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Effect of seed treatment and foliar spray of thiourea on growth, yield and quality of coriander (*Coriandrum sativum* L.) under different irrigation levels

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ABSTRACT

A field experiment was conducted during the rabi 2011-2012 at research farm, College of Horticulture, Mandsaur (Madhya Pradesh) to study the effect of seed treatment and foliar spray of thiourea on growth, yield and quality of coriander (*Coriandrum sativum* L.) under different irrigation levels. The experiment consist three irrigation levels (in main plots) viz., (I_1-one, I_2-three and I_3-six irrigations) and six thiourea treatments (in sub plots) viz., (T_1-Control, T_2-Thiourea 500 ppm seed treatment for 4 hours, T_3-Thiourea 1000 ppm seed treatment for 4 hours, T_4-Thiourea 500 ppm foliar spray at vegetative and flowering stages, T_5-Thiourea 500 ppm seed treatment for 4 hours + Thiourea 500 ppm foliar spray at vegetative and flowering stages and T_6-Thiourea 1000 ppm seed treatment for 4 hours + Thiourea 1000 ppm. foliar spray at vegetative and flowering stages). Both irrigation levels and thiourea treatments significantly influenced the growth, yield and quality attributes of coriander. Irrigation level I_3 and thiourea treatment T_6 resulted in significant higher plant height at 90 DAS, number of branches plant^{-1}, fresh weight of leaves plant^{-1}, dry weight of leaves plant^{-1}, days taken to harvest, number of umbels plant^{-1}, number of umbellets umbel^{-1}, number of seeds umbel^{-1}, test weight, seed yield, straw yield, biological yield, chlorophyll content of leaves, essential oil content of seeds and net return. However days to 50 % flowering was non significantly affected by thiourea treatments. Maximum harvest index and cost: benefit ratio was also found with Irrigation level I_3 and thiourea treatment T_6.

Key words : Coriander, irrigation levels, thiourea, growth, yield, and quality attributes

INTRODUCTION

Coriander (*Coriandrum sativum* L.) is an herbaceous plant grown as a spice in all states of India. Stem, leaves and fruits are used for pleasant aromatic flavour in different way. The fruits are largely exported and extensively used as condiment in the preparation of powder, pickling spices and seasoning. Low productivity (0.9 MT/HA) and quality are major factors responsible for production and demand of coriander N.H.B. (13). Importance of crop for export as well as domestic use there is a great demand of higher production, productivity and quality of coriander. Among the factors responsible for increasing productivity and quality of coriander irrigation levels plays most important role as optimum level of irrigation increased the availability of nutrients and thus enhanced the uptake of nutrients which consequently improved the crop growth, yield and quality. Besides irrigation levels, seed treatment and foliar spray at vegetative and flowering stages with different concentration of thiourea also influences the crop growth, yield and quality. The Malwa region is a potential for coriander production. Therefore an investigation was conducted to evaluate the effect of irrigation levels and thiourea on yield and quality of coriander as well as to work out the economics of different treatments for production and quality of coriander.

MATERIALS AND METHODS

The field experiment was conducted during rabi season 2011-12 at the research farm RVSKVV, College of Horticulture Mandsaur, (Madhya Pradesh) on light black loamy soil having pH 7.2, ECe- 0.35 dSm^{-1}, available nitrogen (243.2 Kg/ha), phosphorus (19.75 Kg/ha) and potassium (448.0 Kg/ha). The average annual rainfall of this resign is 544.05 mm. The coriander variety RCr-436 was used in experiment. The sowing was done on October, 2011 keeping the row to row distance 30 cm and plant to plant distance 15 cm. The experiment consisted of three irrigation levels (in main plots) I_1 (One irrigation), I_2 (Three irrigations) and I_3 (Six irrigations) and six thiourea treatments (in sub plots) viz., T_1 (Control), T_2 (Thiourea 500 ppm seed treatment for 4 hours), T_3 (Thiourea 1000 ppm seed treatment for 4 hours), T_4 (Thiourea 500 ppm foliar spray at vegetative and flowering stages), T_5 (Thiourea 500 ppm seed treatment for 4 hours + Thiourea 500 ppm foliar spray at vegetatine and flowering stages) and T_6 (Thiourea 1000 ppm seed treatment for 4 hours +

