

Original Research Article

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Effect of Fertigation, Levels on Growth and Yield of Cabbage (*Brassica oleracea* L. var. *capitata*)

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ABSTRACT

A field experiment was conducted at Department of Vegetable Science, CoH, GKVK Campus, Bengaluru during *Rabi* Season of 2018-19 to study the effect of fertigation levels on growth and yield of Cabbage. The experiment was laid out in RCBD with seven treatments replicated thrice. The treatments included three different doses fertilizers (100, 75 and 50% RDF) and each doses of fertilizers was applied in 12 and 6 equal splits at 5 and 10 days intervals, respectively and they were compared with soil application of 100% RDF (150: 100: 125 kg NPK ha⁻¹). Phosphorus was applied as basal dose through soil application whereas Nitrogen and Potassium were applied through fertigation. The result revealed that application of 100% RDF in 12 equal splits at 5 days intervals significantly recorded maximum plant height (20.53, 30.53 and 35.46 cm) and plant spread in East-West (59.33, 69.32 and 72.79 cm) and North-South (59.06, 69.06 and 72.53 cm) directions at 45 DAT, 60 DAT and at harvest, respectively. The same treatment recorded highest individual head weight (1194.23 g), head length (11.60 cm), head diameter (29.11 cm), head volume (1296.53 cc), head width (13.60 cm), yield per plot (33.00 kg) and yield per hectare (43.22 t ha⁻¹).

Keywords

Fertigation, Growth, Yield, Water Soluble Fertilizers (WSF)

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Introduction

Cabbage (*Brassica oleracea* L.var. *capitata*) is one of the most important cool season vegetable crop belongs to the family Brassicaceae. It is the most popular vegetable around the world with respect to area, production and available, almost round the year. It occupies prime place among cole crops due to its delicious taste, flavour and nutritive value. It is used as salad, boiled vegetable and dehydrated vegetable as well as

in cooked curries and pickles. Cabbage is well known for its medicinal properties, it is widely used for cough, fever, diarrhea, peptic ulcers and skin diseases. It has anticancer property due to the presence of indole-3-carbinol. It is a rich source of vitamin C and has high fiber and calcium content which reduces the risk of colon cancer. It also contains phosphorus, which is helpful in utilization of calcium and assimilation of carbohydrates and fats in human body.

In India, cabbages are grown in an area of 3,99,000 ha with an annual production of 90,37,000 metric tonnes with an average productivity of 22.65 t ha⁻¹ (Anon., 2018). It is mainly grown in states like Uttar Pradesh, Orissa, Bihar, Assam, West Bengal, Maharashtra and Karnataka. In Karnataka, it is grown in an area of 10,770 ha and an average production of 2,31,210 metric tonnes with an average productivity of 21.47 t ha⁻¹ (Anon., 2016).

Fertigation is reported to enhance the fertilizer use efficiency owing to the frequent application of fertilizers directly into crop root zone and hence, reduction in fertilizer rates is possible without compromising the yield of vegetables. Cabbages are highly responsive to fertilizer application and thus fertilizers offer the best means of increasing yield. Vegetables are perhaps the most intensively irrigated crops all over the world and more so is cabbage. Despite the widespread use of high frequency irrigation system and fertigation elsewhere in India, not much information is available on different aspects of fertigation on closely grown crops like cabbage. Therefore, there is a need to study the vital aspect of fertigation involving the dosage of fertilizers, frequency of fertigation, and methods of fertilizer application. Keeping these points in view, the present study was undertaken to study the "Effect of fertigation levels on growth and yield of cabbage.

Materials and Methods

A field experiment was conducted at Department of Vegetable Science, College of Horticulture, GKVK Campus, Bengaluru, during *Rabi* season of 2018-2019, to study the effect of fertigation levels on growth and yield of cabbage. The experimental site is located at 13°N latitude and 77.37°E longitude in the Eastern Dry Zone of

