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Effect of integrated nutrient management on quality of broccoli (*Brassica oleracia* var. italica) cv. FIESTA under Jharkhand conditions

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Abstract : An investigation was carried out at Birsa Agricultural University, Ranchi during 2008-09 and 2009-10 to standardize integrated nutrient management for broccoli under Jharkhand conditions. The experiment consisted of 19 treatments *i.e.,* four inorganic combinations 200:100:100 kg NPK, 150:75:75 kg NPK, 100:50:50 kg NPK and 50:25:25 kg NPK ha^{-1}, 12 organic and inorganic combinations by substituting 25 per cent N of above inorganic combinations through FYM, vermicompost and karanj cake along with recommended dose 100:50:50 kg NPK + 200 q FYM ha^{-1} and two controls N_0 P_{100} K_{100} and $N_0P_0K_0$. Treatments with high as well as lower content of total nutrient resulted in significantly lower TSS and soluble carbohydrate whereas higher sugar content was obtained with application of higher dose of nutrient and vermicompost. Treatments with lower content of nutrients resulted in maximum phenol content while treatments without nitrogen resulted in minimum content of total soluble protein. With respect to content of ascorbic acid in the curd, the maximum value was recorded in case of treatments without application of nitrogen.

Key words : INM, Broccoli, Quality, Curd, Variety

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Vegetables are considered as essential food, rich in various nutrient elements. Different vegetables are good source of proteins, carbohydrates, minerals, vitamins etc. Hence, they are reckoned as protective food essential for human health. Sprouting broccoli 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). It has a very powerful anti-cancer compound, glucosinolate, which provides protection against bowl cancer.

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. 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.

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 research work undertaken to know the effect of integrated nutrient management on quality of broccoli

RESEARCH METHODS

The investigation was carried out during winter season in the consecutive years 2008-09 and 2009-10 at vegetable section of horticulture garden under the Faculty of Agriculture, Birsa Agricultural University, Kanke, Ranchi (Jharkhand). The experiment consisted of 19 treatments *i.e.,* four inorganic combinations 200:100:100 kg NPK (200% of recommended dose of inorganic nutrients), 150:75:75 kg NPK (150% of recommended dose of inorganic nutrients), 100:50:50 kg NPK (100% of recommended dose of inorganic nutrients) and 50:25:25 kg NPK ha^{-1} (50% of recommended dose of inorganic nutrients), 12 organic and inorganic combinations by substituting 25 per cent N of above inorganic combinations through FYM, vermicompost and karanj cake along with recommended dose 100:50:50 kg NPK + 200 q FYM ha^{-1} and two controls N_0 P_{100} K_{100} and $N_0P_0K_0$.

The experiment was laid out in Randomized Block Design with three replications. Data were recorded on different quality parameters like TSS, Sugar, vitamin C, total soluble carbohydrate, total phenol and total soluble protein. The data were subjected to analysis of variance.

RESEARCH FINDINGS AND DISCUSSION

The cultivation of sprouting broccoli is now gaining popularity with Indian growers for last few years due to increasing awareness of high nutritive values. Sugars, ascorbic acid, phenols, soluble proteins etc comprise a significant proportion of nutritive value of broccoli.

Sugars:

Data on effect of integrated nutrient management on TSS and sugar content of broccoli are given in Table 1. TSS and sugars contribute towards the palatibility of this nutritionally rich vegetable. In the present study, the maximum TSS was recorded in case of application of 100 per cent of recommended dose of nutrients out of which 25 per cent being applied through vermicompost. However, treatments with high as well as lower content of total nutrient in the present experiment resulted in significantly lower TSS.

With respect to content of soluble carbohydrate, the maximum content was obtained in case of application of 200 per cent of recommended dose of inorganic nutrients. As observed in case of TSS, the treatments with higher as well as lower content of total nutrients resulted in lower values of total soluble carbohydrate. This inconsistent trend in TSS, carbohydrate suggested further study into carbohydrate metabolism in broccoli as influenced by different treatments on integrated nutrient management. In this context, investigation on water movement into the plant tissue under different treatments can also give an insight into the process of dilution effect of carbohydrates. Studies are also warranted on uptake of micronutrient by the plant as influenced by integrated nutrient management which greatly influence the process of sugar metabolism.

