

Original Research Article

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Response of Red Cabbage (*Brassica oleracea* L. var. *capitata* f. *rubra*) to Different Levels of Plant and Row Spacing

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ABSTRACT

The experiment was undertaken to determine the effect of different plant and row spacing on yield attributes and yield of red cabbage. Three different spacings were taken viz., 45x45 cm, 60x45 cm and 60x60 cm. Variety Red Jewel was used for the study. The results demonstrated that plant spacing had significant effects on yield components and yield of red cabbage. Significantly wider spacing produced higher size of head circumference, volume and compactness. Fresh weight and dry matter production also have the same trend in wider spacing. The weight of individual red cabbage head (1.15 kg) was increased with the widest spacing of 60x60 cm. On the contrary, the yield per plot and marketable yield were the highest (23.80 kg/plot and 183.69 q/ha, respectively) at the closest spacing (45 x45cm) and the lowest (16.23 kg/plot and 125.21 q/ha) was at widest spacing (60x60 cm).

Keywords

Red cabbage, Spacing,
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Introduction

Red cabbage (*Brassica oleracea* L. var. *capitata* f. *rubra*) is one of the most important cool season vegetables belongs to the family Cruciferae. It is an herbaceous plant distinguished by a short stem upon which is crown with a mass of red colored leaves (head). It is used as salad, boiled vegetable, cooked in curries, used in pickling as well as dehydrated vegetable. Red cabbage is known to possess medicinal properties. It has an anticancer property due to the presence of indole-3-carbinol. Red cabbage is an excellent source of vitamin C, in addition to containing vitamin B complex, red cabbage supplies some potassium and calcium to the diet.

Red cabbage distinguished by exceptional health-enhancing properties and many beneficial sensory traits, 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 388 thousand ha producing 8755 thousand MT (Anonymous, 2015-16). In Andhra Pradesh, the crops are cultivated in 5.43 thousand ha with a production of 81.45 thousand tonnes.

Apart from India, red cabbage can be found throughout Northern Europe, America, and parts of China.

The potential yield of red cabbage is determined by appropriate husbandry practices and the surrounding environment provided to the crop. Among the husbandry practices, a direct effect can be observed due to an increase or a decrease in plant population because a cabbage plant bears a single head. A very common range in optimum plant population recommendations for cabbage is for stand densities of 20,000 to 70,000 plants per ha (Ghanti *et al.*, 1982; Tenday and Kuzyk, 2001; Kumar and Rawat, 2002). Though many authors have reported some information on the plant density of cabbage, no prominent work has been done on red cabbage. In spite of its greater importance in terms of returns, no systematic research work has been carried out to standardize the suitable agro-techniques for successful cultivation of red cabbage in Andhra Pradesh. Therefore, it is essential to find out the optimum plant densities for yield maximization of red cabbage (*Brassica oleracea* var. *capitata* f. *rubra*) in Andhra Pradesh.

Materials and Methods

The present investigation was undertaken to study the response of red cabbage (*Brassica oleracea* L. var. *capitata* f. *rubra*) to different levels of plant and row spacing. The experiment was carried out at AICRP on Citrus, Citrus Research Station, Tirupati; Andhra Pradesh during *rabi*, 2017 under Dr. YSR Horticultural University with the variety Red Jewel. The experiment was laid out in a factorial randomized block design with three replications. The experimental area was divided into plots of 3.5 m x 3.5 m size with an area of 12.96 sq. m. Irrigation channels of 30 cm wide were provided for each row of plots. The seedlings were transplanted at a spacing of 45 x 45cm, 60 x 45 cm and 60 x 60 cm in each plot. To raise the crop recommended package of practices were

followed. The various parameters were recorded from five randomly selected tagged plants viz., head circumference, volume and compactness, fresh weight, dry matter production, yield per plot and marketable yield. The data was subjected to statistical analysis as per method suggested by Panse and Sukhatme (1967).

