

Original Research Article

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Studies on Effect of Spacing on Yield and Yield Attributing Parameters of Red Cabbage (*Brassica oleracea* L. var. *capitata* f. *rubra*)

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ABSTRACT

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Field experiment conducted during rabi, 2017 at AICRP on Citrus, Citrus Research Station, Tirupati involved research on the effect of different plant spacings on yield and yield attributes of red cabbage. Plant density is an important variable for achieving maximum yields and uniform vegetable maturity. Optimal plant density can be achieved by establishing appropriate distances both between the rows as well as in the rows of plants. In this study, increasing the distance between plants caused an increase in number of heading leaves (19.57) with a low percentage of abnormal heads. However, there was no significant difference between different spacings regarding the number of loose leaves per plant. The most favorable parameters characterizing yield per plot (23.80 kg), marketable yield (183.69 q/ha) along with highest available soil N (157.47 kg/ha), P (44.36 kg/ha) and K (259.97 kg/ha) were found at closer spacing (45 x 45 cm).

Introduction

Red cabbage (*Brassica oleracea* var. *capitata* f. *rubra*) is an important fancy and highly nutritive exotic vegetable. It is a biennial but grown as annual for its characteristic purple or red edible heads. It is used as salad, boiled vegetable, cooked in curries, used in pickling as well as dehydrated vegetable. It is a rich source of carotene, proteins (0.35%), fats (0.25%), minerals like calcium (3.56%), phosphorus (19.90%), potassium, sulphur etc. and vitamins viz., A, B₁, B₂ and C. Red cabbage is known to possess medicinal properties. It has an anticancer property due to the presence of indole-3-carbinol. An important advantage of red cabbage is the fact

that it is generally consumed raw, which permits the preservation of vitamins sensitive to thermal processing and some polyphenolic compounds (Ismail *et al.*, 2004). 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 some parts of China.

Plant population studies are common features of many horticultural crops, including

cabbage (Stoffela and Bryan, 1988). There are several citations in the literature that provide information relative to optimum plant population evaluations for cabbage that been conducted over the past 30 years (Day, 1986; Stoffela and Fleming, 1990; Lal, 1996; Stepanovic *et al.*, 2000). Though many authors have reported some information on the plant density of different varieties of cabbage, studies regarding red cabbage are limited. Considering the above stated situations, the present study was undertaken to determine the effects of different plant and row spacing on yield and yield attributes of red cabbage.

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., abnormal heads, number of loose leaves, and heading leaves, yield per plot, marketable yield and available N, P and K. The data was subjected to statistical analysis as per method suggested by Panse and Sukhatme (1967).

Results and Discussion

Abnormal heads (%)

Percentage of abnormal heads in red cabbage showed statistically significant variation due to the application of different levels of plant densities. Lowest percentage of abnormal heads (9.91 %) were found with the lower plant density (60 × 60 cm) while, the highest percentage of abnormal heads (12.13 %) were recorded at high plant density (45 × 45 cm), which was closely followed by medium plant density (10.53 %).

The abnormal head (%) increased with a decrease in plant spacing. This can be attributed to the heavy competition between the plants that might have led to the poor uptake of nutrients and poor head growth causing the formation of abnormal heads. The trend of present results was in conformity with the findings of Indira (2012) in cauliflower.

Number of loose leaves per plant

The number of loose leaves in red cabbage was non-significant with respect to the effect of plant densities. However, maximum number of loose leaves (11.66) at lower plant density (60 × 60 cm) followed by medium plant density (60 × 40 cm) (11.11) and minimum number of loose leaves per plant (10.55) was found with the higher plant density (45 × 45 cm).

Even though the effect of different levels of plant spacing was non-significant on the number of loose leaves per plant, different plant densities did have an effect on the number of loose leaves per plant to some extent. The number of loose leaves per plant increased with the increase in the plant spacing. These findings are in contrary with those of Hossain *et al.*, (2011a) in cabbage.

