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Effects of integrated nutrient management on growth and yield attribute of cauliflower (*Brassica oleracea* var. *botrytis* L.)

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Abstract

The present investigation was carried out at horticulture field of Rama University, Department of Horticulture Faculty of Agriculture and Allied Industries during October 2020 to February 2021 to assess the growth and yield attributes of cauliflower (*brassica oleracea*, botrytis L) cultivar variety, snow crown under various Integrated Nutrient Management (INM). The experiment was carried out in randomized complete block design. There were 8 treatments comparing T1 control, T2 (recommended dose of NPK (150:100:80 kg/ha), T3(half dose of NPK/ha+FYM@15 tonnes/ha) T4, (half dose of NPK/ha + Azospirillum @ 5 kg/ha), T5 (half dose of NPK/ha + FYM @15 tonnes/ha + Azospirillum @5 kg/ha), T6 (half dose of NPK/ha + vermicompost @ 2.5 tonnes/ha), T7 (half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + FYM @ 15 tonnes/ha), T8 (half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + Azospirillum @ 5 kg/ha) which was replicated three times.

The result revealed that the highest plant height (60.50 cm), number of leaves(16.33), plant spread (44.50 cm), curd diameter (20 cm), curd weight per plant (1006.7g), curd yield per plot (9.3 kg) and curd weight per hectare (32 tons/ha) were observed in half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + Azospirillum @ 5 kg/ha (T8). INM treatments showed lesser result on growth and yield of cauliflower in T1 (control). Thus, farmers are suggested to apply half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + Azospirillum @ 5 kg/ha to increase growth and yield of cauliflower.

Keywords: Cauliflower, INM, Azospirillum, vermicompost, yield

Introduction

Cauliflower (*Brassica oleracea* var. *botrytis* L.) belongs to the family Brassicaceae is a most popular cole crop among the winter vegetables. It is grown for its highly suppressed 'pre-floral fleshy apical meristem' branches called 'curd'. Cauliflower was introduced in India in 1822 by Dr. Jemson at Saharanpur (UP) during the amount of East-India Company. It was originated in the Mediterranean region (Bose and Som, 1993) [1]. Cauliflower is a cool season crop which grows best under cool and moist weather condition and it can be grown under temperate to tropical condition. For the human diet agricultural crop and vegetables production play vital role to balance the body. The most delicate vegetable among the cole crops is regarded as cauliflower due to its dietary importance and limitation in production. In the developing countries it plays the vital roles in nutrition. Cauliflower is grown for its so called tender and whitish curd. It is a good source of protein, thiamin, riboflavin, phosphorus and potassium, and a very good source of dietary fiber, vitamin C, vitamin K, vitamin B6, foliate, pantothenic acid and manganese. In India, cauliflower is grown in almost all geographic regions. India is the largest producer of cauliflower in the world followed by China. In India, cultivation of cauliflower is done over an area of about 552.6 ha with a production of 8668.2 MT and their productivity is 19.2 MT/ Ha (NHB, 2018) [9]. The highest production of the crop in the country is West Bengal followed by Bihar, Madhya Pradesh and Orissa.

Integrated Nutrient management (INM) is described as the technique of using balanced dose of organic and inorganic fertilizer in combination with specific microorganism to make nutrients more available for plants and best for maintaining high yields without exposing soil native nutrients and polluting the environment. Thus, the recycling of organic wastes by the farmers themselves could also be a valuable and acceptable option for several of agriculture planner and various farmers to beat the normal methods of organic waste disposal with or without the slight risk to the plants, groundwater or ecological pollution, and human health to realize the simplest use of existing natural resources.

Azospirillum is an associative micro-aerophilic nitrogen fixer. It colonizes the root moss and fixes nitrogen in loose association with plants. It fixes nitrogen in an environment of low oxygen tension. The bacteria induce the plant roots secrete mucilage, which creates low oxygen environment and helps to fix atmospheric nitrogen. Azospirillum fix nitrogen from 10-40 kg per ha per season in many vegetable crops thereby 25-30% nitrogenous fertilizers, where as Azotobacter saves addition of nitrogenous fertilizer by 10-20%. Its inoculation helps the plants in better vegetable growth due to production of growth hormones such as auxins, gibberellins and cytokinins (Yawalkar, 2002) [15].

Vermicompost was also reported to improve soil physical properties like soil aggregates, improvement in drainage, porosity and aeration. Vermicompost is a rich source of macronutrients (N, P₂O₅, K₂O), secondary nutrients (Ca, Mg) and vital 3 micronutrients like (Fe, B, Zn and Mo). It also contains hormones, vitamins and antibiotics which enhance the biological activities and help in release the various nutrients making them available to plant which in turn enhance the negative growth.

