Contemporary Research in India (ISSN 2231-2137): Vol. 7: Issue: 3 September, 2017

INFLUENCE OF DIFFERENT LEVELS OF PHOSPHORUS AND SULPHUR ON YIELD AND BIOCHEMICAL COMPOSITION OF BRINJAL IN LATERITIC SOIL OF KONKAN

Mohan M. G., Sawant Pooja, Sanap P. B. and Sawant A. A.*

Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra, India

Received: 17/07/2017	Edited: 24/07/2017	Accepted: 31/07/2017

Abstract: *A Field experiment was conducted in the department of Soil Science and Agricultural Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli to observe the influence of phosphorus (P) and sulphur (S) on yield and biochemical composition of brinjal during the period from February, 2015 to May, 2015. The experiment was laid out in Factorial Randomized Design with 16 treatments and 3 replications using four (0, 25, 50 and 75 kg P_2O_5 ha^{-1}) levels of phosphorus and four (0, 15, 30 and 45 kg S ha^{-1}) levels of sulphur. Urea, Muriate of potash, and FYM were applied with all the treatments as basal dose. The study revealed that yield and biochemical composition such as total sugars, Anthocyanin content, Ascorbic acid content and Total phenols were significantly influenced by the application of phosphorus and sulphur. The soil application of phosphorus @ 75 kg ha^{-1} and sulphur @ 45 kg ha^{-1} along with the recommended doses of N and K fertilizers to brinjal crop significantly influences the yield and biochemical composition of brinjal fruits and the influence was at par with the soil application of phosphorus @ 50 kg ha^{-1} and sulphur @ 30 kg ha^{-1} along with the recommended doses of N and K fertilizers to the brinjal crop.*

Keywords: *Brinjal, Phosphorus, Sulphur, Yield and Biochemical Composition.*

Introduction

Brinjal (*Solanum melongena* L.) popular as "poor man's vegetable" belongs to family Solanaceae having chromosome number 2n=24. It has been one of the important vegetable crops in human consumption since the prehistoric civilizations. The alkaloid Solanine which has high medicinal value is found in the roots and leaves of brinjal plant. India is the second largest producer of vegetables after China in the world. In India, brinjal is grown over an area of 7,22,000 ha with an annual production of 1,34,44,000 MT and productivity of 18.6 MT/HA. It contributes to 9% of the total vegetable production of the country. In Maharashtra state, the area under brinjal is 26,000ha with a production of 5,78,000MT in the year 2012-13, contributing to 4% of the total country's production. (Anonymous, 2013). Brinjal is grown throughout the year in konkan region as the agro-climatic conditions of the region are ideal for brinjal cultivation. It has occupied prominent place in the rice based cropping system especially during rainy season. Several varieties of brinjal have been released by the scientists with wide variations in their growth habits, shape, sizes, colour, biochemical parameters and taste. The fruits of brinjal contain 92.7% moisture, 1.4g protein, 0.3g fat, 1.3g crude fibre, 4g carbohydrate, 18mg of calcium (Ca), 47 mg of phosphorus (P), 0.9 mg of iron (Fe), 74µg of carotene and 12 mg of vitamin C, per 100g of edible portion (Gopalan *et al.*1987).

Intensive cultivation and growing of exhaustive crops in sequence results in mining of nutrients and deficiency of soil macro and micronutrients. Over-exploitation and unscientific use of soil without regard to long-term sustainability results in deterioration of soil health and jeopardizing the food security (Yadav, 2007). Impaired soil health is one of the important reason for stagnation in crop productivity. The inadequate and imbalanced fertilizer use has caused widespread deficiency of nutrients (N, P, K, S and Zn) and their toxicities leading to deterioration in soil health in many parts of our country. It has been estimated that 63, 42, 13 and 40 per cent of the soils in India are deficient in N, P, K and S, respectively. The deficiencies of micronutrients and secondary nutrients, especially those of Zn, B and Fe are found to increase under intensive cropping systems.

