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Effect of Cutting Frequency on Growth and Yield of Beet Leaf intercropped with Onion Seed Crop

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ABSTRACT: A field experiment was conducted during the *Rabi* seasons of 2018-19 and 2019-20. Onion is a biennial crop; to produce seeds, it takes two full seasons. The objective was that, in this long period, the farmer could take beet leaf as an intercrop for continuous earnings with the onion seed crop. There were nine intercropping combinations treated as treatments with three replications each. The onion spacing was 60×30 cm grown as the main seed crop, and intercrop beet leaf spacing was 15×5 cm. There were 1 or 2 rows of beet leaf between the onion plant spacing with different cutting frequencies. Two years pooled data was found that the treatment T_2: Onion + Beet leaf (1 row) 3 cuttings were highest in leaf length (14.5 cm), leaf width (8.3 cm), petiole length (13.2 cm), onion seed yield (481 kg ha^{-1}), lowest leaf yield (93.3 q ha^{-1}). While among the intercropping treatment T_9: onion + beet leaf (2 rows) 6 cuttings were recorded minimum leaf length (12.2 cm), leaf width (7.0 cm), petiole length (11.1cm), onion seed yield (404 kg ha^{-1}), and highest leaf yield (250.5 q ha^{-1}). Whereas, treatment T_1: sole crop beet leaf recorded in leaf length (12.0 cm), leaf width (7.1 cm), petiole length (11.0 cm), highest leaf yield (412.7 q ha^{-1}), lowest onion equivalent yield (330.1 kg ha^{-1}). Finally, the significant outcomes of this study were that the farmers may get frequent income but lower net returns due to the fairly good onion seed yield in the intercropping patterns.

Keywords: Beet leaf, cutting frequency, leaf yield, intercropping, onion seed crop, equivalent yield.

INTRODUCTION

The onion (*Allium cepa* L.) belongs to the Alliaceae family and is native to Central Asia. The onion is usually referred to as the “Queen of the Kitchen” and sometimes referred to as the "poor man's musk". Onions are primarily grown for local consumption with some exports and an average productivity of 18.1 metric tonnes per hectare, India is the second-largest producer of onion bulbs after China, producing 19.4 mt of onion bulbs from an area of 14.34 lakh hectares (Anonymous, 2019). To cover 0.8 million hectares, India necessities 6500 tonnes of onion seeds per year (Setiya and Muthuselvan 2018). Ever increasing population and urbanization and industrialization, the land holdings are reducing day by day basis, the one of the challenges is to produce more vegetables per unit field in order to fulfil the demand through supply. The cultivable land is not further more enlarges and it is need to focus on the sound techniques of growing more than one crops on same field to enhance the production from available land while increasing the efficiency of resources *i.e.* water, fertilizes and agronomic management practice.

Beet leaf (*Beta vulgaris* var. *orientalis*) is a member of the "Chenopodiaceae" family; also referred to as "*Palak*". This is cultivated in tropical and subtropical areas of the nation. Beet leaf is a nutritious leafy, green vegetable that may benefits skin, hair and bone health, rich in multiple vitamins and minerals. It is cultivated for its fresh green leaves, which are ready for harvest in about 30 to 35 days after sowing (Mishra *et al.*, 2003).

MATERIAL AND METHODS

The studied during the *Rabi* seasons 2018-19 & 2019-20 at the research farms Department of Vegetable Science at CCS Haryana Agricultural University, Hisar. A simple experiment based on a randomized block design (RBD) was used to plan the experiment and replicated three times. In each replication, the treatments were distributed at random. Intercropping combinations were treated as treatments and onion was grown as the main seed crop and beet leaf as intercrop, there were 9 combinations based on cutting frequency and number of beet leaf rows between onion plants rows. The onion spacing was 60×30 cm as the main seed crop and 15×5 cm with different cutting frequencies (3 in each & 6 maximum cuttings) and row patterns (1 or 2 rows between the onion spacing) for beet leaf as intercrop. A recommended package of practices was followed for the optimum plant growth and development of both crops. The observations were taken as per the experiment objectives *i.e.*, Leaf length, leaf width, petiole length, and leaf yield after each cutting & leaf yield/ha, onion seed yield, and onion equivalent yield. The data were collected and averaged

for both years and statistically analyzed as per Gomez and Gomez (1984) using the statistical program developed by O.P. Sheoran.