Materials and Methods

Field experiment was carried out during the Rabi season (Nov 2020 – Feb 2021) at the main experiment station. Department of Horticulture, Rama University, Bandana, Kanpur, UP, India.

The experiments were laid out in Randomized Block Design with three replications. There were eight treatments and each treatment was allocated randomly in each plot during the period of investigation.

Seeds were sown in a well-prepared raised bed by opening the miniature furrows at 5 cm distance at 29 Oct 2020.F.Y.M. @ 15 tonnes/ha and Vermicompost @ 2.5 tonnes/ha were incorporated in the main field at the time of field preparation as per treatments. Fertilizers i.e., NPK (150: 100:80 kg/ha) were applied prior to sowing as per treatments through urea,

DAP and MOP, respectively. The 1/3rd dose of urea and full dose of DAP were applied as basal dressing on the hills as per treatments with common dose of MOP. Remaining 2/3rd dose of Urea were applied at two split doses. First at 30 days and second at 45days after transplanting on top dressed.

Twenty-five days old seedlings were transplanted in the experimental plots at the spacing of 60cm×45cm on 25th Nov 2020. To minimize the damage to the roots of the seedlings, the seedbeds were watered one hour before uprooting the seedlings. The seedlings were transplanted in the evening. Each plot accommodated 12 plants. To protect the seedlings from the scorching effect of sunlight, an artificial shade was provided by using rice straw until the establishment of the seedlings.

Among the total plant population of plots, five plants were selected randomly from a plot for the observations. These plants were tagged for recording the various data on cauliflower. Measuring tape was used to measure plant height, length of leaf, width of leaf and curd diameter. Curd weight and total biomass were determined by using electronic balance. No. of leaves per plant were counted visually.

Table 1: Details of layout

Name of the crop	Cauliflower
Botanical name	<i>Brassica oleracea</i> Var. <i>botrytis</i> L.
Design	Random Block Design
Number of treatments	8
Number of replications	3
Total number of plots	24
plot size	1.5m X 2 m (3m ²)
Spacing	60 cm X 45 cm
Length of field	19.5m
Width of field	5.5 m
Total experiment area	107.25 m ²
Season	Rabi 2020 to 2021
Variety	Snow crown

Table 2: Treatment details

Treatments	Concentration
T1	Control
T2	Recommended dose of NPK (150:100:80 kg/ha)
T3	Half dose of NPK/ha+FYM@15 tonnes/ha
T4	Half dose of NPK/ha + Azospirillum @ 5 kg/ha
T5	Half dose of NPK/ha + FYM @15 tonnes/ha + Azospirillum @5 kg/ha
T6	Half dose of NPK/ha + vermicompost @ 2.5 tonnes/ha
T7	Half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + FYM @ 15 tonnes/ha
T8	Half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + Azospirillum @ 5 kg/ha

Result and Discussion

Effect of integrated nutrient management on growth parameters: Maximum height of plant (60.50cm) were calculated by T8 (Half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + Azospirillum @ 5 kg/ha) which significantly higher than other treatments viz.; T7 (Half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + FYM @ 15 tonnes/ha), T6 (Half dose of NPK/ha + vermicompost @ 2.5 tonnes/ha), and other. Minimum plant height (56.50cm) was calculated in T1 (control) at 90DAT during experiments 2020-2021. The results of present investigation in terms of plant height corroborate the findings of Shree *et al.* (2014) [10] and Mitiku *et al.* (2014) who reported increased plant height due to compound application of organic and inorganic fertilizers. Similar kind results were also observed by Naidu *et al.* (1999)

[7], Mehdi *et al.* (2003) [4] and Singh and Singh (2005) [12].

Treatment T8 (Half dose of NPK/ha + Vermicompost @ 2.5 t/ha + Azospirillum @ 5 kg/ha) produce the maximum number of leaves of plant. (16.33) from the different application of INM on the cauliflower which significantly superior over other treatments. The next best treatment was found T7 (Half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + FYM @ 15 tonnes/ha) respectively. The least number of leaves per plant was observed in case of T1 (control) during 2020-2021. Similar kind results were also observed by Dwivedi and Singh (2007) [2] and. The results obtained were corroboratory with the findings of Singh *et al.* (2018) who reported the utmost number of leaves on Half Dose of NPK/ha + Vermicompost @ 2.5 t/ha + Azospirillum @ 5 kg/ha+ VAM @ 5 kg/ha.