With respect to content of reducing sugar and total sugar, treatment with application of 200 per cent of recommended dose of inorganic nutrients out of which 25 per cent being supplemented through vermicompost resulted in the maximum value. This consistent trend of higher sugar content with application of higher dose of nutrient and vermicompost can be attributed to increased uptake of both major as well as micro nutrients by the plants resulting in higher sugar translocation to the curd.

Total phenol:

Phenolics also form one of the major constituent of broccoli contributing towards antioxidant property of the vegetable. Data on content of phenol as influenced by treatments on integrated nutrient management are given in Table 2. In the present study, treatments with lower content of nutrients resulted in maximum phenol content. Triggering of flavonoid pathway leading to increased phenolic synthesis has been associated with stressed condition of plant. Hence high content of phenolics in case of treatments with low nutrient application can be explained by the stressed condition of the plant.

Total soluble protein:

Data on effect of integrated nutrient management on content of total soluble protein are given in Table 2. Content of total soluble protein was the maximum in case of 100 per cent of recommended dose of inorganic nutrients out of which 25 per cent being supplemented by vermicompost which was at par with application of 200 per cent of recommended dose of nutrients through inorganic sources. The content was minimum in case of treatments without nitrogen. Since nitrogen forms the main constituent of protein and amino acids, the lowest content of protein in treatments without nitrogen can be explained convincingly. According to Brahma *et al.* (2002) protein percentage of broccoli improved significantly when higher level of fertility was applied. Sharma and Chandra (2004) obtained the minimum content of protein in curd of cauliflower in N_0 level of nitrogen.

Ascorbic acid:

Broccoli is known for its richness in ascorbic acid. Data on content of ascorbic acid are given in Table 2. In the present investigation, the maximum content of vitamin C was recorded in case of treatments without application

Table 1 : Effect of integrated nutrient management on TSS, carbohydrate, reducing and total sugar in broccoli

