Biological Forum – An International Journal **14(2a): 589-597(2022)**

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

Effect of different Dates of Sowing on Growth, Yield and Quality of Coriander (*Coriandrum sativum* L.)

Monika Thakur, Puja Rattan*, A.H. Reddy and Anju Pathania
Faculty of Agricultural Sciences, DAV University, Jalandhar (Punjab), India.

(Corresponding author: Puja Rattan)*
(Received 29 April 2022, Accepted 23 June, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The Present investigation was conducted during winter season, 2020 at DAV University, Jalandhar to determine the most suitable sowing date and variety for optimum production of coriander in Jalandhar region. Since very little work on the agronomic manipulation of the crop involving sowing time has been done, therefore the present study was planned and executed. The treatment consisted of three sowing dates (15 October, 30 October, 15 November) and three varieties *viz.*, Bharat Kaveri, Punjab Sugandh and Split Seed. The experiment was laid in Factorial Randomized Complete Block design with three replications. Characters studied were days to germination initiation, days to complete germination, plant height (cm), number of leaves per plant, foliage weight (g), days to 50% flowering, number of primary branches, number of secondary branches, number of umbel per plant, number of umbellets per umbel, number of seeds per umbel, days to harvesting, seed yield per plot (g), 1000 seed weight and TSS. Results obtained revealed that sowing dates and varieties has played outstanding role in deciding the yield and yield contributing traits of coriander. Among the sowing dates and varieties studied in the present investigation 15 October and Bharat Kaveri performed superior for most of the characteristics under observation. The maximum plant height, number of leaves per plant, foliage weight, number of primary branches, number of secondary branches, number of umbel per plant, number of umbellets per umbel, number of seeds per umbel, seed yield per plot, 1000 seed weight were witnessed when Bharat Kaveri sown on 15 October.

Keywords: Date of sowing, coriander, *Coriandrum sativum* L., seed yield, seed quality.

INTRODUCTION

Coriander (*Coriandrum sativum*) is an annual aromatic herb, grown for its green fresh leaves, seed, essential oil and oleoresin. Coriander, also known as cilantro and Chinese parsley, is a member of family Apiaceae (Umbelliferae). It is commonly known as "Dhania" or "Dhana". It is a dual purpose crop, grown for fresh leaf as well as for seed for use as a spice. It is probably one of the earliest seed spices known to humankind (Pruthi, 1976). The dried ground fruits are major ingredient of curry powder. Whole or ground seeds are also used for flavouring various preparations like pickles, sausage and confectionery items. It is a frequent ingredient in the preparation of Ayurvedic medicines (Said *et al.*, 1996).

India is the world's largest producer, consumer and exporter of the spices. It is also known as "home of the spices" from very ancient times. coriander (*Coriandrum sativum)* seed is one of the most important spices. Approx. 80% of the world total coriander seed is produced in our country. In India, coriander is mainly cultivated in Rajasthan, Madhya Pradesh, Uttar Pradesh and Southern States like Andhra Pradesh, Karnataka and Tamil Nadu. The country's annual production of coriander seeds in 2021 was over 822 thousand metric tons (Anonymous, 2021). There is a limited scope of increasing the area under this crop because of competition with food grain crops. The only way to increase the production is to increase its productivity through sound crop production technology. The coriander is a cool season crop and can be successfully cultivated in rabi season on black cotton or other type of heavy soils which have better water retention capacity. Coriander plants are highly sensitive to the abrupt variations in climatic parameters as it is delicate in nature. Coriander exploits the environment most favourably when it is sown at optimum time (Kuri *et al.*, 2015) since sowing date significantly affects the photoperiodic response of plants and determines yields and qualities (Rasam *et al.*, 2007).

It is an established fact that a crop when sown at optimum time, it is able to exploit the environmental factors (*e.g.* sunlight, rainfall, day length etc.) most efficiently. It is the temperature as mediated by solar radiation alone that can make significant differences not only on the process of dry matter accumulation in vegetative phase but dry mater allocation for yield, is also favoured by optimum cardinal temperature.

Besides this, in a crop like coriander too early sowing may lead to poor crop establishment due to heat shock and resultantly restricted seed germination. Furthermore, flowering and/ or seed formation stage may coincide with frost attacking period (Bhati *et al.*, 1989). Whereas, the late sown crop may face high temperature during seed filling, which will adversely affect the economic yield due to shortening of net seed filling period and the consequent forced maturity. The proper date of sowing will also take the advantages of the absence of the pest or avoid susceptible stage of the crop. It should synchronise with the most inactive period or lowest pest population. In Punjab region the **o**ptimum period of sowing of coriander for green leaves is first week of October and for seed last week of October to the first week of November. However, it can be continued up to last week of December. However, very little work on the agronomic manipulation of the crop involving these factors has been done. Therefore, it was deemed imperative to carry out the present study with the objective of finding out the most effective date of sowing for optimum growth yield and quality of coriander.

MATERIALS AND METHODS

The present experiment was laid out in Randomized Block Design and three replications. Total nine treatments consisting of different combination of three different sowing dates (15 October, 30 October and 15 November) and three varieties (Bharat Kaveri, Punjab Sugandh and Split Seed) viz., D_1V_1 (15 October × Bharat Kaveri), D_1V_2 (15 October × Punjab Sugandh), D_1V_3 (15 October × Split Seed), D_2V_1 (30 October × Bharat Kaveri), D_2V_2 (30 October × Punjab Sugandh), D_2V_3 (30 October × Split Seed), D_3V_1 (15 November × Bharat Kaveri), D_3V_2 (15 November × Punjab Sugandh) and D_3V_3 (15 November × Split Seed).Observations on growth, yield and quality parameters *viz.*, days to germination initiation, days to complete germination, plant height (cm), number of leaves per plant, foliage weight per plant, days to 50% flowering, number of primary branches per plant, number of secondary branches per plant, umbels per plant, umbellets per umbel, seed per umbel, days to harvesting, seed yield per plot, 1000 seed weight and total soluble solids (° brix) were recorded. The statistical analysis of data recorded during the course of investigation for all the characters was done by analysis of variance method for factorial randomized block design described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Analysis of variance for the different growth, yield and quality traits in coriander is presented in Table 1 . Significant differences were observed among all the characters for date of sowing and varieties. Interaction effect of date of sowing and varieties resulted significance differences for all characters under study except for days to germination initiation, days to complete germination, plant height and TSS.