The highest length of leaf per plant was found to be significant on different treatments of INM applied on cauliflower during 2020 – 2021. The maximum length of leaf (48cm) was calculated in treatment T8 (Half dose of NPK/ha + Vermicompost @ 2.5 t/ha + *Azospirillum* @ 5 kg/ha), respectively another best leaf length of cauliflower per plant (46) was calculated in treatments T7 (Half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + FYM @ 15 tonnes/ha) and the least length of leaves per plant (39.67) was calculated in case of treatments T1 (control). Similar result was also revealed by experiment performed by Kachari and Korla (2009)^[3] recorded the highest length of leaf of cauliflower by the application of 50 per cent of recommended dose of NPK @ 125:75:65 kg/ha + *Azospirillum* + FYM @ 25 tonnes/ha which enhance the length of leaf of cauliflower.

The treatment T8 (Half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + *Azospirillum* @ 5 kg/ha) produced the maximum spread of plant (44.50 cm) which significantly superior over other treatments and the minimum spread of plant (40.33 cm) were exhibited in T1 (control) during 2020-2021 at 90DAT. Similar result was also revealed by experiment performed by Devi *et al.* (2018) which revealed highest leaf area with treatment integrating vermicompost with inorganic fertilizers. Which reinforces the expansion of leaves.

Table 3: Effect of integrated nutrient management options on Growth parameters

Treatment	PH 90DAT	NL 90DAT	LL 90DAT	SP 90DAT
T1	56.5	14.67	39.67	40.33
T2	56.83	14.33	39.5	40
T3	57.17	13.67	38.67	41.67
T4	58	14.67	41.67	42
T5	58.5	14.33	43.33	41.83
T6	58.5	15	44	42.67
T7	59.83	15.33	46	44
T8	60.5	16.33	48	44.5
Mean	58.229	14.79	42.6	42.12
Cv	0.7	4.2	2.1	1.6
LSD	0.7181	1.081	1.545	1.186
F value	<0.001	0.005	<0.001	<0.001

Table 4: Effect of integrated nutrient management options on yield parameters

Treatment	Diameter (Cm) of curd 90 DAT	Weight (Kg)of curd 90 DAT	Yield Per Plot(kg/plot) 90 DAT	Yield Per Hectare (tons/ha) 90 DAT
T1	15.5	726.7	6.54	21.8
T2	16.5	760	6.84	22.8
T3	16.83	790	7.11	23.7
T4	16.67	850	7.83	26.1
T5	17.5	963.3	8.67	28.9
T6	18.17	1003.3	9.03	30.1
T7	18.5	1005	9.06	30.2
T8	20	1006.7	9.3	32
Mean	17.46	895.8	8.085	26.95
Cv	3.4	3.8	3.7	3.7
LSD	1.044	59.34	0.5257	1.725
F value	<0.001	<0.001	<0.001	<0.001

Conclusion

From this study it can be recommend that the application of INM at half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + *Azospirillum* @ 5 kg/ha can be applied to obtain maximum yield of Cauliflower variety Snow crown in Mandana, Kanpur UP, India.

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Effect of integrated nutrient management options on yield parameters

Maximum diameter of curd (20 cm) were recorded for the treatment T8 (Half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + *Azospirillum* @ 5 kg/ha) during 2020-2021 which significantly higher than other treatments. The minimum diameter of curd (15.50 cm) were recorded in T1 (Control). The results were in consonance with the findings of Swaroop *et al.* (1999)^[13], Nagaraju *et al.* (2000)^[6], Singh (2004)^[11], Narayanamma *et al.* (2005)^[8], Singh and Singh (2005)^[12] and Yadav *et al.* (2007)^[14].

The maximum weight of curd (1006.7 g) was recorded at 90DAT, with the application of treatment T8 (Half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + *Azospirillum* @ 5 kg/ha) which found significantly superior over other treatments. The next best treatment was found T7 (Half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + FYM @ 15 tonnes/ha) which yielded (1005.0 g) weight of curd. The minimum weight of curd (726.7 g) was noted for treatment T1 (Control). Similar result was also revealed by experiment performed by Singh and Singh (2005)^[12] recorded the maximum average curd weight and yield of cauliflower by the application of *Azospirillum* + 100% recommended dose of NPK @ 120:60:60 kg/ha.

The maximum yield per plot at 90 DAT (9.300 kg/plot) were recorded in the application of (T8) half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + *Azospirillum* @ 5 kg/ha but minimum yield per plot were recorded in T1 (6.540 kg/plot). The results were in consonance with the findings of Swaroop *et al.* (1999)^[13], Nagaraju *et al.* (2000)^[6], Singh (2004)^[11], Narayanamma *et al.* (2005)^[8].

The mean table shows that the maximum yield per hectare (32.00 tons/hectare) were obtained in the application of T8 half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ha + *Azospirillum* @ 5 kg/ha which significantly superior over other treatments and the minimum yield per hectare were obtained in T1 (21.80 tons/hectare) by the application of different integrated nutrient management on cauliflower during 2020-2021.

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