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Effect of planting date and nutrient management on yield of broccoli

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ABSTRACT

The study was aimed to find out the optimum planting time and nutrient dose of broccoli in early planting condition when the demand and price of broccoli are high in the market. The experiment was carried out at the research field of Agricultural Research Station, Rajbari, Dinajpur (Latitude: $25^0388.75''$ N, Longitude: $88^0395.70''$ E) during *rabi* season of 2021-22 and 2022-23. The experiment was laid out in Randomized Complete Block Design (Factorial) with three replications. This factorial experiment comprising: A. Three Planting times viz. P_1= 30 October, P_2=15 November, P_3=30 November and B. Four levels of nutrients viz. T_1= STB Recommended chemical fertilizer (RCF) (120-24-60-20-2-1.5 kg/ha NPKSZnB), T_2=T_1+ 25% of NPK (150-30-75-20-2-1.5 kg/ha NPKSZnB), T_3=IPNS with vermicompost 1.5 tha^{-1}(80-20-50-15-1-1 kg/ha NPKSZnB) T_4= IPNS with vermicompost 3 tha^{-1} (76-18-45-15-1-1 kg/ha NPKSZnB). Recorded data regarding on plant height, number of leaves per plant, curd diameter, curd length, number of secondary curd per plant, main curd weight, secondary curd weight per plant and total yield were superior to P_1T_4 treatment combination followed by P_1T_3 combination. Results of economic analysis showed that the maximum gross return (Tk. 556800 ha^{-1}) and gross margin (Tk. 379000 ha^{-1}) were recorded from the treatment combination P_1T_4 but the maximum benefit cost ratio (3.17) was obtained from P_1T_3 treatment combination due to higher total variable cost on P_1T_4 treatment combination in two consecutive years. As such, IPNS with vermicompost 1.5 tha^{-1} when planted on 30 October (P_1T_3) might be more profitable and economically feasible for broccoli growers in the Dinajpur region.

Introduction

Broccoli (*Brassica oleraceavar. italica L.*) belongs to Brassicaceae family is a biennial and herbaceous cole crops. It looks exactly like cauliflower but the color is dark green. The cultivation of broccoli in the country did not start too long ago. As such, the cultivation of broccoli in Dinajpur is completely new. It is rich in vitamins, minerals and antioxidants. It is anti-cancer, anti-inflammatory, anti-gastritis, anti-weight, anti-aging and beautiful skin. So, it plays a great role in meeting the nutritional needs of the people of Dinajpur. Climate of this area is well suited for its production. There are several factors for low yield of broccoli including planting time and nutrient management. Suitable sowing time is one of the basic requirements for obtaining maximum yield and return of any crop. Broccoli is environmentally better adapted and can tolerate comparatively high temperature than cauliflower (Rashid, 1993). For quality production of broccoli, balanced supply of plant nutrients is very much essential. Such requirement of nutrients can be provided by applying inorganic fertilizer or organic manure or both. The combined application of both organic and inorganic fertilizer can increase the yield maintaining sound environmental conditions (Hsieh *et al.*, 1996). Organic manure can serve as an alternative practice to chemical fertilizers (Gupta *et al.*, 1988) which improves soil structure (Dauda *et al.*, 2008) and encourage beneficial microbial population. The use of inorganic fertilizers has increased manifolds in recent years due to shortage or unavailability of organic manures. The increased and imbalance use of chemical fertilizers has negative impacts of soil health due to its effect on soil micro-flora. The judicial application of organic or inorganic fertilizers is an important consideration to improve the yield and quality of the agricultural produce (Bhuma, 2001). Bahadur (2004) suggested that a combined application of manures and fertilizers increased the yield and improved the quality of broccoli. Manures, particularly vermicompost can play an important role in growth and curd yield of broccoli. Therefore, the present study was undertaken to evaluate the effects of inorganic fertilizers and inorganic fertilizers + vermicompost on the growth and yield of broccoli. The study finds out the response of broccoli to

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different levels of nutrient management in early planting condition at Dinajpur region.

