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Influence of N, P, K and biofertilizers on growth and yield attributes of Cabbage (*Brassica oleracea* var. capitata L.)

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Abstract
The present experiment was conducted during the *Rabi* season of the year 2020-2021 at Instructional cum Research Farm at S.G. College of Agriculture and Research Station, Jagdalpur (C.G.) to study the influence of N, P, K and biofertilizers on growth and yield attributes of Cabbage (*Brassica oleracea* var. capitata L.) consisting of seventeen treatments and replicated thrice in RBD. The results revealed the maximum T.S.S. (7.54), leaf length (25.23), plant spread (48.07), net weight (1.84) and yield ha^{-1} (381.60 q) was recorded with the application of 75% RDF + *Azotobacter* + PSB + KSB. The application of 75% RDF + PSB + KSB recorded the maximum stem diameter (26.04 mm) while the highest chlorophyll index (48.53) was recorded in 75% RDF + KSB.

Keywords: Cabbage, biofertilizers, *Azotobacter*, PSB, KSB

Introduction

Cabbage (*Brassica oleracea* var. capitata L.) is one of the most important members of Genus *Brassica*. The word “Cabbage” is derived from the French word “Coboche” means head. It is a popular vegetable around the world in respect of area, production and availability, almost round the year. It has been originated from a single wild ancestor *Brassica oleracea* L. var. oleracea (Syn. sylvestris) commonly known as wild cabbage, Cliff cabbage or ‘Colewart’, through mutation and introgression from wild species, human selection and adaptation. It occupies the prime position among the Cole crops due to its pleasant taste, delicious flavour, nutritive value and very low fat and calories content. It is grown for heads which are used as vegetable, eaten raw and frequently preserved as sauerkraut or pickle. Cabbage is an excellent source of vitamin C, potassium and calcium (Hasan and Solaiman, 2012) [1]. It has cooling effect and helps in preventing constipation, increase appetite, speed up digestion and very useful for the patients of diabetes (Yadav *et al*., 2000) [10]

Bio-fertilizers are agriculturally beneficial microorganisms, which have the ability to mobilize the nutritionally important elements from non-usable form to usable form through biological processes. (Kumar *et al*., 2001) [2]. Biofertilizers can serve as alternative to mineral fertilizers for improving soil structure and microbial biomass for sustainable increased production. *Azotobacter* and Phosphorus Solubilizing Bacteria (PSB) are the biofertilizers which nourish the crops and soil by liberating the growth promoting substances and vitamins. Azotobacter fixes atmospheric nitrogen in the root zone of the plants whereas PSB solubilises insoluble fixed phosphates and KSB solubilises insoluble fixed potassium already present in the soils.

Material and Methods

The present study was laid out in Randomized Block Design with seventeen treatments which were replicated thrice during the *Rabi* season of 2020-2021 at Instructional cum Research Farm at S.G. College of Agriculture and Research Station, Jagdalpur (C.G.). The treatments consisted viz., 75% RDF + *Azotobacter* (T1),75% RDF + PSB (T2), 75% RDF + KSB (T3), 75% RDF + *Azotobacter*+ PSB (T4), 75% RDF + *Azotobacter* + KSB (T5), 75% RDF + PSB + KSB (T6), 75% RDF + *Azotobacter* + PSB + KSB (T7), 50% RDF + *Azotobacter* (T8), 50% RDF + PSB (T9), 50% RDF + KSB (T10), 50% RDF + *Azotobacter* + PSB (T11), 50% RDF + *Azotobacter* +KSB (T12), 50% RDF + PSB + KSB (T13), 50% RDF + *Azotobacter* + PSB + KSB (T14), *Azotobacter* + PSB + KSB (T15), 100% RDF (T16) and Control (T17).

The region has a sub-tropical monsoon climate with three distinct seasons i.e. summer, monsoon and winter. The southwest monsoon starts from June and continues till middle of September, winter season spreads from October to February whereas; summer season extends from March to middle of June. Rainfall is the major source of ground water recharge in the area and receives maximum (85%) rainfall during the southwest monsoon season. The winter rainfall is meagre (10 -15%). The land of the experimental site was irrigated prior to sowing for optimum moisture level. Seedlings were transplanted at a spacing of 60 x 45 cm. The recommended package and practice methods were followed during the experiment to maintain a healthy population of crop. The results of various observations recorded during the experiment were statistically analyzed in order to find out the significance of different treatments.

