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Effect of Organic Manure and Inorganic Fertilizer on the Growth and Yield of Cauliflower (*Brassica oleracea* var. *botrytis*)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The investigation entitled, "Effect of organic and inorganic fertilizers on the growth and yield of Cauliflower *(Brassica oleracea* var. *botrytis*) cv. Snowball-16" was undertaken at the Department of Horticulture, Institute of Agriculture & Natural Sciences, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur. during *Rabi* season 2022-2023. Seven treatments were used laid out in the randomized block design with three replications in this experiment. It is apparent from the results obtained that the vegetative parameters viz., number of leaves per plant, plant height, the spread of

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the plant, the diameter of the stem, number of days required for curd initiation and curd maturity, curd size and total biomass production per plant have been significantly influenced by the potential treatments. The maximum number of leaves per plant (20.54) was recorded under the influence of the treatment T4 (50%RDF along with 50%vermicompost). The integration of organic and inorganic nutrient sources in a way such that an equal proportion of nitrogen being supplied by them documented superior results. Treatment T4 resulted in maximum plant height (21.16 cm), the spread of plant (49.38 cm), diameter of the stem (2.82 cm), reduced number of days for curd initiation (68.53 days) and maturity (99.23 days), curd size (18.74 cm) and total biomass production (33.67 g) per plant when compared to control (T1). Yield parameters viz., net weight of curd (1660.57 g), curd yield per plot (38.81 kg) and yield per hectare (421.35q /ha) showed preponderance in response to 50% RDF along with 50% vermicompost, succeeded by treatment involving the integration of 50% RDF along with 50% FYM, which also showed lead response as result obtained in control.

Keywords: Cauliflower; organic-inorganic effect; eastern Uttar Pradesh; Gorakhpur.

1. INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis*) belongs to the Brassicaceae family and is one of the most essential Cole crops. Cauliflower was introduced in India in 1822 [1]. The leading cauliflower-producing countries of the world are China and India regarding yield per hectare of land [2]. The edible portion of cauliflower, known as "curd," is used as a vegetable in making curries, soups, and pickles. Pieces of cauliflower (buttons) are also used to prepare pakoras. The excess cauliflower is dried and preserved for use in the off-season. It is a highly nutritious and delicious vegetable with vitamins A and C and minerals like calcium, iron, and iodine [3]. It supplies 50 mg of vitamin C, 40 I.U. carotene, 30 calories, 8 g carbohydrate, and 90% water per 100 g edible part. About 32.5% of the world's total production of cauliflower comes from India. In terms of individual vegetable production, the United States produces 5.06% of its cauliflower. In Uttar Pradesh, cauliflower was grown in 2021–2022, with an output of 436.77 tonnes and a share of 4.71%. Organic agriculture, though not in its orthodox version, has the potential to be accepted by farmers [4]. Modernization of Indian agriculture has become more mechanized over the years, and technologies have increased the possibilities for using such inputs to enhance production and food safety. The benefits of organic production on food quality and safety have created high global demand for organic products. Using organic wastes from agriculture as organic fertilizers for growing crops commercially depends on the availability of organic manure and comparability with chemical fertilizers in plant growth and yield performance. Manures are known to improve the quality of vegetables [5]. Turmel et al. [6] reported that crop residues have been found to supplement plant nutrients besides improving the physical health of the soil. The use of organic fertilizers will help to overcome the adverse effects of excessive use of mineral fertilizers [7]. Various types of organic material that can be used as organic fertilizer can be derived from the waste of animals and the residue of plants that can be effectively utilized after composting [8]. Although organic manures contain plant nutrients in small quantities compared to chemical fertilizers, it is essential for improving soil fertility and productivity. Keeping this in view, the present investigation was carried out to evaluate the integrated use of organic manures and inorganic fertilizers in cauliflower.

2. MATERIALS AND METHODS

The present study was carried out in Horticulture Research Farm, Deeksha Bhawan, Department of Horticulture, Institute of Agriculture & Natural Science, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur during the *Rabi* season of the year 2022-23 with Randomized block design (RBD) which is replicated thrice. With the variety *Snowball-16.* The size of each plot was 3 x 3.15 m with a spacing of 60 x 45 cm counting 35 plants per plot. The gap between the plots was 50 cm and between the replications was 1 m. A total of seven treatments were their including the untreated control were selected for the investigation which are 100% RDF (Control,100:80:40), 100% Vermicompost (5 ton), 100% FYM (20 ton), 50% RDF + 50% Vermicompost, 25% RDF + 75% Vermicompost, 25% RDF + 75% FYM The dose was applied at the time of transplanting. The data were taken from five plants randomly selected from each plot on various characters *viz*., growth (number of

leaves per plant, height of plant (cm), spread of plant (cm), diameter of stem (cm), number of days required for curd maturity (days), curd size (cm), total biomass production per plant (g)) and yield parameters (net weight of curd (g), yield of curds /plot (kg), yield of curds/ hectare (q/ha)). All the data analysis was carried out as described by Gomez and Gomez (1984).

