Biological Forum – An International Journal **14(2): 75-79(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of Irrigation Level and Nitrogen Fertigation on Growth Parameters and Seed Yield of Coriander (*Coriandrum sativum* L.) Varieties

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(Received 18 January 2022, Accepted 20 March, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: This study was conducted at area of Research Farm at CCS, HAU, Hisar under Department of Vegetable Science. The material comprised of three coriander varieties *viz.*, V_1- Hisar Bhumit, V_2- Hisar Anand and V_3- Hisar Sugandh as main plot, four levels of irrigation namely, I_1-0.6, I_2-0.8, I_3-1.0 and I_4-1.2 (IW/CPE) ratio as sub plot and 3 nitrogen levels that is N_1 (40 kg ha^{-1}), N_2 (50 kg ha^{-1}) and N_3 (60 kg ha^{-1}) as sub-sub plot replicated thrice using drip fertigation. The application of irrigation with I_4 (1.2 IW/CPE) recorded significantly higher growth parameters over rest of the others levels, nevertheless statistically at par with irrigation schedule at 1.0 IW/CPE. Among nitrogen levels, maximum growth parameters and yield were recorded with nitrogen level at 70 kg ha^{-1} (N_4) which was statistically at par with 60 kg ha^{-1} (N_3). Coriander variety *i.e.* Hisar Sugandh found to be superior in growth parameters and yield when grown at irrigation level at 1.0 IW/CPE (I_3) with nitrogen level at 60 kg ha^{-1} and can be recommended to grow in western region of Haryana.

Keywords: Irrigation, Fertigation, Growth, Variety, Yield.

INTRODUCTION

Coriander (*Coriandrum sativum* L.) is belongs to *Apiaceae* classification and as known or named at another time or place cilantro or *Dhania*, one of the first decorated with flowers annual spices secondhand by society (Luayza *et al.*, 1996). Coriander is native of Mediterranean domain, but now, it's cultured worldwide generally in Morocco, Russia, United States of America of Western hemisphere, Italy, India and Japan. India is recognized as "Land of Spices" and largely cultivated in many states that are Rajasthan, M.P., Gujarat, A.P., Haryana, Punjab and West Bengal under area of 704 thousand hectare accompanying the production of 900 thousand MT. In India, the average production of coriander is approximately 0.9 MT/hectare (Anonymous, 2018).

In India, coriander is mostly cultivated as rainfed crop but there is an immense potentiality to increase the production of this crop with assured irrigations. Irrigation plays a main function in the plant development, increase yield and feature of coriander. Rising water disaster and increase demand of produce more food per drop of water requires some efficient irrigation system to improve productivity of water. Many evidences of research prove that the drip irrigation is superior in term of conditions of water and raised yield in addition to other benefits over common irrigation system (Pandey *et al*., 2013). The reduction in production of coriander can be attributed to imbalanced fertilizer application. Proper utilization of fertilizers helps in right growth, development and higher yield (Kumar *et al*., 2015). Nitrogen is considered as major nutrients that influence the plant growth parameters, yield and quality of seeds and its deficiency affects the size of leaf and rate of photosynthetic (Lal *et al*., 2016). A sufficient amount of nitrogen is necessitate as it encourages vegetative growth which leads to higher quality leave and seed yield generation but its excessive application can decrease plant growth and development. Hence, an optimum amount of nitrogen should be applied with accurate level of watering.

MATERIALS AND METHODS

This study was conducted at area of Research Farm at CCS, HAU, Hisar under department of Vegetable Science to identify the effect of irrigation and N_2 (Nitrogen) fertigation on growth and seed yield of coriander (*Coriandrum sativum* L.) varieties in 2017-2018 and 2018-2019. The material was comprised of three coriander varieties *viz.*, V_1- Hisar Bhumit, V_2- Hisar Anand and V_3- Hisar Sugandh, four levels of irrigation namely, I_1-0.6, I_2-0.8, I_3-1.0 and I_4-1.2 (IW/CPE) ratio as sub plot and 3 nitrogen levels that is

N_1 (40 kg ha^{-1}), N_2 (50 kg ha^{-1}) and N_3 (60 kg ha^{-1}). The experimental was designed out in split-split plot replicated three times such that the varieties were sown as the main plot, irrigation as sub-plot and nitrogen as sub-sub plot was undertaken using drip fertigation. The field was divided into plots of raised beds of size 3.0 × 1.2 m^2 by making small channels between the plots.

