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Cutting Frequencies and Foliar Application of Nutrients on Green and Seed Yield in Spinach Beet (*Beta vulgaris* var*. bengalensis*)

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***Abstract*:** To assess the effect of cutting frequencies and foliar application of macro and micro nutrients on growth and seed yield in spinach beet (*Beta vulgaris* var. *bengalensis*) the experiment was carried out consecutively for two years at Sher-e-Kashmir University of Agricultural Sciences and Technology Jammu. The experiment was designed in factorial RBD comprising of two factors i:e cutting frequencies and different combination of macro and micro nutrients. The crop with one cutting and 100% application of recommended dose of fertilizers +15 ppm micro nutrients+100 ppm of water soluble fertilizers had maximum seed yield per hectare (22.44q), improved germination (80.83%), highest seedling vigour index (1390.00) and maximum B:C ratio (1:4.30). Thus the crop given one cut produced maximum seed yield and better quality seed in spinach beet. The maximum green leaf yield per hectare (220.01q) was recorded in treatment combination with three cuts and 100% application of RDF+15 ppm micro nutrients+100 ppm of water soluble fertilizers. The maximum number of days to 50% flowering (143.06) was with three cuts and minimum (102.73) with no cut. The application of nutrients had no effect on 50% flowering.

***Keywords*:** Cutting frequencies, Micronutrients, RDF, Seedling vigour index

Spinach beet (*Beta vulgaris* var. *bengalensis*; 2n=2x=18) originated in the Indo-Chinese region and is commonly known as “Indian Spinach”. It is a member of genus Beta, species *vulgaris* and family Chenopodiaceae. The forebear of palak is *Beta vulgaris* var. *maritima*. The palak growing states in India are Uttar Pradesh, West Bengal, Maharashtra and Gujarat. In Jammu division of J&K it is cultivated with a yearly production of 12360 MT over an area of 727 hectares (Anonymous 2020). Spinach's nutrients include a wide range of vitamins and minerals that can help to avoid deficiency disorders and meant to prevent the chronic diseases. The addition of nutrients and their uptake by the plants has a significant qualitative and quantitative impact on plant development and fruit yield (Rathore et al 2008), as a result the nutrient application has become one of the most important inputs in the leafy vegetable production which results in more green and seed yield (Tehelan and Thakral 2008, Tunctruk et al 2011). Micronutrients can aid spinach resistance to environmental stresses such as drought and salinity. To get lush green growth after each cutting, the nutrient application is necessary. Green leafy vegetables are obtained by trimming all of the leaves and new shoots and taking multiple cuttings during the growing season but crop without cut is generally recommended for best quality seed. Proper cutting management in this crop boosts green yield, number of branches, number of leaves, dry weight of leaves and stem *viz-a-viz* proper management of cutting with the application of nutrients boosts green and seed yield in spinach beet. Due to absence of any comprehensive study to overcome the hindrance in quality seed production, there was an urgent need to find out the effect of cutting frequencies and foliar application of macro and micro nutrients on growth and seed yield in spinach beet.

MATERIAL AND METHODS

The experiment was conducted at Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu (2020-2021& 2021-2022). The climate of experimental area is sub-tropical, with hot and dry summers, hot humid rainy season and chilly winters. The experiment was laid out in factorial RBD replicated thrice with one factor as cutting frequencies and second as different doses of macro and micro nutrients. Plot size was kept at 3m × 3m.The Seeds of Jammu spinach beet-07 were sown at within row spacing of 20 cm and within plant spacing of 5 cm. The experiment was comprised of four cutting frequencies *viz.,* No cut (C_0), one cut (C_1), two cut (C_2) and three cut (C_3) and different doses of fertilizers *viz.,* recommended dose of fertilizers @ 90:60:60(A_0), recommended dose + 10 ppm micronutrients + 75 ppm of macronutrients (19:19:19) (A_1), recommended

dose + 10 ppm micronutrients+100 ppm macronutrients (A_2), recommended dose + 15ppm micronutrients + 75 ppm macronutrients (A_3) and recommended dose + 15 ppm micronutrients + 100 ppm macronutrients (A_4). Data were recorded on plant height (cm), green leaf yield per plot (kg), green leaf yield per hectare (q), intervals between successive cuttings (days), days to 50% flowering, seed yield per plant (g), seed yield per plot (kg), seed yield per hectare (q), germination (%), seedling vigour index and cost benefit ratio. The germination percentage was tested by placing 50 seeds on Petri plates at 20-25^{0}C with 90-95 percent relative humidity. Seedling vigour index was calculated by using the formula that has been given by Abdul Baki and Anderson (1973). Intervals between successive cuttings was calculated by taking the number of days from the sowing to first cut from first cut to second and from second cut to third cut respectively. Number of days to 50% flowering was estimated from the entire plot in each treatment. B: C ratio was calculated by using the formula with net return divided by cost of cultivation. The treatment mean were separated at 5% level of significance for interpretation of the results.

