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INTEGRATED NUTRIENT MANAGEMENT FOR SUNFLOWER IN COASTAL CHAR LAND OF BANGLADESH

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Abstract

An experiment was conducted at coastal charlandof OFRD, BARI, Noakhali;MLT site, Amtoli,Bargunaand ARS,Benarpota, Satkhira during *Rabi* season of 2018-19to evaluate the effect of integrated nutrient management on growth,yield and economic performance of sunflower. Six treatment combinations viz. T_1= Soil test based fertilizer dose for HYG, T_2 = IPNS with 5 tha^{-1}cowdung, T_3= IPNS with 5 tha^{-1} compost, T_4= IPNS with 1.5 t ha^{-1}vermicompost, T_5= Farmers' practice and T_6= Absolute control were tested. The experiment was laid out in a randomized complete block design with 3 replications and BARI Sunflower-2 was used as test crop.The IPNS treatment combinations are significantly differentfrom rest of the treatments in terms of yield and economic return. Application of treatment IPNS with 1.5 tha^{-1}vermicompost significantly increased all of the parameters such as the plant height, head diameter, number of seed per head,1000 seed weight, seed yield and stover yield. The significantly highest seed yield (2.19, 2.23 and 2.06 t ha^{-1} at Noakhali, Bargunaand Satkhira, respectively) was recorded in IPNS with 1.5 tha^{-1}vermicompost treated plot (T_4) while the lowest seed yield (1.05, 1.10 and 1.02 t ha^{-1} at Noakhali, Barguna and Satkhira, respectively) was observed in absolute control treatment (T_6). Salinity level increased at slower rate in T_2, T_3 and T_4, treatments where IPNS based nutrient management packages were imposed.During the crop growing period soil salinity ranged from 0.62 to 9.72dS m^{-1}, 0.58 to 9.23dS m^{-1}, 0.73 to 9.86dS m^{-1} at Noakhali, Barguna and Satkhira, respectively from emergence to maturity stages of the crop. The highest net return (50790 Tk. ha^{-1}, 52765 Tk. ha^{-1} and 43940 Tk. ha^{-1} at Noakhali, Barguna and Satkhira, respectively) as well as BCR (1.75, 1.78 and 1.67 atNoakhali, Barguna and Satkhira, respectively) were obtained from T_4 treatment (IPNS with 1.5 tha^{-1}vermicompost) whereas the lowest net return (14900 Tk. ha^{-1} ,15175 Tk. ha^{-1} and 11570 Tk. ha^{-1} at Noakhali, Barguna and Satkhira, respectively) and BCR (1.40, 1.33 and 1.26at Noakhali, Barguna and Satkhira, respectively) were obtained from control (T_6) treatment. The overall results indicated that IPNS with 1.5 tha^{-1} vermicompostis more effective than other fertilizer management packages in respect of yield as well as economic return for sunflower cultivation in the coastal charland of Bangladesh.

Introduction

Sunflower *(Helianthus annuus*L.) is an important oilseed crop of the world and it ranks second in production next tosoybean (FAO, 2003).It is a thermo neutral crop growing both in *Rabi* and *Kharif*seasons in anywhere in Bangladesh. Sunflower has potential to reduce the existing gap between production and consumption of edible oil because it contains almost 40-50% oil and rich in protein which is about 23%(Rosa and Rosemar, 2009). Cultivation of sunflower is suitable in the coastal region of Bangladesh because of its extensive adaptability and it is a good substitute when it is difficult to cultivate other crops due to climate change, increasing soil salinity in the coastal areas, scarcity of irrigation facility etc.Sunflower can be grown in any district of Bangladesh and the average production is about 1.2 tha^{-1}, which is relatively encouraging but not satisfactory (BBS, 2016). The lower

productivity of sunflower is mainly due to lack of high yielding varieties, its cultivation onmarginal lands with inadequate nutrients and alsocontinuous and imbalance use of inorganic fertilizer deteriorates soil health. Experimental evidences revealed that the crop was highly responsive to different fertilizers and the yield could be increased remarkably through judicious fertilization (Mohamed, 1984; Roy and Singh, 2005; Kazi*et al.,* 2002).

