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Effect of integrated nutrient management on growth, yield and quality of cauliflower (*Brassica oleracea* L. var *botrytis*) cv. Pusa Snowball-16

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Abstract
The present research was conducted on cauliflower (*Brassica oleracea* L. var *botrytis*) cv. Pusa Snowball-16 to evaluate whether integrated nutrient management affected growth, production, and quality attributes. During the *Rabi* season in 2018 and 2019, the experiment was carried out in a randomized block design with three replications at the Experimental Unit of the Tilak Dhari Post Graduate College in Jaunpur, Uttar Pradesh. Both the recommended quantity of organic sources (FYM and vermicompost) and inorganic fertilisers (160: 80: 80 NPK ha-^{1}) were effective. The treatment 50% N through NPK+50% N through FYM was used after the treatment 100% N through NPK for enhancing the highest growth, yield, and quality metrics. The 50% NPK+50% NPK+50% NPK treatment has been shown to increase maximum curd yield.

Keywords: Cauliflower, integrated nutrient management, chemical fertilizers, organic manures, bio fertilizers

Introduction
In India, cauliflower is one of the vegetables that grows the most in the winter. The family Cruciferae includes cauliflower (*Brassica oleracea* L. var. *botrytis*). Every kind of individual uses it across the nation, either as a cooked vegetable or raw in a salad. However, selection of variety for a particular area or zone is very important for commercial purpose. It is mostly grown in Europe, USA, Japan, Australia and other country. In India, it is grown both hills and plains. In India, growing cauliflower state are; West Bengal, Bihar, Odisha, Haryana, Himachal Pradesh, Madhya Pradesh, Karnataka, and Uttar Pradesh. It is also grown northern Himalayas and Nilgiris hills in south India.

The usage of synthetic chemical fertilisers, which may be to blame for the worsening of the soil condition, is causing growing anxiety. Utilizing synthetic and organic fertilisers appropriately may not be enough to support vegetable production by itself (Singh *et al*., 2004) [10]. Recommending the use of chemical fertilisers alone in deteriorated soil will generally be counterproductive because it lowers soil pH and causes a shortage of or toxicity from micronutrients such calcium, magnesium, and sulphur. Restoring soil fertility and maintaining productivity are two benefits of combining organic manures and synthetic fertilisers. Because these compounds can maintains soil at a high level. An organic manure for use in integrated nutrient management strategies is vermicompost. Despite having a high yield potential, India's productivity for cauliflower is much below the global average. Inadequate fertilizer use, the formation of multinutrient deficits due to poor recycling of organic sources, and the imbalanced use of fertilisers, particularly micronutrients, are among the factors contributing to low production.

Although Uttar Pradesh's soil is rich in nutrients, sadly only a small percentage of it is made available to plants, especially given the region's temperate environment. Its accessibility differs as well since it depends on the physical and chemical composition of soil minerals. In order to achieve sustainable agricultural output, an integrated nutrient supply model incorporating the use of organic manure and inorganic fertilisers has been devised. Higher productivity and financial gains are observed when bio fertilizers and organic and inorganic nutrient sources are combined. Furthermore, compared to inorganic sources, organic sources have a significant residual impact on succeeding harvests.

Materials and Methods

The present research was carried out at the Experimental Unit, Tilak Dhari Post Graduate College, Jaunpur, (U.P.) India, during the *Rabi* seasons of 2018–19 to investigate the effect of integrated nutrient management on the growth, yield, and quality of cauliflower. Thirteen characters were used to record the observations. The sample of soil from experimental field were taken in 10-15 cm. depth before planting the plants and these samples were thoroughly mixed to get the composite samples which were subjected to mechanical, physical and chemical analysis.

