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Influence of PGRs, sowing time and varieties on growth of coriander *(Coriandrum sativum* L.)

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Abstract
The present investigation entitled *"*Influence of PGRs, sowing time and varieties on growth of coriander *(Coriandrum sativum* L.*)"* The present experiment was laid out in the experimental field of department of Horticulture, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during first year (2018 – 19), second year (2019 – 20) and pooled with 24 treatment combinations that were laid out in split plot design and replicated three times. Sowing time and varieties were assigned to main plots whereas, plant growth regulators to sub plots. The observations were recorded on different aspects of plant height at 30, 60 and 90 DAS, number of primary and secondary branches of plant, number of node per plant at harvest, fresh weight of leaves at 45, 90 DAS and at harvest and dry matter accumulation. The result of experiment revealed that the D_1 (last week of December) significantly improved growth parameters among all the date of sowing D_2 (first week of January) and variety V_1 (RCr-41) was significantly always affected the all growth parameters, whereas PGRs T_3 (Thiourea @ 1000 ppm) enhanced all the growth parameters at different growth stages.

Keywords: PGRs, sowing time, varieties, growth and coriander

Introduction
Coriander (*Coriandrum sativum* L.) popularly known as "Dhania" is one of the oldest seed spices used by the mankind. It is the most widely used condiment throughout the world. It is mainly grown for its aromatic and fragrant seed which is botanically a cremocarpic fruit. The fresh green stem leaves and fruits of coriander 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. The oil of coriander seeds is a valuable ingredient in perfumes, cosmetic products, soup, candy, cocoa, chocolate, meat products, soft drinks and alcoholic beverages. 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, 1999) [12]. 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 medicines, 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.

Brassinosteroids are a new group of plant hormones with growth promoting activity (Mandava, 1988) [13]. Brassinosteroids are considered as plant hormones with pleiotropic effects as the influence on developmental processes of plants such as growth, seed germination, flowering, senescence, abscission and maturation (Sasse, 1999) [21]. Brassinosteroids improve the resistance in plant against environmental stresses such as water, salinity, low and high temperature stresses (Rao *et al*., 2002) [17] and it also enhances the crop productivity. Thiourea is a sulphydral compound which contains one-SH group and has been known to bring marked biological activity in plants. Use of thiourea as plant growth regulator (Sahu and Solanki, 1991) [19] may be helpful in this regard. Foliar spray of thiourea have been reported not only to improve growth and development of plants, but also the dry matter partitioning for increased grain yield (Arora, 2004) [2]. Application of naphthalic acetic acid (NAA) is known to induce higher physiological efficiency including photosynthetic ability of plants. It has also been shown to enhance growth and yield of several vegetables and agricultural crops without substantial increase in the cost of production (Sarada *et al*., 2008) [20]. Coriander variety RCr-41 is an important variety of Rajasthan covering large area and is recommended for normal sowing time.

However, the early growth of variety is very slow and the maturity generally coincides with high temperature. Similarly, varieties RCr-435 and RCr-480 are also suitable for normal conditions and also cover a large area of state.

Material and Methods

The present experiment was laid out in the experimental field of department of Horticulture, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.). The experiment comprised of two sowing time, two varieties and six plant growth regulators. Thus, there were 24 treatment combinations that were laid out in split plot design and replicated three times. Sowing time and varieties were assigned to main plots whereas, plant growth regulators to sub plots. The treatments were randomly allotted to the plots as shown in plan of layout using Fisher's random number table (Fisher, 1963) [7].

Result and Discussion

Among morphological characters, plant height, number of primary branch per plant, number of secondary branch per plant, fresh weight of leaves, number of node on main shoot per plant at harvest and dry matter accumulation were studies in coriander. On the basis of two year mean the pooled average was observed that the maximum plant height (4.59, 4.66 and 4.62 at 30 DAS, 25.15, 25.21 and 25.18 at 60 DAS and 76.13, 76.16 and 76.14 at 90 DAS) and fresh weight of leaves (11.09, 11.17 and 11.13 at 45 DAS, 23.54, 23.63 and 23.59 at 90 DAS and 33.16, 33.23 and 33.19 at harvest) were recorded in D_1 (Last week of December), while the minimum data were recorded in D_2 (First week of January) in all growth stages.D_1 and D_2 both were late sowing conditions, but D_2 was show significantly higher plant height and fresh weight of leaf at all over growth stages. It might be due to on sowing time the temperature was not lower than D_2. It was helpful to early and better germination and later growth stages crop was not suffer from higher temperature, while on date D_2 showed minimum data at all over growth stages because of late sowing conditions prevalence of low temperature at early stage and high temperature at terminal phase of the crop might have adversely (forced maturity) affected the growth of each developing structure. Hornok (1976) [9] also observed that low temperature at the time of emergence caused slow germination of coriander.