Table 1: Analysis of variance for growth yield and quality parameters of Coriander

Observations	MSS (Factor A)	MSS (Factor B)	MSS(Factor A × B)	Error
Days to germination initiation	21.68*	1.161*	0.01	0.00
Days to complete germination	8.71*	1.20*	0.00	0.00
Plant height (cm)	34.48*	92.59*	14.26	5.15
Number of leaves per plant	7.03*	2.90*	2.04*	0.67
Foliage weight (g)	2.00*	1.80*	0.99*	0.32
Number of primary branches	77.95*	7.72*	11.48*	2.08
Number of secondary branches	40.90*	32.61*	27.52*	6.73
Number of umbel per plant	40.90*	32.61*	27.52*	6.73
Number of umbellets per plant	1.35*	1.46*	1.32*	0.29
Number of seed per umbel	205.23*	22.02*	23.22*	2.34
Seed yield per plot (g)	73425.93*	28495.37*	17175.93*	1498.84
Days to 50% flowering	76.47*	7.70*	1.24*	0.09
Days to harvesting	1521.64*	9.14*	0.37*	0.00
Test weight (g)	9.74*	0.74*	0.09*	0.01
Total Soluble Solids	3.05*	1.01*	0.01	0.01

*Significant at 5% Factor A = Date of sowing; Factor B = Varieties

A. Days to germination initiation

Significantly minimum days to germination initiation (7.47) were recorded in D_1 (15 October) than all other sowing dates while, D_3 (15 November) revealed significantly maximum days to germination initiation (10.47). Among varieties, significantly minimum days to germination (8.77) were recorded in V_3 (Split Seed) and maximum days to germination initiation (9.48) were observed in variety V_1 (Bharat Kaveri). Interaction effect of dates of sowing and varieties was found non significant for days to germination initiation. (Table 2)

In the present study minimum days of germination was observed when sowing was done on 15 October. The present findings are in line with the findings of earlier researchers namely Guha *et al*. (2014); Karetha *et al*. (2014); Ali *et al*. (2015); Lal *et al*. (2017) in coriander who also observed significant influence of date of sowing on germination in coriander.

B. Days to complete germination

Perusal of data (Table 2) revealed that minimum days to complete germination (13.43 days) were observed when seeds were sown on D_1 (15 October) which was significantly minimum than all other date of sowing. Maximum days to complete germination (15.40) were recorded in D_3 (15 November) which was significantly maximum than all other date of sowing. Among varieties, V_3 (Split

Seed) took minimum days to complete germination (14.06 days) which was statistically lowest than all other varieties. Maximum days to complete germination (14.80) was observed in variety V_1 (Bharat Kaveri) which was significantly higher than all other varieties under study.

The interaction of date of sowing and varieties were found non significant for days to complete germination. The results obtained on days to complete germination were similar to those obtained for days to germination initiation which indicated that sowing done on 15 October provided suitable environmental conditions for coriander seeds to germinate. Findings are in accordance with the reports of earlier researchers namely, Guha *et al.* (2014); Lal *et al.* (2017) who observed early seed germination at early sowing in coriander. Varieties also influenced complete germination significantly which were also found in the findings of Latye *et al.* (2016) in fenugreek, Lal *et al.* (2017); Duwal *et al.* (2019) in coriander.

C. Plant height (cm)

Plant height was significantly influenced by dates of sowing and varieties. Maximum plant height (32.00 cm) was observed when plants were sown on D_1 (15 October) which was significantly tallest among all other dates of sowing. Minimum plant height (28.56 cm) was observed in D_3 (15 November) which was statistically at par with plants height observed in D_2 (30 October) (28.67cm). Among varieties, maximum plant height (33.44cm) was observed in V_1 (Bharat Kaveri) which was significantly highest than other varieties. Significantly minimum plant height (27.89 cm) was observed in varieties V_2 (Punjab Sugandh) and V_3 (Split Seed) (Table 2).

Interaction effect of dates of sowing and varieties was found non significant for plant height. Significant decrease in plant height in late sowing can be related with higher temperature at the time of harvesting. Similar results were obtained by Ghobadi and Ghobadi (2012); Moniruzzaman *et al.* (2013); Sharangi and Roychowdhury (2014); Mohonalakshmi *et al.* (2019) in coriander, Abed and Shebl (2016) in spinach and Dhillon *et al.* (2019) in fennel.

Differences in plant height among varieties were observed in the present investigations. The finding corroborate the findings of Kauim *et al.* (2015); Eltyeb (2015); Latye *et al.* (2016); Bajad *et al.* (2017); Mahajan *et al.* (2017); Pujari *et al.* (2019); Gandepalli and Prasad (2020) in coriander and Anitha *et al.* (2018) in fenugreek.

D. Number of leaves per plant

Perusal of data (Table 2) revealed that maximum number of leaves per plant (15.72) were observed in D_1 (15 October) which was significantly highest than number of leaves per plant observed in other sowing dates. Minimum number of leaves per plant (14.00) were recorded in D_3 (15 November) which was significantly lowest than number of leaves per plant observed in all other sowing dates. Among varieties, maximum number of leaves per plant (15.49) were recorded in V_1 (Bharat Kaveri) which was significantly highest than number of leaves per plant observed in all other varieties. Minimum number of leaves per plant (14.39) were observed in V_3 (Split seed) which was significantly lowest than number of leaves per plant observed in other varieties.

Table 2: Effect of date of sowing and varieties on growth of coriander.

