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Effect of cutting frequency of beet leaf on flowering and seed yield of onion crop under different intercropping patterns

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Abstract
An investigation was carried out to study the effect of cutting frequency of beet leaf crop, on the growth, flowering characteristics and seed yield of onion crops namely days to full bloom, the number of umbels per bulb, length of flowering stalks, diameters of flowering stalks, seeds per umbel and seeds per plant. The beet leaf was cultivated as an intercrop with onion seed crop in one and two rows intercropping arrangements. Different frequencies of beet leaf cuttings such as onion + beet leaf with 3 cuttings, onion + beet leaf with 4 cuttings, onion + beet leaf with 5 cuttings, and onion + beet leaf with 6 cuttings were studied *w.r.t* onion sole crop (control). The observations recorded on the onion crop under different treatments revealed that when the cutting frequency of beet leaf was increased it led to reduction in the number of umbels per bulb, length of flowering stalks, diameters of flowering stalks but days to full bloom of onion crop got extended with increase in the cutting frequency of beet leaf crop. In addition, maximum seed yield on umbel (2.473 g) and plant basis (24.95 g) was attained under onion sole and these parameters decreased successively with increase in cutting frequency of intercropped beat leaf crop. The results of this study indicated that the cutting frequency of intercropped beet leaf crop in the onion setup can influence seed yield of onion crop.

Keywords: Intercropping, onion, seed production, flowering characteristics, beet leaf crop

Introduction
The onion (*Allium cepa* L.), a plant of the Alliaceae family and native to middle Asia, is one of the most important vegetable crops grown worldwide. It is also known as "Pyaz" or "Kanda" in Hindi. However, it is also referred to as Krishnavalln in South India, particularly in rural Karnataka and Tamil Nadu, which is a Sanskrit word for the name of Lord Shree Krishna. India's Average productivity is 18.1 t/ha, ranks first in terms of area (14.34 lakh ha) and second in onion bulb production (26.74 mt) after China (Anonymous, 2020) [1]. When compared to China (22.08 t/ha), the United States (66.82 t/ha), Spain (52.48 t/ha), Ireland (30.5 t/ha), and Spain, India has incredibly low onion productivity (FAOSTAT, 2019) [5]. A need for high-quality seeds is rising as more land is being planted with onion crop (Chengappa, *et al.*, 2012) [3]. The availability of healthy, vigorous seeds at the time of sowing is essential to attaining productivity goals (Bishaw, *et al*., 2007) [2]. Furthermore, as it improves crop productivity by 15-20%, the high-quality seed is a necessity to raise both production and productivity. Onion seed is categorized as an orthodox and poor storer in this regard as it keeps losing viability after 1-1.5 years of storage in an ambient environment (George, 2009) [6] and (Pritchard, and Nadarajan, 2008) [8]. Intercropping has been taken into consideration to improve crop production sustainability (Coolman and Hoyt. 1993) [4]. The intercropping system should be regarded as one of the key cropping system strategies to boost productivity. Additionally, it has become a crucial instrument for raising crop productivity. The selection of an optimum intercrop mixture (Santalla, *et al.*, 2003) [9], population density, and intercrop planting geometry (Myaka, 1995) [7] can all improve cropping productivity. Considering all the above aspects, this study was planned to investigate the effect of cutting frequency of beet leaf on yield attributes of intercropped onion crop.

Materials and Methods
The below mentioned observations were recorded from each treatment during the course of the experiment.

a) **Days to full bloom:** the number of days to full bloom (100% flowering), the planted bulbs of onion took from the date of its planting.
b) **Number of flowering umbels per bulb:** The average number of umbels per bulb was calculated by dividing the total number of seed stalks from each treatment and replication by the total number of plants.
c) **Length of flowering stalks (cm):** The length of flowering stalks (cm) of five randomly selected plants from each treatment were measured with scale in centimeter and their average worked out by dividing with number of flower stalk.
d) **Flower stalk diameter (cm):** Vernier calipers was used to measure the flower stalk diameter on five randomly selected onion plants from each treatment, and the average was calculated by dividing the number of flower stalks from the each replications.
e) **Seed yield per umbel (g):** Five plants were randomly selected, and umbels were harvested from each plant weighed in grammes. The weight of seeds umbel-1 is the result of dividing the total weight of the seeds by the number of umbels.
f) **Seed weight per plant (g):** The five randomly selected plants seeds were weighed in gram, and the estimated seed weights per plant were calculated by dividing the weight by the number of plants.

