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Effect of integrated use of nitrogen and biofertilizer on growth of cabbage (*Brassica oleracea var. capitata* L.)

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Abstract
An investigation was conducted at research farm, Department of Horticulture, Udai Pratap Autonomous College, Bhojubeer, Varanasi (U.P.) during 2018-19 to assess the effect of integrated use of nitrogen and biofertilizer on growth of cabbage cv. Golden Acre. The experiment comprised of 12 treatments *viz.* T0-Control, T1 - Azotobacter, T2 – Azospirillum, T3 - 75% RDN + No biofertilizer, T4 - 75% of RDN + Azotobacter, T5 - 75% of RDN + Azospirillum, T6 - 100% of RDN + No Biofertilizer, T7 - 100% of RDN + Azotobacter, T8 - 100% of RDN + Azospirillum T9 - 125% of RDN + No Biofertilizer, T10 - 125% of RDN + Azotobacter, T11- 125% of RDN + Azospirillum were evaluated in randomized block design with three replications. The treatments T4 (75% of RDN + Azotobacter) was recorded maximum plant height (43.88cm), Seed germination (%) (75.13), plant stand (23.93), plant spread cm^3 (43.88), number of non-wrapper leaves (15.26), number of wrapper leaves (30.29) and diameter of stem (19.70mm). It was statistically at par with 75% of RDN + Azotobacter inoculation.

Keywords: Cabbage, azotobacter, azospirillum and nitrogen

Introduction
Cabbage (*Brassica oleracea var. capitata* L.) is the most important member of genus Brassica of the Brassicaceae family. Most of the cabbages have alternating, thick leaves with wavy or lobed margins. Plant roots are fibrous and shallow. The inflorescence is comprised of unbranched indeterminate terminal raceme with white or yellow flowers which has four petals in a perpendicular pattern; four sepals, six stamens and a superior ovary. It bears seeds in a special kind of bicarpellary pod called the siliqua. The cultivated cabbage is biennial and shows great diversification pertaining to size, shape and colour of leaves and shape, size, colour and texture of head. Basically, cabbage is a crop of temperate zones but it is widely grown in both subtropical and tropical regions of India (Kalia *et al*., 2020) [4]. Cabbage is used as salad, cole slaw, boiled vegetable, cooked in curries and processed. It is also pickled as well as dehydrated. Cabbage is also used for its medicinal properties. It is commonly used against gout, stomach and coeliac troubles & diarrhoea. It has an anticancer property which protects against bowel cancer due to the presence of Indole-3- carbinol. Cabbage juice is used as a remedy against poisonous mushrooms. Cabbage product called 'Sauerkraut' prepared using shredded cabbage leaves fermented under pressure in its own juice with the added salt has a curative effect on scurvy disease (Hazra, P., 2019) [3]. All plants utilize N in the form of NO_3^- and NH_4^+. It is most important macroelement for proper growth and development of plants which enhances the crop yield and quality to a greater extent by playing a vital role in biochemical and physiological functions of plants. Nitrogen is an essential constituent of protein and chlorophyll. It plays a vital role as it imparts dark green colour in plants, promotes leaves, stem and other vegetable's part growth. Moreover, it also stimulates root growth. The usage of chemical fertilisers on a regular and indiscriminate basis has wreaked havoc on the land and ecology. Furthermore, if they are employed alone, the yield cannot be realised. As a result, a well-balanced use of chemical fertilisers and biofertilizers may be beneficial in enhancing vegetable yield. Through biological processes, biofertilizers can mobilise nutritionally significant components from non-usable to usable forms. Biofertilizers are microbial preparations comprising of alive or latent cells of certain microorganisms for use as a seed treatment or soil treatment, allowing the cells to grow and boost the soil's productivity through nitrogen fixation and nutrient mobilisation.

Biofertilizers are natural products that contain living organisms from the root or cultivated soil. As a result, they have no negative impact on soil health or the ecosystem. *Azotobacter* and *Azospirillum* have long been recognised as important biofertilizers for vegetable crops among the numerous types of biofertilizers available (Kachari *et al*., 2009). There are various studies that illustrate the advantages of using *Azotobacter* and *Azospirillum* to fix nitrogen. On the roots of grasses and cereals, *Azospirillum* is known as an associative endosymbiont. They are widely recognized for fixing atmospheric nitrogen and assist the plant by creating auxin, cytokinins, gibberellins, and vitamins, among other things. Azotobacters are free-living heterotrophic N-fixing bacteria. They are gram-negative bacteria with 1.5-2.0 m cells.

