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Effect of Humic Acid fortified Briquettes on Yield, Quality and Nitrogen use Efficiency in Brinjal (*Solanum melongena* L.) in Lateritic Soils of Konkan

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ABSTRACT: Nutrient management in vegetable crops has increased importance as consumption of straight fertilizers is increased at tremendous rate. There is no denying the significance and accessibility of straight fertilizers, but crop availability owing to leaching and other losses makes them less effective and result in lower yield. Adequate and balanced fertilizer management in association with manures is very much essential to exploit the full yield potential of Brinjal Crop. Keeping this view, the field experiment was conducted at Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Tal. Dapoli, Dist. Ratnagiri during the year 2021-2022 and 2022-23 with a view to study the effect of humic acid fortified briquettes on yield, quality parameters and nitrogen use efficiency of brinjal (*Solanum melongena* L.). The experiment was conducted in Factorial Randomized Block Design with three replications and fifteen treatment combinations. The results revealed that significantly highest fruit yield (29.83t ha^{-1} and 30.32t ha^{-1}), highest anthocyanin content (18.68 mg 100 g^{-1} and 19.18 mg 100 g^{-1}), lowest tannin content (118.76 mg 100 g^{-1} and 119.9 mg 100 g^{-1}) and high nitrogen efficiency recorded as 56.15 percent and 59.25 percent was recorded in the year 2021-22 and 2022-23 respectively.

Keywords: Briquettes, UB-10:26:26, Humic Acid, Yield, Anthocyanin,Tannin, Nitrogen Use Efficiency.

INTRODUCTION

Brinjal is used as a vegetable which is inexpensive so majority of consumers can afford. It also has copious medicinal qualities enumerated as beneficial to human health. Eggplant is known as one of the ten sources of the world's healthiest food which is also described as best species cultivated worldwide. It has also gained the interest of scientist in a pharmacological sense as they belong to a group of compounds called alkaloids (McGehee *et al*., 2000). Nutrient management in vegetable crops has increased importance as consumption of straight fertilizers is increased at tremendous rate. There is no denying the significance and accessibility of straight fertilizers, but crop availability owing to leaching and other losses makes them less effective and result in lower yield. The deep placement of fertilizer or spot application of fertilizer, use of slow release fertilizer and nitrification inhibitors are recommended to minimize nutrient losses and increase the fertilizer use efficiency. In order to reduce the import demand and to ensure the efficient use of fertilizers the attempt are made to use the NPK fertilizers in the form of briquettes.

The low nutrient use efficiency of N and P is because of various reasons such as volatilization, denitrification, surface runoff, leaching losses for nitrogen and fixation in soil for phosphorus. Broadcast application of N as urea resulted in an average 10 times higher amounts of ammonium N in flood water compared to deep placement of urea briquette and NPK briquette (Kapoor *et al*., 2008). More or less similar situation exists in case of potassium. Deep placement of fertilizers (USG and NPK briquette) into the anaerobic soil zone is an effective method to reduce volatilization loss (Mikkelsen *et al*., 1978). Deep placement of USG at 8-10 cm depth of soil can save 30% N compared to Prilled Urea, increases absorption rate, improves soil health and ultimately increases rice yield (Savant *et al*., 1991). Humic acid application along with recommended dose of fertilizers and organic manures plays a greater role in plant biochemical and physiological activities and soil fertility, consequently resulting in better growth and yield of crops (Kalaichelvi *et al*., 2006). Briquettes fortified with humic acid will release nutrients more slowly and evenly than non-fortified briquettes. It will improve the

nutrient uptake efficiency of brinjal plants, leading to increased yields and improved fruit quality.

