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ABSTRACT

To study the effect of row spacing and frequency of cuttings on spinach ***(****Spinacia oleracea)*, an experiment was carried out at the Kitchen Gardening Training Center for Women at 61 JB Dharorh Faisalabad, Pakistan, during 2014. The experiment was laid out in Randomized Complete Block Design (RCBD) with factorial arrangements having three replications with a plot size of 3 m × 6 m. This experiment was comprised of two factors, i.e. row spacing (Broadcast, 30 cm apart rows and 45 cm apart rows) and cutting frequency (45 days after sowing and 30 after the first cutting). The result showed that differences in row spacing have non-significant effects on plant height (cm), number of leaves, Fresh Biomass (kg/ha^{-1}) and Dried Biomass (kg/ha^{-1}). The broadcast method of sowing gave the prominent results in all the parameters, such as the maximum plant height of 25.49 (cm), maximum number of leaves at 37.8, maximum fresh biomass of 2252 (kg/ ha^{-1}) and dried biomass of 217.95 (kg/ ha^{-1}). However, the number of cuttings gave significant results for plant height (cm), fresh biomass (kg/ ha^{-1}) and dried biomass (kg/ ha^{-1}). 2nd cuttings showed a maximum plant height of 26.59 (cm), maximum fresh biomass of 2254.67(kg/ ha^{-1}) and dried biomass of 222.6 (kg/ ha^{-1}), but 1st cuttings showed the maximum number of leaves (36.56).

KEYWORDS: *Spinacia oleracea*, Spinach, Row spacing, Frequency of cutting

INTRODUCTION

Spinach (*Spinacia oleracea*) is a cool-season crop that belongs to the family *Chenopodiaceae*, which is now included in *Amaranthaceae* family. It is the most accepted vegetable because it contains a higher amount of vitamins and minerals. Spinach reaches to maturity in 45 days and grows best during the moist seasons of the year. On a commercial basis,

its production is less (Habimana *et al.*, 2014). Spinach is locally called palak and is a highly nutritious green leafy vegetable. It is a long day plant and is grown on a large scale in Pakistan (Hartmann *et al.*, 1981). Spinach is a precious fresh-market vegetable due to its high levels of vitamins, folic acid, potassium and antioxidants. These behaviors, along with good cold tolerance, make spinach an exceptional crop to set off other high tunnel vegetables (Black *et al.*, 2008).

It is reported that spinach gave better yields by using seed planting method as compared to the broadcast method. At some places, the spinach was sown on ridges with the row spacing of 30-45 cm, but row spacing of 15-20 cm helped in weeding throughout the growing period (Baloch, 1994). It was seen that a row spacing of about 15-30cm in productive soils produced the best results regarding yield (Schippers, 2000). Long days along with high temperatures caused early flowering in spinach which is harmful for its production. There are many factors which are accountable for the higher production of spinach, but row spacing and the frequency of cutting are the most important. In Pakistan, spinach is normally grown by using the broadcast method. Close spacing is appropriate for the production of extended shoots, even at seedling stage, but sowing in rows helps in weeding (Baloch, 1994). It has been declared that the broadcast method gave the highest yield as compared to other methods of sowing (Waseem *et al.*, 2000). For seed production, spinach requires wider rows, but for vegetable production, close spacing gave better results. Normally we would use 20-30 cm apart rows for production. Wider plant spacing increases air flow through the plants and decreases disease pressure (Navazio and Colley, 2007; Thro *et al.*, 2008).

Waseem and Nadeem (2001) reported that the broadcast method showed maximum results regarding plant height, fresh and dried foliage. Spinach is a highly nutritious vegetable,

but farmers are really unaware of the different planting densities and their effect on spinach production (Waseem *et al.*, 2001; Waseem and Nadeem, 2001). Keeping in mind the importance of plant densities/spacing, as well as the frequency of cutting and the effect on production, the following experiment was conducted.

MATERIALS AND METHODS

To study the effect of row spacing and frequency on the yield of spinach, an experiment was conducted at the kitchen gardening training center for women at 61 JB Dharorh Faisalabad, Pakistan during 2014. The experiment was comprised of two factors, i.e. row spacing (S_1= Broadcast, S_2 = 30 cm apart rows and S_3 = 45 cm apart rows) and cutting frequency (C_1 = 45 days after sowing and C_2 = 30 after the first cutting). The experiment was laid out in a Randomized Complete Block Design (RCBD) with factorial arrangements having three replications with a plot size of 3 m × 6 m.