Improvement of soil physical environment along with augmentation of soil fertility has a profound influence on enhancing productivity, which is vital for ensuring prosperity including food, nutrition and livelihood security that will ultimately lead to poverty-alleviation. To meet future challenges of food, feed, sugar, fiber, fruits and vegetable requirements for the fast growing population balanced fertilizer combination is required (Javed, 2010). Generally, Solanaceous vegetables require large quantities of major nutrients like N, P and K in addition to secondary nutrients such as Ca and S for better growth, fruit and seed yield. Among the plant nutrients phosphorus and sulphur have a great influence on the yield and quality of brinjal (Hasan *et al.* 2012).

Phosphorus is the second major essential nutrient element for plant growth next only to nitrogen. Deficiency of P is now considered as one of the major constraints under Alfisols of Konkan because of its higher fixation and very low recovery of applied phosphorus (Reddy *et al.* 1999). The efficient use of P can maximize the yield and minimize the production cost of brinjal. The most obvious effect of P is on the plant root system; it promotes root formation and the formation of lateral fibrous and healthy roots. Phosphorus application resulted in maximum height, highest no. of leaves, maximum no. of fruits, maximum size and weight of brinjal (Tiwari and Agarwal, 2003). On the other hand, P is required for the formation of phosphides, nucleoproteins, nucleic acids, adenosine diphosphates, carbohydrates synthesis etc. Without adequate P application, all these activities could be affected. Phosphorus has significant effects on increasing the growth and yield of vegetable crops (Parihar and Tripathi, 2003).

Hence the present investigation entitled, "Influence of different levels of phosphorus and sulphur on yield, nutrient uptake and biochemical composition of Brinjal (*Solanum melongena* L.)"

Material and Methods

The Field experiment was conducted in the Department of Soil Science and Agricultural Chemistry, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during the period from February, 2015 to May, 2015. The soil of the experimental plot was lateritic. To know the initial soil fertility status of the experimental plot, a representative composite surface soil sample was collected from 0-15 cm depth by following the standard method of soil sample collection. It was then air dried in shade. The stubbles, pebbles and other extraneous materials were removed. The soil sample was converted to fine powder form in a wooden mortar and pestle and sieved through 2 mm sieve and then analyzed for different physico-chemical properties by following the standard analytical methods. The climate of Dapoli, Dist. Ratnagiri is hot and humid with three well defined seasons *viz.*, summer (March to May), rainy (June to October) and winter (November to February). Brinjal (*Solanum melongena* L.), variety Swarna Prathiba was taken as a test crop during the *Rabi* season of the year, 2014 -2015 with a spacing of 60cm x 75cm. The field experiment was laid out in a factorial randomized block design comprising of sixteen treatments with three replications. The gross plot size was 4.5m x 3.6m.

The collected soils from 0-15 cm depth were pulverized and inert materials and plant residues were removed. FYM was applied @15t ha^{-1} to all treatments (including control). Phosphorus levels included P_0 - No phosphorus, P_1 - 25 kg P_2O_5 ha^{-1}, P_2 - 50 kg P_2O_5 ha^{-1}, P_3 - 75 kg P_2O_5 ha^{-1} and Sulphur levels included S_0 - No sulphur, S_1- 15 kg S ha^{-1}, S_2 - 30 kg S ha^{-1} and S_3 - 45 kg S ha^{-1}. Nitrogen @ 150 kg ha^{-1} was applied in three splits *viz.,* first dose was applied at the time of transplanting, second dose at 30 DAT and third dose at 60 DAT. Phosphorus @ 0, 25, 50, 75 kg ha^{-1} was applied in a single dose at the time of transplanting and Sulphur @ 0, 15, 30, 45 kg

ha^{-1} was applied in a single dose at the time of transplanting, according to the treatments. Chemical fertilizers, both straight and complex were used to supply N, P, K and S for brinjal crop. N was applied through urea, Di-ammonium phosphate (DAP) and Ammonium sulphate. P was applied through DAP only, while S was applied through Ammonium sulphate. Since DAP and Ammonium sulphate also contains nitrogen, the N dose was adjusted by application of only required quantities of urea. Potassium @ 50 kg ha-1 was applied in a single dose at the time of transplanting. The potassium was applied through Muriate of Potash (MOP).

