruit set. Phosphorus participates in the skeleton of plasma membrane, nucleic acids, many coenzymes, organic molecules and other phosphorylated products, carbohydrates

synthesis and nutrient contents like Ca, Mg, N, K and S (Badiger *et al*., 2006) [2], which are of great importance in the transformation of energy within the plant system, metabolism and also in respiration in plants and it promotes formation of root, healthy roots and formation of lateral fibrous (Parihar and Tripathi, 2003) [17]. Potassium also plays a vital role in crop productivity, vigour and disease resistance to plant, it also regulates water condition within the plant cell and water loss from the plant by maintaining the balance between anabolism and transpiration. Thus, it helps in better utilization of available water which ultimately helps in the formation of protein and chlorophyll and improves the taste and keeping quality of tomato. Potassium activates the fat producing enzymes and enhances the oil content (Mandal and Chatterjee, 1973) [14].

In today's era, the farmers used more doses of chemical fertilizers and pesticides to get a better yield of various field crops. These chemical fertilizers and pesticides decrease soil fertility and caused health problems to the consumers. Due to adverse effects of chemical fertilizers, interest has been stimulated for the use of organic manures. The organic manure could increase the fertility and productivity of the land and produce nutritive and safe food (Ramesh *et al.*, 2005) [20]. Vermicompost means a mixture of worm casting, organic material, humus, living earthworms and their cocoon and other organisms. It use in soil as a result of reduce the soil erosion, deodourification of soil pollutants and to improve soil environment. The advantage of integrated use of inorganic and organic sources generally superior than use of each component separately, (Saravaiya *et al*, 2010) [21]. Boron as micronutrients has great influence on plant growth and development. The essential physiological activities of boron linked to strength of cell wall development, RNA metabolism, sugar transport, hormonal development, respiration, cell division, Indole acetic acid (IAA) metabolism and as a part of the cell membranes, (Marchner, 1995) [15]. Boron is important for carbohydrate metabolism and translocation. It is also responsible for development cell wall and RNA metabolism. Deficiency of boron caused delay in pollen tube development and pollen germination and ultimately it halts flowering and fruit setting, (Halfacre and Barden, 1979) [6]. Further, more macronutrients are quickly absorbed and utilized by the tissues of the plants by the catalyzing effect of micronutrients, (Phillips, 2004). Boron also plays a vital role in flowering and fruit formation, (Nonnecke, 1989) [16]. Several studies have been already conducted on effect of boron on flowering and fruit setting in tomato and potato. Deficiency symptoms of boron will often appear in the form of thickened wilted, or curled leaves, water soaked condition of petioles and stems, and discoloration, cracking or rotting of fruit and roots, (Tisdale *et al*., 1985) [24]. Boron deficiency may cause sterility *i.e* less fruits per plant attributing lower yield, (Islam and Anwar, 1994) [11]. In fertilizer schedule, an inclusion of boron often decides the success and failure of the crops, (Dwivedi *et al.*, 1990) [8].

Materials and Methods

In order to study the **"**Integration effect of NPK with Vermicompost and Boron on Yield and Economics of Brinjal *(Solanum melongena* L.*)*" was conducted at Horticulture farm, Department of Horticulture, S.K.N. College of Agriculture, Jobner (Jaipur) during July to December 2017. The details of the experimental techniques, material used and criteria adopted for the evaluation of treatments during the course of investigation are being presented in this chapter.

The soil of the experimental field was loamy sand in texture, slightly alkaline in reaction, poor in organic carbon, low available nitrogen (135.05 kg ha^{-1}), phosphorus (16.67 kg ha^{-1}) and medium in potassium content (150.83 kg ha^{-1}). Pant Rituraj variety of Brinjal was used in this experiment. Treatments were considered as six levels of INM & Vermicompost, *viz*., N_0= Control, N_1=100 per cent RD of NPK through inorganic fertilizers, N_2=75 per cent RD of NPK through inorganic fertilizers + 25 per cent through Vermicompost, N_3=50 per cent RD of NPK through inorganic fertilizers + 50 per cent through Vermicompost, N_4=25 per cent RD of NPK through inorganic fertilizers + 75 per cent through Vermicompost, N_5=100% RD of NPK through Vermicompost and three levels of Boron *viz*., B_0= Control, B_1= 100 ppm, B_2= 200 ppm. The experiment was laid out in a Randomized Block Design (RBD) with three replications. Thirty days old seedlings were transplanted with the spacing of 60 cm row to row and 45 cm plant to plant on *Kharif*, 2017. The size of the experimental plots was 2.4 m x 2.25 m. Harvesting was done during month of January 2018. Data were collected from five randomly selected plants for each plot and the recoded parameters were Fruit girth (cm), Number of fruit per plant, Fruit yield per plant (kg), Net returns (Rs. ha^{-1}) and B:C ratio.

