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# EFFECT OF PLANT GROWTH PROMOTING RHIZOBACTERIA (PGPR) ON GROWTH OF CAULIFLOWER (*BRASSICA OLERACEA* L. VAR. *BOTRYTIS*)

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## Abstract

A field experiment was carried out at the Directorate of Diyala agriculture, Baqubah nursery, Iraq during August, 2018 to January, 2019 to assess the response of cauliflower (*Brassica oleracea* L. var. *botrytis* cv. rock) to bio fertilizer containing (*Bacillus megaterium*, *Azospirillum brasilense* and *Pseudomonas fluorescens*) as commercial formulation and different levels of nitrogen and phosphorus *viz*. 25, 50, 75 and 100%. The experiment was laid out in Randomized Complete Block Design consisting of 6 treatments with three replicates for each treatment. Application of nitrogen and phosphorus along with the bio fertilizer led to a significant increase in morphological traits and yield as compared to application of nitrogen and phosphorus without bio fertilizer. The maximum leaf length, leaf width, stem height, plant weight and yield ton/hectare were recorded in 75 and 100% of chemical fertilizers along with bio fertilizer, which reached (62.4, 64.3 cm), (30.9, 32.6 cm), (22, 21.9 cm), (1.394, 1.375 kg) and (59.758, 58.925 tons/hectare) respectively. The early days of cauliflower maturity were recorded at levels 50,75 and 100% of nitrogen and phosphorus with bio fertilizer, which reached 111, 111 and 111 days respectively as compared with using of chemical fertilizer alone 139 days.

***Key words*:** cauliflower, *Bacillus megaterium, Azospirillum brasilense Pseudomonas fluorescens,* nitrogen and phosphorus.

## Introduction

Cauliflower *Brassica oleracea* var. *botrytis* L. is one of the most important winter vegetable among the crops belonging to the family Brassicaceae, where it's floral parts are used for culinary purposes (Sable *et al*., 2016). The main goal for getting of high yield requires extensive use of chemical fertilizers, so farmers are repeatedly using chemical fertilizers, but it's costly and create environmental problems such as problem of soil deterioration. Also excess use of chemical fertilizers causes environmental pollution besides affecting the quality of fruit (Salim *et al*., 2016). Therefore, there has recently been increased interest in practices of sustainable, organic and environment friendly agriculture in the world (Esitken *et al*., 2005, 2006), thus the current trend is using bio fertilizers of microbial origin with limited use of chemical fertilizers. Plant Growth Promoting Rhizobacteria (PGPR) is a very significant source for environment friendly farming, which used as bio fertilizer, PGPR can play important role in plant growth either directly by facilitating the uptake of nutrients from the environment or indirectly by reducing phytopathogens, also by enzymatic lowering of plant ethylene levels and by influencing the phytohormones production such as auxin, cytokinin and giberallin (Ibiene *et al.*, 2012; Cakmakci *et al.*, 2006; Bashan and Bashan, 2005; Lucy *et al*., 2004). Secretion of phytohormones from Bacteria can excess in production of root hairs and lateral roots, then increase water and nutrient uptake, subsequently Improving of growth (Persello Cartieaux *et al*., 2003). *Bacillus megaterium* is widespread in soil (Ali *et al.*, 2009), it was industrially used for over 50 years due to it possesses a high capacity for the production of exoenzymes besides it has some very useful enzymes

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(Adriana, Ş.I., 2011). *Azospirillum sp* improve the root system, through production of phytohormones, more tolerance against drought and salinity stresses and allowing absorption of more water and nutrients (Bashan *et al.*, 2004). Pseudomonas strains are capable to control of soil pathogens, thus it enhances the plant growth and yield increased (Elekhtyar, 2015). The present investigation was undertaken to explore the effect of *Bacillus megaterium*, *Azospirillum brasilense* and *Pseudomonas fluorescens* with reduced levels of nitrogen and phosphor on growth of cauliflower.

