



## Effect of different levels of nitrogen and microbial inoculants on yield and quality of cabbage (*Brassica oleracea* var *capitata*) cv Pride of India

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### ABSTRACT

The present investigation was carried out at Bihar Agricultural University, Sabour during *rabi* season of 2010-11 in Factorial Randomized Block Design (RBD) for yield and quality contributing characters. The microbial inoculant (*Azospirillum*) significantly reduced the number of days taken to head initiation (54.74 days). The plants developed under nitrogen level of 150 kg N/ha along with microbial inoculant *Azospirillum* significantly produced the highest average head weight (1.653 kg) per plant. The highest head yield (527.09 q/ha) was obtained with the use of microbial inoculant *Azospirillum* and proved its superiority over *Azotobacter*. For quality components the lowest moisture content in head (80.00%) was associated with nitrogen level of 200 kg N/ha + *Azospirillum*. Moreover, the highest dry weight per head (117.62 g) was associated with nitrogen level of 150 kg N/ha. The plants grown at nitrogen level of N<sub>0</sub> (0 kg N/ha) produced significantly maximum ascorbic acid in head (86.46 mg/100 g). Therefore, it may be concluded that application of microbial inoculants basically *Azospirillum* as seedling treatment as well as soil application of nitrogen @ 150 kg/ha was the most effective treatment combination for higher yield and quality in cabbage.

**Key words:** *Azotobacter*, *Azospirillum*, Cabbage, Nitrogen, Yield, Quality

Among the cole crops, cabbage is one of the most important commercial vegetable crops in India. It is widely grown all over India and abroad for its high nutritive values, high productivity and wider adaptability. It can withstand rough handlings as well as long distance transport and thus fetch better return. A rich source of minerals, vitamins and roughages. In India, cabbage is cultivated in an area of 0.39 Mha with production of 8.41 MT whereas productivity of the crop is 21.6 MT/ ha (Anonymous 2013). However, the national productivity of cabbage is far below the global average productivity (Sachdeva *et al.* 2013).

Consistent and indiscriminate use of chemical fertilizers had caused serious damage to the soil and ecology. Soil micro-organisms play a significant role in regulating the dynamics of organic matter decomposition and the

availability of plants nutrients. It is well recognized that microbial inoculants constitute an important component of Integrated Nutrient Management (INM). In addition, microbial inoculants can be used as an input to increase crop productivity, fertilizer doses can be lowered and more nutrients can be harvested from the soil. It is important to provide enough vegetables, for balanced diet but also to produce quality vegetables that are acceptable and competitive in international market. In addition to nutrient mining, the increasing dependence on imports of inorganic fertilizers at very high international prices underlining the need to explore and exploit the potential of alternative sources of plant nutrients of late biofertilizers have shown a good promise and has emerged as an important component of Integrated Plant Nutrition System (IPNS). Use of biofertilizers is needed as an alternative source to bring forth the eco-friendly methods of farming. The concept of sustainable agriculture envisages primary emphasis on manipulation and management of biological systems not only to maximize yield but also to stabilize the agro-systems and to minimize industrial input demands. In a country like India a large majority of the farmers are poor and have small holdings, the use of biofertilizers in combination with chemical fertilizers offers a great opportunity to increase the crop production at less cost.

Biofertilizers are the carrier based preparations containing beneficial microorganisms in viable state intended for seed or soil application. These microbes help to fix

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atmospheric nitrogen, solubilize and mobilize phosphorus, translocate minor elements like zinc, copper, etc to the plants, produce plant growth promoting hormones, vitamins and amino acids and control plant pathogenic fungi, thus helping to improve the soil health and increase crop production. *Rhizobium*, *Azotobacter*, *Acetobacter*, and *Herbaspirillum* isolates can excrete and synthesize gibberellins, auxin, and cytokinins (Bastian *et al.* 1998). Earlier studies showed that plant growth-promoting rhizobacteria (PGPR) could stimulate the growth and yield of cabbage (Turan *et al.* 2014).

The extent of benefit from these microorganisms depends on their number and efficiency which, however, is governed by a large number of soil and environmental factors. When the number and activity of specific microorganism is sub-optimal, artificially multiplied biofertilizers are used to hasten the biological activity to improve availability of plant nutrient. Thus, it makes imperative to make a concerted efforts to bridge the gap between potential yield and actual yield harvested by the farmers to make cabbage cultivation more remunerative through the better management of inputs like nutrients management practices and microbial inoculants for better exploitation of yield potentialities.