Treatment	Days to germination initiation	Days to complete germination	Plant height (cm)	Number of leaves per plant	Days to 50% flowering	Number of primary branches	Number of secondary branches	Days to harvesting
Date of sowing								
D_1	7.42	13.43	32.00	15.72	102.40	12.15	21.07	175.78
D_2	9.43	14.48	28.67	15.30	99.54	10.13	17.29	171.49
D_3	10.47	15.40	28.56	14.00	96.52	6.35	17.47	151.40
CD(5%)	**0.08**	**0.06**	**2.29**	**0.83**	**0.31**	**1.45**	**2.61**	**0.19**
SE(d)	**0.04**	**0.03**	**1.07**	**0.39**	**0.14**	**0.68**	**1.22**	**0.05**
Varieties								
V_1	9.48	14.80	33.44	15.49	100.16	10.54	20.78	166.86
V_2	9.06	14.45	27.89	15.09	98.36	9.39	17.82	165.04
V_3	8.77	14.06	27.89	14.37	99.89	8.70	17.22	166.72
CD(5%)	**0.08**	**0.06**	**2.29**	**0.83**	**0.31**	**1.45**	**2.61**	**0.19**
SE(d)	**0.04**	**0.03**	**1.07**	**0.39**	**0.14**	**0.68**	**1.22**	**0.05**

Perusal of data pertaining to interaction effect of date of sowing and cultivars on number of leaves per plant (Table 3) depicted that maximum number of leaves per plant (16.52) was observed in $D_2 \times V_1$ (30 October × Bharat Kaveri) which was statistically at par with $D_1 \times V_2$ (15 October × Punjab Sugandh) and $D_1 \times V_1$ (15 October × Bharat Kaveri) which resulted in number of leaves per plant to the tune of 16.48 and 16.02, respectively. Minimum number of leaves per plant (13.69) was observed in $D_3 \times V_3$ (15 November × Split Seed) which was statistically at par with all the treatment except $D_1 \times V_1$ (15 October × Bharat Kaveri) and $D_1 \times V_2$ (15 November × Punjab Sugandh) resulting in 16.02 and 16.48 leaves per plant, respectively. Maximum number of leaves per plant were obtained in 15th October sowing and subsequent decrease in number of leaves per plant in delayed sowing emphasis on the fact that early sowing promotes the vegetative

growth. These findings were also reported by Wassem and Nadeem (2001); Meena and Malhotra (2006); Moniruzzaman *et al*. (2013); Mohanalakshmi *et al.* (2019) in coriander and Abed and Shebl (2016) in spinach.

Table 3: Interaction of effect of date of sowing and varieties on growth of coriander.

Date of sowing/ varieties	Days to germination initiation			Days to complete germination			Plant height (cm)			Number of leaves per plant			Days to 50% flowering		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
D_1	7.85	7.38	7.02	13.80	13.44	13.06	33.67	31.00	31.33	16.02	16.48	14.66	103.78	101.34	101.93
D_2	9.80	9.40	9.08	14.88	14.49	14.07	32.33	25.67	28.00	16.52	14.38	14.75	99.82	98.44	100.37
D_3	10.80	10.40	10.47	15.72	15.42	15.06	34.44	27.00	24.33	13.93	14.39	13.69	96.90	95.30	97.03
CD (5%)	**N/S**			**N/S**			**N/S**			**1.43**			**0.54**		
SE (d)	**0.07**			**0.05**			**1.85**			**0.67**			**0.25**		

E. Days to 50% flowering

Perusal of data (Table 2) revealed that D_3 (15 November) resulted in minimum days to 50% flowering (96.52) which was significantly lowest than all other sowing dates. Maximum days to 50% flowering (102.40) was observed in D_1 (15 October) which was significantly highest than days to 50% flowering observed in all other sowing dates. Among varieties, minimum number of days to 50% flowering (98.36) were recorded in V_2 (Punjab Sugandh) which was statistically lowest than other varieties. Maximum number of days to 50% flowering (100.16) was observed in V_1 (Bharat Kaveri) which were statistically highest than all other varieties.

Data presentation (Table 3) showed interaction effect of dates of sowing and cultivars on days to 50% flowering was significant. It depicted that maximum days to 50% flowering (103.78) observed in $D_1 \times V_1$ (15 October × Bharat Kaveri) which was statistically higher than other interaction effects. Minimum days to 50% flowering (95.30) were observed in $D_3 \times V_2$ (15 November × Punjab Sugandh) which was statistically lowest among all other interaction effects.

Sowing date greatly affected the flower bud development. It was earliest in the plants sown on 15 November. This suggests that delay in sowing of coriander resulted in earlier flowering. Interaction effects revealed that Punjab Sugandh when sown on 15 November resulted in minimum days to flowering initiation. Early flowering in late planting had also been reported by Rameeh (2012) in mustard.

Varieties varied significantly for days to flowering initiation. The findings are in line with the findings of Anitha *et al.* (2018) who also observed significant variation among varieties for days to 50% flowering in fenugreek. Our findings are in line with the findings of Bajad *et al.* (2017); Duwal *et al.* (2019); Gandepalli and Prasad (2020) in coriander.

F. Number of primary branches

It can be observed that D_1 (15 October) resulted in maximum number of primary branches (12.15) which was significantly highest than number of primary branches observed in all other sowing dates. Minimum number of primary branches (6.35) were observed in D_3 (15 November) which was significantly lowest than number of primary branches observed in all other sowing dates. Among varieties, maximum number of primary branches (10.54) were observed in V_1 (Bharat Kaveri) which was significantly highest than number of primary branches observed in all other varieties. Minimum number of primary branches (8.70) was reported in V_3 (Split Seed) which were significantly lowest than number of primary branches observed in all other varieties (Table 2).

Data pertaining to interaction effects of dates of sowing and varieties on number of primary branches is presented in Table 3. It depicted that maximum number of primary branches (13.55) was recorded in $D_2 \times V_1$ (30 October × Bharat Kaveri) which was statistically at par with $D_1 \times V_2$ (15 October × Punjab Sugandh), $D_1 \times V_3$ (15 October × Split Seed) and $D_1 \times V_1$ (15 October × Bharat Kaveri) which produced in 13.38, 11.72 and 11.35 branches, respectively. Minimum number of primary branches (5.80) were observed in $D_3 \times V_3$ (15 November × Split Seed) which was statistically at par with $D_2 \times V_2$ (30 October × Punjab Sugandh), $D_3 \times V_1$ (15 November × Bharat Kaveri) and $D_3 \times V_2$ (15 November × Punjab Sugandh) producing 8.25, 6.71 and 6.54 branches, respectively (Table 4). Similar findings were obtained by earlier researcher namely, Sharangi and Roychowdhary (2014); Mohanalakshmi *et al.* (2019) in coriander, Mengistu and Yomoah (2010) in carrot and Bhutia *et al.* (2017) in fenugreek.