Results
The increasing frequency of beet leaf cuttings led to simultaneous enhancement in days to bloom in the onion crop. Onion sole crop took significantly fewer days (146.33) to the full blooming of umbel while onion crop with 6 cuttings of beet leaf took more time to full bloom, which is 150.0 to 150.67 days for one and two-row arrangement. In addition, the days to full bloom were not affected by beet leaf intercropping arrangement with the onion crop (Table-1). Irrespective of intercropping pattern with beet leaf crop, the number of seed stocks in one onion plant was recorded maximum in sole onion crop (10.10) decrease further to 8.65 with increasing frequency of beet leaf cuttings (Table-2).
The length of onion seed stalks was significantly affected by the frequency of beet leaf cuttings and intercropping patterns (Table-3). The seed stocks of the sole onion crop were comparatively elongated (104.63) than the onion crop with a different frequency of cuttings. In addition, the intercropping pattern of the beet leaf with the onion crop also impacted the length of seed stalks. Onion with one-row beet leaf (98.43) had comparatively longer than two-rowed Beet leaf (96.97). There was no significant effect of intercropping patterns on the diameters of the onion crop. However, the increasing frequency of beet leaf cuttings significantly reduced the diameters of onion stalk from 2.73 cm for onion sole crop to 2.34 cm for onion with beet leaf cuttings (Table-4). The maximum seed yield on umbel (2.473g) and plant basis (24.95 g) was attained under onion sole and these parameters decreased successively with increase in cutting frequency of intercropped beat leaf crop (Table 5 and 6).

Discussion
The parameters such as the days to full bloom, the number of umbels per bulb, length of flowering stalks, diameters of flowering stalks, seed yield per umbel and seed yield per plant were strikingly influenced by the increase in cutting frequency of beet leaf under different intercropping patterns (Table 1, 2, 3, 4, 5, 6) whereas, sole onion crop took comparatively lesser number of days to full bloom than other intercropping systems. The plants under intercropping systems suffers from various types of stresses namely inter-crop competition, competition for soil moisture content, soil nutrition, etc. The abiotic stresses including drought impairs floral pollination by lowering the number of viable pollen grains, making the flowers less attractive to pollinators, and also reduces the amount of nectar in the flowers that flowers produce, that ultimately proves detrimental to the quality of seed. As a result, seed setting also get decreased (Alqudah *et al*., 2011) [10]. It was also inferred from the results of onion - beet leaf intercropping systems that the onion crop under intercropping with beet leaf suffered from the inter-plant competitive stress (higher planting ratio) under all the intercropping patterns. Therefore, the sole onion crop performed better in comparison to other intercropping systems on all the tested parameters. The soybean under water stress during reproductive growth usually lowers the production by decreasing the number of seeds in soybean (Brevedan and Egli, 2003) [11], although water stress during seed filling lowers seed size (De-Souza *et al*., 1997) [12] and yield can be decreased by short periods of stress during flowering and pod set (Vieira *et al*., 1992) [13]. The cutting frequency of beet leaf crop under different onion–beet leaf intercropping systems also caused the reduction in seed yield on umbel and plant basis. Also, the incidence of seed stalks lodging leads to a considerable loss in seed yield in the intercropping conditions. This possibility is supported by previous findings of (Levy *et al.*, 1981) [14]. When the frequency of beet leaf cutting was increased the growth and seed yield characteristics were gradually reduced, which might be due to intercrop competitions among the plants in the studied intercropping systems.

Table 1: Effect of cutting frequency of beet leaf on the number of days in full blooming of onion flowers under different row arrangement in onion-beet leaf intercropping systems

Treatments	Days to full bloom onion umbel		
Beet leaf Rows (R) → Beet leaf Cutting frequency (C) ↓	One row	Two rows	**Mean**
Onion seed crop (sole crop)	146.33	146.33	146.33
Onion + Beet leaf 3 cuttings	147.00	147.00	147.00
Onion + Beet leaf 4 cuttings	147.67	148.00	147.83
Onion + Beet leaf 5 cuttings	148.33	149.00	148.67
Onion + Beet leaf 6 cuttings	150.00	150.67	150.33
Mean	147.87	148.20	
CD (P=0.05)	R	C	R×C
	NS	1.017	NS

R= rows, C= cuttings

Table 2: Effect of cutting frequency of beet leaf on the number of umbels per bulb in onion crop under different row arrangement in onion-beet leaf intercropping systems