Result

The perusal of data revealed that fertilizers (N, P and K) along with biofertilizers alone or in combination were found to have significant effect on the growth, yield and qualitative characters of cabbage as compared to control (Table 1). The average leaf length at successive stages of growth in cabbage responded significantly by the different treatments. The leaf length ranged from 13.20 to 15.47 cm and 18.10 to 23.40 cm with a mean of 14.71 and 21.24 cm at 30 and 45 DAT respectively. The maximum leaf length (25.23) was recorded in the treatment T6 (75% RDF + PSB + KSB) at 60 DAT. The leaf length significantly increased by the different doses of N, P, K and biofertilizers and was the maximum (26.43 cm) in treatment T6 (75% RDF + PSB + KSB) which was closely followed by the treatment T7 (75% RDF + *Azotobacter* + PSB + KSB) having a length of 25.37 cm. However; the minimum leaf length (13.20, 18.10, 20.40 and 22.97 cm respectively) at all the growth stages was observed in T17 (control). According to Negi *et al.* (2017) [6] and Powar & Barkule (2017) [7] the higher vegetative growth of plant might be due to better growth and elongation of leaves in case of microbe's application.

The plant spread at successive stages of growth in cabbage responded significantly by the different treatments at 30, 45 and 60 DAT and at harvest. The maximum plant spread (48.07) was observed with 75% RDF + *Azotobacter* + PSB + KSB which was at par with all the other treatments except 75% RDF + PSB, 50% RDF + *Azotobacter* + PSB + KSB and control recording 46.20, 42.40 and 40.93 cm^2 respectively. This might be due to significantly increased growth contributing characters like leaf area and leaf width which tend to produce more chlorophyll content and further helps to increase in growth and yield. More leaf area in plots which was applied with PSB might be due to fact that it increases the availability of phosphorus present in soil and also due to efficient up take of plant nutrients nitrogen and during later stages of plant growth. These results are in close conformity with the findings of Singh *et al.* (2009) [9] and Yadav *et al.* (2012) [11]. The stem diameter was the maximum (26.04 mm) with 75% RDF + PSB + KSB which was at par (24.43 mm) with 75% RDF + *Azotobacter* + PSB.

75% RDF + *Azotobacter*+ PSB +KSB recorded the maximum (381.60 q) yield ha^{-1} followed by 75% RDF + PSB + KSB and 50% RDF + *Azotobacter* + PSB + KSB with 359.51 and 334.05 q ha^{-1}.The treatment T7 (75% RDF + *Azotobacter* + PSB + KSB) recorded the maximum net weight (1.84) of cabbage head and was followed by 75% RDF + PSB + KSB and 50% RDF + *Azotobacter* + PSB + KSB with 1.64 and 1.61 kg. However, T17 (control) recorded the minimum (1.03 kg) net weight of head $plant^{-1}$ at harvest. According to Kumar *et al.* (2017) [3, 4] and Narayan *et al.* (2018) [5] this might be due to different increasing nitrogen levels favoured the large uptake of nutrients and effective utilization of utilized nutrients for increased metabolism and synthesis of carbohydrates, greater vegetative growth and subsequent partitioning and translocation from leaf (source) to the head (sink) and also release of energy rich organic compounds by biofertilizers which might have been increased auxin activities, growth and activity of microbial saprophytes and phosphates activity which ultimately influenced the yield and yield attributes.

Application of 75% RDF + *Azotobacter* + PSB + KSB recorded the maximum T.S.S. (7.54) which was at par (7.38 and 7.31 respectively) with 75% RDF + *Azotobacter* + PSB and 75% RDF + PSB + KSB. According to Shivran *et al.* (2017) [8] and Kumar *et al.* (2017) [3, 4] the increase in TSS index might be due to the application of biofertilizers that attributed to greater movement and availability of essential nutrients. This might have accelerated the breakdown of complex polysaccharides into simple sugars and directs their accumulation in developing heads. The chlorophyll index was observed to be non-significant. The highest value of chlorophyll index (48.53) was recorded with 75% RDF + KSB while the minimum (39.80) with 50% RDF + *Azotobacter* + PSB + KSB.

