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EFFECTS OF ORGANIC MANURES ON SUSTAINABLE CAULIFLOWER PRODUCTION IN GREY TERRACE SOILS OF BANGLADESH

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ABSTRACT

A field experiment on efficacy of different organic manures on sustainable yield and soil fertility under cauliflower production was conducted in the Grey Terrace Soil (AEZ-28) of Gazipur during the years of 2018-19 to 2019-20. Snow white variety of cauliflower was used as test crop. There were eight treatments viz. T_1: Native nutrient, T_2: Poultry manure @ 10 t ha^{-1}, T_3: Cowdung @ 20 t ha^{-1}, T_4: Farm Yard Manure @ 18 t ha^{-1}, T_5: Vermicompost @ 15 t ha^{-1}, T_6: Compost @ 15 t ha^{-1}, T_7: Tricho-Compost @ 10 t ha^{-1}, T_8: Bioslurry @ 15 t ha^{-1}. Forty percent of recommended N and K fertilizer as common & basal doses applied in experimental field. The experiment was laid out in RCB design with three replications. Data revealed that, the T_5 treatment produced the highest average yield (42.0 t ha^{-1}) of the two years of cauliflower. This trend of influence was consistent for almost all the yield contributing characters of cauliflower. The native nutrient treatment produced the lowest average yield (13.32 t ha^{-1}). The average uptake of nutrients by cauliflower curd was highest in the treatment T_5 (vermicompost) which was followed to T_8 (Bioslurry) treatment. The lowest nutrient uptake was noted from T_1 (control) treatment. In post-harvest soil analytical results explored that application of different organic manure with minimum amount of chemical fertilizers enhances the soil fertility. The highest gross margin (4,03,700 Tk.$ha^{-1}yr^{-1}$) and MBCR (3.13) was noted from T_8 (Bioslurry) treatment.

Key words: Cauliflower, yield, vermicompost, bioslurry, nutrient uptake, soil fertility

Introduction

Cauliflower (*Brassica oleracea*) is an important cole crop widely grown in tropical and temperate regions of the country. It is a nutritious vegetable and a good source of protein, thiamin, riboflavin, phosphorus and potassium, and a very good source of dietary fiber, vitamin C, vitamin K, vitamin B_6, folate, pantothenic acid and manganese (Bhandari and Kwak, 2015). Thus, cauliflower becomes a popular commercial crop among the vegetable growers. But cauliflower is a heavy feeder and for better yield the soil must be fertile. Continuing of using and increasing doses of mineral fertilizer declines the quality of soil fertility. Therefore it is necessary to add organic amendments in cultivation practices such as vermicompost, bioslurry, compost of green biomass, poultry manure, cow manure etc. that may function as an alternative to substitute mineral fertilizers and to improve the physical and biological properties of soil (Golabi *et al*., 2004; Fronning *et al*., 2008). Applying organic compost on agricultural land is aimed to improve the properties of soil biology and physics, including maintaining the function of soil nutrients in the soil so easily used by plants, stimulate microbial activity in the soil to help plants to absorb nutrients provided by organic and inorganic fertilizers, thus contributing to growth and yield (Mucheru-Muna and Mugendi, 2007; Farahzety and Aisah, 2013). Recent developments in intensive agriculture, though contributed immensely towards surplus food, caused degradation of fertile land and left hazardous residues in food products. Thus, there is an increasing awareness throughout the world about the organic, sustainable agricultural practice. Besides these organic manures can be prepared by using local materials which are *eco*friendly, economically viable to the farmers and safe to human health (Mall *et al.,* 2005). Keeping these points in view, the investigation was undertaken with the objectives i) to find out the suitable organic manure for cole crop production, ii) to increase sustainable yield of cole crop, iii) to assess nutrient uptake of cauliflower from different organic manures and iv) to improve the soil properties.

