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Effect of cutting frequencies and nitrogen levels on growth, green and seed yield and quality of water spinach (*Ipomoea reptans* Poir.)

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Abstract: To study the effect of cutting frequencies and nitrogen levels on growth, green and seed yield and quality of upland water spinach (*Ipomoea reptans* Poir.) an experiment was undertaken with four cutting frequencies (C_0 = no cutting; C_1 = one cutting at 45 days after sowing (DAS); C_2 = two cutting at 45 and 65 DAS and C_3 = three cutting at 45, 65 and 85 DAS) and five nitrogen levels (N_0 = no application; N_1 = 50 kg/ha; N_2 = 100 kg/ha; N_3 = 150 kg/ha and N_4 = 200 kg/ha). Results revealed that all growth, seed yield and seed quality attributes were found to decrease significantly with higher cutting frequencies, whereas, reverse effects on all physiological attributes, green yield and its quality parameters. On the other hand, nitrogen level (upto 150 kg N/ha) had significant effect and all these parameters. The highest green yield was recorded at three cuttings and 150 kg N/ha individually and also at their interaction (16.34, 12.57 and 17.77 t/ha, respectively). Maximum value of quality parameter like vitamin A (3072.9 µg/100 g) was recorded in one cutting with 150 kg N/hectare, whereas, maximum ascorbic acid was recorded maximum (45.31 mg/100 g) in one cutting without N fertilizer application Maximum net profit of Rs. 114324.00 with B: C ratio of 2.22:1 was obtained with combination of three cuttings and 150 kg N/ha and that may be adopted for its commercial cultivation in medium to upland situation under terai region of West Bengal.

Keywords: Cutting frequency, Growth, *Ipomoea reptans,* Nitrogen, quality, Water spinach, Yield

INTRODUCTION

Water spinach (*Ipomoea reptans* Poir.) is an under-exploited herbaceous perennial, leafy vegetable of the tropics and subtropics. It is also known as water convolvulus, swamp cabbage etc. is of East Indian or Chinese origin and belongs to the family convolvulaceae (morning glory) family. The edible portion contain up to 29% crude protein on a dry matter basis and is also rich in minerals and vitamins, being especially rich in vitamins A (carotene 2.9 g/100 g edible portion), B_1, B_2 and C (45 mg/100 g edible portion) and iron. There are two main cultivar groups of var. *aquatica* and var. *reptans*. The first is an aquatic plant, propagated by cuttings and growing in the wild or cultivated in the fish ponds and water courses. The second is an upland vegetable and propagated mainly by seeds or cuttings (Palada and Crossman, 1999). A white flower is produced which matures into a four seeded pod. Flowering occurs under short day condition. But the cultivation of upland water spinach (*I. reptans*) is limited due to non-availability of seeds to the farmers. Nitrogen is one of the inevitable major nutrients and an indispensable constituent of protein and nucleic acid molecules. Nitrogen fertilization has become the key inputs in food production. It is essential for vegetative growth of the plant resulting in higher green and seed yield (Tehelan and Thakral, 2008; Tunctruk *et al*., 2011). Increased addition of nitrogen usually results in increased yield of crop plant (Korus and Lisiewska, 2009). Application of nitrogen to increase yield in leafy vegetables is a well recognized practice. Nitrogen deficiency exerts its effect on plant growth through reduced leaf area index and hence low light interception and low dry matter production (Masinde and Agong, 2012). Cutting management is found beneficial for improving green yield, number of branches, number of leaves, dry weight of leaves and stem, whereas, reverse effect is observed with some parameters like length of leaves, breadth of leaves and vine length (Thapa and Maity, 2004). Stem cutting significantly hastened flowering and enhanced branching (Ahmed and Oladiaran, 2012). As a result, green yield and seed yield increases by adopting proper cutting management of the crop. Since, most of the leafy vegetables several cuttings are possible, they require a good amount of nitrogenous fertilizer for their quick growth, good vegetative growth and as well

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as for reproductive growth (Jana *et al*., 1999; Datta *et al*., 2005; Datta *et al*., 2008). Information on green and seed yield of water spinach as affected by cutting frequencies and different levels of nitrogen for the terai zone of the West Bengal is meager. Hence, this experiment was undertaken.