The reducing sugar and total sugars were estimated by following the Lane and Eynon method (1923) with slight modifications as suggested by Ranganna (1986). The Anthocyanin content of brinjal fruits was estimated by using ethanolic HCL (95% Ethanol and 1.5 N HCL in the ratio 85:15) as per the procedure suggested by Ranganna (1986). Total phenols were estimated by using the Folin-ciocalteau reagent as per the method suggested by Sadasivam and Manickam (1996). Determination of ascorbic acid was done by 2, 6, dichlorophenol indophenol dye method as described by Ranganna (1986). The experimental data was analyzed statistically by the technique of analysis of variance as applicable to factorial randomized block design. The significance of treatment difference was tested by 'F' (Variance ratio) test. Critical difference (CD) at 5 per cent level of probability was worked out for comparison and statistical interpretation of the treatment means (Panse and Sukhatme, 1967).

Result and Discussion

Yield of brinjal: The yield of brinjal increased significantly from 15.65 t ha^{-1} to 20.11 t ha^{-1} with increasing doses of phosphorus from 0 to 75 kg P_2O_5 ha^{-1} (Table 1). The highest yield (20.11 t $ha^{-1)}$ was recorded by the treatment in which phosphorus was applied @ 75 kg ha^{-1} and the finding was at par with the application of phosphorus @ 50 kg ha^{-1} (18.63 t ha^{-1}). Similar results have been recorded by Thakre *et al.* (2005) and Mani *et al.* (2006). Beneficial effect of P on the yield could be due to better growth of the plant and increased translocation of photosynthates to reproductive sites (Parihar and Tripathi, 2003). The yield of brinjal increased significantly from 16.61 t ha^{-1} to 19.00 t ha^{-1} with increasing doses of sulphur from 0 to 45 kg S ha^{-1}. The brinjal yield of 19.00 t ha^{-1}, which was the highest among the plots with application of sulphur was recorded by the treatment in which sulphur was applied @ 45 kg ha^{-1} and the finding was at par with application of sulphur @ 30 kg ha^{-1} and @ 15 kg ha^{-1}. Similar results were observed by Hasan *et al.* (2012).

The treatment combination $P_{75}S_{45}$ recorded the highest yield of 23.53 t ha^{-1}. However the interaction effect between phosphorus and sulphur was found to be non-significant with respect to fruit yield. Similar values of fruit yield of brinjal were also reported by Thakre *et al.* (2005) with the application of phopshorus and sulphur.

Table 1: Yield of brinjal (t ha^{-1})

Treatments	Yield (t ha^{-1})				
	S_0	S_{15}	S_{30}	S_{45}	Mean
P_0	13.72	16.05	16.05	16.78	**15.65**
P_{25}	17.04	18.26	16.50	17.37	**17.29**
P_{50}	18.31	18.70	19.19	18.33	**18.63**
P_{75}	17.37	17.80	21.75	23.53	**20.11**
Mean	**16.61**	**17.70**	**18.37**	**19.00**	

	P	S	PXS
S.E.±	**0.55**	**0.55**	**1.10**
C.D(P=0.05)	**1.59**	**1.59**	**NS**

Biochemical composition of brinjal fruit:

Reducing sugars: Among the different levels phosphorus applied, the highest amount of reducing sugars (0.67 %) were found in the brinjal fruits of the experimental plot to which 75 kg P_2O_5 ha^{-1} was applied (Table 2). Similarly, the reducing sugar content was highest (0.57 %) in the brinjal fruits of the experimental plot to which 45 kg ha^{-1} of sulphur was applied. Both of these findings were found to be statistically significant. Further, it was observed that the treatment combination $P_{75}S_{45}$ i.e. 75 kg P_2O_5 ha^{-1} and 45 kg ha^{-1} of sulphur resulted in the highest amount (0.78 %) of reducing sugar compared to the other treatment combinations. However, the interaction effect was statistically non-significant.