Leaf length (cm) at each cutting: From a freshly harvested plot, 10 leaves were selected randomly, and the length from the tip to the base of each leaf was measured in centimeters. The average value of leaf length in centimeters was then computed.

Leaf width (cm) (at each cutting): The width of 10 randomly selected leaves was measured using a meter scale from the middle of each leaf, and the average value in centimeters was then calculated.

Petiole length (cm) (at each cutting): Using a meters scale, the petiole length of ten randomly picked leaves was measured in centimeters, and the average value was then determined.

Yield of first, second, third, fourth, fifth and sixth cutting (q/ha): The leaf yield was taken in kg with digital balance independently for each treatment replication-wise at each cutting *i.e.* at the first, second, third, fourth, fifth, and final cuttings and then averaged.

Total leaf yield (q/ha): The average yield of the first, second, third, fourth, fifth, and final cuttings were used to calculate the total leaf yield for every treatment.

Onion seed yield (q/ha): To record the seed yield plot^{-1}, the net plot area was harvested, the plants were sun-dried, and the seeds of every plant collected from the plot were threshed. The gram weight of seed yield plot^{-1} was converted into quintals per hectare.

Onion equivalent yield (kg/ha): The yield of the intercrop (beet leaf) was converted into onion equivalent yield based on the price of the produce. It was computed by using the following formula

$$OEY = \frac{ROS \times MOS + LBL \times MBL}{MOS}$$

Where,

OEY - Onion equivalent yield (kg/ha), YOS-Yield of onion seed, MOS-Market price of onion seed, LBL-Leaf yield of beet leaf, MBL-Market price of leaf yield.

RESULTS AND DISCUSSION

Leaf length (cm) of beet leaf: The leaf length was influenced by the frequency of beet leaf cuttings under different onion-beet leaf intercropping systems. The highest mean leaf length was recorded in the treatment T_2: Onion + Beet leaf (1 row) 3 cuttings (14.4 and 14.6 cm) during both years 2018-19 and 2019-20, respectively). However, the treatment T_9: Onion + Beet leaf (2 rows) 6 cuttings, leaf length (12.1 and 12.3 cm) were measured lowest under the intercropping combination. It was also observed from the results in the sole beet leaf treatment T_1: Beet leaf 6 leaf cuttings (sole crop) the mean leaf length (11.9 and 12.1 cm) was found to be lowest among the intercropping treatments. Length was higher in low plant population plots while reduced in higher planting density and also increased with cutting frequency. Similar results were also reported by Gaharwar (2014) who found that the leaf length, leaf width, and petiole length increased with the increase in the number of cuttings.

***Leaf width (cm) of beet leaf*:** Under various onion-beet leaf intercropping systems, the cutting frequency of the beet leaf crop affected the leaf width (Table 2). The mean leaf width was (8.3 and 8.3 cm) in the treatment T_2: Onion + Beet leaf (1 row) 3 cuttings, during both years 2018-19 and 2019-20, respectively. The treatment T_9: Onion + Beet leaf (2 rows) 6 cuttings, mean leaf width (6.9 and 7.0 cm) was lowest among the intercropping treatments, it was at par with the results of sole beet leaf (7.0 and 7.2 cm) treatment T_1: Beet leaf with 6 beet leaf cuttings (sole crop) mean leaf width. Leaf width was increased with increasing the cuttings but started to decline after 3rd or 4th cuttings.

