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Influence of plant growth regulators on leaf and seed yield of coriander (*Coriandrum sativum* L.) var. Shalimar dhania-1

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Abstract
Coriander (*Coriandrum sativum* L.) is an important seed spice crop of family Apiaceae (Umbelliferae). Seed is an important component and a quality seed plays a crucial role in agricultural production as well as in national economy. Availability of viable and vigorous seed at the planting time is important for achieving targets of agricultural production because good quality seed acts as a catalyst for realizing the potential of other inputs. Since the total cultivable area is decreasing due to over growing population, the increased agricultural productivity is the only option. The good quality seed is pre-requisite to enhance the production and productivity. Plant growth regulators have emerged as chemical that could increase agricultural production at an unprecedented rate and help in removing or circumventing many of the barrier imposed by genetics and environment. Therefore considering the significance of coriander in national economy, a field experiment entitled "Influence of Plant Growth Regulators on Leat, Seed yield and Quality of Coriander (*Coriandrum sativum* L.) var. Shalimar Dhania-1" was conducted at experimental field of Division of Vegetable Science Sher-e-Kashmir University of Agricultural Sciences and Technology Shalimar during *Rabi* 2017-2018. The experiment consisted of 6 levels of plant growth regulators Gibberlic acid (GA_3), 1- Naphthalenacetic acid (NAA) and 2, 4-Dichlorophenoxyacetic acid (2, 4-D) each at different concentrations, applied at three stages (soaking of seeds, foliar application at 4-6 leaf stage and at initiation of flowering). An absolute control was also maintained. Thus, experiment consisted of 21 treatment combinations.
The results indicated that application of treatment, (T_2) GA_3 45 ppm resulted in maximum values for growth parameters viz., plant height (cm), number of nodes on main shoot, fresh weight of leaves per plant (g), number of branches per plant, number of green leaves per plant, fresh weight of shoots per plant (g), plant spread (cm), and minimum days taken for 50 percent flowering. Similarly maximum values for yield and yield attributing parameters viz., leaf yield per plot (kg), number of umbels per plant, seed yield per plant (g), seed yield per plot (kg) were recorded by treatment, T_2 (GA_3 45 ppm).

Keywords: Coriander, plant growth regulators, growth, and seed yield

Introduction
Coriander (*Coriandrum sativum* L.) popularly known as "Dhania" belongs to family Apiaceae (Umbelliferae) and possess 2n=22 chromosomes is one of the oldest seed spices used by the mankind. It is the most widely cultivated condiment throughout the world. It is native to Mediterranean region and extensively grown in Bangladesh, India, Russia, Central Europe and Morocco. India has the prime position in cultivation and production of coriander. It is mainly grown for its aromatic and fragrant seed which is botanically a cremocarpic fruit. The fresh green stem leaves and fruits have a pleasant aromatic odour. The pleasant aroma in the plant is due to an essential oil called 'Coriandrol' ranges from 0.1 to 1.3 per cent in dry seeds. Good quality oleoresin can be extracted from coriander seed which is used for flavouring beverages, sweets, pickles, sausages, snacks, etc. Coriander bark oil has high germicidal activity and can be used as fungicide (Krishna De, 1999). Besides the essential oil, the seed contain 16.1 percent fatty oil, 14.1 percent protein, 21.6 percent carbohydrate, 32.6 percent fibers, 11.2 percent moisture and 4.4 percent mineral matters and coriander leaves are rich source of vitamin A and Vitamin C (Singh *et al.*, 2017) [20]. The entire young plant is used for flavouring curried dishes of all sorts and chutney. Coriander leaves are also rich source of vitamin C (125-250 mg/100g) and vitamin A (5200 IU/100 g).