The data were recorded (each treatment of each replication) from five randomly picked plants for plant height (cm), number of primary (basic) and secondary (subordinate) branches $plant^{-1}$ at harvest and days to 50% flowering and maturity in days. The field observations were recorded during 2017-18 and 2018-19 years of experiment, and they are averaged on a per plant basis. The experimental data for various growths parameters were examined by statistically methods of analysis of variance as outlined by Panse and Sukhatme (1985). The plot (split-split) design are assigned namely main, sub and sub-sub plot under the levels of factors that is Factor V (varieties) assigned to main plots, Factor I (irrigation) to subplots within each main plot, and Factor N (nitrogen) to sub-subplots within each subplot. The addition of a third factor by splitting sub-plots of a split-plot design using the third level of randomization results in a split-split plot design.

RESULTSANDDISCUSSION

The performance of 0.6, 0.8, 1.0 and 1.2 IW/CPE ratio irrigation levels and 40, 50, 60 and 70 kg ha^{-1} nitrogen fertigation were evaluated to study their effect on growth parameters of three coriander varieties. The results are presented in Table 1 and 2 for individual and Table 3 for interaction effect.

A. Plant height (cm)

Among irrigation levels, significantly taller plants (115.0 cm) of coriander at harvest were recorded in coriander treated with irrigated level at 1.2 IW/CPE, which was statistically at par with plant height (114.2 cm) at harvest of coriander treated with irrigated level at 1.0 IW/CPE. A critical analysis on the effect nitrogen fertigation revealed that significantly taller plants (113.7 cm) of coriander were observed in coriander treatment with nitrogen at level 70 kg ha^{-1}. Pooled analysis of data from two years also showed significantly taller plants (112.7 cm) of coriander in Hisar Bhumit over rest of the other two varieties, *i.e*. Hisar Anand and Hisar Sugandh.

The pronounced effect on plant height by irrigation on growth characters might be accredit the advantageous effect of higher soil moisture rank on immersion of water; nutrients uptake, cell elongation and turgidity, net-assimilation rate and translocation of assimilates to the actively growing parts of plant. Comparable results were also stated by Rao *et al.* (2010); Lal *et al.* (2013); Meena *et al.* (2017). The nitrogen being a important fundamental constituent of cell and helps in exciting cellular division and elongation, that developed in bettering of herbaceous development of the plants. This finding corroborated by the results reported by Patel *et al.* (2000); Naghera *et al.* (2000); Nataraja *et al.*, (2003); Shroff (2003); Patel (2005); Pawar *et al.*, (2007); Tuncturk *et al.* (2011); Patel *et al.* (2013). The increment in the plant height might be due to the genetic characters of different cultivars. Similar results were reported by Sharma *et al.* (2016); Honnappa *et al.* (2017).

B. Numbers of Primary and Secondary branches per plant

The data relevant to numbers of primary branches per plant indicated that varieties, level of irrigation and nitrogen that significantly affected the numbers of primary branches per plant of coriander.

Significantly highest number of primary branches (9.79) per plant at harvest were recorded in coriander treated with irrigation level at 1.2 IW/CPE, which was statistically at par with irrigation level at 1.0 IW/CPE (9.78) *vis-a-vis* 0.8 IW/CPE (9.69) and 0.6 IW/CPE (9.60). Whereas, among nitrogen levels, significantly higher number of primary branches (9.88) per plant was recorded in coriander treated nitrogen at 70 kg ha^{-1}, which was statistically at par (9.78) with nitrogen at 60 kg ha^{-1}. Significantly higher number of primary branches (9.81) per plant were found in Hisar Bhumit, which were closely followed by Hisar Sugandh (9.73) and Hisar Anand (9.61). Pooled analysis of data from two years showed significantly higher number of secondary branches (33.74) per plant at harvest were recorded in coriander treated with irrigation level at 1.2 IW/CPE over all other levels of irrigation. Among nitrogen fertigation, significantly higher number of secondary branches (32.17) per plant at harvest were recorded in coriander treated with nitrogen at 70 kg ha^{-1} over rest of the nitrogen levels. Significantly higher numbers of secondary branches (31.99) per plant were recorded in Hisar Bhumit over other varieties, *i.e*. Hisar Sugandh (30.33) and Hisar Anand (29.11).