MATERIALS AND METHODS

The field experiment was conducted on typical lateritic soils under theVery High Rainfall Lateritic Zone (VRL) of the Konkan region of the Ratnagiri district during *Rabi* season of (November to April) the year2021-22 and 2022-23. The field experiment was laid out in Factorial Randomized Block Design (FRBD)comprising of fifteen treatment combinations replicated thrice during *Rabi* season of 2021-22 and 2022-23 at Research Farm of Agronomy Department, College of Agriculture, Dapoli. The treatment details were as Absolute Control (T_1), Absolute Control+ Na-Humic Acid (T_2), Absolute Control+ K-Humic Acid (T_3), Straight Fertilizers+ Control(T_4), Straight Fertilizers+ Na-Humic Acid(T_5),Straight Fertilizers+ K-Humic Acid (T_6), Konkan Annapurna Briquettes (KAB)+Control (T_7), Konkan Annapurna Briquettes (KAB)+Na-Humic Acid (fortified) (T_8), Konkan Annapurna Briquettes (KAB)+K-Humic Acid (fortified) (T_9),UB-10:26:26 + Control (T_{10}),UB-10:26:26 + Na-Humic Acid (fortified) (T_{11}),UB-10:26:26 + K-Humic Acid (fortified) (T_{12}),UB-DAP + Control (T_{13}), UB-DAP + Na-Humic Acid (fortified) (T_{14}),UB-DAP + K-Humic Acid (fortified) (T_{15}). The briquettes were prepared as per the ratio of fertilizers combination required to be used as per the respective treatment details with the help of "Kranti briquetter" machine. Nitrogen @150kg ha^{-1} was applied in three splits *viz*, first dose of 1/3 was applied at transplanting, second 1/3 dose at 30 days after transplanting and third 1/3 dose at 60 days after transplanting. Phosphorus at 50 kg ha^{-1} and potassium at 50 kg ha^{-1} were applied in single dose at the time of transplanting in the corresponding treatments. In case of treatment T_7, T_8 and T_9 fertilizer briquettes viz., Konkan Annapurna Briquettes, Konkan Annapurna Briquettes (KAB)+ Na-Humic Acid Fortified and Konkan Annapurna Briquettes (KAB)+ K-Humic Acid Fortified respectively, in treatment T_{10}, T_{11}, T_{12} fertilizer briquettes viz., UB-10:26:26, UB-10:26:26 + Na-Humic Acid Fortified, UB-10:26:26 + K-Humic Acid Fortified respectively and in treatment T_{13},T_{14},T_{15} fertilizer briquettes *viz.*, UB-DAP, UB-DAP + Na-Humic Acid Fortified and UB-DAP + K-Humic Acid Fortified briquettes were applied at time of transplanting, after 30 days after transplanting and 60 days after transplanting. The mature brinjal fruits were collected after each picking and weighed immediately from each plot. Fruits were weighed after all pickings and recorded and it was total up and expressed as fruit yield in Kgperplot and tha^{-1}. The fruit samples collected at harvest were analyzedfor quality parameters *viz.* anthocyanin and tannin content.

Nutrient Use Efficiency %. Nutrient use efficiency was calculated in order to assess the utility of the nutrient in comprehensive application. It was calculated as given below

$$\frac{\text{Nutrient uptake in fertilized plot (kgha}^{-1}) - \text{Nutrient uptake in absolute control plot (kgha}^{-1})}{\text{Nutrient applied kgha}^{-1})} \times 100$$

All the observations regarding the yield attributes appropriate stages. Similarly, the data recorded at different crop growth stages during investigation period was statistically analyzed as per procedure given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

A. Effect of humic acid fortified briquettes on yield

The data recorded concerning to yield of brinjal was presented in Table 1 revealed that the highest fruit yield (29.83t ha^{-1} and 30.32t ha^{-1}) was found in the application of application of UB-10:26:26 which was significantly superior in all other treatments of fertilizer applications in both the years *i.e.* 2021-22 and 2022-23.The application of potassium humic acid was found to had highest fruit yield (25.14 t ha^{-1} and 25.37 t ha^{-1}in the year 2021-22 and 2022-23 respectively) which was significantly at par (24.24 t ha^{-1} and 24.36 tha^{-1} in the year 2021-22 and 2022-23 respectively) with no humic acid application. The highest fruit yield (31.37 tha^{-1}and 32.87tha^{-1}) was found in treatment UB-10:26:26 fortified with potassium humic acid which was at par with application of UB-10:26:26 with no humic acid application (30.37tha^{-1}), UB-10:26:26 fortified with sodium humic acid (27.75tha^{-1}) and UB-DAP fortified with potassium humic acid (28.2tha^{-1}) in the year 2021-22 and UB-10:26:26 with no humic acid application (30.00tha^{-1}) in the year 2022-23.

Brinjal generally requires heavy manuring for its potential production. However, the use of expensive commercial fertilizers as per the crop requirement of the crop was not much affordable to the farmers. Therefore, the application of fertilizers combined with humic acid was the newer cost effective method in nutrient management for maintaining its sustainable production and productivity. By the interaction of mineral fertilizers and humic acids, the plant ability to form a larger number of meristmatic cells and increase their size, which was positively reflected on the vegetative growth of the plant resulting from the increased formation of proteins and nucleic acids in broccoli crop. Increasing the growth indicators due to humic acid application attributed to its effect on various vital processes such as respiration, photosynthesis and protein formation, as well as containing mineral compounds such as phenols and amino acids, and increases the absorption of nutrients in saline soils (Isswai *et al.*, 2021).