RESULTS AND DISCUSSION

Growth and yield parameters: Beet leaf plants recorded maximum plant height (225.25 cm), when it was not given any cut. The recorded height was significantly more than other cuttings treatment. Similarly application of nutrients also increased the height of plants (Table 1). Maximum plant height (208.00 cm) was recorded in plants treated with RDF+15 ppm micronutrients+100 ppm macro nutrients. However the recorded height was at par with recommended dose + 15ppm micronutrients + 75 ppm macronutrients (A_3). Among the interaction studies, maximum plant height (228.72 cm.) was obtained when the crop was left without any cut and treated with RDF+15 ppm micronutrients+100 ppm macro nutrients. The least (168.84 cm) was observed when crop was treated with only RDF and cut thrice (Table -2). This can be due to pruning which encourages the development of the side shoots which resulted in bushy habit with decreased plant height (Bharad et al 2013). Singh et al (2018) reported that the tallest plants in fenugreek were recorded where no cutting was given. The decrease in plant height with three cuttings owes to curbing of vertical growth of the plants resulting in translocation of photosynthates to the leaves axils, thus encouraging the auxiliary branches. The increase in plant height in combination with nutrient application had also been reported by Vasudevan et al (2008) in fenugreek. The overall improvement in growth with nutrient application could be ascribed to the pivotal role played by the nutrients. The promotion of growth due to nutrient application had also been attributed to the increase in plasticity of the cell resulting in entry of water into the cell causing the cell elongation. These results were also supported by Gour et al (2009) in fenugreek and Singh et al (2012) in coriander.

The green leaf yield per plot and hectare varied significantly in response to the cuttings and the nutrient application individually and collectively. Maximum green leaf yield per hectare (220.01q) was in treatment with three cuttings (C_3) and minimum was recorded in treatment with one cut (C_0) (Table -1). Similarly the green leaf yield responded favorably towards the nutrient application. Maximum green leaf yield (per plot and per hectare) was

Table 1. Effect of cutting frequencies, foliar application of macro and micro nutrients on growth, seed yield and seed quality parameters

Treatments	Plant height (cm)	Green leaf yield/Plot (kg)	Green leaf yield/hectare (q)	Intervals between successive cuttings	Days to 50% flowering	Seed yield/plant (g)	Seed yield/plot (kg)	Seed yield/hectare (q)	Germination (%)	Seedling vigour index
C_0	225.25	0.00	0.00	0.00	102.73	22.84	2.51	22.31	80.33	1238.81
C_1	209.20	9.53	105.86	45.93	122.20	23.22	2.55	22.44	81.73	1365.01
C_2	204.40	15.49	172.15	75.60	132.33	19.86	2.19	19.39	78.73	1125.45
C_3	178.53	18.80	220.01	96.40	143.06	18.31	2.03	18.07	75.46	995.65
CD (p=0.05)	C=3.19	C=0.61	C=6.83	C=1.72	C=1.86	C=0.97	C=0.09	C=1.02	C=1.49	C=12.29
A_0	196.68	9.25	102.78	58.42	122.33	17.95	1.97	17.55	77.58	979.40
A_1	199.05	10.56	117.31	56.66	123.66	19.17	2.11	18.73	78.25	1087.20
A_2	201.86	11.16	124.04	54.33	125.33	20.07	2.28	20.29	78.58	1164.36
A_3	206.03	12.36	137.36	51.66	126.42	23.27	2.55	22.40	80.08	1288.18
A_4	208.00	12.69	141.04	51.16	127.66	23.94	2.65	23.26	80.83	1390.00
CD (p=0.05)	A=3.56	A=0.68	A=7.64	A=1.92	N.S	A=1.09	A=0.10	A=1.14	A=1.67	A=13.75

