

Original Research Article

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Effect of Different Plant Growth Regulators and Methods of Application on Seed Yield and Quality of Coriander (*Coriandrum sativum* L.)

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ABSTRACT

Keywords

Characters, Coriander, Foliar spray, Seed, Seed soaked, 50% flowering

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A field experiment was conducted during rabi 2018-2019 @ instructional farm department of vegetable science, Dr. PDKV, Akola to study the effect of different plant growth regulators and methods of application on seed yield and quality of coriander. The experiment consists of eighteen treatment combination viz., T₁ - GA₃ 50 ppm seed soaked, T₂ - GA₃ 75 ppm seed soaked, T₃ -GA₃ 100 ppm seed soaked, T₄ . CCC 200 ppm seed soaked, T₅ . CCC 250 ppm seed soaked, T₆ - CCC 300 ppm seed soaked, T₇ . GA₃ 50 ppm foliar spray, T₈ . GA₃ 75 ppm foliar spray, T₉ . GA₃ 100 ppm foliar spray, T₁₀ . CCC 200 ppm foliar spray, T₁₁ . CCC 250 ppm foliar spray, T₁₂ . CCC 300 ppm foliar spray, T₁₃ .GA₃ 50 ppm (S + F), T₁₄ - GA₃ 75 ppm (S + F), T₁₅ . GA₃ 100 ppm (S + F), T₁₆ .CCC0 200 ppm (S + F), T₁₇ .CCC 250 ppm(S + F), T₁₈ . CCC 300 ppm (S + F). Among different treatment combinations M₃P₆ resulted in significantly maximum result in respect to yield parameters andM₃P₃found significantly superior results for all quality contributing characters.

Introduction

Spices are nature's gift to humankind as they add flavour to our food. In addition, they also have preservative and medicinal values (Anonymous, 2015). Spices are almost indispensable in the culinary art, which constitute an important group of horticultural commodities.

Total 109 spices are listed by ISO and 63 spices are grown in India and out of which twenty are being classified as seed spices. Among the seed spices, coriander occupies

prominent place than any other seed spices viz., cumin, fenugreek, ajwain, fennel, dill, aniseed, caraway, celery and mustard etc. The seeds have the lemony flavour when crushed, which is due to terpenes, linalool and pinene. The roots have more intense flavour than leaves and are commonly used in Thai preparations.

Coriander is most widely used seed spice crop by entire mankind of the world. The botanical name of coriander is *Coriandrum sativum* L. which belongs to family Umbellifereae having chromosome number 2n=22. Plant

breeders and the seed traders, often refer to two main group of coriander based on fruit size: var. *Vulgare* (large fruits) and var. *Microcarpum* (small fruits). The fruits are reported to have carminative, diuretic, tonic, stomachic, antibilious, refrigerant, anticatarrhal, antispasmodic, galactagogue, emmenagogue and aphrodisiac effects.

The seeds measures about 4-6 mm in diameter with a central hollow cavity containing two vertical vittae containing some important essential oils, which is used as flavoring agent as an ingredient in pharmaceutical formulation and in perfumery (Singh *et al.*, 2006).

The fruits consist of two halves, the single seeded mericarps (Pruthi, 1997). The odour and taste are due to the compound containing d- linalool or coriandrol. The seed contains 16.15% fatty oils 14.1% protein, 21.6 % carbohydrates, 32.6 % fibers, 11.2% moistures and 4.4% mineral matters and coriander leaves are very rich in vitamin A and vitamin C.

India leads in production, consumption and exporter of spices in the world. Arid and semiarid parts of the India are known as “Spices Bowl” (Rajasthan and Gujarat) assist more than 80% of the total seed spices production.

Plant growth regulators (PGRs), are the magical chemicals that could increase horticultural production at an unprecedented rate and help in removing or circumventing many of the barrier imposed by genetics and environment (Nickel, 1982).

Effectiveness of plant growth regulators depends upon many factors viz. methods of application, concentration of PGRs and time of application.

