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Integrated nutrient management in broccoli (*Brassica oleracea* var. *italica*)

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ABSTRACT

Field experiment was conducted during *rabi* 2016–17 to 2018–19 to determine the effect of INM on of yield and economic attributes of broccoli at Vegetable Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. Nine different treatment combinations, viz. full recommended dose of NPK through chemical fertilizer, FYM @ 20 tonnes /ha, FYM @ 10 tonnes/ha+ half NPK through chemical fertilizer, neem cake @ 5 q/ha, neem cake @ 2.5 q/ha + half NPK through chemical fertilizer, vermicompost @ 5 t/ha, vermicompost @ 2.5 t/ha + half NPK through chemical fertilizer, poultry manure @ 5 t/ha and poultry manure @ 2.5 t/ha + half NPK through chemical fertilizer were tested in randomized block design with four replications under AICRP on Vegetable Crops. Aishwarya variety of broccoli was transplanted at a spacing of 45 cm × 45 cm. Results of the experiment revealed that the application of vermicompost @ 2.5 t/ha + half NPK through chemical fertilizer recorded significantly highest head weight (386.80 g), total yield (204.76 q/ha), net income (₹ 108832/ha) and B:C ratio (3.15). Therefore, the practice of vermicompost integration with half dose of chemical fertilizers may be recommended to exploit the better eco-friendly economic yield of broccoli.

Keywords: Broccoli, Economics, Integrated nutrient management, Organic manures

Broccoli (*Brassica oleracea* L. var. italic Plenck 2n=x=18), which is originated from the Mediterranean region commonly known as *hari gobhi* in Hindi and a member of cole group, belongs to the family Brassicaceae or Cruciferae (mustard family). Broccoli is an Italian vegetable which is cultivated in Italy in ancient roman times. Commercial cultivation of broccoli was started around 1923 (Decoteau 2000). Watt (1983) reported that broccoli is more nutritious than any other cole crops such as cabbage, cauliflower and kohlrabi. On the other hand, broccoli is environmentally better adapted than cauliflower and reported to withstand comparatively at higher temperature than cauliflower (Rashid 1976). Brassica vegetables possess both antioxidant and anticarcinogenic properties (Cartea *et al*. 2008) and it is well known that dietary intake of food containing antioxidants provides effective support for the body's defensive systems and may prevent some diseases (Carty and Mark 2008). Broccoli 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 (Kumar *et al.* 2011). Broccoli contains indole-3-carbinol which helps to fight breast and lung cancer. It is used as curries, soups and pickles and also eaten as a salad and cooked as a single or mixed vegetable with potato (Thamburaj and Singh 2001).

Integrated nutrient management (INM) maintained soil fertility for sustainable crop productivity through optimization of all available organic, inorganic and biotic resources in an integrated manner, appropriate to each cropping system and farming situations with its ecological, social and economic ramifications. There is an urgent need to adopt an integrated nutrient supply and management system for promoting efficient and balanced use of plant nutrients. While the main emphasis was given on increasing the proper and balanced used of mineral fertilizers, the role of organic manure, bio-fertilizers, green manuring and recycling of organic wastes should be considered supplementary and not substitutable. Keeping this in view, the research was carried out with the objectives to study the effect of integrated application of inorganic and organic manures on yield and yield attributes of broccoli.

MATERIALS AND METHODS

The present investigation was undertaken to ascertain the effect of integrated management of nitrogen, phosphorus and potassium through chemical fertilizers and organic manures in broccoli during the period of November 2016 to March 2019 in three consecutive *rabi* seasons. The soil was sandy loam with organic carbon 0.34%, available N 152.0 kg/ha, phosphorus 14.76 kg/ha and potassium 180.0 kg/ha at initiation of experiment. The broccoli variety Aishwarya

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Table 1 Effect of integrated nutrient management on plant length, head weight and total yield of broccoli (pooled data over 3 years)