***Leaf petiole length (cm) of beet leaf*:** Petiole length of leaf of leaf petiole length was influenced by the cuttings frequency of beet leaf crop under different onion-beet leaf intercropping systems (Table 3). Highest petiole was recorded in the treatment, T_2: Onion + Beet leaf (1 row) 3 cuttings (13.1 cm and 13.3 cm) during both years 2018-19 and 2019-20, respectively. The lowest length was recorded in the treatment T_9: Onion + Beet leaf (2 rows) 6 cuttings of 11.0 and 11.1 cm among the intercropping plots, results were at par with sole beet leaf treatment (10.9 cm and 11.0 cm) during both years respectively. The growth characteristics of one crop were lowered by the other. Two rows of beet leaf produced the lower leaf length, leaf width and petiole length might be due to higher crop competition between the beet leaf rows and crops. Higher plant population which in turn reduced the growth and yield attributes of beet leaf crops. Plant-to-plant spacing in the two-row intercropping method enhanced plant population and decreased space requirements, but also intensified competition for all resources per unit area. The present experiment's results are consistent with observations made by Paul *et al.* (2015) on the intercropping system's effects on yield and growth in brinjal + coriander intercropping.

***Leaf yield after each cutting (q/ha) of beet leaf*:** The leaf yield data after each cutting indicated that cutting frequency and number of rows influenced the leaf yield of beet leaf in the intercropping treatments. Higher leaf yield was recorded in two-row plots as compared to one-row plots. The leaf yield was slightly increased with raising the frequency of cutting. Increased up to 3rd and 4th cutting (in the sole beet leaf) that started gradually declined till the final leaf cutting.

***Total leaf yield (q/ha) of beet leaf*:** Under various onion-beet leaf intercropping systems, the frequency of cutting the beet leaf crop exhibited an impact on total leaf yield (Table 4). The highest beet leaf yield (409.4 and 416.0 q/ha) was obtained in the treatment T_1: Beet leaf 6 leaf cuttings (sole crop), followed by the treatment T_9: Onion + Beet leaf (2 rows) 6 cuttings (245.5 and 255.5 q/ha) during both years 2018-19 and 2019-20, respectively. This might be due to the higher plant population in sole beet leaf and the two-row pattern in T9 treatment coupled with the maximum number of leaf cuttings in both plots. While, minimum leaf yield was recorded in the treatments T_2: Onion + Beet leaf (1 row) 3 cuttings, 90.6 and 95.9 q/ha during both years 2018-19 and 2019-20, respectively. This

might be due to only three leaf cuttings coupled with one-row beet leaf patterns resulting in lower leaf yield as compared to the other intercropping treatments. The highest planting density and more leaf cuttings lead to higher leaf yield and minimum leaf cuttings and less planting density are always responsible for lower leaf yield. The similar results were reported by Moghbeli *et al.* (2019) in onion and fenugreek intercropping ratios in different planting densities.

***Onion seed yield per hectare (q/ha)*:** The results indicated (Table 5) that the seed yield of onion crop was influenced by the frequency of leaf cuttings and row patterns of beet leaf in the onion –bee leaf intercropping systems. The maximum seed yield, 4.81q and 4.94 q/ha in the intercropping treatment T_2: Onion + Beet leaf (1 row) 3 during both years 2018-19 and 2019-20, respectively followed by the treatment T_6: Onion + Beet leaf (2 rows) 3 cuttings (4.69 and 4.90 q/ha). The minimum onion seed yield was reported in treatment T_9: Onion + Beet leaf (2 rows) 3 cuttings, 3.98 and 4.04 q/ha during both years 2018-19 and 2019-20, respectively. The onion seed yield reduction might be due to the more spatial and nutritional competition in the high-density plant populations. The results of the present experiment are in close conformity with the results of Obadoni *et al*. (2005); Suresha *et al.* (2010) from yield and economics of chilli based intercropping system, Islam *et al.* (2016) while working with outcome of intercropping garlic with brinjal intercropping systems. And Liu *et al.* (2016) also reported that the population density and intercropping of sorghum (*Sorghum bicolor*) and Soybean (*Glycine max* M.) may alter their growth and yield patterns through responses to light and physiological attributes as compared to their performance in standard densities and monocultures.

