Response of different sowing dates on phenology, yield and quality of Coriander (*Coriandrum sativum* L.) under protected condition

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ABSTRACT

An investigation was carried out during 2017-2018 in the naturally ventilated arched saw teeth type polyhouse in the Faculty of Horticulture, BCKV, Mohanpur, Nadia, WB, India. The main objective of the investigation is to find out the suitable date of sowing of Coriander (local cultivar Khusboo) for getting maximum yield as well as the quality parameters under protected condition of new alluvial zone of West Bengal. The Experiment was laid out in RBD with six replications and five different dates (i.e. 5th September, 5th October, 5th November, 5th December and 5th January) as treatments in 1.5 m × 1.2 m plot size with spacing of 30 cm × 15 cm.

It was revealed from the study that 5th October sown seeds have maximum number of umbels per plant (43.36), number of umbellate per umbel (6.00), number of seeds per umbel (21.55), seed yield per plot (342.01 g) and projected seed yield (1075.62 kg ha^{-1}) than other sowing dates. In case of quality parameters, total chlorophyll content of leaves found to be maximum (7.46 mg100 g^{-1}) under 5th December sown seeds. The highest β-carotene content (10.45 mg100 g^{-1}) and ascorbic acid content (127.20 mg100 g^{-1}) was observed from the leaves of 5th December and 5th November sown seeds, respectively. Seeds sown in the month of October and November showed the highest oleoresin percentage of 0.18. The 5th October sown coriander seeds gave the highest net return of Rs. 59,937.60 ha $^{-1}$ with a maximum benefit cost ratio of 3.30.

From the above investigation it may be concluded that for maximization of yield of coriander under protected condition, the suitable date of sowing is suggested as 5th October followed by 5th September and 5th November under the new alluvial tracts of West Bengal.

Keywords: Coriander, cultivar, date of sowing, protected condition, yield

INTRODUCTION

Coriander (*Coriandrum sativum* L., Family Apiaceae) is mainly cultivated from its seeds throughout the year (Mhemdi *et al.*, 2011). India is the biggest producer, consumer and exporter of coriander in the world. During 2016-17, area under coriander cultivation was 674 thousand hectare with a production of 923 thousand MT (NHB, 2018). It is an annual, herbaceous plant which originated from the Mediterranean and Middle Eastern regions. It contains an essential oil (0.03 to 2.6 %) (Nadeem *et al.*, 2013). All parts of this herb are in use as flavoring agent and/or as traditional remedies for the treatment of different disorders in the folk medicine systems of different civilizations (Sahib *et al.*, 2012). Coriander is a tropical crop and generally sown in the winter season for seed production. West Bengal is not too far behind the traditional

coriander growing states like Rajasthan, Gujarat and Andhra Pradesh. Time of sowing is crucial for crop for the vegetative growth and ultimate expressions of yield. Any early or late sowing may hamper the growth, yield as well as quality of the crop. In case of coriander early sowing leads to early flowering but may be vulnerable to damage in case of extreme cold and frost. On the other hand late sowing affected the growth as well as yield and quality in an adverse way. Gujar *et al.,* (2005) reported from an experiment that the maximum values were recorded for all the characters when the seeds were sown on 10th October followed by 25th October. The production of horticultural crops are higher in protected condition than the open field condition due to congenial inside microclimate and that provided better price. It will further prolong the harvest period, increase yield, quality improvement and keep the availability of commodities frequently. Isaac S.R. (2015) revealed that coriander establishes and grow well with higher biomass production in naturally ventilated polyhouse. Keeping in view the above, the present experiment was undertaken to study the exact date of sowing for getting maximum yield as well as the quality parameters under protected condition of new alluvial zone of West Bengal.