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Thiourea 1000 ppm foliar spray at vegetative and flowering stages). These 18 treatment combinations were replicated in four replications in split plot design. Observations were recorded on growth characteristics viz. days to germination, plant height (cm) at 45 and 90 DAS, number of branches plant^{-1} at harvest, days to 50% flowering, fresh weight of leaves plant^{-1} (g) at 45 and 90 DAS, dry weight of leaves plant $^{-1}$ (g) at 45 and 90 DAS, days taken to harvest, yield and yield attributes viz. number of umbels plant^{-1}, number of umbellets umbel^{-1}, number of seeds umbel^{-1}, test weight (g), biological yield (q ha^{-1}), straw yield (q ha^{-1}), seed yield (q ha^{-1}), harvest index (%), quality attributes viz. chlorophyll content in leaves (mg g^{-1}), essential oil content of seeds (%) and economics of different treatments. The essential oil content was estimated through Clevenger apparatus by stem distillation method A.O.A.C. (1). The data thus generated with the observations was statistical analysed by the method suggested by Pansey and Sukhatme (15).

RESULT AND DISCUSSION

Effect of irrigation levels

There was significant increase in growth attributes (plant height at 90 DAS (87.4), number of branches plant^{-1} at harvest (44.4), days to 50% flowering (53.3), fresh weight of leaves plant^{-1} at 45 (20.68) and 90 DAS (32.88) , dry weight of leaves plant^{-1} at 45 DAS (3.42) and 90 DAS (6.11) were recorded as a result of I_3 - Six irrigations (Table 1). This might be due to the pronounced effect of irrigation on growth characters might be attributed due to beneficial effect of water on cell turgidity, cell elongation, photosynthesis, respiration, uptake of nutrients and translocation of photosynthates to the actively growing plant parts Singh *et al*. (19). The response of different irrigation levels in terms of overall improvement in growth parameters is further supported by the fact the higher irrigation frequency increased the availability of nutrients and thus enhanced the uptake of nutrients which consequently improved the crop growth of coriander Bhunia *et al.* (7). These results are also supported by the results of Tomar *et al.* (20) and Kumar *et al.* (11) in coriander.

Yield and yield attributes significantly increased with I_3 - Six irrigations (Table 2) higher number of umbels plant^{-1} (50.5), umbellets umbel^{-1} (6.6), number of seeds umbel^{-1} (40.5), test weight (16.6), biological yield (58.30), straw yield (33.90), seed yield (24.21). It has might been due to the favourable effect of irrigation may be explained on the basis of more plant height, which ultimately, led to more number of umbellets plant-^{1}. Higher irrigation frequency increased the availability of nutrients and thus enhanced the uptake of nutrients which consequently improved the crop growth and yield. These finding is in conformity with those of Singh *et al.* (19) and Bhunia *et al.* (7) in coriander.

Water deficit had a negative effect on most of the morphological characteristics. It was also observed that as the water stress increased, biological yield, test weight, total yield conversely decreased. These finding is in conformity with those of Amin (2) in Fennel and Nejad (14) in cumin.

Quality attributes also significantly improved with different irrigation levels (Table 2). Chlorophyll content of leaves significantly increased under I_3 -Six irrigations at 45 DAS (1.109) and 90 DAS (0.949). As compared to I_1 (One irrigation) and I_2 (Three irrigations) levels. Reduction in chlorophyll content under I_1 (One irrigation) and I_2 (Three irrigations) levels is might be due to water stress damage to the photosynthesis apparatus and reduce the chlorophyll content of the leaves. These finding is in conformity with those of Sabale and Kale (17) in coriander. Essential oil content of seeds (0.82) significantly increased under I_3 -Six irrigations due to the effect of irrigation on oil yield closely reflected the yield of umbel. The greatest contribution to oil yield was made by the late flowering stage, which accounted for 80 per cent of the yield due to full irrigation. These finding is in conformity with those of Buntain and Chung (8).