In medicine, its seed is used as a Carminative, refrigerant and diuretic. The dry seeds of coriander contain 0.3 per cent essential oil, 19.6 per cent non-volatile oil, 24 per cent carbohydrates, 5.3 per cent mineral matter and 175 IU/100 g vitamin A (Meena *et al.*, 2005) [9].
India accounts for about 80 percent of the total world Coriander production. In 2014-2015, coriander production was recorded 4.62 lakh tons with 5.53 lakh hectare area. In 2015-2016, the coriander production was 5.66 lakh tones from an area of 6.22 lakh hectare. In 2013-2014, coriander export have risen to 45,750 tons from 35,902 tons. Over a period of two years coriander exports have surged by 22 percent during the period of 2013-2015 (Anonymous, 2016) [2]. In agriculture, yield of any crop is increased by the use of fertilizers, pesticides, irrigation and better management coupled with varietal and genetic improvement and with growth regulators (Verma and Sen, 2006) [22]. Similarly, the growth yield and quality of coriander could be improved by the use of plant growth regulators, as their use has resulted in some outstanding achievements with respect to growth, yield and quality of several other crops.
In general, plant growth regulators (PGR`s) have great potential in increasing agricultural production and helps in removing many of the barriers imposed by genetics and environment.. It is well known that all the PGR`s regulate the physiological functions or processes of plant. Some researchers highlighted that spraying of PGR`s on crop plants improves growth, yield and quality attributes (Dhopte and Suradkar, 1988 and Geetha *et al.*, 2000) [5]. Among different PGR's, NAA and GA_3 have been reported to boost the growth, yield and quality attributes in coriander including photosynthetic ability of plants and has also been shown to enhance growth and yield of several vegetable and agricultural crops without substantial increase in the cost of production (Sumeriya *et al.*, 2000) [21]. The present field experiment was conducted to study the "Influence of Plant Growth Regulators on Leaf and Seed Yield (*Coriandrum sativum* L.) Var. Shalimar Dhania-1".

Materials and Methods
The field experiment was carried out at Experimental Field of the Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar. The experimental field (site) is situated at 34.1^o North latitude and 74.89^o East longitude with an altitude of 1587 meters above mean sea level. The experimental material consisted of one variety of coriander crop Shalimar Dhania-1. Time of Plant growth regulator (PGR) application

- Seed treatment (Seeds were treated with GA_3, NAA and 2,4-D for 8 hours)
- Foliar application at 4-6 leaf stage
- At initiation of flowering

Seven plant growth regulators treatments comprising of T_1 (GA_3 30 ppm), T_2 (GA_3 45 ppm), T_3 (NAA 50 ppm), T_4 (NAA 75 ppm), T_5 (2, 4-D 10 ppm), T_6 (2, 4-D 50 ppm), T_7 (Control) were tried under randomized complete block design with three replications. Plot size was 2.4×1.8m and spacing of 30×10cm. Data on growth and yield performance were recorded and statistically analyzed.

Results
The application of GA_3 45 ppm recorded significantly higher plant height (cm), number of nodes on main shoot, fresh weight of leaves per plant (g), number of branches per plant, number of green leaves per plant, fresh weight of shoots per plant (g), plant spread (cm), and minimum days taken for 50 percent flowering. Similarly maximum values for yield and yield attributing parameters viz., leaf yield per plot (kg), number of umbels per plant, seed yield per plant (g), seed yield per plot (kg) were also recorded in T2 (GA_3 45 ppm)

Table 1: Influence of plant growth regulators on growth of coriander

Treatments	Plant height (cm)	No. of nodes per plant	Weight of leaves per plant(g)	No. of branches per plant	No. of leaves per plant	Weight of shoots per plant(g)	Plant spread(cm)	Days taken to 50% flowering
1. GA_3 30 ppm	28.63	7.60	16.00	8.53	36.00	2.30	42.66	224.00
2. GA_3 45 ppm	32.60	8.23	17.10	8.90	37.33	2.59	46.66	221.33
3. NAA 50 ppm	25.16	6.73	13.07	7.96	30.73	1.35	38.06	230.33
4. NAA 75 ppm	26.76	7.10	14.03	8.23	33.66	1.79	39.86	227.00
5. 2,4-D 10 ppm	23.13	6.26	12.03	7.43	28.70	1.30	35.63	235.00
6. 2,4-D 50 ppm	21.80	6.03	11.16	7.20	26.79	1.20	35.06	240.33
7. Control	20.33	5.43	9.05	6.90	25.46	1.14	31.00	243.00
SE (d)	1.75	0.32	0.70	0.28	36.00	0.23	1.98	2.04
C.D at 5%	3.86	0.71	1.58	0.61	3.061	0.52	4.36	4.50

Table 2: Influence of plant growth regulators on yield of coriander.