## Materials and Methods

### Collection of cauliflower seedlings and PGPR bacteria

Cauliflower seedlings that belong to local variety (Rock) were collected from Baqubah nursery, whereas PGPR bacteria as commercial formulation that included (*B. megaterium*, *A. brasilense* and *P. fluorescens*) was obtained from a ministry of science and technology.

### Field experiment

This study was conducted at the Directorate of Diyala agriculture, Baqubah nursery, Iraq during August, 2018 to January, 2019 to study the effect of PGPR bacteria as bio fertilizer beside the different levels of chemical fertilizer on the growth of cauliflower.

The chemical Fertilizer DAP (Di ammonium phosphate) that contain N=18 and P=46 was added at the rate 300 kg/hectare with 4 doses included 25, 50, 75 and 100%. Seedlings of cauliflower were sown directly in field on 29/8/2018 in rows with distances between them 60 cm and between plants were 70 cm which arranged in a Randomized Complete Block Design (RCBD) with three replicates of each treatment where each replicate contain 6 plants, the land was prepared for cultivation by plowing, disking and ridging, then taking soil samples representing the depth of plowing (0 - 0.15 m) in order to record the physical and chemical properties of the soil, as set out in (Table 1). The bio fertilizer was added to each plant by drill the soil close the plant by deep 5 cm at 30/9/2018, also the chemical Fertilizer DAP was added at same method at 2/10/2018, the water was pumped through the drip irrigation system and adding phosphorus and NPK fertilizers at a rate of 80 and 40 kg / ha by this system after 30 days of planting. The details of the treatments employed are as under:

1. Bio fertilizer + chemical fertilizer 25 %
2. Bio fertilizer + chemical fertilizer 50 %
3. Bio fertilizer + chemical fertilizer 75 %
4. Bio fertilizer + chemical fertilizer 100 %
5. Only Bio fertilizer
6. Only chemical fertilizer 100 %

**Table 1:** The physical and chemical properties of the soil before planting.

| Measurements | Value | Unit of measurement |
|---|---|---|
| Clay | 328.1 | g / kg soil |
| Silt | 280.1 | g / kg soil |
| Sand | 391.8 | g / kg soil |
| Texture of soil | Mixed clay | - |
| $CaCO_3$ | 276.13 | g / kg soil |
| Organic matter | 1.4 | % |
| N | 34.89 | mg / kg soil |
| P | 8.13 | mg / kg soil |
| K | 347.30 | mg / kg soil |
| Ca | 17.45 | mill mole / liter |
| Mg | 16.05 | mill mole / liter |
| Na | 2.36 | mill mole / liter |
| $HCO_3$ | 7.9 | mill mole / liter |
| Cl | 14.5 | mill mole / liter |
| $So_4$ | 20.85 | mill mole / liter |
| $Co_3$ | 0.0 | mill mole / liter |
| Ec | 5.93 | ds Siemens \ m |
| pH | 7.82 | - |

### Growth parameters

The following measurements were recorded such as number of leaves, plant diameter, plant length, leaf length, leaf width, stem length, plant weight / kg, yield ton/hectare, Maturity/days.

### Statistical analysis

The data was analyzed by one way Analysis of Variance (ANOVA) (Fisher and Yates, 1968).

## Results and Discussion

The effects of Bio and chemical fertilizers applications on leaves number and plant diameter of cauliflower were not significant (Fig. 1, 2). The effect of treatments 4 and 3 was highly significant in increasing of cauliflower plant length, which reached 77.7 and 75.9 cm respectively from other treatments (Fig. 3). The effect of treatments 3, 4

