Effect of Integrated Use of Nitrogen and Biofertilizer on Yield of Cabbage (*Brassica oleracea* var. *capitata* L.)

ABSTRACT

An investigation was conducted at the research farm, Department of Horticulture, Udai Pratap Autonomous College, Varanasi (U.P.) during 2018-19 to assess the effect of integrated use of nitrogen and biofertilizer on the yield of cabbage cv. Golden Acre. The experiment comprised of 12 treatments viz. T_0- Control, T_1 - *Azotobacter*, T_2 – *Azospirillum*, T_3 - 75 % RDN + No biofertilizer, T_4 - 75% of RDN + *Azotobacter*, T_5 - 75% of RDN + *Azospirillum*, T_6 - 100% of RDN + No Biofertilizer, T_7 - 100% of RDN + *Azotobacter*, T_8 - 100% of RDN + *Azospirillum* T_9 - 125% of RDN + No Biofertilizer, T_{10} - 125% of RDN + *Azotobacter*, T_{11}- 125% of RDN + *Azospirillum* were evaluated in randomized block design with three replications. The experimental findings revealed that no. of days taken to 50% head maturity (65.21), no. of days taken to 100% head maturity (73.23), the diameter of the stem (19.70 mm), head diameter (96.28 mm), gross weight per plant (1.71 kg), net weight of head per plant (1.48 kg), the yield of head per plot (7.57 kg), the yield of head per hectare (406.01 q/ha) were recorded under 75% of RDN + *Azotobacter* treated plot. Overall results indicated that conjoint use of inorganic N and biofertilizers (*Azotobacter & Azospirillum*) significantly increased the performance of cabbage as compared to chemical fertilizers alone. In this investigation, the application of 75% of RDN + *Azotobacter* reduced the 25% chemical nitrogen.

Keywords: Cabbage, *Azospirillum*, *Azotobacter*, Nitrogen, Yield.

Introduction

Cabbage (*Brassica oleracea* var. *capitata* L.) is a member of the cole family of vegetables, which comes from a single wild parent, *Brassica oleracea* L. var. *oleracea* (Syn. *sylvestris*), often known as wild cabbage, cliff cabbage, or 'Cole warts'. It possesses a high level of ability to adapt, disease and stress resistance, yield potential, and transport tolerance. The majority of cabbages have thick, alternate leaves with wavy or lobed borders. The roots of plants are fibrous and shallow. An unbranched indeterminate terminal raceme comprising four petals placed perpendicularly, six stamens, four sepals, and a superior ovary makes up the inflorescence. The commonly grown cabbage is a biennial plant with a wide range of leaf size, shape, and color, as well as head form, size, color, and texture. Cabbage is mostly a temperate zone crop; however, it is commonly grown in India's subtropical and tropical regions (Kalia *et al*., 2020). Cabbage is a vigorous feeder that removes more N, P, and K from the soil. Among the major plant nutrients, nitrogen is mobile both in soil and within the plant. Inorganic nitrogenous fertilizers are widely employed by most farmers due to the rapid availability of nitrogen. It plays a vital role as it imparts dark green color in plants, promotes leaves, stems, and other vegetable's part growth. Even if mineral nutrition has a significant impact on crop quality, but also it is undeniable that soil health also deteriorates (Savci, 2012). Biofertilizers are such forms of helpful microorganisms that may convert nutrient components from non-usable to a usable form. *Azotobacter* is a free-living, aerobic nitrogen-fixing bacteria, and its use helps to reduce the number of inorganic nitrogen fertilizers used by crops. *Azospirillum* can also boost plant development through abiotic stress tolerance mechanisms such as induced systemic tolerance, which is mediated by antioxidants, osmotic adjustment, phytohormone production, and defensive tactics such as pathogenesis-related gene expression. The research of *Azospirillum*-induced mechanisms in plants can aid in the search for more sustainable agricultural practices and may show the usage of PGPB as a major method for reducing the effects of biotic and abiotic stresses on agricultural output (Fukami *et al*.,2018). In light of these challenges, the current study was designed to look into the effects of nitrogen and biofertilizers on the growth and yield of cabbage.

Materials and Methods

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 Autonomous College, Varanasi, U.P., India during the year 2018-2019 in rabi season from October 2018 to January 2019. Varanasi is categorized under humid subtropical climate where the 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 T_0 = Control, T_1= *Azotobacter*, T_2= *Azospirillum*, T_3= 75% of RDN + No Biofertilizer, T_4=75% of RDN + *Azotobacter*, T_5= 75% of RDN + *Azospirillum*, T_6= 100% of RDN + No Biofertilizer, T_7= 100% of RDN + *Azotobacter*, T_8= 100% of RDN + *Azospirillum*, T_9=125% of RDN + No Biofertilizer, T_{10}=125% of RDN + *Azotobacter* and T_{11}=125% of RDN + *Azospirillum*.

