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Original Research Article

Effect of Biofertilizers and Growth Regulators on Growth Attributes of Cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. Pusa Paushja

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A B S T R A C T

In order to study the effect of biofertilizers and growth regulators on growth attributes of cauliflower. The experiment consisting 15 treatments combination with two factors i.e. biofertilizers with three levels (control, PSB and mycorrhiza) and growth regulators with five levels (control, NAA 50 ppm, NAA 100 ppm, GA_3 50 ppm and GA_3 100 ppm) in Factorial Randomized Block Design with three replications. The individual application of biofertilizer treatment B_2 (mycorrhiza) recorded maximum plant height (63.02 cm), numbers of leaves per plant (22.83), length of stem (8.96 cm), minimum days taken to 50 per cent curd initiation (33.20), days taken to 50 per cent marketable curd size (59.35) and maximum chlorophyll content in leaves at 45 DAT (0.45 mg g^{-1}). Similarly, the individual application growth regulator treatment G_3 (GA_3 50 ppm) found maximum plant height (64.58 cm), number of leaves per plant (24.05), length of stem (9.39 cm), minimum days taken to 50 per cent curd initiation (32.48), days taken to 50 per cent marketable curd size (58.32) and maximum chlorophyll content in leaves at 45 DAT (0.45 mg g^{-1}) compared to control. Further, the interaction effect due to application of biofertilizer and growth regulator had significant increased growth and yield over the control. The maximum plant height (65.91 cm), number of leaves per plant (24.45), stem length (9.78 cm), minimum days taken to 50 per cent curd initiation (31.57), days taken to 50 per cent marketable curd size (55.85) and maximum chlorophyll content in leaves at 45 DAT (0.48 mg g^{-1}) with application treatment B_2G_3 (mycorrhiza + GA_3 50 ppm) compared to control.

Keywords

Cauliflower, biofertilizers, growth regulators and growth attributes

Introduction

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is the most popular cruciferous vegetable among the cole crops grown in India. The crop is the native of South Europe in the Mediterranean region and was introduced in India from England in 1822 by Dr. Jemson (Chatterjee and Swarup, 1972). The edible part of cauliflower 'Curd' which is 'prefloral fleshy apical meristem'. It cultivated for its attractive curd which is used as raw cocked vegetables, curries, soups and pickles. It is predominant due to its attractive appearance, good taste, easy digestible, rich source of nutrients and high yielding capacity. It is a major source of protein, calcium, phosphorus, potassium, sodium, iron and vitamins. Biofertilizers improve the soil health and plant nutrient availability resulting in higher crop yields. The current trend of organic farming using organic

fertilizers like biofertilizers of microbial origin with limited use of chemical fertilizers. So, application of plant nutrients through biofertilizers can be maintain soil fertility and crop quality Narayanmma *et al.*, (2005). Among several growth regulators, NAA and GA_3 are very popular and being used in commercial scale in several crops including cauliflower. They help in the synthesis of metabolites as well as translocation of nutrients and assimilation in different parts, which ultimately results in higher yields (Kotecha *et al.*, 2011).

Materials and Methods

A field experiment to study the "Effect of biofertilizers and growth regulators on growth, yield and quality of cauliflower (*Brassica oleracea* var. *botrytis* L.) cv. Pusa Paushja" was conducted at Protected Cultivation Unit, Department of Vegetable Science, College of Horticulture & Forestry, Jhalrapatan city, Jhalawar during *Rabi*, 2016-17.

The experiment consisting 15 treatments combinations with two factors i.e. biofertilizers with three levels (control, PSB and mycorrhiza) and growth regulators with five levels (control, NAA 50 ppm, NAA 100 ppm, GA_3 50 ppm and GA_3 100 ppm) in Factorial Randomized Block Design with three replications each. The treatment combinations are T_0 - Control, T_1 - PSB, T_2 - Mycorrhiza, T_3 - NAA 50 ppm, T_4 - NAA 100 ppm, T_5 - GA_3 50 ppm, T_6 - GA_3 100 ppm, T_7 - PSB + NAA 50 ppm, T_8 - PSB + NAA 100 ppm, T_9 - PSB + GA_3 50 ppm, T_{10} - PSB + GA_3 100 ppm, T_{11} - Mycorrhiza + NAA 50 ppm, T_{12} - Mycorrhiza + NAA 100 ppm, T_{13} - Mycorrhiza + GA_3 50 ppm, T_{14} - Mycorrhiza + GA_3 100 ppm. The treatment application was given as foliar spray of growth regulators at 15 and 30 DAT and seedlings were treated with biofertilizers for half hour before transplanting in each replication.