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Number of leaves per plant

The data presented in Table 1 showed that the various experimental treatments substantially impacted differences in the number of leaves per plant. The number of leaves per plant continuously increased till harvesting. At 20 days after transplanting, the number of compound leaves per plant showed that the treatment T4 (50% RDF+ 50% vermicompost) recorded the highest number of compound leaves (9.11) which was at par with T5 (8.97) followed by T1 (8.67), T6 (8.52) and T7 (8.35). The lowest number of leaves per plant was observed in T3 (100% F.Y.M.) (8.06). In treatment T4, plants had the highest number of leaves after 40 days after transplanting (17.86), followed by T5 (17.02) and T1 (16.31). The minimum number of leaves per plant was reported in T3 (14.95). According to the data analysis on the number of leaves per plant at harvest following transplantation, treatment T4 recorded the highest number of leaves (20.54) per plant followed by T5, and the minimum number of leaves per plant was observed in T3 (17.72). The addition of organic manures, which have solubilizing effects on the soil nutrients, was found to substantially impact leaf number. Chelating actions on metal ions are also present. As a result, they made more nutrients available to the plants. Similar results were observed by Singh et al., [9] and Neupane et al*.,* [10].

3.1.2 Height of plant (cm)

There were noticeable changes in the plant height among the various treatments during research, recorded data on plant height is reported in Table 1. The plant height at 20 days after transplanting showed significant results. After 20 days of transplanting, the T4 had the highest plant height (9.13 cm), which was at par T6, followed by treatments T5 (9.06), T1 (control 8.91), and the lowest plant height (8.59 cm), was recorded in treatment T3 (100% FYM). The treatment T4 (50% RDF+ 50% vermicompost) produced the maximum height of the plant (13.76 cm) over all the treatments, according to measurements taken 40 days after transplanting. The two most effective treatments were T5 and T1, significantly superior to other treatments. The height of the plant after harvest was found to be statistically significant. The maximum size (21.16 cm) of the plant was observed with the application of 50% N through RDF + 50% N through vermicompost, which was statistically at par with T5 (20.17) and T1 (20.73). The lowest plant height was observed in T3 (17.65).

The availability of nutrients leads to more uptakes of nutrients in the plant, which is essential for the proper growth and development of plants. Nitrogen is the part of chlorophyll pigment which helps in photosynthesis. More photosynthesis leads to more plant growth in terms of more plant height [9]. In cauliflower Chahal et al., [11] also observed that the application of 100% N.P.K. through inorganic fertilizers and 25% N substituted through vermicompost had maximum plant height.

3.1.3 Diameter of the stem (cm)

The data indicate clearly that the results on stem diameter per plant were statistically significant Table 1. The stem diameter at 20 days after transplanting was found to be non-significant. At 40 days after transplanting maximum stem diameter per plant (1.77 cm) was recorded in treatment T4 (50% RDF+ 50% vermicompost), which was followed by T5; the minimum stem diameter per plant (1.18 cm) was measured in treatment T3. Maximum stem diameter (2.82 cm) per plant was recorded after harvest transplanting, and 50% RDF+ 50% vermicompost T4 was considerably better than all other treatments. Treatment T5 (2.74) and T1 (control 2.62), also had a good diameter of stem, and the lowest was observed in T3 (2.36 cm). The integrated use of nutrients significantly influenced the stem diameter due to rapid cell division, multiplication, and cell elongation in the meristematic region of the plant, which promoted the vegetative growth of the plant [9]. The same result was also found by Devi et al. [12].

3.1.4 Spread of plant (cm)

The data shown in Table 1 showed that the application of organic and inorganic fertilizers differently affected the spread of plants. The findings concerning plant spread were statistically significant. Maximum plant spread

was observed in T4 (49.38 cm), followed by T5 (48.52 cm). T3 had the lowest plant spread (32.47 cm). The rationale behind this trend of plant spread may be due to a balanced C: N ratio and abundant supply of available nutrients from the soil, comparatively less retention in the roots, and more translocation to the aerial portion for the synthesis of protoplasmic proteins and other metabolites enabling expansion of the photosynthetic area, hence plant spread. A similar finding was observed in research conducted by Devi et al. [12] in cauliflower. Neupane et al. [10] also observed that applying 50% N through RDF + 50% N had maximum plant spread.

