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Effect of nutrients and growth regulator on growth and leaf yield of off-season coriander, *Coriandrum sativum* L.

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ABSTRACT

Coriander is a dual purpose crop grown for green leaf as well as for seed. It is one of the earliest known spices by mankind grown for its leaves, seeds, essential oil and oleoresin. The green leaves are consumed as fresh herbs, in salads and as garnishes due to its attractive green colour and aroma. Growing of leafy coriander in off-season (summer) fetch premium price in the market. The investigation was under taken to study the effect of nutrients and growth regulator on growth and leaf yield of off season coriander in Randomized Block Design with three replications during the year 2012-13 and 2014-15. Among the various treatments, application of 45:40:20 kg of NPK ha^{-1} (T_3) recorded the highest plant height (34.09 cm). The highest leaf yield was recorded by the treatment T_6 (30:40:20 NPK+ GA_3 15 ppm at 20 DAS) (4824 kg ha^{-1}) with highest B: C ratio of 2.37 followed by the treatment T_8 (45:40:20 NPK+ GA_3 10 ppm at 20 DAS) (4448 kg ha^{-1}). Among the different treatments, the treatment T_6 (30:40:20 NPK+ GA_3 15 ppm at 20 DAS) recorded the highest essential oil content (0.023%) and oleoresin content (7.67%) followed by T_8 (45:40:20 NPK+ GA_3 10 ppm at 20 DAS) (0.021% and 7.45% respectively) and T_1 (control) noticed the lowest content of essential oil (0.013% and 5.01% respectively).

Keywords: Coriander, gibberellic acid, leaf yield nutrients and off season vegetables

Coriander (*Coriandrum sativum* L.) belongs to the family Apiaceae (Umbelliferae) which is mainly cultivated from its seed throughout the year (Mhemdi *et al.,* 2011). It is one of the earliest known spices by mankind grown for its leaves, seeds, essential oil and oleoresin. The green leaves are consumed as fresh herbs, in salads and as garnishes due to its attractive green colour and aroma (Norman 1990; Kamat *et al.,* 2003). Coriander is considered as an important herb due to its extensive use in medicine for curing capabilities against many diseases due to the presence of active ingredients in its leaves and fruit (Kubo *et al.,* 2004). All parts of this herb are used as a flavoring agent and/or as traditional remedies for the treatment of different disorders in the folk medicine systems of different civilizations (Sahib *et al.,* 2012). Most importantly, it is well known for its fraction of volatile essential oil composition like terpenoids and phenolic constituents which are of the great importance in the field of pharmacology (Sriti *et al.,* 2013). In addition, its essential oil content ranges from 0.03 to 2.6% (Nadeem *et al.,* 2013) and possess different antioxidants, anticancer, antibacterial and anti-mutagenic agents as trace compounds (Mataysoh *et al.,* 2009).

Menon and Khader (1997) suggested that leaf plucking of coriander seed crop at early stages can provide an extra income to the growers. There is a great demand for leaf during summer months from March to June, as production is limited to only a few areas of the country, where summer temperatures are low. The production of greens in the off-season will fetch premium price in the market especially during summer months. The shade net houses during off season reduce the temperature up to 5^0C and increase the relative humidity, thereby providing optimum environmental conditions for the growth of coriander.

Application of nutrients becomes essential for any crop production in order to get a good yield. Among the primary nutrients, nitrogen has a considerable effect, not only on quality of produce but on quantity of produce also. Nitrogen is one of the major elements for growth and development of plant. It is involved in photosynthesis, respiration and protein synthesis. It impart the dark green colour of the leaves, promotes vigorous vegetative growth and more efficient use of available inputs finally leads to higher productivity. Plant growth regulators leads to better growth and yield without substantial increase in the cost of production. Gibberellic acid is found to induce stem and internode elongation, flowering and fruit setting and growth.

Hence, there is a need to improve the green leaf yield of coriander in the off-season. The nutrient recommendation adopted for the seed coriander is followed for the leaf production. The duration of the leafy coriander production is 45 - 50 days when compared to seed crop which accounts for 120 days. Therefore, with this background this trial was formulated with an objective to standardize the nutrient requirement of off – season production of coriander leaf.