Materials and Methods

A field experiment regarding effect of different types of organic manure on cauliflower production was conducted in the Grey Terrace Soil (AEZ-28) of Gazipur during the years of 2018-19 to 2019-20. The initial soil samples collected from the depth of 0-15 cm and analyzed in the laboratory following standard methods and the properties are in Table 1. From initial soil test results, the rate of different nutrients was calculated. Chemical analysis of poultry manure, cowdung, farm yard manure, vermicompost, compost, tricho-compost and bioslurry were mentioned in Table 2. The experiment was laid out in a randomized complete block design with three replications. Eight different treatments viz. T_1: Native nutrient, T_2: Poultry manure @ 10 t ha^{-1}, T_3: Cowdung @ 20 t ha^{-1}, T_4: Farm Yard Manure @ 18 t ha^{-1}, T_5: Vermicompost @ 15 t ha^{-1}, T_6: Compost @ 15 t ha^{-1}, T_7: Tricho-Compost @ 10 t ha^{-1}, T_8: Bioslurry @ 15 t ha^{-1}. The rate of different organic manures calculated to Phosphorus (P) equivalent for STB recommended doses. The unit plot size was 3m × 3m. The tested crop and variety was cauliflower (var. Snow white). Thirty one days seedlings of cauliflower were transplanted in line with 50 cm row to row and 50 cm plant to plant spacing on 21 November 2018 and 20 November 2019. Nitrogen @ 54 kg and potassium @ 54 kg ha^{-1} (40% Recommended dose of N & K) was supplied from urea and MoP as a common basal dose. All organic fertilizers, MoP and $^1/_3$ of N were applied at the time of final land preparation. The remaining two third of N were applied as top dress at 30 and 60 days after transplanting. Irrigation and other intercultural operations were done as and when necessary. The cauliflower was harvested on 13 February 2019 and 15 February 2020.

Table 1. Chemical properties of experimental soil (initial) at the Central Research Farm (BARI), Gazipur during 2018

Location	pH	OC	Ca	Mg	K	Total N	P	S	B	Zn
		(%)	meq $100g^{-1}$			(%)	µg g^{-1}			
Gazipur	6.7	0.79	4.0	2.1	0.12	0.07	8	11	0.10	1.8
Critical Level		-	2.0	0.5	0.12	0.12	7	10	0.20	0.6

Table 2. Nutrient status of different organic manures used in the experimental field

Manures	pH	OC	Ca	Mg	K	Total N	P	S	B	Zn
		%								
Poultry manure	6.78	15.8	7.20	3.11	0.53	1.35	1.22	0.52	0.029	0.036
Cow dung	6.58	14.6	5.50	1.44	0.27	1.10	1.16	0.37	0.018	0.016
FYM	6.56	12.2	2.47	1.47	0.21	1.22	1.16	0.34	0.013	0.022
VC	6.93	23.5	2.18	1.01	0.78	1.55	1.42	0.58	0.019	0.037
Compost	7.03	16.7	4.44	2.24	0.09	1.24	1.24	0.36	0.028	0.026
Tricho-compost	6.62	14.5	2.66	1.33	1.62	1.15	1.22	0.48	0.011	0.041
Bioslurry	7.02	18.5	7.99	2.33	0.57	1.45	1.36	0.57	0.019	0.036

Data on yield and yield contributing characters were recorded and analyzed statistically using Statistics-10 software. LSD test was used to determine the significant differences between treatments. Plant and soil samples were collected from each plot for laboratory analysis.

Results and Discussion

There was a significant effect of different organic manure treatments on the yield and yield contributing characters of cauliflower (Tables 3 -4). The tallest plant (48.9 and 54.97 cm in 2018-19 and 2019-20, respectively) was recorded in T_5 treatment which was statistically similar to all treatments except control treatments. The increase in plant height in all treatments except control was attributed to availability of optimum nutrients throughout the growing season which might release the optimum and balanced nutrients from different types of organic manure that reflected in plant height. The lowest plant height

(24.4 cm in 2018-2019 and 27.10 cm in 2019-2020) was noted in control treatment. Maximum curd height (9.63 cm in 2018-2019 and 11.2 cm in 2019-2020) was observed also in T_5 treatments. A similar observation was also noted in case of curd circumference (Table 3) and marketable weight (Fig. 1) of cauliflower. This might be due to the greater efficiency of vermicompost that releasing different available nutrients by mineralization. Long *et al.* (2006) found that the higher photosynthetic efficiency of plants estimated in terms of biomass accumulation seems to be one of the potential factors for improving various yield components.