Results and Discussion

Head circumference

Application of different levels of plating densities showed statistically significant variation for head circumference in red cabbage. Data in table 1 revealed that maximum head circumference (46.72 cm) was recorded with the lower plant density (60 × 60 cm) followed by medium plant density (60 × 45 cm) (38.18 cm). However, the minimum head circumference (35.06 cm) was recorded with higher plant density (45 × 45 cm). The general trend observed was as the plant spacing increased from 45x45 cm to 60x60 cm, the head circumference was also increased. The lower plant density or wider spacing provides more space where the individual plant enjoyed a maximum suitable environment which resulted for the development of head with maximum circumference. Head circumference decreased as the plant density increased which may be due to competition for light, moisture and nutrients. This can also be attributed to the availability of progressively lower amount of photosynthesis due to the increasing competition among plants for growth factors. Similar result was given by Jett *et al.*, (1995) in broccoli.

Head volume

It was observed that volume of head differed significantly with planting densities in red cabbage (Table 1). Significantly maximum

head volume (1308.70 cc) was recorded with 60 × 60 cm followed by 60 × 45 cm with 1103.49 cc whereas the minimum head volume (976.89 cc) was recorded with 45 × 45 cm. Increased planting densities resulted in reduced head volume in red cabbage. The increase in head volume at wider plant spacing could be probably due to more nutrients, space and moisture availability. This may also be attributed to the low number of plants per unit area, which results in congenial growing conditions such as more space available for growth of roots, shoot and leaves compared to plants in closer spacing. These results are in agreement with Abed *et al.*, (2015) who reported that wider plant spacing (70 cm) gave the highest values (2974.18 cm³) of head volume, whereas the closer plant spacing (50 cm) showed the lowest values (1967.36 cm³) in cabbage.

Head compactness

The result of the experiment revealed significant difference among treatments with regard to head compactness (Table 1). It was observed that head compactness differed significantly with planting densities in red cabbage. Significantly maximum head compactness (1.06) was recorded with 45 × 45 cm, followed by 60 × 45 cm (1.12) whereas the minimum head compactness (1.16) was recorded with 60 × 60 cm. Head compactness, which is a primary indicator of horticultural maturity (Radovich *et al.*, 2004), which was positively influenced by increasing plant density.

This can be attributed to the more competition between the plants at higher densities for space and nutrients that led to the formation of highly compact heads. The obtained data was in accordance with results reported by Znidarcic *et al.*, (2007) who indicated that the maximum plant spacing achieved minimum head compactness.

Fresh weight of head

Plant spacing has significantly influenced average fresh weight of head. Maximum fresh weight of head (1.15 kg) was obtained with 60 × 60 cm followed by 60 × 45 cm (0.97 kg) while, minimum fresh weight was found in 45 × 45 cm (0.90 kg) (Table 1). It was revealed that with the increase of spacing, fresh weight of plant showed increasing trend. Densely populated plants produced lower fresh weight of head as compared to thinly populated plants. This might be due to the proper utilization of accumulates which were conserved by the plant, under optimally spaced crop. The interplant competition occurred for the available nutrients would have reduced the weights of individual heads in case of high density. These results were well supported by the previous findings of Moniruzzaman (2011) noticed highest head weight (1090 g) in cabbage at a widest spacing of 60 x 45 cm and lowest head weight (1071 g) from the 60 x 40 cm spacing. Hossain *et al.*, (2011) recorded maximum head weight (543.0 g) in 60 x 60 cm spacing and minimum head weight (441.0 g) in 60 x 40 cm in broccoli. Bhangre *et al.*, (2011) observed maximum (181.54 g) and minimum curd weight/plant (104.14 g) in broccoli at a plant spacing of 60 x 60 cm and 45 x 30 cm, respectively.

Dry matter production

Red cabbage dry matter production (%) showed statistically significant variation due to the application of different levels of nitrogen and plant spacings (Table 2). Maximum dry matter production (%) in red cabbage was recorded (10.57 %) at lower plant density (60 × 60 cm) followed by medium plant density (60 × 45 cm) (10.11 %). On the other hand, minimum dry matter production (9.10 %) was found from 45 × 45 cm.