MATERIALS AND METHODS

The field experiments were conducted at College Orchard, Horticultural College and Research Institute,

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Tamil Nadu Agricultural University, Coimbatore for three years (2012-13, 2013-14 and 2014-15). The field is located at 11^o N latitude, 77^o E longitude with an altitude of 411 m above mean sea level. The soil of the experimental area belongs to black clay loam in texture and pH of the soil is 7.00. The experiment was laid out in a Randomized Block Design with nine treatments and replicated thrice. The treatment details are as follows-

T_1 : Control – No fertilizer
T_2 : 30:40:20 NPK kg ha^{-1} (Lal *et al*., 2010)
T_3 : 45:40:20 NPK kg ha^{-1} (Lal *et al*., 2010)
T_4 : 30:40:20 NPK kg ha^{-1} + spraying with GA_3 5 ppm at 20 DAS.
T_5 : 30:40:20 NPK kg ha^{-1} + spraying with GA_3 10 ppm at 20 DAS.
T_6 : 30:40:20 NPK kg ha^{-1} + spraying with GA_3 15 ppm at 20 DAS.
T_7 : 45:40:20 NPK kg ha^{-1} + spraying with GA_3 5 ppm at 20 DAS.
T_8 : 45:40:20 NPK kg ha^{-1} + spraying with GA_3 10 ppm at 20 DAS.
T_9 : 45:40:20 NPK kg ha^{-1} + spraying with GA_3 15 ppm at 20 DAS.

(*P as basal and N & K in two split applications –*i.e* basal + top dressing @ 30 DAS)

Coriander variety CO (CR) 4 was raised in flat beds of 2.5 x 4 m during summer season of three consecutive seasons (2012-13 to 2014-15) and water soaked seeds were sown 25 cm apart between the rows in 50% shade net house. Recommended package of practices was followed uniformly for all the plots. Light irrigation was given on the third day after sowing and subsequent irrigations were scheduled at 5 to 7 days intervals depending on the soil and climatic conditions. Weeding was done on 20th and 30th days after sowing. Physiologically matured leaves were harvested from 45th day after sowing. Data on plant height, number of leaves, leaf yield and essential oil content was recorded during the crop growth period. Pooled analysis was done as per the method suggested by Jawahar (2006).

RESULTS AND DISCUSSION

The pooled analysis of the data (Table 1) revealed that significant difference was observed between the treatments. The plant height varied significantly from 26.42 to 34.09 cm. Application of 45:40:20 NPK (T_3) recorded the highest plant height (34.09 cm) followed by 32.39 cm under the treatment T_6 (30:40:20 NPK+ GA_3 15 ppm at 20 DAS). This is as per hypothesis; increased nutrients through fertilizers must have made the nutrients available in larger quantity than the rest of the corresponding treatments. Beneficial effect of fertilizer levels on coriander growth is well documented by Singh *et al.* (1999) is in the line of present research work and provides a scientific support. Thus, increased endogenous level of nutrition in plant by virtue of its increased availability in the soil medium and there after efficient absorption and translocation in various growth stages by way of active cell division and elongation resulting in greater plant height (Bhat and Sulikeri, 1992). The results are in conformation with Das *et al*. (1991) and Oliveira *et al.* (2003) in coriander.

The highest mean number of shoots per plant (5.34) was noticed in T_6 (30:40:20 NPK+ GA_3 15 ppm at 20 DAS) at 45 DAS. With regard to the number of leaves it was on par in all the treatments. The highest number of leaves was recorded by the treatment T_6 (30:40:20 NPK+ GA_3 15 ppm at 20 DAS). Application of 30:40:20 NPK along with foliar spraying of GA_3 15 ppm at 20 DAS (T_6) exhibited greater leaf weight (9.06 g) and stem weight (4.28 g). The highest plant weight was registered at T_6 (30:40:20 NPK+ GA_3 15 ppm at 20 DAS) with 14.62 g, whereas, the lowest plant weight was observed in control (T_1) being, 9.71 g. The projected leaf yield per hectare was significantly influenced by different treatments and the data pertaining are furnished in Table 2. The highest projected leaf yield per hectare of 4824.07 kg ha^{-1} was obtained with the application of 30:40:20 NPK + GA_3 15 ppm at 20 DAS under shade and the lowest projected leaf yield per hectare (3525.56 kg ha^{-1}) was registered in control (T_1). It is obvious from the findings that leaf yield increased with inorganic fertilizer along with GA_3. Balanced supply of nutrients plays a vital role in various metabolic processes, which resulted in increased plant growth and development thereby improving yield. These processes might be favourably improved with readily available nitrogen through inorganic chemical fertilizers and finally resulted in higher yield and harvest index. Similar result was observed by Bhati *et al.* (1988) and Patel *et al.* (2000) in fennel and Diovisalvi *et al.* (2016) in sunflower.

