EFFECT OF FOLIAGE CUTTINGS ON SEED YIELD AND QUALITY OF CORIANDER (*Coriandrum sativum* L.)

ABSTRACT

Coriander (*Coriandrum sativum* L.) is an important seed spices crop of family Apiaceae (Umbelliferae) and possess 2n=22 chromosomes with cross-pollination as mode of reproduction. A field experiment was conducted at CCS Haryana Agricultural University, Hisar to study the effect of foliage cuttings on seed yield and quality of Coriander. The Research material comprised of four genotypes viz. DH-5, DH-36, DH-228 and DH-246 was grown with three replications in factorial RBD. The foliage cutting was taken to make different treatments i.e. C_0 (without cutting), C_1 (one cutting at 45 days after sowing) and C_2 (two cuttings at 45 days and 60 days after sowing). The investigation resulted that number of foliage cuttings reduced the plant growth, seed yield and quality of coriander. The crop without cutting of foliage gave the maximum plant growth along with highest seed yield which was followed by one cutting and lowest performance was observed after two cuttings. The increase in number of foliage cuttings of coriander significantly reduced the growth parameters of plant such as plant height, number of branches per plant, number of umbels per plant, number of seeds per umbel, number of seeds per umbellate, foliage and seed yield. The increase in number of foliage cutting also influenced the seed quality of coriander seed. The best quality seed with highest value of seed quality parameters such as test weight, standard germination, seedling length, seedling dry weight, vigour index-I, vigour index-II, field emergence index and seedling establishment, seed was harvested from without foliage cutting followed by one cutting at 45 days and two cuttings at 45 and 60 days after sowing. The genotype Hisar Anand (DH-5) was found best seed producing genotype. Whereas, Hisar Bhoomit (DH-228) was found best genotype both for foliage yield and seed yield.

Keywords: Coriander, foliage cuttings, green, seed yield and quality

1. INTRODUCTION

Coriander (*Coriandrum sativum* L.) is an important seed spices crop of family Apiaceae (Umbelliferae) and possess 2n = 22 chromosomes with cross-pollination as mode of reproduction. India has a unique place in world which produces 5.28 lakh tonnes seeds from 5.47 lakh ha area .Out of the total seed spices produced in India, Coriander alone contribute 51.54 per cent whereas, in respect of area coriander covers 63.68 per cent (Anonymous, 2014). The seed type is dicot and having epigeal germination. It is extensively cultivated in the arid and semi-arid region of India during *rabi* season. This spice is used by man as common flavouring substances. It is not only added flavor and taste to our food but also enhance keeping quality of food. The stem, leaves and grain have a pleasant aroma. Coriander seed have aromatic odour and taste of coriander fruits due to an essential oil, which is made up of hydrocarbon and oxygenated compounds. Besides the essential oil, the seed contains 16.1% fatty oil, 14.1% protein, 21.6% carbohydrate, 32.6% fibers, 11.2% moisture and 4.4% mineral matters and coriander leaves are very rich in Vitamin A and Vitamin C. Coriander plant has regenerative capacity and hence 2 to 3 cuttings can be undertaken very easily. Leaf plucking of coriander seed crop at early stages can provide an extra income to the farmers. Seed is an important component and the quality seed plays a crucial role in agricultural production as well as in national economy. Availability of viable and vigorous seed at the planting time is important for achieving targets of agricultural production because good quality seed acts as a catalyst for realizing the potential of other inputs. Since the total cultivable area is decreasing due to over growing population, the increased agricultural productivity is the only option. The good quality seed is pre-requisite to enhance the production and productivity. Use of quality seeds increased productivity of crop by 15-

20% (Sidhawani, 1991). Foliage cutting at the appropriate time before flowering causes multiplies of the branches that lead to increase in inflorescence number and seed yield. Whereas delayed cutting or cutting near to flowering reduces the plant growth and ultimately decrease the seed yield. So overall to take good yield of foliage and seed the crop should be left for seed production on time, at last foliage cutting. For green leafy vegetables i.e. coriander, harvested by clipping of the leaves and young shoots and repeated cutting influences the seed yield and quality (Datta *et al*., 2008).