Results

Fruit girth (cm)

The maximum fruit girth (14.75 cm) was observed under the treatment N_3 (50% NPK + 50% VC), which was statistically at par with application of treatment N_4 (25% NPK + 75% VC). Whereas, minimum fruit girth (11.95 cm) was noticed under control. The increase in fruit girth under the treatment N_3 (50% NPK + 50% VC) was found to be 23.43 per cent over control. The compost produced by earthworms known as vermicompost, is a rich source of macro and micronutrients. It not only supplies a good amount of different nutrient elements but also contains beneficial microbes like nitrogen fixing bacteria, mycorrhizae and growth promoting substances. Boron also had significant effect on fruit girth as compared to control. The maximum fruit girth (14.33 cm) was recorded in treatment B_2 (200 ppm). Whereas, minimum fruit girth (12.58 cm) was observed under B_0 (control). The increase in fruit girth under the treatment B_2 (200 ppm) was found to be 73.30 per cent over control. Yamouchi et al. (1986) [25] reported that boron helps maintain membrane stability. Smit and Combrink (2004) [22] stated that at low level of boron, tomato fruit lacked firmness. Study by Kashem *et al.* (2015) [15] on the effect of cow manure vermicompost and inorganic fertilizers on the vegetative growth and fruits of tomato plant have shown a significant increase in all the parameters studied in the plants supplied with vermicompost rather than inorganic fertilizer. Microorganism help in faster decomposition of organic manures there by increasing the availability of nutrients to the plants.

Number of fruit per plant

Maximum number of fruit per plant (11.06) was observed under the treatment N_3 (50% NPK + 50% VC), which was statistically at par with application of treatment N_4 (25% NPK + 75% VC). Whereas, minimum number of fruit per plant (7.91) was observed under control. The per cent increase in Number of fruit per plant under the treatment N_3 (50% NPK + 50% VC) was found to be 39.82 per cent over control. Vermicompost are characterized by high porosity, aeration, drainage, water-holding capacity and microbial activity.

Significantly increase number of fruit per plant (10.99) was recorded under the treatment B_2 (200 ppm), while minimum number of fruit per plant (8.93) was observed under control. The number of fruit per plant under the treatment B_2 (200 ppm) was recorded 23.06 per cent more over control. Increased yield of brinjal due to application of micronutrients may be attributed to enhanced photosynthetic activity, resulting into the increased production and accumulation of carbohydrate and favorable effect on vegetative growth, flower and fruits which increased more number of fruits per plant besides improvement in the fruit size. Also have been similar results reported by Davis *et al.* in brinjal (2003), Suganiya and Kumuthini in brinjal (2015) [23], Haribhushan *et al.*, in tomato (2016) [10].

Fruit yield per plant (kg)

Fruit yield per plant (0.91 kg/plant) was observed under the treatment N_3 (50% NPK + 50% VC), which was statistically at par with application of N_4 (25% NPK + 75% VC). While, the minimum fruit yield per plant (0.56 kg/plant) was observed under control (N_0). The per cent increase in fruit yield per plant under the treatment N_3 (50% NPK + 50% VC) was found to be 62.50 per cent over control. The application of boron significantly increase fruit yield per plant (0.89 kg/plant) was recorded in treatment B_2 (200 ppm), and minimum (0.65 kg/plant) was observed under control. Application of treatment B_2 (200 ppm) registered an increase of 36.92 percent over control. Dey, (2000) reported that optimum apply dose of boron encouraged the uptake of phosphorus by plant roots and might have promoted more flower clusters formation, as phosphorus directly promotes flowering, Balley, (1999) [3] also obtained similar results. The vegetable cultivated with organic manures recorded fewer pests and disease attack and produced a high yield. Boron also role in enhance the movement of sugar complex from the leaves to the fruit and ultimately increased the fruit yield is according to result given by Pandita *et al.* (1976) [18]; Bose and Tripathi (1996) [4].

Net returns (Rs. ha^{-1})

A critical study of data revealed that 50% NPK + 50% VC (N_3) significantly increased the net returns. Maximum net returns (Rs. 246634 ha^{-1}) was recorded under 50% NPK + 50% VC, while minimum net returns (Rs. 149884 ha^{-1}) was recorded under control. The data revealed that application of boron (200 ppm) significantly increased the net returns. The maximum net returns (Rs. 246660 ha^{-1}) was under B_2 (200 ppm), while minimum (Rs. 154652 ha^{-1}) was recorded under under control.