Treatments	Number of umbels per bulb		
Beet leaf Rows (R) → Beet leaf Cutting frequency (C) ↓	**One row**	**Two rows**	**Mean**
Onion seed crop (sole crop)	10.10 (3.33)	10.10 (3.33)	10.10 (3.33)
Onion + Beet leaf 3 cuttings	9.40 (3.22)	9.37 (3.22)	9.38 (3.22)
Onion + Beet leaf 4 cuttings	9.33 (3.21)	9.13 (3.18)	9.23 (3.20)
Onion + Beet leaf 5 cuttings	9.03 (3.17)	8.80 (3.13)	8.92 (3.15)
Onion + Beet leaf 6 cuttings	8.70 (3.11)	8.60 (3.10)	8.65 (3.11)
Mean	9.31 (3.21)	9.20 (3.19)	
CD (P=0.05)	R	C	R×C
	NS	0.081	NS

R= rows, C= cuttings

Table 3: Effect of cutting frequency of beet leaf on the length of onion seed stalks under different row arrangement in onion-beet leaf intercropping systems

Treatments	Length of seed stalks (cm)		
Beet leaf Rows (R) → Beet leaf Cutting frequency (C) ↓	**One row**	**Two rows**	**Mean**
Onion seed crop (sole crop)	104.63	104.63	104.63
Onion + Beet leaf 3 cuttings	103.03	100.20	101.62
Onion + Beet leaf 4 cuttings	97.33	94.43	95.88
Onion + Beet leaf 5 cuttings	94.40	93.27	93.83
Onion + Beet leaf 6 cuttings	92.73	92.33	92.53
Mean	98.43	96.97	
CD (P=0.05)	R	C	R×C
	1.136	1.796	NS

R= rows, C= cuttings

Table 4: Effect of cutting frequency of beet leaf on the diameters of onion seed stalk under different row arrangement in onion-beet leaf intercropping systems

Treatments	Diameter of seed stalks (cm)		
Beet leaf Rows (R) → Beet leaf Cutting frequency (C) ↓	**One row**	**Two rows**	**Mean**
Onion seed crop (sole crop)	2.73	2.73	2.73
Onion + Beet leaf 3 cuttings	2.59	2.56	2.58
Onion + Beet leaf 4 cuttings	2.53	2.45	2.49
Onion + Beet leaf 5 cuttings	2.42	2.38	2.40
Onion + Beet leaf 6 cuttings	2.34	2.27	2.31
Mean	2.52	2.48	
CD (P=0.05)	R	C	R×C
	NS	0.073	NS

R= rows, C= cuttings

Table 5: Effect of cutting frequency of beet leaf on the seed yield per umbel of onion under different row arrangement in onion-beet leaf intercropping systems

Treatments	Seed yield per umbel (g)		
Beet leaf Rows (R) → Beet leaf Cutting frequency (C) ↓	**One row**	**Two rows**	**Mean**
Onion seed crop (sole crop)	2.473	2.473	2.473
Onion + Beet leaf 3 cuttings	2.497	2.293	2.395
Onion + Beet leaf 4 cuttings	2.187	2.127	2.157
Onion + Beet leaf 5 cuttings	2.023	2.027	2.025
Onion + Beet leaf 6 cuttings	1.973	1.957	1.965
Mean	2.231	2.175	
CD (P=0.05)	R	C	R×C
	NS	0.185	NS

Table 6: Effect of cutting frequency of beet leaf on the seed yield per plant of onion under different row arrangement in onion-beet leaf intercropping systems

Treatments	Seed yield per plant (g)		
Beet leaf Rows (R) → Beet leaf Cutting frequency (C) ↓	**One row**	**Two rows**	**Mean**
Onion seed crop (sole crop)	24.95	24.95	24.95
Onion + Beet leaf 3 cuttings	23.29	21.40	22.34
Onion + Beet leaf 4 cuttings	20.40	19.36	19.88
Onion + Beet leaf 5 cuttings	18.20	17.80	18.00
Onion + Beet leaf 6 cuttings	17.20	16.80	17.00
Mean	20.81	20.06	
CD (P=0.05)	R	C	R×C
	0.647	1.023	NS

Conclusion

All the studied parameters of onion crop were severely impacted by the increasing frequency of beet leaf cuttings. This further resulted in poor seed yield of onion crop on plant and umbel basis. If maximum seed yield of onion is desired then it is better to plant onion as a sole crop than onion in any intercropping systems.

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