Method and Material

The present experiment work entitled "Effect of integrated use of nitrogen and biofertilizers on growth and yield of cabbage (*Brassica oleracea var. capitata* L.) were carried out at Udai Pratap Autonomus College, Varanasi, UP, India during the year 2018-2019 in rabi season from October, 2018 to January, 2019. Varanasi is categorized under humid subtropical climate where average annual rainfall received is 1,110 mm or 44 inches. The experiment was laid out in Randomized Block Design with 4 levels of nitrogen (0, 75%, 100% and 125%) alone and in combination with 2 biofertilizers i.e. Azotobacter and Azospirillum in combination with nitrogen levels and one is absolute control was laid out in simple RBD with three replications. The treatments were T0 = Control, T1= Azotobacter, T2= Azospirillum, T3= 75% of RDN + No Biofertilizer, T4=75% of RDN + Azotobacter, T5= 75% of RDN + Azospirillum, T6= 100% of RDN + No Biofertilizer, T7= 100% of RDN + Azotobacter, T8= 100% of RDN + Azospirillum, T9=125% of RDN + No Biofertilizer, T10=125% of RDN + Azotobacter T11=125% of RDN + Azospirillum. The soil application of Azotobacter and Azospirillum @ 2 kg/ha was done in plots at the time of transplanting. Thirty day old seedlings developed from different treatments were dipped in biofertilizer solution for 15 minutes. The FYM @ 20 kg/ha was applied 15 days prior to transplanting. The requirement of phosphorous and potassium were fulfilled by applying full amount of recommended dose of fertilizer through Single Super Phosphate (60 kg/ha) and Muriate of Potash (60 kg/ha) respectively as basal dressing. The recommended dose (150 kg/ha) of nitrogen was applied through Urea as per treatments. Half dose of nitrogen was given as basal dressing at the time of transplanting and second one splited into two equal doses. First top dressing given at 30 DAT and second at 45 DAT as per treatments. The seedlings were ready for transplanting within five-six weeks. Five plants were randomly selected and tagged before flowering from each line to recorded the data on the following attributes. The observations were record on plant height, Seed germination (%), Plant spread (cm^2), Plant stand, No. of non-wrapper leaves, No. of wrapper leaves, Diameter of stem (mm). Least significant difference at 5%level was used for finding the significant differences among the treatment means. The data obtained from selected plants were subjected to analysis of variance (Panse and Sukhatme 1961) [5].

Results and Discussion

The results of present investigation showed that application of nitrogen and biofertilizers significantly increased that the maximum value of growth parameters i.e the maximum seed germination percent (75.13) was recorded in 75% RDN + Azotobacter (T4) treated plot as compared to other treatments while it was remained at par with Treatment T5. Significantly lower germination per cent (64.23) was observed in control (T0) over other treatments. These results conformity with those reported by Bhardwaj *et al.* (2007) [2], Sharma (2002) [7], Singh *et al.* (2007) [8].

The maximum plant stand 23.92 was observed in Treatment T4 (75% RDN+Azotobacter). The next plant stand 22.74 was recorded from Treatment T5 (75% RDN+ Azospirillum). The significant increase in plant spread (43.88 cm) at 60 DAT recorded in Treatment T4 (75% RDN + Azotobacter). The result in respect of this character are in complete agreement by Bhagavantagoudra and Rokhade (2002) [1], Walker and Bernel (2004), Sharma and Chandra (2002) [7] for cole crops. The significant increase in plant height of cabbage 26.34 cm was recorded in Treatment T4 (75% RDN + Azotobacter) over other treatment. The results of present investigation in terms of plant height are in concordance with the findings reported by Meena and Paliwal (2003).

The conjoint use of inorganic N and biofertilizer increased the no. of non wrapper leaves as compared to other treatment while the effect of various treatment was statistically non-significant. The effect of various treatments of nitrogenous fertilizer and biofertilizer could be arranged in order of T4 > T5 > T7 > T8 > T6 >T10 >T11 >T9 >T3 >T1 >T2 >T0 and respective value were 15.26, 14.11, 14.08, 13.36, 13.27, 13.18, 12.16, 12.14, 11.29, 11.15 and 10.21. The interaction of nitrogen and biofertilizer revealed the non significant differences among treatments. However, the maximum no. of wrapper leaves in Treatment T4 (75% of RDN + Azotobacter). Were recorded 30.29 and followed by T5 (75% of RDN + Azospirillum) was 30.22. The minimum no. of wrapper leaves (24.29) were observed in Treatment T0 (control).

The significant difference in the observation recorded and Treatment T4 (75% of RDN + Azotobacter) was the best combination as it gave the stem diameter of 19.70 mm and followed by 18.16 mm which was recorded in Treatment T5 (75% of RDN + Azospirillum). The minimum diameter of stem was recorded in Treatment T0 (Control) as it was only10.87 mm in diameter. The results of present investigation in terms of stem diameter are in concordance with the findings reported by Bhardwaj *et al*. (2007) [2].