2. MATERIALS AND METHODS

Seed material comprised of four genotype namely DH-228 (Hisar Bhoomit), DH-246 Hisar Surbhi), DH-36 (Hisar Sugandh) and DH-5 (Hisar Anand). The experiment was carried out using a RBD with three Replication and three cutting treatment was also applied i.e. C_0 = no cut, C_1 (one cutting) = one cut at the 45 days after sowing and C_2 (two cutting) first cutting at 45 days after sowing and second cutting at 60 days after sowing. All the (108) treatment combinations were replicated thrice. Seed were sown during the second week (11^{th}) of October in plots of size 3.0 m × 1.5 m at a spacing of 50 cm × 20 cm. Sowing and other cultural operation were done using recommended practices. Statistical analysis of data collected during the study was done by applying the technique of analysis of variance (ANOVA) as suggested by Gomez and Gomez (1984); and Panse and Sukhatme (1961). All the statistical analysis was carried out by using OPSTAT statistical software.

3. RESULTS AND DISCUSSION

Growth and yield parameters

The data pertaining to various plant growth and yield parameters (plant height, number of branches per plant, number of umbels per plant, number of seeds per umbel, number of seeds per umbellate and foliage yield) are presented in Table 1. A perusal of the data revealed that the foliage cuttings significantly affect plant height and maximum plant height (78.38 cm) was recorded when no cutting was undertaken followed by one cutting (78.13 cm) and minimum plant height (75.63 cm) was recorded when two cuttings were taken among the treatments irrespective of genotypes. The overall genotypic mean irrespective of cuttings resulted that DH-228 was found maximum plant height (104.67 cm) followed by DH-5 (73.48 cm) and minimum in DH-36 was (61.89 cm) among the genotype. These results are in accordance with the findings of Malik and Tehlan (2013), Duhan (1998); and Baboo and Rana (1995) in coriander.

Table 1: Effect of foliage cuttings on growth and yield parameters of Coriander

Genotype	Plant height at maturity (cm)				No. of branches per plant				No. of umbels per plant			
	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean
DH-228	106.73	106.07	101.20	**104.67**	6.33	6.10	6.07	**6.17**	33.73	29.87	28.73	**30.78**
DH-246	69.67	69.93	68.87	**69.49**	6.20	6.00	6.00	**6.07**	29.07	18.93	17.27	**21.76**
DH-36	62.27	61.87	61.53	**61.89**	5.80	5.70	5.67	**5.72**	23.73	22.27	18.20	**21.40**
DH-5	74.83	74.67	70.93	**73.48**	6.20	6.13	5.77	**6.03**	28.60	23.33	19.93	**23.96**
Mean	**78.38**	**78.13**	**75.63**		**6.13**	**5.98**	**5.88**		**28.78**	**23.60**	**21.03**	
CD @ 5%	**G = 3.397, C = 2.922, G × C = 5.846**				**G = 0.077, C= 0.067, G × C = 0.134**				**G = 1.746, C = 1.512, G × C = 3.024**			
Genotype	**No. of seeds per umbel**				**No. of seeds per umbellate**				**Foliage yield (q/ha)**			
	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean
DH-228	41.57	38.50	37.47	**39.18**	5.73	5.43	5.27	**5.48**	0	82.90	168.82	**83.91**
DH-246	26.97	26.33	24.00	**25.77**	4.80	4.40	4.07	**4.42**	0	81.96	159.04	**80.34**
DH-36	26.40	25.67	24.73	**25.60**	4.63	4.33	4.13	**4.37**	0	79.53	155.45	**78.33**

DH-5	33.57	28.27	25.33	**29.06**	4.77	4.63	4.27	**4.56**	0	82.87	161.54	**81.47**
Mean	**32.13**	**29.69**	**27.88**		**4.98**	**4.70**	**4.43**		**0**	**81.81**	**161.21**	
CD @ 5%	**G = 1.195, C = 1.035, G × C = 2.070**				**G = 0.116, C = 0.1 G × C = 0.199**				**G = 2.41, C = 2.087 , G × C = 4.175**			

Foliage cuttings significantly affect number of branches per plant and maximum number of branches per plant (6.13) was recorded when no cutting was undertaken followed by one cutting (5.98) and minimum number of branches per plant (5.88) was recorded when two cuttings were taken among the treatments irrespective of genotypes. The overall genotypic mean irrespective of cuttings resulted that DH-228 was found maximum number of branches per plant (6.17) followed by DH-246 (6.07) and minimum in DH-36 was (5.72) among the genotype. These results are in accordance with the findings of Malik and Tehlan (2013); Duhan (1998), Verma and Sen (2006) and Kumar (2010) in coriander.

