Nutrient Uptake, Economics And Yield Of Broccoli Influenced By Integrated Nutrient Management Practices

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Abstract

The investigation was carried out during winter season in two consecutive years at vegetable section of horticulture garden under the Faculty of Agriculture, Birsa Agricultural University, Kanke, Ranchi (Jharkhand). To study the effect of N, P and K fertilizer with FYM, Karanj cake and vermicmopst on yield, nutrient uptake and fertility status of soil available NPK. The highest head yield of broccoli was recorded in the treatment receiving 50 Kg N through vermicompost + 150:100:100 kg NPK ha^{-1} through inorganic sources. Integrated uses of FYM, Vermicompost, Karanj cake with 50 Kg N through FYM + 150 : 100 : 100 kg NPK ha^{-1} through inorganic sources received the maximum uptake of nitrogen (311.49 kg/ha), application of 37.5 Kg N through FYM + 112.5 : 75 : 75 kg NPK ha^{-1} through inorganic sources resulted in maximum uptake of phosphorus (33.44 kg/ha) and application of 100 : 50 : 50 kg NPK ha^{-1} throughinorganic sources resulted in maximum uptake of potassium (367.77 kg/ha). Intergraded nutrient management enhanced the organic carbon and available N,P and K in the soil. Highest net income and benefit: cost ratio was obtained application of 50 Kg N through Vermicompost + 150 :100 : 100 kg NPK ha^{-1} through inorganic sources resulted in maximum net profit (Rs. 72467/- per ha) and application of 150 : 75 : 75 kg NPK ha^{-1}throughinorganic sources resulted in maximum benefitcost ratio (2.25) respectively.

Keywords: Nutrient Management, Uptake, Broccoli,Yield

Introduction

Sprouting broccoli (*Brassica oleracea*v*aritalica*) belonging to the family Brassicaceae is an important cole crop after cabbage and cauliflower. It is one of the most nutritious cole crops and contains vitamin A (130 times and 22 times higher than cauliflower and cabbage, respectively), thiamin, riboflavin, niacin, vitamin C and minerals like Ca, P, K and Fe [Sanwal and Yadav, 2005]. In India, broccoli is gaining popularity during the last few years among the consumers particularly in and around bigger cities owing to the increased awareness about the nutritional properties as well as palatability. The state of Jharkhand provides ample opportunity for successful cultivation of broccoli due to the mild climatic conditions prevailing in Ranchi and adjoining areas.

Nutrient management is one of the most important practices for profitable cultivation of any vegetable crop. A number of research

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works have been carried out to demonstrate the role of different major and micronutrients in broccoli [Wang *et al.,* 1997]. Recommendations on fertilizer application in broccoli have also been made from different parts of the country [Singh and Singh, 2000; Brahma *et al.,* 2002] with varying doses of different nutrients depending upon the soil fertility status under different regions.

Integrated nutrient management having chemical fertilizers applied along with organic sources of nutrients is an effective method for economization of production cost as well as maintenance of soil fertility. Beneficial effects of integrated management strategies on broccoli have been reported by various workers [Sharma, 2000; Sharma *et al.,* 2002; Sharma *et al* 2005; Maurya*et al.,*2008]. However, no work has been reported so far on integrated management strategies in broccoli for the eastern plateau and hill agro climatic zone, particularly for the state of Jharkhand. Nutrient management for this region deserves special attention due to poor edaphic conditions. Being a newly introduced crop of Jharkhand, there is an urgent need for standardization of integrated nutrient management packages having locally available organic sources integrated with chemical fertilizers. Keeping this in view, the present investigation was aimed to study the effect of integrated nutrient management on yield of broccoli, nutrient uptake and changes in availability of N, P, and K in sandy loam soil of Ranchi

