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Effect of Different Levels of Foliar Spray of Water-soluble Fertilizer NPK on Growth, Yield and Quality of Curly Kale (*Brassica oleracea* var. Acephala)

Rahul Mishra [a*], Samir E. Toppno [a], Anita Kerketta [a] and Suhel Eraqui [a]

[a] Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Science, Prayagraj-211007, (U.P), India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A trial was conducted at the Vegetable Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP) during 2022 to study the "Effect of different levels of foliar spray of water-soluble fertilizer NPK on growth yield and quality of Curly Kale (*Brassica oleracea* var. acephala)"results revealed that maximum plant height, leaf area, days to germination, days to leaves picking ,number of leaves per plant, average leaves weight, yield per plot, yield per hectare, TSS and chlorophyll content were found in T6 {5% (N.P.K. 20:20:20) + 75% RDF.

Keywords: Chlorophyll content; curly kale; Brassicaceae; vegetable foliar spray.

**Corresponding author: E-mail: rickymishra543@gmail.com;*

1. INTRODUCTION

Curly kale (*Brassica oleracea* var. acephala) is a leafy vegetable that belongs to the family Brassicaceae, which includes other popular vegetables such as broccoli, cauliflower, and cabbage [1]. Curly kale is known for its dark green, frilly leaves that are tightly packed together in a rosette shape. It is a coolseason crop that is typically grown in the fall and winter months in temperate regions. It is a hardy crop that is widely grown for its edible leaves, which are rich in vitamins, minerals, and antioxidants. Curly kale is a biennial plant that is grown as an annual, with a growing period of 60-90 days [2,3]. Curly kale can be eaten raw or cooked, and it can be prepared in a variety of ways, including steaming, sautéing, baking, and blending .Curly kale is a rich source of vitamins A, C, and K, as well as minerals such as calcium, potassium, and iron. It also contains antioxidants such as carotenoids and flavonoids, which have been shown to have anti inflammatory and anti-cancer properties. Additionally, curly kale is low in calories and high in fiber ,making it an ideal food for weight management and digestive health The crop is typically grown in cool temperate climates, with a minimum temperature of 10°C and a maximum of 25°C. The optimum temperature range for growth is 15-20°C. The crop requires a well-drained, fertile soil with a pH range of 6.0-7.5. The site should be free of weeds and debris, and it should receive full sun or partial shade. The soil should be prepared by plowing or tilling to a depth of 15-20 cm, followed by the application of organic matter such as compost or well-rotted manure. Curly kale can be grown from either seed or seedlings. Seedlings are typically grown in nurseries and transplanted to the field after 4 -6 weeks. The seedlings should be planted in rows with a spacing of 30-45 cm between plants and 60-90 cm between rows. Theseeds can also be sown directly in the field, but this method is less common. Curly kale requires adequate amounts of nutrients, especially nitrogen (N), phosphorus (P), and potassium (K). The soil should be tested before planting to determine the nutrient status and the amount of fertilizer required. In general, 150 - 200kg/ha of N, 50-70 kg/ha of P, and 100-150 kg/ha of K are recommended for curly kale production.

2. MATERIALS AND METHODS

The details of the various material used and methods adopted in carrying out experiment are presented below:-

Chart 1. Experimental materials

S.No.	Treatment	Solution	Frequency
1.	T0	control	7 days interval
2.	T1	5% (N.P.K. 19:19:19) +25% RDF 1.5g/l of water 12.37g N.	7 days interval
3.	T2	5% (N.P.K. 19:19:19)+50% RDF 1g/l of water 24.75g N.	7 days interval
4.	T3	5% (N.P.K. 19:19:19)+ 75% RDF 0.5g/l of water 37.12 g N.	7 days interval
5.	T4	5% (N.P.K. 20:20:20)+ 25% RDF 1.5g/l of water 12.37 g N.	7 days interval
6.	T5	5% (N.P.K. 20:20:20)+ 50% RDF 1g/l of water 24.75 g N.	7 days interval
7.	T6	5% (N.P.K. 20:20:20)+ 75% RDF 0.5g/l of water 37.12 g N.	7 days interval
8.	T7	RDF (200:125:150)	split in 2 doses

Table 1. Performance of different treatment combination of different level of foliar spray of water soluble fertilizer N.P.K on growth , yield , and quality of curly kale (*brassica oleracea* var, acephala)

Treatment no.	Treatment details.	Plant height (cm) (45DAS)	Leaf area(cm.sq) (cm2)	Days to germination	Days to leaves picking	No.leaves per plant	Fresh leaves weight(g)	Leaves yield/plot (kg)	Leaves yield (t/ha)
T0	control	19.77	85.59	9.67	50.31	12.54	130.85	1.18	9.71
T1	5% (N.P.K. 19:19:19) +25% RDF 1.5g/l of water 12.37g N.	22.45	88.47	9.32	48.88	15.29	135.47	1.20	10.02
T2	5% (N.P.K. 19:19:19) +50% RDF 1g/l of water 24.75 g N.	24.80	92.28	9.33	47.16	17.59	137.43	1.23	10.18
T3	5% (N.P.K. 19:19:19) +75% RDF 0.5g/l of water 37.12 g N.	26.02	93.66	9.33	46.43	17.84	138.63	1.25	10.29
T4	5% (N.P.K.20 :20:20) +25% RDF 1.5g/l of water 12.37g N.	23.32	89.57	9.32	47.73	17.84	135.70	1.22	10.04
T5	5% (N.P.K. 20:20:20) +50% RDF 1g/l of water 24.75g N.	26.70	94.66	8.33	43.08	17.32	138.81	1.25	10.29
T6	5% (N.P.K. 20:20:20) +75% RDF 0.5g/l of water 37.12g N.	27.91	96.80	7.33	42.25	19.61	140.56	1.26	10.39
T7	RDF(200:125: 150)	20.91	87.15	9.66	49.44	20.18	135.92	1.19	9.85
F-test		S	S	S	S	S	S	S	S
SE(D)			0.45	0.45	0.45	0.45	0.45	0.45	0.45
CD			0.99	0.99	0.99	0.99	0.99	0.99	0.99
C.V			4.34	4.34	4.34	4.34	4.34	4.34	4.34