MATERIALS AND METHODS

The present investigation was carried out during *kharif* seasons of 2007-08 and 2008-09 at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya in terai region of West Bengal. The experimental field was medium low in position, sandy loam in texture, acidic in nature and with low fertility status. The sowing of seed was done directly in the main field in 1st day of June and plot size was 4.5 sq m with spacing of 30 cm × 15 cm in each experimental plot of 4.50 square meter area. The crop was supplied with 20 tonnes well rotten farmyard manure per hectare along with 60 kg P_2O_5 and 80 kg K_2O kg per hectare. Full amount of P_2O_5, K_2O and 1/4th N as per treatment were applied at the time of land preparation and another 3/4th of N in three equal splits as top dressing. The experiment was conducted with upland water spinach (*I. reptans*) with its locally collected genotype named as *Kalmi Sag*. The experiment was comprised of four cutting frequencies (C_0 = no cutting; C_1 = one cutting at 45 days after planting; C_2 = two cutting at 45 and 65 DAS and C_3 = three cutting at 45, 65 and 85 DAS) and five nitrogen levels (N_0 = no application; N_1 = 50 kg/ha; N_2 = 100 kg/ha; N_3 = 150 kg/ha and N_4 = 200 kg/ha) and was conducted in factorial randomized block design with three replications. Harvesting of green leaves with tender stems was done by top shoot cutting of 25-30 cm length twigs leaving 10 cm above the ground. Thereafter, subsequent harvesting was done at 20 days interval. After 3 times harvesting of green twigs, the plants were left for seed production. Flowering generally starts when the day become shorter and average temperature gradually goes down from October and seed sets in December. Harvesting of fruits was done by picking with hands in the month of middle of February when fruits turned to yellow colour. The harvested fruits were dried on threshing floor and then seeds were extracted plot wise separately. Chlorophyll content of green leaves was recorded at time flowering by chlorophyll meter. Leaf area index and crop growth rate was estimated. Ascorbic acid content in water spinach was determined by colorimetric method based on the reduction of 2, 6-dichlorophenol indophenol by ascorbic acid and was expressed in milligram of ascorbic acid per 100 g of sample (Ranganna, 2001). Vitamin A content of leaf was estimated by analyzing the beta carotene content of the leaf and dividing the value with 0.6 to obtain the vitamin A content of leaf (Ranganna, 2001). Different seed testing parameters like shelling percentage, test weight, germination percentage, seedling vigour index (SVI) and seedling growth rate was calculated. The statistical analysis of data was done as per method suggested by Gomez and Gomez (1984). Then the weight of the cleaned and dried seeds from each of the experimental plots as per treatment schedule was recorded for computation of seed yield. All the seed quality testing parameters was carried out in the month of May. The cost of cultivation and gross return were estimated on the basis of price of different components fixed by the state Government to work out the economics.

RESULTS AND DISCUSSION

In the present study different plant growth attributes viz. vine length, number of nodes/plant and average internodes length gave significant changes in different cutting frequency and nitrogen levels (Table 1). The maximum vine length (44.30 cm), number of nodes/ plant (22.68) and average internodes length (1.68 cm) in control treatment (C_0), whereas, they were reported to be minimum at highest cutting frequency i.e. three cuttings (C_3). It might be due to the apical dominance which causes development of lateral buds, ultimately increase the number of shoots. Reduction in vine length by taking three cuttings (C_3) was 53.76% as compared to control (C_0). Thapa and Maity (2004) reported that cutting management significantly reduced the vine length, length of leaves, etc. These parameters were significantly increased with greater supply of nitrogen upto 150 kg N/ha, thereafter, decreased at highest N level. Significantly maximum vine length (35.42 cm), number of nodes/plant (19.98) and average internodes length (1.79 cm) were recorded as a result of higher nitrogen level of 150 kg N/ha (N_3) and this was statistically *at par* with 200 kg N/ha (N_4). Li and Harahap (1994) reported that nitrogen fertilizer application led to a significant increase of plant height, number of nodes, stem diameter and average intermodal length in water spinach which are in conformity with the present investigation. The improvement in all growth parameters with higher nitrogen fertilizer application might be due to the contribution of nitrogen to its role in plant growth, photosynthesis and synthesis of proteins. Interaction between cutting frequency and nitrogen levels was found to be significant.

