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Effect of Kitchen Waste Compost, Urea and FYM on Production of Broccoli (*Brassica oleracea* var. *Italica* Plenck) cv Pusa KTS-1

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ABSTRACT

The present investigation was conducted during 2019-2020 at Babasaheb Bhimrao Ambedkar University, Lucknow (Uttar Pradesh), India to study the effect of various plant nutrient sources along with kitchen waste compost (KWC) on the production of broccoli a high value vegetable crop. The experiment laid out in a Randomized Block Design having nine treatments i.e., T_1 : Control (no fertilizer and manure), T_2 : Full dose of RDF of N P K through chemical fertilizer, T_3 : 120 kg Nitrogen by urea, T_4 : 120 Kg Nitrogen by KWC, T_5 : 120 Kg Nitrogen by FYM, T_6 : 60 kg Nitrogen by urea + 60 kg Nitrogen by KWC, T_7 : 60 kg Nitrogen by urea + 60 kg Nitrogen by FYM, T_8 : 30 kg Nitrogen by urea + 90 kg Nitrogen by KWC, T_9 : 30 kg Nitrogen by urea + 90 kg Nitrogen by FYM replicated thrice. Application of various levels of fertilizers in combination with organic and inorganics showed a significant influence on growth, yield and quality of broccoli. Maximum height of plant (55.17 cm), leaf length (22.12 cm), leaf width (18.10 cm), number of leaves (21.23 per plant), leaf area (401.09 cm^2) were recorded when nitrogen was applied through urea and KWC (30kg N_2 through urea + 90 kg N_2 through KWC-T_8. Whereas, plant spread i.e., 63.22 cm (E-W) and 60.40 cm (N-S) was found maximum under T_7 (60 kg N_2 through urea + 60 kg N through FYM). Earliest harvesting was done in T_8 which also increased the curd diameter (14.82 cm), curd length (16.38 cm) and curd weight (385.52 g). Subsequently, T_8 also showed maximum curd yield (190.12 q/ha), Vitamin C (82.42 mg/100g) and dry matter content (12.23 %) and TSS (11.73 °B) followed by application of 60 kg N_2 through urea + 60 kg N through FYM (T_7). Thus, it concluded that the supply of nitrogen through combined application of urea (30 kg N through urea) and KWC (90 kg N through KWC) was beneficial for quality production of broccoli at Lucknow area having sub tropical climate and slightly alkaline sandy loam soil.

Keywords Broccoli, Kitchen waste compost, Organics, Integrated nutrient management.

INTRODUCTION

Broccoli (*Brassica oleracea* L. var. *italica* Plenck) belonging to family Brassicaceae is a herbaceous winter vegetable grown in India and abroad (Hossain *et al.* 2011) although, commercial cultivation was started

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around 1923 (Decoteau 2000) in Italy. Broccoli is nutritious cole crop containing vitamin A 130 times higher than cauliflower and 22 times more than cabbage (Watt 1983). It also possess both anti-oxidant and anti-carcinogenic properties (Cartea *et al.* 2008) along with thiamin, riboflavin, niacin, vitamin C and minerals like Ca, P, K and Fe (Kumar *et al.* 2011). It is well known that dietary intake of food containing antioxidants provides effective support for the body's defensive systems and may protect from some life threatening diseases Carty and Mark 2008. Broccoli contains indole-3-carbinol which helps to fight breast and lung cancer (Katz *et al.* 2018). It is used as curries, soups, pickles and also eaten as a salad and cooked as a single or mixed vegetable with potato (Thamburaj and Singh 2001, Singh *et al.* 2014).