Therefore, this study was carried out to investigate the effect of different levels of nitrogen and microbial inoculants on yield and quality of cabbage.

#### MATERIALS AND METHODS

The present investigation was carried out at the Department of Horticulture (Vegetable & Floriculture), Bihar Agricultural University, Sabour, Vegetable Research Farm during *rabi* season of 2010-11. The design of experiment was RBD (Factorial), replicated thrice and most popular cabbage variety was used, i.e. Pride of India for this region. Microbial inoculants were used as seedling inoculation and seedlings were transplanted at the spacing of 45 × 45 cm.

Initial and composite post-harvest surface (0.15 cm) soil samples from the experimental plot were collected and dried and pulverized to pass through 2 mm sieve. All the samples were mixed to form a composite sample and brought to the laboratory for chemical analysis. The available nitrogen of soil was 279 kg/ha, phosphorus 52 kg/ha and potassium 352 kg/ha. The soil was alkali in nature (pH 7.31) with organic carbon of 0.42%.

The treatments comprised of three microbial inoculants ( $M_0$ -0,  $M_1$ -*Azospirillum* and  $M_2$ -*Azotobacter*) and five levels of nitrogen ( $N_0$ - 0 (control),  $N_1$ -50 kg/ha,  $N_2$ -100 kg/ha,  $N_3$ -150 kg/ha,  $N_4$ -200 kg/ha).

The climate of this place is tropical to subtropical of slightly semi-arid in nature and is characterized by very dry summer, moderate rainfall and very cold winter (Fig 1). December and January are usually the coldest months where the mean temperature normally falls as low as 8.2°C, whereas May and June are the hottest months, having the maximum average temperature of 29.6°C. The major rainfall precipitates generally between June to October (Fig 2).

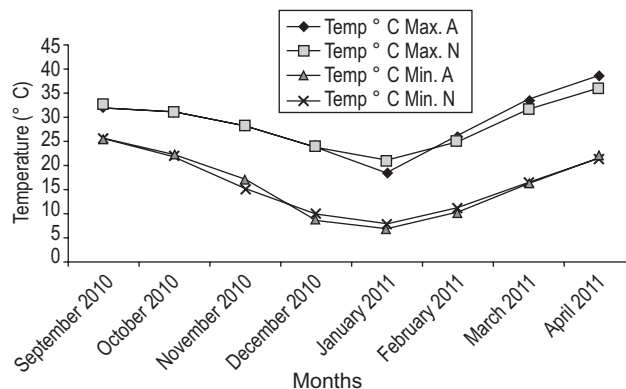


Fig 1 Temperature (°C) during the experimental period

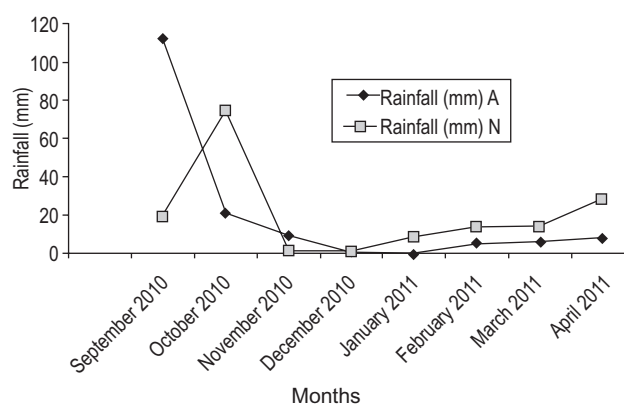


Fig 2 Rainfall during the experimental period

Five plants in each treatment combination and in each replication were randomly selected and tagged properly. Tagged plants were used for recording various observations. The observations recorded for the aforesaid five plants were worked out to give means in respect of all the parameters, which were utilized in statistical analysis for the three yield characters, viz. number of days taken to head initiation, diameter of head (cm), weight of head (kg), yield/plot (kg), yield (q/ha) and three quality characters, viz. moisture content in head (%), dry matter content in head (g), ascorbic acid (mg/100 of juice). Ascorbic acid was determined by titration method, using 2, 6 dichloroindophenol solution (AOAC 1990).

The statistical analysis was carried out by the method of "Analysis of the variance prescribed by Fisher and Yates (1963)". Comparison of the treatments was made with the help of critical differences (CD).

