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Effect of organic and inorganic sources of nutrients on growth, yield and quality of sprouting broccoli cv. CBH-1

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ABSTRACT

A study was conducted to evaluate the effect of different organic sources and fertility levels on the growth, yield, quality and economics of sprouting broccoli under semi-arid conditions of Rajasthan. Significant increase in plant height, number of leaves, leaf area, volume and diameter of head, total head yield, crude protein and chlorophyll content in head was recorded under various levels of organic sources and fertility levels. Growth, yield and quality attributes were recorded maximum under treatment combination of vermi-compost 5.0 t ha^{-1} along with 125% recommended dose of fertilizers (NPK, 100, 80 and 60 kg/ ha), which was at par with poultry manure 5.0 t ha^{-1} and 100% recommended dose of fertilizers, respectively. Furthermore, it also registered maximum net return and B:C ratio (4.09) than rest of the treatments.

Key words: Sprouting broccoli, vermi-compost, poultry manure, yield, quality.

INTRODUCTION

Sprouting broccoli (*Brassica oleracea* L. var. *italica* Plenck) is a winter season rare vegetable in India but now it is gaining popularity in metropolitan cities. Morphologically, it resembles cauliflower except secondary heads which develop in the axil of leaves and may contribute up to 50 per cent of total yield. World over 40 per cent of it is marketed as fresh and remaining 60 per cent as frozen. Among cole crops, sprouting broccoli is highly nutritious. It is a rich source of sulphoraphane, a compound associated with reducing the risk of cancer (Thamburaj and Singh, 18).

It is well established fact that nitrogen, phosphorus and potassium are essential macronutrients, which have great significance in plant growth and development. The use of organic manures is an important factor, which has direct influence on the growth, yield and quality of the crop. Integrated nutrient supply system for the crop by judicious mixture of organic manures along with inorganic fertilizers has a number of agronomic and environmental efficiencies. Among various organic sources, vermi-compost and poultry manure are excellent sources being slow releasing and contain most of the macro- as well as micro-nutrients in chelated form thus increase nutrient uptake by fulfilling the nutrient requirements of plants at longer period (Abusaleha, 2; Jose *et al.* 7). The various workers have reported the significant effect of different organic and inorganic sources of nutrients in different cole crops in general and sprouting broccoli in particular but under semi-arid agro-climatic conditions of Rajasthan the information is meagre. Hence, keeping these facts the study was conducted.

MATERIALS AND METHODS

The experiment was conducted at Horticulture farm, S.K.N. College of Agriculture, Jobner (Jaipur). The soil of the experimental site was loamy sand with pH of 8.5, EC of 2.24 dS m^{-1}, organic carbon 0.15% and available N, P_2O_5 and K_2O of 132, 15.0 and 142 kg ha^{-1}, respectively. The treatments comprised of five levels of organic manures (control, vermi-compost and poultry manure @ 2.5 and 5.0 t ha^{-1} each) and four levels of recommended doses of NPK fertilizers (control, 75, 100 and 125%). The experiment was laid out in factorial randomized block design with three replications. The recommended dose of NPK for sprouting broccoli was 100, 80 and 60 kg ha^{-1}. The application of urea was given in two doses, first at the time of transplanting and remaining half in two split doses, *i.e*., 30 days after transplanting and at the time of head initiation. Single super phosphate, murate of potash, vermi-compost and poultry manure were applied at the time of transplanting of the crop. The observations on various traits like plant height, number of leaves, leaf area, volume and diameter of head, head yield plant^{-1}, head yield plot^{-1}, total head yield ha^{-1} and biological yield plant^{-1} were recorded as per standard methods. Chlorophyll content in leaves was estimated as per method described by Hiscox and Israelstom (6) and crude protein content in head by AOAC (1).

