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

ABSTRACT

An investigation was conducted at 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 growth 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 number of days taken to 50% head maturity (65.21), number of days taken to 100% head maturity (73.23), diameter of 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), yield of head per plot (7.57 kg), 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, application of 75% of RDN + *Azotobacter* reduced the 25% chemical nitrogen.

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

1. 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 colour, as well as head form, size, colour, and texture. Cabbage is mostly a temperate zone crop; however, it is commonly grown in India's subtropical and tropical regions[1].. 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 fertilisers are widely employed by most farmers due to the rapid availability of nitrogen. It plays a vital role as it imparts dark green colour in plants, promotes leaves, stem 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 [2]. Biofertilizers are such forms of helpful microorganisms that may convert nutrient components from non-usable to usable form. *Azotobacter* is a free-living, aerobic nitrogen-fixing bacteria, and its use helps to reduce the quantity of inorganic nitrogen fertilisers 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 **[3].** In light of these challenges, the current study was designed to look into the effects of nitrogen and biofertilizers on yield of cabbage.

2. MATERIALS AND METHODS

2.1 Location of Experimental Site

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 situated between 25.3176° N latitude, 82.9739° E longitudes covering an area of 112.1 km^2. The altitude of Varanasi is 80.71 m above mean sea level. It is categorized under humid subtropical climate where average annual rainfall received is 1,110 mm or 44 inches. The soil was sandy loam in texture (62.54% sand, 21.36% silt, and 17.87% clay) and slightly alkaline in reaction with moderate fertility status. The available nitrogen (219.24 kg/ha), phosphorous (23.17 kg/ha) and potassium (234.41 kg/ha) was found in soil after analysis.

2.2 Experimental Design

Twelve treatments were arranged in Randomized Block Design 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* with three replications. A seedbed area of 300 square metres is required for raising seedlings in one hectare and incorporated with FYM @ 10 kg/sq m. The seeds were sown on 19 September, 2018 after treating with *Azotobacter* & *Azospirillum* @ 200 g/10 kg of seed as per treatments at a depth of 2 cm on nursery bed of 3m x 1m x 0.15 m. 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 sterilised. Hand weeding was also used to keep the nursery free of weeds. Thirty days old healthy and sturdy seedlings were selected and transplanted after dipping in biofertilizer solutions for 15 minutes in evening at 45 cm x 45 cm spacing on flat beds of 1.52 m x 1.21 m and soil application of *Azotobacter* and *Azospirillum* @ 2 kg/ha was also done in the plots at the time of transplanting. 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 (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 second one splited into two equal doses. First top dressing given at 30 DAT and second at 45 DAT as per treatments. The recommended package of practices was followed to during entire crop period.

2.3 Observational Procedure

Five plants were randomly selected in each plot and tagged to record the data on the following yield attributes- Number of days taken to 50% head maturity, number of days taken to 100% head maturity, head diameter (mm), gross weight of head (kg), net weight of head (kg), head yield (kg/plot), and yield (q/ha).

2.4 Statistical Analysis

To test the significance of variation for the data recorded from growth and yield attributes, the analysis of variance [4].(R. A. Fisher, 1950) was computed for Randomized Block Design. Significance of difference within the treatment was tested through ‘F’ test at 5 per cent and 1 per cent level of significance and critical difference was calculated wherever the result found significant.

3. RESULTS AND DISCUSSIONS

3.1 Effect of Integrated Use of Nitrogen and Biofertilizers on Number of Days Taken to 50% Maturity

The results of present investigation reveal that application of nitrogen and biofertilizers showed non-significant differences among treatment for number of days taken to 50% head maturity. The treatment combination T_4 (75% of RDN + *Azotobacter*) took the minimum number of days taken to 50% head maturity (65.21) followed by treatment T_5 (75% of RDN + *Azospirillum*) (65.31) and maximum number of days taken to 50% head maturity (74.14) resulted in T_0(Control).

3.2 Effect of Integrated Use of Nitrogen and Biofertilizers on Number of Days Tken to 100% Maturity

There are non-significant differences reported among treatments also for number of days taken to 100 % head maturity and the treatment who took minimum 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 number of days taken to form 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.* [5].

3.3 Effect of Integrated Use of Nitrogen and Biofertilizers on Head Diameter (mm)

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 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.* [6]), Bashyal [7].

3.4 Effect of Integrated Use of Nitrogen and Biofertilizers on Gross Weight of Head

Interactions of different levels of nitrogen and biofertilizer resulted significant influence on head weight and head yield of cabbage. There was a significant variation among treatments due to combined application of nitrogen and biofertilizer. The highest mean value for gross weight were 1.712 kg observed in Treatment T_4 (75% of RDN + *Azotobacter*) followed by 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).

3.5 Effect of Integrated Use of Nitrogen and Biofertilizers on Net Weight of Head

The plants which develop under T_4 (75% RDN + *Azotobacter*) combination produced the highest net weight 1.486 kg and 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.* [8].