Results also revealed that number of primary (5.79, 5.86 and 5.83) and secondary branches (16.13, 16.22 and 16.17), number of node (9.79, 9.88 and 9.3) and dry matter accumulation (0.0490, 0.0498 and 0.0494) were recorded higher in D_1 as compared to D_2. It was due to D_1 date showed early germination and better plant growth as compared to D_2 because D_2 suffer from low and higher temperature at germination and later growth stage. The result is D_2 date of sowing showed lower result than D_1. This happened because of temperature was highly affected to plant growth and D_1 also indicated significantly higher chlorophyll content of the leaves, ultimately leading to higher contribution of photosynthesis to leaves. The findings are in close harmony with the result of Baswana *et al*. (1989) [5], Bhati (1991) [6], Jat (1995) [10] and Pan *et al*. (2003) [15].

Effect of varieties on growth parameters

The results revealed that variety RCr-435 was superior to RCr-41 in growth parameters viz. plant height (4.70, 4.77 and 4.73 at 30 DAS, 25.73, 25.78 and 25.75 at 60 DAS and 76.84, 76.90 and 76.87 at 90 DAS) and fresh weight of leaf (11.72, 11.80 and 11.76 at 45 DAS, 24.16, 24.24 and 24.20 at 90 DAS and 33.64, 33.71 and 33.68 at harvest) at all over growth stages of coriander. The improvement of plant height and fresh weight of leaf were manifest in higher biomass production by RCr-435 as compared to RCr-41. It is an established fact that growth, development and yield potential of crop/variety is an outcome of genomic, environmental and agronomic interactions. Since, these varieties were grown under identical agronomic (management) practices and environmental conditions; the observed variation in overall growth of varieties seems to be due to their genetic milieu. The better growth of RCr-435 as compared to other varieties was also observed by other workers, AICRPS, 2007 [1] and Balai and Keshwa, 2010 [4].

Results also revealed that number of primary (6.00, 6.08 and 6.04) and secondary branches (16.81, 16.90 and 16.85), number of node (10.08, 10.16 and 10.12) and dry matter accumulation (0.0496, 0.0503 and 0.0499) were recorded higher in variety RCr-435 as compared to variety RCr-41. The improvement in number of primary and secondary branches, number of node and dry matter accumulation manifested in higher biomass production by RCr-435 over RCr-41 at harvest. It is an established fact that growth, development and yield potential of crop/ variety is an outcome of genomic, environmental and agronomic interactions. Since, both the varieties were grown under identical agronomic (management) practices and environmental conditions; the observed variation in overall growth of varieties seems to be due to their genetic milieu. The findings are in close harmony with the result of Singh (1995) [22], Reddy *et al*. (1993) [18], Balai (2005) and Balai and Keshwa (2010) [4].

Effect of plant growth regulators

It is evident from results that the maximum plant height (4.64, 4.71 and 4.68 at 30 DAS, 25.66, 25.76 and 25.71 at 60 DAS and 76.92, 76.99 and 76.95 at harvest), number of primary (5.92, 5.98 and 5.95) and secondary branches (16.63, 16.70 and 16.66) per plant, fresh weight of leaves (11.41, 11.49 and 11.45 at 45 DAS, 24.00, 24.11 and 24.05 at 90 DAS and 33.62, 33.68 and 33.65 at harvest) and number of nods (10.04, 10.13 and 10.08) were recorded in T_3 (Brassinolide @ 1ppm) over water sprayed (control). Similarly, significant improvement in dry matter accumulation (0.0496, 0.0503 and 0.0500) during both the years of study and in pooled mean.