Treatment	Plant length (cm)	Head weight (g)	Total yield (q/ha)
Full recommended dose of NPK through chemical fertilizer	44.39	342.96	172.42
FYM @ 20 t/ha	40.76	292.62	166.08
FYM @ 10 t/ha + half NPK through chemical fertilizer	49.39	355.61	200.96
Neem cake @ 5 q/ha	38.22	288.12	154.05
Neem cake @ 2.5 q/ha + half NPK through chemical fertilizer	44.96	326.28	180.92
Vermicompost @ 5 t/ha	44.74	319.50	165.22
Vermicompost @ 2.5 t/ha + half NPK through chemical fertilizer	47.44	386.80	204.76
Poultry manure @ 5 t/ha	41.97	339.63	167.48
Poultry manure @ 2.5 t/ha + half NPK through chemical fertilizer.	45.50	337.06	193.56
SEm±	1.48	12.22	7.50
LSD (P=0.05)	4.32	35.69	21.91
CV	4.71	7.31	6.71

was used in the experiment, which is an early-maturity variety and takes around 70 days from transplanting to first harvesting. Nine different treatment combinations, viz. full recommended dose of NPK through chemical fertilizer, FYM @ 20 tonnes /ha, FYM @ 10 tonnes/ha+ half NPK through chemical fertilizer, neem cake @ 5 q/ha, neem cake @ 2.5 q/ha + half NPK through chemical fertilizer, vermicompost @ 5 t/ha, vermicompost @ 2.5 t/ha + half NPK through chemical fertilizer, poultry manure @ 5 t/ha and poultry manure @ 2.5 t/ha + half NPK through chemical fertilizer were tested in Randomized Block Design (RBD) with four replications. The available N, P and K contents in FYM, vermicompost, neem cake and poultry manure were 0.45, 0.24 and 0.52%, 1.46, 0.45 and 1.38%, 4.58, 0.69 and 1.29% and 1.42, 1.24 and 1.10%, respectively. The crop was transplanted in plots size of 3.15 m × 3.15 m with a spacing of 45 cm between rows and 45 cm between plants. Organic manures were applied at the time of field preparation as per treatment. Chemical fertilizers were applied at the rate of 200 kg nitrogen, 50 kg phosphorus and 100 kg potash per ha under the treatment of full recommended dose of NPK through chemical fertilizers. Crop was raised with recommended package of practices except treatments. The observations were taken on plant length, head weight and yield and recorded observations were analysed by using statistical techniques. On the basis of total variable cost and gross return, net return and B:C ratio were calculated as per methods suggested by Devasenapathy *et al*. (2008).

RESULTS AND DISCUSSION

Several factors have been found to influence growth and yield of high value crops like vegetables, which ensure high and quick returns per unit area and time. It is an established fact that continuous sole and imbalanced use of chemical fertilizers leads to deterioration of soil health and ecological balance in conjunction with decrease in nutrient uptake efficiency of the applied nutrients. Although chemical fertilizers contribute a lot in fulfilling the nutrient requirement of sprouting broccoli, which is an exhaustive crop, but their regular, excessive and unbalanced use may lead to deterioration of physical and chemical properties of the soil and ultimately poor crop yields.

Effect of integrated nutrient management on growth and yield: Plant length, head weight and total yield of broccoli were influenced significantly by different treatment combinations of integrated nutrient management (Table 1). Based on three consecutive years pooled data, application of FYM @ 10 t/ha + half NPK through chemical fertilizer recorded significantly highest plant length of 49.39 cm. It was followed by vermicompost @ 2.5 t/ha + half NPK through chemical fertilizer with 47.44 cm and poultry manure @ 2.5 t/ha + half NPK through chemical fertilizer with 45.50 cm. However, these three treatments were found statistically at par with each other in terms of plant length. Full recommended dose of NPK through chemical fertilizer produced 44.39 cm plant length (Fig 1). The lowest plant length of 38.22 cm was found in application of neem cake @ 5 q/ha. It might be attributed to the availability of nutrients for crop use. The results are in confirmation with the findings of Das *et al.* (2019).

Effect of integrated nutrient management on head weight showed significant variation among the treatments (Table 1). Application of vermicompost @ 2.5 t/ha + half NPK through chemical fertilizers produced significantly highest head weight of 386.80 g followed by FYM @ 10 t/ha + half NPK through chemical fertilizer (355.61 g) and full recommended dose of NPK through chemical fertilizer (342.96 g). However, the effect of treatment vermicompost @ 2.5 t/ha + half NPK through chemical fertilizers and FYM @ 10 t/ha + half NPK through chemical fertilizer was found statistically at par with each other in terms of head weight. Application of neem cake @ 5 q/ha recorded lowest head weight of 288.12 g in broccoli. The increase in head weight might be due to the more photosynthesis from a larger area of the leaves and the translocation of photosynthates to the sink, which is ultimately the head. The increase in the head