#### RESULTS AND DISCUSSION

##### Yield contributing traits

The microbial inoculant (Table 1)  $M_1$  (*Azospirillum*) significantly reduced the number of days taken to head initiation (54.74 days) which was at par with  $M_2$  (*Azotobacter*). The maximum number of days taken to head initiation was noted in treatment without microbial inoculant ( $M_0$ ). The microbial inoculants might have accelerated to complete the vegetative growth earlier due to certain growth

Table 1 Effects of different levels of nitrogen and microbial inoculants on yield contributing traits in cabbage cv. Pride of India

Levels of nitrogen	Number days taken to head initiation after transplanting				Average head weight (kg)				Head yield (q/ha)			
	Microbial inoculants				Microbial inoculants				Microbial inoculants			
	M <sub>0</sub> -0	M <sub>1</sub> - <i>Azos-pirillum</i>	M <sub>2</sub> - <i>Azo-tobacter</i>	Mean	M <sub>0</sub> -0	M <sub>1</sub> - <i>Azos-pirillum</i>	M <sub>2</sub> - <i>Azo-tobacter</i>	Mean	M <sub>0</sub> -0	M <sub>1</sub> - <i>Azos-pirillum</i>	M <sub>2</sub> - <i>Azo-tobacter</i>	Mean
N <sub>0</sub> -0 kg/ha (control)	66.70	58.90	59.10	61.57	0.713	0.811	0.779	0.768	203.95	252.59	236.67	231.07
N <sub>1</sub> -50 kg/ha	62.50	56.20	58.30	59.00	1.010	1.268	1.206	1.161	350.74	478.03	447.53	425.43
N <sub>2</sub> -100 kg/ha	60.40	54.90	55.10	56.80	1.228	1.483	1.473	1.395	458.15	584.45	579.26	540.62
N <sub>3</sub> -150 kg/ha	55.10	52.80	54.00	53.97	1.489	1.653	1.554	1.565	587.41	668.27	624.20	626.63
N <sub>4</sub> -200 kg/ha	52.00	50.90	53.10	52.00	1.534	1.620	1.520	1.558	609.26	652.10	602.47	621.28
Mean	59.34	54.74	55.92		1.195	1.367	1.306		441.90	527.09	498.03	
CD (P=0.05)	Microbial inoculants (M)			2.16				0.049				22.50
	Nitrogen (N)			2.79				0.063				29.05
	M × N			NS				0.109				50.32

promoting substances secreted by the microbial inoculants, which in turn, might have to be better root development, better transportation of water, uptake and deposition of nutrients. The plants getting the highest dose of nitrogen, i.e. N<sub>4</sub> were reached first to head initiation (52.00 days) which showed statistical equality with N<sub>3</sub>. The lowest level of nitrogen, i.e. N<sub>0</sub> (0 kg N/ha) significantly delayed to head initiation (61.57 days) which was at par with nitrogen level of N<sub>1</sub>. The interaction effect of microbial inoculants and levels of nitrogen was found to be non-significant. The probable reasons for earlier heading is due to higher uptake of nitrogen and increased nutrients transport from root to the aerial parts and increased rate of photosynthesis and transport of photosynthates. These results are in close agreement with the findings of Chaubey *et al.* (2006).

The plants developed under nitrogen level of N<sub>3</sub> along with microbial inoculants M<sub>1</sub>, i.e. M<sub>1</sub>N<sub>3</sub> (Table 1) significantly produced the highest average head weight (1.653 kg) which was statistically comparable to treatment combinations of M<sub>1</sub>N<sub>4</sub> and M<sub>2</sub>N<sub>3</sub>. The nitrogen level of N<sub>0</sub> without microbial inoculant (M<sub>0</sub>), i.e. M<sub>0</sub>N<sub>0</sub> gave the lowest head weight (0.713 kg). The head weight of cabbage was markedly influenced by application of microbial inoculants. The maximum head was recorded with the use of microbial inoculants M<sub>1</sub> which was significantly superior to *Azotobacter*. It is a well known fact that *Azospirillum* has definite role in cell division, cell enlargement, cell elongation and physiological activities. These physiological activities give beneficial response on uptake of water and nutrients development of cambial growth, respiration, co-enzyme activity, utilization of ATP, formation of RNA and cell permeability, due to these activities application of *Azospirillum* had induced effect on weight of head. The result in respect of head weight of cabbage is in complete agreement with the findings of Manivannan and Singh (2004). Moreover, higher dose of nitrogen probably has resulted in the production of larger number of leaves and increased leaf area, which ultimately contributed towards the manufacture of more carbohydrates, consequently more

weight of head. The findings pertaining to head weight are in close agreement with those reported by Bhardwaj *et al.* (2007).