Sr No.	Treatments	Total soluble solids (°Brix)			Soluble Carbohydrate (per cent)			Content of reducing sugar (%)			Content of total sugar (per cent)		
		2008 2009	2009 2010	Pooled	2008 2009	2009 2010	Pooled	2008 2009	2009 2010	Pooled	2008 2009	2009 2010	Pooled
T_1	200:100:100 kg NPK ha^{-1}	7.37	10.05	8.71	4.05	7.72	5.89	1.89	1.05	1.47	2.13	1.35	1.74
T_2	150:75:75 kg NPK ha^{-1}	9.31	7.98	8.65	2.72	2.63	2.68	1.73	1.23	1.48	2.56	1.58	2.07
T_3	100:50:50 kg NPK ha^{-1}	10.34	5.37	7.85	2.82	1.90	2.36	1.92	0.98	1.45	2.69	1.25	1.97
T_4	50:25:25 kg NPK ha^{-1}	7.85	5.84	6.85	3.52	3.63	3.58	1.89	0.91	1.40	2.32	1.42	1.87
T_5	50 Kg N through FYM 150:100:100 kg NPK ha^{-1} through inorganic	9.69	5.83	7.76	2.90	2.85	2.88	1.79	1.08	1.44	2.22	1.38	1.80
T_6	37.5 kg N through FYM 112.5:75:75 kg NPK ha^{-1} through inorganic	7.43	8.00	7.71	2.52	1.75	2.14	1.62	0.88	1.25	2.36	1.13	1.74
T_7	25 kg N through FYM 75:50:50 kg NPK ha^{-1} through inorganic	9.21	7.05	8.13	8.13	2.48	5.31	1.75	1.10	1.42	1.92	1.40	1.66
T_8	12.5 kg N through FYM 37.5:25:25 kg NPK ha^{-1} through inorganic	8.12	6.24	7.18	5.94	2.15	4.04	1.80	1.26	1.53	2.15	1.61	1.88
T_9	50 kg N through vermicompost 150:100:100 kg NPK ha^{-1} through inorganic	8.51	6.14	7.32	2.90	2.01	2.45	2.82	1.28	2.05	3.00	1.64	2.32
T_{10}	37.5 kg N through vermicompost 12.5:75:75 kg NPK ha^{-1} through inorganic	6.96	7.52	7.24	4.27	1.89	3.08	2.05	1.33	1.69	2.13	1.71	1.92
T_{11}	25 kg N through vermicompost 75:50:50 kg NPK ha^{-1} through inorganic	8.97	8.69	8.83	6.32	3.88	5.10	1.44	1.08	1.26	2.21	1.38	1.80
T_{12}	12.5 kg N through vermicomposst 37.5:25:25 kg NPK ha^{-1} through inorganic	7.38	6.94	7.16	3.57	1.95	2.76	1.43	1.01	1.22	1.92	1.29	1.61
T_{13}	50 Kg N through karanj cake 150:100:100 kg NPK ha^{-1} through inorganic	8.22	7.55	7.88	2.75	3.44	3.09	1.69	1.24	1.46	1.83	1.58	1.71
T_{14}	37.5 kg N through karanj cake 112.5:75:75 kg NPK ha^{-1} through inorganic	8.47	8.07	8.27	2.36	1.72	2.04	1.39	1.30	1.34	2.01	1.66	1.83
T_{15}	25 kg N through karanj cake 75:50:50 kg NPK ha^{-1} through inorganic	8.35	7.18	7.76	2.74	1.81	2.28	2.26	1.39	1.83	2.53	1.78	2.16
T_{16}	12.5 kg N through karanj cake 37.5:25:25 kg NPK ha^{-1} through inorganic	8.34	5.23	6.78	3.73	1.59	2.66	2.05	0.89	1.47	2.18	1.14	1.66
T_{17}	100:50:50 kg NPK ha^{-1} along with 200q FYM ha^{-1} (Recommended dose)	8.98	5.83	7.41	4.74	2.57	3.66	2.50	1.08	1.79	2.81	1.39	2.10
T_{18}	$N_0:P_{100}:K_{100}$	8.15	4.84	6.49	2.88	1.79	2.33	1.89	1.13	1.51	1.89	1.45	1.67
T_{19}	$N_0:P_0:K_0$ (control)	8.29	6.13	7.21	3.29	2.32	2.81	2.12	1.08	1.60	2.12	1.38	1.75
	S.E. (±)	0.53	0.63	0.48	0.26	0.26	0.17	0.13	0.08	0.05	0.15	0.10	0.08
	C.D. (P=0.05)	1.52	1.81	1.40	0.75	NS	0.49	0.37	0.22	0.16	0.43	0.30	0.22

Table 2 : Effect of integrated nutrient management on content of phenol, soluble protein and ascorbic acid of broccoli