G. Number of secondary branches

Perusal of data (Table 2) revealed that D_1 (15 October) resulted in maximum number of secondary branches (21.07) which was significantly highest than number of secondary branches observed in all other sowing dates. Minimum number of secondary branches (17.29) were recorded in D_2 (30 October) which was significantly lowest than number of secondary branches observed in all other sowing dates. Among varieties, V_1 (Bharat Kaveri) produced maximum number of secondary branches (20.78) which was significantly highest than number of

secondary branches observed in all other varieties. Variety, V_3 (Split Seed) produced minimum number of secondary branches (17.22) which was significantly lowest than number of secondary branches observed in all other varieties.

Interaction effects of date of sowing and varieties significant for number of secondary branches and are presented in Table 4. It depicted that maximum number of secondary branches (27.27) were recorded in $D_1 \times V_1$(15 October × Bharat Kaveri) which was significantly highest than all other interactions. Minimum number of secondary branches (16.87) were recorded in $D_2 \times V_3$ (30 November × Split Seed) which was statistically at par with all the treatment except $D_1 \times V_1$ (15 October × Bharat Kaveri).

Maximum number of secondary branches were observed when Bharat Kaveri was sown on 15 October indicating effect of sowing dates on different varieties for number of secondary branches. Similar results were obtained by Yousaf *et al.* (2002) who also observed significant effect of sowing dates on growth and yield of canola variety (sarson), Kaium *et al.* (2015) in coriander, Sowmya *et al.* (2017); Tamboli *et al.* (2020) in fennel.

Table 4: Interaction of effect of date of sowing and varieties on growth of coriander.

Date of sowing/ varieties	Number of primary branches			Number of secondary branches			Days to harvesting		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
D_1	11.35	13.38	11.72	27.27	18.13	17.80	176.89	174.40	176.05
D_2	13.55	8.25	10.13	17.27	17.73	16.87	171.86	170.40	172.05
D_3	6.71	6.54	5.80	17.80	17.60	17.00	151.83	150.33	152.05
CD(5%)	**2.52**			**4.53**			**0.17**		
SE (d)	**1.18**			**2.19**			**0.08**		

H. Days to harvesting

Perusal of data representing effect of dates of sowing and varieties on days to harvesting, revealed that minimum number of days to harvesting (151.40) were observed in D_3 (15^{th} November) which was significantly highest than all other sowing dates. Maximum number of days to harvesting (175.78) were observed in D_1 (15^{th} October) which was significantly highest than number of days to harvesting observed in all other sowing dates. Among Varieties, minimum number of days to harvesting **(**165.04) was observed in V_2 (Punjab Sugandh) which was significantly lowest than all other varieties. Maximum number of days to harvesting (166.86) reported in V_1 (Bharat Kaveri) which was significantly highest than days to harvest all other varieties (Table 2).

In case of early planting late physiological maturity indicates a prolonged vegetative phase which could have resulted in better seed yield as indicated in seed yield per plot. The results corroborate the findings of early researches namely Sultana *et al.* (2016); Bhutia *et al*. (2017) who observed that fenugreek plants sown late took least time to attain maturity. Guha *et al.* (2014) also observed the similar results in coriander.

Varieties varied significantly for harvest duration Punjab Sugandh showed minimum days to harvest. The significant difference for harvest duration among varieties might be due to difference in their growth habits. These results have close conformity with results obtained by Bajad *et al.* (2017); Mahajan *et al.* (2017); Pujari *et al.* (2019) in coriander.

I. Foliage weight (g)

Foliage weight was observed at 60 DAS and the data depicted that maximum foliage weight (5.29 g) was observed in D_1 (15 October) which was significantly highest than foliage weight observed in plants sown at other sowing dates. Lowest foliage weight (4.36 g) was observed in D_3 (15 November) which was significantly lowest than foliage weight of plants sown at other sowing dates. Among varieties, highest foliage weight (5.30g) was observed in V_1 (Bharat Kaveri) which was significantly highest than foliage weight observed in all other varieties. Lowest foliage weight (4.48 g) was observed in V_3 (Split Seed) which was significantly lowest than foliage weight of all other varieties (Table 5).

Table 5: Effect of date of sowing and varieties on yield and quality traits of coriander.

Treatment	Foliage weight (g)	Number of umbel per plant	Number of umbellets per umbel	Number of seeds per umbel	Seed yield per plot (g)	1000 seed weight(g)	TSS
Date of sowing							
D_1	5.29	21.07	6.07	27.21	708.33	12.55	5.37
D_2	4.71	17.29	5.57	22.74	647.22	11.50	5.44
D_3	4.36	17.47	5.31	17.67	530.56	10.47	4.40
CD(5%)	**0.57**	**2.61**	**0.54**	**1.54**	**39.02**	**0.11**	**0.13**
SE(d)	**0.27**	**1.22**	**0.25**	**0.72**	**18.25**	**0.05**	**0.06**
Varieties							
V_1	5.30	20.78	6.06	24.29	691.67	11.83	5.44
V_2	4.58	17.82	5.62	22.16	611.11	11.29	4.98
V_3	4.48	17.22	5.25	21.20	583.33	11.40	4.78
CD(5%)	**0.57**	**2.61**	**0.53**	**1.54**	**39.02**	**0.11**	**0.13**
SE(d)	**0.27**	**1.22**	**0.25**	**0.72**	**18.25**	**0.05**	**0.06**