Integrated nutrient management practices applied for sunflower can contribute to sustainable growth, yield and quality, influences plant health and reduces environmental risks. Use of organic manures with optimum rate of fertilizers under intensive farming system increases the turnover of nutrients in the soil plant system. The organic manures help in reducing the dose of inorganic fertilizer, whichinturn reduces the cost of cultivation and help in improving the soil health.

Although sunflower cultivation in Bangladesh is rather limited, there is an ample scope of increasing its cultivation and productivity through integrated nutrient management. Therefore, the present piece of research work was undertaken to know the effect of integration of nutrients for cultivation of sunflower in coastal charlands and to find out the optimum and economic fertilizer dose for sunflower.

Materials and Methods

A field experiment was conducted at coastal charlandof OFRD, BARI, Noakhali (AEZ-18);MLT site, Amtoli,Barguna (AEZ-13) and ARS, Benarpota, Satkhira (AEZ-13) during *Rabi* season of 2018-19to evaluate the effect of integrated nutrient management for better yield of sunflower. Before conducting the experiment, initial composite soil samples (0-15 cm) were collected from the experimental plots and collected samples were analyzed in the laboratory following standard methods (Table 1). Moreover, nutrient status of vermicompost, compost and cowdung used in the experimental field were also analyzed (Table 2). The experiment was laid out in a RCB design with three (03) replicates. The unit plot size was 4m×3m and BARI Sunflower-2 was used as the test crop. Treatments were randomly distributed within the blocks as follows: T_1= Soil test based fertilizer dose for HYG, T_2 = IPNS with 5 tha^{-1}cowdung, T_3= IPNS with 5 tha^{-1} compost, T_4= IPNS with 1.5 t ha^{-1} vermicompost, T_5= Farmers' practice and T_6= Absolute control (Table 3a, 3b & 3c). The seeds were sown @ 10 kg ha^{-1} in line with the spacing of 50 cm x 25 cmon 18 December, 20 December and 17 December, 2018 atNoakhali,Barguna and Satkhira,respectively. Different intercultural operations and plant protection measures were taken as and when necessary to raise healthy crops.

Table 1. Chemical properties of initial soil of experimental field during 2018-19

Location	pH	EC	OM	Ca	Mg	K	Total N	P	S	B	Cu	Fe	Mn	Zn
		dSm^{-1}	(%)	meq $100g^{-1}$			(%)	μg g^{-1}						
Noakhali	6.9	1.05	1.28	5.0	2.3	0.11	0.08	9.3	28.2	0.61	1.01	18	6.74	1.95
Barguna	6.5	0.91	1.19	3.7	1.9	0.22	0.09	2.6	22.6	0.50	1.13	21	5.12	1.60
Satkhira	7.6	1.13	1.44	1.69	1.1	0.20	0.11	12.1	26.7	0.47	1.18	13	7.68	0.65
Critical Level		-	-	2.0	0.5	0.12	0.12	7/10	10	0.20	0.2	4	1	0.6

EC= Electrical Conductivity & OM= Organic Matter

Table 2. Nutrient status of compost,cowdung andvermicompost used in the experimental field

Name of the manure	pH	OC	Ca	Mg	K	Total N	P	S	B	Zn	Pb	Cd	As
		%										(ppm)	
Compost	7.1	16.3	1.50	2.10	1.17	1.23	0.79	0.50	0.013	0.14	2.89	2.11	1.72
Cow dung	7.5	15.4	2.23	0.44	0.69	1.15	0.57	0.36	0.011	0.15	3.10	2.84	1.26
Vermicompost	7.2	17.9	2.10	2.60	1.94	1.68	1.26	0.89	0.015	0.16	2.61	2.19	1.14

OC = Organic Carbon

Moisture content of Compost = 12.15 %,Cowdung = 12.46 % and Vermicompost = 11.96 %