The foliage cutting significantly affect number of umbels per plant and maximum number of umbels (28.78) was recorded at no cutting followed by one cutting (23.60) and minimum number of umbels per plant (21.03) was recorded when two cuttings were taken among the treatment irrespective of genotypes. The overall genotypic mean irrespective of cuttings resulted that DH-228 had maximum number of umbels per plant (30.78) and DH-36 had minimum number of umbels (21.40) among the genotypes. The similar findings were also observed by Verma and Sen (2006); and Malik and Tehlan (2013) in coriander.

The overall genotypic mean irrespective of cuttings showed that DH-228 had maximum number of seeds per umbel (39.18) and DH-36 had minimum number of seeds per umbel (25.60) among the genotype. was The foliage cuttings significantly affect number of seeds per umbel and maximum number of seeds per umbel (32.13) recorded without cutting followed by one cutting (29.69) and minimum number of seeds per umbel (27.88) was recorded when two cuttings were taken among the treatments irrespective of genotypes. These results are in conformity with the findings of Malik and Tehlan (2013); and Chaulagain *et al*. (2011) in coriander.

The foliage cuttings significantly affect number of seeds per umbellate and maximum number of seeds per umbellate (4.98) was recorded when no cutting was undertaken followed by one cutting (4.70) and minimum number of seeds per umbellate (4.43) was recorded when two cuttings were taken among the treatments irrespective of genotypes. The overall genotypic mean irrespective of cuttings resulted that DH-228 had maximum number of seeds per umbellate (5.48) and DH-36 had minimum number of seeds per umbellate (4.37) among the genotype. These results are in conformity with the findings of Malik and Tehlan (2013) in coriander.

In the present study foliage cuttings showed significant reduction in all the growth parameters while without cutting, there was a significant enhancement in plant growth. The crop which was left without foliage cutting came in flowering early as compared to one and two foliage cuttings. Better growth is the result of various enhanced physiological activities in the plant. The mean of genotypes revealed that the foliage yield of coriander genotypes was significantly higher for two cuttings (161.21 q/ha) as compared to one cutting (81.81 q/ha) irrespective the cutting levels. Among different genotypes of coriander, maximum foliage yield (83.91 q/ha) was recorded in DH-228 followed by (81.47 q/ha) found in DH-5 and minimum leaf yield was observed in DH-36 at one cutting (78.33 q/ha). Foliage cuttings significantly affect the foliage yield and maximum foliage yield (Figure 1) was recorded when two cutting were taken followed by one cutting irrespective of genotypes. Similar observation was reported in coriander by Baboo and Rana (1995), Menon and Khader (1997); and Chaulagain *et al*. (2011).