Application of compost made from kitchen waste in combination with chemical fertilizers provides an excellent opportunity to replace chemical fertilizers by increasing yield and quality of broccoli (Shree *et al.* 2014). Incorporation of phytonutrients in the form of compost of kitchen scraps, manure and bio-fertilizers is known to have a beneficial effect on the physico-chemical and biological properties of the soil, resulting in the absorption of better uptake of nutrients in the soil (Lal and Kanaujia 2013). Nutrient requirement is basically a genetic characteristic of the crop plants and this requirement may vary with the cultivar of the particular crop (Hazra and Som 1999). Nitrogen, phosphorus and potassium are three major plant nutrients, which are required by the plants in more quantities for better growth, yield and qualities. So, balanced nutrition supply is very important. Compost making from kitchen wastes is now becoming very popular having capabilities to provide good amount of plant nutrients (Petrovic *et al.* 2021, Govind *et al.* 2015, Tiwari *et al.* 2016, Kiran *et al.* 2017 and Singh *et al.* 2020) due to its easy in preparation, abundant availability in house hold and also due to the fact that it influences on environmental pollution control. However, standardization of dose and variation in nutrient content in it, use of kitchen waste in commercial cultivation is not well established. Thus, the present investigation is carried out to study the influence of kitchen waste compost on growth, yield and quality of broccoli along with other sources of nutrients.

MATERIALS AND METHODS

The present study was carried out at Horticulture Research Farm, Department of Horticulture, School of Agricultural Sciences and Technology, Babasaheb Bhimrao Ambedkar University, Lucknow (Uttar Pradesh), India during 2019-20. Soil of experimental field was sandy loam (pH 8.2) and moderately fertile. The experiment was laid out in Randomized Block Design (RBD) with 9 treatments [T_1- Control (no fertilizer and manure), T_2- Full dose of RDF of N PK through chemical fertilizer, T_3-120 kg Nitrogen (urea form), T_4- 120 Kg Nitrogen (by kitchen waste manure), T_5–120 Kg Nitrogen through FYM, T_6–60 kg Nitrogen (urea) + 60 kg (kitchen waste manure), T_7–60 kg Nitrogen (urea) + 60 kg FYM, T_8- 30 kg Nitrogen (urea) + 90 kg Nitrogen (kitchen waste manure), T_9- 30 kg Nitrogen (urea) + 90 kg Nitrogen through FYM] replicated thrice. Seedlings were transplanted on main plots at 45 cm × 45 cm spacing accommodating 16 plants in each plot (1.8 m × 1.8 m). The entire recommended dose of phosphorus, potassium and one third dose of nitrogen as per treatment were applied before transplanting. Well decomposed farmyard manure and kitchen waste compost were mixed thoroughly as per treatment within the top layer of soil before transplanting. The remaining dose of nitrogen was top dressed in two equal splits after 15–20 and 30–35 days of transplanting along with earthing up. Growth contributing parameters such as height of plant (cm), leaf length (cm), leaf width (cm), number of leaves, leaf area (cm^2), plant spread ; yield related parameters viz., first harvesting (days), average curd weight (g), curd diameter (cm), curd length (cm), curd yield (q/ha) were recorded as per standard measurement methods. vitamin C (mg/100g) content was estimated by volumetric method, sample prepared with 4% oxalic acid and was titrated against 2, 6- dichlorophenol indophenol dye. The appearance of pink color was taken as end point (AOAC 2000). After chopping the curd, fresh weight was recorded and samples were oven dried at 60ºC for 72 hrs. Oven dried samples were again weighed and dry matter was expressed in percentage value. TSS (°Brix) was measured by digital refractometer after extracting juice from curd. The data recorded on each character

Table 1. Growth attributing characters of sprouting Broccoli cv. Pusa KTS-1.