Table 3a. Treatment combinations for sunflower atNoakhali

Treatments	Treatment combination								
	Chemical fertilizer (kg ha^{-1})						Organic manure (t ha^{-1})		
	N	P	K	S	Zn	B	Cowdung	Compost	Vermicompost
T_1= Soil test based fertilizer dose for HYG (FRG,2012)	134	29	56	1.3	-	-	0	0	0
T_2= IPNS with 5 tha^{-1}cowdung	111	17.6	42.2	0	-	-	5	0	0
T_3= IPNS with 5 tha^{-1} compost	109.4	11.2	32.6	0	-	-	0	5	0
T_4= IPNS with 1.5 tha^{-1}vermicompost	124	21.4	44.3	0	-	-	0	0	1.5
T_5= Farmers' practice	138	18	25	0	-	-	-	-	-
T_6 = Absolute control	Native fertility						-	-	-

Table 3b. Treatment combinations for sunflower at Barguna

Treatments	Treatment combination								
	Chemical fertilizer (kg ha^{-1})						Organic manure (t ha^{-1})		
	N	P	K	S	Zn	B	Cowdung	Compost	Vermicompost
T_1= Soil test based fertilizer dose for HYG (FRG,2012)	125	42	31.3	6.9	-	-	0	0	0
T_2= IPNS with 5 tha^{-1}cowdung	102	30.6	17.5	0	-	-	5	0	0
T_3= IPNS with 5 tha^{-1} compost	100	26.2	7.9	0	-	-	0	5	0
T_4= IPNS with 1.5 tha^{-1}vermicompost	114	34	19.6	1.6	-	-	0	0	1.5
T_5= Farmers' practice	100	20	30	5	-	-	-	-	-
T_6 = Absolute control	Native fertility						-	-	-

The crop was harvested on 28 March, 31 March and 25 March, 2019 at Noakhali, Barguna and Satkhira, respectively. Soil salinity level was measured by using Electrical Conductivity meter Adwa (AD 310) at different growth stages of the crop. Data were collected on an individual plant basis from ten (10) randomly selected plants of each plot in such a way that the border effect was avoided for high precision. Data on yield and yield contributing parameters were recorded and statistically analyzed with the help of statistical package statistix 10 (Analytical Software. Tallahassee, Fla, USA) and mean separation was tested by Duncan's Multiple Range Test (DMRT) (Steel and Torrie, 1960).

Table 3c. Treatment combinations for sunfloweratSatkhira

Treatments	Treatment combination								
	Chemical fertilizer (kg ha^{-1})						Organic manure (t ha^{-1})		
	N	P	K	S	Zn	B	Cowdung	Compost	Vermicom post
T_1= Soil test based fertilizer dose for HYG (FRG,2012)	100	23	36	3.1	1.5	-	0	0	0
T_2= IPNS with 5 tha^{-1}cowdung	77	11.6	22.2	0	-	-	5	0	0
T_3= IPNS with 5 tha^{-1} compost	75.4	7.2	12.6	0	-	-	0	5	0
T_4= IPNS with 1.5 tha^{-1}vermicompost	89	15.9	24.3	0	0.5	-	0	0	1.5
T_5= Farmers' practice	115	20	25	2	-	-	-	-	-
T_6 = Absolute control	Native fertility						-	-	-

Methods of chemical analysis

Soil pH was measured by a combined glass calomel electrode (Jackson, 1958). Organic carbon was determined by wet oxidation method (Walkley and Black, 1934). Total N was determined by modified Kjeldahl method. Ca and Mg were determined by NH_4OAc extraction method. K, Cu, Fe, Mn and Zn were determined by DTPAextraction followed by AAS reading. Boron was determined by $CaCl_2$ extraction method. Phosphorus was determined by Bray and Kurtz method (Acid soils) and Modified Olsen method (Neutral + Calcareous soils). S was determined by $CaH_4(PO_4)_2.H_2O$ extraction followed by turbidimetric method with $BaCl_2$.

Results and Discussion

Yield and yield components

The effect of integrated nutrient management on the yield and yield parameters of sunflower are summarized in the Table 4, 5&6. Seed yield, stoveryield and yield attributes like plant height, head diameter, number of seeds head^{-1} and thousand seed weight of sunflower were significantly influenced by different nutrient management packages in this study.