MATERIALS AND METHODS

The experiment was conducted at the naturally ventilated arched saw teeth type polyhouse in the Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India during 2017 to 2018. The experimental site was on a high land with assured irrigation facilities as well as good drainage facilities. The soil of the experimental site was Gangetic alluvial soil with sandy clay loam texture, good water holding capacity and soil pH of 6.75. The experiment was laid out in Randomized Block Design (RBD) with six replications and five different dates (*i.e.* 5th September, 5th October, 5th November, 5th December and 5th January) as treatments in 1.5 m × 1.2 m plot size with spacing of 30 cm × 15 cm. Well rotten FYM @ 12 t ha^{-1} was applied and mixed thoroughly at the time of land preparation and inorganic fertilizers in the form of Urea (46% N), SSP (16% P_2O_5) and MOP (60% K_2O) were applied @ 15 kg N, 40 kg P_2O_5 and 20 kg K_2O ha^{-1} as basal dose. Another 15 kg N ha^{-1} was applied 60 days after sowing. Seeds were soaked overnight in water to facilitate the quick and uniform germination then the seeds were sown in the raised plots. All the cultural and management practices like weeding, irrigation, plant protection measures, etc. were carried out uniformly for all the treatments. Data on time taken for germination from the days after sowing (DAS), plant height (cm), time taken for flowering, seed setting, physiological maturity (DAS), number of branches plant^{-1}, number of umbels plant^{-1}, number of umbelletes umbel^{-1}, number of seeds umbel^{-1}, 1000 seed weight (g), Seed yield plot^{-1} (g), projected seed yield (kg ha^{-1}) and economics were recorded. The chlorophyll content of leaves (mg100g^{-1}) and β-carotene content of leaves (mg100g^{-1}) was determined as per Sadasivam and Manickam(1996).The ascorbic acid content of leaves (mg100g^{-1}) was estimated as per Ranganna(2001) and oleoresin content of seeds (%) as per A.S.T.A.(1960). The data collected from the experimental field were subjected to statistical analysis, appropriated to RBD as suggested by Gomez and Gomez (1984) and Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Plant phenology and flowering

Days required for germination of coriander is influenced by different date of sowing. Date of sowing had significant effect on days required for germination (Table 1). The earliest days required for germination of 7.55 days was noted from the plants which were sown on 5th November whereas, 5th September sown seeds had register the longest days for germination (10.32 days). This may be due to the favourable environmental factors may enhance the germination quickly as well as late sown plants hindrance the germination process in which it required delay for germination. Robinson (1954) explained that low

temperature seems to favour germination by promoting the breakdown of reserve proteins in the seeds into particular amino acids which are necessary for growth of the embryo.

The date of sowing has significant effect on plant height of coriander. At 30, 60 and 90 DAS the maximum plant height was obtained from 5th October sown seeds (4.83 cm, 26.44 cm and 101.26 cm, respectively). The reason might be due to the fact that favourable climate helps to induce the better plant height. Sharma in the year 1996 also reported that seeds sown on 5th October produced taller plants with more branches and yield attributes than late sown seeds.

Different date of sowing has significant effect on time taken for flowering. Early flowering was noticed in 5th January sown seed with the shortest time period of about 72.18 DAS, whereas, 5th October sown seeds recorded the most delayed in flowering (81.22 DAS). Pan *et al.*, (2003) also observed that early flower initiation occurred in coriander with delayed sowing under new alluvial zone of West Bengal.

Date of sowing has significant effect on time taken for seed setting. Seed setting occurred at about 90.33 DAS for 5th October sown seeds which were observed to be the most delayed. But, early seed setting was observed for 5th January sown seeds which were noticed to avail the shortest time period of about 79.52 DAS. Similar result was reported by Guha *et al*., (2014) under Gangetic plains of West Bengal.

The date of sowing influenced significantly on physiological maturity. It revealed from Table 1 that, most delayed physiological maturity was observed from 5th October sowing which required 126.96 DAS whereas, earliest physiological maturity was observed from 5th January sown seeds which required 110.72 DAS. Prolonged vegetative stage required for 5th October sown seeds may be the reason for delayed in physiological maturity.

Yield attributing, yield and economics

Perusal of the data presented in Table 2 showed that the number of branches per plant has significant effect on different dates of sowing. The highest number of branches per plant (13.68) was associated with 5th October sown seeds. Meena *et al*., (2006) also opined that 5th October sown seeds were resulted in more number of branches and also exhibit improvement in yield attributes. Different date of sowing has significant effect on number of umbels per plant. Among the different dates of sowing, 5th October sown seeds were found to record the highest number of umbels per plant (43.36). The lowest number of umbels per plant (38.67) was observed in late sown seeds (5th January). Higher number of umbels per plant in 5th October sown seeds might be due to the fact that the plants got adequate time for its growth under favourable condition (Pan *et al*., 2003).