B:C ratio

Maximum B:C ratio (3.16) was recorded under the treatment 100% NPK (N_1), while it was recorded minimum (1.74) under 100% VC (N_5). However 100% NPK remained statistically at par with application of treatment 50% NPK+50% VC (2.88). Significantly maximum B:C ratio (3.07) was recorded under the treatment B_2 (200 ppm), while minimum B:C ratio (1.94) was recorded under control.

Table 1: Effect of NPK with vermicompost and boron on fruit girth, Number of fruit per plant, Fruit yield per plant (kg), Net returns (Rs/ha) and B:C ratio of brinjal

Treatments	Fruit girth (cm)	Number of fruit per plant	Fruit yield per plant (kg)	Net returns (Rs/ha)	B:C ratio
INM levels					
N_0-Control	11.95	7.91	0.56	149884	2.39
N_1-100% NPK	13.56	10.15	0.78	215775	3.16
N_2-75% NPK + 25% VC	13.63	10.20	0.78	209223	2.72
N_3-50% NPK + 50% VC	14.75	11.06	0.91	246634	2.88
N_4-25% NPK + 75% VC	14.47	10.69	0.85	217917	2.32
N_5-100% VC	13.42	10.06	0.77	178393	1.74
SEm±	0.35	0.22	0.03	8371	0.10
CD (P=0.05)	1.01	0.64	0.10	24059	0.28
Boron levels					
B_0-Control	12.58	8.93	0.65	154652	1.94
B_1-100 ppm	13.98	10.12	0.78	207601	2.59
B_2- 200 ppm	14.33	10.99	0.89	246660	3.07
SEm±	0.25	0.16	0.02	5919	0.07
CD (P=0.05)	0.71	0.45	0.07	17012	0.20
CV (%)	7.71	6.68	13.38	12.4	11.56

Conclusion

On the basis of one year experiment results, it may be concluded that the treatment N_3 (50% NPK + 50% VC) was found better in terms of yield and net returns compared to other treatment. The treatment B_2 (Boron 200 ppm) significantly better in terms of yield and net returns than control (B_0). Thus, application of 50% NPK + 50% VC or Boron 200 ppm to brinjal is recommended. The results are only indicative and require further experimentation to arrive at more consistent and final conclusion. It is clearly established from the above given discussion that boron is an essential nutrient for growth and flowering in brinjal.

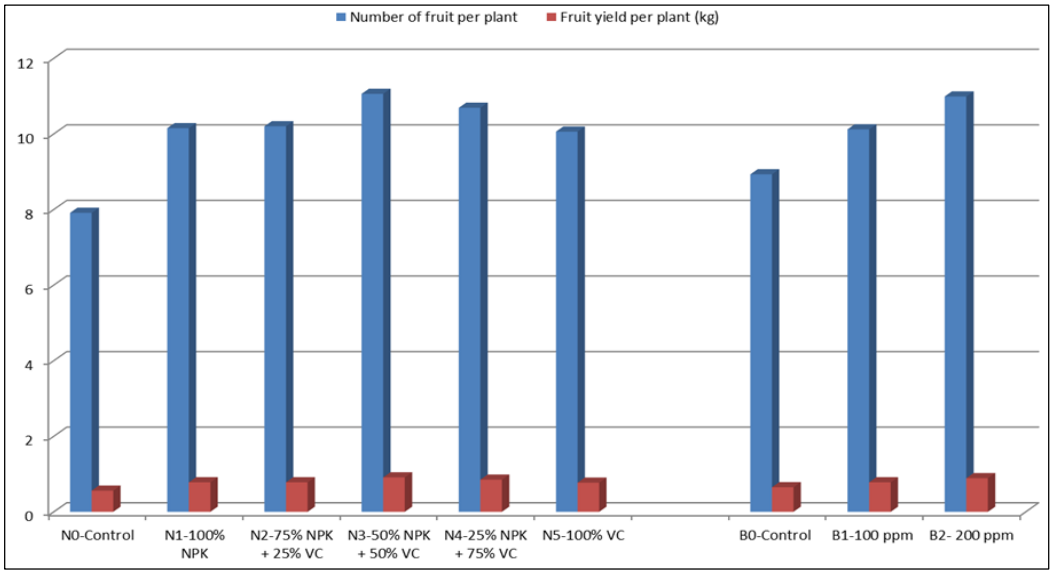

Fig 1: Effect of NPK with vermicompost and boron on number of fruit per plant and fruit yield per plant of brinjal

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