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EFFECTS OF VERMICOMPOST AND RICE HUSK ASH ON THE YIELD OF SWEET GOURD

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Abstract

A field experiment was carried out at the research field of Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI), Rajbari, Dinajpur (Latitude: 25^{0}388.9″ N, Longitude: 88^{0}395.79″ E) during rabi season of 2020-21 and 2021-22 to see the response of vermicompost and rice husk ash on the yield of sweet gourd. Five treatments were included in the experiment as T_1=100% RCF (Recommended Chemical Fertilizer) + Vermicompost 3 t/ha, T_2=100% RCF+ Rice husk ash 2 t/ha, T_3= 100% RCF+ Vermicompost 1.5 t/ha + Rice husk ash 1.5 t/ha, T_4=100% RCF +Vermicompost 3 t/ha +Rice husk 1 t/ha, T_5=100% RCF + 50% extra potassium. The results revealed that the highest fruit yield was recorded in (T_4) 100% RCF +Vermicompost 3 t/ha +Rice husk 1 t/ha followed by that in (T_1) 100% RCF+ Vermicompost 3 tha^{-1} and (T_3) 100% RCF + Vermicompost 1.5 t/ha + Rice husk ash 1. t/ha and the lowest in (T_5) 100% RCF+50% extra potassium. The highest gross return (Tk. 328500 ha^{-1}), as well as gross margin (Tk. 214600 ha^{-1}), was obtained in (T_4) 100% RCF +Vermicompost 3 t/ha +Rice husk 1 t/ha and the lowest gross return (Tk. 151200 ha^{-1}) and gross margin (Tk. 78675 ha^{-1}) were obtained from the treatment (T_5) 100% RCF + 50% extra potassium. The highest BCR (2.88) was also obtained from the treatment (T_4) 100% RCF + Vermicompost 3 t/ha + Rice husk 1 t/ha combination could be effective for overall productivity and monetary return.

Keywords: Benefit-cost**,** Rice husk ash, Sweet gourd, Vermicompost.

Introduction

Bangladesh ranked 3rd in global vegetable production, alongside China and India. Farmers are making a big profit from the cultivation of vegetables, which is changing their lives. Vegetables are gradually acknowledged as crucial for food and nutrition security (Schreinemachers *et al.*, 2018). Today, the cheapest source of vitamins and minerals which are required for good health are vegetables. Sweet gourd is an important vegetable crop grown extensively throughout the tropical and subtropical countries. Due to its high nutritional content and lucrative market price, sweet gourd may be considered as a high-value crop. In our country, both immature and mature fruits are used as vital