recorded with the application of RDF+15 ppm micronutrients+100 ppm macronutrients (12.69kg/plot and 141.04 q/ha). The combined effect of cutting frequencies and application of macro and micro nutrients also had the significant effect. Maximum leaf yield was with C_3A_4 which was at par with C_3A_3. Increased leaf yield with cuttings and nutrient application was also reported by Bharad et al (2013). The intervals in days between successive cuttings responded significantly in response to the cutting frequencies and the nutrient application. The first cutting took more number of days (45.93) as compared to the second and third cutting. Similarly the nutrient application of RDF+15ppm micronutrients+100 ppm macronutrients (A_4) took lesser number of days for producing the economic yield. However, was at par results with A_3. Among the interaction studies the minimum numbers of days were taken in treatment with three cuttings+RDF+15ppm micronutrients+100 ppm macronutrients (C_3 A_4) and C_3 A_3 (Table-3). Rafat et al (2017) also indicated that in fenugreek the growth and yield traits increased as the cuttings dates were delayed across the growing period.

Seed parameters: Minimum numbers of days taken by a crop for 50% flowering indicates its early maturity. Three cuttings delayed the flowering (Table 1) and crop took 143.06 days to came into 50% flowering. However, application of nutrients and their interaction with cuttings had no effect on 50% flowering. In fenugreek Krishnaveni *et al*. (2014) revealed significantly lesser number of days for flowering with no pinching. Similar results were also obtained by Vasudevan et al (2008). Seed yield per hectare (q) was significantly influenced by the cutting frequencies and nutrient application. Maximum seed yield per hectare was recorded in the treatments involving only one cut (23.22 g/plant, 2.55 kg/plot and 22.44 q/ha respectively). The application of nutrients also significantly favored the seed yield and maximum value of seed parameters was in A_4. Among interaction studies maximum seed yield was in treatment combination of one cutting followed by nutrient

Table 2. Interaction effect of cuttings and foliar application of macro and micro nutrients on spinach beet (Pooled data for two years)

Treatments	Plant height (cm)	Green leaf yield/Plot (kg)	Green leaf yield/ hectare (q)	Intervals between successive cuttings	Days to 50% flowering	Seed yield/plant (g)	Seed yield/plot (kg)	Seed yield/ hectare (q)	Germination (%)	Seedling vigour index
C_0A_0	225.50	0.00	0.00	0.00	99.00	18.65	2.05	18.24	79.00	1019.39
C_0A_1	223.76	0.00	0.00	0.00	100.33	19.19	2.11	19.46	79.67	1120.51
C_0A_2	223.01	0.00	0.00	0.00	103.66	22.17	2.43	21.63	80.00	1217.37
C_0A_3	228.41	0.00	0.00	0.00	105.00	26.23	2.88	25.59	81.00	1381.59
C_0A_4	228.72	0.00	0.00	0.00	105.66	27.23	2.99	26.63	82.00	1455.29
C_1A_0	202.01	7.77	86.36	50.00	119.33	18.62	2.14	18.21	80.33	1142.58
C_1A_1	203.09	8.97	99.70	47.00	121.33	20.51	2.26	20.08	81.66	1287.01
C_1A_2	209.09	9.37	104.18	45.00	122.00	22.90	2.52	22.39	81.69	1357.41
C_1A_3	214.87	10.34	114.88	44.33	123.33	26.59	2.96	24.67	82.00	1464.69
C_1A_4	216.93	11.18	124.22	43.33	125.00	27.47	3.02	26.84	83.00	1573.36
C_2A_0	197.69	11.86	132.73	80.00	130.00	18.29	2.07	17.86	77.00	920.35
C_2A_1	198.35	14.29	158.77	79.00	131.33	18.97	2.08	18.51	78.00	1053.49
C_2A_2	207.53	15.38	170.96	76.33	132.33	19.25	2011	18.81	78.67	1091.98
C_2A_3	208.77	17.47	194.14	70.67	133.66	21.02	2.31	20.53	79.00	1217.64
C_2A_4	209.71	18.46	205.18	72.00	134.33	21.77	2.39	21.27	81.00	1344.51
C_3A_0	168.84	17.37	193.03	103.66	141.00	16.27	1.78	15.87	71.67	823.39
C_3A_1	171.62	18.97	210.77	100.00	141.66	17.28	1.89	16.85	74.67	887.78
C_3A_2	177.14	19.89	221.03	96.00	143.33	18.79	2.06	18.36	75.33	991.41
C_3A_3	178.41	21.13	234.77	91.66	143.66	19.25	2.12	18.80	77.33	1088.82
C_3A_4	196.64	21.64	240.44	89.33	145.66	19.96	2.19	19.52	78.33	1186.85
CD (p=0.05)	7.13	1.37	15.28	3.84	N.S	2.18	0.21	2.28	N.S	27.50