Karnataka (Zone-5). The altitude of the location is 750 m above mean sea level. An initial composite soil sample up to a depth of 0-22.5 cm was collected from the experimental site before imposing treatments. At the end of experiment, treatment wise soil samples were collected from the same depth in undisturbed experimental site. The soil samples were dried under shade, powdered with wooden mallet, passed through 2 mm sieve and stored in clean polythene bags for analysis. The soil of experimental site was near neutral in reaction (pH 6.50), low in soluble salts content (0.36 dS m⁻¹) and medium in available nitrogen (300.60 kg ha⁻¹), phosphorus (40.10 kg ha⁻¹) and potassium (146.49 kg ha⁻¹) content. The experiment was laid in Randomized Complete Block Design (RCBD) with seven treatments replicated thrice. The treatments included the three different doses of fertigation (100, 75 and 50% RDF) and each dose of fertilizers were applied in 12 and 6 equal splits at 5 and 10 days intervals respectively and compared with soil application of 100% RDF (150: 100: 125 kg NPK ha⁻¹). The 100 per cent phosphorus was applied as basal dose through soil application whereas in respect out treatments nitrogen and potassium were applied through fertigation. The spacing of crop was 60 cm × 45 cm.

All the recommended cultural practices were followed to maintain good growth of the crop. The observations were recorded on five randomly selected plants in each treatment for twelve characters *viz.*, plant height and plant spread in East-West and North-South directions at 45 DAT, 60 DAT and at harvest, days to first head initiation, days to 50 % head initiation, head weight, head length, head diameter, head volume, head width, yield per plot and yield per hectare. The data were subjected to analysis of variance as per the procedure described by Panse and Sukhatme (1985).

Results and Discussion

The results revealed that the plant height significantly varied among the different treatments at 45 DAT, 60 DAT and at harvest (Table 1). The plant height varied from 14.93 cm to 20.53 cm at 45 DAT, 24.93 cm to 30.53 cm at 60 DAT and 27.20 cm to 35.46 cm at harvest. The plant height at different stages of growth was found to be higher with higher doses of fertilizers. The tallest plants were observed when the fertilizers were applied with 100 % RDF (150:100:125 kg NPK ha⁻¹) in 12 equal splits at 5 days intervals at 45 DAT, 60 DAT and at harvest. On the other hand, shortest plants were observed in soil application of 100 % RDF (14.93, 24.93 and 27.2 cm at 45 DAT, 60 DAT and at harvest, respectively).

An increased in plant height at 100 % RDF (150:100:125 kg NPK ha⁻¹) in 12 equal splits at 5 days intervals at different stages might be due to maximum uptake of nutrients resulted from better availability of sufficient quantity of major nutrients. The enhanced plant growth might be due to the fact that nitrogen with synthesized carbohydrates was metabolised into amino acids and proteins which allowed the plants to grow faster. As nitrogen is one of the major plant nutrient required for the growth consequently its uptake increases the cell number and size leading to better growth. The results are in conformity with Rakh (1992), Sanchita *et al.*, (2004), Singh *et al.*, (2006), Shinde *et al.*, (2006) and Tanpure *et al.*, (2007).

The plant spread was influenced significantly due to different fertigation levels at all crop growth stages. The plant spread in both East-West (59.33, 69.32 and 72.79 cm) and North-South (59.06, 69.06 and 72.53 cm) directions at 45 DAT, 60 DAT and at harvest was found to be higher with higher doses of fertilizers through fertigation. The plant spread was

more when the fertilizers were applied with 100% RDF (150:100:125 kg NPK ha⁻¹) in 12 equal splits at 5 days intervals. The minimum plant spread in East-West (52.26, 62.26 and 64.13 cm) and North-South (52.05, 62.00 and 64.26 cm) was noticed due to soil application of 100 % RDF at 45 DAT, 60 DAT and at harvest.

The maximum plant spread might be attributed to increased uptake of nutrients and effective utilization of these nutrients for increase synthesis of carbohydrates, greater vegetative growth and subsequent partitioning and translocation from leaf (source) to the head (sink). These results are in conformity with those reported by Rakh (1992), Sanchita *et al.*, (2004), Shinde *et al.*, (2006) and Singh *et al.*, (2004). Overall, the higher doses of NPK fertilizers resulted in higher values of all the growth parameters at different stages of crop growth. The results are in line with those reported by Parameshwara (2003), Hegazi and ALSodon (2001).

The earliness traits like days to first head initiation and fifty per cent head initiation in cabbage were not affected by different levels and methods of fertilizes application in the present study (Table 2). These results are in accordance with those reported by Thompson *et al.*, (2002) and Kadam *et al.*, (2006).