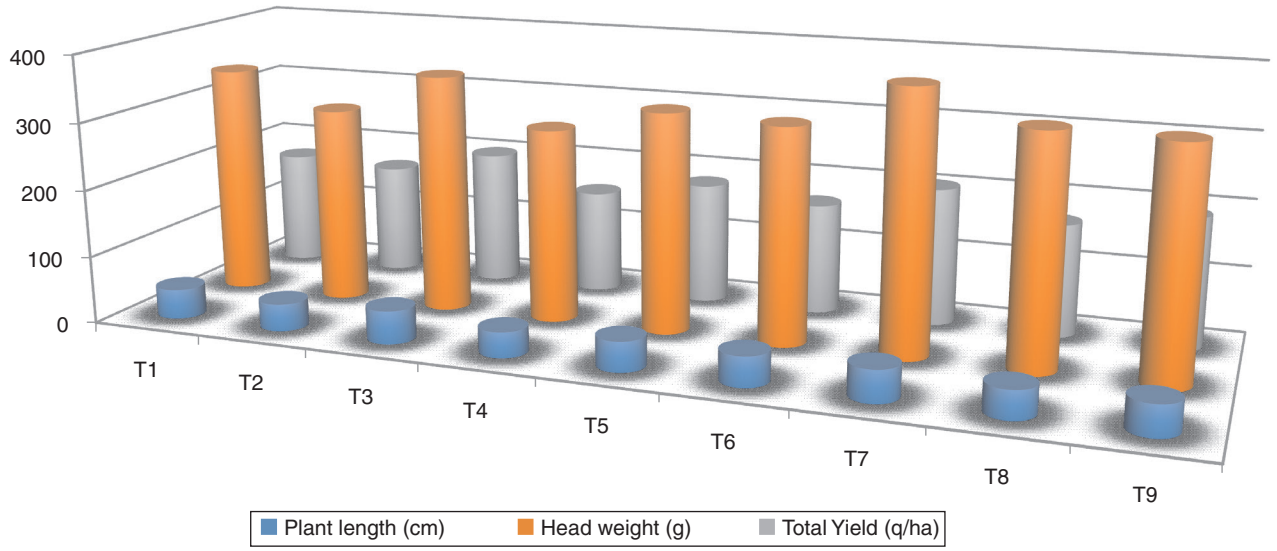

Fig 1 Effect of INM on plant length, head weight and total yield of broccoli.

weight at this level might also be due to the increase in the leaf weight and also due to higher values of head length and head width cited by Sharma *et al.* (2008).

In case of total yield of broccoli, application of vermicompost @ 2.5 t/ha + half NPK through chemical fertilizers produced significantly highest total yield of 204.76 q/ha (Table 1). It was followed by FYM @ 10 t/ha + half NPK through chemical fertilizer with 200.96 q/ha and poultry manure @ 2.5 t/ha + half NPK through chemical fertilizer with 193.56 q/ha. The lowest total yield of 154.05 q/ha was observed in treatment of neem cake @ 5 q/ha. The beneficial role of farmyard manure and vermicompost is in improving physical, chemical and biological properties of soil, which in turn, help in better nutrient absorption by plants, also resulted in higher values for yield contributing parameters. Sole organics could not meet the nutrition need of crop. The combination of organic and inorganic nutrients is more effective due to the reason of better uptake of nutrients in broccoli. Similar results were reported by Bahadur *et al.* (2003) and Chaterjee *et al.* (2005).

Effect of integrated nutrient management on economics: The economics of crop was affected by different treatments (Table 2). Application of neem cake @ 5 q/ha required highest cultivation cost followed by vermicompost @ 5 t/ha. It might be attributed to higher cost of organic manures like neem cake and vermicompost. Gross returns were significantly affected by different treatments and was worked out highest of ₹ 143332/ha in vermicompost @ 2.5 t/ha + half NPK through chemical fertilizers followed by FYM @ 10 t/ha + half NPK through chemical fertilizer with ₹ 140672/ha. Application of neem cake @ 5 q/ha recorded lowest gross income. These results indicated that the combination of organic and inorganic nutrients increased gross income (Fig 2).