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ingredient for several culinary preparations. The sweet gourd is rich in carbohydrates and minerals and a cheaper source of vitamins, especially carotenoid pigments, which have a major role in nutrition in the form of pro-vitamin-A, antioxidants, when used at the ripening stage (Dutta *et al.,* 2006). Thus, this vegetable can contribute to improving nutritional status of the people of Bangladesh, particularly the vulnerable group in respect of vitamin-A requirement. It is easy to cultivate and requires limited resources and time, which makes cultivating sweet gourd very profitable. Most vegetables require fertilizer (organic and inorganic) for growth and optimum yield. The nutrient requirement of sweet gourd is generally high due to lots of biomass being produced by the plant (Oloyede *et al.,* 2013). Organic fertilizers release nutrients over time thereby creating a healthy growing environment, while a fast release of nutrients is provided by inorganic fertilizers. Manures are a good source of fertilizer as they are natural products used to provide nutrients to plants by farmers. Inorganic fertilizers application tends to release fast nutrients to sustain soil fertility and crop production and it has led to reduced crop yield, soil acidity, and nutrient imbalance (Agbede *et al.,* 2008; Uyovbisere *et al.,* 2000). Fertility and nutrient status of the soil a major factor for improving crop yield and quality (Kolodziej, 2006). The amount of fertilizer used as a soil amendment, including organic and inorganic fertilizer have a positive impact on the availability of nutrients for the crop and nutrient status of the soil (Bijlsma *et al.,* 2000). Thus, the use of different organic fertilizers solely or in combination with inorganic fertilizers enhanced the yield and quality of crops (Zhang and Fang, 2007). Soil amelioration and improvement via integrated soil fertility management strategy including organic and inorganic fertilizer is a major intervention component that has improved crop production worldwide (Chand *et al.,* 2006; Urmi *et al.,* 2022). Vermicompost enhances the effect of soil microbial activity, increases oxygen supply, retains normal soil temperature, increases soil porosity and water penetration, improves nutrient content, and increases plant growth, yield, and quality (Arora *et al.,* 2011; Rehman *et al.,* 2023; Oyege *et al.,* 2023). In Sri Lanka, rice husk ash is highly available amendment in large quantities. It has reasonable quantities of cations Ca, Mg, K, Na, and other essential elements including P and very little N. Rice husk ash from various locations contains 0.72–3.84% K_2O and 0.23-1.59 MgO . Bronzeoak Ltd (2003) reported that potassium and phosphorous contents of rice husk ash were 0.01-2.69% P_2O_5 and 0.1-2.54% K_2O respectively and the pH was 08.1-11.0. The ash increases the soil pH, thereby increasing available phosphorous, it improves the aeration in the crop root zone, and also increases the water holding capacity and level of exchangeable potassium and magnesium (AICOAF, 2001;Yuan and Xu, 2011; Singh *et al.*, 2018 ; Oladele *et al.,* 2019; Yin *et al.*, 2022). The amount of potassium varies with the temperature and time at which the husk burns, therefore it can be used as a potassium source for crop production. Potassium is one of sixteen essential nutrients required for plant growth and reproduction and it is classified as a macronutrient, as are nitrogen and phosphorus (Marschner, 1995; Rawat *et al.,* 2016; Torabian *et al.,* 2021). Potassium is supplied by inorganic fertilizers such as muriate of potash sulphate of potash or complex fertilizers, or by some organic sources. Potassium is one of the key limiting nutrients for plant growth and development. Due to intensive cropping, mining of potassium from soil reserves is now a great concern to researchers. Rice husk ash is now available in rural areas and is considered a good source of potassium and silica. Sweet gourd is an important and nutritious vegetable in our country. Therefore it needs to evaluate the effect of ash as a source of potassium and silicon on this vegetable. Hence the experiment needs to be conducted to ascertain the effect of potassium and silica on yield components and yield of sweet gourd.

Materials and Methods

Experimental site description

The experiment was conducted at the research field of Agricultural Research Station, BARI, Rajbari, Dinajpur, Bangladesh during winter (rabi*)* season of 2020-21 and 2021-22. The experimental site was located at Latitude: 25.63671^0 N and Longitude: 88.65269^0 E at an elevation of 38 m above mean sea level and it belongs to the Agro-ecological Zone-1 (Old Himalayan Piedmont Plain) in Bangladesh (FRG, 2018). The initial soil sample (0-15 cm) was tested at the Soil Resources Development Institute (SRDI), Dinajpur, Bangladesh. The soil in the experimental area was medium-high and clay loam texture having 2.16% organic matter, pH 6.07, 0.10% total nitrogen (N), 0.14 meq 100 g^{-1} soil potassium (K), 48.16 μg/g phosphorus (P), 8.15 μg/g sulfur (S), 0.89 μg/g zinc (Zn) and 0.35 μg/g boron (B). During crop growth period, Monthly weather data on temperature (maximum and minimum) and total rainfall (mm) were recorded in the both years (Fig.1). The average maximum and minimum temperature in the crop season (November to April) were ranged 22.69°C-33.99°C and 11.15°C-21.76°C during in 2020-21 and 22.25°C-33.43°C and 11.4°C-23.28°C in 2021-22 respectively. The weather of the experimental site is hot sub-humid with total rainfall of 25 mm in 2020-21 and 106 mm in 2021-22 during crop season.