The weight of individual head is an important parameter which ultimately decides the yield of the cabbage crop (Table 2). Fertigation with 100% RDF (150:100:125 kg NPK ha⁻¹) in 12 equal splits at 5 days intervals registered significantly higher head weight (1,194.23 g) than rest of the fertigation levels. Whereas minimum head weight (683.96g) was observed due to Soil application of 100% RDF. An increased in head weight might be due to increased nutrient availability in the root zone leads greater absorption of nutrients by plants which caused more head weight.

Table.1 Plant height (cm), plant spread (cm) in North- South and East- West direction at different growth stages of cabbage as influenced by fertigation levels

Treatments		Plant height (cm)			Plant Spread (cm)					
					North- South direction			East- West direction		
		45 DAT	60 DAT	At harvest	45 DAT	60 DAT	At harvest	45 DAT	60 DAT	At harvest
T₁	100% RDF (150:100:125 kg NPK ha ⁻¹) in 6 equal splits at 10 days intervals	19.13	29.13	33.40	58.53	68.59	70.93	58.59	68.53	70.79
T₂	75% RDF (112.5:75:93.75 kg NPK ha ⁻¹) in 6 equal splits at 10 days intervals	18.53	28.53	31.33	56.52	66.53	68.13	56.25	66.26	67.79
T₃	50% RDF (75:50:62.5 kg NPK ha ⁻¹) in 6 equal splits at 10 days intervals	16.66	26.66	29.93	53.92	63.93	65.86	54.19	64.19	66.12
T₄	100% RDF (150:100:125 kg NPK ha ⁻¹) in 12 equal splits at 5 days intervals	20.53	30.53	35.46	59.06	69.06	72.53	59.33	69.32	72.79
T₅	75% RDF (112.5:75:93.75 kg NPK ha ⁻¹) in 12 equal splits at 5 days intervals	18.66	28.66	32.06	57.92	67.92	70.53	58.19	68.19	70.53
T₆	50% RDF (75:50:62.5 kg NPK ha ⁻¹) in 12 equal splits at 5 days intervals	17.80	27.80	30.26	55.13	65.13	67.06	55.06	65.06	66.79
T₇	Soil application of 100% RDF (150:100:125 kg NPK ha ⁻¹)	14.93	24.93	27.20	52.05	62.00	64.26	52.26	62.26	64.13
S.Em±		0.24	0.44	0.48	0.93	1.04	0.89	0.60	1.41	1.18
CD @ 5%		0.76	1.37	1.49	2.91	3.23	2.76	1.89	4.39	3.68

Table.2 Days to first and 50 per cent head initiation, fresh head weight (g), head diameter (cm), head volume (cc), head length (cm), head width (cm), and yield of cabbage as influenced by fertigation levels

Treatments		Days to first head initiation	Days to 50 per cent head initiation	Fresh weight (g)	Head diameter (cm)	Head volume (cc)	Head length (cm)	Head width (cm)	Yield per plot (kg)	Yield per hectare (t)
T ₁	100% RDF (150:100:125 kg NPK ha ⁻¹) in 6 equal splits at 10 days intervals	40.73	43.00	994.267	28.74	1,093.53	10.70	12.66	23.86	36.83
T ₂	75% RDF (112.5:75:93.75 kg NPK ha ⁻¹) in 6 equal splits at 10 days intervals	41.46	43.50	891.24	26.10	987.717	10.26	12.06	21.39	33.01
T ₃	50% RDF (75:50:62.5 kg NPK ha ⁻¹) in 6 equal splits at 10 days intervals	41.26	43.32	743.973	24.15	780.867	9.63	10.90	17.86	27.56
T ₄	100% RDF (150:100:125 kg NPK ha ⁻¹) in 12 equal splits at 5 days intervals	40.66	42.70	1,194.23	29.11	1,296.53	11.60	13.60	33.00	43.22
T ₅	75% RDF (112.5:75:93.75 kg NPK ha ⁻¹) in 12 equal splits at 5 days intervals	41.33	43.71	919.747	26.18	1,019.87	10.33	12.06	22.08	34.08
T ₆	50% RDF (75:50:62.5 kg NPK ha ⁻¹) in 12 equal splits at 5 days intervals	41.26	43.11	713.573	24.88	786.067	9.63	10.15	17.13	26.43
T ₇	Soil application of 100% RDF (150:100:125 kg NPK ha ⁻¹)	41.40	43.99	683.96	23.18	722.6	8.63	9.40	16.03	24.74
S.Em±		0.20	0.81	26.081	0.36	36.197	0.32	0.22	1.36	0.99
CD @ 5%		NS	NS	81.255	1.12	112.768	1.02	0.70	4.26	3.10