All the physiological parameters viz. leaf area index, crop growth rate and leaf chlorophyll content (Table 1) which are very important yield attributing characters, were significantly influenced due to cutting frequency as well as nitrogen application. Among cutting treatments, significantly maximum (45.54 SPAD 502) leaf chlorophyll was recorded in one cutting (C_1). This was statistically *at par* with two cuttings (C_2) treatment (45.10 SPAD 502), while, it was found minimum (41.49 SPAD 502) at control (C_0). Besides, LAI (1.24) and CGR (6.62 g/m^2/day) were also found to be maximum with three cuttings (C_3) closely followed by two cuttings (C_2) and minimum (LAI, 0.88 and CGR, 5.18 g/m^2/day) at control (C_0). Significant variations were reported by application of nitrogen fertilizer with respect to all these parameters. The application 200 kg N/ha (N_4) recorded maximum (47.23 SPAD 502) chlorophyll and minimum (39.37 SPAD 502) at control (N_0). Significantly maximum LAI (1.29) and CGR (6.46 g/m^2/day) were recorded as a result of application of 150 kg N/ha (N_3) followed by N_4 and N_2 treatments. The control treatment (N_0) gave minimum values (LAI, 0.81 and CGR, 5.02 g/m^2/day) of these parameters. The increase in LAI in response to an increase in N fertilizer is probably due to enhanced availability of nitrogen which enhanced more leaf area resulting in higher photo assimilates and thereby in more dry matter accumulation. Interaction between cutting frequency and nitrogen had positive effect on all physiological attributes. Three cuttings with 150 kg N/ha (C_3N_3) recorded maximum LAI (1.49) and CGR (7.19 g/m^2/day), whereas, the leaf chlorophyll was found to be maximum (49.00 DPAD 502) in C_1N_4 combination. All these attributes were minimum in control (C_0N_0). The highest leaf chlorophyll under highest N level might be due to maximum instant nitrogen could have absorbed and used which could lead to increase in chlorophyll content. Singh *et al.* (1986) reported that nitrogen application increased leaf chlorophyll content in amaranthus.

The perusal of data (Table 1) revealed that green yield of water spinach significantly increased with higher cutting frequencies and also due to higher nitrogen level upto application of 150 kg N/ha, thereafter, decreased at 200 kg N/ha. Significantly highest green yield (16.34 t/ha) was recorded at three cuttings (C_3), the second highest (10.66 t/ha) was obtained by two cutting (C_2). The lowest green yield of 5.85 t/ha was observed in one cutting (C_1). Jana *et al.* (1999) reported the maximum green leaf yield of palak with three cuttings which are in accordance with present study. On the other hand, significantly highest green yield (12.57 t/ha) was registered with the application of 150 kg N/ha (N_3) and lowest green yield of 9.27 t/ha was obtained in control (N_0). The green yield increased with higher N fertilizer application rate might be due to better nutritional environment in the root zone as well as in the plant system. The combination of three cuttings with 150 kg N/ha (C_3N_3) gave significantly highest green yield (17.77 t/ha) which was statistically *at par* with C_3N_4 (17.29 t/ha). Datta *et al.*, (2008) reported that green leaf yield was significantly increased with the increase in nitrogen levels in coriander.

The quality of green produce viz. ascorbic acid, vitamin A and leaf nitrate content (Table 1) were significantly affected by cutting frequency and nitrogen levels. Significantly maximum ascorbic acid (43.02 mg/100 g), vitamin A (2802.4 μg/100 g) and leaf nitrate content (401.0 mg/kg) were recorded in one cutting (C_1) closely followed by two cuttings (C_2), whereas, all these parameters were found to be minimum at control treatment (C_0). Tomar (2001) reported that all green quality parameters such as ascorbic acid and vitamin A were significantly influenced with cutting management in spinach. The application of 150 kg N/ha indicated significant increase in the quality of water spinach leaf with respect to vitamin A (26.4%) and leaf nitrate (25.8%) higher over control (N_0). The greater nitrogen resulted more vitamin A synthesis. It might be due to the participation of nitrogen in carotene synthesis which is the precursor of vitamin A. Reverse effect was noticed in ascorbic acid due to increase in N levels and maximum (44.68 mg/100 g) was recorded in control (N_0). This might be due to the interaction of nitrogen in the hormonal metabolism of the plant system, especially the auxins. Interaction between cutting frequency and nitrogen level showed positive results on all green quality attributes. Singh *et al.* (1986) reported that nitrogen increased crude protein and carotene content but decreased the ascorbic acid content in amaranthus which are in good connection with the findings of present study. The leaf nitrate accumulated due to all the treatments remains within the daily acceptable limit. On the other hand, Schmidt *et al.* (2007) reported the similar findings in different leafy vegetable including water spinach (average nitrate content of 0.39%) which are in accordance with the present investigation in respect to leaf nitrate content.