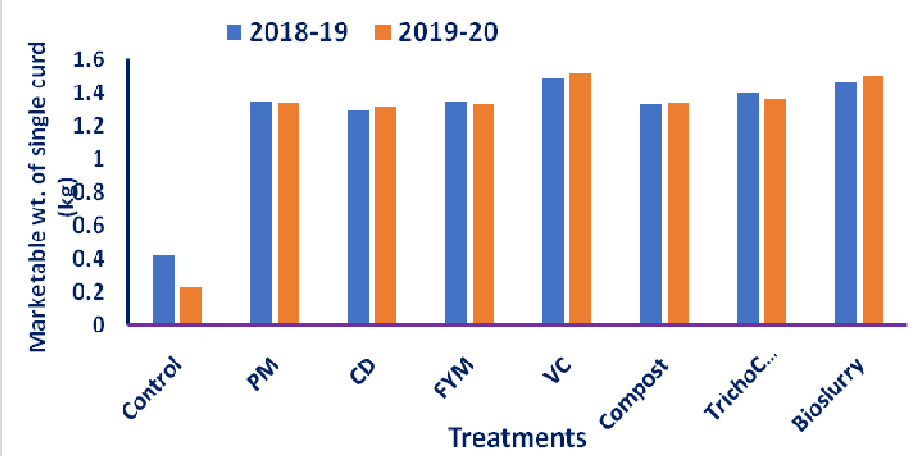

Fig. 1. Efficacy of different organic manures on marketable wt. of single curd of cauliflower

Table 3. Efficacy of different organic manures on the yield parameters of cauliflower during 2018-19 to 2019-20

Treatments	Plant height		Curd height		Curd circumferences	
	(cm)					
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
T_1 (Control)	24.4b	27.10c	5.10b	6.07d	22.70 d	32.9e
T_2 (PM)	43.3a	50.43a	9.23a	10.3bc	39.67bc	46.7cd
T_3 (CD)	43.3a	38.27b	9.02a	10.1c	38.07c	43.7d
T_4 (FYM)	44.5a	40.50b	9.10a	10.3bc	38.43c	48.3bcd
T_5 (VC)	48.9a	54.97a	9.63a	11.2a	50.53a	56.2a
T_6 (Compost)	43.6a	49.10a	9.42a	10.8abc	44.07abc	49.3abcd
T_7 (Tricho-Compost)	47.6a	51.30a	9.45a	10.6abc	44.87ab	51.6abc
T_8 (Bioslurry)	48.7a	54.20a	9.52a	11.1ab	46.70ab	54.1ab
SE (±)	3.97	2.75	0.30	0.36	3.37	3.42
CV (%)	11.21	7.36	4.12	4.37	10.14	8.74

Means followed by the same letter in a column are not statistically significant at 5% level in LSD test.

The highest yield of cauliflower (41.52 t ha^{-1} in 2018-2019 and 42.44 t ha^{-1} in 2019-2020) was obtained in T_5 (vermicompost @ 15 t ha^{-1}) treatment which was statistically similar (39.03 t ha^{-1} in 2018-2019 and 39.32 t ha^{-1} in 2019-2020) to T_8 (Bioslurry @ 15 t ha^{-1}) treatments. The lowest curd yield (16.81 t ha^{-1} in 2018-2019 and 9.82 t ha^{-1} in 2019-2020) of cauliflower was found in control treatment. Simarmata *et al.* (2016) reported that the highest curd yield of cauliflower was observed in the treatment of 50% of mineral fertilizers combined with cow manure compost @ 20 t ha^{-1}. Similar results on cauliflower were also investigated by Farahzety and Aishah (2013) and Jahan *et al.* (2014). Highest average yield (42.0 t ha^{-1}) of cauliflower and maximum % of yield increased (68%) over control also found with T_5 (vermicompost) treatment which was followed to T_8 (Bioslurry) treatments.