Materials and Methods

The field experiment was carried out during *rabi* season of academic year 2018-19, at Instructional Farm, Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) in Factorial Randomized Block Design with three replications and eighteen treatment combinations.

The seed material used for the present investigation was variety pant haritima which was procured from the GBPUA and T, Pantanagar. There were two factors, main factor being methods of application of PGRs (three) and another sub factor was six concentrations of PGRs (GA₃ and CCC).

In present investigation three concentration of GA₃ and CCC were used at different growth stage (30 and 45 DAS). The crop was fertilized with NPK @ 60:20:30 Kg ha⁻¹ (ICAR, Recommendation). Gap filling was performed 20 days after sowing.

Need based cultural and plant protection operations were taken up to harvest. Five plants from each treatment combination were selected at random to record data on yield attributing characters and quality aspects of coriander. The test weight was calculated by counting weight of 1000 seed. The experimental data was analysed statistically by the method of analysis of variance as outlined by Panse and Sukhatme (1995).

Experimental details

Design: Factorial Randomized Block Design

Replications: Three

Treatment combinations: 18

Total plots: 54

Plot size: 1.8 x 1.20 m

Plant spacing: 30 x 10 cm

Treatment Details

Treatments	Treatment combinations	Treatment Details
T ₁	M ₁ P ₁	GA ₃ 50 ppm seed soaked
T ₂	M ₁ P ₂	GA ₃ 75 ppm seed soaked
T ₃	M ₁ P ₃	GA ₃ 100 ppm seed soaked
T ₄	M ₁ P ₄	CCC 200 ppm seed soaked
T ₅	M ₁ P ₅	CCC 250 ppm seed soaked
T ₆	M ₁ P ₆	CCC 300 ppm seed soaked
T ₇	M ₂ P ₁	GA ₃ 50 ppm foliar spray
T ₈	M ₂ P ₂	GA ₃ 75 ppm foliar spray
T ₉	M ₂ P ₃	GA ₃ 100 ppm foliar spray
T ₁₀	M ₂ P ₄	CCC 200 ppm foliar spray
T ₁₁	M ₂ P ₅	CCC 250 ppm foliar spray
T ₁₂	M ₂ P ₆	CCC 300 ppm foliar spray
T ₁₃	M ₃ P ₁	GA ₃ 50 ppm seed soaked + foliar spray
T ₁₄	M ₃ P ₂	GA ₃ 75 ppm seed soaked + foliar spray
T ₁₅	M ₃ P ₃	GA ₃ 100 ppm seed soaked + foliar spray
T ₁₆	M ₃ P ₄	CCC 200 ppm seed soaked + foliar spray
T ₁₇	M ₃ P ₅	CCC 250 ppm seed soaked + foliar spray
T ₁₈	M ₃ P ₆	CCC 300 ppm seed soaked + foliar spray

Results and Discussion

Flowering parameters

Days required to first flowering

The data regarding days required to first flowering as influenced by different plant growth regulators (PGRs) and methods of application was presented in Table 1.

Effect of methods of application of PGRs

A perusal of the data indicated that significantly minimum days required to first flowering (29.66) was recorded when PGRs applied as seed soaked + foliar spray (M₃). However, it was recorded maximum (37.77) when applied as seed soaked (M₁).

Effect of concentration of PGRs

The application of PGRs with different concentrations on coriander plant influence significantly. Significantly minimum days

required to first flowering (30.00) was noticed with an application of GA₃ @ 100 ppm (P₃) which was found at par with P₂. Whereas, maximum days required to first flowering (37.90) was recorded with an application of CCC @ 200 ppm (P₄).

Interaction effect

The data presented in Table (1) revealed that the interaction effect in between the methods of application and concentration of PGRs was found statistically significant. Significantly the minimum number of days to first flowering (27.66) was recorded when the GA₃ was applied as seed soaked + foliar spray treatment combination (M₃P₃), which was found at par with treatment combinations M₃P₂, M₃P₁, M₃P₆ and M₂P₃. While, it was recorded maximum (43.66) due to an application of CCC @ 200 ppm as seed soaked treatment combination (M₁P₄).