Table 1: Effects of cutting frequency on leaf length (cm) of beet leaf in the intercropping combinations.

Treatments	Leaf length (cm) at different frequency of cuttings													
	2018-19							2019-20						
	1st	2nd	3rd	4th	5th	6th	Mean	1st	2nd	3rd	4th	5th	6th	Mean
T_1 : Beet leaf 6 leaf cuttings (sole crop)	13.0	13.5	14.4	12.3	11.5	6.9	11.9	13.2	13.8	14.5	12.3	11.5	7.3	12.1
T_2 : Onion + Beet leaf (1 row) 3 cuttings	13.5	14.6	15.2	-	-	-	14.4	13.8	14.7	15.4	-	-	-	14.6
T_3 : Onion + Beet leaf (1 row) 4 cuttings	13.6	14.0	14.8	13.2	-	-	13.9	13.8	14.6	15.2	13.6	-	-	14.3
T_4 : Onion + Beet leaf (1 row) 5 cuttings	13.6	14.2	15.0	13.3	12.8	-	13.8	13.7	14.3	15.6	13.4	13.1	-	14.0
T_5 : Onion + Beet leaf (1 row) 6 cuttings	13.5	14.2	14.8	13.5	12.3	7.8	12.7	13.7	14.7	14.9	13.4	12.7	8.2	12.9
T_6 : Onion + Beet leaf (2 rows) 3 cuttings	12.7	13.8	14.4	-	-	-	13.6	13.0	13.9	14.0	-	-	-	13.6
T_7 : Onion + Beet leaf (2 rows) 4 cuttings	12.7	13.4	14.0	12.6	-	-	13.2	12.8	13.7	14.6	12.8	-	-	13.5
T_8: Onion + Beet leaf (2 rows) 5 cuttings	12.4	13.4	14.4	12.5	11.9	-	12.9	12.8	13.6	14.7	12.7	12.0	-	13.2
T_9 : Onion + Beet leaf (2 rows) 6 cuttings	13.0	13.6	14.2	12.6	11.7	7.2	12.1	13.2	13.9	14.5	12.7	11.9	7.5	12.3

Table 2: Effects of cutting frequency on leaf width (cm) of beet leaf in the intercropping combinations.

Treatments	Leaf width (cm) at different frequency of cuttings													
	2018-19							2019-20						
	1st	2nd	3rd	4th	5th	6th	Mean	1st	2nd	3rd	4th	5th	6th	Mean
T_1 : Beet leaf 6 leaf cuttings (sole crop)	6.4	7.4	8.5	7.6	6.6	5.6	7.0	7.2	7.4	8.6	7.6	6.7	5.8	7.2
T_2 : Onion + Beet leaf (1 row) 3 cuttings	7.3	8.3	9.3	-	-	-	8.3	7.5	8.3	9.1	-	-	-	8.3
T_3 : Onion + Beet leaf (1 row) 4 cuttings	6.9	8.2	9.0	7.9	-	-	8.0	7.2	8.2	9.0	8.1	-	-	8.1
T_4 : Onion + Beet leaf (1 row) 5 cuttings	7.1	8.4	9.2	8.0	7.0	-	7.9	7.5	8.1	8.9	8.4	6.9	-	8.0
T_5 : Onion + Beet leaf (1 row) 6 cuttings	7.2	8.2	9.0	8.2	6.8	5.8	7.5	7.3	8.2	8.9	8.3	7.0	6.0	7.6
T_6 : Onion + Beet leaf (2 rows) 3 cuttings	6.6	7.6	8.5	-	-	-	7.6	6.6	7.5	8.4	-	-	-	7.5
T_7 : Onion + Beet leaf (2 rows) 4 cuttings	6.6	7.3	8.6	7.5	-	-	7.5	6.6	7.4	8.3	7.5	-	-	7.5
T_8: Onion + Beet leaf (2 rows) 5 cuttings	6.5	7.5	8.7	7.1	6.4	-	7.2	6.6	7.7	8.3	7.7	6.3	-	7.3
T_9 : Onion + Beet leaf (2 rows) 6 cuttings	6.7	7.3	8.1	7.4	6.2	5.5	6.9	6.5	7.6	8.6	7.4	6.4	5.6	7.0

Table 3: Effects of cutting frequency on leaf petiole length (cm) of beet leaf in the intercropping combinations.