Table 4. Effect of integrated nutrient management on yield and yield contributing characters of sunflower
var. BARI Sunflower-2 at Noakhali during *Rabi* season of 2018-19

Treatments	Plant height (cm)	Head diameter(cm)	Number of seeds head^{-1}	1000 Seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1	127.6c	14.5bc	547d	57.7abc	1.59c	3.38c
T_2	131.4b	15.1ab	599c	59.6ab	1.87b	3.80b
T_3	134.7ab	15.8ab	632b	60.3ab	2.08ab	4.05a
T_4	136.3a	16.3a	648a	62.2a	2.19a	4.20a
T_5	123.2cd	13.7c	528d	57.1bc	1.48c	2.97d
T_6	114.8d	12.2d	463e	54.3c	1.05d	2.35e
CV (%)	5.42	4.12	4.60	2.13	6.81	5.14

Means followed by same letter (s) do not differ significantly at 5% level of significance

T_1= Soil test based fertilizer dose for HYG (FRG,2018),T_2= IPNS with 5 tha^{-1}cowdung, T_3= IPNS with 5 tha^{-1}compost, T_4= IPNS with 1.5 tha^{-1}vermicompost,T_5= Farmers' practice and T_6 = Absolute control

Significantly the highest plant height (136.3 cm, 137.4 cm and 129.5 cm at Noakhali, Bargunaand Satkhira, respectively) was observed in T_4 treatment (IPNS with 1.5 t ha^{-1} vermicompost) which was statistically identical with T_3 treatment. The lowest plant height (114.8 cm, 115.5 cm and 112.1 cm Noakhali, Bargunaand Satkhira, respectively) was obtained from absolute control treatment (T_6). The result related to plant height was similar to the findings of Vedpathak and Chavan (2016) who observed that application of vermicompost along with chemical fertilizers increased plant height significantly in sunflower. Significantly the maximum head diameter (16.3 cm, 16.5 cm and 15.8 cm at Noakhali, Barguna and Satkhira, respectively) was recorded in IPNS with 1.5 t ha^{-1} vermicompost treated plot (T_4) whereas the minimum head diameter (12.2 cm, 12.6 cm and 11.9 cm at Noakhali, Barguna and Satkhira, respectively) was observed in absolute control treatment (T_6).

Table 5. Effect of integrated nutrient management on yield and yield contributing characters of sunflower
var. BARI Sunflower-2 at Bargunaduring *Rabi* season of 2018-19

Treatments	Plant height (cm)	Head diameter (cm)	Number of seeds $head^{-1}$	1000 Seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1	127.1c	14.6d	556d	58.7c	1.66cd	3.54d
T_2	132.6b	15.7c	602c	59.3bc	1.89bc	3.83c
T_3	135.3ab	16.1b	625b	61.5ab	2.12ab	4.16b
T_4	137.4a	16.5a	656a	62.4a	2.23a	4.35a
T_5	125.2c	13.5e	534e	57.6c	1.56d	3.06e
T_6	115.5d	12.6f	469f	55.8d	1.10e	2.47f
CV (%)	5.61	4.23	5.87	2.94	7.24	6.12

Means followed by same letter (s) do not differ significantly at 5% level of significance

T_1= Soil test based fertilizer dose for HYG (FRG, 2018), T_2= IPNS with 5 tha^{-1}cowdung,T_3= IPNS with 5 tha^{-1} compost,T_4= IPNS with 1.5 tha^{-1}vermicompost,T_5= Farmers'practice and T_6 = Absolute control

Table 6.Effect of integrated nutrient management on yield and yield contributing characters of sunflower
var. BARI Sunflower-2 at Satkhira during *Rabi* season of 2018-19

Treatments	Plant height (cm)	Head diameter (cm)	Number of seeds $head^{-1}$	1000 Seed weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})
T_1	120.8c	14.1ab	546d	54.1bc	1.52c	3.01c
T_2	124.4b	14.7ab	589c	56.6ab	1.80b	3.34b
T_3	127.3a	15.2ab	617b	58.3a	1.97ab	3.65a
T_4	129.5a	15.8a	639a	59.2a	2.06a	3.73a
T_5	117.6d	13.3bc	501e	53.5bc	1.37d	2.76d
T_6	112.1e	11.9c	443f	51.1c	1.02e	2.11e
CV (%)	4.87	4.14	3.85	3.40	7.35	7.72

