

Original Research Article

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## Studies on the Effect of Nitrogen Levels on Growth, Yield Components and Quality of Red Cabbage (*Brassica oleracea* var. *capitata* f. *rubra*)

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### ABSTRACT

The investigation entitled Studies on the effect of nitrogen levels on growth, yield and quality of red cabbage (*Brassica oleracea* var. *capitata* f. *rubra*) was carried out in Rabi season 2018-2019 at Mango Research Station, Nuzvid, Krishna Dist. (A.P.). Study included four levels of nitrogen (80, 120, 160 and 200 Kg Nitrogen per hector) each replicated thrice in FRBD. Nitrogen levels significantly influenced the growth, yield and quality parameters at all the growth stages. Among all the treatments, significantly highest plant height (34.93 cm), plant spread (53.81cm), number of heading leaves per plant (23.18) and number of loose leaves per plant (13.87) recorded at final harvest. Among yield and yield attributing characters maximum head circumference (47.12 cm), head length (16.77 cm), head volume (950.55 cc), head compactness (1.60), head weight (616 g), head yield per plot (49.26 kg), Estimated head yield (382.15q ha<sup>-1</sup>) and dry matter production (11.67%) with minimum days to head initiation (46.77days) and head harvest (85.03days) were recorded by 200 kg nitrogen per hector and the same was also maintained best quality with respect to anthocyanin content (117 mg/100g), ascorbic acid content (38.32 mg/100g) and TSS (8.34° Brix).

#### Keywords

Red cabbage,  
Nitrogen levels,  
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### Introduction

Red cabbage (*Brassica oleracea* var. *capitata* f. *rubra*) is also known as purple cabbage or red kraut. It is an important fancy and highly nutritive exotic vegetable. It belongs to the family brassicaceae and comes under the subgroup *rubra* of cabbage (*Brassica oleracea* var. *capitata* L.). It is having chromosome number  $2n=2X=18$ . Red cabbage is a native

crop in the Mediterranean region of Europe and now grows all over the world as a fresh market vegetable. Red cabbage synthesized and accumulated anthocyanin at all the developmental stages of vegetative growth (Yuan, 2009). It is a cool season crop and widely grown in temperate and subtropical region of India. The transition from vegetative to reproductive growth is triggered by temperature. The optimum temperature for

growth is 15-18°C. It can tolerate freezing temperatures but is less tolerant to high temperatures (More, 2006). It is a rich source of anthocyanin, proteins, fats and minerals like calcium, phosphorus, potassium, sulphur *etc.* and vitamins viz. A, B<sub>1</sub>, B<sub>2</sub> and C. Red cabbage distinguished by the presence of exceptional health enhancing properties like anticancer properties due to the presence of Indole-3-Carbinol and many beneficial sensory traits, which has become more and more important in recent years (Wojciechowska *et al.*, 2007). In India, cabbage including red cabbage is cultivated in an area of 4.03 lakh hectares producing 91.92 lakh metric tonnes (NHB, 2019).

Red cabbage is a heavy feeder of mineral elements and it removes large amount of macronutrients from the soil. Thus, a major constraint in increasing crop yields is the supply of nutrients (Arakari *et al.*, 1956). Among the nutrients, nitrogen plays the most important role to promote vigorous vegetative growth, attractive colour, higher yield and good quality heads. It is usually the most abundant element in plants. It has essential role as a constituent of protein, nucleic acids, chlorophyll and growth hormones (Hossain *et al.*, 2011). Very few studies on the growth, yield and quality of red cabbage have been carried out in our country. Therefore, the study of cultivation practices with respect to suitable fertilizer levels is a pre-requisite for any new crop assessment to achieve more returns per unit area. Since, red cabbage crop has been introduced recently in our country there is a need to standardize the fertilizer to suit the local conditions.

### **Materials and Methods**

An investigation entitled Studies on the effect of nitrogen levels on growth, yield and quality of red cabbage (*Brassica oleracea* var. *capitata* f. *rubra*) was carried out during *rabi*

season, 2018-2019 at MRS, Nuzvid, Krishna district (A.P.). The location falls under Agro-climatic zone-10, east coastal plain and hills (Krishna-Godavari zone) with an average rainfall of 900 mm, located at an altitude of 34 m (112 feet) above mean sea level. The location is geographically situated at 16°83'N latitude and 81°5'E longitude. It experiences hot humid summer and mild winter climate. Study included four levels of nitrogen (80, 120, 160 and 200 Kg Nitrogen per hectare) each replicated thrice in FRBD. The observations were recorded on various growth, yield and quality parameters.