Treatments	Leaf petiole length (cm) at different frequency of cuttings													
	2018-19							2019-20						
	1st	2nd	3rd	4th	5th	6th	Mean	1st	2nd	3rd	4th	5th	6th	Mean
T_1 : Beet leaf 6 leaf cuttings (sole crop)	11.2	12.0	13.8	11.4	9.4	7.3	10.9	11.5	12.1	13.6	11.6	9.5	7.4	11.0
T_2 : Onion + Beet leaf (1 row) 3 cuttings	12.2	13.2	13.8	-	-	-	13.1	12.4	13.4	14.2	-	-	-	13.3
T_3 : Onion + Beet leaf (1 row) 4 cuttings	12.6	13.4	14.2	12.7	-	-	13.2	13.1	13.8	14.3	12.4	-	-	13.4
T_4 : Onion + Beet leaf (1 row) 5 cuttings	12.2	13.1	13.9	12.6	9.9	-	12.3	12.8	13.5	14.0	12.8	9.8	-	12.6
T_5 : Onion + Beet leaf (1 row) 6 cuttings	12.6	13.3	14.2	12.5	10.2	7.6	11.7	12.9	13.5	14.4	12.5	10.3	7.8	11.9
T_6 : Onion + Beet leaf (2 rows) 3 cuttings	11.6	12.4	13.3	-	-	-	12.4	11.7	12.6	13.5	-	-	-	12.6
T_7 : Onion + Beet leaf (2 rows) 4 cuttings	11.8	12.3	13.0	11.8	-	-	12.2	11.6	12.5	13.4	11.7	-	-	12.3
T_8: Onion + Beet leaf (2 rows) 5 cuttings	11.8	12.2	13.0	11.8	9.3	-	11.6	12.1	12.6	13.6	12.0	9.3	-	11.9
T_9 : Onion + Beet leaf (2 rows) 6 cuttings	11.7	12.5	13.4	11.8	9.2	7.1	11.0	11.8	12.5	13.5	11.8	9.4	7.5	11.1

Table 4: Effects of cutting frequency on beet leaf crop leaf yield (q/ha) at different frequency of cutting and total yield (q/ha) after final cutting in the intercropping combinations.

Treatments	Beet leaf yield (q/ha) at different frequency of cutting and total yield (q/ha) after final cutting													
	2018-19							2019-20						
	1st	2nd	3rd	4th	5th	6th	Total yield	1st	2nd	3rd	4th	5th	6th	Total yield
T_1 : Beet leaf 6 leaf cuttings (sole crop)	65.3	82.3	89.9	93.7	59.7	18.4	409.4	67.7	84.4	90.3	93.4	60.1	20.2	416.0
T_2 : Onion + Beet leaf (1 row) 3 cuttings	26.4	30.2	34.0	-	-	-	90.6	27.0	33.4	35.5	-	-	-	95.9
T_3 : Onion + Beet leaf (1 row) 4 cuttings	24.0	30.9	35.1	27.1	-	-	117.0	24.8	34.3	35.9	27.8	-	-	122.7
T_4 : Onion + Beet leaf (1 row) 5 cuttings	25.4	33.0	34.0	25.7	21.2	-	139.3	26.2	35.2	37.5	24.8	22.0	-	145.6
T_5 : Onion + Beet leaf (1 row) 6 cuttings	27.1	33.7	35.1	27.4	21.5	8.3	153.1	28.1	35.8	36.1	24.0	22.2	9.7	155.9
T_6 : Onion + Beet leaf (2 rows) 3 cuttings	43.8	53.1	62.1	-	-	-	159.0	45.1	56.3	63.1	-	-	-	164.5
T_7 : Onion + Beet leaf (2 rows) 4 cuttings	45.5	55.6	61.5	44.1	-		206.6	45.1	54.2	66.5	45.8	-	-	211.6
T_8: Onion + Beet leaf (2 rows) 5 cuttings	43.4	54.5	63.9	43.7	36.5	-	242.0	46.4	53.1	66.7	45.8	37.5	-	249.5
T_9 : Onion + Beet leaf (2 rows) 6 cuttings	43.8	50.0	60.1	45.8	35.1	10.8	245.5	44.4	53.1	64.6	44.7	36.1	12.5	255.5