Application of plant growth substances has been shown to produce early flowering due to

fact that the plant on account of their rapid and increasing vegetative growth build up suitable carbohydrate reserved. Thus accumulation of photosynthesis in the quantity more than that required for the growth causes flower production. GA₃ treated plant contain more protenious material along with chlorophyll content. There by leading to early production of flower in coriander. Similar findings were also reported by Dhage *et al.*, (2011) in okra as well as Chatterjee and Choudhuri (2012) in cowpea.

Days required to 50 % flowering

The data in regard to days required to 50 % flowering as influenced by different concentration of plant growth regulators (PGRs) and methods of application were presented in Table 1.

Effect of methods of application of PGRs

A perusal of the data indicated that, significantly minimum days required to 50 % flowering (42.77) was recorded when PGRs applied as seed soaked + foliar spray (M₃). However, it was recorded maximum (50.38) when applied as seed soaked (M₁).

Effect of concentration of PGRs

The application of PGRs with different concentrations on coriander plant influence significantly. The minimum days required to 50 % flowering (43.00) was noticed with an application of GA₃ @ 100 ppm (P₃) which was found at par with P₂. Whereas, maximum days required to 50 % flowering (50.80) was recorded with an application of CCC @ 200 ppm (P₄).

Interaction effect

Significantly minimum number of days to 50 % flowering (40.66) was recorded when the

GA₃ was applied as seed soaked + foliar spray treatment combination (M₃P₃) which was found at par with treatment combinations M₃P₂, M₃P₁ and M₃P₆. While, it was recorded maximum (56.33) due to an application of CCC @ 200 ppm as seed soaked treatment combination (M₁P₄).

This might be due to the fact that GA₃ involvement in transition of vegetative apices to floral apices. According to Lang (1965), GA₃ could substitute for the proper environmental conditions which initiates early flowering. The similar results in this regard were reported by Haokip *et al.*, (2016), Yugandhar *et al.*, (2017) and Kurmi *et al.*, (2019) in coriander.

Yield parameters

Number of umbels per plant

The data regarding number of umbels per plant as influenced by different concentration of plant growth regulators (PGRs) and methods of application is presented in Table 1.

Effect of methods of application of PGRs

It is opined from the data presented in an application of PGRs with Table 1 that significantly maximum number of umbels per plant (26.95) were recorded when applied as seed soaked + foliar spray (M₃). However, it was recorded minimum (20.25) when applied as seed soaked (M₁).

Effect of concentration of PGRs

The application of PGRs with different concentration on coriander plant showed statistically significant differences. Significantly the maximum number of umbels (26.10) were recorded with an application CCC @ 300 ppm (P₆) which was found at par

with P₅. Whereas, significantly minimum number of umbels (20.25) were noticed with an application of GA₃ @ 50 ppm (P₁).

Interaction effect

The data presented in Table (1) revealed that the interaction effect in between the methods of application and concentration of PGRs was found statistically significant. Significantly maximum (31.97) number of umbels per plant were recorded due to an application of CCC @ 300 ppm as seed soaked + foliar spray treatment combination (M₃P₆). While, it was recorded minimum (17.50) when GA₃ was applied @ 50 ppm as seed soaked treatment combination (M₁P₁). This might be due to the fact that, the increase in number of umbels per plant could be attributed due to the increase in the number of branches per plant. Similar results were reported by Yugandhar *et al.*, (2017) and Kurmi *et al.*, (2019) in coriander.

Number of umbellets per umbel

The data regarding number of umbellets per umbel as influenced by different concentration of plant growth regulators (PGRs) and methods of application is presented in Table 1.

Effect of methods of application of PGRs

It is opined from the data presented in an application of PGRs with Table 1 that significantly the maximum number of umbellets per umbel (6.76) were recorded when PGRs applied as seed soaked + foliar spray (M₃). However, it was recorded minimum (6.06) when applied as seed soaked (M₁).