Treatments	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	Number of leaves plant^{-1}	Leaf area (cm^2)	Plant spread (cm) E-W	N-S
T_1 - Control (no fertilizer & manure)	41.10	17.15	14.28	14.42	244.38	44.42	51.32
T_2 - RDF of N P K through chemical Fertilizer	43.06	18.36	15.79	19.38	289.90	47.59	52.19
T_3 -120 kg Nitrogen by urea	47.36	19.08	16.53	18.63	315.39	49.78	52.56
T_4- 120 Kg Nitrogen by kitchen waste manure	47.75	19.46	16.93	17.34	329.45	53.29	55.19
T_5 -120 Kg Nitrogen by FYM	49.21	19.84	17.18	17.35	340.85	53.64	57.12
T_6- 60 kg Nitrogen by urea + 60 kg kitchen waste manure	51.33	20.60	17.41	18.33	385.64	55.41	54.58
T_7 - 60 kg Nitrogen by urea + 60 kg FYM	52.99	21.74	18.39	18.20	399.79	63.22	60.42
T_8 - 30 kg Nitrogen by urea + 90 kg Nitrogen by kitchen waste manure	55.17	22.12	18.10	21.23	401.09	59.72	56.86
T_9 - 30 kg Nitrogen by urea + 90 kg Nitrogen by FYM	50.24	18.15	15.58	19.15	282.77	61.28	58.20
SEm±	2.69	2.82	1.83	2.52	11.29	5.13	4.62
CD at 5%	6.54	5.65	5.64	4.23	41.13	9.81	10.56

were analyzed by the ANOVA in RBD design (Sahu and Das 2014) and treatment means were compared at p= 0.05 significance level.

RESULTS AND DISCUSSION

The data (Table 1) clearly reveal that the maximum plant height (55.17 cm) was observed in T_8 i.e., application of 30 kg nitrogen supplied through urea and 90 kg N_2 applied through KWC followed by application of 30 kg N_2 through urea and 90 kg N_2 through FYM (T_7).

Similarly, maximum leaf length (22.12 cm), leaf area (401.09 cm^2) was observed when 30 kg N^2 through urea + 90 kg N^2 though KWC was applied

Table 2. Physical characters of curd of sprouting broccoli cv Pusa KTS-1.

Treatments	First harvesting after transplanting (days)	Average curd weight (g)	Curd diameter (cm)	Curd length (cm)
T_1 - Control (no fertilizer and manure)	64.24	185.70	9.67	12.20
T_2 - RDF of NPK through chemical fertilizer	56.00	261.60	11.44	13.68
T_3 -120 kg Nitrogen by urea	58.12	238.21	13.23	14.05
T_4- 120 kg Nitrogen by kitchen waste manure	57.24	302.22	13.85	14.12
T_5 -120 kg Nitrogen by FYM	54.42	308.20	12.07	15.25
T_6- 60 kg Nitrogen by urea +60 kg kitchen waste manure	59.67	295.63	13.09	15.38
T_7 - 60 kg Nitrogen by urea + 60 kg FYM	55.32	310.42	13.82	15.80
T_8 - 30 kg Nitrogen by urea + 90 kg Nitrogen by kitchen waste manure	52.13	385.52	14.82	16.38
T_9 - 30 kg Nitrogen by urea + 90 kg Nitrogen by FYM	53.82	289.71	13.52	14.98
SEm ±	2.38	10.54	1.42	1.86
CD at 5%	5.32	39.43	3.42	2.15

Fig. 1. Positive relation between dry matter content and curd yield of broccoli.

followed by T_7 (21.74 cm, 399.79 cm^2, respectively), while, control treatment showed the minimum leaf length (17.15 cm) and leaf area (244.38 cm^2). However, application of 60 kg N_2 through urea + 60 kg N_2 through FYM (T_7) recorded the maximum leaf width of 18.39 cm followed by application of 30 kg N_2 through urea + 90 kg N_2 through kitchen waste manure (T_8) and minimum leaf width (14.28 cm) in control (Table 1).

Application of 30 kg N_2 through urea + 90 kg N_2 through kitchen waste manure (T_8) also produced the maximum number of leaves (21.23 per plant) followed by application of full dose of RDF of NPK through chemical fertilizer (19.38 per plant), while, control treatment showed the minimum number of leaves (14.42 per plant). Plant spread in both directions (E-W and N-S) was also observed maximum in treatment T_7 i.e., application of 60 kg N_2 through urea + 60 kg N_2 through FYM (63.22 cm E-W, 60.42 cm N-S) followed by T_9 i.e., 30 kg N_2 through urea + 90 kg N_2 through FYM (61.28 cm E-W, 58.20 cm N-S) (Table 1).