B. Effect of humic acid fortified briquettes on quality parameters of the brinjal

Anthocyanin Content. The data regarding the quality parameter i.e. anthocyanin and tannin was given in Table 2 and 3. Application of different fertilizer briquettes showed a significant effect on the Anthocyanin content. The highest anthocyanin content (18.16 mg 100 g^{-1} and 18.87 mg 100 g^{-1} in the year 2021-22 and 2022-23 respectively) was found in

treatment B_3 (UB-10:26:26) which was significantly superior with the other treatments in the year 2021-22and at par with treatment B_4(18.54 mg 100 g^{-1}) in the year 2022-23. In humic acid treatments the highest anthocyanin content was found in application of potassium humic acid (17.28 mg 100 g^{-1} and 17.37 mg 100 g^{-1} in the year 2021-22 and 2022-23, respectively) which was significantly superior with all other treatments. The treatment combination of UB-10:26:26 fortified with potassium humic acid recorded the highest anthocyanin content (18.68 mg 100 g^{-1} and 19.18 mg 100 g^{-1}) in the year 2021-22 and 2022-23 respectively.

The significant increase in anthocyanin content in the brinjal fruits as a result of the different treatment combinations might be attributed to the application of fertilizers with biofertilizer to the crop. Potash plays important role in activation of several enzymes which promotes the anthocyanin pigmentation. Similar results were found by Tisdale *et al*. (1993). Similar, findings were also reported by Mohan (2016); Kadlag *et al*. (2007); Tripathi *et al*. (2014).

Tannin Content. The highest tannin content (149.61 mg 100 g^{-1} and 150.35 mg 100 g^{-1}in the year 2021-22 and 2022-23, respectively) was found treatment B_0(Absolute Control) which was significantly superior then all other treatment of fertilizer applications. The highest tannin content (133.16 mg 100 g^{-1} and 133.16 mg 100 g^{-1}) was found in no humic acid application treatments.

Application of fertilizers reduces the stress experienced by plants like nutrient deficiencies and competition which trigger increase of tannin production. Rapid growth of plant affects the secondary metabolite production i.e. tannin production. Due to supply of nutrients through organic or inorganic resources it enhances the physiological growth of crop hence the crop become more susceptible for pest incidence and had low tannin content whereas the crops grown on control plots had poor vegetative and reproductive growth then fertilized crops and hence contain more tannin percent. Such findings were made by (Sowmya and Pradeep 2020). Fertilizing the plants with nitrogen sources reduces the nitrogenase activity and tannin content, compare to plants not amended with nitrogen. The phenolic and tannin content increased when nutrient availability decreased (Valdiviezo *et al*., 2009).

C. Effect of Humic Acid Fortified Briquettes on Nitrogen Use Efficiency

The nitrogen use efficiency was the major concern in plant nutrition. The data regarding the nitrogen use efficiency was presented Fig. 1. The treatment combination B_3H_2 (UB-10:26:26 fortified with potassium humic acid) recorded high nitrogen efficiency in the both the year of study, 2021-22 and 2022-23. In the year 2021-22 it was recorded as 56.15 percent and in the year 2022-23, it was recorded as 59.25 percent.

The urea + organics briquettes, revealed much higher NUE compared to the prilled urea treated plot. These results indicated that application of urea+organics briquettes and urea super granules in rice field decrease the losses of N and save the fertilizer, leading to efficient uptake and utilization of applied N. (Roy *et al*., 2018). The nitrogen use efficiency (NUE) was found highest with use of 100 per cent NPK RD through briquette followed by 75 per cent NPK RD through briquette and 100 per cent NPK RD through non-briquette by spot method of application (Singh and More 2018). Apparent nitrogen recovery (ANR) of conventional chemical fertilizers at 100% RD for potato was 49.7%. When chemical fertilizers mixed with humic acids, the ANR was increased to 58.7%. This may be because urea+organics briquettes application or USG slowly releases the nitrogen in soil resulting in minimum losses of N due to volatilization and leaching as well as it also increases the efficiency of nitrogen (Selladurai and Tapan 2015).

Table 1: Effect of humic acid fortified briquettes on fruit yield (t ha^{-1}).

Treatments	2021-22				2022-23			
	H_0	H_1	H_2	Mean	H_0	H_1	H_2	Mean
B_0	14.10	14.26	17.67	**15.34**	14.48	14.85	17.83	**15.72**
B_1	24.82	23.73	25.13	**24.56**	25.04	24.31	25.39	**24.91**
B_2	27.21	21.43	23.34	**23.99**	26.36	22.11	23.89	**24.12**
B_3	30.37	27.75	31.37	**29.83**	30.00	28.08	32.87	**30.32**
B_4	24.71	25.23	28.2	**26.05**	25.90	25.57	26.87	**26.11**
Mean	**24.24**	**22.48**	**25.14**	**23.95**	**24.36**	**22.98**	**25.37**	**24.23**
	B	**H**	**BxH**		**B**	**H**	**BxH**	
S.Em±	0.69	0.53	1.20		0.58	0.45	1.02	
C.D@5%	2.01	1.56	3.49		1.70	1.32	2.95	

Table 2: Effect of Humic Acid fortified briquettes on biochemical parameters of brinjal fruit (2021-22).