Materials and methods

A field experiment was conducted on sandy loam soil at vegetable section of horticulture garden under the Faculty of Agriculture, Birsa Agricultural University, Kanke, Ranchi (Jharkhand). Birsa Agricultural University, Kanke, Ranchi is situated between 23˚17' North latitude and 85˚19' East longitude and located at a height of 625 m above the mean sea level. Broccoli (*Brassica oleracea* var. italica) cv. Fiesta was carried out during winter season in the consecutive years 2008-09 and 2009-10. The climate of Ranchi is humid to sub-tropical type. The temperature varies from as low as 2.2˚C in winter (December-January) to 42.4˚C in summer (April-May). The relative humidity (RH) rises up to 93.0 percent during July-August and falls down to 37.0 percent during April-May. The soil of the experimental field (0-15 cm) had pH (1:2.5) 5.9, organic carbon 0.34 percent, available N 340 kg ha^{-1}, available P 29.9 kg ha^{-1}, available and K 164.0 kg ha^{-1}. The integrated nutrient management treatment consisted of: (T_1) 200:100:100kg NPK ha^{-1},(T_2) 150:75:75 kg NPK ha^{-1}, (T_3) 100:50:50 kg NPK ha^{-1} (T_4) 50:25:25 kg NPK ha^{-1}, (T_5) 50 Kg N through FYM+150:100:100 kg NPK ha^{-1} through inorganic (T_6) 37.5 Kg N through FYM+112.5:75:75 kg NPK ha^{-1} through inorganic, (T_7) 25 Kg N through FYM +75:50:50, ($T_{8)}$ 12.5 Kg N through FYM+37.5:25:25 kg NPK ha^{-1} through inorganic, (T_9)50 Kg N through vermicompost + 150 :100 :100 kg NPK ha^{-1} through inorganic (T_{10}) 37.5 Kg N through vermicompost + 112.5:75:75 kg NPK ha^{-1} through inorganic, (T_{11})25 Kg N through vermicompost +75:50:50 kg NPK ha^{-1} through inorganic, (T_{12}) 12.5 Kg N through vermicomposst + 37.5 : 25 : 25 kg NPK ha^{-1} through inorganic, (T_{13}) 50 Kg N through karanj cake+150:100:100 kg NPK ha^{-1} through inorganic, (T_{14}) 37.5 Kg N through karanj cake+112.5:75:75 kg NPK ha^{-1} through inorganic, (T_{15}) 25 Kg N through karanj cake +75:50:50 kg NPK ha^{-1} through inorganic,

(T_{16})12.5 Kg N through karanj cake+37.5:25:25 kg NPK ha^{-1} through inorganic, (T_{17})100:50:50 Kg NPK ha^{-1} along with 200q FYM ha^{-1} (Recommended dose) (T_{18}) N_0:P_{100}:$K_{100,}$ and (T_{19}) N_0:P_0:K_0 (control), The experiment was laid out in Randomized Block Design (RBD) with three replications having plot size of 3.60m X 3.00 m for crop . The soil was treated with Linden dust and Bavistin 0.1% solution. The fertilizer mixture containing calculated amount of nitrogen, phosphorous, potash, FYM, vermicompost and karanj cake was applied treatment wise prior to transplanting. The fertilizer mixture was mixed thoroughly in soil. Half dose of inorganic nitrogen as urea with full dose of phosphorous (P_2O_5) as single super phosphate and potash (K_2O) as murriate of potash were applied. Remaining half of nitrogen was applied in two split doses, first at 30 days after transplanting and second before curd initiation. Nursery bed was irrigated a few hours earlier to uprooting of seedlings. Seedlings of four weeks old having 4-5 leaves and of uniform size, well developed and healthy were uprooted with the utmost care in the afternoon and were dipped in 1 gmbavistin per liter of water solution.

Seedlings of four weeks old having 4-5 leaves and of uniform size, well developed and healthy were transplanted with spacing of 60 cm × 30 cm and followed the recommended package of practices. The length of time from planting to the harvesting for the cultivation periods was divided into four equal parts determining in this way four phases of growth. The plants were harvested when the heads were fully developed. Five plants in each treatment and in each replication were selected randomly, numbered, tagged properly for detailed studies at vegetative stage after transplanting and then at harvesting time. The stage of curd maturity was observed very carefully on alternate day from the date when they showed maturity signs. The maturity of curd under different treatments was different and necessary records were maintained. Yield and yield attributes were taken at harvesting time. Composite surface (0-15 cm) soil sample from each plot were collected at the harvest of broccoli. Soil sample were air-dried and pulverized to using standard procedures as described for pH [Jackson 1973], organic carbon [Walkley and Black 1934], available nitrogen [Subbiah and Asija 1956], Available Phosphorus [Bray and Kurtz 1945] and available potassium [Jackson 1973].

Result and discussion

Effect of different treatments on uptake of nutrient in broccoli

Data on effect of integrated nutrient management on uptake of nutrients in broccoli is given in table 1. Among the different nutrients, the maximum uptake of nitrogen was recorded in case of application of 100% of recommended dose of inorganic nutrients which was at par with application of 200% of recommended dose of inorganic nutrients, application of 200% of recommended dose of inorganic nutrient out of which 25% being supplemented through FYM, application of 200% of recommended dose of inorganic nutrients out of which 25% being supplemented through vermicompost, application of 100% of recommended dose of inorganic nutrients out of which 25% being supplemented through vermicompost, application of 50% of recommended dose of inorganic nutrients out of which 25% being supplemented through vermicompost, application of 100% of recommended dose of