Results and Discussion

The result of present study clearly indicate that plant height, number of leaves per plant, stem length, days taken to 50 per cent curd initiation, days taken to 50 per cent marketable curd size as well as chlorophyll content in leaves (mg g^{-1}) at 45 DAT were significantly increased by individual application of different biofertilizer and growth regulator as compare to control.

The application of B_2 (mycorrhiza) had maximum plant height (63.02 cm), numbers of leaves per plant (22.83), length of stem (8.96 cm), minimum days taken to 50 per cent curd initiation (33.20), days taken to 50 per cent marketable curd size (59.35) and maximum chlorophyll content in leaves at 45 DAT (0.45 mg g^{-1}) as compared to minimum plant height (59.35 cm), numbers of leaves per plant (21.64), length of stem (7.51 cm), maximum days taken to 50 per cent curd initiation (35.49), days taken to 50 per cent marketable curd size (62.16) and minimum chlorophyll content in leaves at 45 DAT (0.38 mg g^{-1}) under control, respectively. Similar observations were recorded by Bahadur *et al.*, (2004) in cabbage, Kachari and Korla (2009) in cauliflower, Verma and Yadav (2011) in cabbage and Singh *et al.*, (2014) in broccoli.

The plant height significantly increased by application of mycorrhiza over control. It might be due to effect of mycorrhiza increased the availability of nutrients (N, P, Zn, Cu etc.), improve the water holding capacity, soil texture and increase disease resistance (Chaterjee *et al.*, 2005). The increase number of leaves might be due to the fact that mycorrhiza secreted some bio active substances like gibberellins,

cytokinins, auxins and vitamins which resulted more cell division, cell elongation and cell enlargement which ultimately increase the growth (Narayanamma *et al.*, 2005 in cauliflower). Mycorrhiza stimulate nutrient uptake specially nitrogen which have role in the assimilation of numerous amino acids which help in chlorophyll synthesis. The earliness in the treatment might be due to quick release of nutrients to soil, quick uptake by plants resulting better vegetative growth, curd initiation and curd maturity as compare to control (Chaterjee *et al.,* 2005). The more vegetative growth promote the early curd initiation and minimum days required to marketable curd size Champawat and Pathak, (1993) and Qiao *et al.,* (2011).

The application of growth regulator G_3 (GA_3 50 ppm) had maximum plant height (64.58 cm), numbers of leaves per plant (24.05), length of stem (9.39 cm), minimum days taken to 50 per cent curd initiation (32.48), days taken to 50 per cent marketable curd size (58.32) and maximum chlorophyll content in leaves at 45 DAT (0.45 mg g^{-1}) as compare to minimum plant height (55.98 cm), numbers of leaves per plant (17.83), length of stem (6.35 cm), maximum days taken to 50 per cent curd initiation (37.38), days taken to 50 per cent marketable curd size (64.19) and minimum chlorophyll content in leaves at 45 DAT (0.35 mg g^{-1}) as compared to control, respectively. These results were confirmed by Dhengle and Bhosale (2008) in cabbage, Roy and Nasiruddin (2011) in cabbage and Sitapara *et al.,* (2011) in cauliflower.

Plant height increased by application of growth regulators over control. It might be due to GA_3 which increase the cell division and cell elongation in sub apical meristem. The increase in number of leaves per plant with application of GA_3 may be due to the activity of GA_3 at the apical meristem resulting in more nucleo - protein synthesis responsible for increasing leaf initiation Dhengle and Bhosle (2007). The stem length was increased by application of GA_3 over control. It might be due to the foliar spray of GA_3 which stimulate vegetative growth and involved in initiation of the cell division in cambium (Mishra and Singh, 1986).