Interaction effects of dates of sowing and varieties on foliage weight was significant and presented in Table 6. Data revealed that maximum foliage weight (5.70 g) was observed in $D_1 \times V_1$ (15 October × Bharat Kaveri) which was statistically at par with $D_1 \times V_3$ (15 October × Split Seed), $D_2 \times V_1$ (30 October × Bharat Kaveri) and resulted in 5.58 g, 5.53 g and 4.87 g foliage weight, respectively. Minimum foliage weight (3.73 g) was observed in $D_2 \times V_3$ (30 October × Split Seed) which was statistically at par with $D_3 \times V_1$ (15 November × Bharat Kaveri), $D_1 \times V_2$ (15 October × Punjab Sugandh) and $D_3 \times V_3$ (15 November × Split Seed) which resulted in foliage weight to the tune of 4.68 g, 4.61 g and 4.36 g, respectively. Similar results of significant differences in foliage weight due to dates of sowing were also reported by Chaudhari *et al.* (2009); Karetha *et al.* (2014); Sharangi and Roy chowdhury (2014); Mohanalakshmi *et al.* (2019) in coriander and Abed and Shebl (2016) in spinach. Foliage yield was varied significantly among the varieties. It was maximum in Bharat Kaveri which also showed maximum germination percentage, plant height, number of leaves per plant etc. Significant effect of varieties on leaf yield per plant was also observed by Ibrahim and Heyduck *et al.* (2019) in spinach, Duwal *et al.* (2019); Gandepalli and Prasad (2020) in coriander, Narayan *et al.* (2018) in palak.

Table 6: Interaction of effect of date of sowing and varieties on yield of coriander

Date of sowing/ varieties	Foliage weight (g)			Number of umbels per plant			Number of umbellets per umbel			Number of seeds per umbel			Seed yield per plot (g)		
	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3	V_1	V_2	V_3
D_1	5.70	4.61	5.57	27.27	18.13	17.80	6.30	5.60	6.30	26.37	28.60	26.67	725.00	650.00	750.33
D_2	5.53	4.87	3.73	17.27	17.73	16.87	6.40	5.93	4.33	28.01	20.33	19.87	725.00	691.67	525.00
D_3	4.68	4.28	4.36	17.80	17.60	17.00	5.47	5.62	5.25	18.40	17.53	17.07	625.00	491.67	475.00
CD(5%)	**0.99**			**4.53**			**0.94**			**2.67**			**67.59**		
SE (d)	**0.46**			**2.19**			**0.44**			**1.25**			**31.61**		

J. Number of umbel per plant

Effects of dates of sowing and varieties on number of umbels per plant reveals that maximum number of umbels (21.07) were reported in D_1 (15 October) which was significantly highest than number of umbels observed in all other dates of sowing. Minimum number of umbels per plant (17.29) was recorded in D_2 (30 October) which was significantly lowest than number of umbel observed in all other sowing dates. Among varieties, V_1 (Bharat Kaveri) resulted in maximum number of umbels per plant (20.78) which was significantly highest than number of umbels observed in all other varieties. However, minimum number of umbels (17.22) were reported in V_3 (Split Seed) which was statistically lowest than number of umbels observed in all other varieties (Table 5).

Interaction effects of dates of sowing and cultivars on number of umbels per plant is presented in Table 6. Data depicted maximum number of umbels per plant (27.27) in $D_1 \times V_1$ (15 October × Bharat Kaveri) which was significantly highest than all other interaction effects. Minimum number of umbels (16.88) was observed in $D_2 \times V_3$ (30 November × Split Seed) which was statistically at par with all the treatments except $D_1 \times V_1$ (15 October × Bharat Kaveri).

It was observed that there was decrease in number of umbels per plant with delay in sowing. The findings are in line with the findings of Eltyeb (2015) who also advocated the decrease in number of umbels per plant with delayed sowing in coriander. Singh and Singh (2013); Katiyar *et al.* (2014); Kaium *et al.* (2015); Bajad *et al.* (2017); Pujari *et al.* (2019) also suggested variation among varieties for yield contribution traits such as umbels per plant in coriander and Dhillon *et al.* (2019) in fennel.

K. Number of umbellets per umbel

Perusal of data (Table 5) revealed that D_1 (15 October) showed maximum number of umbellets per umbel (6.07) which was significantly highest than number of umbellets per umbel observed in all other sowing dates. Minimum number of umbellets per umbel (5.31) were recorded in D_3 (15 November) which was significantly lowest than all other sowing dates. Among varieties, maximum number of umbellets per umbel (6.06) were observed in V_1 (Bharat Kaveri) which was statistically highest than all other varieties. Minimum number of umbellets per umbel (5.25) were recorded in V_3 (Split Seed) which was significantly lowest than number of umbellets per umbel observed in other varieties.

Interaction effects of dates of sowing and varieties on number of umbellets per umbel is presented in Table 6. Data depicted that maximum number of umbellets per umbel (6.40) were recorded in $D_2 \times V_1$ (30 October × Bharat Kaveri) which was statistically at par with all the treatments except $D_3 \times V_3$ (15 November × Split Seed) and $D_2 \times V_3$ (30 October × Split Seed) which produced 5.25 and 4.33 umbellets per umbel, respectively. Minimum number of umbellets per umbel (4.33) were observed in $D_2 \times V_3$ (30 October × Split Seed) which was statistically at par with $D_3 \times V_3$ (15 November × Split Seed). The findings of Mengistu and Yomoah (2010) also revealed decrease in number of umbellets per umbel with delayed sowing in carrot and Sharangi and Roychowdhary (2014) reported similar results in coriander. Varieties also showed significant differences for number of umbellets per plant. The findings are in line with

the finding of Singh and Singh (2013); Kaium *et al.*, (2015); Bajad *et al.* (2017); Gandepalli and Prasad (2020) who also observed significant differences for number of umbellets per umbel in different varieties of coriander.