The data obtained in respect to all the characters *viz.*, plant height (cm), plant spread (cm), number of heading leaves per plant, number of loose leaves per plant, number of days to head initiation (days), number of days to head harvest (days), head circumference (cm), head length (cm), head volume (cc), head compactness, head weight (g), head yield per plot (kg), estimated head yield per hectare (q), dry matter production (%), anthocyanin content (mg 100g<sup>-1</sup>), ascorbic acid (mg 100g<sup>-1</sup>) and TSS (° Brix) was subjected to the statistical analysis. The data were analyzed by the methods outlined by Panse and Sukhatme (1985) using the mean values of five random plants in each replication from all treatment to find out the significance of nitrogen levels.

### **Results and Discussion**

#### **Growth parameters**

#### **Plant height (cm), Plant spread (cm), number of heading and loose leaves per plant**

It was observed that significantly highest plant height (34.93cm), plant spread (53.81cm), number of heading leaves per plant (23.18) and number of loose leaves per plant (13.87) was observed by 200 kg nitrogen per

hector(N<sub>4</sub>). However, the minimum plant height (25.33 cm), plant spread (35.05 cm), number of heading leaves per plant (15.93) and number of loose leaves per plant (9.63) was recorded with the 80 kg nitrogen per hectore(N<sub>1</sub>) (Table 1).

These above results are indicating the influence of nitrogen levels on all growth parameters. This might be due to better nutritional environment in the root zone for growth and development of plants and also nitrogen functions in plants by being part of chlorophyll which is responsible for photosynthesis, helps plants with rapid growth and improves the all growth parameters like plant height, plant spread, number of heading leaves per plant and number of loose leaves per plant. Similar results under different nitrogen levels were reported in cabbage (Mankar *et al.*, 2015; Verma and Nawange, 2015)for plant height; With respect to plant spread (cm), similar results were observed in cabbage (Verma and Nawange, 2015), broccoli (Singh *et al.*, 2015), whereas the results were in line with findings in cabbage(Hossain *et al.*, 2011), red cabbage (Manasa *et al.*, 2017) and in broccoli (Singh *et al.*, 2015)for number of heading leaves per plant and loose leaves per plant.

#### **Number of days taken to head initiation and head harvest (days)**

The minimum number of days taken to head initiation (46.77 days) and number of days taken to harvest (85.03 days) was recorded with 200 kg nitrogen per hectore (N<sub>4</sub>) which was significantly superior to with 160 kg nitrogen per hectore (N<sub>3</sub>)with 52.57and 87.14days to head initiation and harvest, respectively. Whereas the maximum number of days taken to head initiation (58.44 days) and number of days taken to head harvest (99.00 days) was recorded with 80 kg nitrogen per hectore(N<sub>1</sub>)(Table. 1).

Significantly minimum number of days to head initiation and harvest was might be due to favourable climatic conditions and sufficient quantity of fertilizers available during growth period which enhanced early head initiation and head harvest.

Successive increase in nitrogen levels decreased the number of days to head harvest and the increase in number of days to head initiation and head harvest might be due to the deficiency nitrogen prevailing during growth period which resulted in delayed head formation. These results are similarity in cabbage (Lavanya *et al.*, 2014 and Naher *et al.*, 2014), cauliflower (Mansoor *et al.*, 2018) and broccolli (Dheerendra *et al.*,2012).

#### **Yield and yield attributing parameters**

##### **Head circumference (cm) and Head length (cm)**

Significantly superior head circumference (47.12 cm) and head length (16.77 cm) was recorded with 200 kg nitrogen per hectore (N<sub>4</sub>), followed by 160 kg nitrogen per hectore (N<sub>3</sub>) with (42.71 cm) and head length (14.96 cm), whereas the minimum head circumference (34.90 cm) and head length (11.65 cm) was recorded with 80 kg nitrogen per hectore(N<sub>1</sub>)(Table. 2).