Experimental treatments details

The experiment was laid out in a randomized completely block design (RCBD) with three replications. The unit plot size was 4 m×4 m. Five treatments viz., T_1=100% RCF (Recommended Chemical Fertilizer) +Vermicompost 3 tha^{-1}, T_2=100% RCF+ Rice husk ash 2 t/ha, T_3=100% RCF +Vermicompost 1.5 t/ha + Rice husk ash 1.5 t/ha, T_4=100% RCF +Vermicompost 3 t/ha +Rice husk 1 t/ha, T_5=100% RCF+50% extra potassium was tested.

Crop husbandry

The land of the experimental plot was prepared with a power tiller by ploughing and cross ploughing followed by laddering and the soil was brought into a good tilth. Sweet gourd var. BARI Mistikumra-2 was used in the experiment. Fifteen days old seedlings of sweet gourd were transplanted on 07 November 2020 and 10 November 2021 according to treatments. The land was fertilized with @ $N_{80}P_{36}K_{100}S_{24}Zn_4B_2$ kg/ha respectively (FRG, 2018). The source of N, P, K, S, Zn, and B were urea, triple super phosphate (TSP), Muriate of potash (MoP), gypsum, zinc sulphate, and boric acid, respectively. All organic manure rice husk ash and all PKSZnB were applied in the pit 5-7 days before planting and mixed thoroughly with the soil. N was applied around the plant as a side dressing at 15, 30, 50, and 70 DAT under moist soil conditions and mixed thoroughly with the soil as soon as possible. Following urea application, four irrigations were given. To control powdery mildew on sweet gourd, fungicide Indofil M @ 0.2% was sprayed at every 15 days interval. Pheromone traps (Cue lure) @ 100 traps per hectare were used to control cucurbit fruit fly in the sweet gourd field from 30 days after planting till the sweet gourd harvest. (Cork *et al.*, 2003). Sweet gourd harvesting started at 120 DAT and was carried out four times. Yield components of sweet gourd were taken from randomly selected 4 plants from each plot. Fruit yields were taken from the whole plot. Collected data were analyzed statistically by using R software packages and mean differences for each character were compared by the Least Significant Difference (LSD).

Table 1. Nutrient status of vermicompost and rice husk ash used in experiment field

Name of the manure	PH	OM	K	Total N	P	S	B	Zn
		%						
Vermicompost	5.3	14.2	0.30	1.71	0.304	0.698	0.008	0.014
Rice husk ash	5.5	12.3	0.70	0.52	0.518	0.586	0.005	0.012

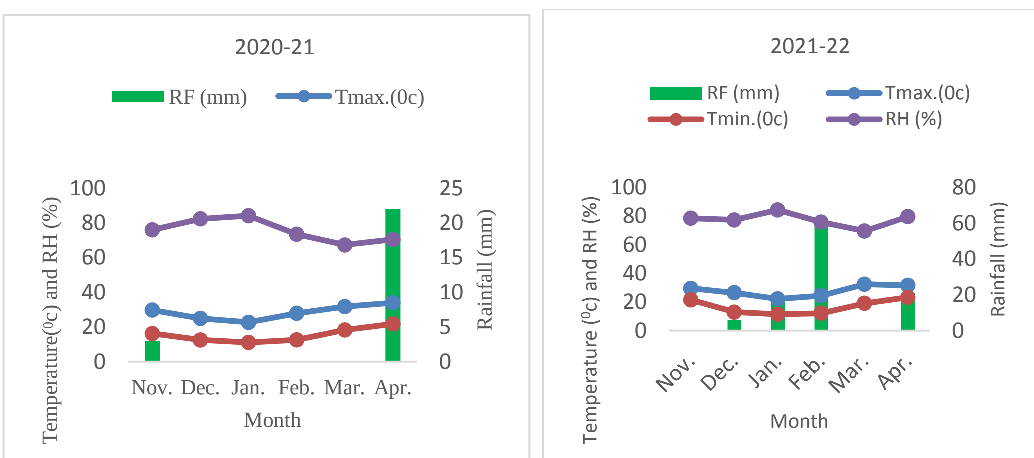


Fig. 1. Monthly average maximum temperature, minimum temperature, Relative Humidity and rainfall during the growing period (2020-21 and 2021-22)