Effect of concentration of PGRs

The application of PGRs with different concentration on coriander plant showed

statistically significant differences. Significantly maximum number of umbellets per umbel (7.34) were recorded with an application of 300 ppm CCC (P₆). Whereas, significantly minimum number of umbellets per umbel (5.26) were noticed with an application of GA₃ @ 50 ppm (P₁).

Interaction effect

The data presented in Table (1) revealed that the interaction effect in between the methods of application and concentration of PGRs was found statistically significant. Significantly the maximum number of umbellets per umbel (7.86) were recorded due to an application of CCC @ 300 ppm as seed soaked + foliar spray treatment combination (M₃P₆). While, it was recorded minimum (5.10) when the GA₃ was applied as seed soaked treatment combination (M₁P₁).

This might be due to the fact that, the increase in number of umbellets per umbel by CCC might be due to accumulation of metabolites stimulation get translocated towards the reproductive sinks and these in turn resulted in stimulation of umbellets. Similar results were reported by Haokip *et al.*, (2016), Yugandhar *et al.*, (2017) and Kurmi *et al.* (2019) in coriander.

Days required to harvesting

The data pertaining to days required to harvesting as influenced by different concentrations of plant growth regulators (PGRs) and methods of application were recorded and presented in Table 1.

Effect of methods of application of PGRs

It is opined from the data presented in an application of PGRs with Table 1 that significantly minimum days required to harvesting (104.17) were recorded when

PGRs applied as seed soaked + foliar spray (M₃). However, it was recorded maximum (113.11) when applied as seed soaked (M₁).

Effect of concentration of PGRs

The application of PGRs with different concentration on coriander plant showed statistically significant differences. Significantly minimum number of days required to harvesting (105.00) were noticed with an application of GA₃ @ 100 ppm (P₃) which was found at par with P₂. Whereas, significantly maximum number of days required to harvesting (113.00) were recorded with an application of 200 ppm CCC (P₄).

Interaction effect

Significantly the minimum days required to harvesting (98.33) was recorded when the GA₃ was applied @ 100 ppm as seed soaked + foliar spray treatment combination (M₃P₃), which was found at par with treatment combination M₃P₂. While, it was recorded maximum (116.00) due to an application of CCC @ 200 ppm as seed soaked treatment combination (M₁P₄).

Early flowering and harvesting in GA₃ treatment might be due to its involvement in transition of vegetative apices to floral apices. According to Lang (1965) GA₃ could substitute for the proper environmental conditions which initiate early flowering and there by harvesting. Similar findings were also reported by Panda *et al.*, (2007) and Yugandhar *et al.*, (2014) in coriander.

Number of seeds per umbel

The data related to number of seeds per umbel as influenced by different concentration of plant growth regulators (PGRs) and methods of application were recorded and presented in Table 1.

Effect of methods of application of PGRs

It is observed from the data presented in an application of PGRs with Table 1 that significantly the maximum number of seeds per umbel (39.01) were recorded when PGRs applied as seed soaked + foliar spray (M₃). However, it was recorded minimum (27.70) when applied as seed soaked (M₁).

Effect of concentration of PGRs

The application of PGRs with different concentration on coriander plant showed statistically significant differences. Significantly the maximum number of seeds per umbel (39.00) was recorded with an application of CCC @ 300 ppm (P₆). Whereas, significantly the minimum number of seeds per umbel (25.65) was noticed with an application of GA₃ @ 50 ppm (P₁).

Interaction effect

The interaction effect in between the methods of application and concentration of PGRs was found statistically significant (Table 1). Significantly the maximum number of seeds per umbel (46.00) was recorded due to an application of CCC @ 300 ppm as seed soaked + foliar spray treatment combination (M₃P₆), which was found at par with treatment combination M₃P₅. While, it was recorded minimum (20.40) when the GA₃ was applied @ 50 ppm as seed soaked treatment combination (M₁P₁). There were increase in the number of seeds per umbel in coriander with increase in level of CCC viz. more number of umbellets with seed soaked + foliar spray than only single mode of application in the present investigation. This might be due to the fact that the increase in number of seeds per umbel could be attributed to the increase in the number of umbellets per umbel by CCC. Similar results were reported by Yugandhar *et al.*, (2014), Yugandhar *et al.*, (2017) and Kurmi *et al.*, (2019) in coriander.