The reducing sugar content in the fruits of brinjal ranged from 0.42 % to 0.78 % in various treatment combinations. The findings of the present investigation are in par with the findings of Kashyap *et al.* (2014) who have reported the reducing sugar content to be 0.47 % in brinjal. However, higher levels of reducing sugars could be due to the application of phosphorus and sulphur, whose influence has been found to be statistically significant.

Total sugars: The total sugar content was highest (1.97%) in brinjal fruits of the plants to whom P_2O_5 was applied @ 75 kg ha^{-1} and the findings were found to be statistically significant over rest of all the other treatments (Table 2). Similar were the findings with sulphur application. The highest amount of total sugars (1.94 %) was found in brinjal fruits of the plants to whom sulphur was applied @ 45 kg ha^{-1} and the findings were significantly superior over rest of all the other treatments. The findings of the study are in par with the findings of Kassem (2012) who has reported that the total sugar content in brinjal fruits increased with increased levels of sulphur. The total sugar content in the fruits of brinjal ranged from 1.72 % to 2.08 % in various treatment combinations. However, the interaction effect was found to be non-significant.

Table 2: Reducing and Total sugar content in brinjal fruit

Treatments	Reducing-sugar (%)					Total sugar (%)				
	S_0	S_{15}	S_{30}	S_{45}	Mean	S_0	S_{15}	S_{30}	S_{45}	Mean
P_0	0.46	0.42	0.50	0.57	**0.49**	1.76	1.72	1.80	1.87	**1.79**
P_{25}	0.56	0.61	0.58	0.65	**0.60**	1.86	1.91	1.88	1.95	**1.90**
P_{50}	0.62	0.42	0.62	0.57	**0.56**	1.92	1.72	1.92	1.87	**1.86**
P_{75}	0.55	0.66	0.68	0.78	**0.67**	1.85	1.96	1.98	2.08	**1.97**
Mean	**0.46**	**0.42**	**0.50**	**0.57**		**1.85**	**1.83**	**1.89**	**1.94**	
	P	**S**	**PXS**			**P**	**S**	**PXS**		
S.E.±	**0.02**	**0.02**	**0.05**			**0.02**	**0.02**	**0.05**		
C.D(P=0.05)	**0.07**	**0.07**	**NS**			**0.07**	**0.07**	**NS**		

Ascorbic acid content: Phosphorus application showed a significant impact on ascorbic acid content of brinjal fruits. The highest amount (24.83 mg 100 g^{-1}) of ascorbic acid was found in the brinjal fruits of the experimental plot to which 75 kg P_2O_5 ha^{-1} was applied and the findings were significantly superior over rest of all the other treatments (Table 3). The highest amount of ascorbic acid was found in brinjal fruits of the plants to whom sulphur was applied @ 45 kg ha^{-1}. The ascorbic acid content in the fruits of brinjal ranged from 18.20 mg 100g^{-1} to 26.00 mg 100g^{-1} in various treatment combinations.

Table 3: Ascorbic acid content (mg 100 g^{-1}) in brinjal fruit

Treatments	Ascorbic acid content (mg 100 g^{-1})				
	S_0	S_{15}	S_{30}	S_{45}	Mean
P_0	19.76	18.20	22.36	20.80	**20.28**
P_{25}	18.20	18.20	20.28	21.84	**19.63**
P_{50}	20.80	21.84	19.76	22.88	**21.32**
P_{75}	24.44	26.00	23.40	25.48	**24.83**
Mean	**20.80**	**21.06**	**21.45**	**22.75**	
	P	**S**	**PXS**		
S.E.±	**0.91**	**0.91**	**1.81**		
C.D(P=0.05)	**2.62**	**NS**	**NS**		