The experimental materials were arranged in a Randomized Block Design with 10 treatments for the present field investigation. With a total of 30 cauliflower plots, these treatments were randomly distributed over three replications. Throughout the 2018–19 *Rabi* season, various integrated nutrients were applied. The various symbol of treatment were T_1 - Control, T_2 - 100% NPK, T_3 - 75% NPK+25% FYM, T_4 - 75% NPK+ 25% Vermicompost, T_5 - 75% NPK+25% Poultry Manure, T_6 - 75% NPK+ 25%Neem Cake, T_7 - 50% NPK+ 50%FYM, T_8 - 50% NPK+ 50% Vermicompost, T_9 - 50% NPK+ 50% Poultry Manure and T_{10} - 50% NPK+ 50% Neem Cake.

The present experiments were conducted out and in RBD with three replications to evaluate the performance of cauliflower in the conditions of the north Indian plain during the winter for the effect of integrated nutrient management on growth, yield, and quality of cauliflower (*Brassica oleracea* L. var. *botrytis*) cv. Pusa Snowball-16. With a plant to plant spacing of 60 cm and rows 45 cm apart, the crop was sowed. On October 10, 2018–19, the sowing was done. To cultivate high-quality crops, the entire agronomic package of procedures and safety precautions were followed. Observations were recorded on height of plant (cm), number of leaves per plant, spread of plant (cm), stem diameter (cm), curd initiation (days), curd maturity (days), curd diameter (cm), net weight of curd (g), curd yield per plot (kg), curd yield per ha (q), staying of curd (days), compactness of curd (%) and total soluble solid (^{0}Brix). All observations' data were statistically analysed using analysis of variance techniques, and treatments were contrasted using the crucial difference approach as suggested by Panse and Sukhatme (1998) [4].

Result and discussion

Using manures, bio fertilizers, and chemical fertilisers, integrated nutrient management (INM) aims to maintain crop productivity while improving soil health. The productivity and sustainability of vegetable production must be maintained. Systematic research on integrated nutrition management strategies with regard to the region's production of cauliflower is limited, nevertheless. The impact of integrated nutrient management on the growth, production, and quality of cauliflower was examined in this study and presented in Table-1.

Perusal of Table-1 revealed that effect of growth, yield and quality of differed for different characters and over seasons in various cross combinations. In case of plant height of cauliflower was significantly influence with the increasing age of crop. The plant height ranges from (7.33 cm to 8.86 cm), (9.10 cm to 11.43 cm), (17.21cm to 20.11 cm), at 20, 40, and 60 days respectively. After 60 days the maximum average plant height of cauliflower was recorded in T_2 (20.11 cm) followed by T_3 (19.95 cm) and T_4 (19.87), minimum average plant height was observed in T_1 (17.21 cm) control. The above results were in close agreement with the finding of investigated the influence of organic and inorganic fertilizer on growth and yield of cauliflower). The days after transplanting on number of leaves at 20, 40, and 60 days after transplanting are presented in the number of leaves ranged from (8.69 to 9.63), (12.95 to 17.75), and (16.98 to 20.60), at 20, 40, and 60 days respectively. After 60 days the maximum number of leaves of Cauliflower was recorded in T_8 treatment (20.60) followed by T_5 treatment (19.95) and T_1 treatment (19.75), minimum number of leaves was observed in T_{10} treatment (16.98). The response of integrated nutrient management showed pronounced on the fresh leaves per plant. The above the results are in conformity with the findings of Kumar *et al*. (2013) [2], Pawar and Barkule (2017) [5] and Mohanta *et al*. (2018) [3]