The soil application of *Azotobacter* and *Azospirillum* @ 2 kg/ha was done in plots at the time of transplanting. A seedbed area of 300 square meters is required for raising seedlings in one hectare and incorporated with FYM @ 10 kg/sq m. The cabbage seeds were grown on a nursery bed of 3 m x 1m x 0.15 m size at a depth of 2 cm. With the goal of achieving better and faster germination, the beds were covered immediately after watering with a black polythene sheet. By soaking the soil with 0.3 percent Captan or Thiram, the seedbed was sterilized. Hand weeding was also used to keep the nursery free of weeds. Thirty days old seedlings developed from different treatments were dipped in biofertilizer solution for 15 minutes and were transplanted in the evening at a spacing of 45 cm x 45 cm on flatbeds. The FYM @ 20 kg/ha was applied 15 days prior to transplanting. The requirement of phosphorous and potassium was fulfilled by applying the 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 (150kg/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 the second one split into two equal doses. The first top dressing gave at 30 DAT and the second at 45 DAT as per treatments. The seedlings were ready for transplanting within five-six weeks. The recommended package of practices was followed during the entire crop period.

Five plants were randomly selected and tagged to record the data on the following attributes- No. of days taken to 50% head maturity, no. of days taken to 100% head maturity, head diameter (mm), gross weight of the head (kg), net weight of the head (kg), head yield (kg/plot), and yield (q/ha). The observations were recorded on 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).

Results and discussion

The results of the present investigation reveal that application of nitrogen and biofertilizers showed non-significant differences among treatment for no. of days taken to 50% head maturity. The treatment combination T_4 (75% of RDN + *Azotobacter*) took the minimum no. of days taken to 50% head maturity (65.21) followed by treatment T_5 (75% of RDN + *Azospirillum*) (65.31) and maximum no. of days taken to 50% head maturity (74.14) resulted in T_0(Control).

There are non-significant differences reported among treatments also for no. of days taken to 100 % head maturity and the treatment who took a number of days 73.23 was Treatment T_4 (75% of RDN + *Azotobacter*) and 73.18 were recorded in Treatment T_5 (75% of RDN +

Azospirillum). The maximum no. of days taken to form a marketable size head was recorded in Treatment T_0 (82.14). Higher nitrogen and nutrient intake from the root to the aerial portions, as well as enhanced photosynthesis and photosynthate transport, are likely reasons for this. These results are in close agreement with the findings of Chaubey *et al.* (2006).

The significant difference in the observation recorded and Treatment T_4 (75% of RDN + *Azotobacter*) was the best combination as it gave the head diameter of 96.28 mm followed by T_5 (75% of RDN + *Azospirillum*) recorded 93.72 mm. The minimum diameter of the head was recorded from control i.e.,71.18 mm. The biggest head diameter of cabbage might be associated with increased N availability to the plant due to the combined application of inorganic nitrogen and biofertilizer, which accelerated photosynthesis and photosynthate accumulation. This result in respect of head diameter is in complete agreement with the findings of Bhardwaj *et al.* (2007), Bashyal (2011).

Interactions of different levels of nitrogen and biofertilizer resulted in a significant influence on head weight and head yield of cabbage. There was a significant variation among treatments due to the combined application of nitrogen and biofertilizer. The highest mean value for gross weight was 1.712 kg observed in Treatment T_4 (75% of RDN + *Azotobacter*) followed by a gross weight of 1.710 kg in Treatment T_5 (75% of RDN + *Azospirillum*) which was statistically at par with T_4. The lowest gross weight 0.815 kg was recorded in control (T_0).

The plants which develop under the T_4 (75% RDN + *Azotobacter*) combination produced the highest net weight 1.486 kg and was found statistically at par with treatment T_5 i.e., 1.466 kg. Significantly lower net head weight 0.553 kg reported under control (T_0). These results are in close agreement with the findings of Sarkar *et al.* (2010).

The study of data revealed that a significantly higher yield of the head of cabbage (7.57 kg/plot) was obtained in 75% of RDN + *Azotobacter* (T_4) treated plot followed by 75% of RDN + *Azospirillum* (6.66 kg/plot) treated plot. The minimum yield of cabbage head 2.76 kg/plot was recorded in treatment T_0 (control). However, the maximum yield of 406.01 q/ha was recorded from Treatment T_4 (75% of RDN + *Azotobacter*) followed by T_5 (75% of RDN + *Azospirillum*). The minimum yield of 151.09 q/ha was recorded in treatment T_0 (control).