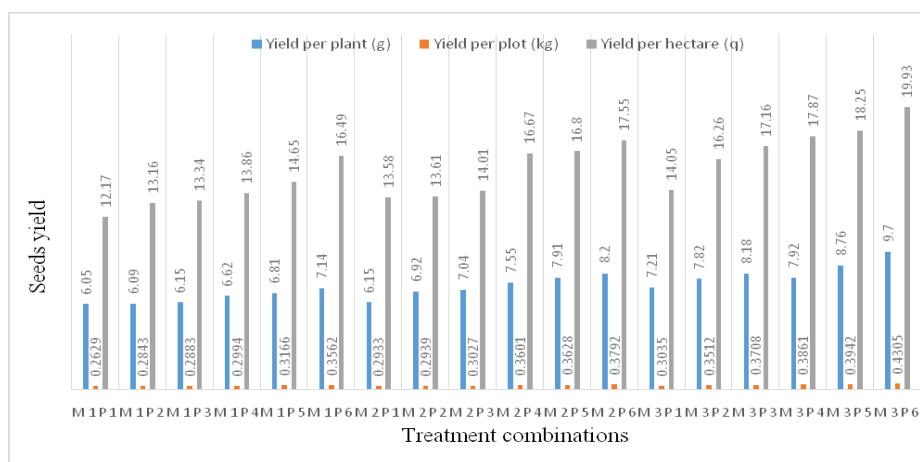
Table.1 Effect of different plant growth regulators and methods of application on flowering and yield parameters