Foliar spray of thiourea was at par with triacontanol, and thiourea was significantly increased plant height, number of primary branches per plant, number of nodes per plant, fresh weight of leaves and dry matter accumulation as compared to water spray, NAA, GA_3 and brassinolide during both the years and in pooled analysis. The favourable effect of thiourea on plant growth might be due to improved photosynthetic efficiency. It might be due to the change in the metabolites present in the seedlings as a result of changed activity of hydrolytic enzymes and change in the oxidation mechanism especially those concerned with electron transport (Poljakoff-Mayber *et al*., 1958) [16]. Thiourea is a sulphydryl compound which plays a bio-regulatory role in plants due to presence of SH-group and stimulated the photosynthetic CO_2 fixation mechanism. The SH-group has diverse biological activities such as diversion of photosynthates from source to sink (Jocelyn, 1972) [11]. These results also corroborate the findings of Garg *et al*. (2006) [8] in clusterbean, Balai and Keshwa (2010) [4] and Meena (2011) [4] in coriander.

Table 1: Effect of PGRs, sowing time and varieties on plant height at 30, 60 and 90 DAS and number of primary and secondary branches per plant of coriander

Treatment	Plant height 30 DAS			Plant height 60 DAS			Plant height 90 DAS			Number of primary branches per plant			Number of secondary branches per plant		
	First year	Second year	Pooled	First year	Second year	Pooled	First year	Second year	Pooled	First year	Second year	Pooled	First year	Second year	Pooled
Sowing date				**Sowing date**			**Sowing date**			**Sowing date**			**Sowing date**		
D_1 (Last week of December)	4.59	4.66	4.62	25.15	25.21	25.18	76.13	76.16	76.14	5.79	5.86	5.83	16.13	16.22	16.17
D_2 (First week of January)	4.39	4.47	4.43	24.00	24.04	24.02	74.44	74.48	74.46	5.20	5.24	5.22	14.53	14.63	14.58
SEm(d)	0.083	0.039	0.046	0.142	0.090	0.084	0.121	0.103	0.079	0.021	0.023	0.016	0.039	0.048	0.031
CD(at 5%)	NS	NS	NS	0.861	0.548	0.329	0.733	0.625	0.311	0.126	0.142	0.061	0.237	0.293	0.122
Variety				**Variety**			**Variety**			**Variety**			**Variety**		
V_1 (RCr-41)	4.29	4.36	4.33	23.42	23.46	23.44	73.73	73.74	73.74	4.99	5.03	5.01	13.85	13.94	13.90
V_2 (RCr-435)	4.70	4.77	4.73	25.73	25.78	25.75	76.84	76.90	76.87	6.00	6.08	6.04	16.81	16.90	16.85
SEm(d)	0.060	0.037	0.035	0.180	0.168	0.123	0.224	0.215	0.155	0.023	0.027	0.018	0.038	0.042	0.028
CD(at 5%)	0.171	0.104	0.099	0.512	0.479	0.346	0.638	0.612	0.436	0.067	0.077	0.050	0.107	0.119	0.079
Treatment				**Treatment**			**Treatment**			**Treatment**			**Treatment**		
T_0 (Water spray (control))	4.07	4.15	4.11	21.83	21.88	21.85	71.98	71.96	71.97	4.46	4.54	4.50	12.81	12.88	12.85
T_1 (Triacontanol @ 1,000 ppm)	4.61	4.69	4.65	25.51	25.56	25.54	76.46	76.49	76.47	5.88	5.88	5.88	16.01	16.11	16.06
T_2 (Brassinolide @ 1 ppm)	4.59	4.65	4.62	25.11	25.12	25.12	75.88	75.89	75.89	5.67	5.73	5.70	15.79	15.88	15.84
T_3 (Thiourea @ 1,000 ppm)	4.64	4.71	4.68	25.66	25.76	25.71	76.92	76.99	76.95	5.92	5.98	5.95	16.63	16.70	16.66
T_4 (NAA @ 50 ppm)	4.49	4.58	4.53	24.61	24.62	24.61	75.23	75.24	75.23	5.48	5.50	5.49	15.22	15.35	15.28
T_5 (GA3 @ 50ppm)	4.55	4.61	4.58	24.73	24.78	24.76	75.25	75.34	75.29	5.57	5.67	5.62	15.52	15.61	15.56
SEm(d)	0.104	0.063	0.061	0.311	0.291	0.213	0.387	0.372	0.268	0.041	0.046	0.031	0.065	0.072	0.049
CD(at 5%)	0.297	0.181	0.171	0.887	0.829	0.598	1.105	1.060	0.755	0.116	0.133	0.087	0.186	0.205	0.137