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RESULTS AND DISCUSSION

The growth attributes like plant height, number of leaves, leaf area and volume and diameter of head increased significantly with the use of vermi-compost and poultry manure (Table 1). The application of vermi-compost 5.0 t ha^{-1} being at par with 5.0 t ha^{-1} poultry manure recorded significantly highest values for above parameters. These findings clearly indicated that vermi-compost and poultry manure played a significant role on enhancing the growth of broccoli. Improvement in plant growth attributes with the application of vermi-compost might be due to better moisture holding capacity, supply of micronutrients and availability of major nutrients due to favorable soil condition (Reddy *et al*., 12). Poultry manure contains uric acid having 60 per cent nitrogen. The uric acid rapidly changes to ammonia form causing its immediate and efficient utilization for better plant growth and development. These results are in agreement with findings of Thanunathan *et al.* (19), and Oliveira *et al.* (11).

Similarly, the application of different levels of organic manure increased the head yield $plant^{-1}$, $plot^{-1}$, total head yield ha^{-1}, and biological yield $plant^{-1}$ (Table 2). These results showed that with the application of 5.0 t ha^{-1} vermi-compost the yield parameters increased significantly over control, 2.5 t ha^{-1} vermi-compost and poultry manure each but found statistically at par to poultry manure 5.0 t ha^{-1}. The beneficial effect of vermi-compost on yield and yield attributes might be due to enhanced supply of macro- and micro-nutrients during entire growing season. The significant improvement in yield attributes and yield on account of 5.0 t ha^{-1} vermi-compost along with nutrients from soil at latter stages of crop growth might have enhanced the rate of photosynthesis which further increased vegetative growth and provided more sites for translocation of photosynthates, which ultimately increased the yield attributes and yield. The increased yield and yield attributes with poultry manure might be because of rapid availability and utilization of nitrogen for various internal plant processes for carbohydrate production. Later on these carbohydrates undergo hydrolysis and get converted into reproductive sugars, which ultimately helped in increasing yield. Singh *et al.* (16) reported that high carbohydrates content due to application of poultry manure might be attributed to balanced C: N ratio and increased activity of plant metabolism. These results are in accordance with the findings of Shreeniwas *et al.* (15), and Shelke *et al.* (14). Similarly, the quality parameters like crude protein and chlorophyll content in head were significantly increased with vermi-compost and poultry manure (Table 2). The vermi-compost 5.0 t ha^{-1} being statistically at par with 5.0 t ha^{-1} poultry manure was significantly superior over control, 2.5 t ha^{-1} vermi-compost and poultry manure each. This might be due to improved nutritional environment in

Table 1. Effect of organic and inorganic sources of nutrients on growth attributes of sprouting broccoli.

Treatment	Plant height (cm)			No. of leaves $plant^{-1}$			Leaf area (cm^2)	Head volume (cm^3)	Head dia. (cm)
	40 DAT	60 DAT	At harvest	45 DAT	60 DAT	At harvest			
Organic source									
Control	16.96	34.95	41.51	11.20	17.72	21.30	1239.38	72.09	7.06
2.5 t ha^{-1} VC	21.82	44.95	55.58	14.47	22.79	27.47	1666.59	93.68	9.12
5.0 t ha^{-1} VC	2460	50.62	60.72	16.24	25.67	31.15	1796.61	104.84	10.23
2.5 t ha^{-1} PM	21.17	43.61	51.98	13.99	22.11	26.59	1547.78	90.24	8.63
5.0 t ha^{-1} PM	23.90	49.41	58.65	15.81	25.06	30.08	1749.01	100.79	9.93
CD (P = 0.05)	1.78	3.55	4.50	1.18	1.77	2.27	131.73	6.82	0.71
Inorganic source									
Control	17.84	35.32	43.11	11.65	18.06	21.42	1250.25	80.32	7.29
75% RDF	21.52	43.51	52.20	13.97	22.03	26.65	1550.97	90.75	8.83
100% RDF	23.25	48.65	57.45	15.45	24.46	29.82	1715.36	97.23	9.75
125% RDF	24.19	51.35	60.39	16.30	26.13	31.39	1830.12	101.02	10.24
CD (P = 0.05)	1.60	3.18	4.03	1.06	1.58	2.03	117.82	6.10	0.64

VC = Vermi-compost; PM= Poultry manure; RDF = Recommended dose of fertilizers; DAT = Days after transplanting.

the rhizosphere as well as its utilization in the plant system, leading to enhanced translocation of nutrient, vitamins and proteins in heads. Another reason might be the increased activity of nitrate-reductase, which helped in synthesis of certain amino acids and protein as reported by Yadav and Vijayakumari (20).