Treatments	Flowering parameters			Yield parameters					
	Days to 1 st flowering	Days to 50% flowering	Number of umbels per plant	Number of umbellets per umbel	Days to harvesting	Number of seeds per umbel	Seed yield per plant (g)	Seed yield per plot(kg)	Seed yield per hectare (q)
Methods of Application of PGRs (M)									
M ₁ (Seed soaked)	37.77	50.38	20.25	6.06	113.11	27.70	6.48	0.30	13.95
M ₂ (Foliar spray)	33.55	46.38	22.37	6.28	109.22	31.44	7.30	0.33	15.37
M ₃ (Seed soaked + foliar spray)	29.66	42.77	26.95	6.76	104.17	39.01	8.27	0.37	17.25
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)±	0.39	0.37	0.30	0.06	0.38	0.31	0.07	0.0032	0.15
CD at 5%	1.13	1.08	0.87	0.18	1.11	0.89	0.20	0.009	0.43
Concentration of PGRs (P)									
P ₁ (GA ₃ - 50 ppm)	31.88	44.55	20.25	5.26	107.44	25.65	6.47	0.28	13.26
P ₂ (GA ₃ - 75 ppm)	30.70	43.70	21.40	5.48	106.00	26.60	6.95	0.31	14.30
P ₃ (GA ₃ - 100 ppm)	30.00	43.00	22.92	6.29	105.00	30.82	7.13	0.32	14.80
P ₄ (CCC- 200 ppm)	37.90	50.80	23.43	6.89	113.00	36.90	7.37	0.35	16.10
P ₅ (CCC- 250 ppm)	36.40	49.30	25.00	6.98	112.00	37.50	7.83	0.36	16.60
P ₆ (CCC- 300 ppm)	35.10	47.80	26.10	7.34	111.00	39.00	8.35	0.39	18.00
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)±	0.55	0.53	0.43	0.09	0.54	0.43	0.17	0.0045	0.21
CD at 5%	1.60	1.53	1.24	0.26	1.57	1.26	0.50	0.013	0.61
Interaction (M X P)									
M ₁ P ₁	35.66	47.66	17.50	5.10	112.66	20.40	6.05	0.2629	12.17
M ₁ P ₂	33.00	46.00	17.86	5.26	111.00	21.06	6.09	0.2843	13.16
M ₁ P ₃	32.00	45.00	19.53	5.40	110.00	21.60	6.15	0.2883	13.34
M ₁ P ₄	43.66	56.33	21.60	6.76	116.00	33.83	6.62	0.2994	13.86
M ₁ P ₅	41.66	54.66	22.32	6.83	115.00	34.16	6.81	0.3166	14.65
M ₁ P ₆	40.66	52.66	22.70	7.03	114.00	35.16	7.14	0.3562	16.49
M ₂ P ₁	31.00	44.00	20.40	5.26	108.66	26.33	6.15	0.2933	13.58
M ₂ P ₂	30.66	43.66	21.46	5.40	107.00	27.00	6.92	0.2965	13.73
M ₂ P ₃	30.33	43.33	22.76	6.40	106.00	32.00	7.04	0.3027	14.01
M ₂ P ₄	38.00	51.00	22.80	6.70	112.33	33.50	7.55	0.3601	16.67
M ₂ P ₅	36.66	48.66	23.10	6.83	111.33	34.16	7.91	0.3628	16.80
M ₂ P ₆	34.66	47.66	23.70	7.13	110.00	35.68	8.20	0.3792	17.55
M ₃ P ₁	29.00	42.00	22.87	5.43	101.00	30.21	7.21	0.3035	14.05
M ₃ P ₂	28.33	41.33	24.83	5.76	99.66	31.71	7.82	0.3512	16.26
M ₃ P ₃	27.66	40.66	26.46	7.06	98.33	38.86	8.18	0.3708	17.16
M ₃ P ₄	32.00	45.00	25.90	7.20	109.66	43.22	7.92	0.3861	17.87
M ₃ P ₅	31.00	44.66	29.68	7.27	108.66	44.05	8.76	0.3942	18.25
M ₃ P ₆	30.00	43.00	31.97	7.86	107.66	46.00	9.70	0.4305	19.93
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m)±	0.96	0.92	0.75	0.15	0.94	0.76	0.17	0.0079	0.36
CD at 5%	2.77	2.65	2.15	0.45	2.72	2.18	0.50	0.023	1.05

Table.2 Effect of different plant growth regulators and methods of application on quality parameters

Treatments	Quality parameters		
	Test weight (g)	Germination (%)	Oleoresin content (%)
Methods of Application of PGRs (M)			
M ₁ (Seed soaked)	10.71	83.38	2.77
M ₂ (Foliar spray)	11.20	84.89	3.04
M ₃ (Seed soaked + foliar spray)	11.58	89.27	3.45
'F' test	Sig	Sig	Sig
SE(m)±	0.03	0.59	0.04
CD at 5%	0.13	2.28	0.18
Concentration of PGRs (P)			
P ₁ (GA ₃ - 50 ppm)	11.38	86.44	3.23
P ₂ (GA ₃ - 75 ppm)	11.60	87.78	3.38
P ₃ (GA ₃ - 100 ppm)	11.80	88.50	3.52
P ₄ (CCC- 200 ppm)	10.60	82.83	2.68
P ₅ (CCC- 250 ppm)	10.70	84.18	2.77
P ₆ (CCC- 300 ppm)	10.90	85.39	2.97
'F' test	Sig	Sig	Sig
SE(m)±	0.04	0.83	0.06
CD at 5%	0.18	3.23	0.26
Interaction (M X P)			
M ₁ P ₁	10.73	84.66	2.90
M ₁ P ₂	11.13	85.00	3.00
M ₁ P ₃	11.26	85.33	3.16
M ₁ P ₄	10.16	81.00	2.43
M ₁ P ₅	10.36	82.00	2.56
M ₁ P ₆	10.60	82.33	2.60
M ₂ P ₁	11.50	85.66	3.23
M ₂ P ₂	11.66	86.80	3.36
M ₂ P ₃	11.73	87.66	3.46
M ₂ P ₄	10.70	82.16	2.66
M ₂ P ₅	10.73	82.90	2.73
M ₂ P ₆	10.86	84.19	2.80
M ₃ P ₁	11.93	89.00	3.56
M ₃ P ₂	12.00	91.56	3.76
M ₃ P ₃	12.43	92.50	3.93
M ₃ P ₄	10.90	85.33	2.93
M ₃ P ₅	11.03	87.63	3.00
M ₃ P ₆	11.20	89.83	3.50
'F' test	Sig	NS	NS
SE(m)±	0.08	-	-
CD at 1%	0.32	-	-

