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FEASIBILITY OF GROWING SELECTED VEGETABLES IN HANGING SAC WITH DIFFERENT LEVELS OF MANURE

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Abstract

Vegetable production in the waterlogged condition is the main challenge in Southwest Bangladesh and to address the problem the present investigation was undertaken to determine the prospect and profitability of hanging sack vegetable cultivation in the waterlogged condition under various levels of organic matter. The investigation comprised three of vegetables such as Brinjal, Tomato, and Okra in hanging sacs under three soil and organic matter combinations at Germplasm Center of Agrotechnology Discipline, Khulna University Bangladesh from November 2018 to March 2019. Three soil+cowdung combinations were $T_{0=}$ 100% soil, T_1= 50% soil+50% cowdung, T_2= 75% soil+ 25% cowdung, T_3=25% soil+ 75% cowdung replicated seven times to produce the less erroneous results. Brinjal in the hanging sac had significantly better biological yield (28.92 t/ha), net return (451,000Tk./ha)and benefit-cost ratio (BCR) (2.08)over okra or tomato when the sac was filled with 75% cowdung + 25% soil. The higher price plus advanced yield contributed to enhancing the profitability of brinjal. These results will inform decision-making about cropping system modification that can be adopted by vegetable growers of Southwest Bangladesh to considerably reduce fallow waterlogged areas and enhanced vegetable production in waterlogged conditions.

Keywords: Hanging sac, waterlogged, profitability, cowdung, BCR.

Introduction

Waterlogged is such a situation when water table increases in a certain height wherein the soil pores become inundated, thus dislocating the air from soil apertures (Barrett-Lennard, 2002) and hinders agricultural activity (Ahmed, 2005). Waterlogged is an acute problem in southwest Bangladesh due to special geographic location and climate. Khulna and Jessore districts of southwest Bangladesh cover about 8000 hectares of waterlogged land areas that made a devastating effect on livelihoods (Ali, 1996). Due to global warming, with the rise of sea level more areas will undergo waterlogging, as a result, cultivable lands gradually become unfit for crop production (BARC, 1991). This worrying situation directs the researchers to explore different adaptation practices viz.

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vegetable cultivation in a hanging sac, discharging the waterlogged water by fitting of drainage pump (Hsu *et al.,* 2000; Chandio *et al.,* 2012), downing water table by boost up groundwater (Singh, 2011) etc.

During monsoon season vegetable growing areas in waterlogged condition could be expanded by sac farming. Sac farming involves filling the sac with fertile soil, manures, and placed a few pebbles in bottom for proper drainage and keep few holes in-side for aeration and finally placed the plants in top and allow to grow. The main merits of sack farming are their portability, efficiency, productivity, and contributions to food security (Falguni, 2009) as well as reduce the risk of production (Ram *et al.,* 2007). Sac cultivation was highly effective in helping families adapt to salinity intrusion and waterlogging conditions (Angrish *et al.,*2006). Nutrient management system in sac cultivation is handy (Qureshi *et al.,* 2008). The system allows the more helpless families to cultivate vegetables otherwise they would struggle to buy and help to diversify their diet.

The farmers of Southwest Bangladesh face many challenges associated with a changing climate viz. waterlogging, salinization, flooding and so forth to meet up the food demand for increasing population. Vertical agriculture can address those challenges by maximizing the space around households by suspending organic horticulture production in sacks along bamboo structures over the water bodies. Now-a-days peoples demand for organic vegetables is growing gradually, but the supply is meager. Also, hanging sac vegetables cultivation allows women to better manage their own food security, nutrition and consumption of fresh vegetables. It is assumed that the extra cost of using hanging structure and organic manure may be compensated by greater yield and decreased intercultural costs. Therefore, the present study was designed to assess the prospect and profitability of hanging sac vegetable cultivation in waterlogged condition and to determine the impact of different levels of organic matter in sac.

Materials and Methods

The field trial was conducted at Germplasm Center of Agrotechnology Discipline, Khulna University, Khulna, Bangladesh from November 2018 to May 2019. The experimental site was located at 89°34' E Longitudes and 22°47' N Latitude (FAO, 1988).

To assess the profitability of selected three types of vegetables viz. brinjal (*Solanum melongena*), tomato (*Solanum lycopersicum*), okra (*Abelmoschus esculentus*) and to find out the suitable combination of soil and manure for sac, four different proportion viz. T_0= 100% soil, T_1= 50% soil + 50% cowdung, T_2= 75% soil + 25% cowdung, T_3= 25% soil + 75% cowdung were used as treatments. The single factor experiment was laid out in a Completely Randomized Design (CRD) with seven replications.

Seeds of brinjal, tomato and okra were used as planting material. Seeds of the selective vegetables were properly sun-dried and then treated with Provex-200 @ 2 g/kg of seeds before being placed in plastic cell tray for seedling preparation.