L. Number of seeds per umbel

Perusal of data (Table 5) revealed that D1 (15th October) showed maximum number of seeds per umbel (27.21) which was significantly highest than number of seeds per umbel observed in all other sowing dates. Minimum number of seeds per umbel (17.67) were observed in D3 (15th November) which was significantly lowest than all other sowing dates. Among the varieties, V1 (Bharat Kaveri) produced maximum number of seeds per umbel (24.26) which was significantly highest than number of seeds per umbel observed in all other varieties. However, variety V3 (Split seed) produced minimum number of seeds per umbel (21.20) which was significantly lowest than all other varieties.

Interaction effects of dates of sowing and varieties on number of seeds per umbel are presented in Table 6. It revealed that $D_1 \times V_2$ (15^{th} October × Punjab Sugandh) produced maximum number of seeds per umbel (28.60) which was statistically at par with $D_2 \times V_1$ (30^{th} October × Bharat Kaveri) $D_1 \times V_3$ (15^{th} October × Split Seed) and $D_1 \times V_1$ (15^{th} October × Bharat Kaveri), which resulted in number of seeds per umbel to tune of 28.00, 26.67 and 28.37, respectively. Minimum number of seeds per umbel (17.07) were observed in $D_3 \times V_3$ (15^{th} November × Split Seed) which was statistically at par with $D_3 \times V_2$ (15^{th} November × Punjab Sugandh) and $D_3 \times V_1$ (15^{th} November × Bharat Kaveri) which resulted in number of seeds per umbel to tune of 17.53, 18.40, respectively.

Number of seeds per umbel varied significantly with varieties. Similar results were obtained by Meena and Malhotra (2006); Singh and Singh (2013); Kaium *et al.* (2015); Bajad *et al.* (2017) in coriander.

M. Seed yield per plot (g)

Effects of dates of sowing and varieties on seed yield per plot revealed that maximum seed yield per plot (708.33 g) was observed in D_1 (15^{th} October) which was significantly highest than all other sowing dates. Minimum seed yield (530.56 g) was reported in D_3 (15^{th} November) which was significantly lowest than seed yield per plot observed in all other sowing dates. Among varieties, V_1 (Bharat Kaveri) resulted maximum seed yield per plot (691.67 g) which was significantly highest than all other varieties. Minimum seed yield (583.33 g) was observed in V_3 (Split Seed) which was significantly lowest than seed yield per plot observed in all other varieties (Table 5).

Interaction effects of dates of sowing and cultivars on seed yield per plot (Table 6) revealed that maximum seed yield per plot (750.33 g) was observed in $D_1 \times V_3$ (15^{th} October × Split seed) which was statistically at par with $D_1 \times V_1$ (15^{th} October × Bharat Kaveri), $D_2 \times V_1$ (30^{th} October × Bharat Kaveri) and $D_2 \times V_2$ (30^{th} October × Punjab Sugandh) which produced seed yield per plot to the tune of 725.00 g, 725.00 g and 691.67 g, respectively. Minimum seed yield per plot (475.00 g) was observed in $D_3 \times V_3$ (15^{th} November × Split Seed) which was statistically at par with $D_2 \times V_3$ (30^{th} October × Split Seed) and $D_3 \times V_2$ (15^{th} November × Punjab Sugandh) which resulted in seed yield per plot to the tune of 525.0 g and 491.7 g, respectively

Delayed sowing resulted in reduction in seed yield per plot as revealed from the results. The lower seed yield could be due to shorter growth period of the plants in late sowing which hinder them to make full use of the available resources resulting in lower yield. Similar results were obtained by earlier researcher namely Ayub *et al.* (2008) in fennel and Sharangi and Roychowdhury (2014). Eltyeb *et al.* (2015); Mohanalakhshmi *et al.* (2019) in coriander. Rawal *et al.*, (2015) reported same results in cumin and Bhutia *et al.*, (2017) also observed same results in fenugreek. Significant variation in seed yield per plot among varieties could be due to their genetic makeup. Similar findings were also observed by earlier researcher namely Kaium *et al.* (2015); Bajad *et al.* (2017); Mahajan *et al.* (2017); Pujari *et al.* (2019) in coriander and Anitha *et al.* (2018) in fenugreek.

N. 1000 Seed weight (g)

Perusal of data revealed that maximum 1000 seed weight (12.55 g) was observed in D_1 (15^{th} October) which was significantly highest than other sowing dates. Minimum 1000 weight (10.47 g) was observed in D_3 (15^{th} November) which was significantly lowest than 1000 seed weight observed in all other sowing dates. Among varieties, maximum 1000 seed weight (11.83 g) was observed in V_1 (Bharat Kaveri) which was statistically highest than 1000 seed weight observed in all other varieties. Minimum 1000 seed weight (11.29 g) was observed in V_2 (Punjab Sugandh) which was statistically lowest than 1000 seed weight observed in all other sowing dates (Table 5).

Among interaction effects (Table 7), the variety Bharat Kaveri which surpassed other varieties in most of the phenological and yield attributes produced maximum 1000 seed weight when sown on 15^{th}October. This suggests that best time to the sow Bharat Kaveri is 15^{th} October and there is greater influence of sowing time on 1000 seed weight. The results are in conformity with the findings of early researchers (Anitha *et al.*, 2016) in fenugreek.

1000 seed weight is one of the important yield component which plays important role in determining the seed yield. It varied significant for different dates of sowing and maximum 1000 seed weight was observed in treatments which were sown on 15^{th} October. This could be due to availability of favourable climatic conditions and prolonged growth period helping in completing all

physiological processes leading to increased 1000 seed weight. These findings are in line with the findings of earlier researchers namely Chaudhari *et al*. (2009) in amaranth, Anitha *et al*. (2016); Bhutia *et al*. (2017) in fenugreek, Sharangi and Roychowdhury (2014); Eltyeb (2015) in coriander and Raj *et al.* (2016) in fennel.

O. Total soluble solids (TSS)

Effects of dates of sowing, varieties and their interactions on total soluble solids (TSS) revealed that maximum TSS (5.37° brix) was observed in D_1 (15^{th} October) which was significantly highest than all other sowing dates. Minimum TSS (4.40° brix) was observed in D_3 (15^{th} November) which was significantly lowest than TSS observed in all other sowing dates. Among varieties, maximum total soluble solids (5.44° brix) were observed in V_1 (Bharat Kaveri) which was significantly highest than TSS observed in all other varieties. Minimum TSS (4.79° brix) was observed in V_3 (Split Seed) which was significantly lowest than total soluble solids observed in all other varieties (Table 5).