inorganic nutrients out of which 25% being supplemented through karanj cake. The minimum uptake was obtained in case of application of 150% of recommended dose of inorganic nutrients out of which 25% being supplemented through vermicompost. The maximum uptake of phosphorus was recorded in case of application of 200% of recommended dose of inorganic nutrient of which 25% being supplemented through vermicompost which was at par with application of 200% of recommended dose of inorganic nutrient, application of 200% of recommended dose of inorganic nutrient of which 25% being supplemented through FYM, application of 150% of recommended dose of inorganic nutrient of which 25% being supplemented through FYM. The maximum uptake of potassium was recorded in case of application of 100% of recommended dose of inorganic nutrients which was at par with application of 200% of recommended dose of inorganic nutrients. Higher uptake of nutrients in case of higher dose of nutrients can be attributed to increased availability of nutrients in the soil under the treatments. Non-significant correlation was observed between total biomass yield and uptake of different nutrients indicating factors other than biomass contributing significantly towards nutrient uptake under different treatments.

Everaarts *et al.*(1999) have reported a maximum uptake of 300 kg ha^{-1}nitrogen in case of broccoli. Rincon*et al.* (1999) have reported that total quantity of N exported by the crop during the sampling period was 243.9 kg/ha, while total amount of P extracted by the crop was 28.7 kg/ha, and total quantity of K accumulated by the crop was 240.9 kg/ha. Similar observation was also recorded under the present investigation. Lower uptake of nutrients in some of the treatments with higher doses of nutrient combination can be explained through the findings of Ching Fang *et al.*(1996) who had reported that a combination of chemical fertilizers and compost in the partial organic treatment caused an antagonistic effect on the mineralization and uptake of soil nutrient elements. N, Mn, and Zn contents in the broccoli plants in the partial organic treatment were significantly lower than those in the control indicating deficiency.

Effect of different treatments on reproductive and yield parameters

Data on effect of integrated nutrient management on reproductive characters and yield of broccoli is given in table 1. The minimum days taken for curd initiation was recorded in case of application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented with FYM which was at par with application of 200% of recommended dose of inorganic nutrients, application of 100% of recommended dose of inorganic nutrients, application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented with vermicompost, application of 150% of recommended dose of inorganic nutrients of which 25% being supplemented with vermicompost and application of recommended dose of nutrients. The maximum days taken to curd initiation was recorded in case of control. With respect to days taken for 50% curd initiation the minimum number of days was recorded with application of application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented with FYM and application

recommended dose of nutrients which was at par with application of 200% of recommended dose of inorganic nutrients, application of 150% of recommended dose of inorganic nutrients, application of 100% of recommended dose of inorganic nutrients, application of 100% of recommended dose of inorganic nutrients of which 25% being supplemented with FYM, application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented with vermicompost and application of 150% of recommended dose of inorganic nutrients of which 25% being supplemented with vermicompost. As observed in case of initiation of curd, maximum number of days taken for 50% curd initiation was recorded in case of control. The minimum number of days taken for 50% of curd maturity was recorded in case of application of 200% of recommended dose of inorganic nutrients which was at par with application of 100% of recommended dose of inorganic nutrients, application 50% of recommended dose of inorganic nutrients of which 25% being supplemented with FYM, application 150% of recommended dose of inorganic nutrients of which 25% being supplemented with vermicompost, application 200% of recommended dose of inorganic nutrients of which 25% being supplemented with karanj cake, application 100% of recommended dose of inorganic nutrients of which 25% being supplemented with karanj cake and application of recommended dose of nutrients. The maximum number of days taken for 50% curd maturity after planting was recorded in case of control.

The results indicated that the treatments receiving high doses of nutrients resulted in hastening of different reproductive growth phases whereas the unset of different reproductive phases were drastically delayed in case of plants recieving low rate of nutrients or no nutrients. In cabbage, Chaubey*et al*. (2006) observed that higher fertility level favoured the maturity time whereas the process of growth and development was slower at lower fertility level.

The maximum curd weight was recorded with application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented with karanj cake which was at par with application of 200% of recommended dose of inorganic nutrients, application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented with FYM, application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented with vermicompost and recommended dose of nutrients. This indicated that the maximum curd weight was recorded in case of plants receiving at least a total of 200 :100 :100 kg/ha N, P and K. Sharma (2000) have reported that integration of organic and inorganic fertilizers application significantly increased the head yield over inorganic fertilizers alone and also over control. The treatment N175 P75 K60 + FYM 12.5 t/ha recorded the maximum yield (63.12 q/ha). Pandey*et al.* (2008) recorded highest values for growth of broccoli head in terms of head depth, girth and apical head weight with application of vermicompost @ 2.5 t/ha + ½ dose of recommended NPK + Azotobacter.