Combine use of kitchen waste (organic) and NPK (inorganic) increased vegetative growth of broccoli in general which was in close conformity with the finding of Devi *et al.* (2003) who also showed a positive relation in respect of nitrogen fertilization with organic sources in case of cabbage.

The increase in vegetative growth in terms of plant height, canopy, leaf number, leaf length, leaf width and leaf height by application of urea in combination of organic sources could be attributed to the availability of more nitrogen compounds for plants from organic and inorganic sources. Increases in foliage area of the plant also improved the capacity of photosynthesis. NPK is required for favorable regulation of plant physiological functions and morphological responses. It may also be due to cell elongation by the presence of nitrogenous compounds (Shree *et al.* 2014). Nitrogen being an ingredient of amino acids, nucleotides, nucleic acids, a number of co-enzymes, auxins, cytokinins and alkaloids, induces cell elongation, cell enlargement and cell division.

The results of present investigation in terms of plant height are in compliance with the findings reported earlier by Patil *et al.* (2003) in knol khol, Bhardwaj *et al.* (2000) and Mohapatra *et al.* (2013) in broccoli, Harish (2009) in brinjal.

Application of various doses of fertilizer with organic manure could not influence the number of leaves in broccoli and all the treatments are at par with the organic fertilizer. This is perhaps due to the facts that nitrogen might have contributed towards an enhancement in leaf buds and finally increased leaf number (Shree *et al*. 2014).

The treatments having organic manure, as one of the components, might have improved the growing environment by providing better aeration, water holding capacity and might have increased the fertilizer use efficiency. The beneficial effect of farmyard manure and urea in vegetable production has also been reported by Shalini *et al.* (2002 a, b) in knol-khol and Kumar and Sharma (2004) in cabbage - tomato cropping sequence.

In the present study, urea + kitchen waste compost and urea + FYM produced significantly more number of leaves which might be due to increased availability of nutrients, moisture and optimum root environment (aeration). Similar findings have been reported by Chattoo *et al.* (1997) and Shalini *et al.* (2002a) in knol-khol.

Application of 30 kg N_2 through urea + 90 kg N_2

Table 3. Yield and quality characters of Broccoli cv Pusa KTS-1.

Treatments	Marketable yield (kg plot^{-1})	Curd yield (q ha^{-1})	Vitamin C (mg 100 g^{-1})	Dry matter content (%)	TSS (°Brix)
T_1 - Control (no fertilizer and manure)	2.97	91.66	64.82	6.39	8.60
T_2 - RDF of NPK through chemical fertilizer	4.18	129.01	74.45	10.82	9.82
T_3 -120 kg Nitrogen by urea	3.81	117.59	69.78	9.76	8.91
T_4- 120 kg Nitrogen by kitchen waste manure	4.83	149.07	76.34	8.85	10.19
T_5 -120 kg Nitrogen by FYM	4.93	152.16	65.67	10.12	9.42
T_6- 60 kg Nitrogen by urea +60 kg kitchen waste manure	4.73	145.98	71.34	11.23	9.95
T_7 - 60 kg Nitrogen by urea + 60 kg FYM	4.96	153.08	77.42	11.44	10.43
T_8 - 30 kg Nitrogen by urea + 90 kg Nitrogen by kitchen waste manure	6.16	190.12	82.42	12.23	11.73
T_9 - 30 kg Nitrogen by urea + 90 kg Nitrogen by FYM	4.63	142.90	68.54	10.54	10.80
SEm ±	1.16	3.87	2.98	1.08	1.83
CD at 5%	2.51	19.79	7.58	3.49	3.52