The data in Table 1 showed that increasing the levels of recommended dose of NPK up to 100% significantly increased the plant height, number of leaves, leaf area, volume and diameter of head. This may be due to the better nutritional environmental in the root zone for growth and development of the plant. N, P and K are considered as major nutrients required for proper growth and development of the plants. These nutrients play important role in plant metabolism by virtue of being an essential constituent of diverse type of metabolically active compounds like amino acids, proteins, nucleic acids, prophytins, flavins, purine and pyrimidine, nucleotide, flavin nucleotides, enzymes, co-enzymes and alkaloid (Yadav, 21; Kumhar, 9).

The yield and yield attributes like head yield plant^{-1}, plot^{-1}, total head yield ha^{-1} and biological yield plant^{-1}were also influenced significantly up to 100% recommended dose of fertilizers. This might be due to the fact that increased NPK levels, helped in the expansion of leaf area and chlorophyll content which coupled with increased net photosynthetic rates and in turn increased the supply of carbohydrates to plants. The application of NPK favoured the metabolic and auxin activities in plant and ultimately resulted in increased head weight, biological yield and finally the total yield. However, potassium does not increase the yield of plant but indirectly supported to yield. These results are also in close conformity with the findings of Rutkauskiene and Poderys (13), Everaarts (3).

The crude protein and chlorophyll content in head were also recorded significantly highest under 125% recommended dose of fertilizers (Table 2). The significant influence of NPK fertilization on quality parameters in plant appeared to be due to improved nutritional environment both in the root zone and the plant system, because an adequate supply of N, P and K early in the crop season increased the availability of nutrients to the root zone coupled with increased metabolic activity at cellular level might have increased the nutrient uptake and accumulation in the vegetative plant parts (Soni, 17). Increase in protein content in head of cabbage with increased nitrogen level was also reported by Khudair *et al*. (8).

The data (Table 2) revealed that net profit and B:C ratio of sprouting broccoli differed significantly with organic sources and in contrary of various growth, yield and quality characters, which were recorded maximum in vermi-compost 5.0 t ha^{-1}, economic returns in terms of net profit and B:C ratio were found highest with poultry manure 5.0 t ha^{-1} followed by vermi-compost 5.0 t ha^{-1} and this was only due to the cost of poultry manure which was much cheaper than vermi-compost. Net profit and B:C ratio of

Table 2. Effect of organic and inorganic sources of nutrients on yield, quality and economics of sprouting broccoli.

Treatment	Total head yield			Biological yield plant (kg)	Crude protein (%)	Chlorophyll content (mg g^{-1})	Net profit (Rs ha^{-1})	B:C ratio
	Plant^{-1} (kg)	Plot^{-1} (kg)	ha^{-1} (q)					
Organic source								
Control	0.292	4.69	144.63	1.00	2.72	1.59	101957	2.38
2.5 t ha^{-1} VC	0.406	6.51	200.86	1.38	2.76	2.05	153182	3.19
5.0 t ha^{-1} VC	0.460	7.38	227.65	1.56	2.95	2.30	173727	3.21
2.5 t ha^{-1} PM	0.387	6.19	191.18	1.32	2.77	1.99	148328	3.44
5.0 t ha^{-1} PM	0.445	7.13	220.03	1.50	2.93	2.24	177007	4.09
CD (P = 0.05)	0.030	0.49	15.18	0.08	0.19	0.08	15182	0.39
Inorganic source								
Control	0.292	4.67	144.27	1.05	2.71	1.85	100371	2.29
75% RDF	0.386	6.18	190.84	1.32	2.81	2.01	144759	3.14
100% RDF	0.446	7.12	219.45	1.48	2.87	2.10	172509	3.69
125% RDF	0.470	7.54	232.92	1.54	2.91	2.18	185722	3.94
CD (P = 0.05)	0.027	0.44	13.58	0.07	0.17	0.07	13519	0.35

VC = Vermi-compost; PM = Poultry manure; RDF = Recommended dose of fertilizers.

sprouting broccoli increased significantly with fertility levels and 125% recommended dose of fertilizers closely followed by 100% recommended dose of fertilizers recorded the maximum values. Therefore, it could be inferred from findings that 5.0 t ha^{-1} poultry manure and 125% recommended dose of fertilizers were most economical.