The increase in number of branches per plant might be due to availability of sufficient soil moisture for progressive plant growth maintained by drip irrigation, which leads to better development of photosynthetic area and accelerate photosynthetic rate. Similar results were also reported by Rao *et al.* (2010) Solanki *et al.* (2017); Harisha *et al.* (2019). This might be due to the fact that higher level of nitrogen, which may have increased interception, absorption and utilization of radiant energy which in turn increased photosynthesis and thereby number of branches per plant and finally resulting in better growth. Similar findings were also reported by Pratap *et al.* (2003); Patel *et al.* (2013); Harisha *et al.* (2019). The increment in the number of primary and secondary branches per plant might be due to their genetic characters of different cultivars. Similar results were also reported by Bhunia *et al.* (2009).

Table 1: Effect of level of irrigation and nitrogen fertigation on plant height (cm), number of primary and secondary branches per plant of coriander varieties.

Treatments	Plant height (cm)			Number of primary branches			Number of secondary branches		
	(2017-18)	(2018-19)	Mean (Pooled)	(2017-18)	(2018-19)	Mean (Pooled)	(2017-18)	(2018-19)	Mean (Pooled)
Varieties									
V_1: Hisar Bhumit	111.4	114.1	112.7	9.72	9.9	9.81	31.57	32.4	31.99
V_2: Hisar Anand	98.6	104	101.3	9.53	9.7	9.61	28.9	29.32	29.11
V_3: Hisar Sugandh	102	109.1	105.6	9.63	9.83	9.73	29.1	31.56	30.33
CD at 5%	3.49	0.76	1.89	0.08	0.08	0.07	1.18	1.34	1.05
Irrigation schedule									
I_1: Irrigation at 0.6 IW/CPE	89	92.6	90.8	9.51	9.69	9.6	26.94	27.79	27.37
I_2: Irrigation at 0.8 IW/CPE	103.9	108.2	106.1	9.61	9.78	9.69	28.71	29.91	29.31
I_3: Irrigation at 1.0 IW/CPE	111.1	117.2	114.2	9.69	9.86	9.78	30.66	32.32	31.49
I_4: Irrigation at 1.2 IW/CPE	111.9	118.1	115	9.69	9.89	9.79	33.13	34.35	33.74
CD at 5%	1.15	1.6	1.01	0.12	0.09	0.1	1	0.85	0.72
Nitrogen levels									
N_1: Nitrogen at 40 kg ha^{-1}	89.9	97.5	93.7	9.47	9.64	9.56	28.67	29.63	29.15
N_2: Nitrogen at 50 kg ha^{-1}	104.3	109.4	106.9	9.56	9.74	9.65	29.28	30.58	29.93
N_3: Nitrogen at 60 kg ha^{-1}	110	113.5	111.8	9.71	9.88	9.8	30.04	31.27	30.66
N_4: Nitrogen at 70 kg ha^{-1}	111.8	115.7	113.7	9.79	9.96	9.88	31.44	32.89	32.17
CD at 5%	0.89	1.1	0.71	0.09	0.09	0.09	0.72	0.73	0.57

Table 2: Effect of level of irrigation and nitrogen fertigation on days to 50% flowering, days to maturity and seed yield (kg ha^{-1}) of coriander varieties.

