

## Enhancement of Spinach Production by Varying Sowing Dates, Row Spacing and Frequency of Cuttings

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**Abstract:** The enhancement of spinach production was evaluated by varying sowing dates, row spacings and frequency of cuttings. The data were checked on two aspects of spinach i.e. fresh foliage yield and dried foliage yield ( $\text{Kg ha}^{-1}$ ). The analysis of the trial didn't show the significant variations in case of different sowing dates. However, the maximum fresh foliage as well as dried weight was obtained from October sowing (2082.78 and 207.78  $\text{Kg ha}^{-1}$ ) respectively. While both the other factors i.e. row spacings and different cuttings revealed significant differences for fresh and dried yield of spinach. Broadcast ( $S_1$ ) and third cutting ( $C_3$ ) gave the highest fresh foliage yield i.e. 2157.59 and 2329.44  $\text{Kg ha}^{-1}$ , respectively. Maximum dried weight of spinach (212.37 and 222.61  $\text{Kg ha}^{-1}$ ) was also obtained from these two levels i.e. broadcasting ( $S_1$ ) and third cutting ( $C_3$ ). More yield from broadcasting and third cutting might be due to high plant stand per unit area, favourable temperature and climate for the spinach growth.

**Key words:** *Spinacia oleracea*, vegetative growth, fresh foliage, dried foliage

### Introduction

Spinach (*Spinacia oleracea* L.) which is locally also called as Palak is an annual dioecious plant belonging to the family chenopodiaceae. Spinach is the most important highly nutritious green leafy winter vegetable grown in Pakistan on a large scale. It is one of the most common herbage vegetable grown for its greens or leaves. Spinach is a long-day plant that produces its best vegetative growth under cool temperature (15-18°C) than short day length (Hartman *et al.*, 1981). Long days especially coupled with high temperatures above 25°C cause the plant to bolt and flower, which is detrimental to the spinach production. Several factors are responsible for good spinach production but sowing time, plant spacing and number of cuttings are the most important. Spinach is generally grown by broadcast method in Pakistan. Close spacing between plants don't form a rosette of leaves and are apt to develop elongated shoots even at seedling stage. Planting in rows eases the weeding in the earlier stages of the growth. Plants within the rows are relatively close i.e. (5-10 cm) (Baloch, 1994). Khan *et al.* (1994) observed that spinach cv. Kandiairi was sown at monthly intervals from 1st October to 1st January and leaves harvested once, twice and thrice. Waseem *et al.* (2000) stated that maximum yield of spinach was gained in broadcast method as compared to any other method. Broadcast method showed the prominent results in all the parameters studied. The cuttings showed significant results for plant height, fresh and dried foliage yield (Waseem *et al.*, 2001). Although, it is a very important, valuable and nutritious leafy winter vegetable but our farmers really don't know various planting densities and their effect on production. However, no such research has yet been performed on the various sowing methods, plant spacing and number of cuttings in the country. Therefore, this experiment was conducted to check the enhancement of spinach production by varying sowing dates, row spacings and frequency of cuttings.

### Materials and Methods

The research project was carried out to check the enhancement of spinach production by varying sowing dates, row spacing and frequency of cuttings at the Horticultural Research Area, Faculty of Agriculture, Gomal University, D.I.Khan, during the season 1999-2000. The yield data (Fresh and Dried) of spinach were analyzed by using the 3-factor split-split plot arrangements with randomized complete block design (RCBD). Different sowing dates were kept as factor A

while the row spacing and number of cuttings were assigned to factor B and factor C, respectively. The net plot size was kept as  $2 \times 3 \text{ m}^2$ . The seeds of local spinach cultivar were used @ 25  $\text{Kg ha}^{-1}$  on the respective sowing dates kept in the research. Different sowing dates (factor A) were  $D_1$  = September sowing,  $D_2$  = October sowing and  $D_3$  = November sowing of spinach seeds. Different row spacings (factor B) were maintained in the field i.e.  $S_1$  = Broadcast,  $S_2$  = 15 cm apart with 12 rows,  $S_3$  = 30 cm apart with 6 rows and  $S_4$  = 45 cm apart with 4 rows. Data on yield ( $\text{Kg ha}^{-1}$ ) of three cuttings were recorded and subjected to analysis. First cutting ( $C_1$ ) was taken at 60 days after sowing whereas the second cutting ( $C_2$ ) was taken after 30 days of first cutting and the third cutting ( $C_3$ ) was taken after 15 days to second cutting. The analysis was performed by using ANOVA techniques (Steel and Torrie, 1984) while DMR test (Duncan, 1955) was used to check the differences among the treatment means.