3.1.5 Curd initiation and Curd maturity

The effect of organic and inorganic fertilizers on the days required for curd initiation of cauliflower variety Snowball 16 is shown in Table 1. The treatment T4 had the shortest days to curd initiation (68.53 days), followed by T5 (70.16). In treatment T3, the last curd initiation (78.67 days) was observed. Application of 100% F.Y.M. resulted in the longest day for curd initiation. Regarding the number of days needed for curd maturity, Table 2 observations revealed notable variations among the treatments. Compared to all other treatments, T4 recorded much quicker curd maturity (99.23 days), followed by T5 (101.45). The treatment T3 required the most days for curd maturity (118.63 days). The reason behind earliness might be due to the vigorous vegetative growth of plants, which resulted in better food assimilation by photosynthesis. The food material was translocated rapidly to the edible portion of the plant (curd), resulting in the early development of cabbage Yadav et al. [13]. Ghosh et al. [14] observed that the plants treated with 50% V.C. + 50% N.P.K. were early in head initiation.

3.1.6 Curd size (cm)

It is clear from the data in Table 2 that the results were statistically significant regarding curd size. The observations recorded that the maximum curd size (18.74 cm) was recorded in treatment T4; the T3 treatment had the smallest curd size (14.80 cm). The balanced C: N ratio of vermicompost and improved availability of vital plant nutrients contribute to rising yields by enhancing the rate and efficiency of metabolic processes and promoting high uptake of protein and carbohydrates. The positive impact of organic manures in enhancing soil physical, chemical, and biological qualities is well documented, resulting in improved nutrient absorption by plants and higher yields. Increased yields can also be due to increased nutrient availability throughout the growing season; additionally, the efficacy of inorganic fertilizers is greatly enhanced when mixed with organic manures. Such beneficial effects of vermicompost and inorganic fertilizers have been established in cauliflower [15,16] also observed that the application of 50 % N.P.K. + vermicompost @ 2.5 t per ha maximum values for gross yield.

3.1.7 Total biomass production per plant (g)

According to the findings shown in Table 2, significant differences in total biomass output were seen at various application levels. Treatment T5 produced the most total biomass per plant (3.422 g), significantly better than all other treatments. In the following best treatment after T5, the next best treatment was T4 (3.367 g) which was statistically at par. (T3) plants produced the least total biomass (2.393 g) per plant. The integrated use of nutrients significantly influenced biomass production due to rapid cell division, multiplication, and cell elongation in the meristematic region of the plant, which promoted the plant biomass and vegetative growth of the plant Singh et al. [9]. The same result was found in Devi et al. [12].

3.2 Yield Parameters

3.2.1 Net weight of curd

The data described in Table 2 provide evidence of the significance of crop production differences in response to the various treatments and their combinations. Treatment T4 (1.66 kg) produced the maximum net weight of the curd, followed by treatment T5 (1.57 kg), which were comparable to one another in order of the weight of the curds. The lowest net curd weight (1.08 kg) was found in T3. The increase in curd yield caused by vermicompost fertilization in conjunction with inorganic fertilizers could be attributed to an increased supply of nutrients and a proliferous root system that allows for more excellent absorption of water and nutrients and the physical environment. The results were consistent with those found in cauliflower [15] and the same effect was found by Neupane et al. [10], that the application of 50% N through RDF + 50% N had maximum curd weight.

Table 1. Influence of integrated nutrients management on growth parameters

Treatment	Treatment name	No. of leaves per plant			Plant height(cm)			Diameter of stem(cm)			Spread of plant (cm)	Number of days required for curd initiation
		20 days	40 days	At harvest	20 days	40 days	At harvest	20 days	40 days	At harvest	(cm)	Days
T1	100% RDF (Control)	8.67	16.31	19.26	8.91	12.37	20.73	0.87	1.48	2.58	44.75	72.63
T2	100% Vermicompost	8.23	15.36	18.35	8.65	10.59	18.23	0.84	1.27	2.44	36.60	77.48
T3	100% FYM	8.07	14.95	17.72	8.59	9.85	17.64	0.84	1.18	2.36	32.47	78.67
T4	50% RDF + 50% Vermicompost	9.11	17.86	20.54	9.13	13.76	21.17	0.95	1.77	2.82	49.38	68.53
T5	50% RDF + 50% FYM	8.96	17.02	20.17	9.06	13.42	20.17	0.88	1.65	2.76	48.52	70.16
T6	25% RDF + 75% Vermicompost	8.52	15.77	18.65	8.79	11.83	19.97	0.87	1.33	2.48	41.78	73.27
T7	25% RDF + 75% FYM	8.33	15.63	18.57	8.71	10.93	18.59	0.85	1.30	2.44	39.35	75.83
CD		**0.347**	**0.337**	**0.117**	**0.336**	**0.302**	**0.347**	**N/A**	**0.131**	**0.079**	**0.421**	**0.224**
SE(m)		0.112	0.108	0.038	0.108	0.097	0.112	0.082	0.042	0.025	0.135	0.072
C.V		2.256	1.161	0.342	2.116	1.419	0.990	16.192	5.098	1.707	0.560	0.169