TSS was found to be greatly influenced by dates of sowing. It was found gradually decreasing with delay in sowing. The results are in close conformity with the findings of Karetha *et al*. (2014) in coriander.

TSS was significantly varied with the varieties. The finding are in line with findings of earier researchers namely Gandepalli and Prasad (2020) in coriander.

Table 7: Interaction of effect of date of sowing and varieties on quality of coriander.

Date of sowing/varieties	1000 seed weight (g)			Total Soluble Solids		
	V_1	V_2	V_3	V_1	V_2	V_3
D_1	12.72	12.26	12.67	5.78	5.27	5.05
D_2	11.84	11.35	11.30	5.77	5.43	5.13
D_3	10.93	10.25	10.23	4.77	4.24	4.18
CD(5%)	**0.19**			**N/S**		
SE (d)	**0.09**			**0.11**		

CONCLUSION

It may be concluded that yield attributing traits like number of leaves per plant, foliage weight, number of primary branches, number of secondary branches, number of umbels per plant, number of umbellets per umbel, number of seeds per umbel, seed yield per plot and 1000 seed weight were observed maximum when Bharat Kaveri was sown on 15 October. However, days to 50% flowering and days to harvesting were observed minimum when Punjab Sugandh sown on 15 November.

FUTURE SCOPE

The findings established will help the farmers to get good seed yield and quality by following proper sowing time.

Acknowledgment. The authors are obliged to DAV University, Jalandhar for providing all the necessary materials and facilities required for carrying out the research.

Conflict of Interest. None.

REFERENCES

Abed, M. Y. and Shebl, E. F. (2016). Effect of sowing dates and number of cuttings on yield and quality of Spinach (*Spinacia oleracea L.). Journal of Plant Production, Mansoura University, 7*(12): 1437 -1442.

Ali, H., Ayub, G., Elahi, E., Shahab, M., Ahmed, S. and Ahmed, N. (2015).Response of coriander (*Coriandrumsativum* L.) to different nitrogen levels and sowing dates. *Asian Journal Agriculture Biology, 3*(4): 140-144.

Anitha, B., Reddy, M. L. N., Rao A. V. D. D., Patro, T. S. K. K. K. and Suneetha, D. R. S. (2016). Effect of sowing date of yield and quality of fenugreek. *Plant Archives, 16*(1): 479 – 484.

Anitha, B., Reddy, M. L. N., Rao, A. V. D. D., Patro, T. S. K. K. K. and Suneetha, D. R. S. (2018). Performance of fenugreek cultivars for growth and seed yield. *International Journal of Applied Bioscience, 6*(6): 271-277.

Anonymous (2020). https://www.statista.com/statistics/1039106/india-coriander production - volume.

Ayub, M., Nadeem, M. A., Tanveer, A., Tahir, M., Saqib, M.T.Y. and Nawaz, R. (2008). Effect of different of sowing methods and times on the growth and yield of fennel (*Foeniculum vulgare Mill). Journal of Botany, 40*(1): 259-264.

Bajad, G. B., Dahale, M. H. and Nandeshwar, V. N. (2017). Performance of different coriander varieties for seed yield. *Journal of Krishi Vigyan, 5*(2): 132-137.

Bhutia, K.C., Bhutia, S.O., Chatterjee, R. and Chattopadhyay, N. (2017). Growth, phenology and yield of fenugreek (*Trigonella foenum- graecum* L.) as influenced by date of sowing. *International Journal of Current Microbiology and Applied Science, 6*(10): 1810-1817.

Chaudhari, J. H., Raj, V. C., Srivastava, R. K. and Ahir, M. P. (2009).Effect of varying sowing date and row spacing on yield attributes and yields of rabi grain amaranth *(Amaranthus hypochondriacus* L.*). Department of Agronomy, Navsari Agricultural University*.

Dhillon, S., Tinna, D. and Gandhi, N. (2019). Effect of different sowing dates and does of nitrogen on morphology, yield contributing characters and yield of fennel (*Foeniculum vulgare). Journal of Pharmacognosy and Phytochemistry*, 653-656.

Duwal, A., Nepal, A., Luitel, S., Acharya, S., Pathak, R., Poudel, P. R. and Shrestha, J. (2019). Evaluation of coriander varieties for growth and yield parameters. *Nepalese Journal of Agricultural Sciences, 18*: 36-46

Eltyeb, M. A. (2015). Effect of sowing date and seed rate on yield of coriander. *International Journal of Agriculture Innovations and Research, 3*(4) : 2319-1473.

Gandepalli, L. and Prasad, V. M. (2020). Evaluation of coriander (*Coriandrum sativum* L.*)* varieties in Prayagraj Agro-climatic conditions. *International Journal of Current Microbiology and Applied Sciences, 9*(12): 1086-1091.

Ghobadi, M. E. and Ghobadi, M. (2012). Effect of late sowing on quality of coriander (*Coriandrum sativum* L.). *International Journal of Agricultural and Biosystems Engineering*, *6*(7): 425-428.

Guha, S., Sharangi, A. B. and Debnath, S. (2014). Phenology and green leaf yield of coriander at sowing dates and harvesting times. *Journal of Food, Agriculture and Environment*, *V 12*(3&4): 251-254.

Heyduck, R. F., Guldan, S. J. and Guzman, I. (2019). Effect of sowing date and harvest schedule on organic spinach grown during the winter in high tunnels. *Horticulture Technology*, *29*(3): 320-329.

Kaium, A., Islam, M., Sultana, S., Hossain, E., Shovon, S. C. and Mahjuba, A. (2015). Yield and yield contributes of coriander (*Coriandrum sativum* L.*)* as influenced by spacing and variety. *International Journal of Scientific and Research Publications*, *5*(3): 1-5.