Materials and methods

Experimental site description

The experiment was conducted at the research field of Agricultural Research Station, Bangladesh Agricultural Research Institute (BARI), Rajbari, Dinajpur during *rabi* season of 2021-22 and 2022-23. The experimental site was located at Latitude: $25^0$38'10.91" N and Longitude: $88^0$39'.61" Eat 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 analyzed at the Soil Resources Development Institute (SRDI), Dinajpur, Bangladesh. The soil of the experimental site was medium-high and clay loam texture having 0.69% organic matter, pH 6.50, 0.038% total nitrogen (N), 0.10 meq 100 g^{-1} soil potassium (K), 22.5 µg/g phosphorus (P), 6.20 µg/g sulfur (S), 0.90 µg/g zinc (Zn) and 0.30 µg/g boron (B).During crop growth period, Monthly weather data on temperature (maximum and minimum) and rainfall (mm) were recorded in the years (Figure 1). The average maximum and minimum temperature in the crop season (October to March) were 32.43°C and 32.33°C and 11.4°C and 10.33°C during in 2021-22 and 22-23. The weather of the experimental site is hot sub-humid with total rainfall of 517 mm and 412 mm during both crop season.

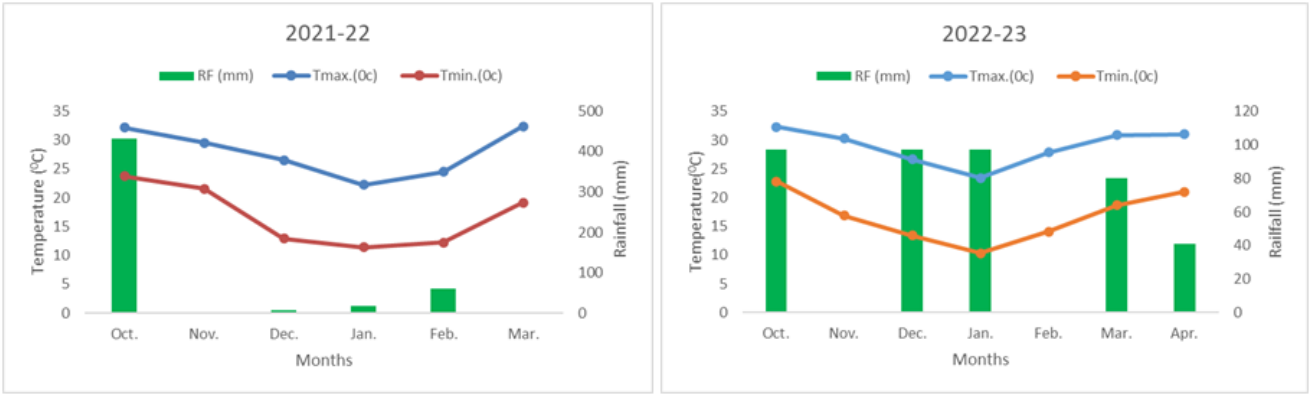

Figure 1: Monthly average maximum and minimum temperature and total rainfall during the cropping period from 2021-22 and 2022-23 at ARS, BARI, Dinajpur

Experimental design and treatments

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications for each treatment with the objectives to find out optimum planting time and nutrient dose of broccoli in early planting condition when the demand and price of broccoli are high in the market. The unit plot size was 7.5 m^2 (3m×2.5m)and spacing 50cm×50cm were maintained. This factorial experiment comprising: A. Three Planting times viz.P_1=30 October, P_2=15 November, P_3=30 November and B. Four levels of nutrients viz. T_1=STB Recommended chemical fertilizer (RCF) (120-24-60-20-2-1.5 kg/ha NPKSZnB), T_2=T_1+ 25% of NPK(150-30-75-20-2-1.5 kg/ha NPKSZnB) T_3=IPNS with vermicompost 1.5 tha^{-1}(80-20-50-15-1-1 kg/ha NPKSZnB), and T_4= IPNS with vermicompost 3 tha^{-1}(76-18-45-15-1-1 kg/ha NPKSZnB).