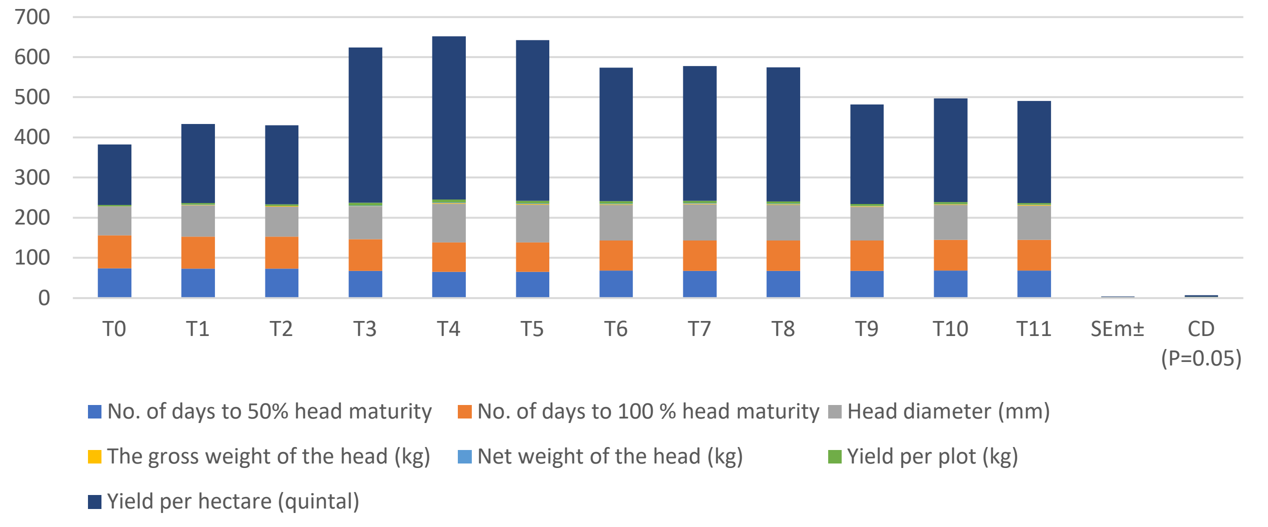
The increase in yield could be attributed to higher amounts of N fixed by the biofertilizer *Azotobacter* and made accessible to plants, as well as growth-promoting substances secreted by Azotobacter, such as IAA, GA, cytokinins, and vitamins, which may have aided in greater photosynthetic rate as well as more physiological and biological activities, which increased the movement of photosynthates from source to sink. The result in respect of head weight and head yield is in complete agreement with the findings of Sarkar *et al.* (2010), Manivannan *et al.* (2004), Bhardwaj *et al.* (2007).

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

Treatment combinations	No. of days to 50% head maturity	No. of days to 100 % head maturity	Head diameter (mm)	The gross weight of the head (kg)	Net weight of the head (kg)	Yield per plot (kg)	Yield per hectare (quintal)
T_0	74.14	82.14	71.18	0.815	0.553	2.76	151.09
T_1	72.66	80.23	77.76	1.142	0.726	3.63	197.43
T_2	72.70	80.19	74.89	1.112	0.722	3.61	197.26
T_3	67.45	79.22	80.69	1.241	1.416	7.05	386.88
T_4	65.21	73.23	96.28	1.712	1.486	7.57	406.01
T_5	65.31	73.18	93.72	1.710	1.466	6.66	400.54
T_6	68.18	75.18	88.67	1.545	1.219	6.09	333.06
T_7	67.52	75.27	90.60	1.632	1.230	5.48	336.06
T_8	67.78	75.22	88.71	1.625	1.222	6.11	333.87
T_9	67.15	76.25	83.84	1.426	0.907	4.53	247.81
T_{10}	68.23	76.29	87.20	1.435	0.945	4.72	258.19
T_{11}	68.37	76.22	85.25	1.420	0.929	4.64	253.82
SEm±	0.62	0.38	0.91	0.005	0.01	0.463	1.51
CD (P=0.05)	NS	NS	2.03	0.011	0.02	1.033	3.37

T_0 = Control, T_1= *Azotobacter*, T_2= *Azospirillum*, T_3= 75% of RDN + No Biofertilizer, T_4=75% of RDN + *Azotobacter*, T_5= 75% of RDN + *Azospirillum*, T_6= 100% of RDN + No Biofertilizer, T_7= 100% of RDN + *Azotobacter*, T_8= 100% of RDN + *Azospirillum*, T_9=125% of RDN + No Biofertilizer, T_{10}=125% of RDN + *Azotobacter* T_{11}=125% of RDN + *Azospirillum*, NS= non-significant

Fig 1. Effect of nitrogen and biofertilizers on yield of the cabbage (*Brassica oleracea* var. *capitata* L.) var. Golden Acre



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