Karetha, K. M., Jat, G. and Ladumor, A. R. (2014). Effect of different date of sowing and growing conditions on coriander (*Coriandrum sativum* L.*). International Journal of Agricultural Sciences*, *10*(2): 524-528.

Katiyar, R.S., Nainwal, R.C., Singh, D., Chaturvedi, V. and Tewari, S. K. (2014). Effect of spacing and varieties on growth and yield of coriander (*Coriandrum sativum* L.*)*on reclaimed sodic waste soil. *Progressive Research*, *9(Special)*: 811-814.

Kuri, B. R., Jat, N. L., Shivran, A. C., Saharawat, Y. S., Bana, R. S. and Dadarwal, R. S. (2015). Effect of sowing time, varieties and plant growth regulators on growth, physiological indices and productivity of coriander (*Coriandrum sativum* L.). *Indian Journal of Agronomy*, *60*(3): 464-470.

Lal, G., Metha, R.S., Singh, R., Choudhary, M. K. and Maheria, S. P. (2017). Effect of sowing dates on plant growth and seed yield of ajmer green coriander -1 in winter season. *International Journal of Seed Spices*, *7*(2): 14-18.

Latye, P. T., Bharad, S. G., Kale, V. S., Nandeshwar, V.N. and Kholia, A. (2016). Varietal performance of fenugreek under akola conditions. *International Journal of Minor Fruits, Medicinal and Aromatic Plants, V 2*(1): 32-34.

Mahajan, R. D., Patgaonkar, D. R., Garande, V. K., Pawar, R. D., Dhumal, S. S. and Sonawane P. N. (2017). Response of coriander cultivars under different shade net intensities during summer. *Asian Journal of Horticulture*, *12*(2): 211-217.

Meena, S. S. and Malhotra, S. K. (2006). Effect of sowing time, nitrogen and plant growth regulators on green leaf yield of coriander. *Haryana Journal Horticulture Science*, *35(3&4)*: 310-311.

Mengistu, T. and Yamoah, C. (2010). Effect of sowing date and planting density on seed production of carrot (*Daucus carota var. sativa)* in Ethiopia. *African Journal of Plant Science*, *4*(8): 270-279.

Mohanalakshmi, M., Boomiga, M. and Gowtham, T. (2019). Effect of season and growing condition on yield and quality parameters of coriander (*Coriandrum sativum* L.*). International Journal of chemical studies*, *7*(3): 2989-2993.

Moniruzzaman, M., Rahman, M. M., Hossain, M. M., Sirajul, A. J. M., Karim, S. and Khaliq, Q. A. (2013). Effect of sowing dates on year round production of foliage of coriander (*Coriandrum sativum* L.*). Journal Agriculture Research*, *38*(1) : 29-39.

Narayan, S., Malik, A., Makhdoomi, M. I., Nabi, A., Hussain, K. and Khan, F. A. (2018). Influence of date of sowing and number of cuttings on leaf yield and quality of seed in palak (*Beta vulgaris var. bangalensis). International Journal of Experimental Agriculture*, *24*(3): 1-4.

Panse V. G. and Sukhatme, P. V. (1967). Statistical methods for Agriculture workers. Indian council of Agriculture, New Delhi.

Pruthi, J.S., 1976. Spices and Condiments. National Book Trust, New Delhi, India, pp: 226

Pujari, R., Sunada, B. B., Kurubar, A. R., Narayan, J., Chetan, T. and Kale, S. (2019). Collection and evaluation of coriander varieties in UKP command area. *International Journal of Current Microbiology and Applied Sciences*, *8*(6): 3125-3130.

Raj, H., Panghal, V. P. S., Lal, M., Duhan, D. S. and Kumar, K. (2016). Effect of sowing dates and planting methods on quality of different order umbels in fennel. *International Journal of Environment, Agriculture Biotechnology*, *1*(3), 577-580.

Rasam, G., and Nadaf, M., & Sefid Con, F. (2007). Effect of planting date and plant density on yield and seed yield components of anise (*Pimpinella anisum* L.) pajouhesh-va-sazandegi, 20(2 (75 in natural resources)), 127-133.

Rawal, R., Sharma, M., Srivastava, A., Thapa, R. B. and Khadka, R. B. (2015). Performance of cumin *(Cuminum cyminum* L.*)* varieties at different sowing dates in salyan, Nepal. *Nepal Agricultural Research Journal*, *V* (14): 53-58.

Said, H. M., Saeed, L. A. D., Zubairy, H. N. and Bano, Z. (1996). Medicinal Herbal: A Textbook for Medical Students and Doctors. *Hamdard Foundation Pakistan*, (*1)*: 1-82.

Sharangi, A. B. and Roychowdhury, A. (2014). Phenology and yield of coriander (*Coriandrum sativum* L.) at different sowing dates. *Journal of Plant Sciences*, *9*(2): 32-42.

Singh, S. J. and Singh, S. K. (2013). Genetic variability analysis in coriander (*Coriandrum sativum* L.*). Journal of Spices Aromatic Crops*, *22:* 81-84.

Sowmya, P. T., Naruka, I. S., Shaktawat, R. P. S. and Kushwah, S. S. (2017). Effect of sowing dates and stage of pinching on growth, yield and quality of fenugreek *(Trigonella foenum- graecum* L.*). International Journal of Bio-resources and stress management*, *8*(1): 091-095.

Tamboli, Y. A., Amin, A.U., Patil, J. K. and Birla, J. (2020). Growth, yield attributes and yield of rabi fennel (*Foeniculum vulgare, Mill.*) as influenced by different time of sowing, variety and spacing, *9*(4): 339-351.

Yousaf, M., Ahmed, A., Jahangir, M. and Naseeb, T. (2002). Effect of different sowing dates on the growth and yield of canola (Sarson) Varieties. *Asian Journal of Plant Sciences*, *1*(6): 634-635.

How to cite this article: Monika Thakur, Puja Rattan, A.H. Reddy and Anju Pathania (2022). Effect of different Dates of Sowing on Growth, Yield and Quality of Coriander *(Coriandrum sativum* L.). *Biological Forum – An International Journal*, *14*(2a): 589-597.