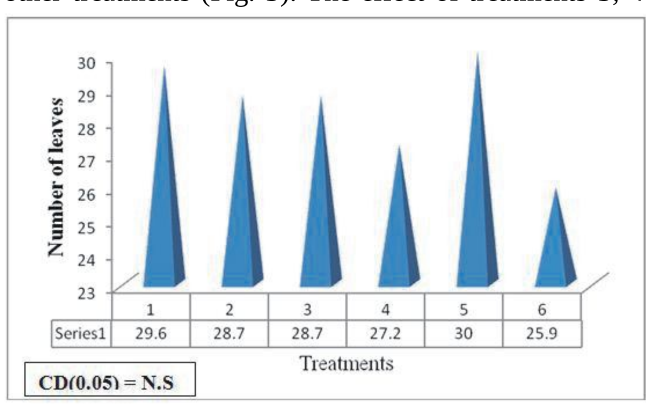


**Fig. 1:** Effect of bio and chemical fertilizers on number of leaves.

followed by 5 was significant in increasing leaf length and leaf width of cauliflower, which reached 62.4, 64.3, 59.2 cm and 30.9, 32.6, 30.3 cm respectively (Fig. 4,5),

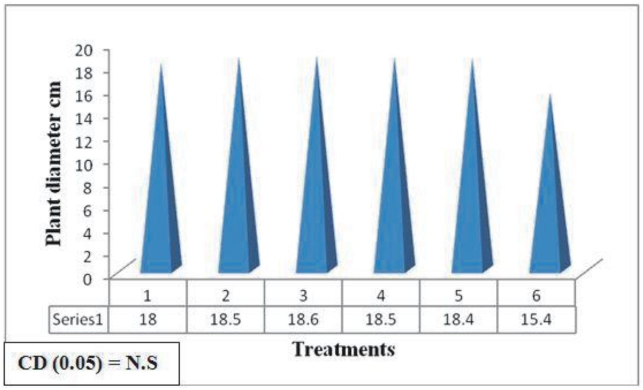


**Fig. 2:** Effect of bio and chemical fertilizers on plant diameter.

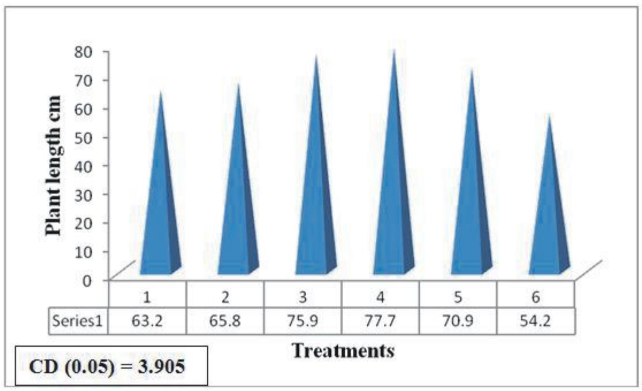


**Fig. 3:** Effect of bio and chemical fertilizers on plant length.

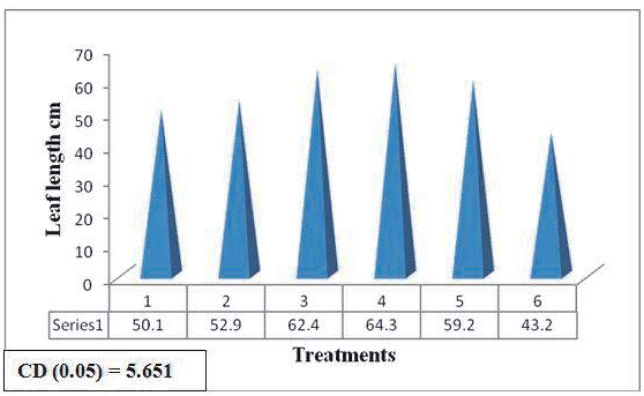


**Fig. 4:** Effect of bio and chemical fertilizers on leaf length.

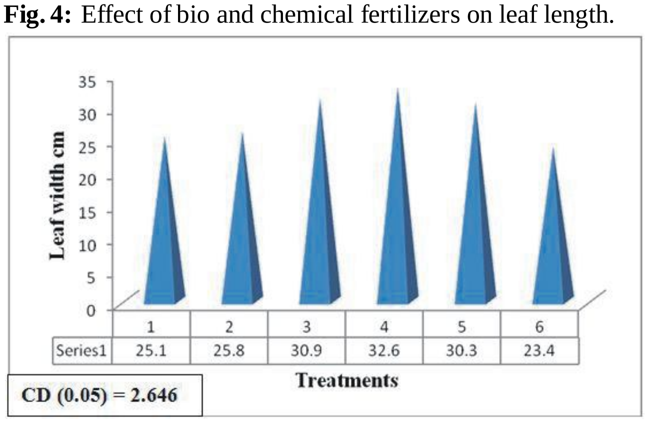


**Fig. 5:** Effect of bio and chemical fertilizers on leaf width.

the data in fig. 6 indicate that the treatments 3, 4, 5 showed the maximum rate of stem length, which reached (22, 21.9, 20.6 cm) respectively as compared with treatment 6 (15.2 cm), there was a significant effect of different treatments 1, 2, 3, 4, 5 on plant weight and yield ton/ hectare after the cauliflower harvest, which reached (1.167, 1.139, 1.394, 1.375, 1.311 kg) and (50.044, 48.807, 59.758, 58.925, 56.188 ton) as compared with treatment 6 (0.766 kg and 32.854 ton) respectively (Fig. 7,8), also the treatments 1, 2, 3, 4, 5 has led to reducing in rate of maturity days, which reached (132, 111, 111, 111, 117 days) respectively as compared with treatment 6 (139 day) (Fig. 9). From the above investigation, it is concluded that all growth traits of cauliflower were increased by application of bio fertilizer (*B. megaterium*, *A. brasilense* and *P.*