The depicted results on seed yield and its attributes viz. number of flowers/hill, number of capsules/hill and seed yield (Table 2) were significantly reduced due to higher cutting frequency but reverse effects were observed in all these parameters to be higher with greater nitrogen supply upto 150 kg N/ha, thereafter, decreased at 200 kg N/ha (Table 2). Significantly maximum number of flowers/hill (274.3), number of capsules/hill (210.6) and seed yield (1.17 t/ha) were recorded under no cutting (C_0), whereas, all these were lowest at three cutting (C_3). Jana *et al.* (1999) reported that no cutting gave the highest seed yield in palak. The application of 150 kgN/ha (N_3) significantly increase, 30.80%, 55.33% and 36.0% higher number of flowers/hill, number of capsules/hill and seed yield, respectively, as compared to control (N_0). Interaction between cutting frequency and N levels had linear effects with respect to these attributes. The combination of no cutting and 150 kg N/ha (C_0N_3) recorded maximum number of flowers/hill (308.6), number of capsules/hill (249.5) and seed yield (1.32 t/ha) closely followed by C_0N_4, C_1N_3 and C_0N_2, whereas, combination of C_3N_0 produced minimum values all these traits. Datta *et al.* (2008) also reported significant increase in different yield attributing characters and seed yield with an increase in nitrogen levels in coriander which were in good connection with the

Table 1. Effect of cutting frequencies and nitrogen levels on growth, physiological, green yield and its quality parameters of water spinach (pooled).