Means followed by same letter (s) do not differ significantly at 5% level of significance

T_1= Soil test based fertilizer dose for HYG (FRG, 2018), T_2= IPNS with 5 tha^{-1}cowdung,T_3= IPNS with 5 tha^{-1} compost,T_4= IPNS with 1.5 tha^{-1}vermicompost,T_5= Farmers'practice and T_6 = Absolute control

Significantly the highest number of seeds $head^{-1}$ (648, 656 and 639 at Noakhali, Barguna and Satkhira, respectively) was observed in T_4 treatment which was followed by T_3, T_2, T_1 and T_5 treatment whereas the lowest number of seeds $head^{-1}$ (463, 469 and 443 at Noakhali, Barguna and Satkhira, respectively) was obtained from absolute control treatment (T_6). Significantly the maximum 1000 seed weight (62.2 g, 62.4 g and 59.2 g at Noakhali, Barguna and Satkhira, respectively) was recorded in T_4 treatment

which was statistically at par with T_3 and T_2 treatments whereas the minimum 1000 seed weight (54.3 g, 55.8 g and 51.1 g at Noakhali, Barguna and Satkhira, respectively) was recorded in control treatment (T_6).Significantly the highest seed yield (2.19 t ha^{-1}, 2.23 t ha^{-1} and 2.06 t ha^{-1} at Noakhali, Barguna and Satkhira, respectively) was recorded in IPNS with 1.5 t ha^{-1} vermicompost treated plot (T_4) which was statistically at par with T_3 (IPNS with 5 t ha^{-1} compost) treatment The lowest seed yield (1.05 t ha^{-1}, 1.10 t ha^{-1} and 1.02 t ha^{-1} at Noakhali, Barguna and Satkhira, respectively) was observed from absolute control treatment (T_6). The result was similar to the findings of Kalaiyarasan and Vaiapuri (2008) who observed that integrated use of chemical fertilizers along with vermicompost gave maximum seed yield in sunflower. The highest stover yield (4.20 t ha^{-1}, 4.35 t ha^{-1} and 3.73 t ha^{-1} at Noakhali, Barguna and Satkhira, respectively) was recorded in IPNS with 1.5 t ha^{-1} vermicompost treated plot (T_4) whereas the lowest stover yield (2.35 t ha^{-1}, 2.47 t ha^{-1} and 2.11 t ha^{-1} at Noakhali, Barguna and Satkhira, respectively) was observed from absolute control treatment (T_6).

Soil salinity

Soil salinity level gradually increased from emergence to maturity stages of the crop (Table 7). Initial salinity level was more or less same among the treatments. Salinity level increased at slower rate in T_2, T_3 and T_4 treatments where IPNS based nutrient management packages were imposed.Itmay be due to the fact that any kind of organic matter will release organic acids upon decaying.So acid will result into lowering of pH.The decrease in pH can lead to charging of clay minerals and electrostatic adsorption of the organic compounds.So all kinds of organic materials shall be definitely reducing soil salinity.Moreover, the use of organic matter improves the soil structure and permeability.

Table 7. Changes in soil salinity of sunflower field as influenced by various treatment combinations at different growth stages at Noakhali, Bargunaand Satkhira during *Rabi* season of 2018-19