The highest head yield (527.09 q/ha) was obtained with the use of microbial inoculant (Table 1) M<sub>1</sub> and proved its superiority over M<sub>2</sub>. The lowest head yield (441.90 q/ha) was recorded in plants developed under without microbial inoculant (M<sub>0</sub>). The improvement in yield might be due to higher amount of nitrogen fixed in soil by *Azospirillum* and made available to plants, and growth promoting substances like IAA, GA, cytokinins and vitamins secreted by *Azospirillum* which have beneficial effects on crop growth. Better crop due to all these factors, which might have helped in increasing photosynthetic rate and more physiological and biochemical activities which in turn, perhaps increased the movement of photosynthates from source to sink. Thus, finally resulted in increasing the yield and yield components. Significant increase in head yield has also been reported by Bhardwaj *et al.* (2007).

#### Quality contributing traits

The microbial inoculants exhibited significant variation on moisture content in head (%). Different microbial inoculants failed to bring about significant variation in moisture percentage in head (Table 2). Though, moisture percentage in head ranged between 80.00 to 98.70%. The lowest moisture content in head (80.00%) was associated with treatment combination of N<sub>4</sub>M<sub>1</sub>. However, maximum moisture content in head was observed in N<sub>0</sub>M<sub>0</sub> (98.70%).

The highest dry weight of head (117.62 g) was associated with nitrogen level of N<sub>3</sub> which was statistically similar to N<sub>4</sub> (Table 2). The lowest dry weight/head (84.30 g) was registered at nitrogen level of N<sub>0</sub>. The application of microbial inoculant M<sub>1</sub> helped to bear maximum dry weight of head per plant which was at par with *Azotobacter*. This may be due to the fact that microbial inoculants have ability to produce some growth promoting substances which might have led to better accumulation of food materials in head. These findings get support from the results obtained by

Table 2 Effects of different levels of nitrogen and microbial inoculants on quality contributing traits in cabbage cv. Pride of India

Levels of nitrogen	Moisture content in head (%)				Dry matter content in head (g)				Ascorbic acid content in head (mg/100g)			
	Microbial inoculants				Microbial inoculants				Microbial inoculants			
	M <sub>0</sub> -0	M <sub>1</sub> -Azos- pirillum	M <sub>2</sub> -Azo- tobacter	Mean	M <sub>0</sub> -0	M <sub>1</sub> -Azos- pirillum	M <sub>2</sub> -Azo- tobacter	Mean	M <sub>0</sub> -0	M <sub>1</sub> -Azos- pirillum	M <sub>2</sub> -Azo- tobacter	Mean
N <sub>0</sub> -0 kg/ha	98.70	90.70	91.90	93.50	79.14	88.07	85.69	84.30	87.14	85.56	86.67	86.46
N <sub>1</sub> -50 kg/ha	94.50	87.50	89.20	90.40	98.47	112.85	111.43	107.58	84.75	83.68	84.06	84.16
N <sub>2</sub> -100 kg/ha	91.10	85.90	86.30	87.77	105.36	116.56	118.14	113.35	82.15	80.56	81.62	81.44
N <sub>3</sub> -150 kg/ha	88.60	81.60	84.50	84.90	117.18	118.52	117.61	117.62	79.48	77.65	78.86	78.66
N <sub>4</sub> -200 kg/ha	81.90	80.00	82.40	81.43	112.90	114.05	109.90	112.28	75.31	76.07	76.22	75.87
Mean	90.96	85.14	86.70		102.61	110.01	108.46		81.77	80.70	81.49	
CD (P=0.05)	Microbial inoculants (M)			4.85				4.73				NS
	Nitrogen (N)			6.97				6.11				4.64
	M × N			NS				NS				NS

Chaudhary and Choudhary (2005).

Application of microbial inoculants caused non-significant effect on ascorbic acid content in head (Table 2). The plants grown at nitrogen level of N<sub>0</sub> produced significantly maximum ascorbic acid in head (86.46 mg/100 g) which was at par with N<sub>1</sub>. The lowest ascorbic acid (75.87 mg/100g) was recorded at the highest level of N<sub>4</sub>. The interaction effect of microbial inoculants and different dosages of nitrogen was found non-significant. These results are in accordance with the findings of Sable and Bharmare (2007).

On the basis of results and discussion made so far, it may be concluded that application of microbial inoculants basically *Azospirillum* as seedling treatment as well as soil application of nitrogen @ 150 kg/ha was the most effective treatment combination for higher yield and quality improvement in cabbage cultivation. Hence, the use and management of natural resources in sustainable agriculture, the microbial fertilizers hold vast potential for future.

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