The sacks were filled with the mixture of soil and rotten cowdung according to the treatments leaving 5 cm unfilled from the brim. The individual sac was 50 cm × 40 cm in size and placed at spacing of 75 cm × 90 cm. The sacks were hanged from the bar by rope and iron wire. For easy access, intercultural operation and data collection in waterlogged conditions, a cork sheet boat was made. Recommended dose of cowdung (10,000 kg/ha) and chemical fertilizers were applied according to the respective crops such as Tomato (Urea: 280 kg/ha, TSP: 180 kg/ha, MoP: 220 kg/ha), Brinjal (Urea: 260 kg/ha, TSP: 180 kg/ha, MoP: 220 kg/ha), Okra (Urea: 150 kg/ha) (Azad *et al.*, 2019). However, no additional TSP and MoP fertilizers were applied in the sac of okra because okra was planted in tomato sac when the tomato plant was died.

The healthy thirty days old seedlings were transplanted in each sac. Irrigation was done daily until the plants were fully established. According to standard commercial practice, irrigation cycles were adjusted based on annual precipitation. Disease and pest infestation were monitored periodically, and its level was much below the action threshold level.

The fruits of tomato, brinjal and okra were harvested at mature stage. Cost of production was analyzed according to the procedure followed by Das*et al*. (2018) and Ozkan*et al*. (2004)to find out the most economic return under different treatment combinations. During growing period vegetable growers having prices for brinjal 30 Tk./kg, tomato 20 Tk./kg, okra 20 Tk./kg (DNCRP, 2019).

Recorded data were analyzed statistically using the GLIMMIX procedure of SAS and mean separation was done with Tukey-Kramer adjustment at $p \leq 0.05$ (SAS software Version 9.4, SAS Institute Inc, Cary, NC).

Results and Discussion

Yield and profitability of Brinjal

The economic yield of brinjal was significantly affected by different levels of cowdung in the sacs (Table 1). The highest yield of brinjal (28.92 t/ha) was found from 25% soil + 75% cowdung combination (T_3)and the lowest from control (soil) (15.5 4 t/ha) (T_0). Similar trend was found in the cost of production, gross return, net return and benefit-cost ratio of brinjal. The effect of different levels of cowdung was highly significant for the cost of production, gross return, net return and benefit-cost ratio of brinjal. The maximum cost was recorded from $T_3$and the lowest from T_0. Alike cost of production, the maximum gross return and net return were obtained from $T_3$and the lowest from T_0. Also, the highest benefit-cost ratio was obtained from T_3 (2.08) followed by T_1 and T_2 and the lowest from T_0 (1.88).

Table 1. Yield and profitability of Brinjal as affected by different levels of cowdung in sack

Treatment	Yield (t/ha)	Total cost	Gross return	Net return	BCR
		('000 Tk./ha)			
T_0 = 100% soil	15.54 c	248 c	466 c	218 c	1.88 b
T_1 = 50% soil + 50% cowdung	23.26 b	357 b	698 b	341 b	1.95 b
T_2 = 75% soil + 25% cowdung	19.74 b	312 b	592 b	280 b	1.89 b
T_3 = 25% soil + 75% cowdung	28.92 a	417 a	868a	451 a	2.08 a
LS	**	**	**	**	*

Means followed by the same letters within each column do not differ significantly whereas means having dissimilar letters differ significantly by Tukey-Kramer adjustment for multiple comparison. LS= Level of significance, BCR= Benefit cost ratio. *, ** significant at $p < 0.05$ and $p<0.01$, respectively.

Yield and profitability of Tomato

A significant difference in tomato yield was apparent due to various levels of cowdung (Table 2). The highest tomato yield (26.11 t/ha) was obtained from 25% soil + 75% cowdung combination (T_3). However, cost of production significantly differed with different cowdung levels. The highest cost of production (417,000 Tk./ha) was documented from T_3 followed by T_1 and T_2 and the lowest cost was calculated from T_0 (248,000Tk./ ha). Alike yield, different cowdung levels had significant effect on gross and net return. The highest gross and net return were attained from T_3 compared to other treatments. However, different cowdung levels had no significant effect on benefit-cost ratio.

Table 2. Yield and profitability of Tomato as affected by different levels of cowdung in Sack

Treatment	Yield (t/ha)	Total cost	Gross return	Net return	BCR
		('000 Tk./ha)			
T_0 = 100% soil	15.40 b	248 c	308 c	60 b	1.24
T_1 = 50% soil + 50% cowdung	20.74 b	357 b	415b	58 b	1.16
T_2 = 75% soil + 25% cowdung	17.21 b	312 b	344c	32 c	1.10
T_3 = 25% soil + 75% cowdung	26.11 a	417 a	522 a	105 a	1.25
LS	*	**	*	*	NS

Means followed by the same letters within each column do not differ significantly whereas means having dissimilar letters differ significantly by Tukey-Kramer adjustment for multiple comparison. LS= Level of significance, BCR= Benefit cost ratio, *, ** significant at $p < 0.05$, $p<0.01$, respectively, NS-Non-significant

