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Effect of Sowing Dates and Row Spacing on the Yield of Spinach (*Spinacia oleracea* L.)

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Abstract: The differences in sowing dates and row spacing were highly significant for plant stand. Maximum plant stand (53.77 plants/m²) was recorded in the plots sown on 20th October and the wider row spacing of 45 cm produced the maximum plant stand of 53.88 plants/m². Significantly, 20th October crop gave the maximum plant height of 24.58 cm but row spacing did not effect statistically on the plant height. Sowing dates and row spacing did not show any significant effect on the number of leaves per plant. However, maximum number of leaves 10.98/plant was obtained in the plots sown on 20th October, broadcast produced the maximum 11.02 number of leaves per plant. Fresh and dried foliage yield was significantly affected by the varioust row spacing but was not affected by different sowing dates and their interaction. However, plots sown on 20th October gave the highest fresh yield of 1753.33 Kg/ha while broadcast ledby obtaining the maximum fresh foliage yield of 1962.78 Kg/ha. Almost the similar trend was observed in the dried foliage yield. The differences among sowing dates were not whereas row spacing were highly significant in terms of total fresh yield. Plots sown on 20th October produced significantly the highest yield of 6249 Kg/ha as compared to other sowing dates while broadcast again gained the maximum total fresh yield of 6474 Kg/ha.

Key words: *Spinacia oleraceae*, Sowing dates, Row spacing, Yield.

Introduction

Spinach (*Spinacia oleraceae* L.) locally known as Palak is an annual dioecious plant and belongs to Chenopodiaceae family. It is one of the most important winter leafy vegetable commercially grown in Pakistan. Spinach is one of the most common herbage vegetable grown for its greens or leaves. It is consumed in fresh form as salad as well as in dishes as a cooked pot herb. Hartmann *et al.* (1988) reported that long-day plant that produces its best vegetative growth under cool 15-18°C temperatures than short day length. Long days especially coupled with higher temperatures above 25°C cause the plant to bolt and flower, which is detrimental to production of spinach crop. Many factors are responsible for spinach production i.e. sowing time, seed rate, planting methods etc. Among these, sowing time and row spacing are important factors which affect the production of this crop. In Pakistan, it is generally sown by broadcast method on the flat beds. Close plant spacing do not form a rosette of leaves and are apt to develop elongated shoots even in seedling stages. Planting in row eases the manual weeding in the earlier stages of growth. Plants within the rows are relatively close (5-10 cm) (Hartmann *et al.*, 1988; Baloch, 1994). Aria and Okayama (1982) investigated the effects of growing spinach seedlings at 2, 3, 4 or 5 per soil block of 10 × 20 cm² on the growth, quality and yield. The best quality and high yielding crops were obtained with 3 seedlings/block. Also the sowing of spinach seed in rows is better than broadcast method in terms of yield (Baloch, 1994). Khan *et al.* (1994) observed that spinach cultivar Kandhari was sown at monthly intervals from 1st October to 1st January and leaves harvested once, twice or three times. Although, it is a very important, valuable and nutritious leafy vegetable but a very little work has been reported regarding its time of sowing and planting methods in the country in general and N.W.F.P. in particular.

Materials and Methods

The experiment was laid out in Split-Plot arrangement with sowing dates as main plots and row spacings as sub-plots. Each sub-plot was 2x3 m². The experiment was replicated thrice. The different sowing dates were allotted the main plots i.e.:

S1 = Sowing done on 20th September, S2 = Sowing done on 20th October and S3 = Sowing done on 20th November. Whereas the various row spacing were kept under sub-plots i.e., Broad Casting, 15 cm apart with 12 rows, 30 cm apart with 6 rows and 45 cm apart with 4 rows.

The experimental area was thoroughly prepared by ploughing the land thrice with a local scarifier to a depth of 10-15 cm followed by planking. The seed beds were well prepared. The seed of local

spinach variety at the rate of 25 kg/ha was sown on respective dates with specified methods. Soon after the sowing, the experimental trail was irrigated. Culting was taken after 60 days from date of sowing. All cultural practices were maintained uniformly throughout the growing period for all treatments. Plantstand/m², Number of leaves/plant, Plant height (cm), Fresh foliage yield (kg/ha), Dry foliage yield (kg/ha) and Total yield (kg/ha) at the end of the season was studied.

The data collected on various parameters were analyzed statistically using Analysis of Variance Technique for the interpretation by the method as described by Steel and Torrie (1980).

Results and Discussion

It is clear from the results that differences among sowing dates and row spacing were significant (Table 1). The maximum plant stand was recorded in 20th October sowing, while the minimum plant stand was observed in 20th September sowing. This result obtained, may be due to the favourable temperature existing during the mid of October. Maximum plant stand was obtained at 45 cm row spacing, while the minimum plant stand was observed in case of broadcasting due to the less competition between the seeds as the lines were 45 cm apart from each other.

Plant height (cm) was highly significantly affected by different sowing dates (Table 1). Maximum plant height was recorded in the plots sown on 20th October which was at par with 20th November. The row spacing did not show significant effect. However, the maximum plant height was obtained in broadcast method, whereas the minimum plant height was recorded in 30 cm row spacing. Interaction between different sowing dates and various row spacing was also non-significant. Encouraging results were obtained by 20th October sowing and similarly by broadcast method. This could have been due to the favourable conditions throughout this growth period.

Data pertaining to the number of leaves per plant (Table 1) revealed that the number of leaves per plant was not significantly affected by different sowing dates, row spacing as well as their interaction. Maximum number of leaves were recorded in the crop sown on 20th October whereas the minimum number of leaves was observed in the crop sown on 20th November.