Treatments	Days to 50% flowering			Days to maturity			Seed yield (kg ha^{-1})		
Varieties	(2017-18)	(2018-19)	Pooled	(2017-18)	(2018-19)	Pooled	(2017-18)	(2018-19)	Pooled
V_1: Hisar Bhumit	101.2	107.8	104.5	129.6	136.2	132.9	1,395.70	1,439.80	1,417.70
V_2: Hisar Anand	97.6	103	100.3	121.8	126.7	124.2	1,679.20	1,737.20	1,708.20
V_3: Hisar Sugandh	100.6	107.5	104.1	126.3	129.4	127.8	1,793.00	1,818.50	1,805.70
CD at 5%	2.37	2.17	1.5	4.68	3.09	3.48	13.35	11.36	12.21
Irrigation scheduling									
I_1: Irrigation at 0.6 IW/CPE	87.2	101.2	94.2	119.2	124.2	121.7	1,546.80	1,586.60	1,566.70
I_2: Irrigation at 0.8 IW/CPE	100.6	104.9	102.7	124.9	128.9	126.9	1,602.90	1,643.60	1,623.30
I_3: Irrigation at 1.0 IW/CPE	105.1	108.9	107	129	134.8	131.9	1,665.10	1,713.70	1,689.40
I_4: Irrigation at 1.2 IW/CPE	106.4	109.5	107.9	130.4	135.2	132.8	1,675.60	1,716.80	1,696.20
CD at 5%	1.94	1.15	0.91	2.21	1.15	1.38	12.38	12.79	12.58
Nitrogen levels									
N_1: Nitrogen at 40 kg ha^{-1}	88.8	93.3	91.1	110.9	115.3	113.1	1,411.50	1,449.30	1,430.40
N_2: Nitrogen at 50 kg ha^{-1}	99.6	105.3	102.4	125.6	129.5	127.6	1,612.40	1,653.10	1,632.70
N_3: Nitrogen at 60 kg ha^{-1}	105.3	112.8	109.1	133	138.9	136	1,731.30	1,777.10	1,754.20
N_4: Nitrogen at 70 kg ha^{-1}	105.5	113.1	109.3	134	139.3	136.6	1,735.30	1,781.20	1,758.30
CD at 5%	1.54	0.85	0.79	1.59	1.2	1.26	13.55	13.94	13.74

Table 3: Interaction of effect of level of irrigation and nitrogen fertigation days to maturity and seed yield (kg ha^{-1}) of coriander varieties.

Irrigation Levels	Irrigation × Nitrogen				
	Nitrogen levels				
	N_1	N_2	N_3	N_4	Mean B
I_1	1,326.10	1,584.70	1,676.50	1,679.50	1,566.70
I_2	1,411.60	1,616.70	1,731.30	1,733.40	1,623.30
I_3	1,491.30	1,663.60	1,798.90	1,804.00	1,689.40
I_4	1,492.50	1,666.00	1,810.10	1,816.20	1,696.20
Mean N	1,430.40	1,632.70	1,754.20	1,758.30	
CD at 5%	I-12.58		N-13.74		

C. Days to 50% flowering and days to maturity

The data clearly shows that varieties, irrigation and nitrogen levels significantly influenced the days to 50% flowering of coriander during both the years. Significantly least number of days (94.2) taken to 50% flowering were reported when coriander irrigated with irrigation level of 0.6 IW/CPE followed by 0.8 IW/CPE (102.7). Among nitrogen levels, significantly least number of days (91.1) taken to 50% flowering were reported when coriander treated with nitrogen at 40 kg ha^{-1} followed by nitrogen at 50 kg ha^{-1} (102.4). Among verities, significantly least number of days (100.3) were taken to 50% flowering in Hisar Anand over rest of the varieties. Result presented clearly indicated that significantly least number of days (121.7) taken to maturity were recorded in coriander treated irrigation level at 0.6 IW/CPE followed by 0.8 IW/CPE (126.9). The data of nitrogen fertigation, significantly least number of days (113.6) were taken to maturity in coriander treated with lowest nitrogen level *i.e*. 40 kg ha^{-1}followed by 50 kg ha^{-1} (136.6). Lowest number of days (124.2) taken to maturity were observed in Hisar Anand of coriander in over Hisar Sugandh (127.4) and Hisar Bhumit (132.9).

The result obtained can be attributed to lower nitrogen dose that could not carry out the nutritional requirement of plant for better root and vegetative growth, which ultimately resulted in reduced growth, early accumulation of photosynthesis and ultimately early flowering and fruiting. While, optimum nitrogen dose maintained the appropriate pertaining to food surrounding in the root zone, which balanced physiological process, or proper uptake of nutrients resulted in better foliage and delayed the flowering and fruiting. Further, it helped in proper seed development by maintaining source and sinks relationship and finally resulted in early and prolonged harvesting. Almost similar results attained by Godara *et al.*, (2013); Meena *et al.* (2016). Among different cultivars, the minimum number of days taken to 50% flowering and maturity in coriander was recorded in Hisar Anand over Hisar Bhumit followed by Hisar Sugandh. The variation in this aspect may be due to their genetic characters of different cultivars of coriander. Analogous results were also stated by Bhunia *et al*. (2009.