Table 5: Effects of cutting frequency of beet leaf on onion seed yield (q/ha) and Onion equivalent yield (OEY kg/ha in the intercropping combinations.

Treatments	Onion seed yield (q/ha)			Onion equivalent yield (kg/ha)		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean
T_1 : Beet leaf 6 leaf cuttings (sole crop)	-	-	-	327.5	332.8	330.1
T_2 : Onion + Beet leaf (1 row) 3 cuttings	4.81	4.94	4.88	553.6	570.6	562.1
T_3 : Onion + Beet leaf (1 row) 4 cuttings	4.62	4.86	4.74	555.8	584.3	570.0
T_4 : Onion + Beet leaf (1 row) 5 cuttings	4.29	4.43	4.36	540.4	559.8	550.1
T_5 : Onion + Beet leaf (1 row) 6 cuttings	4.10	4.21	4.16	532.6	545.6	539.1
T_6 : Onion + Beet leaf (2 rows) 3 cuttings	4.69	4.90	4.80	596.0	622.1	609.0
T_7 : Onion + Beet leaf (2 rows) 4 cuttings	4.38	4.60	4.49	603.6	629.5	616.5
T_8: Onion + Beet leaf (2 rows) 5 cuttings	4.20	4.38	4.29	613.8	637.9	625.8
T_9 : Onion + Beet leaf (2 rows) 6 cuttings	3.98	4.10	4.04	594.2	614.1	604.1

***Onion equivalent yield (OEY) produced in intercropping*:** The maximum onion equivalent yield (613.8 and 637.9 kg /ha) was recorded during both years 2018-19 and 2019-20, respectively, in the treatment T_8: Onion + Beet leaf (2 rows) 5 cuttings. While minimum onion equivalent yield (327.5 and 332.8 kg/ha) was found the treatment T_1: Beet leaf 6 leaf cuttings (sole crop) followed by the treatment T_5: Onion + Beet leaf (1 row) 6 cuttings (532.6 kg and 545.6 kg/ha) during both years 2018-19 and 2019-20, respectively. The number of umbels per plant, the number of seeds per umbel, and the rise in growth

attributes might all be responsible for the onion's enhanced crop outcomes. Although the primary onion crop grew slowly and beetroot leaf as an intercrop grew quickly and was more highly valued in the market. A similar study was conducted and reported by Singh *et al.* (2016) on potato-based intercropping. The intercropping radish and spinach with potato increased potato equivalent yield over the monocrop potato.

CONCLUSIONS

Onion crop is a biennial, requiring two complete growing seasons to yield seeds. Over this prolonged time frame, the farmer might use beet leaf as an intercrop to provide ongoing income. A study was carried out to determine the optimal intercropping combination without compromising the income keeping this in mind. Lastly, one of the study's major findings was that although the intercropping patterns produced a reasonably decent yield of onion seeds, the farmers may get frequent revenue but lower net returns.

FUTURE SCOPE

Farmers could produce seeds as per needs in their fields as the private seed companies raise the seed price year after year. Due to this net income is always influenced.

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Conflict of Interest. None.

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