The application of GA_3 decreased number of days taken to 50 per cent curd initiation. It might be due to the more cell division and elongation with increase in photosynthetic activity and better food accumulation Yadav *et al.,* (2000). The early curd initiation resulting decrease the number of days required to 50 per cent marketable curd size Reddy *et al.,* (1989). The increase in chlorophyll content by application of growth regulators might be due to stimulated nutrient uptake specially which have role in the assimilation of numerous amino acids that are subsequently incorporated in proteins and nucleic acid, which provides framework for chloroplast results into better chlorophyll content in leaves of plant Ramteke *et al.,* (2016).

Similarly, the result of present study clearly indicate that plant height, number of leaves per plant, stem length, days taken to 50 per cent curd initiation, days taken to 50 per cent marketable curd size as well as chlorophyll content in leaves (mg g^{-1}) at 45 DAT were significantly increased by interaction effect of biofertilizers and growth regulators as compare to control.

The treatment B_2G_3 (mycorrhiza + GA_3 50 ppm) had maximum plant height (65.91 cm), numbers of leaves per plant (24.45), length of stem (9.78 cm), minimum days taken to 50 per cent curd initiation (31.57), days taken to 50 per cent marketable curd size (55.85), maximum chlorophyll content in

leaves at 45 DAT (0.48 mg g^{-1}) as compared to minimum plant height (55.25 cm), numbers of leaves per plant (17.17), length of stem (6.06 cm), maximum days taken to 50 per cent curd initiation (38.06), days taken to 50 per cent marketable curd size (64.91), minimum chlorophyll content in leaves at 45 DAT (0.35 mg g^{-1}). These results were confirmed by Narayanamma *et al.*, (2005) in cauliflower, Singh (2008) in cauliflower, Lendve *et al.*, (2010) in cabbage and Singh *et al.*, (2014) in broccoli.

Table.1 Individual effect of biofertilizers and growth regulators on growth attributes plant height, number of leaves per plant, stem length, days taken to 50 per cent curd initiation, days taken to 50 per cent marketable curd size and chlorophyll content in leaves at 45 DAT

Treatment	Plant height (cm)	No. of leaves per plant	Stem length (cm)	Days taken to 50 per cent curd initiation	Days taken to 50 per cent marketable curd size	Chlorophyll content in leaves (mg/g)
B_0	59.35	21.64	7.51	35.49	62.16	0.38
B_1	61.90	22.40	8.23	33.58	60.27	0.42
B_2	63.02	22.83	8.96	33.20	59.35	0.45
SEm ±	**0.43**	**0.18**	**0.17**	**0.23**	**0.34**	**0.02**
C.D. (p=0.05)	**0.88**	**0.38**	**0.34**	**0.48**	**0.71**	**0.04**
G_0	55.98	17.83	6.35	37.38	64.19	0.35
G_1	63.62	23.50	9.02	32.76	59.38	0.43
G_2	61.24	22.74	7.92	34.31	60.93	0.41
G_3	64.58	24.05	9.39	32.48	58.32	0.45
G_4	61.70	23.32	8.49	33.51	60.13	0.42
SEm ±	**0.55**	**0.24**	**0.21**	**0.30**	**0.45**	**0.02**
C.D. (p=0.05)	**1.14**	**0.50**	**0.44**	**0.63**	**0.92**	**0.05**

B_0 - control, B_1 - PSB, B_2 - mycorrhiza, G_0 - control, G_1 - NAA 50 ppm, G_2 - NAA 100 ppm, G_3 - GA_3 50 ppm and G_4 - GA_3 100 ppm.