3. RESULTS AND DISCUSSION

3.1 Plant Height at 45 DAT

Data reveals that there was a significant effect of various treatment on plant height at 45 daysafter sowing. Among different levels of NPK fertilizers T6 {5% (N.P.K. 20:20:20) + 75% RDF}recorded maximum height of 27.91 cm whereas minimum plant height of 19.77 cm was recorded in T0 (Control).

3.2 Leaf Area

Data reveals that there was a significant effect of various treatment on leaves area. Among different levels of NPK fertilizers T6 {5% (N.P.K. 20:20:20) + 75% RDF} recorded maximum leaf area of 96.80 cm2 whereas minimum leaf area of 85.59 cm2 was recorded in T0(Control).

3.3 Days to Germination

Data reveals that there was a significant effect of various treatment on days to germination. Among different levels of NPK fertilizers T6 {5% (N.P.K. 20:20:20) + 75% RDF} recorded minimum days to germination of 7.33 whereas maximum days to germination lof 9.67 cm2 was recorded in T0 (Control).

3.4 Days to Leaf Picking

Data reveals that there was a significant effect of various treatment on days to leaves picking. Among different levels of NPK fertilizers T6 {5% (N.P.K. 20:20:20) + 75% RDF} recorded minimum days to leaves picking of 40.25 whereas maximum days to leaves picking of 50.31 cm2 was recorded in T0 (Control).

3.5 No.of Leaves per Plant

Data reveals that there was a significant effect of various treatment on number of leaves per plant. Among different levels of NPK fertilizers T6 {5% (N.P.K. 20:20:20) + 75% RDF} recorded maximum number of leaves per plant of 20.18 whereas minimum number of leaves per plant of 12.54 was recorded in T0 (Control).

3.6 Fresh Leaves Weight (g)

Data reveals that there was a significant effect of various treatment on average fresh leaves weight. Among different levels of NPK fertilizers T6 {5% (N.P.K. 20:20:20) + 75% RDF} recorded maximum fresh weight leaves of 140.56 gm whereas minimum fresh weight leaves of 130.85 gm were recorded in T0 (Control).

3.7 Leaves Yield per Plot

Data reveals that there was a significant effect of various treatment on average fresh leaves weight. Among different levels of NPK fertilizers T6 {5% (N.P.K. 20:20:20) + 75% RDF} recorded maximum leaves yield per plot of 1.26 kg whereas minimum leaves yield per plot of 1.18 kg was recorded in T0 (Control).

3.8 Leaves Yield (t/ha)

Data reveals that there was a significant effect of various treatment on average fresh leaves weight. Among different levels of NPK fertilizers T6 {5% (N.P.K. 20:20:20) + 75% RDF} recorded maximum leaves yield per plot of 10.39 tonn/ha whereas minimum leaves yield per plot of 9.71 tonn/ha was recorded in T0 (Control).

Tsegaye et al. [4] concluded that the simultaneous application of nitrogen and phosphorus significantly enhanced the growth parameters, such as plant height, leaf area, and shoot biomass of kale and maintaining an appropriate balance between nitrogen and phosphorus levels is crucial for optimizing kale growth, as excessive nitrogen may reduce phosphorus uptake and vice versa.

A study conducted by Yin et al in the year 2017 and studied increased nitrogen levels promoted leaf growth, plant height, and overall biomass production in kale, adequate phosphorus supply enhanced root development, increased leaf area, and improved nutrient uptake efficiency in kale plants, higher potassium levels resulted in improved leaf quality, enhanced water-use efficiency, and increased resistance to pests and diseases.

A study by Zhang et al. in the year 2018 showed that combined application of nitrogen, phosphorus, and potassium resulted in significantly higher plant height, leaf number, and shoot fresh weight compared to individual nutrient treatments. Its application maintained a balanced ratio of nitrogen, phosphorus, and potassium is important for maximizing the vegetative growth and yield of kale.

In the year 2019, Qi et al. evaluated that optimal combinations of nitrogen and potassium fertilizers led to increased plant height, leaf size, and chlorophyll content in kale plants.High

nitrogen supply combined with potassium application resulted in higher leaf yield, total biomass, and enhanced photosynthetic activity.

Gong et al. [5] explored the influence of nitrogen, phosphorus, and potassium on the growth and nutrient uptake of kale (*Brassica oleracea* L. var. sabellica). Their findings revealed that optimal combinations of nitrogen and phosphorus fertilizers enhanced growth parameters, nutrient uptake, and accumulation in kale plants. Moreover, adequate potassium supply improved leaf area, shoot biomass, and nutrient use efficiency in kale.

4. SUMMARY AND CONCLUSION

From the above experimental finding, it is concluded that the treatment T6 {5% (N.P.K. 20:20:20) + 75% RDF} was found to be best in terms of growth, yield and quality. Highest net return was found in the same T6 {5% (N.P.K. 20:20:20) + 75% RDF} while the highest B:C ratio was found in T5 {5% (N.P.K. 20:20:20) + 50% RDF} with 12.85.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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