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Effect of Row Spacing and Green Leaf Cuttings on Seed Yield and its Contributing Attributes in Coriander

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ABSTRACT: A field investigation was carried out to evaluate the effect of varying row spacing and green leaf cuttings on seed yield and its contributing traits in coriander cultivar 'Punjab Sugandh'for two years (2016-17 and 2017-18) at University Seed Farm, Ladhowal of Punjab Agricultural University, Ludhiana, Punjab. The experiment was laid out in split plot design with 12 treatments comprising three inter row spacing (30, 45 and 60 cm) and varying number of leaf cuttings (no cut, one, two and three cuttings). The highest green leaf yield was obtained from plants in 30 cm row spacingand three leaf cuttings. Maximum plant height was recorded with narrow spacing of 30 cm and with no cutting. The maximum expression of number of primary, secondary shoots per plant and stem diameter was observed with 60 cm spacing and one leaf cutting. However, the leaf area was observed to be maximum with widely spaced plants from where no green leaf cutting was taken. The highest seed yield was obtained with 30 cm spacing and one leaf cutting. The studies implicated that the closer spacing of 30 cm significantly reduced the vegetative growth and green leaf yield of the crop whereas it was beneficial for improvement in seed yield. On the other hand the wider spacing improved the vegetative growth of crop but the seed yield was compromised with the wider spacing. The treatment combination of one green leaf cutting with planting in 30 cm row spacing proved to be the best for seed yield with added advantage of green leaf cutting.

Keywords: Row spacing,Green leaf yield, Leaf cutting, Seed yield, Coriander

Coriander (*Coriandrum sativum* L.) belongs to family Apiaceae (Umbeliiferae) is an herbaceous plant which is a native of eastern Mediterranean region and of southern Europe. India, "home of spices" is recognized as the world's largest producer, consumer and exporter of seed spices.The total spice cultivation occupies an area of 3.9 million hectares with an annual production 8.4 million tonnes and coriander contributes 10.3 percent of total production of seed spices with an area of 16.8 per cent [1]. Coriander has dual purpose value as green leaves and seeds as a spice. The agronomic practices for cultivation as green leaves and seed will be entirely different. Plant canopy, branches and spread will be entirely different in coriander grown for leaves than seed crop. In leafy vegetables, the maintenance of adequate plant population and number of leaf cuttings are the major factors affecting the quality and quantity of the end product. One must sort the ideal combination of planting density and leaf cuttings to be taken for obtaining optimum seed yield and reaping maximum economic returns. When the plants are spaced in wider rows, they will grow luxuriantly because of lesser competition which may result in higher vegetative growth and better quality of the produce. On the other hand, the narrow spacing increases the competition for nutrients, light etc. which may ultimately reduce the quality and quantity of produce.Generally in case of leafy vegetables and fodder crops, there is a common practice to leave the crop for flowering after having maximum possible green cuttings so that the seed can be produced. The maximum percentage (60-70 percent) of photosynthates is stored in the crown root and the remaining protein is utilized in the development of new branches and leaves. The reserved proteins in the crown root are the source of energy for the development for new tillers and branches in plants. As a result of this, the seed bearing branches are enhanced and higher yield can be obtained. So, being a multi-cut leafy vegetable, there is a scope in coriander to take green leaf cutting before allowing the crop to enter the reproductive phase. But this aspect is still underworked and can be standardized to increase the economic returns of the farmers. The present investigations were therefore planned with the objective of standardizing the row spacing and appropriate number of leaf cuttings with which maximum and good quality seed yield can be produced.