Treatment	Emergence stage	Vegetative stage	Flowering stage	Seed formation stage	Maturity stage
	Salinity range (dS m^{-1})				
At Noakhali					
T_1	0.76-1.97	1.75-3.61	2.47-5.27	4.50-7.00	6.75-9.41
T_2	0.62-1.75	1.64-2.90	2.38-4.10	3.72-5.54	5.11-7.90
T_3	0.69-1.85	1.59-2.97	1.98-3.91	3.27-5.12	4.68-7.35
T_4	0.71-1.79	1.60-2.81	2.23-3.98	3.57-5.33	4.76-7.41
T_5	0.65-1.89	1.68-3.50	2.49-5.17	4.80-6.96	6.94-9.67
T_6	0.71-2.10	2.11-3.92	2.82-5.89	4.92-7.71	7.15-9.72
At Barguna					
T_1	0.69-1.85	1.52-2.90	2.41-4.89	4.66-6.26	5.94-8.85
T_2	0.58-1.71	1.40-2.41	2.32-3.84	3.61-5.10	4.30-7.10
T_3	0.63-1.80	1.32-2.10	1.87-3.78	2.49-5.79	4.12-6.35
T_4	0.59-1.82	1.30-2.32	2.20-3.82	2.85-5.81	4.39-6.24
T_5	0.72-1.91	1.63-3.22	2.50-5.19	4.71-7.10	5.98-9.10
T_6	0.66-1.86	1.70-3.43	2.63-5.32	4.78-7.12	6.13-9.23
At Satkhira					
T_1	0.86-2.14	1.70-3.61	3.25-5.75	4.92-7.20	6.70-9.34
T_2	0.95-2.10	1.67-3.10	2.36-4.10	3.87-6.79	5.17-8.30
T_3	0.82-1.76	1.62-2.98	2.82-4.70	3.40-6.52	5.10-7.95
T_4	0.73-1.98	1.56-2.87	2.19-3.92	3.72-6.80	4.92-7.62
T_5	0.81-2.23	1.81-3.70	2.95-5.48	4.62-8.20	7.11-9.74
T_6	0.80-2.29	2.15-4.10	3.67-6.89	5.14-9.17	7.20-9.86

T_1= Soil test based fertilizer dose for HYG (FRG,2012),T_2= IPNS with 5 tha^{-1}cowdung,T_3= IPNS with 5 tha^{-1} compost,T_4= IPNS with 1.5 tha^{-1}vermicompost,T_5= Farmers' practice and T_6 = Absolute control

This enhances leaching of salt, reduces surface evaporation, and inhibits salt accumulation in the surface layers. In addition, organic matter also increases water infiltration, water-holding capacity, and aggregate stability and reduces electrical conductivity (Qadir*et al.,* 2001). On the other hand, salinity level increased at higher rate in T_6 treatment followed by T_5 and T_1. During the crop growing period soil salinity ranged from 0.62 to 9.72 dS m^{-1}, 0.58 to 9.23 dS m^{-1}, 0.73 to 9.86 dS m^{-1} at Noakhali, Barguna and Satkhira, respectively from emergence to maturity stages of the crop.

Cost and return analysis

Cost and return of sunflower as influenced by different nutrient management packages have been shown in the Table 8, 9&10. Among the treatments, the highest gross return (117900 Tk. ha^{-1}, 120200 Tk. ha^{-1} and 110460 Tk. ha^{-1}at Noakhali, Barguna and Satkhira, respectively), net return (50790 Tk. ha^{-1}, 52765 Tk. ha^{-1} and 43940 Tk. ha^{-1} at Noakhali, Bargunaand Satkhira, respectively) as well as BCR (1.75, 1.78 and 1.67 at Noakhali, Barguna and Satkhira, respectively) were obtained from T_4 treatment (IPNS with 1.5 tha^{-1} vermicompost) whereas the lowest gross return (57200 Tk. ha^{-1} , 59940 Tk. ha^{-1} and 55220 Tk. ha^{-1}at Noakhali, Barguna and Satkhira, respectively), net return (14900 Tk. ha^{-1}, 15175 Tk. ha^{-1} and 11570 Tk. ha^{-1} at Noakhali, Barguna and Satkhira, respectively) and BCR (1.40, 1.33 and 1.26 at Noakhali, Barguna and Satkhira, respectively) were obtained from control (T_6) treatment.