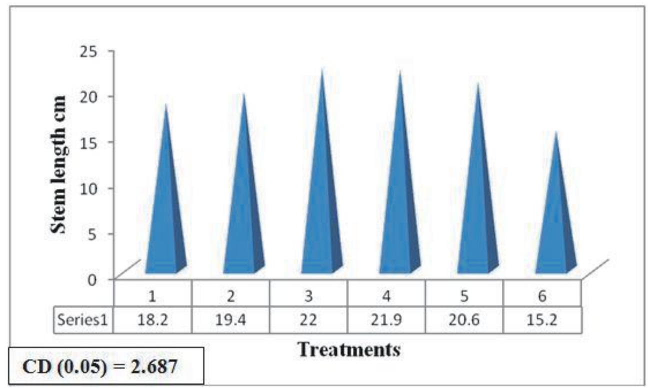


**Fig. 6:** Effect of bio and chemical fertilizers on stem length.

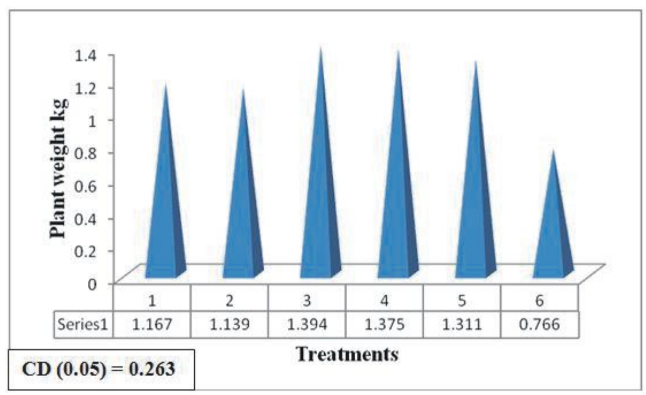


**Fig. 7:** Effect of bio and chemical fertilizers on plant weight.

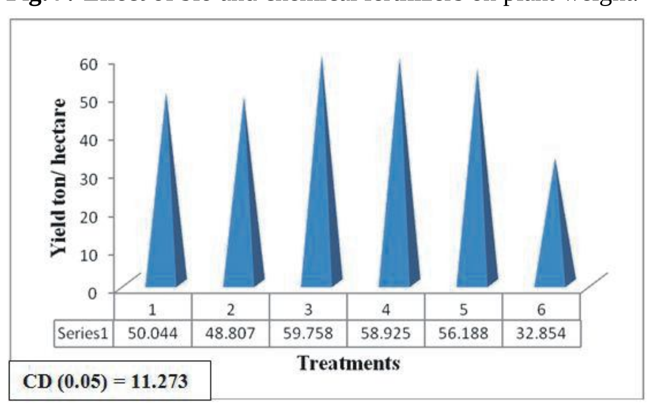


**Fig. 8:** Effect of bio and chemical fertilizers on yield ton/hectare.

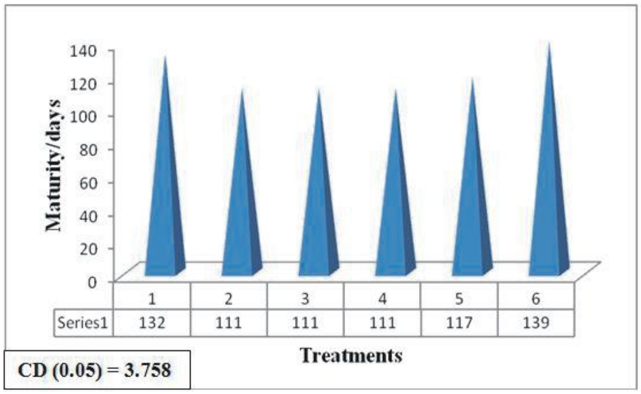


**Fig. 9:** Effect of bio and chemical fertilizers on Maturity/days.

*fluorescens*) with the gradual increase in the levels of nitrogen and phosphorus from 25 to 100 % as compared with using of chemical fertilizer alone. These findings are coming in conformity with the findings of Bhattacharya *et al*., (2000); Bhhattarai *et al*., (2005) and Budhathoki, (2006) who have reported an increase in yield of cauliflower by using bio fertilizer with different nitrogen levels. Application of chemical fertilizers with organic manure and bio-fertilizers may be attributed to improved vegetative growth, yield, nutrient availability and synthesis and transfer of carbohydrates (Singh, 1987). The stem height and stem diameter of cauliflower were highly significant due to the main effect of nitrogen and bio fertilizer (Azospirillum and Azotobacter) and their interactions (Bashyal, 2011). Azospirillum stimulates the growth and yield of several plants (Ramos *et al*., 2010; Hungria *et al*., 2010; Kappes *et al*., 2013). It plays an important role in enhancing the growth of cauliflower due to their ability to produce growth promoting substances such as gibberellins, indole acetic acid, riboflavin (B2), vitamin