Economics of the treatments (Table 2) showed that irrigation level I_3 -Six irrigations resulted in maximum net return of Rs. 81005 ha^{-1}. Irrigation treatments significantly increase the seed yield of coriander the favourable effect of irrigation may be explained on the basis of more plant height, which ultimately, led to more number of branches and hence more number of umbels plant^{-1} Singh *et al*. (19). Higher yield with higher levels of irrigation might be due to its key role in root development by reducing mechanical resistance of soil, higher transpiration, greater nutrient uptake and more photosynthesis due to better metabolic activities in the plants Bhunia *et al*. (6). Ultimately led to more number of branches and hence more number of umbels plant^{-1} Singh *et al*. (19). Higher yield with higher levels of irrigation might be due to its key role in root development by reducing mechanical resistance of soil, higher transpiration, greater nutrient uptake and more photosynthesis due to better metabolic activities in the plants Bhunia *et al*. (6).

Effect of thiourea treatments

Different thiourea treatments significantly influenced the growth attributes (Table 1). Days to germination significantly decrease with T_3 (Thiourea 1000 ppm seed treatment for 4 hours) and higher plant height at 90 DAS (82.5), branches plant^{-1} (39.1), fresh weight of leaves plant^{-1} at 45 DAS (24.75) and 90 DAS (41.70) and dry weight of leaves plant^{-1} at 45 DAS (4.11) and 90 DAS (7.70) were recorded as a result of T_6 (Thiourea 1000 ppm seed treatment for 4 hours + Thiourea 1000 ppm foliar spray at vegetative and flowering stages). The pronounced

Table 1. Effect of different irrigation levels and thiourea treatments on growth attributes of coriander

Treatments	Days to germination	Plant height (cm)		Number of branches plant^{-1}	Days to 50% flowering	Fresh weight of leaves plant^{-1} (g)		Dry weight of leaves plant^{-1} (g)		Days taken to harvest
		45 DAS	90 DAS			45 DAS	90 DAS	45 DAS	90 DAS	
Irrigation levels										
I_1	15.2	20.8	71.1	26.6	52.6	12.25	26.80	2.25	4.91	100.0
I_2	15.4	20.8	74.7	28.9	53.1	13.70	28.31	2.26	5.15	116.0
I_3	15.5	22.4	87.4	44.4	53.3	20.68	32.88	3.42	6.11	129.1
SEm±	0.271	0.759	2.408	0.408	0.151	1.927	1.251	0.267	0.218	0.388
CD 5%level	NS	NS	8.333	1.414	0.524	6.671	4.332	0.917	0.756	1.345
Thiourea treatments										
T_1	17.7	18.0	71.5	28.8	53.1	7.83	21.92	1.64	3.99	111.6
T_2	14.1	21.2	75.5	30.4	53.3	11.00	24.01	1.98	4.34	113.6
T_3	14.0	21.5	77.5	32.2	53.0	13.66	26.20	2.31	4.75	114.0
T_4	17.2	19.7	79.0	33.7	52.9	15.83	28.98	2.76	5.28	115.6
T_5	14.5	22.7	80.3	35.7	52.7	20.20	33.19	3.05	6.27	117.0
T_6	14.7	24.8	82.5	39.1	53.0	24.75	41.70	4.11	7.70	118.3
SEm±	0.264	0.570	1.342	0.429	0.137	1.486	1.126	0.225	0.212	0.429
CD 5% level	0.752	1.624	3.824	1.223	NS	4.235	3.209	0.642	0.605	1.222

effect of thiourea on growth characters might be attributed due to its dormancy breaking and germination stimulating effects, it appears to have more divers biological activities because of its –SH group Sahu *et al.* (18). Thiourea with its sulf hydral group not only favoured larger green photosynthetic surface but it might have also favoured the activity of starch synthetase and hence the effective period of filling seeds. Significant increase in grain yield with thiourea spray treatment also appears to have resulted via -SH group enhanced photosynthetic efficiency. In the present study thiourea also, maintained large no. of green leaves such effects of thiourea might have favoured canopy photosynthesis and hence large accumulating of photosynthate during seed development. These observations are also supported by the results of Sahu *et al.* (18). Application of thiourea also creates lighter microbial population in soil which is responsible for mobilizing essential nutrients and improves the growth and yield of plants. These observations are also supported by the results of Balai and Keshwa (5) in coriander