Table 3. Economics of treatments depicting B:C ratio for foliage and seed yield of Jammu spinach beet

Treatments	Cost of cultivation (Rs/ha)	Green leaf yield/hectare	Seed yield/hectare	Green leaf yield (Rs/ha)	Seed yield (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
C_0A_0	110408	0	18.24	0	228000	228000	117592	1:1.06
C_0A_1	114925	0	19.46	0	243250	243250	128325	1:1.10
C_OA_2	123158	0	21.63	0	270375	270375	147217	1:1.90
C_OA_3	143158	0	25.59	0	319875	319875	176717	1:2.30
C_OA_4	148408	0	26.63	0	332875	332875	184467	1:2.40
C_1A_0	150408	86.36	18.21	86360	227625	313985	162577	1:1.08
C_1A_1	166075	99.70	20.08	99700	251000	350700	184625	1:1.10
C_1A_2	167325	104.18	22.39	104180	279875	384055	216730	1:2.90
C_1A_3	182908	114.88	24.67	114880	308375	423255	240347	1:3.10
C_1A_4	188908	124.22	26.84	124220	335500	459720	270812	1:4.30
C_2A_O	168408	132.73	17.86	132730	223250	355980	187572	1:1.10
C_2A_1	180075	158.77	18.51	158770	231375	390145	210070	1:1.60
C_2A_2	185075	170.96	18.81	170960	235125	406085	221010	1:1.90
C_2A_3	190908	194.14	20.53	194140	256625	450765	259857	1:3.60
C_2A_4	196908	205.18	21.27	205180	265875	471055	274147	1:3.90
C_3A_O	188408	193.03	15.87	193030	198375	391405	202997	1:1.07
C_3A_1	190075	210.77	16.85	210770	210625	421395	231320	1:2.10
C_3A_2	200075	221.03	18.36	221030	229500	450530	250455	1:2.50
C_3A_3	206908	234.77	18.63	234770	232875	467645	260737	1:2.60
C_3A_4	208808	240.44	19.52	240440	244000	484440	275632	1:3.10

Average sale price of green leaf=10/- per kg, Average sale price of seed=185/- per kg

application with RDF+15 ppm micronutrients+100 ppm macronutrients (C_1A_4) (26.84 q/ha). Singh et al (2013) also recorded maximum seed yield with one cutting that was at par with two cuttings. Lal et al (2003) revealed that seed yield considerably reduced with increased cutting levels. Similarly, Said-Al-Ahl and Omer (2009) observed significant increase in seed yield of coriander by foliar spraying with Zn alone or by Zinc and Iron combination.

The germination percentage (81.73%) and seedling vigour index (1365.01) were significantly higher when the crop was given with one cut (C_1). Among the macro and micronutrients combination RDF+15 ppm micronutrient+100 ppm (A_4) recorded more germination percentage (80.83%) and seedling vigour index (1390.00) as compared to control. However the interactions between cuttings and macro and micronutrients application showed non-significant effect towards the germination percentage, but it had significant effect on seed vigour. Maximum seedling vigour index (1573.36) was in treatment combination of C_1A_4 that was significantly more than other treatments.The improvement in seed quality might be due to the better mineral utilization of the plants accompanied with enhancement of photosynthesis and other metabolic activities and greater diversion of food material to the seed (Naga et al 2013). Similarly Islam et al (2019) reported that the highest germination in spinach when treated with nitrogen and phosphorus as compared to the control. The increase in this parameter may be due to involvement of nutrients in catalytic activity and breakdown of the complex substances into simple form like glucose, amino acids and fatty acids which in turn were reflected to enhanced seedling vigour index in coriander (Santosh 2012).

Economic studies: Among the various treatment combinations one cut with RDF+15 ppm micronutrient+100 ppm macronutrient fetched the highest net returns of 27081 due to maximum yield/ha, which resulted in cost benefit ratio of 1:4.30. Lal et al (2014) recorded maximum B: C ratio (2:7.2) with the application of 0.6% Zinc in coriander. Similar results were also obtained by Patil et al (2008). It can be concluded from the investigation that the combination of one cut+RDF+15ppm micronutrient+100 ppm macronutrient had maximum value for seed yield, quality and maximum B: C ratio.

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