Fig.1 Interaction effect of different concentration of PGRs and methods of application on seed yield



Seed yield

The data pertaining to seed yield as influenced by different concentration of plant growth regulators (PGRs) and methods of application were recorded and presented in Table 1.

Effect of methods of application of PGRs

The seed yield per plant (g), seed yield per plot (kg) and seed yield per hectare (q) exhibited significant differences. Significantly maximum seed yield (8.27 (g), 0.37 (kg) and 17.25 (q)) was recorded when PGRs was applied as seed soaked + foliar spray (M₃). Whereas, minimum seed yield (6.48 (g), 0.30 (kg) and 13.95 (q)) was recorded with an application of PGRs as seed soaked (M₁) respectively.

Effect of concentration of PGRs

The effect of various concentrations of PGRs on seed yield was statistically significant. For seed yield per plant (g), seed yield per plot (kg) and seed yield per hectare (q) significantly maximum seed yield (8.35 (g), 0.39 (kg) and 18.00 (q)) was recorded when CCC was applied @ 300 ppm (P₆). Whereas,

minimum seed yield (6.47 (g), 0.28 (kg) and 13.26 (q)) was recorded when GA₃ was applied @ 50 ppm (P₁).

Interaction effect

It is evident from the data presented in Table (1), seed yield per plant (g), seed yield per plot (kg) and seed yield per hectare (q) was found maximum (9.70 (g), 0.4305 (kg) and 19.93 (q)) when CCC was applied @ 300 ppm as seed soaked + foliar spray (M₃P₆). Whereas, the minimum (6.05 (g), 0.2629 (kg) and 12.17 (q)) seed yield was noticed when GA₃ was applied @ 50 ppm as seed soaked application (M₁P₁). From the expression of result of the data presented about seed yield of coriander plant, it was observed that the seed yield was increase with the increase in the concentration of CCC. More seed yield per hectare in coriander occurs due to application of CCC @ 300 ppm as seed soaked + foliar spray treatment combination (M₃P₆). The increase in seed yield might be due to increase in yield attributes such as number of umbels per plant, number of umbellets per umbel, number of seeds per umbel and increase in growth parameters like number of branches per plant. The above results were conformity with findings of

Yugandhar *et al.*, (2014) and Yugandhar *et al.*, (2017) in coriander.

Quality attributing parameters

Test weight (g)

The data regarding test weight (g) as influenced by different concentration of plant growth regulators (PGRs) and methods of application was presented in Table 2.

Effect of methods of application of PGRs

A perusal of the data indicated that significantly maximum test weight of seed (11.58 g) was recorded when applied as seed soaked + foliar spray (M₃). However, it was recorded minimum (10.71 g), when applied as seed soaked (M₁).

Effect of concentration of PGRs

The application of PGRs with different concentration on coriander plant influence significantly. The maximum test weight of seed (11.80 g) was recorded with an application of GA₃ @ 100 ppm (P₃). Whereas, significantly minimum test weight of seed (10.60 g) was noticed with an application of CCC @ 200 ppm (P₄).

Interaction effect

The data presented in Table (2) revealed that the interaction effect in between the methods of application and concentration of PGRs was found statistically significant. Significantly maximum test weight of seed (12.43 g) was recorded due to an application of 100 ppm GA₃ as seed soaked + foliar spray treatment combination (M₃P₃). While, it was recorded minimum (10.16 g) when the CCC was applied as seed soaked treatment combination (M₁P₄).