### Results and Discussion

**Fresh foliage yield of spinach ( $\text{Kg ha}^{-1}$ ):** The data on the fresh foliage yield of spinach (Table 1) showed significant results for all the three factors, which are sowing dates, row spacings and number of cuttings.

Non-significant results were recorded for the sowing dates with the maximum yield of 2082.78  $\text{Kg ha}^{-1}$  ( $D_2$ ) against the lowest of ( $D_1$ ) 1961.00  $\text{Kg ha}^{-1}$  (Table 1). Various row spacings significantly affected the spinach yield. Broadcast ( $S_1$ ) gave the highest yield of 2157.59  $\text{Kg ha}^{-1}$ . Statistically the results of 15 cm, 30 cm and 45 cm ( $S_2$ ,  $S_3$  and  $S_4$ ) row spacings were non-significant with each other. The lowest production was 1935.52  $\text{Kg ha}^{-1}$  from 15 cm spaced plots. On the other hand, when the data was checked on various row spacings and different cuttings (Table 2), significant results were obtained from both the sides. Row spacings revealed the significant variations with the maximum yield of 2157.59  $\text{Kg ha}^{-1}$ . Different cuttings also gave significant results with the maximum yield of 2329.44  $\text{Kg ha}^{-1}$  recorded in the third cutting of spinach. The minimum yield was 1647.11  $\text{Kg ha}^{-1}$ , which was obtained in the first cutting. The data when average across sowing dates and cuttings given in Table 3, significant results were obtained from number of cuttings.

As far as the interaction of these three factors is concerned non-significant results were obtained. The spinach yield in the third cutting with broadcast method showed best results due

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**Table 1: Interactive competition between sowing dates and row spacing on the fresh yield of Spinach (Kg ha<sup>-1</sup>)**

Sowing Dates	Row Spacing				Means
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	
D <sub>1</sub>	2006.11bcd	1968.78bcd	1812.33d	2056.78abcd	1961.00NS
D <sub>2</sub>	2285.56a	1924.44bcd	2105.56abc	2015.56bcd	2082.78
D <sub>3</sub>	2181.11ab	1913.33cd	2044.44abcd	1968.89bcd	2026.94
Means	2157.59a	1935.52b	1987.44b	2013.74b	

Any two mean(s) not sharing a common letter(s) are significant at 5%. NS = Non significant

**Table 2: Interactive competition between row spacing and different cuttings on the fresh yield of Spinach (Kg ha<sup>-1</sup>)**

Cuttings	Row Spacing				Means
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	
C <sub>1</sub>	1962.78c	1499.89d	1520.11d	1605.67d	1647.11c
C <sub>2</sub>	2243.33abc	2036.67c	2028.89c	2067.78bc	2094.17b
C <sub>3</sub>	2266.67abc	2270.00abc	2413.33a	2367.78ab	2329.44a
Means	2157.59a	1935.52b	1987.44b	2013.74b	

Any two mean(s) not sharing a common letter(s) are significant at 5%.

**Table 3: Interactive competition between different sowing dates and number of cuttings on the fresh yield of Spinach (Kg ha<sup>-1</sup>)**

Sowing dates	Cuttings			Means
	C1	C2	C3	
D <sub>1</sub>	1616.33c	1788.33c	2478.33a	1961.00NS
D <sub>2</sub>	1753.33c	2122.50b	2372.50ab	2082.00
D <sub>3</sub>	1571.67c	2371.67ab	2137.50b	2026.94
Means	1647.11c	2094.17b	2329.44a	

Any two mean(s) not sharing a common letter(s) are significant at 5%. NS = Non significant

**Table 4: Interactive competition between sowing dates and row spacing on the dried yield of Spinach (Kg ha<sup>-1</sup>)**