These variations might be due to the increased supply of nitrogen might have accelerated synthesis of chlorophyll and amino acids and effective utilization of carbohydrates and their organic factors might have resulted in enlargement of head size viz head circumference and head length.

Similar findings have been reported in cabbage (Naher *et al.*, 2014 and Hope *et al.*, 2017) for head circumference. Whereas, in cabbage (Hossain *et al.*, 2011) and broccolli (Singh *et al.*, 2015) for head length.

### **Head volume (cc) and Head compactness**

It was observed that head volume and head compactness differed significantly with nitrogen levels in red cabbage. The highest head volume (950.55 cc) and head compactness (0.51) was recorded with 200 kg nitrogen per hectare ( $N_4$ ), whereas the minimum head volume (727.77 cc) and head compactness (0.77) was recorded with 80 kg nitrogen per hectare ( $N_1$ ) (Table. 2).

Head volume and head compactness exhibited a significant variation with nitrogen levels. Increased application of nitrogen significantly increased the growth parameters which might have synthesized more plant metabolites. Due to better availability of metabolites to plant, head volume and head compactness might have increased. Similar results have been reported in cabbage (Lavanya *et al.*, 2014; Verma and Nawange, 2015), cauliflower (Shree *et al.*, 2014) for head volume, with respect to head compactness, similar findings have been reported in cabbage (Gamal *et al.*, 2009) and cauliflower (Tekasangla *et al.*, 2015).

### **Head weight (g), Head yield per plot ( $\text{kg}/12.87\text{m}^2$ )**

The data on head weight and head yield per plot revealed significant differences among different nitrogen levels. Significantly higher head weight (616 g) and head yield per plot (49.26 kg) was recorded with 200 kg nitrogen per hectare ( $N_4$ ), whereas the 80 kg nitrogen per hectare ( $N_1$ ) recorded lowest head weight (358 g) and head yield per plot (28.63 kg) (Table. 3). Results was clear that head weight and head yield per plot were significantly

affected by nitrogen levels. Increased application of nitrogen significantly increases the growth parameters which might have synthesized more plant metabolites. Due to better availability of metabolites to plant, weight of head might have increased.

Results of head weight were in similar with findings in cabbage (Hossain *et al.*, 2011 and Lavanya *et al.*, 2014) and in cauliflower (Shree *et al.*, 2014; Tekasangla *et al.*, 2015). With respect to head yield per plot, Similar results findings with cabbage (Aquinas *et al.*, 2005) and cauliflower (Mansoor *et al.*, 2018).

### **Estimated head yield per hectare (q) and Dry Matter Production (%)**

Significantly higher estimated head yield per hectare (382.15 q) and dry matter production (11.67%) was recorded with 200 kg nitrogen per hectare ( $N_4$ ), whereas the crop applied with on 80 kg nitrogen per hectare ( $N_1$ ) recorded the lowest estimated head yield per hectare (222.50 q) and dry matter production (9.20%) (Table 3).

From the above results, it was clear that estimated head yield per hectare and dry matter production were significantly affected by nitrogen levels. As the nitrogen doses increases, the supply of nutrients and their utilization in plants also increases, which resulted in the more production of metabolites that enhances the production estimated head yield per hectare as well as dry matter production in red cabbage. Similar findings were reported in cabbage (Lavanya *et al.*, 2014; Naher *et al.*, 2014; Mankar *et al.*, 2015), With regarding dry matter production, in cabbage (Akand *et al.*, 2015).

**Table.1** Effect of nitrogen levels on growth parameters of red cabbage

Treatment	Plant height (cm) at final harvest	Plant spread (cm) at final harvest	No.of heading leaves plant <sup>-1</sup>	No.of loose leaves plant <sup>-1</sup>	No. of days to head initiation (days)	No. of days to head harvest (days)
N1: 80 kg N ha <sup>-1</sup>	25.33	35.05	15.93	9.63	58.44	99.00
N2: 120 kg N ha <sup>-1</sup>	28.58	41.39	17.73	10.74	55.49	93.47
N3: 160 kg N ha <sup>-1</sup>	31.75	47.59	20.29	12.20	52.57	87.14
N4: 200 kg N ha <sup>-1</sup>	34.93	53.81	23.18	13.87	46.77	85.03
SEm±	1.037	2.069	0.277	0.247	0.822	3.406
CD @ 5%	3.062	6.107	0.817	0.729	2.427	10.055