Spinach was sown according to the above mentioned spacing at the rate of 25 kg/ha. For fertilizers, urea was used as a source of nitrogen and DAP was used as phosphorus source. Nitrogen was applied in two splits (half at the time of sowing and half in 2 splits along with 1st and 2nd irrigation) at the rate of 120 kg ha^{-1}. All the cultural practices were kept the same during the growing period for all the treatments. Data were recorded on the number of leaves per plant, plant height (cm), fresh bio mass (kg/ ha^{-1}) and dried bio mass (kg/ ha $^{-1}$). The plant height of five randomly selected plants was recorded at harvesting time from the ground level to the tip of the plant and the average was worked out and expressed in cm. In the same way, the numbers of leaves were counted from the five selected plants at harvesting time. The average value was recorded as number of leaves per plant. For the determination of fresh biomass, all the plants in

all treatments were harvested and were weighed to estimate fresh weight. Fresh biomass yield per hectare was recorded based on the leaves yielded per treatment and expressed in tons. Data on these parameters were recorded and analyzed statistically using the analysis of variance technique (Steel *et al.*, 1980).

RESULTS AND DISCUSSION

Plant Height (cm):

The row spacing showed a non-significant effect on plant height (cm). The maximum plant height was 25.49 (cm) and was observed in S_1 (broadcast method), while in S_2 and S_3 plant heights were 24.12 (cm) and 23.99 (cm) respectively, which are at par with each other. In spite of that, the no. of cuttings significantly affected the plant height. A maximum plant height of 26.59 (cm) was reported in C_1 (first cutting), while the C_2 (second cutting) gave a 22.47 (cm) plant height. Waseem *et al.* (10) also found the same results. This may be due to the favorable environment throughout the growing period.

Number of leaves per plant:

Both the factors have a non-significant effect on the number of leaves per plant, while the broadcast method gave the maximum number of leaves of 37.8 per plant. For the other two treatments, the number of leaves per plant is at par with each other at 35.75 and 34.5 respectively. The results regarding the no. of cuttings indicated that the 2^{nd} cutting showed a higher number of leaves as compared to the 1^{st} cutting. Similar results were recorded by Waseem *et al.* (2000). According to them, spacing has little effect on the growth of spinach.

Table:1 Effect of row spacing and frequency of cutting on growth and yield of spinach

Treatments	Numbers of Cutting		Means
	1st cutting	2nd cutting	
Plant height (cm)			
Broadcast	28.29 A	22.69 B	25.49 NS
30cm	25.85 A	22.39 B	24.12
45cm	25.63 A	22.35 B	23.99
Mean	26.59 A	22.47 B	
Number of leaves			
Broadcast	37.4 A	38.2 AB	37.8 NS
30cm	35 AB	36.5 A	35.75
45cm	34 B	35 AB	34.5
Mean	35.46	36.56 NS	
Fresh biomass(kg ha^{-1})			
Broadcast	2245 A	2259 A	2252 NS
30cm	2034 B	2262 A	2148
45cm	2030 B	2243 A	2136
Mean	2103 B	2254 A	
Dried biomass (kg ha $^{-1}$)			
Broadcast	217 A	218.9 A	217.95 NS
30cm	208 B	224.9 A	216.45
45cm	202 B	224.0 A	213.00
Mean	209 B	222.6 A	

Fresh biomass (kg/ha^{-1}):

Fresh biomass of the plant was not affected by row spacing. In spite of that, the maximum fresh biomass 2252 (kg ha^{-1}) was reported in S_1 (broadcast method). However, the other two treatments (S_2 & S_3) have 2148 (kg ha^{-1}) and 2136.5 (kg ha^{-1}) respectively. Similar effects were reported by Waseem *et al.* (2001) who recorded that the maximum fresh biomass was obtained using the broadcast method. It can be affirmed that the second cutting gave maximum fresh weight 2254.66 (kg ha $^{-1}$) as compared to the first cutting. This might be due to climate change, which affects many biological processes. Development of the crop is highly dependent on the prevailing temperature throughout the growing period (Davidson and Campbell, 1983).

Dried biomass (kg/ha^{-1}):

This parameter showed the same trend as was found in fresh biomass. The broadcast method produced the maximum dried biomass of 217.95.3 (kg ha^{-1}), while S_2 gave 216.45 (kg ha^{-1}). Minimum dried biomass 213 (kg ha^{-1}) was recorded in S_3. Waseem *et al.* (2000) reported the same results that broadcast method gave the maximum dried biomass. It is stated that maximum dry matter, 222.6 (kg ha^{-1}), was found in the second cutting, while the first cutting produced less.

Conclusion:

It can be concluded that the broadcast method of sowing gave better production as compared to other methods. It has also been proven that the second cutting gave the maximum yield, as compared to first cutting.

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