through KWC (T_8) took minimum number of days (52.13) for first harvesting (Table 2), followed by treatment T_9 i.e., 30 kg N_2 through urea + 90 kg N_2 through FYM (53.82), while, control treatment showed maximum first harvesting after days transplanting (64.24). T_8— also showed the maximum curd weight (385.52 g) followed by T_7 i.e., application of 60 kg N_2 through urea+ 60 kg N_2 through FYM (310.42 g), while control treatment showed minimum curd weight (185.70 g). Table 2 showed that curd diameter and length was significantly increased by application of 30 kg N_2 through urea + 90 kg N_2 through KWC (T_8) (14.82 cm, 16.38 cm, respectively) followed by T_4 i.e., application of 120 Kg N_2 through KWC (13.85 cm curd diameter) and T_7 i.e., application of 60 kg N_2 through urea + 60 kg N_2 through FYM in curd length (15.80 cm).

It was clearly observed (Table 3) that varying fertilizer concentrations resulted in large variations in yield (per plot and per hectare). The curd yield per plot and per hectare was recorded maximum T_8 i.e., by application of 30 kg N_2 through urea + 90 kg N_2 through KWC (190.12 q/ha) followed by T_7.

The data manifested that the lowest curd weight in broccoli was found in control plots which were not fertilized (T_1). Increase in length and width of leaves and plant spread increased the area for photosynthesis and due to more photosynthates dry matter might be improved and because of increase in dry matter curd weight as well as curd yield increased as reflected in Fig. 1.

Application of manure and kitchen waste compost improved the physical, chemical and biological properties of the soil, thereby contributed to better absorption of nutrients by plants, ultimately resulted in higher yield and quality. The study further revealed that various yield parameters have not been significantly influenced when organic manures are not applied (T_1), which signifies the role of organic manures in combination with inorganic fertilizers for enhancing yield in sprouting broccoli.

The quality study (Table 3) on vitamin C content indicated that it decreased significantly with application of higher dose of nutrients. The highest ascorbic acid content in curd was recorded in the treatment T_8 i.e., application of 30 kg N_2 through urea + 90 kg N_2 through KWC (82.42 mg/100 g) followed by application of 60 kg N_2 through urea + 60 kg N_2 through FYM (77.42 mg/100g) while control treatments showed minimum (64.82 mg/100g).

Dry matter content (Table 3) was found to be the highest in T_8 (12.23%). Followed by T_7 (11.44%), while, control plants recorded minimum dry matter

(6.39%). T_8 also showed the maximum TSS (11.73 OB) followed by 10.43 °B in T_7.

These findings are in close conciliation with those earlier reported by Singh (2004) in cauliflower, Guo *et al.* (2004) in cabbage, Sable and Bhamare (2007) in cauliflower and Dutta Ray *et al*. (2014) in pomegranate. Reduction in vitamin C at higher nutrient level is due to the more vegetative growth which provides larger area for the photosynthesis and transpiration resulting thereby in upward movement of water from root zones to the upper parts of the plants and decrease in the vitamin C content.

It might be also due to the fact that the chemical fertilizers reduced the content compared to the organics by dilution effects. There is a general observation that organically managed crops have usually higher vitamin C than the conventional fertilized crops because when a plant is exposed to more nitrogen, it increases protein production and reduces carbohydrates synthesis. Since vitamin C is synthesized from carbohydrates, its levels are also reduced. In case of organically managed soil, plants are generally exposed to comparatively lower amount of nitrogen and several plant nutrients are released slowly over time. Therefore, organic crop would be expected to maintain higher vitamin C and carbohydrates and less protein as reported by Bahadur *et al.* (2003) in broccoli. The beneficial role of farm yard fertilizers and kitchen compost from food waste in improving the physical, chemical and biological properties of soil contributes to better nutrient absorption by plants, yield determination parameters and quality scores. Also became higher.

CONCLUSION

Integrated application of inorganic fertilizers and kitchen waste manure and FYM proved significantly better over the recommended practice. Application of 30 kg N_2 through urea + 90 kg N_2 through kitchen waste compost, emerged as best over all other treatment, in relation to growth, yield, curd quality for broccoli cv Pusa KTS -1 grown in Lucknow subtropical condition having sandy loam soil (slightly alkaline in nature).

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