Table 2. Effect of integrated nutrients management on yield parameters

Treatment	Treatment name	No. of days required for curd maturity	Curd size(cm)	Total biomass production per plant	Net weight of curd(g)	Curd yield per plot(kg)	Curd yield per plot(q/ha)
T1	100% RDF (Control)	104.72	17.49	3144.66	1512.38	36.04	384.15
T2	100% Vermicompost	115.52	15.52	2443.66	1218.12	29.54	309.24
T3	100% FYM	118.63	14.80	2393.39	1087.64	26.57	276.03
T4	50% RDF + 50% Vermicompost	99.23	18.74	3367.12	1660.57	39.81	421.35
T5	50% RDF + 50% FYM	101.45	18.33	3426.29	1589.51	38.53	403.58
T6	25% RDF + 75% Vermicompost	107.34	16.86	2725.87	1411.81	33.90	358.40
T7	25% RDF + 75% FYM	111.67	16.12	2562.82	1325.71	31.92	336.52
CD		**0.960**	**0.856**	**70.005**	**49.514**	**0.882**	**28.28**
SE(m)		0.308	0.275	22.470	15.893	0.283	9.080
CV		0.493	2.827	1.358	1.965	1.452	4.423

3.2.2 Yield per plot (kg) and hectare (q/ha)

The analysis of the yield parameter data shown in Table 2 revealed that the different treatments significantly differed in terms of yield per plot (kg) and yield per hectare (q/ha). The treatment T4 had the highest curd yield per plot (39.81 kg) followed by T5 (38.53). In T3, the lowest yield per plot (26.57 kg) was observed. The maximum yield per hectare was achieved by the treatment T4 (421.35 q/ha), which was statically at par with T5 (403.58 q/ha), followed by T1 (384.15 q/ha), T6 (358.40 q/ha), T7 (336.52 q/ha), T2 (309.24 q/ha). The treatment T3 had the lowest yield per hectare (276.03 q/ha). vermicompost's contribution to increasing yields can be due to the balanced C: N ratio and improved availability of essential plant nutrients, resulting in increased rate and efficiency of metabolic processes and high protein and carbohydrate assimilation. The positive impact of organic manures in enhancing soil physical, chemical, and biological qualities is well documented, resulting in improved nutrient absorption by plants and higher yields. Increased yields can also be due to increased nutrient availability throughout the growing season; additionally, the efficacy of inorganic fertilizers is greatly enhanced when mixed with organic manures. Such beneficial effects of vermicompost and inorganic fertilizers have been established in cauliflower Wani et al., [15]. Mohanta et al. [16] also observed that the application of (50 % N.P.K. + vermicompost @ 2.5 t per ha) recorded maximum values for gross yield.

4. CONCLUSION

It is apparent from the results obtained that the vegetative parameters *viz.,* number of leaves per plant, plant height, the spread of the plant, the diameter of the stem, number of days required for curd initiation and curd maturity, curd size and total biomass production per plant have been significantly influenced by the potential treatments. The maximum number of leaves per plant (20.54) was recorded under the influence of the treatment (T4) application of 50% N through RDF along with 50% N through vermicompost and the minimum was recorded in T3 (18.57). The integration of organic and inorganic nutrient sources in such a way that an equal proportion of nitrogen being supplied by them documented superior results. Treatment T4 resulted in maximum plant height (21.17 cm), spread of plant (49.38 cm), diameter of stem (2.82 cm), reduced number of days for curd initiation (68.53 days) and maturity (99.23 days), curd size (18.74 cm) and total biomass production (3367.1 g) per plant when compared to control (T1). Yield parameters *viz.,* net weight of curd (1660.5 g), curd yield per plot (39.81 kg) and yield per hectare (421.35 q ha'1) showed preponderance in response to treatment (T4) 50% N through RDF along with 50% N through vermicompost, succeeded by treatment (T5) 50% N through RDF along with 50% N through FYM, which also showed better response as compared to control.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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