As observed in case of curd weight, the maximum yield of curd per ha was recorded in case of application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented with vermicompost which was

at par with application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented with FYM, application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented with karanj cake and application of recommended dose of nutrients. The minimum yield was recorded in case of control. This indicated that application of a minimum nutrient of 200 :100 :116 kg/ha N,P, K resulted in maximum yield of broccoli.

Economics

Economic analysis of different treatments is given in table 2. The maximum total cost of cultivation(Rs. 72533/- per ha), the maximum gross return (Rs 1,45,000/- per ha) and maximum net profit (Rs. 72467/- per ha)was recorded with application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented through vermicompost. Application of 150% of recommended dose of inorganic nutrients resulted in maximum benefit cost ratio (2.25). Similar value of benefit cost ratio has also been reported by Sharma *et al.* (2002) who have obtained maximum yield of broccoli with application of 90 kg N and 60 kg P_2O_5/ha. Hence, for farmers with high investment capacity, application of 200% of recommended dose of inorganic nutrients of which 25% being supplemented through vermicompost can be recommended for obtaining maximum profit.

Table 1.Effect of INM Treatment on nutrient uptake, reproductive growth and yield of Broccoli.

Treatments	Nitrogen(kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	Days to curd initiation (DAT)	Days to 50% curd initiation (DAT)	Curd weight (g)	Curd yield (q/ha)
T1	249.75	25.49	240.62	67.67	74.67	280.00	80.79
T2	196.36	17.90	210.49	68.33	74.67	236.33	82.10
T3	261.28	17.81	296.77	68.00	74.83	160.00	67.21
T4	196.62	19.64	246.00	72.00	81.50	81.33	52.01
T5	241.15	22.34	122.12	65.50	73.50	286.00	84.88
T6	181.41	22.52	210.95	70.33	76.50	216.00	83.33
T7	161.47	17.03	238.49	69.67	75.17	154.00	70.99
T8	186.25	18.78	157.57	71.50	79.67	84.83	42.75
T9	255.80	26.24	204.36	68.00	75.50	291.67	96.67
T10	148.66	13.82	185.53	67.50	74.17	259.33	84.57
T11	245.89	16.43	161.18	72.17	76.67	135.83	74.54
T12	221.89	21.69	183.73	70.33	78.00	74.00	50.23
T13	185.22	17.02	144.47	68.50	75.33	305.50	85.65
T14	184.39	18.49	158.65	69.83	76.17	241.67	83.72
T15	208.02	19.01	168.22	69.17	77.50	171.67	72.07
T16	167.93	17.66	147.16	72.83	80.67	119.67	51.08
T17	165.95	16.72	143.38	66.50	73.50	286.83	85.96
T18	179.12	17.47	135.24	75.33	83.17	50.00	38.43
T19	171.71	19.04	164.13	80.17	87.50	40.17	28.01
SE (m) ±	21.41	2.04	20.18	0.89	0.76	13.34	4.18
CD at 5 %	61.43	5.85	57.92	2.56	2.17	38.31	12.00
CV %	10.80	10.69	10.89	1.27	0.98	7.30	6.04

Table 2.Effect of INM on economics of Broccoli

Treatments	Total cost of cultivation (Rs / ha)	Curd yield (q / ha)	Gross return (Rs/ ha)	Net profit (Rs/ ha)	B: C Ratio
T1	56233.00	80.79	121180.6	64947.56	2.15
T2	54639.00	82.10	123148.1	68509.15	2.25
T3	52686.00	67.21	100810.2	48124.19	1.91
T4	51273.00	52.01	78009.26	26736.26	1.52
T5	63629.00	84.88	127314.8	63685.81	2.00
T6	61670.00	83.33	125000	63330.00	2.03
T7	59355.00	70.99	106481.5	47126.48	1.79
T8	54517.00	42.75	64120.37	9603.37	1.18
T9	72533.00	96.67	145000	72467.00	2.00
T10	69770.00	84.57	126851.9	57081.85	1.82
T11	62955.00	74.54	111805.6	48850.56	1.78
T12	56317.00	50.23	75347.22	19030.22	1.34
T13	65159.00	85.65	128472.2	63313.22	1.97
T14	61420.00	83.72	125578.7	64158.70	2.04
T15	57505.00	72.07	108101.9	50596.85	1.88
T16	53772.00	51.08	76620.37	22848.37	1.42
T17	70766.00	85.96	128935.2	58169.19	1.82
T18	54060.00	38.43	57638.89	3578.89	1.07
T19	43380.00	28.01	42013.89	-1366.11	0.97

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