Spread of plant of cauliflower was recorded at harvest. The mean spread of plant of cauliflower as influenced by different treatments. Curd compactness showed statistically significant with nutrient treatment under open system. Maximum curd diameter of cauliflower was observed in T_2 (23.31cm), followed by T_{10} (21.86 cm) and T_4 (21.22 cm) the minimum curd diameter cauliflower of was observed in Control T_1 (19.23 cm). The response of integrated nutrient management showed pronounced maximum spread of plant. Curd diameter of cauliflower was recorded at harvest. Curd diameter showed statistically significant with nutrient treatment under open system. Maximum curd diameter of cauliflower was observed in T_2 (20.30 cm), followed by T_7 (19.83 cm) and T_{10} (19.31cm) the minimum curd diameter cauliflower of was observed in Control T_1 (15.84 cm). It was investigated and their found the maximum curd diameter of cauliflower. Stem diameter of cauliflower was recorded 20, 40 and 60 DAT. Stem diameter showed statistically significant with nutrient treatment under open system. Maximum stem diameter of cauliflower was observed at 20 DAT in T_2 (0.97), followed by T_3 (0.91cm) and T_5 (0.89 cm) the minimum stem diameter cauliflower of was observed in Control T_1 (0.71 cm). Stem diameter showed statistically significant with nutrient treatment under open system. Maximum stem diameter of cauliflower was observed at 40 DAT in T_2 (1.57) followed by T_3 (1.49 cm) and T_5 (1.42 cm) the minimum stem diameter cauliflower of was observed in Control T_1 (1.27 cm) he has found similar that above. Stem diameter showed statistically significant with nutrient treatment under open system. Maximum stem diameter of cauliflower was observed at 60 DAT in T_2 (2.66 cm) followed by T_3 (2.58cm) and T_5 (2.54 cm) the minimum stem diameter cauliflower of was observed in Control T_1 (2.28 cm). The period of curd initiation was regarded by counting the number of days after transplanting up to curd initiation. The minimum days to curd initiation T_1 69.50 days were recorded in treatments and maximum treatment T_2 (76.75 days) was recorded. The treatments (50% N though NPK+50% N though vermicompost) recorded significantly earlier curd maturity maximum T_2 (116.93 days) followed by T_{10} (115.20 days) and T_3 (113.91 days) minimum T_1 (100.57 days). The above the results are in conformity with the findings of Velmurugan *et al*. (2008) [8]. Singh, *et al*. (2018) [7]

The highest magnitude of net weight of the curd was obtained in treatment T_8 involving 50% N though NPK + 50% N though Vermicompost which was followed in order of weight of the curds by the treatments T_1 least net curd weight was

observed in control T_1. After harvesting curd yield kg per plot of cauliflower under different treatments. Maximum curd yield kg per plot of cauliflower was observed under in treatment T_2 (75.48 kg) followed by T_5 (71.43 kg) and T_8 (73.34 kg) the minimum fruit yield kg per plot was observed in T_1 treatment (46.00 kg) Control. The mean curd yield per ha of cauliflower as influence by different treatments. After harvesting curd yield quintal per ha of cauliflower under different treatments was recorded each plot curd yield quintal per ha of cauliflower showed statistically significant with INM treatments under open field system condition. Maximum fruit yield q/ha of cauliflower was observed under in treatment T_2 (494.52 q) followed by T_8 (490.77 q) and T_6 (461.56 q) the minimum fruit yield quintal per ha was observed under treatment T_1 (292.80 q) control. The above the results are in conformity with the findings of Wani *et al*. (2010) [9]. Khan *et al*. (2010) [1].

The staying capacity of curd varied between 6.29 days in T_1 to 9.26 days in T_6. TreatmentT6 involving 75% N though NPK+ 25% N though Neem cake (9.26 days) proved 53 best with maximum staying capacity of curd. This was followed by the treatments involving T_7 (50% N though NPK+ 50% N though FYM), T_8 50% N though NPK+ 50% N though VC and T_8 8.45 days, and 8.23 respectively. Other treatment in general showed at par relations. The shortest staying capacity of curd was obtained in the treatment T_1 (6.29 days). The curd compactness is less in treatment T1 (19.45%) involving control as compare to other treatments. While more compactness of curd (23.35%) was regarded in the treatment T_2. Curd compactness showed statistically significant with nutrient treatment under open system. Maximum curd diameter of cauliflower was observed in T_2 (23.31 cm), followed by T_{10} (21.86 cm) and T_4 (21.22 cm) the minimum curd diameter cauliflower of was observed in Control T_1 (19.23 cm). Maximum T.S.S (7.58 ^{0}Brix) was regarded in treatment T_2 (7.51 Brix) fallowed by T_8 (7.51 Brix). These treatments were statistically at par with each other. Treatment (T2) was significant superior over control (T_1). Minimum T.S.S (5.52 ^{0}Brix) was regarded in control (T_1). The above the results are in conformity with the findings of Shaheen *et al*. (2007) [6].