There were increase in the test weight (g) in coriander with different methods of application of PGRs viz. more test weight of seed with seed soaked + foliar spray (M₃P₃) than other methods of application in the present investigation. It might be due to apportioning efficiency viz. increased allocation of photosynthesis towards the economic part and hormonal balance in the plant system. The promoting effect of GA₃ on DNA, RNA and protein synthesis as well as ribose and polyribosome multiplication would contribute toward biomass production of vegetative part as well as test weight of seed. The similar results in this regard were reported by Panda *et al.*, (2007) and Singh *et al.*, (2012) in coriander.

Germination (%)

The data in regard to germination (%) as influenced by different concentration of plant growth regulators (PGRs) and methods of application was presented in Table 2.

Effect of methods of application of PGRs

A perusal of the data indicated that, significantly maximum germination of seed (89.27 %) was recorded when applied as seed soaked + foliar spray (M₃). However, it was recorded minimum (83.38 %) when applied as seed soaked (M₁).

Effect of concentration of PGRs

The application of PGRs with different concentration on coriander plant influence significantly. The maximum germination of seed (88.50 %) was recorded with an application of GA₃ @ 100 ppm (P₃) which was found at par with P₂, P₁ and P₆. Whereas, significantly minimum germination of seed (82.83 %) was noticed with an application of CCC @ 200 ppm (P₄).

Interaction effect

The data presented in Table (2) depicted that the interaction effect in between the methods of application and concentration of PGRs was found statistically non-significant. It might be due to apportioning efficiency viz. increased allocation of photosynthesis towards the economic part and hormonal balance in the plant system. The promoting effect of GA₃ on DNA, RNA and protein synthesis as well as ribose and polyribosome multiplication would contribute toward biomass production of vegetative part as well as test weight of seed. The similar results in this regard were reported by Panda *et al.*, (2007) and Singh *et al.*, (2012) in coriander.

Oleoresin content (%)

The data regarding oleoresin content (%) as influenced by different concentration of plant growth regulators (PGRs) and methods of application was presented in Table 2.

Effect of methods of application of PGRs

A perusal of the data indicated that, significantly maximum oleoresin content of seed (3.45 %) was recorded when applied as seed soaked + foliar spray (M₃). However, it was recorded minimum (2.77 %) when applied as seed soaked (M₁).

Effect of concentration of PGRs

The application of PGRs with different concentration on coriander plant influence significantly. The maximum oleoresin content of seed (3.52 %) was recorded with an application of GA₃ @ 100 ppm (P₃) which was found at par with P₂. Whereas, significantly minimum oleoresin content of seed (2.68 %) was noticed with an application of CCC @ 200 ppm (P₄).

Interaction effect

The data presented in Table (2) examined that the interaction effect in between the methods of application and concentration of PGRs was found statistically non-significant. The positive effect of foliar application of growth regulators on oleoresin content might be attributed to the improved over all plant growth and metabolism. The improved oleoresin content values with plant growth regulators might be because of their role in directing the translocation of metabolites to the seed which synthesize more oil in seeds. The present results are in close accordance with the findings of Kurmi *et al.*, (2019) in coriander.

In conclusion the methods of application of plant growth regulators (PGRs) as seed soaked + foliar spray (M₃) revealed significantly maximum results in terms of yield and quality parameters. As regards to concentration of PGRs, GA₃ @ 100 ppm (P₃) revealed significantly maximum results for quality of seed and CCC @ 300 ppm (P₆) revealed significantly maximum results for yield parameters. The treatment combination M₃P₃ - GA₃ @ 100 ppm as seed soaking + foliar spray show significantly maximum results for test weight (g) except germination (%) and oleoresin content (%), whereas significantly minimum results were noticed for days required to first flowering, days required to 50 % flowering and days required to harvesting and M₃P₆ - CCC @ 300 ppm as seed soaking + foliar spray showed significant interaction for all yield contributing characters.

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