3.6 Effect of Integrated Use of Nitrogen and Biofertilizers on Head Yield (kg/plot and q/ha)

The study of data revealed that significantly higher yield of head of cabbage (7.57 kg/plot) 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 406.01 q/ha recorded from Treatment T_4 (75% of RDN + *Azotobacter*) followed by T_5 (75% of RDN + *Azospirillum*). The minimum yield 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.*[8], Manivannan *et al.*[9], Bhardwaj *et al.* [6].

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

Treatment combinations	Number of days to 50% head maturity	Number of days to 100 % head maturity	Head diameter (mm)	Gross weight of head (kg)	Net weight of 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.

4. CONCLUSION

On the basis of the results obtained it is concluded that the application of nitrogen and biofertilizers had significant effect on yield of cabbage as compared to control. The results revealed that 75% recommended dose of nitrogen + *Azotobacter* (T_4) was found most effective in the increasing number of days taken to 50% head maturity, number of days taken to 100% head maturity, diameter of stem, head diameter, gross weight per plant, net weight of head per plant, yield of head per plot, yield of head per hectare. The treatment 75% RDN + *Azospirillum* and 100% RDN + *Azotobacter* was at par with 75% RDN + *Azotobacter*. Overall results reveal that conjoint use of inorganic nitrogen and biofertilizer significantly enhanced the crop productivity as well as application of biofertilizer substitute the 25 per cent inorganic nitrogen.

5. ACKNOWLEDGEMENTS

I am highly grateful to Dr. Diwaker Singh, for his supervision, sagacious guidance, constructive criticism and affectionate behaviour during course of this investigation. I am highly indebted to Dr. Sanjay Kumar Shahi, Associate Professor, Department of Agricultural Chemistry and Soil Science, Dr. Manish Mishra Department of Agriculture Statistics, Faculty of Agriculture, Udai Pratap Autonomous College, Varanasi for giving encouragement and help at different levels during the period of study and preparation of the manuscript. I also wish to convey thanks to my classmates Mr. Sapan Kumar Maurya, and Mr. Sanjay Kumar,

and my senior Mr. Shatrunjay Yadav, Research Scholar, Department of Horticulture, School of Agricultural Sciences and Technology, BBAU, Lucknow for their painstaking effort, selfless devotion, moral support, and providing helping hand throughout the course of investigation.

REFERENCES

7. Bashyal L N. Response of cauliflower (*Brassica oleracea* var. *botrytis* L.) to nitrogen fixing biofertilizers and graded levels of nitrogen. Journal of Agriculture and Environment. 2011; 12: 41-50

6. Bhardwaj, A. K., Kumar, P. and Singh R. K. (2007). Response of nitrogen and pre-planting treatment of seedling with the *Azotobacter* on growth and productivity of broccoli (*Brassica oleracea* var. *italica* L.). *Asian Journal of Horticulture*; 2*(1)*: 15-17

5. Chaubey, T., Srivastava B. K., Singh, M., Chaubey, P. K. and Rai. M. (2006). Influence of fertility levels and seasons on maturity and morphological traits of cabbage, *Vegetable Science*; 33*(1)*: 29- 33

3.Fukami, J., Cerezini, P. & Hungria, M. (2018). *Azospirillum*: benefits that go far beyond biological nitrogen fixation. *AMB Express*; **8:** 73

Hari Har Ram (2012). Vegetable Breeding: Principles and Practices. Kalyani Publishers, Ludhiana-141 008

Jha, M. K., Urraiya, P., Bharti, J. and Sahu, M. R. (2017). Effect of organic, inorganic & biofertilizers on growth attributes of cabbage (*Brassica oleracea* var. *capitata*). Under C.G. Plain zone. *Journal of Pharmacognosy and Phytochemistry*; 6*(6)*: 2298-2300

1. Kalia, P., and Singh, S. (2020). Division of Vegetable Science, ICAR- Indian Agricultural Research Institute, New Delhi. © Springer Nature Switzerland AG

9. Manivannam, M. I. and Singh J. P. (2004). Effect of Biofertilizers on the growth and yield of sprouting broccoli (*Brassica oleracea* var. *capitata* Plenk) under Allahabad agrocimatic conditions, *Bioved*; 15*(1/2)*: 33-6

8.Sarkar, A., Mandal, A. R., Prasad, P.H. and Maity, T. K. (2010). Influence of nitrogen and biofertilizer on growth and yield of cabbage. *Journal of Crop and Weed* 6*(2)*72-73

2.Savci, S. (2012). An agricultural pollution: chemical fertilizer, *International Journal of Environmental Science and Development*; 3*(1)*: 77-80.

Sreekanth, K., Cheena, J., Laxminarayana, D. and Kumar, S. P. (2022). Studies on effect of organic and inorganic fertilizers on growth, yield attributes of cabbage (*Brassica oleracea* L. var. *capitata*). *The Pharma Innovation Journal*; 11*(2)*: 2065-2069

4. R. A. Fisher, 1950…….?