Anthocyanin content: Phosphorus application had a significant but negative impact on the anthocyanin content of brinjal fruits. It was found that the anthocyanin content decreased with increasing levels of phosphorus. The anthocyanin content in the fruits of brinjal ranged from 12.79 mg $100g^{-1}$ to 14.81 mg $100g^{-1}$ with application of various levels of phosphorus (Table 4). The highest amount of anthocyanin (14.81 mg 100 g^{-1}) was found in the treatment in which no phosphorus was applied to the crop and the lowest amount of anthocyanin (12.79 mg $100g^{-1}$) was observed in the treatment in which phosphorus was applied @ 75 kg ha^{-1}. Similar findings i.e. decreasing levels of phosphorus result in increasing amounts of anthocyanin content have been reported by Marie *et al.* (2008). The anthocyanin content in the fruits of brinjal ranged from 13.56 mg $100g^{-1}$ to 14.00 mg $100g^{-1}$ with application of various levels of sulphur. However, the sulphur application showed non-significant effect on anthocyanin content in the fruits of brinjal even though the highest amount (14.00 mg 100 g^{-1}) of anthocyanin content was observed in the brinjal fruits of the experimental plot to which sulphur was applied @ 30 kg ha^{-1}.

Total phenols: The total phenol content in brinjal fruits was found to be in the range of 47.37 mg 100 g^{-1} to 52.13 mg 100 g^{-1} and 45.58 mg 100 g^{-1} to 52.90 mg 100 g^{-1} with application of various levels of phosphorus and sulphur, respectively (Table 4). The influence of application of phosphorus and sulphur was found to be statistically significant. Highest phenol content (52.13 mg 100 g^{-1}) in brinjal fruits of the plants to whom P_2O_5 was applied @ 75 kg ha^{-1} was found and the finding was at par with P_{50} treatment. Similarly, the highest phenol content (52.90 mg 100 g^{-1}) in brinjal fruits of the plants to whom sulphur was applied @ 45 kg ha^{-1} was observed and it was at par with the treatment S_{30}. Similar findings have been reported by Tripathi *et al.* (2014) and Judita *et al.* (2015).

Table 4: Anthocyanin Total phenol content in brinjal fruit

Treatments	Anthocyanin (mg $100g^{-1}$)					Total phenols (mg 100 g^{-1})				
	S_0	S_{15}	S_{30}	S_{45}	Mean	S_0	S_{15}	S_{30}	S_{45}	Mean
P_0	15.10	14.26	14.42	15.44	**14.81**	43.16	44.33	48.77	53.20	**47.37**
P_{25}	13.66	13.83	14.00	13.66	**13.79**	43.46	47.25	49.46	51.54	**47.93**
P_{50}	14.42	13.32	14.08	12.90	**13.68**	49.24	49.71	49.33	52.22	**50.13**
P_{75}	11.88	12.81	13.49	12.98	**12.79**	46.46	53.96	53.46	54.63	**52.13**
Mean	**13.77**	**13.56**	**14.00**	**13.75**		**45.58**	**48.81**	**50.26**	**52.90**	

	Anthocyanin P	Anthocyanin S	Anthocyanin PXS	Total phenols P	Total phenols S	Total phenols PXS
S.E.±	**0.37**	**0.37**	**0.74**	**1.21**	**1.21**	**2.42**
C.D(P=0.05)	**1.06**	**NS**	**NS**	**3.49**	**3.49**	**NS**

Conclusion:

The yield of brinjal increased significantly with the application of increasing doses of phosphorus from 0 to 75 kg P_2O_5 ha^{-1} and the influence was at par with the soil application of phosphorus @ 50 kg ha^{-1} and sulphur @ 30 kg ha^{-1}. Significant amounts of reducing sugars of 0.67 % and total sugars of 1.97% were found in the brinjal fruits of the experimental plots to which 75 kg P_2O_5 ha^{-1} was applied, respectively. The highest amount (24.83 mg $100g^{-1}$) of ascorbic acid was found in the brinjal fruits of the experimental plot to which 75 kg P_2O_5 ha^{-1} was applied. Phosphorus application had a significant but negative impact on the anthocyanin content of brinjal fruits. The anthocyanin content decreased with increasing levels of phosphorus. The total phenol content in brinjal fruits was found to be significantly influenced by the application of phosphorus.