Treat-ment	Vine length (cm)	No. of nodes / plant	Avg. internodes length (cm)	Leaf area index	Crop growth rate	Chlorophyll content (SPAD 502)	Green yield (t/ha)	Ascorbic acid (mg/100g)	Vitamin A (µg/ 100g)	Nitrate content (mg/kg)
Cutting frequency										
C_0	44.30	22.68	1.68	0.88	5.18	41.49	0.00	40.98	2649.4	369.0
C_1	31.50	18.58	1.67	1.03	5.64	45.54	5.85	43.02	2802.4	401.0
C_2	29.35	16.77	1.64	1.13	6.13	45.10	10.66	42.36	2759.9	395.0
C_3	28.81	16.31	1.61	1.24	6.62	43.37	16.34	41.83	2716.8	388.0
S. Em±	0.19	0.13	0.01	0.01	0.01	0.15	0.08	0.16	10.62	2.40
C.D. at 5%	0.54	0.37	0.04	0.02	0.03	0.44	0.24	0.67	29.81	6.70
Nitrogen level										
N_0	30.95	17.10	1.47	0.81	5.02	39.37	9.27	44.68	2375.3	337.0
N_1	32.51	17.96	1.57	0.92	5.47	42.79	10.12	43.38	2561.8	364.0
N_2	33.90	18.61	1.67	1.14	6.17	44.57	10.96	41.65	2757.8	402.0
N_3	35.42	19.98	1.79	1.29	6.46	45.41	12.57	40.55	3002.8	424.0
N_4	34.67	19.28	1.74	1.20	6.34	47.23	11.84	39.98	2963.0	414.0
S. Em±	0.22	0.15	0.01	0.01	0.01	0.17	0.09	0.18	11.87	2.70
C.D. at 5%	0.78	0.42	0.05	0.02	0.03	0.47	0.27	0.70	33.32	7.50
Interaction (C X N)										
N_0C_0	42.55	21.08	1.48	0.67	4.37	37.79	0.00	43.52	2297.8	330.0
N_0C_1	28.30	17.01	1.50	0.78	4.91	40.78	4.29	45.31	2482.8	343.0
N_0C_2	26.89	15.32	1.48	0.86	5.19	40.10	8.69	45.18	2382.5	340.0
N_0C_3	26.07	14.98	1.45	0.93	5.63	38.82	14.83	44.72	2337.9	335.0
N_1C_0	43.70	22.22	16.2	0.75	4.79	40.27	0.00	42.28	2498.0	352.0
N_1C_1	30.23	17.93	1.59	0.88	5.43	44.36	4.92	44.51	2623.0	376.
N_1C_2	28.30	16.02	1.55	0.97	5.53	44.25	9.87	43.73	2585.4	368.0
N_1C_3	27.83	15.68	1.53	1.07	6.14	42.28	15.57	43.01	254.8	362.0
N_2C_0	44.35	22.76	1.73	0.93	5.48	41.91	0.0	40.42	2703.3	381.0
N_2C_1	32.23	18.18	1.69	1.09	5.68	46.49	5.79	43.04	2799.7	415.0
N_2C_2	29.98	16.61	1.64	1.20	6.52	45.94	10.82	41.95	2774.9	411.0
N_2C_3	29.03	16.19	1.63	1.32	7.01	43.96	16.26	41.18	2753.3	404.0
N_3C_0	45.76	23.86	1.82	1.06	5.71	42.78	0.00	39.67	2893.2	395.0
N_3C_1	33.86	19.83	1.80	1.25	6.17	47.07	7.53	41.37	3072.9	441.0
N_3C_2	31.15	18.48	1.79	1.37	6.78	46.95	12.42	40.75	3045.8	433.0
N_3C_3	30.92	17.75	1.75	1.49	7.19	44.84	17.77	40.48	2999.5	428.0
N_4C_0	45.16	23.51	1.76	.99	5.58	44.72	0.00	39.01	2854.8	388.0
N_4C_1	32.91	19.23	1.76	1.15	6.02	49.00	6.71	40.93	3033.7	432.0
N_4C_2	30.42	17.43	1.74	1.27	6.62	48.29	11.53	40.23	3011.0	422.0
N_4C_3	30.19	16.97	1.69	1.39	7.15	46.93	17.29	39.77	2952.5	413.0
S. Em±	0.43	0.30	0.03	0.01	0.02	0.34	0.19	0.36	23.74	5.40
C.D. at 5%	1.21	0.83	0.07	0.04	0.06	0.95	0.53	1.01	66.65	15.10

Treatments: Nitrogen levels- N_0, 0 kg N/ha; N_1, 50 kg N/ha; N_2, 100 kg N/ha; N_3, 150 kg N/ha; N_4, 200 kg N/ha and cutting frequencies- C_0, no cutting; C_1, one cutting at 45 DAP; C_2, two cuttings at 45 and 65 DAP; C_3, three cuttings at 45, 65 and 85 DAP.

Table 2. Effect of cutting frequencies and nitrogen levels on seed yield and its quality parameters of water spinach (pooled).