These results are in conformity with the findings of Shinde *et al.*, (2006) and Tanpure *et al.*, (2007), Imtiyaz *et al.*, (1999), Kumar and Sahu (2013), Verma *et al.*, (2014), Kumari *et al.*, (2015) and Mankar *et al.*, (2015). An optimum nutrition levels might have provided better translocation of minerals and increased accumulation of photosynthates in plants thus increased head weight. The findings of this investigation were in close conformity with those of Wange *et al.*, (1995), Chattoo *et al.*, (1997) and Mohapatra *et al.*, (2013).

The head diameter of cabbage is a vital parameter which influences the head size and its market value (Table 2). A larger diameter of head fetches better market quality of cabbage as well as processing. An application of 100 % RDF (150:100:125 kg NPK ha⁻¹) in 12 equal splits at 5 days intervals resulted in higher head diameter (29.11 cm) followed by 100 % RDF in 6 equal splits (150:100:125 kg NPK ha⁻¹) at 10 days intervals with (28.73 cm). The higher values for diameter of head with these levels and combinations might be due to higher uptake of nutrients. These results are in conformity with the findings of Sharma *et al.*, (2004), Shinde *et al.*, (2006) and Tanpure *et al.*, (2007).

The head volume was influenced significantly due to different fertigation levels (Table 2). A significantly higher head volume (1,296.53 cc) was observed in application of 100 % RDF (150:100:125 kg NPK ha⁻¹) in 12 equal splits at 5 days intervals. While, the minimum head volume (722.6 cc) was observed with Soil application of 100 % RDF. Head volume is positively correlated with yield. Significant variation in the head volume might be due to the variations in head length and head width. An increased head volume might be due to increased nutrient availability in the root zone leads greater absorption of nutrients by plants which caused more head weight. These results

are in conformity with the findings of Shinde *et al.*, (2006) and Tanpure *et al.*, (2007), Imtiyaz *et al.*, (1999), Kumar and Sahu (2013), Verma *et al.*, (2014), Kumari *et al.*, (2015) and Mankar *et al.*, (2015).

The head length and head width were influenced significantly due to different fertigation levels (Table 2). Fertigation of 100 % RDF (150:100:125 kg NPK ha⁻¹) in 12 equal splits at 5 days intervals registered significantly higher head width (11.60 cm) and core width (4.88 cm) than rest of the fertigation treatments. The minimum head length of 8.63 cm and head width of 9.40 cm was observed due to soil application of 100 % RDF. The maximum head length and width may be due to increased nutrient availability in the root zone leads to greater absorption of nutrients by plants which might increased the vegetative growth and more translocation of photosynthates towards head which increased head length. These results are in conformity with the findings of Sharma *et al.*, (2004), Shinde *et al.*, (2006) and Tanpure *et al.*, (2007). Verma *et al.*, (2014), Verma and Nawange (2015) in cabbage and Prasad *et al.*, (2009) in Chinese cabbage, Hossain *et al.*, (2011).

The cabbage yield was influenced significantly due to different fertigation levels (Table 2). Fertigation of 100 % RDF (150:100:125 kg NPK ha⁻¹) in 12 equal splits at 5 days intervals registered significantly higher cabbage yield per plot (33.00 kg) and yield per hectare (43.22 t ha⁻¹) than rest of the fertigation levels. However, minimum yield per hectare was recorded in T₇ (control). Yield is a complex character which involves the interaction of several intrinsic and external factors. It largely depends upon the production and mobilization of carbohydrates, uptake of water and nutrients from the soil, in addition to several environmental factors to which plants is exposed during the growing

period. At higher dose of fertigation level, crop might meet out its nutritional requirement at respective growth stages leads to luxurious growth resulted in more interception of light and more translocation of photosynthates from source (vegetative part) to sink (reproductive part) which enhanced the yield. These results are in agreement with those reported by Shinde *et al.*, (2006) and Tanpure *et al.*, (2007).

From the present investigation, it can be concluded that application of 100 % RDF (150:100:125 kg NPK ha⁻¹) in 12 and 6 equal splits at 5 and 10 days intervals through drip irrigation with water soluble fertilizers is ideal to achieve maximum growth and yield in cabbage.

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