Table 1: Growth, yield and quality attributes of Cabbage

Treatment	Leaf length (cm)				Plant spread (cm^2)				Stem diameter (mm)	Net weight of head $plant^{-1}$ (kg)	Yield ha^{-1} (q)	T.S.S. (w/w)	Chlorophyll index
	30 DAT	45 DAT	60 DAT	At harvest	30 DAT	45 DAT	60 DAT	At harvest					
T1 (75% RDF + *Azotobacter*)	14.53	21.63	23.37	24.77	33.33	40.93	44.63	47.00	21.97	1.25	290.36	6.34	44.17
T2 (75% RDF + PSB)	14.47	21.30	23.90	24.80	33.13	41.53	45.70	46.20	23.23	1.24	286.81	5.78	44.07
T3 (75% RDF + KSB)	14.93	20.83	21.73	24.97	33.47	42.00	41.83	47.60	23.56	1.22	297.83	6.14	48.53
T4 (75% RDF + *Azotobacter*+ PSB)	14.83	21.13	22.37	23.70	33.00	41.73	45.43	47.07	24.43	1.39	331.80	7.38	45.37
T5 (75% RDF + *Azotobacter*+ KSB)	14.60	19.70	22.17	24.87	32.73	41.23	46.83	47.20	23.16	1.26	277.42	6.71	41.40
T6 (75% RDF + PSB + KSB)	14.67	21.30	25.23	26.43	33.67	41.87	45.10	47.80	26.04	1.64	359.51	7.31	45.43
T7 (75% RDF + *Azotobacter*+ PSB +KSB)	15.47	23.40	25.17	25.37	34.60	43.30	46.07	48.07	22.38	1.84	381.60	7.54	47.17
T8 (50% RDF + *Azotobacter*)	14.90	20.30	23.37	24.33	33.07	40.80	42.83	46.60	20.66	1.29	279.99	6.08	41.77
T9 (50% RDF + PSB)	14.83	20.63	24.83	24.88	32.67	41.20	42.47	47.27	21.77	1.20	281.52	5.70	44.97
T10 (50% RDF + KSB)	14.97	21.43	22.37	24.40	33.00	40.87	43.67	47.53	21.78	1.10	258.63	5.66	43.90

T11 (50% RDF + *Azotobacter* + PSB)	15.03	22.70	22.37	24.37	32.67	41.33	44.20	47.27	21.37	1.09	280.80	5.54	41.80
T12 (50% RDF + *Azotobacter* +KSB)	15.33	20.40	21.10	25.10	32.80	41.47	43.20	47.67	22.69	1.20	272.95	5.63	41.60
T13 (50% RDF + PSB + KSB)	14.40	23.10	22.07	25.20	33.13	41.13	43.23	47.67	20.88	1.15	285.14	6.16	45.47
T14 (50% RDF + *Azotobacter* + PSB + KSB)	14.33	21.77	22.87	23.23	33.53	41.87	39.70	42.40	23.40	1.61	334.05	6.59	39.80
T15 (*Azotobacter*+ PSB +KSB)	15.37	22.60	24.13	24.73	33.33	41.07	39.27	48.00	20.66	1.18	264.01	6.23	43.23
T16 (100% RDF)	14.13	20.80	21.16	24.13	33.60	40.47	44.13	47.27	19.74	1.25	257.02	5.51	41.20
T17 (Control)	13.20	18.10	20.40	22.97	28.30	38.07	38.33	40.93	19.64	1.03	230.52	5.29	44.60
Mean	14.71	21.24	22.86	24.6	32.94	41.23	43.33	46.68	22.20	1.29	292.29	6.15	43.79
S.Em±	0.26	0.80	0.65	0.38	0.84	0.41	0.90	0.52	0.60	0.04	5.68	0.28	2.33
C.D. @5%	0.77	2.32	1.88	1.08	2.43	1.19	2.60	1.51	1.74	0.13	16.43	0.81	NS

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