Okra yield and profitability

Different cowdung levels significantly interacted with economic yield of okra (Table 3). The maximum yield of okra (23.10 t/ha) was observed in treatment T_3 (25% soil + 75% cowdung) while minimum yield was obtained from T_0 (14.10 t/ha) where no cowdung was used followed by T_2 and T_1. Similar inclination was found in total cost of production, gross return, net return. However, different cowdung levels had no significant effect on benefit cost ratio of okra. The highest total cost was recorded from $T_3$and the lowest cost was calculated from T_0. Similarly, the peak gross return of okra was found from T_3 and the least from T_0followed by T_2 and T_1, respectively. The highest net return of okra was obtained from treatment T_3 and the lowest net return was recorded from T_0.

Table 3. Yield and profitability of Okra as affected by different levels of cowdungin Sack

Treatment	Yield (t/ha)	Total cost	Gross return	Net return	BCR
		(‘000 Tk./ha)			
T_0 = 100% soil	14.10 b	221 c	282 c	61 b	1.28
T_1 = 50% soil + 50% cowdung	19.76 b	315 b	395 b	80 b	1.25
T_2 = 75% soil + 25% cowdung	17.18 b	282 b	344 b	62 b	1.22
T_3 = 25% soil + 75% cowdung	23.10 a	355 a	462 a	107 a	1.30
LS	**	**	**	**	NS

Means followed by the same letters within each column do not differ significantly whereas means having dissimilar letters differ significantly by Tukey-Kramer adjustment for multiple comparison. LS= Level of significance, BCR= Benefit cost ratio, *, ** significant at $p < 0.05$, $p<0.01$, respectively, NS-Non-significant

Average yield and profitability of brinjal, tomato and okra

The effect of different vegetables was non-significant for comparative average yield as well as total cost of production (Table 4). However, different vegetables had a significant effect on average gross and net return. The highest average gross and net return were found from brinjal followed by tomato and the lowest gross return was obtained from okra. Like gross and net return, benefit-cost ratio significantly differed among different vegetables. The highest benefit-cost ratio was obtained from brinjal (1.94) followed by tomato and the minimum from okra (1.13).

Table 4. Average yield and profitability of different vegetables cultivated in hanging Sack

Variety	Yield (t/ha)	Total cost	Gross return	Net return	BCR
		('000 Tk./ha)			
Brinjal	23.68	366	710 a	344 a	1.94 a
Tomato	21.86	366	437 b	71 b	1.19 b
Okra	19.03	336	381 c	45 c	1.13 b
LS	NS	NS	*	**	*

Means followed by the same letters within each column do not differ significantly whereas means having dissimilar letters differ significantly by Tukey-Kramer adjustment for multiple comparison. LS= Level of significance, NS, *, ** Non-significant or significant at $p < 0.05$, and 0.01, respectively

Hsu *et al.* (2000) reported that organic matter in the soil improves the biological activities viz. water retention capacity, infiltration rate, soil aggregate stability and cation- exchange capacity facilitating plant growth and yield. Again, Hossain *et al.* (2014) and Das *et al.* (2018) reported that soil fertility was restored by organic matter that enhanced vegetative growth ensuring more yield which supported this finding. Organic matter helps to increase availability of nutrients in the soil and a combination of organic (60%) + inorganic (40%) matter showed better performance for brinjal growth and fruit yield (Ullah *et al.*, 2008) which supports this finding. The results suggested that organic matter addition, more labor for intercultural operation facilitated to increase cost of production although gross and net return and BCR were highest from the same treatment due to advance yield and more price of brinjal. However, Keskin *et al.* (2010) informed that high labor cost increased total tomato production cost in turkey that was comparable with this finding. Also, per plant tomato production cost was higher in the organic system over conventional one reported by Santos *et al.* (2017). As par brinjal, Muqtadir *et al.* (2019) reported similar findings where they stated that okra yield increased by more organic and less inorganic fertilizer combination. Organic matter fosters the growth of various beneficial microbes that create a proper environment for plant growth and development (Bulluck *et al.,* 2002) which is comparable with this study. Also, the comparative results reveled that the brinjal performed better (>BCR) than tomato or okra in hanging sac at waterlogged condition because of higher yield and price.

Conclusion

In a nut shell, brinjal cultivation in hanging sac was profitable in terms of maximum benefit-cost ratio (2.08) in waterlogged condition compared to tomato or okra where per hanet return was Tk., 451,000. Similar trend was observed in average results. Out of four combinations of cowdung and soil, 75% cowdung +

25% soil in sac was the best for brinjal cultivation in waterlogged condition. Above all, production of brinjal in hanging sack with 3:1 ration of organic matter and soil is prospective and feasible for vegetable cultivation in waterlogged environment of southwest Bangladesh even though the ration can change with the types of vegetables. However, to establish consistency in the feasibility of vegetable cultivation in hanging sac in different waterlogged areas of Bangladesh, extensive research works are recommended.

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