Table 2 indicates the results of fresh foliage yield (kg/ha). The analysis shows that the different sowing dates and the interaction had a non-significant effect on the fresh foliage yield (Kg/ha) of spinach. However, 20th October sowing crop gave maximum fresh foliage yield of 1753 Kg/ha. Whereas, row spacing had statistically significant effect on the fresh foliage yield (Kg/ha) of

Table 1: Different Parameters as Affected by Different Sowing Dates and Row Spacing.

Spacings (cm)	Sowing dates			
	20TH SEPT	20TH OCT	20TH NOV	Means
Plant Stand/m²				
BROAD CAST	12.667 e	41.667 bc	41.667 bc	32.000 c
15 cm	26.333 d	55.667 a	52.667 a	44.889 b
30 cm	33.333 cd	54.000 ab	56.333 a	47.889 ab
45 cm	38.333 cd	63.333 a	60.000 a	53.889 a
MEANS	27.667	b	53.667 a	52.667 a
Plant height (cm)				
BROAD CAST	21.650 N.S	27.777	21.907	23.778 N.S
15 cm	18.297	25.443	22.687	22.142
30 cm	19.397	22.530	21.083	21.003
45 cm	19.220	22.597	22.263	21.360
MEANS	19.641 b	24.587a	21.985 ab	
Number of leaves per plant				
BROAD CAST	11.287 N.S	11.863	9.910	11.020 N.S.
15 cm	8.507	10.907	8.883	9.432
30 cm	10.530	10.040	7.910	9.493
45 cm	9.753	11.110	7.773	9.546
MEANS	10.019 N.S	10.980	8.619	

Means followed by similar letter(s) donot differ significantly from one another at 5% level of significance.

Table 2: Fresh and Dry Foliage Yield (Kg/ha) of Spinach as Affected by Different Sowing Dates and Row Spacing.

Spacings (cm)	Sowing Dates			
	20TH SEPT	20TH OCT	20TH NOV	MEANS
Fresh foliage yield (kg/ha)				
BROAD CAST	1868.33 N.S	2113.33	1906.67	1962.78 a
15 cm	1623.00	1723.33	1470.00	1605.44 b
30 cm	1320.33	1753.33	1486.67	1520.11 b
45 cm	1653.00	1423.33	1423.33	1499.89 b
MEANS	1616.17 N.S	1753.33	1571.67	
Dry foliage yield (kg/ha)				
BROAD CAST	195.67 N.S	209.67	195.33	200.22 a
15 cm	179.67	186.00	169.33	178.33 b
30 cm	161.67	186.33	171.67	173.22 b
45 cm	182.00	167.00	170.33	173.11 b
MEANS	179.75 N.S.	187.25	176.67	
Total fresh foliage yield (kg/ha)				
BROAD CAST	6018 N.S	6858	6543	6474 a
15 cm	5907	5772	5793	5805 b
30 cm	5505	6318	6132	5985 b
45 cm	6168	6048	5904	6039 b
MEANS	5898 N.S	6249	6081	

Means followed by similar letter(s) donot differ significantly from one another at 5% level of significance.

spinach. The maximum fresh foliage yield of 1963 Kg/ha was recorded in broadcast method and it was significant from the yield of other row spacings. The interaction between different sowing dates and various row spacing had a non significant effect on fresh foliage yield of spinach. The foliage production is a function of the combined contribution of various yield components which are affected by ecological growing conditions and cultural practices. The rates of most biological processes are affected by climate and especially by temperature (Beinhauer, 1980). In particular, the rate of crop development is closely related to the sum of effective temperature over the growing season (Davidson and Campbell, 1983). The sowing dates did not influence the fresh foliage weight while spacing showed significant effect. Broadcast appeared the best with maximum foliage production of 1963 Kg/ha. The data recorded on dry foliage yield (kg/ha) of spinach (Table 2) revealed the non-significant differences among different sowing dates. However, it was observed that the maximum dry foliage yield of 187.3 Kg/ha was recorded in the crop sown on 20th October. Various row spacing showed significant effects on the dry foliage yield. Maximum dry foliage yield of 200 Kg/ha was observed in broadcast method whereas the rest of the spacing remained non-significant. So far, the interaction is concerned, statistically non significant results were obtained. It may be due to the ecological conditions of the region. The trend of the results was almost similar to that of the fresh foliage yield. These results are in support of Gonzalez and Marx (1982). The total fresh foliage yield of spinach on per hectare basis was recorded after various cutting at the end of the season (Table 2). The results indicated that the sowing dates had non significant effect on the total yield of fresh spinach. The maximum total yield of 6249 kg/ha was obtained in the crop sown on 20th October. However, various row spacing had a significant effect on the total spinach yield. The maximum total yield 6474 kg/he in case of row spacing was observed in broadcast method of sowing. The maximum yield with broadcast method may be due to the less competition among the plants for light, moisture and nutrients etc because of low number of plants

per unit area in broadcast method. Their interaction was also found to be non significant. This may be due to the favourable temperature during October as compared to September and November. Hartmann *et al.* (1988) also mentioned that 15-18°C is the optimum temperature for spinach production. For getting higher yield, the best time of spinach sowing is the 20th October followed by 20th November. Broadcast proved better than other row spacings in terms of foliage, fresh and dry yield. The findings of this research would be very helpful for the ordinary farmer in deciding the Particular time and relative method of spinach sowing in the agro-limatic conditions of Dere Ismail Khan.

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