Table 1: Effect of integrated nutrient management on growth, yield and quality of cauliflower (*Brassica oleracea* L. var *botrytis*)

Symbols	Treatments	Height of plant (cm)	Number of leaves per plant	Spread of plant (cm)	Stem diameter (cm)	Curd initiation (days)	Curd maturity (days)	Curd diameter (cm)	Net weight of curd (g)	Curd yield per plot (kg)	Curd yield per ha (q)	Staying of curd (days)	Compactness of curd (%)	Total Soluble Solid (0Brix)
T_1	Control	17.21	16.98	29.2	2.28	15.84	100.57	69.5	384.35	3.33	220.33	6.29	19.45	5.52
T_2	100% NPK	20.11	17.22	49.45	2.66	20.3	116.93	76.75	451.96	3.5	232	9.26	23.35	7.58
T_3	75% NPK + 25% FYM	19.95	17.73	32.21	2.58	18.73	113.91	75.43	451.12	3.23	254	7.32	22.52	6.6
T_4	75% NPK + 25% VC	19.87	19.43	37.47	2.46	19.2	105.93	71.38	423.44	4	265.67	8.23	21.72	6.12
T_5	75% NPK + 25% PM	19.74	19.95	30.87	2.54	17.15	101.34	69.6	408.01	4.12	272	9.16	21.02	7.4
T_6	75% NPK + 25% NC	18.85	17.94	35.74	2.43	19.3	111.04	74.16	496.82	4.5	302.33	7.29	21.13	6.79
T_7	50% NPK+ 50% FYM	18.55	19.12	41.93	2.36	19.83	105.79	71.45	415.93	4.41	291	8.45	21.43	6.98
T_8	50% NPK + 50% VC	19.73	20.6	48.57	2.44	17.77	99.17	67.44	503.12	4.34	287.67	9.04	20.63	7.51
T_9	50% NPK + 50% PM	19.46	18.47	37.72	2.37	15.89	107.7	72.62	450.97	3.99	278	7.95	21.05	6.84
T_{10}	50% NPK +50% NC	19.04	19.75	47.72	2.4	19.31	115.2	75.53	485.22	3.58	236.33	7.06	20.28	5.74

*FYM= Farm Yard Manure, VC = Vermicompost, NC = Neem Cake, PM = Poultry Manure.

Conclusion

The following conclusions may be concluded from the experiment's findings: Integrated nutrient management fertilisers had beneficial benefits on the growth, yield, and quality parameters of cauliflower. Neither the recommended amount of organic sources (FYM and vermicompost) nor the recommended amount of inorganic fertilisers (160 80:80 NPK ha^{-1}) were effective. The treatment 50% N through NPK+50% N through FYM was used after the treatment 100% N through NPK for enhancing the highest growth, yield, and quality metrics. The 50% NPK + 50% NPK + 50% NPK treatment has been shown to increase maximum curd yield. In combination of the present investigation, the following line of works is suggested for future research. (i) If the effect of organic manures on crop growth and yield is continued at least for next two to three years in the same field, results was be at par with INM can be expected. (ii) Production as well as nutrition to human health from different cauliflower varieties under organic conditions can be studied. (iii) Complete organic production technology for cauliflower is may be developed for better production and human health. Effect of other locally available organic manures, green manures and bio fertilizers in different combinations on growth and yield of cauliflower is to be studied which can improved the production and net return.

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