Sowing dates	Row Spacing				Means
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	
D <sub>1</sub>	203.00bcd	201.00bcd	192.11d	206.11abcd	200.56N.S
D <sub>2</sub>	220.67a	199.33bcd	208.67abc	202.44bcd	207.78
D <sub>3</sub>	213.44ab	197.33cd	206.33abcd	200.56bcd	204.42
Means	212.37a	199.22b	202.37b	203.04b	

Any two mean(s) not sharing a common letter(s) are significant at 5%. NS = Non significant

**Table 5: Interactive competition between row spacing and different cuttings on the dried yield of Spinach (Kg ha<sup>-1</sup>)**

Cuttings	Row Spacing				Means
	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	S <sub>4</sub>	
C <sub>1</sub>	200.02c	172.67d	173.22d	178.33d	181.11c
C <sub>2</sub>	217.78abc	204.78bc	206.11bc	207.44bc	209.03b
C <sub>3</sub>	219.11abc	220.22abc	227.78a	223.33ab	222.61a
Means	212.37a	199.22b	202.37b	203.04b	

Any two mean(s) not sharing a common letter(s) are significant at 5%.

**Table 6: Interactive competition between different sowing dates and number of cuttings on the dried yield of Spinach (Kg ha<sup>-1</sup>)**

Sowing dates	Cuttings			Means
	C1	C2	C3	
D <sub>1</sub>	179.58c	190.83c	231.25a	200.56NS
D <sub>2</sub>	187.25c	210.50b	225.58ab	207.78
D <sub>3</sub>	176.50c	225.75ab	211.00b	204.42
Means	181.11c	209.03b	222.61a	

Any two mean(s) not sharing a common letter(s) are significant at 5% NS = Non significant

to favourable conditions, more nutrients utilization and more number of plants per unit area. An increase in the third cutting might be due to decrease in the temperature because spinach is basically a cool season crop and as the temperature falls

down, an increase in the foliage weight occurs. The rates of the most biological processes are affected by the climate and especially by temperature (Beinhauer, 1980). In particular, the rate of the crop development is closely related to the sum of

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effective temperature over the growing season (Davidson and Campbell, 1983). These findings are in agreement with those of Waseem *et al.* (2001) who also concluded that broadcasting method provided the best results in all the yield components as well as the second cutting produced the better results compared to the first cutting.

**Dried foliage yield of spinach ( $\text{Kg ha}^{-1}$ ):** The data presented in the Tables 4-6 shows the dried foliage yield ( $\text{Kg ha}^{-1}$ ) of spinach. Almost similar trend was observed as it was being observed in case of fresh foliage yield.

When averaged across sowing dates and row spacings (Table 4) non-significant results were obtained in case of sowing dates. However, the maximum dried weight of  $207.78 \text{ Kg ha}^{-1}$  was recorded in October sowing ( $D_2$ ) while the minimum dried foliage yield of  $200.56 \text{ Kg ha}^{-1}$  was recorded in September sowing ( $D_1$ ). Different row spacings showed significant variations for the dried foliage yield. Maximum weight ( $212.37 \text{ Kg ha}^{-1}$ ) was observed in Broadcast ( $S_1$ ), while the minimum weight was  $199.22 \text{ Kg ha}^{-1}$  given by 15 cm row spacing. Statistically the results of 15 cm, 30 cm and 45 cm ( $S_2$ ,  $S_3$  and  $S_4$ ) row spacings were at par with each other.

The interactive comparison of row spacings and number of cuttings was significant (Table 5). Broadcast ( $S_1$ ) gave the maximum dried weight of  $212.37 \text{ Kg ha}^{-1}$ . On the other hand, the results on the three cuttings were significant with each other. Maximum weight ( $222.61 \text{ Kg ha}^{-1}$ ) was noted in third cutting against the minimum of  $181.11 \text{ Kg ha}^{-1}$  obtained in the first cut.

The data when averaged across sowing dates and number of cuttings (Table 6), non-significant behaviour was observed from different sowing dates as well as significant differences were observed in different cuttings.

As far as the interaction of three factors is concerned non-significant results were observed. The results coincides with the findings of Waseem *et al.* (2000) who reported that the dried foliage yield of Spinach was maximum in October sowing with broadcast method.

It can be concluded from these results that broadcasting proved to be the best as compared to the other row spacings. It was also concluded that usually the third cutting gives higher yield comparative to first and second cuttings.

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