References

Anonymous (2013). Indian Horticulture Database ,2013.

Gopalan, C., Rama Sastri and Balasubramanian, S.C. (1987). Nutritive Value of Indian Foods. National Institute of Nutrition.,Hyderabad. pp. 76.

Hasan, M.M., Chowdhury, M.A.H., Saha, B.K.and Islam, M.R. (2012) Influence of of phosphorus and sulphur on yield attributes and biochemical composition of brinjal. *J. Bangladesh Agril. Univ.*11(1): 41-46.

Javed, MD. (2010). "Effect of organic and inorganic sources of nutrients on soil fertility and yield of brinjal (*Solanum melongena* L.)". M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Judita Bystrická, Petra Kavalcová, Alena Vollmannová and Ján Tomáš. (2015). The role of sulphur on the content of total polyphenols and antioxidant activity in onion. *Potravinarstvo Scie. J.*8(1): 284-289.

Kashyap, S., Sanjay Kumar and Devendra Kumar. (2014). Effect of organic manures and inorganic fertilizers on growth, yield and quality of brinjal. *Int. J. of Agric. Sci.*, 10(1): 305-308.

Kassem,H, A. (2012). The response of egg plant to calcareous soil fertilization. *J.of Soil Sci. and Plant Nut.,* 12 (1): 45-58.

Lane, J. H. and Eynon (1923).Determination of reducing sugar by Fehling's solution with methylene blue as internal indicator. *J. Soc. Chem, India.,* 39(3):16-20.

Mani, D., Arvind Kumar, and Chitranjan Kumar. (2006). Effect of Ammonium Sulphate and DAP on yield Sulphur and Phosphorus uptake by Mustard. *New Agriculturist*,17(1, 2): 163-166.

Marie Ulrychová and Věra Sosnová (2008). Effect of phosphorus deficiency on anthocyanin content in tomato plants.*Biologia Plantarum,*12(3): 231-235.

Panse, V.G. and Sukhatme, P.V. (1967). Statistical methods of Agricultural Workers, ICAR, Newdelhi.

Parihar, S.S. and Tripathi, R.S. 2003. Dry matter nodulation and nutrient uptake in potato as influenced by irrigation and P. Experimental Agriculture.25(3): 349-355.

Ranganna, S. (1986). *Manual of analysis of fruit and vegetables products*. Tata Mc Graw Hill publishing Co. Ltd., New Delhi pp 9-82.

Reddy, K. Chandrashekhar; S. Riazuddin and S.P Moula (1999). Soil test based fertilizer prescription for specific yield target of chilli (*Capsicum annum* L.) grown in alfisols of Guntur in Andra Pradesh. *South Indian Hort.*47(1-6): 247-249.

Sadasivam, S. and Manickam, A. (1996). Estimation ofAscorbic acid, Reducing sugar and total Carbohydratebyby Volumetric, Dinitro salicylic acid and Phenol by sulphuric acid method (Biochemical method).

Thakre, C.M., Badole, W.P., Tiwari, T.K. and Sarode, P.B., (2005), Effect of different levels of sulphur, phosphorus and potassium on yield and quality of brinjal. *J.of Maharashtra Agri. Uni.,* 30(3): 352 - 353.

Tiwari, R.S. and Agarwal, A. (2008). Influence of N, Pand K levels on yield of garlic *(Allium sativum L.). Indian J. of Agri. Sci.,* 19:119-123.

Tripathi, M., Prathibha and Praveen Pandey., (2014), Antioxidant Activities and Biochemical Changes in Different Cultivars of Brinjal. *American J, of Plant Phys.,* 9(1): 24-31.

Yadav, K.K. and Chhipa, B.R., (2007), Effect of FYM, gypsum and Iron pyrites on fertility status of soil and yield of wheat irrigated with high RSC water. *J. Indian Soc. Soil Sci.* 55(3): 324-329.