Table 1: Effect of nitrogen and biofertilizers on growth of the cabbage (Brassica oleracea var. capitata L.) var. Golden Acer

Treatment combinations	Seed germination (%)	Plant stand	Plant spread (cm^2)	Plant height (cm)	No. of non-wrapper leaves	No. of wrapper leaves	Diameter of stem (mm)
T_0	64.23	12.66	31.18	13.16	10.21	24.29	10.87
T_1	66.35	14.53	35.68	17.32	11.15	25.42	12.48
T_2	66.31	15.68	35.99	15.87	10.26	25.31	11.71
T_3	68.24	17.02	36.87	19.60	11.29	26.25	13.57
T_4	75.13	23.93	43.88	26.34	15.26	30.29	19.70
T_5	75.11	22.74	42.71	24.60	14.11	30.22	18.16
T_6	72.16	19.82	39.96	21.58	13.27	27.20	16.58
T_7	73.17	21.17	41.55	23.92	14.08	28.31	17.95
T_8	73.13	19.88	39.32	22.25	13.36	28.22	16.90
T_9	69.11	18.37	37.73	19.88	12.14	26.30	14.28
T_{10}	70.27	18.76	38.56	21.52	13.18	27.25	15.78
T_{11}	70.26	18.50	38.20	21.43	12.16	27.14	15.05
S.Em±	0.03	0.32	1.01	0.44	0.08	0.05	0.18
CD (P=0.05)	0.08	0.72	2.26	1.00	NS	NS	0.42

T0 = Control, T1= Azotobacter, T2= Azospirillum, T3= 75% of RDN + No Biofertilizer, T4=75% of RDN + Azotobacter, T5= 75% of RDN + Azospirillum, T6= 100% of RDN + No Biofertilizer, T7= 100% of RDN + Azotobacter, T8= 100% of RDN + Azospirillum, T9=125% of RDN + No Biofertilizer, T10=125% of RDN + Azotobacter T11=125% of RDN + Azospirillum

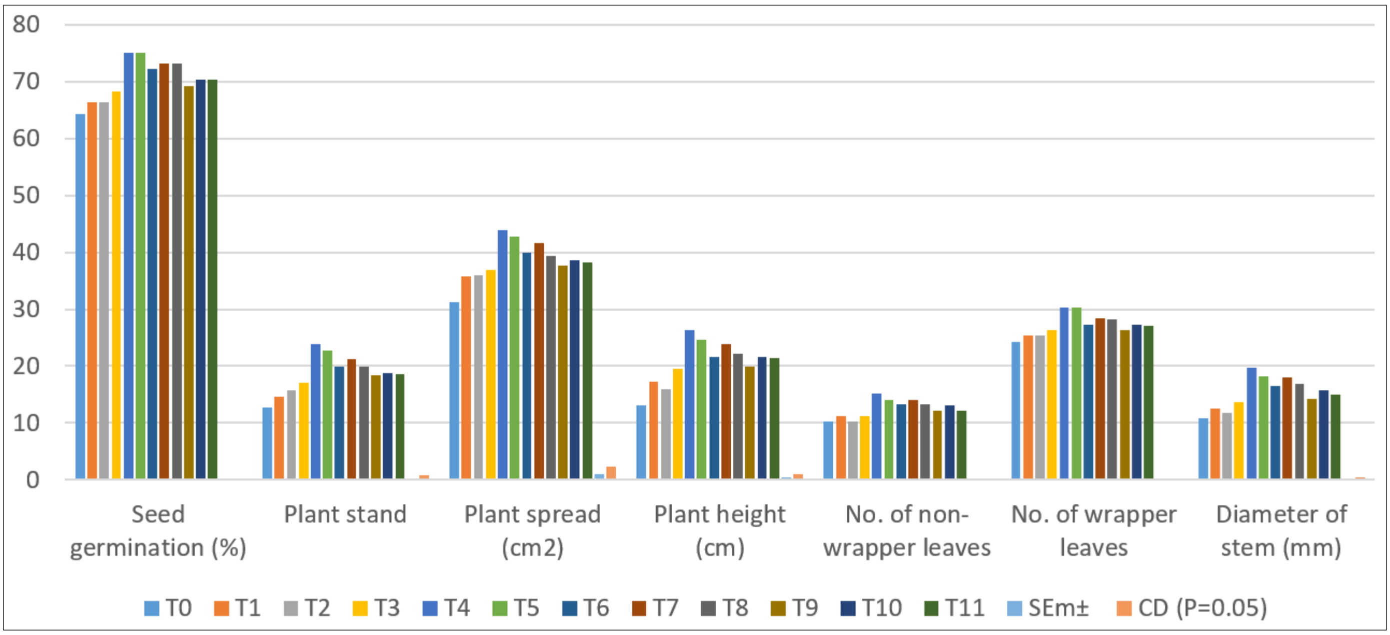

Fig 1: Effect of nitrogen and biofertilizers on growth of the cabbage (Brassica oleracea var. capitata L.) var. Golden Acer

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