MATERIALS AND METHODS

The present investigations were conducted at University Seed Farm, Ladhowal of Punjab Agricultural University, Ludhiana during 2016-17 and 2017-18. The experiment comprised of twelve treatments with inter row spacingof 30, 45 and 60 cm (S_1, S_2, S_3) as main plot treatment and number of leaf cuttings (no cut, one, two and three cuttings) as sub plot treatments. The experiment was conducted in split plot design and was replicated thrice. The main season variety of coriander 'Punjab Sugandh' was evaluated in the experiment. The leaf cuttings were done 30, 45 and 60 days after sowing. The normal cultural practices were followed as per standard agronomic practices [1]. The data were recorded for plant height, number of primary and secondary shoots at the time of seed harvesting. The stem diameter was measured with the help of Vernier caliper and the leaf area was estimated with the help of electronic area meter and was expressed by multiplying number of leaves per plant with average leaf area per leaf. The green leaf yield after no cut (C_0), one cutting (C_1) 30 days after sowing (DAS), two cuttings (C_2) 30 and 45 DAS and three cuttings (C_3)30, 45 and 60 DAS were taken and the green leaf yield after each cutting were recorded per plot in grams and was converted into yield per hectare in quintals. The seed yield was recorded per plot for each treatment after threshing and cleaning of the total biomass and weighed in gramsand converted into yield per hectare in quintals.The seed harvested from each treatment was tested for germination as per ISTA guidelines [2] in laboratory conditions. The data thus recorded was evaluated statistically for Split Plot Design as per the procedure given by [3] and adapted by [4] in statistical package CPCS-I, software developed by the Department of Mathematics and Statistics, Punjab Agricultural University, Ludhiana. The comparisons were made at five per cent level of significance.

RESULTS AND DISCUSSION

As the data for two years show the same trend, therefore mean values for two years for each observation has been depicted in tables. The data presented in table 1 clearly revealed that plant height decreased significantly as the spacing increased. The maximum plant height (88.3 cm) was observed when spaced at 30 cm and minimum (84 cm) was recorded with plants in 60 cm rowsspacings. Similarly leaf cutting reduced the height drastically. The maximum plant height (88.1 cm) was observed with no leaf cutting and minimum (84.4 cm) was observed with three leaf cuttings. The interaction effect showed maximum plant height when sown at 30 cm row spacing and no leaf cutting while the minimum plant height at 60 cm row spacing with three leaf cuttings. The increased plant height at narrow spacing can be attributed to more competition for light amongst the plants due to mutual shading and plant stem in search of light might have accelerated elongation of lower internodes. The results are in conformity of the findings of [5-8]. The possible reason for decreased plant height due to leaf cuttings is the breakdown of apical dominance and reduction in growing period of plant after cutting. Also the plant lost its photosynthates due to leaf cutting which otherwise is used by plants for its growth. The results are in accordance with the findings of [9].

The numbers of primary and secondary shoots per plant were observed maximum with 60 cm spacing and minimumwith 30 cm row spacing (Table 1). The plants with one leaf cutting were observed with maximum number of primary and secondary shoots followed by plants with no leaf cutting. The treatment combination S_3C_1 was observed with maximum number of primary and secondary shoots. The higher number of primary and secondary branches per plant at wider row spacing may be due to less competition among plants for light, CO_2, moisture and nutrients. The results are in line with the investigations of [7,10,11] who stated that number of primary and secondary branches increased with increasing row spacing. The possible reason for increased branches with leaf cutting may be due to breakdown of apical dominance and the plants utilize stored carbohydrates for its lateral growth which leads to more number of primary and secondary branches after one cutting. But with increased cutting frequency, there is decreased energy supply for growth which leads to lower primary shoots per plant. The results are in accordance with the studies of [9,12] who recorded that there is increase in primary branches with one cutting.

It was observed that wider row spacing had resulted in more stem diameter of plants than narrow spacing. The maximum stem diameter (1.9 mm) was observed when plants were spaced at 60 cm and was significantly higher than other row spacing (Table 1). Minimum stem girth (0.6 mm) was observed at 30 cm during both the

years. As far as leaf cuttings are concerned, maximum stem diameter (1.4 mm) was found without cutting and minimum was at three cuttings (1.1 mm). The plants with one and two leaf cuttings were found with same stem diameter. The interaction effect of spacing and leaf cuttingwas found to be non-significant. The reason for maximum stem diameter at wider spacing may be due to the less competition. Plants would have synthesized more food and stored in different parts including stem. The narrow spaced sown plants tend to increase their height in search of light and consequently the nutrients are used for that purpose rather than strengthening the stem diameter. Our results are in accordance with studies of [13]. The maximum stem diameter with no cutting may be due to undisturbed continuous growth of plants while others get cutting shock which ultimately lead to lost stored material and development of poor growth. The cut plants try to rejuvenate by using the nutrients for its primary and secondary shoots rather than feeding to the main stem. Our results are in accordance with [14] who reported higher plant growth with no leaf cutting. The maximum leaf area (68.7 cm^2) was recorded when row

Table 1. Effect of row spacing and number of leaf cuttings on plant height (cm) number of primary and secondary branches, stem diameter and leaf area of Coriander variety 'Punjab Sugandh'