B12, thiamine (Sharma and Chandra, 2002; Shree *et al*., 2014). Usage of Azospirillum at the rate of 2 kg / ha led to increase in nutrient content of different plants such as chili, onion, okra, brinjal, tomato, cabbage and cauliflower (Subbiah, 1994). Cavallet *et al*., (2000) and Ramos *et al*., (2010) reported that the seeds that inoculated with *Azospirillum spp* and treated with nitrogen resulted to increment in plants length. Some strains of *Bacillus megaterium* can improve plant growth and control of pathogens (Chakraborty *et al.*, 2006). *Bacillus megaterium* led to an increase of germination, height and weight in soybean plants for all different soils amended with phosphogypsum (Adriana, 2011). The bio fertilizers that included *Pseudomonas fluorescens* combined with *Azotobacter chroococcum* led to enhancing of growth performance, nutrition and increment in broccoli yield (Salim *et al.*, 2018a). The productivity of cabbage significantly increased in response to the bio-fertilizer (*Pseudomonas fluorescens* and *Azotobacter chroococcum*) which played an important role in enhancing of plant nutrient status and increasing the growth of cabbage plant (Salim *et al.*, 2018b).

## Conclusion

From the above investigation, it is concluded that the efficiency of bio-fertilizers (*B. megaterium, A. brasilense* and *P. fluorescens*) increased with the increase in the dose of chemical fertilizers, which included nitrogen and phosphorus from 25 to 100% through improvement of the growth characteristics of cauliflower.

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