Treatments	Anthocyanin (mg 100 g^{-1})				Tannin (mg 100 g^{-1})			
	H_0	H_1	H_2	Mean	H_0	H_1	H_2	Mean
B_0	10.39	13.06	15.56	**13.00**	151.66	149.03	148.13	**149.61**
B_1	13.82	13.51	16.59	**14.64**	130.73	130.93	124.56	**128.74**
B_2	16.01	16.31	17.20	**16.51**	129.96	131.5	126.93	**129.46**
B_3	17.90	17.91	18.68	**18.16**	123.36	120.53	118.76	**120.88**
B_4	16.18	17.22	18.39	**17.26**	130.1	133.1	130.66	**131.28**
Mean	**14.86**	**15.60**	**17.28**	**15.91**	**133.16**	**133.02**	**129.81**	**131.99**
	B	**H**	**B×H**		**B**	**H**	**B×H**	
S.Em±	0.26	0.20	0.46		0.77	0.60	1.34	
C.D@5%	0.77	0.59	1.34		2.25	1.74	NS	

Table 3: Effect of Humic Acid fortified briquettes on biochemical parameters of brinjal fruit (2022-23).

Treatments	Anthocyanin (mg 100 g^{-1})				Tannin (mg 100g^{-1})			
	H_0	H_1	H_2	Mean	H_0	H_1	H_2	Mean
B_0	9.30	11.63	15.37	**12.10**	150.7	152.1	148.26	**150.35**
B_1	12.55	14.57	15.71	**14.28**	132.13	130.6	126.4	**129.7**
B_2	17.03	17.37	17.65	**17.35**	129.06	129.93	127.23	**128.74**
B_3	18.37	19.06	19.18	**18.87**	122.36	121.66	119.9	**121.31**
B_4	17.74	18.92	18.94	**18.53**	132.23	131.33	132.36	**131.97**
Mean	**15.00**	**16.31**	**17.37**	**16.22**	**133.3**	**133.12**	**130.83**	**132.41**
	B	**H**	**BxH**		**B**	**H**	**BxH**	
S.Em±	0.21	0.16	0.37		0.80	0.62	1.39	
C.D@5%	0.62	0.48	1.07		2.32	1.80	NS	

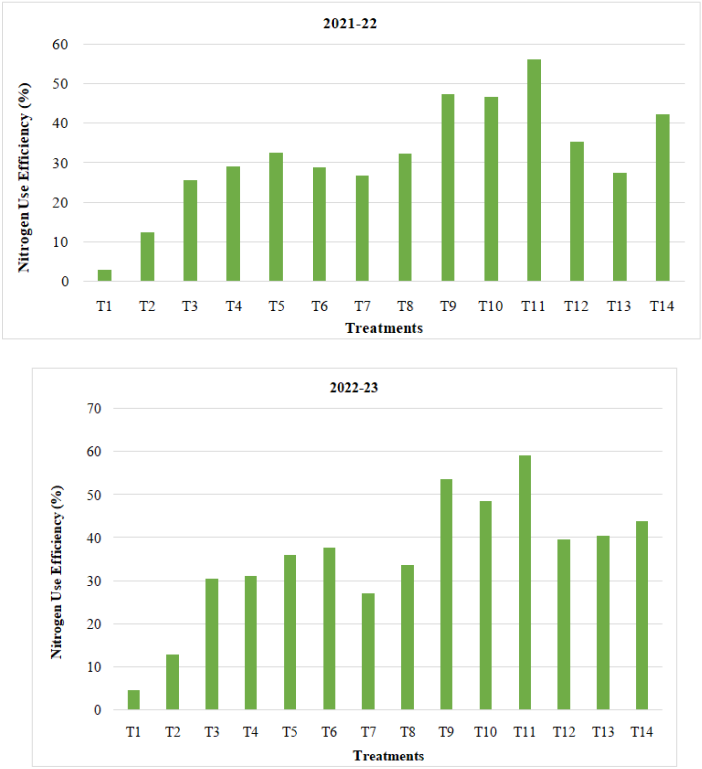

Fig. 1. Effect of humic acid fortified briquettes on nitrogen use efficiency (%).

CONCLUSIONS

In summary the results of this investigation revealed the influence of humic acid fortified briquettes on yield, quality parameters and nitrogen use efficiency of brinjal. Based on the findings of investigation it may be concluded that UB-10:26:26 fortified with potassium humic acid gave highest yield, high content of anthocyanin, lower content of tannin and high nitrogen use efficiency. The nitrogen use efficiency was found to be increased by 54-60 per cent by using fertilizer briquettes over straight fertilizers.

FUTURE SCOPE

The fertilizer briquettes fortified with organic sources reduces the consumption, input cost of the fertilizers as well as increasing nutrient use efficiency, production and quality of the crop which is helpful for the farmers to get a good yield.

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