Treatments	Plant height (cm)	Number of primary shoots per plant	Number of secondary shoots per plant	Stem diameter (mm)	Leaf area (cm^2)
S_1	88.3	5.7	13.7	0.6	61.1
S_2	85.9	6.1	16.3	1.1	65.4
S_3	84.0	6.3	19.1	1.9	68.7
CD(p=0.05)	1.1	0.2	0.7	0.2	0.7
C_0	88.1	6.2	16.4	1.4	67.2
C_1	86.2	6.5	19.0	1.2	65.3
C_2	85.5	5.9	15.5	1.2	64.2
C_3	84.4	5.5	14.6	1.1	63.5
CD(p=0.05)	0.6	0.1	0.5	0.1	0.2

Table 2. Interaction effects of varying row spacing and number of leaf cuttings on plant height (cm) number of primary and secondary branches, stem diameter and leaf area of Coriander variety 'Punjab Sugandh'

Treatments	Plant height (cm)	Number of primary shoots per plant	Number of secondary shoots per plant	Stem diameter (mm)	Leaf area (cm^2)
S_1C_0	90.5	5.8	15.7	0.8	63.1
S_1C_1	88.8	6.2	13.8	0.6	61.5
S_1C_2	87.7	5.6	12.9	0.5	60.4
S_1C_3	86.2	5.2	12.3	0.5	59.2
S_2C_0	88.3	6.2	18.9	1.4	67.8
S_2C_1	85.7	6.5	16.2	1.2	65.5
S_2C_2	85.3	6.0	15.6	1.0	64.5
S_2C_3	84.4	5.6	14.5	0.9	63.8
S_3C_0	85.6	6.5	19.1	2.0	70.7
S_3C_1	84.0	6.7	22.3	1.9	68.9
S_3C_2	83.6	6.3	17.9	2.0	67.8
S_3C_3	82.6	5.6	17.1	1.8	67.4
CD(p=0.05)	NS	NS	NS	NS	NS

spacing was 60 cm which was significantly better than other row spacing (Table 1). However, leaf area decreased with increase in leaf cuttings. Maximum leaf area (67.2 cm^2) was observed without leaf cuttings and minimum in three leaf cuttings.

The combined effect of spacing and leaf cutting indicated that maximum leaf area (70.7 cm^2) was reported when spaced at 60 cm and without any cutting and significantly better than all the interactions (Table 2). The minimum leaf area (59.2 cm^2) was recorded with S_3C_3. The reduced leaf area in closer spacing may be due to more plant population which further increased the competition for growth factors and the plants respond to density stress by reduction in leaf area. Similar results were obtained by [15] who reported maximum leaf area at wider spacing in French bean. The higher leaf area without leaf cutting may be due to availability of longer period for vegetative growth, efficient utilization of available nutrients and no leaf cutting shock. It was also observed that more frequent harvesting leads to reduced leaf area [16].

It was observed that during both the years, maximum green leaf yield was obtained with closer spacing and it was significantly higher than other row spacing (Table 3). The higher green leaf yield obtained was 172.7q/ha when spaced at 30 cm while minimum leaf yield observed was 144.7q/ha when row spacing was 60 cm. The three leaf cutting has resulted in significant higher green leaf yield while no cutting produced zero foliage yields. For the combined effect of row spacing and leaf cutting, maximum foliage yield (262.8) obtained was at 30 cm spacing and with three leaf cuttings whereas in all spacings without cutting resulted in zero leaf yield (Table 4). The leaf yield per unit area was inversely related to row spacing i.e., the closest row spacing produced the maximum yield of leaves per unit area. The higher yield of leaves was mainly contributed by the higher plant population per unit area in closer row spacing. Similar results were obtained by [17] who recorded higher leaf yield at closer spacing in fenugreek. Three leaf cuttings resulted in more leaf yield per hectare. The obvious reason for this may be better vegetative growth of the crop after previous cuttings. [9,18-20] also reported that leaf cutting had a significant effect on green leaf yield and two cuttings produced significantly higher leaf yield than one cutting and [21-22] reported that the maximum foliage yield was recorded with three cuttings.