Different thiourea treatments significantly influenced the yield attributes (Table 2). Significantly higher number of umbel plant^{-1} (50.1), number of umbellets umbel^{-1}(6.2), number of seeds umbel^{-1} (42.2), test weight (18.0), biological yield (58.27), straw yield (34.49), seed yield (23.77), harvest index (31.3) were recorded as a result of T_6 (Thiourea 1000 ppm seed treatment for 4 hours + Thiourea 1000 ppm foliar spray at vegetative and flowering stages). The yield increase by the application of thiourea may due to the beneficial effect of thiourea on seed germination, seedling growth and chlorophyll content, protein content, biomass production and better dry matter partitioning. These observations are also supported by the result of Anitha *et al.* (3). Application of thiourea significantly increase the production of umbellets umbel^{-1}, umbels plant^{-1}, seeds umbel^{-1}, test weight (g), biological yield (q ha^{-1}), straw yield (q ha^{-1}) and seed yield (q ha^{-1}) and harvest index (%) due to the photosynthetic efficiency of thiourea applied plants. Thiourea is reported to delay leaf ageing and senescence and enhance photosynthetic efficiency leading to increase growth and yield of plants. Thus thiourea application favourably affects both carbohydrates and nitrogen metabolism which in turn enhance plant performance Mathur *et al*. (12).

Different thiourea treatments significantly influence the quality attributes (Table 2). Significantly chlorophyll content in leaves at 45 DAS (1.290) and 90 DAS (1.051) and essential oil content (0.88) of coriander seeds were recorded as a result of T_6 (Thiourea 1000 ppm seed treatment for 4 hours + Thiourea 1000 ppm foliar spray at vegetative and flowering stages) thiourea treatment, due to thiourea had also been reported to suppress the speed of chlorophyll decrease which may be responsible for maintenance of higher chlorophyll concentration causing

Table 2. Effect of different irrigation levels and thiourea treatments on yield, quality attributes and economics of coriander

Treatments	No. of umbels plant^{-1}	No. of umbellets umbels^{-1}	No. of seeds umbel^{-1}	Test weight (g)	Seed yield q/ha	Straw yield q/ha	Biological yield q/ha	Harvest Index (%)	Chlorophyll content of leaves (mg/g) 45 DAS	90 DAS	Essential oil content of seeds (%)	Net return Rs/ha	B:C ratio
Irrigation levels													
I_1	33.6	4.1	34.2	13.2	13.88	26.19	40.07	25.4	1.066	0.886	0.55	42770	4.32
I_2	39.7	6.4	38.0	15.1	16.32	28.27	44.60	27.4	1.104	0.890	0.70	51538	4.72
I_3	50.5	6.6	40.5	16.6	24.21	33.90	58.30	32.1	1.109	0.949	0.82	81005	5.76
SEm+	0.595	0.281	1.278	0.102	1.332	1.484	2.120	1.529	0.008	0.009	0.018	5281	0.36
CD at 5%	2.060	0.975	4.425	0.356	4.610	5.138	7.337	NS	0.030	0.033	0.063	18277	NS
Thiourea treatments													
T_1	32.4	5.1	31.1	12.9	12.67	25.54	38.21	23.9	0.967	0.788	0.55	38486	3.50
T_2	37.2	5.4	35.1	13.2	15.10	27.26	42.36	26.3	1.023	0.861	0.57	46383	4.23
T_3	38.2	5.5	37.1	13.8	16.97	28.00	45.36	28.4	1.039	0.883	0.64	53846	4.76
T_4	42.2	5.8	37.7	15.1	18.88	29.45	48.68	29.5	1.072	0.925	0.70	60746	5.03
T_5	46.5	6.1	40.1	16.9	21.43	31.99	53.42	30.7	1.168	0.941	0.80	70903	5.74
T_6	50.1	6.2	42.2	18.0	23.77	34.49	58.27	31.3	1.290	1.051	0.88	80260	6.35
SEm+	1.129	0.157	0.989	0.127	0.828	0.875	1.222	1.021	0.029	0.019	0.017	3339.1	0.227
CD at 5%	3.216	0.448	2.817	0.362	2.359	2.492	3.482	2.909	0.084	0.055	0.049	9511.1	0.647

delay in leaf ageing and senescence as reported by earlier investigators. These observations are also supported by the results of Grag *et al.* (9).