Table.2 Interaction effect of biofertilizers and growth regulators on growth attributes plant height, number of leaves per plant, stem length, days taken to 50 per cent curd initiation, days taken to 50 per cent marketable curd size and chlorophyll content in leaves at 45 DAT

Treatment	Plant height (cm)	No. of leaves per plant	Stem length (cm)	Days taken to 50 per cent curd initiation	Days taken to 50 per cent marketable curd size	Chlorophyll content in leaves (mg/g)
T_0 (B_0G_0)	55.25	17.17	6.06	38.06	64.91	0.35
T_1 (B_1G_0)	55.99	17.63	6.24	37.56	64.52	0.35
T_2 (B_2G_0)	56.69	18.70	6.75	36.51	63.13	0.35
T_3 (B_0G_1)	62.25	23.20	8.07	34.03	60.65	0.38
T_4 (B_0G_2)	57.84	21.37	6.99	36.70	63.32	0.36
T_5 (B_0G_3)	63.32	23.30	8.66	33.83	60.45	0.41
T_6 (B_0G_4)	58.08	23.14	7.76	34.83	61.45	0.37
T_7 (B_1G_1)	63.88	23.50	9.36	32.20	58.82	0.44
T_8 (B_1G_2)	62.18	23.11	7.54	33.20	59.82	0.42
T_9 (B_1G_3)	64.51	24.40	9.71	32.03	58.65	0.46
T_{10} (B_1G_4)	62.95	23.36	8.27	32.90	59.52	0.43
T_{11} (B_2G_1)	64.73	23.79	9.62	32.06	58.68	0.47
T_{12} (B_2G_2)	63.69	23.73	9.22	33.03	59.65	0.46
T_{13} (B_2G_3)	65.91	24.45	9.78	31.56	55.85	0.48
T_{14} (B_2G_4)	64.07	23.46	9.42	32.80	59.42	0.47
SEm ±	**0.96**	**0.42**	**0.37**	**0.53**	**0.78**	**0.04**
C.D. (p=0.05)	**1.98**	**0.87**	**0.76**	**1.09**	**1.60**	**0.09**

The parameters related to growth increased by application of biofertilizers and growth regulators over control. It might be due to the interaction fact of biofertilizers and growth regulators increased in growth attributes compared to control. The mycorrhiza hyphae reach beyond the depletion zone around the root and absorb soil nutrients (N, P, Zn, Cu etc.) and translocate to plant, secret growth promoting substances likes, IAA, GA, Cytokinins and enzyme. Mycorrhiza increase cell division and cell elongation, increase drought tolerance, increase disease and insect pest resistance which leading to vegetative growth and yield Chatterjee *et al.,* (2005).

The increase vegetative growth might be due to rapid and better nutrient transport from roots to their aerial parts of the plants as a result of foliar spray of gibberellic acid Denisova and Lupinovich (1962). Another reason might be that gibberellic acid increased the rate of photosynthesis Alvin (1960). Further greater vegetative growth due to mycorrhiza and GA_3 application which resulted in large amount of carbohydrate synthesis during the process of photosynthesis. The increase photosynthesis promote greater accumulation of carbohydrates in plant due to mycorrhiza and GA_3 facilitate the development of curd resulted ultimately increased Rajput and Pandey (2004), Purbey and Sen (2005) and Singh *et al.,* (2013).

The individual application of biofertilizer B_2 (mycorrhiza) and growth regulators G_3 (GA_3 50 ppm) exhibited maximum plant height (63.02 and 64.58 cm), numbers of leaver per plant (22.83 and 24.05), length of stem (8.96 and 9.39 cm), minimum days taken to 50 per cent curd initiation (33.20 and 32.48), days taken to 50 per cent marketable curd size (59.35 and 58.32) and maximum chlorophyll content in leaves at 45 DAT (0.45 and 0.45 mg g^{-1}), respectively. Similarly, the interaction effect due to application of treatment B_2G_3 (mycorrhiza + GA_3 50 ppm) exhibited significantly maximum plant height (65.91 cm), numbers of leaves per plant (24.45), length of stem (9.78 cm), minimum days taken to 50 per cent curd initiation (31.57), days taken to 50 per cent marketable curd size (55.85) and maximum chlorophyll content in leaves at 45 DAT (0.48 mg g^{-1}).

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