Crop husbandry

BARI Broccoli-1 was used in this experiment. Seeds were collected from Agricultural Research Sub-station, Bangladesh Agricultural Research Institute, Thakurgaon. Fertilizers were applied as per treatments in the form of urea, triple super phosphate, muriate of potash, gypsum, zinc sulphate and boric acid, respectively. At first, seeds were sown in seedbed and then thirty days old healthy seedlings were transplanted into the main field according to the treatments. Irrigation was given the first 4-5 days after transplanting of seedlings. 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 good tilth. Vermicompost will be applied at the time of final land preparation. All of phosphorus, sulphur, zinc and boron were applied during final land preparation, while the nitrogen and potassium were applied in three equal splits at 15, 30, and 50

DAT as ring method around the plants and mixed thoroughly with the soil followed by irrigation. Intercultural operation like weeding was done two times at 20 DAT and 35 DAT. Broccoli was harvested several times according to planting date. Insecticide Acimix 55EC 1ml/L water was sprayed at every 15 days interval to control cut worm and Fungicide Rovral 50 WP @ 2gm/L water was sprayed at every 15 days interval to control leaf spot and on broccoli. Yield components of broccoli were taken from randomly selected 5 plants from each plot. Curd yields were taken from whole plot. Collected data were analyzed statistically by using R software packages and mean differences for each character were compared by Least Significant Difference (LSD) test (Gomez and Gomez. 1984). The cost- benefit analysis of broccoli production was calculated based on present market price in Dinajpur.

Results and Discussion

Effect of planting time

The effect of planting time on plant height, number of leaves per plant, curd diameter, curd length, number of secondary curd per plant, Main curd weight, secondary curd weight per plant and total yield were significant. Result revealed that delayed planting decreased plant height at different growth stages. The tallest plant was recorded at planting time 30 October (58.13 cm). In contrast, the shortest plant was recorded at 30 November planting time (54.85 cm). The highest leave per plant (18.85) was recorded in 30 October planting of broccoli seedlings and lowest value (17.22) was obtained in 30 November planting of broccoli seedlings. Numerically, the maximum curd diameter (15.13 cm) was recorded in P_1 (30 October planting of broccoli seedling) while 30 November planting of broccoli produced the lowest curd diameter (13.50 cm). Similar trends and significant variation were also observed in curd length, number of secondary curd per plant, secondary curd weight per plant and curd weight. The highest yield (16.06 tha^{-1}) was recorded in P_1 (30 October planting of broccoli seedling) and the lowest yield of broccoli (14.21 tha^{-1}) was obtained in P_3 (30 November planting of broccoli seedling). The results suggested that the average yield of broccoli was decreasing and it may be due to the late planting of broccoli as temperature was rising.

Effect of nutrient dose

Irrespective of transplanting time broccoli seedling, it is revealed that nutrient showed significant variations in plant height, Number of leaves per plant, curd diameter, curd length, number of secondary curd per plant, Main curd weight, secondary curd weight per plant and total yield of broccoli (Table 2). The highest plant height (60.48 cm) was obtained in T_4, while the lowest plant height (52.98 cm) was gained in the T_1. Statistically similar and higher number of leaves per plant (18.00 and 19.74) was found both in T_3 and T_4. The lowest leaves per plant (16.84) was found in T_1. Superior curd diameter and length (15.13 cm and 24.70 cm) were recorded in T_4 (IPNS with vermicompost 3 tha^{-1}) while T_1 (STB Recommended chemical fertilizer) produced the lowest curd diameter and curd length (13.16 cm and 21.11 cm). Similar trends and significant variation were also observed in number of secondary curd per plant, secondary curd weight per plant and curd weight. The highest yield (17.08 tha^{-1}) was recorded in T_4 (IPNS with vermicompost 3 tha^{-1}) and the lowest yield of broccoli (13.96 tha^{-1}) was obtained in T_1 (STB Recommended chemical fertilizer).

Table 1: Effect of planting time on the growth and yield of Broccoli (pooled data of 2 years)

Treatments	Plant height (cm)	Leaves Per plant (no.)	Terminal curd diameter (cm)	Terminal curd length (cm)	No. of secondary curd (no.)	Terminal curd wt.(g)	Secondary curd wt. (g)	Yield (tha^{-1})
P_1	58.13	18.85	15.13	23.39	5.16	401.56	224.43	16.06
P_2	56.36	17.90	14.57	22.74	4.91	375.68	216.48	15.03
P_3	54.85	17.22	13.50	21.94	4.67	355.25	198.47	14.21
$LSD_{(0.05)}$	1.21	0.61	0.86	0.67	0.30	9.03	3.84	0.36
CV(%)	2.54	3.99	7.06	3.49	7.10	2.83	2.13	2.83