Interaction effect between organic sources and fertilizer doses was found significant with respect to total head yield and net returns of sprouting broccoli (Tables 3, 4). Maximum total head yield and net returns were recorded under the vermi-compost 5.0 t ha^{-1} with 125% recommended dose of fertilizers closely followed by poultry manure 5.0 t ha^{-1} at the same level of fertilizer dose. However, it is important to note that vermi-compost 2.5 t ha^{-1} at 100% recommended dose of fertilizers and vermi-compost 5.0 t ha^{-1} at 75% recommended dose of fertilizers recorded significantly higher total head yield and net returns than 125% recommended dose of fertilizers at control. Similar results were recorded under each level of poultry manure also. The application of 100% recommended dose of NPK along with 5.0 t ha^{-1} poultry manure increased the yield of broccoli, this treatment combination was found best from economics point of view. But production point of view, treatment combination 75% recommended dose of NPK along with 5.0 t ha^{-1} vermi-compost gave best results.

This might be due to availability of adequate amount of NPK at longer period and improved fertility levels of soil. The vermi-compost have nutrients solubilizing bacteria which solublized the N, P and other micronutrients in soil near the root zone of the crop and provide nutrients in the readily available chelated form to the plants such as nitrate, exchangeable phosphorus, soluble K, Ca and Mg. It also contains biologically active substances such as plant growth regulators. It is also due reported that vermi-compost has high porosity, aeration, drainability and water holding capacity, thus, it is capable to improve the physical conditions of soil and all the factors associated to increase the yield and quality of different vegetables in general and broccoli in particular when applied in the combination of chemical fertilizers. These findings are in agreement with those of Hangarge *et al.* (4), Naidu *et al.* (10), and Hiranmani *et al.* (5).

It can be inferred from present investigation that optimum yield with best quality of broccoli can be obtained with the application of 5.0 t ha^{-1} vermi-compost or poultry manure along with 75% of recommended dose of NPK, which also reduced the cost of cultivation.

Table 3. Interaction effects of organic and inorganic sources of nutrients on total head yield (q ha^{-1}).

Treatment	Control	Vermi-compost		Poultry manure		Mean
		2.5 t ha^{-1}	5.0 t ha^{-1}	2.5 t ha^{-1}	5.0 t ha^{-1}	
Control	114.89	145.71	166.63	143.26	150.86	144.27
75% RDF	136.08	174.71	231.96	175.57	235.88	190.84
100% RDF	160.20	239.49	252.07	201.89	243.59	219.45
125% RDF	167.36	243.51	259.94	243.98	249.80	232.92
Mean	144.63	200.86	227.65	191.18	220.03	
		CD (P = 0.05)		30.36		

RDF = Recommended dose of NPK.

Table 4. Interaction effects of organic and inorganic sources of nutrients on net return (Rs. ha^{-1}).

Treatments	Control	Vermi-compost		Poultry manure		Mean
		2.5 t ha^{-1}	5.0 t ha^{-1}	2.5 t ha^{-1}	5.0 t ha^{-1}	
Control	74,095	99,918	1,15,838	1,02,291	1,09,711	1,00,371
75% RDF	93,101	1,26,738	1,78,981	1,32,421	1,92,551	1,44,759
100% RDF	1,17,363	1,91,655	1,94,235	1,58,883	2,00,408	1,72,509
125% RDF	1,23,268	1,94,416	2,05,853	1,99,715	2,05,356	1,85,722
Mean	1,01,957	1,53,182	1,73,727	1,48,328	1,77,007	
		CD (P = 0.05)		30,364		

RDF = Recommended dose of NPK.

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