Results and discussion

Yield and yield contributing characters of sweet gourd

The vine length at 1st fruiting, fruits plant^{-1}, fruit length and diameter, flesh thickness, single fruit weight, and fruit yield of sweet gourd had significant differences among the fertilizer doses except for days to 1st male and female flowering (Table 1). The plant required 51.00-56.50 days for 1st male flowering and 67.66-72.66 days for 1st female flowering. The longest length of the vine was recorded from T_4 (283.67 cm) followed by T_1 (250.31 cm) and the shortest vine was recorded from T_5 (210.22 cm) at 1st fruiting. This is in agreement with the findings of Bello *et al.* (1995). The highest number of fruits plant^{-1} (5.08) was obtained from T_4 followed by T_1 (4.70), while the lowest number of fruits plant^{-1} (3.43) was found in the treatment T_5. The treatment T_4 gave the highest fruit length (28.66 cm) and diameter (21.06 cm) which was followed by the T_1 treatment (27.20 cm length and 20.54 cm diameter) and the lowest fruit length (24.33 cm) and diameter (17.93 cm) were measured in T_5. The highest single fruit weight (2714.03 g) was observed from T_4 followed by T_1 (2106.54 g). Nahar (2016) stated that the fruit length and diameter were positively and significantly correlated with individual fruit weight. Fruit yield was recorded as the highest in T_4 (32.85 tha^{-1}) followed by T_1 (25.34 tha^{-1}) and T_3 (21.18 t/ha) and producing the lowest in T_5 (15.12 t/ha). The results expressed that a higher fertilizer dose increased the fruit yield of the sweet gourd as compared to the recommended dose of fertilizers. The results are in agreement with the findings of other researches (Anonymous, 2017 and Rathod, 2018).

Table 2. Yield and yield contributing character of sweet gourd at different treatment combinations (pooled data of 2 years)

Treatments	1st male flower (days)	1st female flower (days)	Vine length at 1st fruiting (cm)	Fruits/ Plant (no.)	Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (cm)	Single fruit wt. (g)	Yield (t/ha)
T_1	51.33	68.66	250.31	4.70	27.20	20.54	4.36	2106.54	25.34
T_2	52.33	71.00	230.86	3.80	25.86	18.56	3.87	1841.60	16.58
T_3	51.33	69.33	246.33	4.33	26.40	20.17	4.12	1960.26	21.18
T_4	51.00	67.66	283.67	5.08	28.66	21.06	4.50	2714.03	32.85
T_5	56.50	72.66	210.22	3.43	24.33	17.93	3.65	1760.90	15.12
LSD (0.05)	2.54	6.75	17.09	0.68	2.94	1.20	0.33	275.92	2.63
CV (%)	2.57	5.13	3.72	8.37	1.48	3.21	4.31	6.98	6.29

T_1=100% RCF+ Vermicompost 3 tha^{-1}, T_2=100% RCF+ Rice husk ash 2 tha^{-1}, T_3=100% RCF + Vermicompost 1.5 tha^{-1}+ Rice husk ash 1.5 tha^{-1}, T_4=100% RCF +Vermicompost 3 tha^{-1}+Rice husk 1 tha^{-1}, T_5=100% RCF + 50% extra potassium

Correlation study

The correlation coefficient among different characters has been presented in Table 3. Fruit yield obtained a positive response in all the characters, whereas a significant positive correlation was showed with vine length at 1st fruiting (0.83***), fruit/plant (0.89***), fruit diameter (0.80***), flesh thickness (0.87***) and Single fruit weight (0.93***). Single fruit weight and flesh thickness showed a significant positive correlation in almost all the characters except fruit length (0.36). Fruit diameter showed a strong positive and significant relationship in all the traits, except fruit length (0.24). Fruit length showed a positive and insignificant relationship in all the traits. Fruit per plant showed a positive and significant relationship with almost entire the study traits, except fruit length (0.19).