Thiourea molecule is a good donor of sulphur atoms in biological reactions Randle and Bussard (16). Application of thiourea increases the total uptake of N, P and K and creates lighter microbial population in soil which is responsible for mobilizing essential nutrients Balai and Keshwa (5). Nitrogen and sulphur play an important role in enhancing the carbohydrate and protein synthesis, its action as activator of various enzymes involved as essential oil synthesis Kumar *et al*. (10).

Economics of different thiourea treatments (Table 2) indicate that T_6 (Thiourea 1000 ppm seed treatment for 4 hours + Thiourea 1000 ppm foliar spray at vegetative and flowering stages) resulted in maximum net return of Rs. 80260 ha^{-1} with a B: C ratio of 6.35: 1. Thiourea implying its favourable impact on photosynthetic production and its partitioning Anitha *et al.* (4). The potential of thiourea foliar spray significantly increase seed yield in coriander Balai and keshwa (5).

Interaction effect of different treatments

Interactive effect of different irrigation levels and thiourea treatments (Table 3) showed that treatment combination I_3T_6 (Six irrigations + Thiourea 1000 ppm seed treatment for 4 hours + Thiourea 1000 ppm foliar spray at vegetative and flowering stages) significantly higher number of branches plant^{-1} (52.3), dry weight of leaves pant^{-1} at 90 DAS (8.65) and test weight (20.4). Although different irrigation levels and thiourea treatments independently brought significant increase in growth and yield attributes but interaction of both showed that response of irrigation levels were governed by thiourea treatments and vice versa exhibiting their interdependence for obtaining higher value of these parameters thus, the I_3 (Six irrigations) and T_6 (Thiourea 1000 ppm seed treatment for 4 hours + Thiourea 1000 ppm foliar spray at vegetative and flowering stages) showed the positive response regarding the growth, yield and yield attributing characters as obtained in the present study. Higher irrigation frequency increased the availability of nutrients and thus enhanced the uptake of nutrient which consequently improved the crop growth and yield. Similarly the pronounced effect of thiourea on growth characters might be attributed due to thiourea is chiefly known for its dormancy breaking and germination stimulating effect and also improved photosynthetic efficiency of plant there by overall improvement in growth and yield attributes. Similar findings have also been reported by Anitha *et al*. (3) in horse gram and Garg *et al*. (9) in cluster bean.

Table 3. Combined effect of different irrigation levels and thiourea treatments on number of branches, dry weight of leaves and test weight of coriander

Treatment combinations	No. of branches plant^{-1} at harvest	Dry weight of leaves plant^{-1} (g) at 90 DAS	Test weight (g)
I_1T_1	23.0	3.67	11.5
I_1T_2	23.7	4.30	11.7
I_1T_3	26.4	4.45	12.2
I_1T_4	26.7	4.85	13.8
I_1T_5	29.0	5.62	14.6
I_1T_6	31.0	6.60	15.4
I_2T_1	23.7	4.12	13.2
I_2T_2	26.6	4.32	13.4
I_2T_3	27.8	4.52	14.0
I_2T_4	30.3	4.75	14.9
I_2T_5	30.8	5.30	17.0
I_2T_6	34.0	7.87	18.3
I_3T_1	39.6	4.17	14.1
I_3T_2	40.9	4.40	14.4
I_3T_3	42.5	5.30	15.2
I_3T_4	44.0	6.25	16.4
I_3T_5	47.4	7.90	19.0
I_3T_6	52.3	8.65	20.4
SEm±	0.744	0.368	0.220
CD at 5%	2.120	1.049	0.628

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