P_1= 30 October, P_2=15 November, P_3=30 November

Table 2: Effect of nutrient dose on the growth and yield of Broccoli (pooled data of 2 years)

Treatments	Plant height (cm)	Leaves per plant (no.)	Terminal curd diameter (cm)	Terminal curd length (cm)	No. of secondary curd	Terminal curd wt.(g)	Secondary curd wt.(g)	Yield (tha^{-1})
T_1	52.98	16.84	13.16	21.11	3.91	349.10	190.30	13.96
T_2	55.11	17.38	14.25	21.96	4.41	355.62	204.31	14.22
T_3	57.23	18.00	14.29	22.98	5.27	378.16	217.96	15.13
T_4	60.48	19.74	15.92	24.70	6.07	427.12	239.93	17.08
$LSD_{(0.05)}$	1.40	0.70	0.99	0.77	0.34	10.43	4.44	0.42
CV (%)	2.54	3.99	7.06	3.49	7.10	2.83	2.13	2.83

T_1= STB Recommended chemical fertilizer (RCF) (120-24-60-20-2-1.5 kg/ha NPKSZnB), T_2=T_1+ 25% of NPK (150-30-75-20-2-1.5 kg/ha NPKSZnB), T_3=IPNS with vermicompost 1.5 tha^{-1}, T_4= IPNS with vermicompost 3 tha^{-1}

Combined effect

The interaction effect of days to transplanting and nutrient dose was observed significant in all the yield contributing characters and yield of broccoli (Table 3). However, the maximum plant height (62.06 cm) of broccoli was measured from plants grown under P_1T_4treatment combinations and the minimum plant height (51.80 cm) was recorded from P_3T_1. Thompson and Kelly (1988) reported that the rate of release of nitrogen is higher from vermicompost than chemical fertilizer which ultimately was reflected in higher plant growth. The combined effect of different planting time and nutrient dose were significantly influenced the morphological parameters of broccoli. The maximum number of leaves (20.10) was recorded in the treatment combination $P_1T_4$and the lowest number of leaves (15.83) was observed in the treatment combination P_3T_1. In this study, organic manure increased the activity of microorganisms which ultimately made more availability and absorption of essential plant nutrients resulting in increased leaf and plant morphology. The maximum curd diameter and curd length (16.94 cm and 25.16 cm) were obtained from the treatment combination $P_1T_4$and the lowest from P_3T_1 treatment combination. The highest (6.40) number of secondary curd was also observed in P_1T_4 treatment combination. The interaction effect of different planting time and nutrient dose were highly significant for secondary curd weight. The highest terminal curd weight (463.93 g) was recorded from the treatment combination $P_1T_4$and the lowest (332.80 g) from P_3T_1 treatment combination. The highest yield (18.56 tha^{-1}) was produced by the treatment combination $P_1T_4$and the lowest yield (13.31tha^{-1}) was recorded from the combination P_3T_1.Vermicompost retains nutrients for long time while the conventional compost fails to deliver the required amount of macro and micronutrient including the vital NPK to plants in shorter time. Euras (2009) reported that the vermicompost is proving to be highly nutritive organic fertilizer and more powerful growth promoter over the conventional composts. It accelerates the rate of decomposition of the organic matter, alters the physical and chemical properties of the material, and lowers the C: N ratio, leading to a rapid humification process in which the unstable organic matter is fully oxidized. This increase in microbial mass and dehydrogenase activity helps in nitrogen fixation and increase the availability to the crop and boost up the growth and development.

Table 3: Interaction effect of planting time and nutrient dose on the growth and yield of broccoli (Pooled data of 2 years)

Treatment Combinations	Plant height (cm)	Leaves Per plant (no.)	Terminal curd diameter (cm)	Terminal curd length (cm)	No. of secondary curd	Terminal curd wt.(g)	Secondary curd wt.(g)	Yield (tha^{-1})
P_1T_1	54.93	17.90	13.76	21.70	4.03	369.77	196.63	14.79
P_1T_2	57.40	18.20	14.43	22.90	4.66	372.57	212.40	14.90
P_1T_3	58.80	19.20	15.41	23.80	5.56	399.98	229.67	15.99
P_1T_4	62.06	20.10	16.94	25.16	6.40	463.93	259.70	18.56