Data in Table 2 clearly revealed that dates of sowing have significant effect on number of umbelletes per umbel. Among the different dates of sowing, 5th October sown seeds were found to produce the highest number of umbelletes per umbel (6.00). Similar findings was also observed by Meena *et al*., (2006) .They recorded that 5th October sown seeds resulted in crops exhibited significant improvement in yield attributes including the highest number of umbelletes per umbel under Rajasthan condition. The date of sowing has a significant effect on number of seeds per umbel. The seeds sown on 5th October produce higher number of seeds per umbel (21.55). The later sown seeds (5th December) produced the lower number of seeds (17.65). Sharma *et al*., (1991) also opined that the seeds per umbel decreases with delay in sowing. Bhadkariya *et al*., (2007) also observed the maximum number of seeds per umbel in earlier sown coriander seeds. Date of sowing had no significant effect on thousand seed weight (test weight) of coriander. However, the higher

test weight was obtained from 5th October sown seeds (9.13 g). Kaya *et al*., (2000) also reported that the effect of sowing dates was insignificant on thousand seed weight. The date of sowing has significant effect on seed yield. The 5th October sown seeds were found to produce the highest seed yield (342.01 g plot^{-1}).However, the lowest seed yield was obtained from late sown seeds (240.5 g plot^{-1}). Gujar *et al.*, (2005) also reported that the highest seed yield of coriander was recorded under the seed sown on 5th October.

The statistically analyzed data of projected seed yield (kg ha^{-1}) displayed in Table 2. Date of sowing has a significant effect on projected seed yield. Seeds sown on 5th October were found to produce the highest seed yield (1075.62 kg ha^{-1}). The lowest seed yield was obtained from 5th January sown seeds (756.38 kg ha^{-1}). The lower yield in delayed sowing was due to insufficient time for vegetative growth as the plant entered the reproductive phase at a faster rate. Similar findings also reported by Pan *et al*., (2003).

From an assessment of the economics of Coriander (local cultivar Khusboo) on different sowing dates, highest net return of Rs. 59937.60 ha^{-1} with a benefit cost ratio of 3.30 was obtained from the October sown seeds and lowest net return of Rs. 34993.40 ha^{-1} with a benefit cost ratio of 2.37 was obtained from the January sown seed.

Quality parameters of coriander

The data presented in Table 3, showed that the higher chlorophyll-a content of leaves was obtained from 5th December and 5th January sown seeds (2.83 mg 100g^{-1}) and the lowest value was noted from 5th September (2.69 mg 100g^{-1}). Similarly, chlorophyll-b content was found to be maximum (4.64 mg 100g^{-1}) from 5th December sown seeds whereas, 5th October sown seeds recorded the minimum chlorophyll-b (4.47 mg 100g^{-1}) content. In case of total chlorophyll content of leaves, 5th December sown seeds were found to be maximum (7.46 mg 100g^{-1}). The reason might be due to the fovourable climate during the month of December sown seeds helps to enrich the chlorophyll synthesis.

Sowing dates had no significant effect on β-carotene content of coriander leaves (Table 3). The highest β-carotene content (10.45 mg 100g^{-1}) was noted in the leaves of 5th December sown seeds whereas, lowest β-carotene content (10.19 mg 100g^{-1}) was recorded in 5th January sown seeds. Like β-carotene content of coriander leaves sowing date had no significant effect on ascorbic acid content. The highest ascorbic acid content (127.20 mg 100g^{-1}) was recorded from the leaves of 5th November sown seeds whereas, lowest ascorbic acid content (124.77 mg 100g^{-1}) was recorded from 5th December sown seeds. Oleoresin content was found significant with different dates of sowing. Negligible variation on oleoresin content with the different sowing dates was recorded. The maximum content of 0.18% of oleoresin with seeds of coriander has been exhibited when the seeds were sown in 5th October and 5th November whereas, the lowest oleoresin content of 0.16% was observed from the seeds which were sown late (5th January). The reason behind the lower oleoresin content during the month of January sown seeds might be due to fact that the development of seed was not proper as because of unfavourable climatic condition.