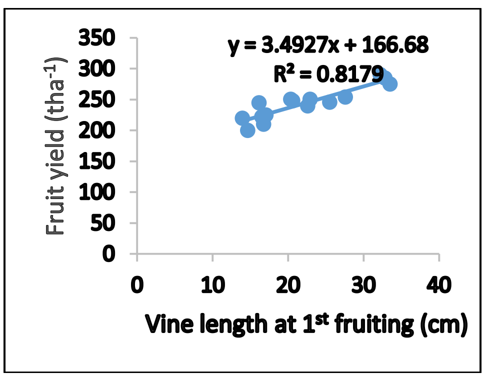
Table 3. Correlation among the study characters

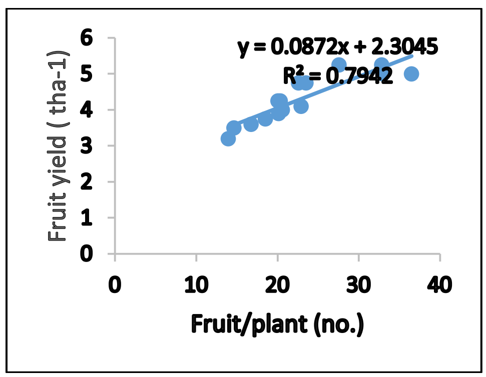
	VL	FPP	FL	FD	FT	SFW	FY
VL	1						
FPP	0.82***	1					
FL	0.19	0.24	1				
FD	0.79***	0.86***	0.24	1			
FT	0.83***	0.86***	0.26	0.80***	1		
SFW	0.86***	0.68**	0.36	0.65**	0.65**	1	
FY	0.90***	0.89***	0.35	0.80***	0.87***	0.93***	1

*significant at = 0.05; **significant at = 0.01; ***significant at = 0.001; VL= Vine length; FPP= Fruit per plant; FL= fruit length; FD=Fruit diameter; FT=Flesh thickness; SFW= Single fruit weight; FY= Fruit yield

The functional relationship of different yield contributing traits on bulb yield of sweet gourd

The functional linear analysis was performed using the data of yield contributing characters along with the fruit yield. From the relationship, it was displayed that the studied characters had a positive contribution to the fruit yield, which indicated that the fruit yield was dependent on those characters. To evaluate the role of those characters, linear regressions were done. The results exposed that yield contributing characters like vine length at 1st fruiting, number of fruits per plant, fruit length, fruit diameter, flesh thickness, and single fruit weight accounted for 82, 79, 12, 76, 65 and 88% of the total fruit yield variation, respectively (Fig. 2).