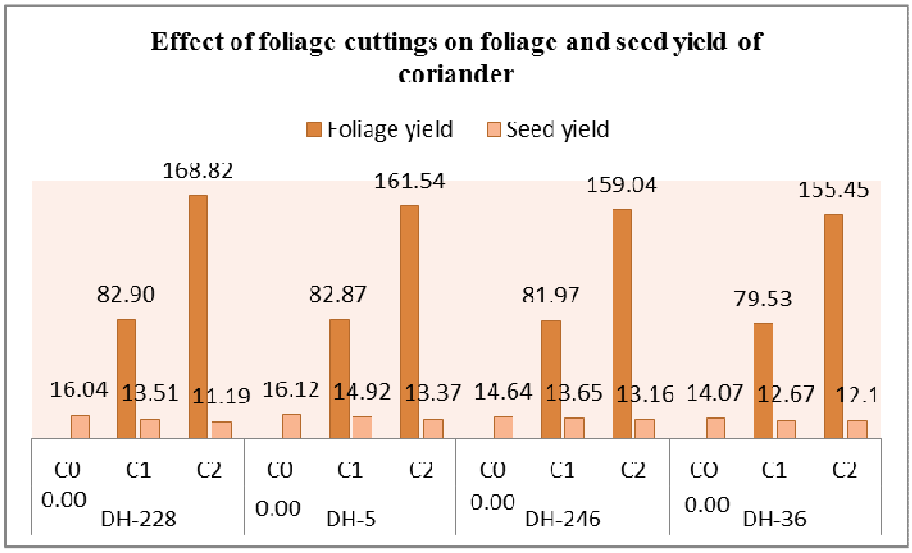

Fig. 1: Effect of foliage cuttings on foliage and seed yield of coriander

The perusal of data in Table 2 revealed that the maximum seed yield (15.22 q/ha) was recorded without cutting followed by one cutting (13.69 q/ha) and minimum seed yield (12.46 q/ha) was recorded when two cuttings were taken among the treatments irrespective of genotypes. The overall genotypic mean irrespective of cutting levels resulted that maximum seed yield (14.80 q/ha) for the genotype DH-5 and minimum seed yield (12.95 q/ha) for the genotype DH-36 among the genotype. Foliage cutting significantly affect the seed yield and maximum seed yield (Figure 1) was found (16.12, 14.92, 13.37 q/ha) in DH-5 followed by (16.04, 13.51, 11.19 q/ha) DH-228 and minimum seed yield (14.07, 12.67, 12.10 q/ha) in DH-36. Similar observation was reported in coriander by Baboo and Rana (1995), Menon and Khader (1997), Chaulagain *et al*. (2011), Verma and Sen (2006); and Bairva *et al*. (2012).

Table 2: Effect of foliage cuttings on seed yield (q/ha) of Coriander

Genotype	**Seed yield (q/ha)**			
	C_0	**C_1**	**C_2**	**Mean**
DH-228	16.04	13.51	11.19	**13.58**
DH-246	14.64	13.65	13.16	**13.82**
DH-36	14.07	12.67	12.10	**12.95**
DH-5	16.12	14.92	13.37	**14.80**
Mean	**15.22**	**13.69**	**12.46**	
C.D. @ 5%	**G = 0.494, C = 0.427, G × C = 0.855**			

Quality parameters

The quality of the seed is determined by test weight (1000 seed weight), standard germination, seed vigour, seedling dry weight, dehydrogenase activity test, field emergence index and seedling establishment showed in Table 3. Increasing foliage cutting levels decreased the quality of the seed. All the seed quality parameters decreased significantly at one cutting and two cuttings respectively.

Table 3: Effect of foliage cuttings on quality parameters of coriander

Genotype	Test Weight (g)				Standard Germination (%)				Seedling Length (cm)			
	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean
DH-228	8.40	8.22	8.04	**8.22**	89.67 (71.22)	88.55 (70.21)	88.22 (69.91)	**88.81 (70.45)**	26.45	26.26	26.25	**26.32**
DH-246	14.53	14.34	13.83	**14.23**	87.33 (69.12)	84.11 (66.49)	82.67 (65.43)	**84.70 (67.01)**	22.31	21.61	20.28	**21.40**
DH-36	13.90	13.49	13.20	**13.53**	82.89 (65.54)	81.55 (64.54)	79.55 (63.11)	**81.33 (64.40)**	22.33	21.53	19.78	**21.21**
DH-5	14.60	14.33	14.12	**14.35**	87.89 (69.61)	84.78 (67.01)	84.22 (66.61)	**85.63 (67.74)**	26.02	25.15	25.07	**25.42**
Mean	**12.86**	**12.59**	**12.30**		**86.94 (68.87)**	**84.75 (67.06)**	**83.67 (66.26)**		**24.28**	**23.64**	**22.84**	
CD @ 5%	**G = 0.403, C = 0.349, G × C = 0.692**				**G = 1.47, C = 1.27, G × C = 2.53 Figures in parentheses indicate transformed values**				**G = 0.718, C = 0.622, G × C = 2.467**			
Genotype	**Vigour index-I**				**Seedling Dry Weight (g)**				**Vigour index-II**			
	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean
DH-228	2,200.32	2,152.32	2,107.80	**2,153.48**	0.273	0.213	0.15	**0.212**	15.74	14.84	13.21	**14.60**
DH-246	1,966.47	1,831.18	1,685.24	**1,827.63**	0.16	0.133	0.127	**0.140**	12.99	10.74	9.89	**11.21**
DH-36	1,950.99	1,825.83	1,701.87	**1,826.23**	0.11	0.103	0.087	**0.100**	9.78	8.66	7.28	**8.57**
DH-5	2,336.36	2,237.71	2,219.31	**2,264.46**	0.18	0.177	0.16	**0.172**	24.37	19.05	13.44	**18.95**
Mean	**2,113.54**	**2,011.76**	**1,928.56**		**0.181**	**0.157**	**0.131**		**15.72**	**13.32**	**10.96**	
CD @ 5%	**G = 70.26, C = 60.85, G × C = 120.74**				**G = 0.023, C = 0.02, G × C = 0.04**				**G = 2.098, C = 1.817, G × C = 3.634**			
Genotype	**Seedling establishment (%)**				**Dehydrogenase enzyme activity**				**Field Emergence index**			
	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean	C_0	C_1	C_2	Mean
DH-228	76.89 (61.25)	75.78 (60.51)	73.11 (58.76)	**75.26 (60.17)**	0.074	0.043	0.039	**0.052**	5.55	5.49	4.85	**5.30**
DH-246	74.45 (59.68)	72.67 (58.50)	69.78 (56.63)	**72.30 (58.27)**	0.047	0.043	0.041	**0.044**	5.61	4.98	4.92	**5.17**
DH-36	74.22 (59.50)	70.22 (56.91)	68.22 (55.67)	**70.89 (57.36)**	0.038	0.033	0.019	**0.03**	5.32	5.16	4.79	**5.09**
DH-5	76.22 (60.82)	75.56 (60.45)	71.56 (57.77)	**74.45 (59.68)**	0.054	0.049	0.042	**0.048**	5.54	5.08	5.06	**5.23**
Mean	**75.45 (60.31)**	**73.56 (59.09)**	**70.67 (57.21)**		**0.053**	**0.042**	**0.035**		**5.51**	**5.18**	**4.91**	
CD @ 5%	**G = 1.761, C = 1.525, G × C = 3.03 Figures in parentheses indicate transformed values**				**G = 0.007, C = 0.006, , G × C = 0.012**				**G = 0.134, C = 0.116, , G × C = 0.233**			