Table 2: Effect of PGRs, sowing time and varieties on number of nodes per plant, fresh weight of leaves at 45, 90 DAS and at harvest and dry matter accumulation of coriander

Treatment	Number of node per plant at harvest			Fresh weight of leaves at 45 DAS			Fresh weight of leaves at 90 DAS			Fresh weight of leaves at harvest			Dry matter accumulation		
	First year	Second year	First year	First year	Second year	Pooled	First year	Second year	Pooled	First year	Second year	Pooled	First year	Second year	Pooled
Sowing date				**Sowing date**			**Sowing date**			**Sowing date**			**Sowing date**		
D_1 (Last week of December)	9.79	9.88	9.83	11.09	11.17	11.13	23.54	23.63	23.59	33.16	33.23	33.19	0.0490	0.0498	0.0494
D_2 (First week of January)	9.19	9.27	9.23	10.16	10.21	10.18	22.34	22.45	22.40	32.33	32.40	32.37	0.0465	0.0472	0.0468
SEm(d)	0.044	0.054	0.035	0.088	0.101	0.067	0.083	0.108	0.068	0.158	0.134	0.104	0.0004	0.0003	0.0002
CD(at 5%)	0.267	0.326	0.136	0.533	0.613	0.262	0.504	0.658	0.267	0.960	0.817	0.407	0.0024	0.0019	0.0010
Variety				**Variety**			**Variety**			**Variety**			**Variety**		
V_1 (RCr-41)	8.90	8.98	8.94	9.53	9.58	9.56	21.73	21.84	21.78	31.85	31.92	31.88	0.0459	0.0467	0.0463
V_2 (RCr-435)	10.08	10.16	10.12	11.72	11.80	11.76	24.16	24.24	24.20	33.64	33.71	33.68	0.0496	0.0503	0.0499
SEm(d)	0.048	0.041	0.032	0.189	0.181	0.131	0.201	0.185	0.136	0.241	0.196	0.155	0.0004	0.0004	0.0003
CD(at 5%)	0.137	0.117	0.089	0.538	0.517	0.368	0.572	0.527	0.383	0.686	0.558	0.436	0.0012	0.0010	0.0008
Treatment				**Treatment**			**Treatment**			**Treatment**			**Treatment**		
T_0 (Water spray (control))	8.16	8.24	8.20	8.68	8.67	8.67	20.45	20.54	20.50	30.52	30.57	30.54	0.0440	0.0447	0.0443
T_1 (Triacontanol @ 1,000 ppm)	9.90	9.97	9.93	11.25	11.30	11.28	23.78	23.88	23.83	33.33	33.42	33.38	0.0490	0.0497	0.0494
T_2 (Brassinolide @ 1 ppm)	9.73	9.84	9.79	10.98	11.07	11.02	23.40	23.50	23.45	33.14	33.21	33.18	0.0487	0.0494	0.0490
T_3 (Thiourea @ 1,000 ppm)	10.04	10.13	10.08	11.41	11.49	11.45	24.00	24.11	24.05	33.62	33.68	33.65	0.0496	0.0503	0.0500
T_4 (NAA @ 50 ppm)	9.48	9.57	9.52	10.58	10.67	10.63	22.74	22.83	22.78	32.88	32.95	32.91	0.0472	0.0481	0.0476
T_5 (GA3 @ 50ppm)	9.62	9.70	9.66	10.85	10.93	10.89	23.28	23.39	23.33	32.98	33.05	33.02	0.0479	0.0487	0.0483
SEm(d)	0.083	0.071	0.055	0.327	0.314	0.227	0.347	0.320	0.236	0.417	0.339	0.269	0.0007	0.0006	0.0005
CD(at 5%)	0.237	0.203	0.154	0.933	0.896	0.637	0.991	0.913	0.664	1.189	0.966	0.755	0.0020	0.0018	0.0013

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