Treatment	No. of flowers / hill	No. of capsules / hill	Seed yield (t/ha)	Shelling percentage	1000 seed weight (g)	Germination percentage	Seedling vigour index	Seedling growth rate
Cutting frequency								
C_0	274.3	210.6	1.17	61.14	39.84	82.7 (9.09)	5.24	0.106
C_1	257.3	193.2	0.93	59.72	38.24	79.7 (8.93)	5.00	0.103
C_2	239.3	179.3	0.81	58.97	37.25	77.3 (8.79)	4.86	0.100
C_3	206.8	156.9	0.69	57.61	35.94	75.0 (8.66)	4.63	0.096
S. Em±	0.73	0.77	0.01	0.34	0.25	0.30	0.04	0.001
C.D. at 5%	2.06	2.16	0.01	0.95	0.70	0.85	0.14	0.003
Nitrogen level								
N_0	208.1	140.6	0.75	54.58	35.22	73.7 (8.58)	4.37	0.081
N_1	231.6	169.2	0.83	57.31	36.37	76.2 (8.73)	4.65	0.088
N_2	249.0	191.1	0.92	60.36	38.19	78.9 (8.88)	4.94	0.102
N_3	272.2	218.4	1.02	62.99	40.13	83.5 (9.14)	5.44	0.121
N_4	261.3	205.6	0.98	61.56	39.16	81.2 (9.01)	5.27	0.116
S. Em±	0.82	0.86	0.01	0.38	0.28	0.34	0.05	0.001
C.D. at 5%	2.30	2.42	0.02	1.06	0.78	0.95	0.15	0.004
Interaction (C X N)								
N_0C_0	231.0	159.2	0.98	55.98	37.28	77.2	4.68	0.086
N_0C_1	213.0	144.4	0.82	54.57	35.26	74.7	4.41	0.083
N_0C_2	203.4	135.4	0.67	54.15	34.67	72.1	4.30	0.079
N_0C_3	185.0	123.4	0.56	53.64	33.68	70.7	4.09	0.075
N_1C_0	256.7	19.1	1.13	59.25	38.77	8.0	4.99	0.092
N_1C_1	245.5	177.8	0.85	57.92	36.65	77.3	4.77	0.090
N_1C_2	229.0	165.5	0.74	57.45	35.69	74.9	4.56	0.087
N_1C_3	195.1	143.7	0.62	54.62	34.40	72.5	4.27	0.083
N_2C_0	279.9	217.7	1.20	62.10	40.40	83.2	5.26	0.105
N_2C_1	263.7	200.4	0.94	60.84	38.70	79.7	4.97	0.103
N_2C_2	244.1	185.6	0.83	59.64	37.62	77.7	4.87	0.100
N_2C_3	208.3	160.8	0.70	58.86	36.06	75.2	4.69	0.099
N_3C_0	308.6	249.5	1.32	64.71	41.65	87.9	5.70	0.128
N_3C_1	287.7	229.6	1.09	63.62	40.69	84.5	5.52	0.124
N_3C_2	265.7	211.7	0.88	62.52	39.60	82.4	5.39	0.119
N_3C_3	226.9	183.0	0.82	61.13	38.59	79.3	5.16	0.112
N_4C_0	295.5	236.4	1.24	63.67	41.11	85.4	5.58	0.122
N_4C_1	276.4	214.1	098	61.65	39.88	82.5	5.36	0.119
N_4C_2	254.4	198.5	0.92	61.10	38.69	79.7	5.19	0.114
N_4C_3	218.8	173.5	0.77	59.82	36.97	77.2	4.94	0.110
S. Em±	1.64	1.72	0.01	0.76	0.56	0.68	0.10	0.003
C.D. at 5%	4.60	4.83	0.03	2.12	1.57	1.90	0.27	0.007

Treatments: Nitrogen levels- N_0, 0 kg N/ha; N_1, 50 kg N/ha; N_2, 100 kg N/ha; N_3, 150 kg N/ha; N_4, 200 kg N/ha and cutting frequencies- C_0, no cutting; C_1, one cutting at 45 DAP; C_2, two cuttings at 45 and 65 DAP; C_3, three cuttings at 45, 65 and 85 DAP, *-Figures in the parenthesis indicate square root transformed values.

present investigation.

Significant variations on shelling percentage, 1000 seed weight, germination percentage, seedling vigour index (SVI) and seedling growth rate (Table 2) were noticed due to both the treatments and also their interaction. These quality parameters showed gradual

Table 3. Economics of water spinach green and seed production for different cutting frequencies and nitrogen levels.