**Table.2** Effect of nitrogen levels on yield attributing parameters of red cabbage

Treatment	Head circumference (cm)	Head length (cm)	Head volume (cc)	Head compactness
N1: 80 kg N ha <sup>-1</sup>	34.90	11.65	727.77	0.77
N2: 120 kg N ha <sup>-1</sup>	39.30	13.54	788.88	0.68
N3: 160 kg N ha <sup>-1</sup>	42.71	14.96	873.33	0.61
N4: 200 kg N ha <sup>-1</sup>	47.12	16.77	950.55	0.51
SEm±	1.640	0.385	7.700	0.040
CD @ 5%	4.840	1.137	22.730	0.117

**Table.3** Effect of nitrogen levels on yield parameters of red cabbage

Treatment	Head weight (g)	Head yield plot <sup>-1</sup> (kg/12.87m <sup>2</sup> )	Estimated yield per hectare (q)	Dry matter production (%)
N1: 80 kg N ha <sup>-1</sup>	358	28.63	222.50	9.20
N2: 120 kg N ha <sup>-1</sup>	476	38.09	291.43	9.89
N3: 160 kg N ha <sup>-1</sup>	541	43.30	336.41	10.76
N4: 200 kg N ha <sup>-1</sup>	616	49.26	382.15	11.67
SEm±	10.474	0.837	6.186	0.029
CD @ 5%	30.720	2.471	18.261	0.085

**Table.4** Effect of nitrogen levels on quality parameters of red cabbage

Treatment	Anthocyanin content (mg/100g)	Ascorbic acid content (mg/100g)	TSS (°Brix)
N1: 80 kg N ha <sup>-1</sup>	110.44	34.82	7.73
N2: 120 kg N ha <sup>-1</sup>	112.22	35.91	7.90
N3: 160 kg N ha <sup>-1</sup>	115.55	37.23	8.13
N4: 200 kg N ha <sup>-1</sup>	117.00	38.32	8.34
SEm±	0.281	0.578	0.055
CD @ 5%	0.831	1.707	0.162

## Quality parameters

### **Anthocyanin content (mg/100g), Ascorbic acid content (mg/100g) and TSS (°Brix)**

With regarding quality parameters like anthocyanin content (117 mg/100g), ascorbic acid content (38.32 mg/100g) and TSS (8.34°Brix) were recorded higher with 200 kg nitrogen per hectare (N<sub>4</sub>) compared to all other nitrogen levels. The lowest values for quality parameters like anthocyanin content (110.44 mg/100g), ascorbic acid content (34.82 mg/100g) and TSS (7.73°Brix) were recorded with 80 kg nitrogen per hectare (N<sub>1</sub>)(Table 4).

The maximum anthocyanin content recorded with 200 kg nitrogen per hectare (N<sub>4</sub>) might be due to the sufficient level of nitrogen along with favourable climatic conditions prevailing during head formation stage. These results are in conformity with red cabbage (Manasa *et al.*, 2017 and Patel *et al.*, 2017) and broccoli (Vinod *et al.*, 2017 and Vipul *et al.*, 2017).

Based on the results obtained in the present investigation, it can be concluded that 200 kg nitrogen per hectare (N<sub>4</sub>) proved to be best for getting higher growth, yield, quality and economic returns in red cabbage for coastal Andhra Pradesh. Significantly higher values were recorded with vegetative parameters like plant height, plant spread and number of heading and loose leaves per plant leads to maximum photosynthetic activity and thereby facilitates better translocation of food material to economic parts. This might have resulted in obtaining higher values with yield parameters like volume of head, head circumference, head weight, head yield per plot, estimated head yield per hectare and dry matter production with the above treatment (N<sub>4</sub>) and the same was also maintained best quality with respect to anthocyanin content, ascorbic acid content and TSS. Red cabbage applied with 80 kg nitrogen per hectare (N<sub>1</sub>) recorded the lowest

values for vegetative and yield parameters. The crop applied with lower dose of nitrogen received very less quantity of nitrogen level which is not conducive for red cabbage. The deficiency of nitrogen content during the crop growth period restricted the photosynthetic activity and translocation of food materials that might have resulted in poor vegetative growth leading to lesser yields and quality with the above treatment (N<sub>1</sub>).

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