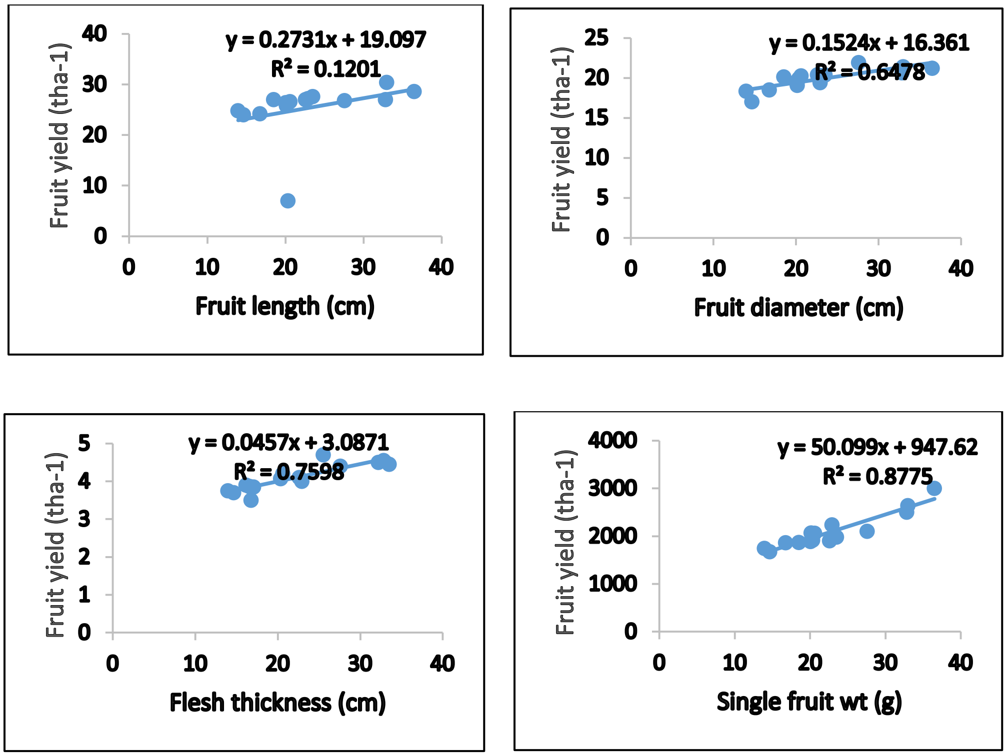


Fig. 2. Relationship of different yield contributing characters on fruit yield of sweet gourd

Cost and return

The maximum gross return was obtained from T_4 treatment (Tk. 328500 ha^{-1}) followed by T_1 treatment (Tk. 253400 ha^{-1}) and T_3 treatment (Tk. 211800 ha^{-1}), while the minimum (Tk. 151200 ha^{-1}) from T_5 treatment (Table 4). The highest gross margin was also recorded from the T_4 treatment (Tk. 214600 ha^{-1}) followed T_1 treatment (Tk. 141000 ha^{-1}) and T_3 treatment (Tk. 114900 ha^{-1}), while the lowest (Tk. 78675 ha^{-1}) was from T_5 treatment. The benefit-cost ratio (BCR) was also the highest in the T_4 treatment (2.88) followed by T_1 (2.25) and T_3 (2.19) treatments, while the lowest in local T_5 (2.08) treatment.

Table 4. Cost and return for sweet gourd cultivation at ARS, Rajbari, Dinajpur

Treatments	Gross return (Tk ha^{-1})	TVC (Tk ha^{-1})	Gross margin (Tk ha^{-1})	BCR
T_1	253400	112400	141000	2.25
T_2	165800	77400	88400	2.14
T_3	211800	96900	114900	2.19
T_4	328500	113900	214600	2.88
T_5	151200	72525	78675	2.08

Sweet gourd @ Tk. 10 kg^{-1}

Conclusion

The results revealed that the highest fruit yield was recorded in (T_4) 100 % RCF +Vermicompost 3 t/ha + Rice husk 1 t/ha followed by that in (T_1) 100 % RCF + Vermicompost 3 tha^{-1} and (T_3) 100 % RCF + Vermicompost 1.5 t/ha + Rice husk ash 1.5 t/ha and the lowest in (T_5)100 % RCF + 50% extra potassium. The highest gross return (Tk. 328500 ha^{-1}) as well as gross margin (Tk. 214600 ha^{-1}) was obtained in (T_4) 100 % RCF + Vermicompost 3 t/ha + Rice husk 1 tha^{-1} and the lowest gross return (Tk. 151200 ha^{-1}) and gross margin (Tk. 78675 ha^{-1}) were obtained from the treatment (T_5) 100 % RCF + 50% extra potassium. The highest BCR (2.88) was also obtained from the treatment (T_4) 100 % RCF +Vermicompost 3 t/ha + Rice husk 1 t/ha. The overall results indicated that among the treatments (T_4) 100 % RCF + Vermicompost 3 t/ha + Rice husk 1 t/ha and (T_1) 100 % RCF + Vermicompost 3 t/ha were found suitable for total productivity and economic return of the system.

Author's contribution

All authors contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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