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

Treatments	Abnormal head (%)	Number of loose leaves/plant	Number of heading leaves/plant	Yield per plot (Kg/plot)	Marketable yield (q/ha)	Available soil NPK (Kg/ha)		
						N	P	K
D ₁	12.13	10.55	16.43	23.80	183.69	129.73	37.12	191.16
D ₂	10.53	11.11	18.59	19.87	153.29	150.81	39.89	225.85
D ₃	9.91	11.66	19.56	16.23	125.21	157.47	44.36	259.97
S.Em ±	0.140	0.316	0.155	0.077	0.783	0.669	0.180	0.301
C.D(P=0.05)	0.420	N.S*	0.466	0.232	2.350	2.006	0.540	0.902

Plot size: 12.96 sq. m.

* N.S. – Non-significant

D₁: High density (45 cm x 45 cm) (49,383 plants/ha)

D₂: Medium density (60 cm x 45 cm) (37,037 plants/ha)

D₃: Low density (60 cm x 60 cm) (27,778 plants/ha)

Number of heading leaves per plant

The number of heading leaves in red cabbage was significant with respect to the effect of plant densities. The maximum number of heading leaves (19.56) at lower plant density (60 × 60 cm) followed by medium plant density (60 × 45 cm) (18.59) and minimum number of heading leaves per plant (16.43) was found with the higher plant density (45 × 45 cm). Higher plant density resulted in maximum number of heading leaves per plant in red cabbage. The plants grown under wider spacing received more nutrients, light and moisture around compared to plants of closer spacing, which was probably the cause of better performance in yield attributes like number of heading leaves per plant. These findings are in line with Moniruzzaman (2011) in cabbage.

Yield per plot

There was a prominent effect of different spacings on yield of red cabbage. Significantly highest yield per plot (23.80 kg/12.96 sq.m.) was recorded with the higher plant density (45 × 45 cm) which was statistically similar to medium plant density (60 × 45 cm) (19.87kg/12.96 sq.m.). Lowest yield (16.23 kg/12.96 sq.m.) 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. 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. 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. Moniruzzaman (2011) conducted a field experiment on cabbage (*Brassica oleracea* var. *capitata*) comprising two plant spacings *i.e.* 60 × 40 cm and 60 × 45 cm and his results indicated that highest marketable head yield (73.32 t/ha) was produced in K- K Cross cultivar at a spacing of 60 x 40 cm. Sanderson and Fillmore (2010) achieved the highest marketable yield in broccoli at 5.56 plants /m² in a single row with 90 cm between the row and 20 cm within the row. Singh and Naik (1988) observed that closest spacing of 45 x 30 cm produced significantly higher number of marketable heads resulting in higher marketable yield/ha in cabbage, however, maximum head weight/plant was found in the widest spacing of 60 x 45 cm. Similar results have been reported by Agarwal *et al.*, (2007) in broccoli.

Available soil NPK

Different planting densities significantly influenced the available soil nitrogen, phosphorus and potassium in red cabbage. The data regarding the effect of plant densities on available soil NPK are presented in Table 1. The available soil nitrogen was significantly higher with 60 × 60 cm (157.47 kg/ha) followed by 60 × 45 cm with 150.81 kg/ha and lower available soil nitrogen (129.73 kg/ha) was recorded with 45 × 45 cm. Available soil phosphorus in soil was found to be highest at 60 × 60 cm (44.36 kg/ha) and lowest at 45 × 45 cm (37.12 kg/ha). Highest available soil potassium (259.97 kg/ha) was recorded with 60 × 60 cm followed by 60 × 45 cm (225.85 kg/ha) and the lowest soil potassium content (191.16 kg/ha) was recorded by 45 × 45 cm. This may be attributed to the nature of nitrogen which governs the availability and utilization of soil phosphorus, potassium and other constituents to a considerable degree. These results were in agreement with the findings of Lavanya (2014) in cabbage.

Red cabbage cv. Red Jewel was evaluated for the best combination of planting spacing for obtaining highest yield and yield attributes. At the lowest spacing treatment the yield of red cabbage is highest. Therefore, we can conclude that plant at closer space growth yields more due to more number of plants per unit area. On the other hand, closer plant spacing didn't increase the yield attributes like number of loose leaves, number of heading leaves, abnormal head (%) etc., The yield attributes along with available soil nitrogen, phosphorus and potassium were observed to be maximum with wider spacing.

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