The importance of endogenous growth regulators in affecting many growth and morphogenetic processes has been well documented (Jacobs, 1968). Growth of stems and other organs is promoted by GA_3 and results from enhanced cell division, increased carbohydrate hydrolysis, and increased cell wall plasticity (Sachs, 1961; Salisbury & Ross, 1978 and Boyle *et al*., 1994). GA_3 increased petiole length, leaf area and delayed petal abscission and color fading (senescence) by the hydrolysis of starch and sucrose into fructose and glucose (Khan and Chaudhry, 2006; Emongor, 2004). Khan *et al.* (1998) reported that foliar application of gibberellic acid at the pre-flowering stage of mustard plants causes 35.5% increase in leaf area, followed by increased trapping of sunlight, which apparently enhances dry matter. The treatment T_6 (30:40:20 NPK+ GA_3 15 ppm

Table 1: Effect of nutrient and growth regulator on growth of off season coriander (Pooled)

Treatments	Plant height (cm)	No. of shoots plant^{-1}	No. of leaves plant^{-1}	Leaf weight (g)	Stem weight (g)	Plant weight (g)
T_1- Control	26.42	3.23	23.32	6.84	3.81	9.71
T_2- 30:40:20 NPK	27.92	4.04	23.84	7.02	4.04	11.02
T_3- 45:40:20 NPK	34.09	4.19	22.57	7.29	4.19	12.23
T_4- 30:40:20 NPK+GA 5 ppm at 20 DAS	31.46	3.64	24.06	7.43	4.24	12.05
T_5-30:40:20 NPK+GA 10 ppm at 20 DAS	30.45	4.55	23.69	6.74	3.64	11.01
T_6-30:40:20 NPK+ GA 15 ppm at 20 DAS	32.39	5.34	26.05	9.06	4.28	14.62
T_7-45:40:20 NPK+ GA 5 ppm at 20 DAS	30.43	4.16	23.51	7.47	3.89	12.62
T_8-45:40:20 NPK+ GA 10 ppm at 20 DAS	28.75	4.24	24.68	8.17	4.15	13.15
T_9-45:40:20 NPK+ GA 15 ppm at 20 DAS	28.92	3.81	22.94	6.71	3.81	11.21
SEm (±)	**1.43**	**0.04**	**0.18**	**0.06**	**0.03**	**0.10**
LSD (0.05)	**3.03**	**0.07**	**0.36**	**0.12**	**0.06**	**0.21**

Table 2: Effect of nutrient and growth regulator on leaf yield and quality of off season coriander (Pooled)

Treatments	Leaf yield plot^{-1} (10 m^2) (kg)	Projected leaf yield (kg ha^{-1})	Essential oil content (%)	Oleoresin content (%)	B:C
T_1- Control	3.53	3525.56	0.012	5.01	1.59
T_2- 30:40:20 NPK	4.11	4112.78	0.015	5.72	1.96
T_3- 45:40:20 NPK	4.38	4378.33	0.017	6.23	2.08
T_4- 30:40:20 NPK+GA 5 ppm at 20 DAS	4.40	4398.70	0.018	6.56	2.10
T_5-30:40:20 NPK+GA 10 ppm at 20 DAS	3.82	3820.00	0.013	5.26	1.85
T_6-30:40:20 NPK+ GA 15 ppm at 20 DAS	4.82	4824.07	0.023	7.67	2.37
T_7-45:40:20 NPK+ GA 5 ppm at 20 DAS	4.16	4160.56	0.016	5.86	2.05
T_8-45:40:20 NPK+ GA 10 ppm at 20 DAS	4.45	4448.33	0.021	7.45	2.24
T_9-45:40:20 NPK+ GA 15 ppm at 20 DAS	3.90	3900.74	0.014	5.48	1.92
SEm (±)	**0.24**	**236.17**	**0.002**	**0.14**	**-**
LSD (0.05)	**0.49**	**498.30**	**0.003**	**0.29**	**-**

at 20 DAS) expressed a greater oil content (0.023 per cent) which was on par with the treatment T_8 (45:40:20 NPK+ GA 10 ppm at 20 DAS) (0.021 per cent) as against 0.012 per cent in the treatment T_1 (control). The oleoresin content in leaf was highest in 30:40:20 NPK + GA_3 15 ppm at 20 DAS (7.67 per cent). The above results are in conformity with the findings of Meena *et al.* (2006), Panda *et al.* (2007), Singh *et al.,* (2012) and Mary Haokip *et al.* (2016) in coriander. The economics worked out for different treatments (Table 2) showed that T_6 (30:40:20 NPK+ GA_3 15 ppm at 20 DAS) recorded the highest benefit cost ratio of 2.37.

The study showed that different levels of nutrients and different concentrations of GA_3 significantly influenced growth parameters, leaf yield and quality parameters. However, application of 30:40:20 NPK along with foliar spraying of GA_3 15 ppm at 20 DAS was found to be superior followed by the application of 45:40:20 NPK along with foliar spraying of GA_3 10 ppm at 20 DAS with benefit cost ratio of 2.24.

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