The maximum test weight (12.86 g) was recorded without cutting followed by one cutting (12.59 g) and minimum test weight (12.30 g) was recorded when two cuttings were taken among the treatments irrespective of genotypes. The overall genotypic mean irrespective of cutting levels observed that maximum test weight (14.35 g) for the genotype DH-5 and minimum test weight (8.22 g) for the genotype DH-228 among the genotype. This may be due to inadequate transport of photosynthates to the developing coriander seeds of late left over crop after foliage cuttings for seed production, which resulted in the decrease of seed weight with the increase in number of foliage cuttings i.e. from 0 to 2.

The overall genotypic mean irrespective of cutting levels observed that maximum standard germination (88.81%) for the genotype DH-228 and minimum standard germination (81.33%) for the genotype DH-36 among the genotype. The maximum standard germination (86.84%) was recorded without cutting followed by one cutting (84.75%) and minimum standard germination (83.67%) was recorded when two cuttings were taken among the treatments irrespective of genotypes. The

maximum enhancement in seedling length (24.28 cm) was recorded without cutting followed by one cutting (23.64 cm) and minimum seedling length (22.84 cm) was recorded when two cuttings were taken among the treatments irrespective of genotypes. The overall genotypic mean irrespective of cutting levels observed that maximum seedling length (26.32 cm) for the genotype DH-228 followed by (25.42 cm) genotype DH-5 and minimum seedling length (21.21 cm) for the genotype DH-36 among the genotypes. A continuous decline in the standard germination was observed from 0 to 2 cuttings in all the genotypes. Similar trend was observed in lettuce by Kohli *et al*. (1985). In case of seedling length the decline trend was found like standard germination. These results are in accordance with the finding of Vasudevan *et al*. (2008) in fenugreek. The result indicated that vigour index decreased significantly with increase in number of foliage cuttings. The maximum vigour index-I (2113.54) was recorded when no cutting was undertaken followed by one cutting (2011.76) and minimum (1928.56) was recorded when two cuttings were taken among the treatment irrespective of genotypes. The overall genotypic mean irrespective of cutting levels observed that maximum vigour index-I (2264.46) for the genotype DH-5 followed by (2153.48) for the genotype DH-228 and minimum vigour index-I was recorded (1826.23) for the genotype DH-36 among the genotypes. The results of seedling vigour index are in accordance with the results obtained by Phor and Mangal (1991) in palak.