D. Seed yield (kg ha^{-1})

The data related to seed yield depicted that varieties, irrigation and nitrogen levels significantly influenced the seed yield of coriander during both the years. Among irrigation levels, significantly higher seed yield (1696.2 kg ha^{-1}) of coriander were recorded in coriander treated with irrigation level at 1.2 IW/CPE, which was statistically at par with coriander treated with irrigation level at 1.0 IW/CPE (1689.4 kg ha^{-1}). Data pertaining to the effect of nitrogen levels, significantly higher seed yield (1758.3 kg ha^{-1}) were recorded in coriander treated with nitrogen at 70 $kgha^{-1}$, which was statistically at par with coriander treated with nitrogen at 60 kg ha^{-1} (1754.2 kg ha^{-1}). Among varieties, significantly higher seed yield of coriander in Hisar Sugandh (10.84 g $plant^{-1}$) over other varieties, *i.e.* Hisar Anand (10.42 g $plant^{-1}$) and Hisar Bhumit (8.51 g $plant^{-1}$).

The effect of irrigation scheduling on seed yield per hectare were increased significantly by 7.7 per cent through irrigation scheduling at 1.2 IW/CPE over 0.6 IW/CPE. Seed yield of the crop is the results of many physiological processes under which the crop is grown. The optimum moisture condition in the entire root zone of the crop reflects in better physiological activities of plant plants. Application of appropriate amount of irrigation water maintained the proper soil moisture when overcomes the moisture stress during growing period and ultimately enhanced the yield. Results of present study were in close agreement with the findings of Rao *et al.* (2010); Godara *et al.* (2013); Solanki *et al.* (2017); Meena *et al.* (2017); Harisha *et al.* (2019).

E. Interaction effect

On examining the interaction effect of irrigation and nitrogen levels (I×N) showed in Table 3, it was revealed that significantly higher seed yield (1816.2 kg ha^{-1}) were recorded in coriander sown at irrigation level of 1.2 IW/CPE with nitrogen applied at 70 kg ha^{-1} (I_4N_4), which was statistically at par with coriander sown at irrigation level of 1.2 IW/CPE with nitrogen applied at 60 kg ha^{-1} (1810.1 kg ha^{-1}), 1.0 IW/CPE with nitrogen applied at 70 kg ha^{-1} (1804.0 kg ha^{-1}) and 1.0 IW/CPE with nitrogen applied at 60 kg ha^{-1} (1798.9 kg ha^{-1}), whereas, the lowest seed yield (1326.1 kg ha^{-1}) was recorded at irrigation level of 0.6 IW/CPE with nitrogen applied at 40 kg ha^{-1}.

CONCLUSION

It can be concluded that the variety Hisar Sugandh with irrigated scheduling at 1.0 IW/CPE with nitrogen level of 60 kg ha^{-1} can be grown to get statistically at par productivity as while irrigated scheduling at 1.2 IW/CPE with level of nitrogen at 70 kg ha^{-1}. The growth parameters *viz*., taller plants, higher numbers of primary and secondary branches, lowest number of days taken to 50% flowering and maturity were recorded with irrigation schedule at 1.2 IW/CPE ratios (I_4), which was statistically at par with irrigation scheduled at 1.0 IW/CPE ratio (I_3). Furthermore, higher growth parameters of coriander were recorded with nitrogen level at 70 kg ha^{-1} (N_4), which was statistically at par with 60 kg ha^{-1} (N_3).

Acknowledgments. The authors are grateful to CCS HAU and sincerely thank the guide, co-guide, co-authors, seniors and juniors of the Department of Vegetable Science, College of Agriculture, CCS Haryana Agricultural University, Hisar to provide guidance through the research work.

Conflict of Interest. None.

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How to cite this article: Vikram, T.P. Malik, Khyati Singh, Amit Kumar, Desh Raj Chaudhary and Vinod Kumar (2022). Effect of Irrigation Level and Nitrogen Fertigation on Growth Parameters and Seed Yield of Coriander (*Coriandrum sativum* L.) Varieties. *Biological Forum – An International Journal*, *14*(2): 75-79.