Tr. No.	Treatments	Content of phenol (mg / 100 g)			Content of total soluble protein (mg/g)			Content of vit. C (mg/100 g)		
		2008-09	2009-10	Pooled	2008-09	2009-10	Pooled	2008-09	2009-10	Pooled
T_1	200:100:100 kg NPK ha^{-1}	50.94	155.75	103.35	6.16	13.29	9.72	30.37	68.88	49.63
T_2	150:75:75 kg NPK ha^{-1}	74.38	123.45	98.91	5.56	7.62	6.59	30.60	68.00	49.30
T_3	100:50:50 kg NPK ha^{-1}	36.11	117.51	76.81	2.52	7.35	4.93	30.79	48.12	39.46
T_4	50:25:25 kg NPK ha^{-1}	56.05	98.34	77.20	3.73	14.32	9.02	43.10	100.6	71.85
T_5	50 kg N through FYM 150:100:100 kg NPK ha^{-1} through inorganic	118.43	103.81	111.12	2.83	7.56	5.19	28.00	77.87	52.93
T_6	37.5 kg N through FYM 112.5:75:75 kg NPK ha^{-1} through inorganic	51.73	113.33	82.53	2.35	6.22	4.28	37.46	53.96	45.71
T_7	25 kg N through FYM 75:50:50 kg NPK ha^{-1} through inorganic	26.79	162.67	94.73	2.95	9.58	6.26	29.73	37.25	33.49
T_8	12.5 kg N through FYM 37.5:25:25 kg NPK ha^{-1} through inorganic	101.47	180.43	140.95	7.57	10.30	8.93	72.14	105.8	89.01
T_9	50 kg N through vermicompost 150:100:100 kg NPK ha^{-1} through inorganic	22.29	129.89	76.09	3.95	8.52	6.24	33.48	72.51	52.99
T_{10}	37.5 kg N through vermicompost 12.5:75:75 kg NPK ha^{-1} through inorganic	42.37	95.72	69.04	6.49	7.08	6.79	42.97	49.92	46.44
T_{11}	25 kg N through vermicompost 75:50:50 kg NPK ha^{-1} through inorganic	84.06	138.24	111.15	15.18	7.59	11.38	61.39	57.63	59.51
T_{12}	12.5 kg N through vermicomposst 37.5:25:25 kg NPK ha^{-1} through inorganic	59.18	65.05	62.12	2.42	7.49	4.96	77.55	100.8	89.18
T_{13}	50 kg N through karanj cake 150:100:100 kg NPK ha^{-1} through inorganic	70.38	80.63	75.51	4.11	6.95	5.53	36.41	44.83	40.62
T_{14}	37.5 kg N through karanj cake 112.5:75:75 kg NPK ha^{-1} through inorganic	109.23	73.58	91.41	4.51	5.58	5.05	36.22	92.94	64.58
T_{15}	25 kg N through karanj cake 75:50:50 kg NPK ha^{-1} through inorganic	62.84	72.64	67.74	3.72	7.60	5.66	46.73	102.9	74.83
T_{16}	12.5 kg N through karanj cake 37.5:25:25 kg NPK ha^{-1} through inorganic	186.03	111.62	148.82	7.69	10.86	9.28	73.08	107.8	90.45
T_{17}	100:50:50 kg NPK ha^{-1} along with 200q FYM ha^{-1} (Recommended dose)	83.95	119.34	101.65	3.05	7.09	5.07	49.10	101.9	75.54
T_{18}	N_0:P_{100}:K_{100}	57.85	86.85	72.35	1.97	5.93	3.95	80.11	111.2	95.69
T_{19}	N_0:P_0:K_0 (control)	61.17	177.15	119.16	3.40	5.24	4.32	50.94	84.10	67.52
	S.E.	22.57	7.06	12.03	1.57	0.58	0.83	3.41	5.27	4.25
	C.D. (P 0.05)	64.78	20.28	34.53	4.49	1.66	2.38	9.78	15.12	12.20

of nitrogenous fertilizer. Wang *et al*. (1997) reported additive effects on source-sink vitamin C content when K was applied together with N or N + P. Application of potassium has been found to result in increased content ascorbic acid by in cauliflower (Shi-ZhenYun *et al.,* 2004). Lisiewska and Kmiecik (1996) also reported decrease in concentration of ascorbic acid in cauliflower with increase in the amount of nitrogen fertilizer application. Anac and Colcoglu (1995) found that K increased the ascorbic acid concentration in tomato fruits. However, contrasting results have also been reported by Randhwa and Bhal (1976) where increased application rates of nitrogen exhibited positive response in increasing the ascorbic acid contents in cauliflower.

Hence, the study clearly indicated increase in the content of total phenol, total soluble protein and ascorbic acid with lower doses of nutrients, particularly nitrogen.

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