Table 4. Efficacy of different organic manures on sustainable yield and soil fertility under cauliflower production during the year of 2018-19 to 2019-20

Treatments	Yield of cauliflower (t ha^{-1})		Average yield of cauliflower	Yield increased over control
	2018-19	2019-20	(t ha^{-1})	(%)
T_1 (Control)	16.81d	9.82e	13.32	-
T_2 (PM)	34.06bc	34.15cd	34.11	61
T_3 (CD)	33.39c	33.00d	33.20	60
T_4 (FYM)	34.39bc	34.75cd	34.57	61
T_5 (VC)	41.52a	42.44a	42.00	68
T_6 (Compost)	34.48bc	34.64cd	34.56	61
T_7 (Tricho-Compost)	37.04abc	37.10bc	37.07	64
T_8 (Bioslurry)	39.03ab	39.32ab	39.18	66
SE (±)	2.48	1.88	-	-
CV (%)	8.98	6.94	-	-

Means followed by the same letter in a column are not statistically significant at 5% level in LSD test.

Nutrient uptake: Nutrient uptake (average of 2 years) by cauliflower curd was influenced by different treatments (Fig.2). The uptake of NPKSZnB by cauliflower curd was highest in the treatment T_5 (vermicompost @ 15 t ha^{-1}) which was followed by T_8 (Bioslurry @ 15 t ha^{-1}) treatment. Organic fertilizers (i.e. cow dung, poultry manure, vermicompost, bioslurry etc) resulted better nutrient uptake and it might be play the key role in enhancing efficient utilization of native nutrients which increases plant uptake. The lowest nutrient uptake was obtained from T_1 (control) treatment.

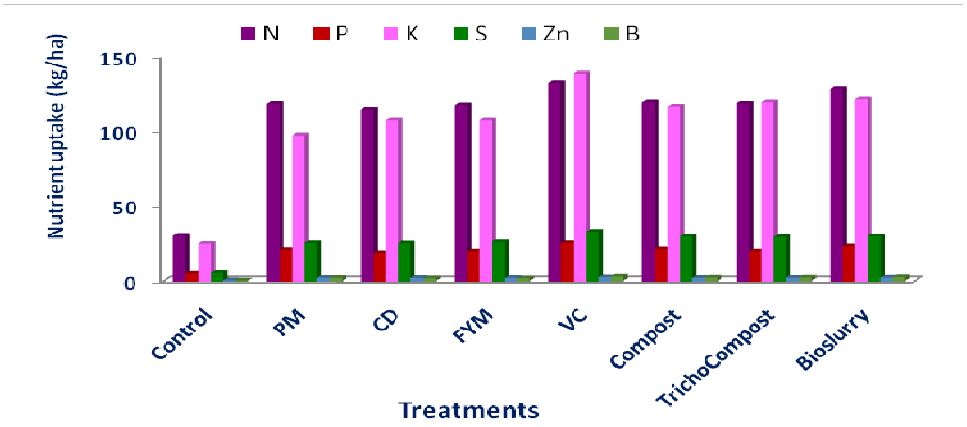

Fig. 2. Effect of different organic manures on nutrient uptake by cauliflower curd

Chemical Properties of post harvest soil: pH of the post harvest soil ranged from 5.90 to 6.63 whereas the initial soil pH was 6.7. It may be stated that the decrease in pH of the post harvest soil compared to initial might be due to release of organic acid by decomposition of organic manures. Nutrient content in post harvest soil was significantly differed by the different treatments. The content of organic carbon and total N in post-harvest soils ranged from 0.79-1.16% and 0.06-0.11% respectively. The available P, S, B & Zn content of the post harvest soils ranged from 8-15, 10.9-23, 0.10-0.53 and 1.71-2.55 ppm respectively. Organic carbon, total N, exchangeable K, Ca and Mg, available P, S, B and Zn were increased due to application of organic manure compared to that of initial soil. The highest NPKSBZnCaMg content and OC% in post harvest soil received from vermicompost @ 15 t ha^{-1} which was supported by Sabina Devkota *et al.* (2021).

Table 5. Chemical properties in post harvest soil of efficacy of different organic manures on sustainable yield and soil fertility under cauliflower production during the year of 2020