A perusal of data revealed that the overall genotypic mean irrespective of cutting levels observed that maximum seedling dry weight (0.212 g) for the genotype DH-228 followed by (0.172 g) for the genotype DH-5 and minimum seedling dry weight was recorded (0.100 g) for the genotype DH-36 among the genotypes. The maximum enhancement in seedling dry weight (0.181 g) was recorded without cutting followed by one cutting (0.157 g) and minimum seedling dry weight (0.131 g) was recorded when two cuttings were taken among the cutting levels irrespective of genotypes. Similar results are recorded in fenugreek by Sharangi *et al.* (2005).

The result indicated that vigour index-II decreased significantly with increase in number of foliage cuttings. The maximum vigour index-II (15.72) was recorded when no cutting was undertaken followed by one cutting (13.32) and minimum (10.96) was recorded when two cuttings were taken among the treatment irrespective of genotypes. The overall genotypic mean irrespective of cutting levels observed that maximum vigour index-II (18.95) for the genotype DH-5 followed by (14.60) for the genotype DH-228 and minimum vigour index-II was recorded (8.57) for the genotype DH-36 among the genotypes. The results of seedling vigour index are in accordance with the results obtained by Phor and Mangal (1991) in palak; and Sarkar *et al.* (2014) in water Spinach.

The range of optical density of formazan was estimated with the help of spectrophotometer. The foliage cuttings significantly affect the intensity of formazan and maximum intensity of formazan (0.053) was recorded when no cutting was undertaken followed by one cutting (0.042) and minimum (0.035) was recorded when two cuttings were done among the treatments irrespective of genotypes. The overall genotypic mean irrespective of cuttings results that maximum intensity of formazon (0.052) for the genotype DH-228 and minimum (0.03) for the genotype DH-36 among the genotypes. Under field condition, the speed of emergence was calculated as emergence index. There was a significant differences among genotypes, cutting levels, and their interaction for the speed with which seedling emerged in the field as indicated in Table 3. The overall genotypic mean irrespective of cuttings results that maximum field emergence index (5.30) for the genotype DH-228 and minimum (5.09) for the genotype DH-36 among the genotype. The foliage cuttings significantly affect field emergence index and maximum field emergence index (5.51) was recorded when no cutting was undertaken followed by one cutting (5.18) and minimum (4.91) was recorded when two cuttings were taken among the treatments irrespective of genotypes. The seedling establishment was recorded by counting the total numbers of seedling at completion of emergence i.e. 14 days of sowing. The foliage cuttings significantly affect seedling establishment in Table 3 and maximum seedling establishment

(75.45%) was recorded at no cutting followed by one cutting (73.56%) and minimum (70.67%) was recorded at two cuttings among the treatments irrespective of genotypes. The overall genotypic mean irrespective of cuttings results that maximum seedling establishment (75.56%) for the genotype DH-228 and minimum (70.89%) for the genotype DH-5 among the genotypes. These finding are also corroborates with the finding of Vasudevan *et al*. (2008) in fenugreek, Phor and Mangal (1991), Lal *et al*. (1979) in palak; and Lakshmi *et al.* (2015) in fenugreek.

4. CONCLUSION

On the basis of present investigation it is concluded that among all genotypes, irrespective of cuttings and growth regulators, Hisar Anand (DH-5) was the highest seed yielder followed by Hisar Bhoomit (DH-228), Hisar Surbhi (DH-246) and Hisar Sugandh (DH-36). Whereas, Hisar Bhoomit (DH-228) was found best for foliage yield followed by Hisar Anand (DH-5), Hisar Surbhi (DH-246) and Hisar Sugandh (DH-36). The genotype Hisar Anand (DH-5) was good for seed crop and Hisar Bhoomit (DH-228) was suitable for dual purpose. The number of foliage cuttings had significant reduction in the seed yield of coriander. The maximum reduction was observed at two cuttings followed by one cutting. The increase in number of foliage cutting also influenced the seed quality of coriander seed. The best quality seed with highest value of seed quality parameters such as test weight, standard germination, seedling length, seedling dry weight, vigour index-I, vigour index-II, dehydrogenase activity test, field emergence index and seedling establishment; seed was harvested from without foliage cutting followed by one cutting at 45 days and two cuttings at 45 and 60 days after sowing.

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