P_2T_1	52.89	16.81	13.70	21.30	3.93	344.73	189.53	13.78
P_2T_2	55.00	17.16	14.06	21.70	4.33	357.10	205.70	14.28
P_2T_3	57.50	17.87	14.60	23.16	5.30	371.42	220.13	14.85
P_2T_4	60.08	19.78	15.93	24.80	6.10	429.50	250.53	17.18
P_3T_1	51.80	15.83	12.00	20.33	3.76	332.80	185.40	13.31
P_3T_2	52.93	16.80	14.26	21.28	4.23	337.20	194.83	13.49
P_3T_3	55.40	16.93	12.86	22.00	4.96	363.08	204.07	14.52
P_3T_4	59.30	19.33	14.87	24.13	5.73	387.93	209.57	15.51
LSD $_{(0.05)}$	5.22	1.38	1.72	2.05	0.97	27.54	24.37	1.81
CV $_{(\%)}$	5.75	4.37	7.06	5.45	7.10	4.56	7.14	7.14

Cost and benefit analysis

Cost and benefit analysis of broccoli curd yield was presented in Table 4. Result showed that the maximum gross return (Tk. 556800 ha^{-1}) and gross margin (Tk.379000ha^{-1}) were recorded from the treatment combination P_1T_4 but the maximum benefit cost ratio (3.17) was obtained from P_1T_3 treatment combination due to higher total variable cost on P_1T_4treatment combination and the lowest gross return (Tk. 199650ha^{-1}), gross margin (Tk. 70245 ha^{-1}) and benefit cost ratio (1.53) were recorded from the treatment combination P_3T_1.

Table 4: Cost and benefit analysis of broccoli production as influenced by planting time and nutrient dose

Treatment Combinations	Yield (tha^{-1})	Gross return (Tk.)	Total variable cost (Tk.)	Gross Margin (Tk.)	BCR
P_1T_1	14.79	369750	129405	240345	2.85
P_1T_2	14.90	372500	131557	240943	2.83
P_1T_3	15.99	479700	150950	328750	3.17
P_1T_4	18.56	556800	177800	379000	3.13
P_2T_1	13.78	275600	129405	146195	2.12
P_2T_2	14.28	285600	131557	154043	2.17
P_2T_3	14.85	371250	150950	220300	2.45
P_2T_4	17.18	429500	173800	255700	2.47
P_3T_1	13.31	199650	129405	70245	1.53
P_3T_2	13.49	202350	131557	70793	1.54
P_3T_3	14.52	290400	150950	139450	1.92
P_3T_4	15.51	310200	173800	136400	1.78

The price rate of fertilizer and vermicompost: urea:16.00 $Tk.Kg^{-1}$,TSP:22.00 $Tk.Kg^{-1}$,MOP:15 $Tk.Kg^{-1}$,Gypsum: 25 $Tk.Kg^{-1}$, Zinc Sulphate: 200 $Tk.Kg^{-1}$, Boron: 400 $Tk.Kg^{-1}$ and Vermicompost: 20 $Tk.Kg^{-1}$,
Price of broccoli ($Tk.Kg^{-1}$):25 (Treat. Comb. P_1T_1 &P_1T_2), 30 (Treat. Comb. P_1T_3 &P_1T_4), 20 (Treat. Comb. P_2T_1 &P_2T_2), 25 (Treat. Comb. P_2T_3 &P_2T_4), 15 (Treat. Comb. P_3T_1 &P_3T_2), 20 (Treat. Comb. P_3T_3 &P_3T_4).

Conclusion

The study revealed that the highest yield was obtained from IPNS with vermicompost 3 tha^{-1} when planted on 30October (P_1T_4)followed by IPNS with vermicompost 1.5 tha^{-1} when planted on 30October(P_1T_3). However, the highest benefit cost ratio (3.17) was recorded from IPNS with vermicompost 1.5 tha^{-1} when planted on 30 October(P_1T_3) followed by IPNS with vermicompost 3 $tha^{-1}$when planted on 30October (P_1T_4) BCR (3.13) due to higher price of vermicompost and for early planting when the demand and price of broccoli are higher on the market. As a result, from an economic standpoint, IPNS with vermicompost 1.5 tha^{-1} when planted on 30 October (P_1T_3) might be more profitable and economically feasible for broccoli growers in the Dinajpur region.

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