Treatments	pH	OC (%)	Total N (%)	P	S	B	Zn	K	Ca	Mg
				ppm				meq $100g^{-1}$ soil		
T_1	6.47ab	0.79c	0.06c	8.0e	10.9c	0.10d	1.71c	0.12b	3.25b	1.32b
T_2	6.40ab	1.08ab	0.10ab	12bcd	20.6b	0.39bc	2.21b	0.15a	4.65a	2.61a
T_3	6.10ab	1.02b	0.09b	10.3d	19.5b	0.34c	2.13b	0.15a	4.58a	2.49a
T_4	6.37ab	1.01b	0.09b	11.0cd	19.9b	0.37c	2.24b	0.15a	4.66a	2.58a
T_5	6.63a	1.16a	0.11a	15.0a	18.4b	0.53a	2.55a	0.15a	4.84a	2.65a
T_6	6.53a	1.09ab	0.10ab	13abc	20.2b	0.39bc	2.21b	0.16a	4.70a	2.59a
T_7	6.43	1.02b	0.10ab	12.3bc	23.0a	0.39bc	2.19b	0.16a	4.71a	2.47a
T_8	5.90b	1.12ab	0.11ab	14.0ab	20.1b	0.44b	2.30ab	0.15a	4.80a	2.63a
SE (±)	0,27	0.07	0.007	1.07	1.10	0.03	0.13	0.008	0.19	0.29
CV (%)	5.11	7.80	9.85	11.01	7.09	10.18	7.16	7.13	5.05	14.7

Means followed by the same letter in a column are not statistically significant at 5% level by LSD
SE (±) = Standard error of means, CV = Coefficient of Variance

Cost and return analysis: The estimated gross return, variable cost, gross margin and marginal benefit cost ratio (MBCR) are presented in Table 6. The cost and return analysis showed that the highest gross margin (4,03,700 Tk. ha^{-1} yr^{-1}) was obtained from T_8 (Bioslurry) treatment but the highest marginal value product (4,30,200 Tk. ha^{-1} yr^{-1}) was noted from T_5 (VC) treatment. The highest marginal benefit cost ratio (3.13) was recorded from T_8 (Bioslurry) treatment. Although, the highest gross return (6,30,000 Tk $ha^{-1}yr^{-1}$) was found from T_5 (VC) treatment but the gross margin and MBCR were highest in T_8 (Bioslurry) treatment due to higher price of vermicompost.

Table 6. Marginal Benefit Cost Ratio (MBCR) of efficacy of different organic manures on sustainable yield and soil fertility under cauliflower production (average of 2 years)

Treatments	Yield (t ha^{-1})	Gross return	Total variable cost	Gross margin	*MVP	**MVC	MBCR
		(Tk. ha^{-1} yr^{-1})					
T_1 (Control)	13.32	199800	60000	139800	-	-	-
T_2 (PM)	34.11	511650	184000	327650	311850	124000	2.51
T_3 (CD)	33.20	498000	164000	334000	298200	104000	2.87
T_4 (FYM)	34.57	518550	164000	354550	318750	104000	3.06
T_5 (VC)	42.00	630000	364000	266000	430200	304000	1.42
T_6 (Compost)	34.56	518400	364000	154400	318600	304000	1.05
T_7 (Tricho-Compost)	37.07	556050	364000	192050	356250	304000	1.17
T_8 (Bioslurry)	39.18	587700	184000	403700	387900	124000	3.13

* Marginal Value Product, ** Marginal Value Cost

Legend:

Urea	= 16 $Tkkg^{-1}$	PM	= 8 $Tkkg^{-1}$
TSP	= 25$Tkkg^{-1}$	CD	= 5 $Tkkg^{-1}$
MoP	= 15 $Tkkg^{-1}$	FYM	= 5$Tkkg^{-1}$
Gypsum	= 12 $Tkkg^{-1}$	VC	= 20 $Tkkg^{-1}$
Zinc sulphate	= 200 $Tkkg^{-1}$	Compost	= 20 $Tkkg^{-1}$
Boric acid	= 250 $Tkkg^{-1}$	Tricho-compost	= 20 $Tkkg^{-1}$
Cauliflower	= 15 $Tkkg^{-1}$	Bioslurry	= 15 $Tkkg^{-1}$

Conclusion

Application of different sources of organic manure along with minimum amount of mineral nutrients gave better performance on growth, yield and nutrient uptake as well as improved post harvest soil of cauliflower. Economic analysis showed that, the highest gross return and highest marginal value product were noted with T_5 (VC) treatment but gross margin and MBCR were highest in T_8 (Bioslurry) treatment due to higher price of vermicompost. The farmers may preferably choose any of these treatments which can give a higher gross margin with relatively a lower variable cost and which can sustain soil fertility.

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