Table.1 Effect of different plant spacings on yield components of red cabbage

Treatments	Head circumference	Head volume	Head compactness	Fresh weight of head
45 × 45 cm	35.06	976.89	1.06	0.90
60 × 45 cm	38.18	1103.49	1.12	0.97
60 × 60 cm	46.72	1308.70	1.16	1.15
S.Em ±	0.676	2.117	0.004	0.014
C.D(P=0.05)	2.027	6.348	0.013	0.044

Table.2 Effect of different plant spacings on yield of red cabbage

Treatments	Dry matter production	Yield per plot	Marketable yield
45 × 45 cm	9.10	23.80	183.69
60 × 45 cm	10.11	19.87	153.29
60 × 60 cm	10.57	16.23	125.21
S.Em ±	0.087	0.077	0.783
C.D(P=0.05)	0.261	0.232	2.350

The fore mentioned results revealed that the wide plant spacing produce heads with larger dimensions and density. The present findings can be attributed to the more competition between the plants at higher densities for space and nutrients that resulted in the negative impact of plant densities on dry matter production. The results are in line with Dragan *et al.*, (2007) in cabbage.

Yield per plot

Effects of different plant densities on head yield of red cabbage per plot are presented in Table 2. Significantly highest yield per plot (23.80 kg/plot) was recorded with the higher plant density (45 × 45 cm) which was statistically similar to medium plant density (60 × 45 cm) (19.87kg/plot). Lowest yield (16.23 kg/plot) was recorded with lower plant density (60 × 60 cm). The maximum yield per plot was found superior at higher plant density which was possibly due to more number of plants per unit area; higher ground covers of leaf area resulted in higher light interception and hence, higher assimilate production. Khatun *et al.*, (2011) reported that

maximum curd yield/plant (380.88 g) was recorded in broccoli at wider spacing (60 x 50 cm), but yield per plot (9.64 kg) and per hectare (16.07 t) were found to be higher in closer spacing (45x45 cm). Similar results have been reported by Sharma and Chaudhary (1996) in cauliflower and Agarwal *et al.*, (2007) in broccoli.

Marketable yield

Different levels of nitrogen application and spacing significantly influenced marketable yield of red cabbage (Table 2). Highest yield (183.69 q/ha) was recorded with the higher plant density (45 × 45 cm) followed by the medium plant density (60 × 45 cm) (153.29 q/ha) while, minimum yield (125.21 q/ha) was recorded with lower plant density (60 × 60 cm). The maximum marketable yield was found superior at higher plant density due to more number of plants per unit area; higher ground covers of leaf area resulted in higher assimilates production. The obtained results clearly indicated that although low planting density increased head weight but it failed to compensate the decrease in total yield and the

highest yield was resulted from the higher planting density. These results match with those obtained by Khatiwada (2000) who mentioned that cabbage head yields were statistically higher (35 t/ha) at closer plant spacing (45 × 20 cm) and Znidarcic *et al.*, (2007) who stated that yield/ha generally increased about 12.5% as plant spacing increased from 1,08,000 to 1,66,000 plant/ ha. Solunke *et al.*, (2011) noticed that higher curd yield (122.14 q/ha) was recorded in broccoli at a spacing of 60 x 60 cm and concluded that yield increment was due to maximum growth parameters like plant height, number of leaves and stem diameter under wider spacing (60 x 60 cm). Similar results have been reported by Agarwal *et al.*, (2007) in broccoli.

From the investigations it can be concluded that among the different plant densities for yield parameters, the yield and yield attributing characters like head circumference (46.72 cm), head volume (1308.70 cc), fresh weight (1.15 kg) and dry matter production (10.57%) showed better expression with lower plant density (60 × 60 cm). However, the head yield per plot (23.80 kg), marketable yield (183.69 q/ha) and compactness (1.06) were found significantly superior with the high density planting (45 × 45 cm).

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