SUMMARY AND CONCLUSION

It was observed that different date of sowing has significant influence on some growth parameters like height of plant, time taken for germination, time taken for flowering, seed setting etc. It is apparent from the study that plant sown on 5th October was found to produce highest seed yield of 342.01 g plot^{-1} and projected seed yield of 1075.62 kg ha^{-1}. On the other hand, yield attributing characters like number of branches per plant, number of umbels per plant, number of umbelletes per umbel, number of seeds per umbel, 1000 seed weight were influenced significantly on the date of sowing. The 5th October sown seeds

produced the maximum number of branches (13.68), number of umbels per plant (43.36), number of umbelletes per umbel (6.00), and number of seeds per umbel (21.55) over the other dates of sowing. In case of quality parameters, total chlorophyll content of leaves found to be maximum (7.46mg100g^{-1}) under 5th December sown seed, the highest β-carotene content (10.45 mg100g^{-1}) and ascorbic acid content (127.20 mg100g^{-1}) was observed from the leaves of 5th December and 5th November sown seeds, respectively and the highest oleoresin percentage of 0.18from the seeds sown in the months of October and November.

Almost all the growth and yield attributing parameters had shown boosting effect with 5th October sown seeds. Considering the overall performance in relation to the time of sowing, thus it lead to a conclusion that for obtaining higher yield of coriander, 5th October sowing may be suggested in the new alluvial tracts of West Bengal. However, the experiment should be carried out for at least 2-3 years to confirm the results.

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Table 1: Response of date of sowing on plant phenology and flowering of coriander

Treatments	Time taken for germination (DAS)	Plant Height (cm)			Time taken for flowering (DAS)	Time taken for seed setting (DAS)	Time taken for physiological maturity (DAS)
		30 DAS	60 DAS	90 DAS			
D_1	10.32	4.46	24.68	96.18	74.04	81.39	120.60
D_2	9.68	4.83	26.44	101.26	81.22	90.33	126.96
D_3	7.55	4.63	23.54	95.12	75.47	86.15	117.02
D_4	8.13	4.67	22.14	87.24	78.46	86.56	112.59
D_5	8.92	4.34	19.63	79.32	72.18	79.52	110.72
Mean	**8.92**	**4.59**	**23.29**	**91.82**	**76.28**	**84.79**	**117.58**
SEm(±)	**0.15**	**0.08**	**0.43**	**1.72**	**1.36**	**1.50**	**1.90**
CD (0.05)	**0.49**	**0.28**	**1.43**	**5.70**	**4.51**	**4.96**	**6.28**

Table 2: Response of date of sowing on yield attributing, yield and economics of coriander

Treatments	No. of branches plant^{-1}	No. of umbels plant^{-1}	No. of umbelletes umbel^{-1}	No. of seeds umbel^{-1}	Test weight (g)	Seed yield plot^{-1} (g)	Projected seed yield (kg ha^{-1})	B : C ratio
D_1	12.33	41.01	5.67	20.43	9.06	303.90	955.77	2.96
D_2	13.68	43.36	6.00	21.55	9.13	342.01	1075.62	3.30
D_3	11.69	40.74	5.34	18.65	8.95	273.50	860.15	2.63
D_4	12.09	41.35	5.00	17.65	8.57	250.55	787.97	2.46
D_5	11.33	38.67	4.33	17.83	8.72	240.50	756.38	2.37
Mean	**12.21**	**41.03**	**5.27**	**19.22**	**8.89**	**282.09**	**887.18**	
SEm(±)	**0.22**	**0.75**	**0.10**	**0.35**	**0.16**	**15.63**	**49.16**	
CD (0.05)	**0.73**	**2.49**	**0.33**	**1.15**	**NS**	**51.77**	**162.80**	

Table 3: Response of date of sowing on quality parameters of coriander

Treatments	Chlorophyll content of leaves (mg100g^{-1})			β-carotene content of leaves (mg100g^{-1})	Ascorbic acid content of leaves (mg100g^{-1})	Oleoresin content of seeds (%)
	Chl. a	Chl. b	Total Chl.			

D_1	2.69	4.48	7.17	10.36	125.49	0.17
D_2	2.71	4.47	7.17	10.41	125.75	0.18
D_3	2.75	4.54	7.27	10.27	127.20	0.18
D_4	2.83	4.64	7.46	10.45	125.34	0.17
D_5	2.83	4.63	7.45	10.19	124.77	0.16
Mean	**2.76**	**4.55**	**7.3**	**10.34**	**125.71**	**0.17**
SEm(±)	**0.04**	**0.07**	**0.11**	**0.22**	**2.30**	**0.004**
CD (0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Note: D_1 - 5th September, D_2 - 5th October, D_3 - 5th November, D_4 - 5th December, D_5 - 5th January, DAS - Days After Sowing, NS - Non Significant