Treatment combinations	Total green yield (t/ha)	Total seed yield (t/ha)	Total input (Rs.)	Gross return (Rs.)	Net return (Rs.)	BCR
C_0N_0	-	0.98	46296	107800	61504	2.33
C_0N_1	-	1.13	46841	124300	77459	2.65
C_0N_2	-	1.20	47381	132000	84619	2.79
C_0N_3	-	1.32	47926	145200	97274	3.03
C_0N_4	-	1.24	48466	136400	87934	2.81
C_1N_0	4.29	0.82	47454	108433	60979	2.29
C_1N_1	4.92	0.85	47999	114410	66411	2.38
C_1N_2	5.79	0.94	48539	128008	79469	2.64
C_1N_3	7.53	1.09	49084	151903	102819	3.09
C_1N_4	6.71	0.98	49624	136318	86694	2.75
C_2N_0	8.69	0.67	48612	110633	62021	2.28
C_2N_1	9.87	0.74	49157	123348	74191	2.51
C_2N_2	10.82	0.83	49697	137285	87588	2.76
C_2N_3	12.42	0.88	50242	149585	99343	2.98
C_2N_4	11.53	0.92	50782	150203	99421	2.96
C_3N_0	14.83	0.56	49769	124628	74859	2.50
C_3N_1	15.57	0.62	50314	134373	84059	2.67
C_3N_2	16.26	0.70	50854	146105	95251	2.87
C_3N_3	17.77	0.82	51399	165723	114324	3.22
C_3N_4	17.29	0.77	51939	158183	106244	3.05

Sale price of green produce Rs. 4.00 per kg; seed, Rs. 110.00 per kg.

decrease with higher cutting frequency but reverse results were seen due to N fertilization upto 150 kg N/ ha. Significant variations on shelling percentage, 1000 seed weight, germination percentage, seedling vigour index (SVI) and seedling growth rate (Table 2) were noticed due to both the treatments and also their interaction. These quality parameters showed gradual decrease with higher cutting frequency but reverse results were seen due to N fertilization upto 150 kg N/ ha. Significantly maximum shelling percentage (61.14), 1000 seed weight (39.84 g), germination percentage (82.7), SVI (5.24) and seedling growth rate (0.106 g/plant/day) were recorded in control treatment (C_0) where plants were kept untouched. On the contrary the highest cutting treatment of three cuttings (C_3) recorded minimum of all these parameters. Pandita and Randhawa (1996) reported that cutting of leaves significantly reduced 1000 seed weight and germination percentage in spinach beet. The application of 150 kg N/ha (N_3) gave significantly superior quality seed of water spinach (shelling percentage, 62.99; 1000 seed weight, 40.13 g; germination percentage, 83.5; SVI, 5.44 and seedling growth rate, 0.121 g/plant/day) closely followed by N_4 (200 kg N/ha) and N_2 treatment (100 kg N/ha) and comparatively poor quality seed was recorded in control (N_0). The combination of no cutting with 150 kg N/ha application (C_0N_3) showed best quality water spinach seed with respect to all parameters such as shelling percentage (64.71), 1000 seed weight (41.65 g), germination percentage (87.9), SVI (5.70) and seedling growth rate (0.128 g/plant/day). This was closely followed by C_0N_4, C_1N_3 and C_2N_3 combinations. Improvement in all these seed quality attributes because of the greater supply of nitrogen might be due to the fact that nitrogen helps in protein synthesis and ultimately increase the plumpness of seed. Effect of nitrogen on yield and yield attributes of fenugreek was reported by Sharma (2000). Present findings in this study were in conformity with the results by Sharma (2000). The economics of production for water spinach cultivation under cutting frequencies and nitrogen levels (Table 3) revealed that the gross return and net return of water spinach was influenced to a great extend by combination of cutting frequencies and nitrogen levels. The combination of three cutting with 150 kg N/ha (C_3N_3) recorded maximum gross return (Rs. 1,65,723.00), highest net return (Rs. 1,14,324.00) as well as highest B:C ratio (2.22). Comparatively, higher B:C ratio was also recorded in C_1N_3 (2.09), C_3N_4 (2.05) and C_0N_3 (2.03). The treatment combination C_2N_0 recorded lowest B:C ratio (1.28) amongst all treatments combinations.

Maximum green yield and seed yield of the upland water spinach crop was recorded with the treatment combination of three cuttings with 150 kg N/ha and no cutting with 150 kg N/ha. Considering the economics of the crop cultivation, the treatment combination of three cuttings with 150 kg N/ha that gave 17.77 t/ha green and 0.82 t/ha seed yield was the higher remunerative and may be recommended under terai zone of West Bengal.

Conclusion

It was concluded that on economic point of view, the combination of three cuttings and 150 kg N/ha was noticed to be superior amongst all other remaining treatment combinations with respect to growth, yield, and economic point of view and that may be adopted for its commercial cultivation in medium to upland situation under terai region of West Bengal.

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