Treatments	Leaf yield per plot (kg)	No. of umbels per plant	Seed yield per plant (g)	Seed yield per plot (kg)
1. GA_3 30 ppm	2.13	45.66	8.60	1.32
2. GA_3 45 ppm	2.42	48.00	9.48	1.38
3. NAA 50 ppm	1.52	40.33	6.73	1.02
4. NAA 75 PPM	1.80	43.00	7.48	1.15
5. 2,4-D 10 ppm	1.51	37.33	5.71	0.89
6. 2,4-D 50 ppm	1.38	31.66	5.55	0.82
7. Control	1.13	27.66	4.49	0.73
SE (d)	1.98	1.94	0.65	0.11
C.D at 5%	0.36	4.29	1.43	0.24

These results indicated that the plant growth regulators have their own specific influence on these growth and yield parameters. The primary physiological effect of plant growth regulators is to stimulate the elongation of cells due to increased enzymatic activities, permeability of cell wall and formation of energy rich phosphates (Salisbury and Ross, 1992). The better growth and yield of coriander might be due to the increased osmatic uptake of water and nutrients under the influence of plant growth regulators and in turn improving nutrient metabolism of plant system. Among the plant growth regulators and also among the modes of application, the highest plant height (32.60 cm), number of leaves (37.33), nodes per plant (8.23), fresh weight of leaves (17.10 g), shoots plant per plant (2.59 g) and plant spread (46.66 cm) were recorded with treatment, (T_2) GA_3 at 45 ppm and minimum in treatment, (T_7) control i.e., 20.33 cm, 25.46, 5.43, 9.05 g, 1.14 and 31.00 cm, respectively. This increase in growth and yield attributes could be due to the typical action of gibberellins .Gibberellic acid has been found to increase cell wall activity thus, creating water diffusion pressure deficit which results in water uptake, thereby causing cell elongation (Randhawa, 1971) [14].

There are numerous reports showing that gibberellin promotes growth of intact plants. The increase in plant height has been thought to be due to increased plasticity of the cell wall followed by hydrolysis of starch to sugars which lowers the water potential of cell there by resulting in the entry of water into the cell causing elongation. These osmotic driven responses under the influence of gibberellins might had attributed to increase in photosynthetic activity, accelerated translocation and efficiency of utilizing photosynthetic products, thus resulting in increased cell elongation and rapid cell division in the growing portion leading to increased length of internodes (Sargent, 1965) [17]. These results were in conformity with the findings of Meena *et al.* (2006) in coriander, Mobin *et al.* (2007) [10], Panda *et al.* (2007) [11], Verma and Sen (2008) [13], Singh *et al.*(2012) [19] in coriander, Vasudevan *et al.* (2008), Bairva *et al.* (2012) [3] in fenugreek, Abbas (2013) [1] in dill and Rohamare *et al.* (2013) [15] in cumin.

The highest leaf yield per plot (2.42 kg), seed yield per plant (9.48 g) and seed yield per plot (1.38 kg) was recorded in treatment, (T_2) GA_3 45 ppm, while the lowest seed yield per plant (4.49 g) and seed per plot (0.73 kg) was recorded with treatment, (T_7) control. This increase in seed yield could be due to increased in yield attributes such as number of umbels per plant, number of umbellets per umbel, and number of seeds per umbel. Improved vegetative growth due to Gibberellic acid application coupled with increased photosynthesis on one hand and greater mobilization of photosynthates towards reproductive sites on the other hand might have been found to increase the yield attributes. Thus, the cumulative effect of all yield attributes resulted in significant increase in seed yield. The results also support the findings of Pariari *et al.* (2007) [11], Verma and Sen (2006) [22] and Shah and Samiullah (2006) [18], who observed the beneficial effect of gibberellic acid with respect to seed yield in different crops. Prajapat *et al*., (2015) [13] in fennel, Krishnaveni *et al.* (2016) [8] in fenugreek and Haokip *et al*., (2016) [6] in coriander shows the maximum seed yield with application of GA_3.

Conclusion

On the basis of present one year experiment, it may be concluded that higher concentration of GA_3 significantly influencing the growth parameters, seed yield and yield attributing characters of coriander followed by NAA as compared to control.

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