Table 3. Effect of row spacing and number of leaf cuttings on seed germination (%), green leaf yield (q/ha) and seed yield (q/ha) of Coriander variety 'Punjab Sugandh'

Treatments	Seed germination (%)	Green leaf yield (q/ha)	Seed yield(q/ha)
S_1	78.9	172.72	6.5
S_2	80.7	162.26	5.5
S_3	81.9	144.71	5.0
CD(p=0.05)	NS	5.22	0.5
C_0	82.6	0.00	5.9
C_1	86.3	174.94	6.4
C_2	77.4	221.65	6.0
C_3	75.7	243.01	4.8
CD(p=0.05)	1.0	5.07	0.2

The data pertaining to effect or row spacing and leaf cutting on seed yield in table 3 depicted that higher seed yield was obtained with closer spacing during both the years. When spaced at 30 cm seed yield obtained was 6.5q/ha which was significantly higher than other row spacing. The row spacing of 60 cm has recorded reduced seed yield (5 q/ha).The leaf cutting also hadsignificant influence on seed yield of coriander. The data clearly revealed that higher seed yield (6.4 q/ha) was obtained with one cutting. Whereas no leaf and two leaf cuttings were statistically at par with each other and recorded seed yield 5.9q/ha and 6.0 q/ha, respectively. For the interaction effect maximum seed yield (7.1 q/ha) was obtained when row spacing was 30 cm and with one leaf cutting while the minimum seed yield (4.2 q/ha) was recorded with 60 cm spacing and three cuttings (Table 4). It is justified from the results that closer spacing significantly reduced growth and yield attributes of the crop but compensated the seed yield to a higher level because of higher plant population. On the other hand, wider spacing improved overall growth of crop but failed to record highest yield due to less number of plants per hectare. These results are in accordance with the studies of [10,23-25] who reported lower seed yield at wider spacing. It has also been reported that the seed yield decreased by increasing the spacing [7]. The increase in seedyield by one cutting and decrease by three cuttings may be attributed to the reasons that by one cutting, there is in crease in branching there by bearing more number of umbels and fruits, whereas, the decrease by three cuttings may be due to the loss of photosynthetic energy, which other wise would have been used by the plants for enhancing

the plant vigor and ultimately the seed yield. The plants with no cut had less number of primary and secondary branches which ultimately reduced the number of umbels per plant causing reduction in seed yield. The results were in line with the findings of [18,21-20,26-28] who reported that the highest seed yield was obtained with one cutting. Three cuttings resulted in the minimum seed yield per hectare because of reduced source strength and poor photosynthate accumulation and were in line with the findings of [9,20,29] who stated that increasing number of leaf cuttings significantly reduced seed yield.Table 4. Effect of row spacing and number of leaf cuttings on seed germination (%), green leaf yield (q/ha) and seed yield (q/ ha) of Coriander variety 'Punjab Sugandh'

Table 4. Effect of row spacing and number of leaf cuttings on seed germination (%), green leaf yield (q/ha) and seed yield (q/ha) of Coriander variety 'Punjab Sugandh'

Treatments	Seed germination (%)	Green leaf yield (q/ha)	Seed yield(q/ha)
S_1C_0	81.2	0.00	6.6
S_1C_1	84.1	192.21	7.1
S_1C_2	75.9	235.92	6.3
S_1C_3	74.4	262.77	5.4
S_2C_0	82.4	0.00	5.8
S_2C_1	87.0	179.12	6.2
S_2C_2	77.4	223.27	5.5
S_2C_3	75.9	246.67	4.7
S_3C_0	84.2	0.00	5.3
S_3C_1	87.8	153.50	5.8
S_3C_2	78.9	205.75	5.0
S_3C_3	76.6	219.58	4.2
CD(p=0.05)	NS	8.78	NS

The seed germination (%) was not affected by spacing (Table 3). The seeds harvested from plants after one green leaf cutting showed maximum seed germination of 86.3 per cent. The interaction effects were also found to be non significant. The improved germination due to single leaf cutting may be due to vigorous growth of plants after cutting and plants getting sufficient time for its vegetative growth before entering reproductive phase and there could be the product of effective synthesis and translocation of photosynthates from source to sink conferring higher seed weight leading to better seed germination. Our results are in accordance with [30] who recorded highest seed germination with one cutting in *palak*.

The present studies have implicated that for the vegetative growth of coriander plant, wider spacing and one leaf cutting has performed better as maximum number of primary and secondary shoots were observed in these treatments. For the highest green leaf yield, combination of closer spacing and three leaf cuttings has performed best whereas for higher seed yield 30 cm spacing and one leaf cutting has been observed the best. So, to get maximum quality seed yield of coriander, it should be spaced at 30 cm and one cutting before leaving for seed production.

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