Table 8.Cost and return analysis of BARI Sunflower-2 as influenced by integrated nutrientmanagement atNoakhali during 2018-19

Treatments	Yield (t ha^{-1})		Gross Return (Tk. ha^{-1})	Total Cost (Tk. ha^{-1})	Net Return (Tk. ha^{-1})	BCR
	Seed	Stover				
T_1	1.59	3.38	86340	57200	29140	1.50
T_2	1.87	3.80	101100	64109	36991	1.57
T_3	2.08	4.05	112100	70970	41130	1.58
T_4	2.19	4.20	117900	67110	50790	1.75
T_5	1.48	2.97	79940	50550	29390	1.43
T_6	1.05	2.35	57200	42300	14900	1.40

T_1= Soil test based fertilizer dose for HYG (FRG,2012),T_2= IPNS with 5 tha^{-1}cowdung,T_3= IPNS with 5 tha^{-1} compost, T_4= IPNS with 1.5 tha^{-1}vermicompost,T_5= Farmers' practice and T_6 = Absolute control

Input and output price per Kg: Sunflower seed = Tk. 70, Urea = Tk. 16, TSP = Tk. 22, MoP = Tk. 15, Gypsum = Tk. 12, Vermicompost = Tk. 12, Compost = Tk. 5, Cowdung= Tk.3, Sunflower = Tk. 50 and Stover = Tk. 2

Table 9.Cost and return analysis of BARI Sunflower-2 as influenced by integrated nutrient management
atBarguna during 2018-19

Treatments	Yield (t ha^{-1})		Gross Return (Tk. ha^{-1})	Total Cost (Tk. ha^{-1})	Net Return (Tk. ha^{-1})	BCR
	Seed	Stover				
T_1	1.66	3.54	90100	57177	32923	1.57
T_2	1.89	3.83	102160	62213	39947	1.64
T_3	2.12	4.16	114320	69370	44950	1.65
T_4	2.23	4.35	120200	67435	52765	1.78
T_5	1.56	3.06	84120	54842	29278	1.53
T_6	1.10	2.47	59940	44765	15175	1.33

T_1= Soil test based fertilizer dose for HYG (FRG,2012),T_2= IPNS with 5 tha^{-1}cowdung,T_3= IPNS with 5 tha^{-1} compost,T_4= IPNS with 1.5 tha^{-1}vermicompost,T_5= Farmers' practice and T_6 = Absolute control

Input and output price per Kg:Sunflower seed = Tk. 70, Urea = Tk. 16, TSP = Tk. 22, MoP = Tk. 15, Gypsum = Tk. 12, Vermicompost = Tk. 12, Compost = Tk. 5, Cowdung= Tk.3, Sunflower = Tk. 50 and Stover= Tk. 2

Table 10.Cost and return analysis of BARI Sunflower-2 as influenced by integrated nutrient management at Satkhira during 2018-19

Treatment	Yield (t ha^{-1})		Gross Return (Tk. ha^{-1})	Total Cost (Tk. ha^{-1})	Net Return (Tk. ha^{-1})	BCR
	Seed	Stover				
T_1	1.52	3.01	82020	55177	26843	1.48
T_2	1.80	3.34	96680	60120	36560	1.60
T_3	1.97	3.65	105800	67424	38376	1.56
T_4	2.06	3.73	110460	66520	43940	1.67
T_5	1.37	2.76	74020	52842	21178	1.40
T_6	1.02	2.11	55220	43650	11570	1.26

T_1= Soil test based fertilizer dose for HYG (FRG, 2012), T_2= IPNS with 5 t ha^{-1} cowdung, T_3= IPNS with 5 t ha^{-1} compost, T_4= IPNS with 1.5 t ha^{-1} vermicompost, T_5= Farmers' practice and T_6 = Absolute control

Input and output price per Kg: Sunflower seed = Tk.70, Urea = Tk. 16, TSP = Tk. 22, MoP = Tk. 15, Gypsum = Tk. 12, Zinc sulphate =Tk. 150, Boric acid = Tk.220,Vermicompost = Tk. 12, Compost = Tk. 5, Cowdung= Tk. 3, Sunflower = Tk. 50 and Stover = Tk. 2

Conclusion

Based on the results, it may be concluded that IPNS with 1.5 tha^{-1}vermicompostis superior to the other fertilizer management packages in respect of yield as well as economic return for sunflower cultivation in the coastal char land of Bangladesh.

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