Table 2 Effect of integrated nutrient management on economics of different treatments (pooled data over three years)

Treatment	Cost of cultivation (₹/ha)	Gross return (₹/ha)	Net income (₹/ha)	B:C ratio
Full recommended dose of NPK through chemical fertilizer	34000.0	120694.0	86694.0	2.54
FYM @ 20 t/ha	34500.0	116256.0	81756.0	2.37
FYM @ 10 t/ha + half NPK through chemical fertilizer	34500.0	140672.0	106172.0	3.08
Neem cake @ 5 q/ha	45000.0	107835.0	62832.0	1.39
Neem cake @ 2.5 q/ha + half NPK through chemical fertilizer	35000.0	126644.0	91644.0	2.61
Vermicompost @ 5 t/ha	41000.0	115654.0	74654.0	1.82
Vermicompost @ 2.5 t/ha + half NPK through chemical fertilizer	34500.0	143332.0	108832.0	3.15
Poultry manure @ 5 t/ha	34000.0	117236.0	83236.0	2.44
Poultry manure @ 2.5 t/ha + half NPK through chemical fertilizer.	36000.0	135492.0	99492.0	2.76
SEm±	1278.6	4173.9	2982.3	0.08
LSD (P=0.05)	3790.5	12498.8	8856.4	0.24

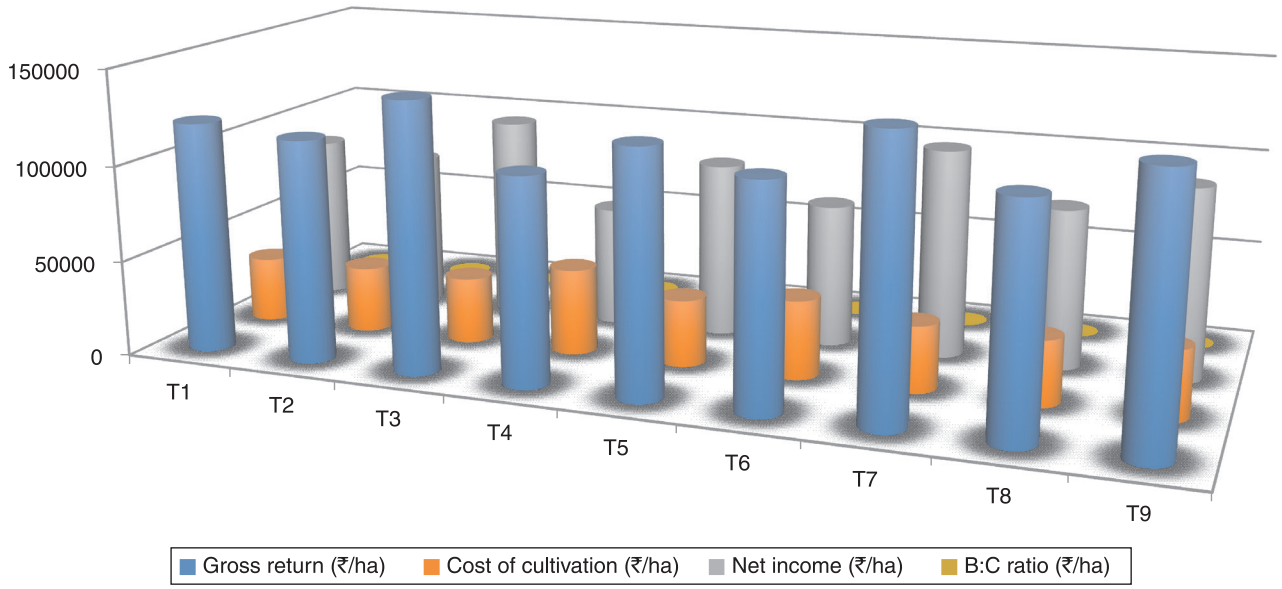

Fig 2 Effect of INM on economics of broccoli.

Net returns were also significantly affected by different treatments. The highest net return of ₹ 108832/ha was recorded in vermicompost @ 2.5 t/ha + half NPK through chemical fertilizers followed by FYM @ 10 t/ha + half NPK through chemical fertilizer with ₹ 106172/ha and poultry manure @ 2.5 t/ha + half NPK through chemical fertilizer with ₹ 99492/ha (Table 2). The B:C ratio of 3.15 was also significantly highest in vermicompost @ 2.5 t/ha + half NPK through chemical fertilizers. The lowest benefit : cost ratio (1.39) was obtained under the treatment of neem cake @ 5 q/ha. It might be due to higher cultivation cost under this treatment. Sarkar *et al*. (2011) in potato and Bilashini *et al*. (2018) in garden pea also reported similar findings.

From the above said findings, it can be concluded that application of vermicompost (@ 2.5 t/ha) integration with half recommended dose of inorganic fertilizers is profitable alternative of full recommended dose of inorganic fertilizers in broccoli under Kanpur condition.

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