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EFFECT OF DIFFERENT LEVELS OF NITROGEN AND SPACING ON THE GROWTH AND YIELD OF STEM AMARANTH (*AMARANTHUS LIVIDIS* L.)

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ABSTRACT

An experiment was conducted to find out the effect of different levels of nitrogen and spacing on the growth and yield of stem amaranth (*Amaranthus lividis* L.) at Horticulture Farm in Sher-e-Bangla Agricultural University (SAU), Dhaka, during March 15, 2004 to May 15, 2004. Three spacing viz. S_1=20cm×20cm, S_2=20cm×30cm and S_3=20cm×40cm and four levels of nitrogen viz. N_0=control, N_1=100kgN/ha, N_2=150kgN/ha, N_3=200kgN/ha were used in this experiment. The yield contributing characters such as plant height, leaf length, average number of leaves per plant, average number of branch per plant, stem girth, branched girth and average plant weight were significantly differed among the three spacing and four levels of nitrogen. The maximum plant height (57.67cm), leaf length (21.71cm), average number of leaves per plant (75.58), average number of branch per plant (13.67), stem girth (1.90cm), branch girth (1.31cm) were found from the widest spacing (S_3) and the highest dose of nitrogen (N_3) and the minimum of all the parameters were found in the closest spacing (S_1) and control nitrogen level (N_0). The highest marketable yield (79.44t/ha) of was found from S_2N_3 and the minimum yield (25.0t/ha) was recorded from S_1N_0.

Key word: Nitrogen, spacing, growth, yield, and stem amaranth

INTRODUCTION

Stem amaranth (branched type) botanically referred to the genus *Amaranthus* is the member of Amaranthaceae family. It was native of India (Nath, 1976). Stem amaranth is one of the important vegetables in tropical countries of South and South-East Asia (Muthukrisnan and Irulappan (1986). It is one of the most important summer vegetables in Bangladesh. Most of the vegetables are grown in winter season and a few vegetables are grown in summer season. There was a statistic that about 80.82 per cent vegetables are grown in *rabi* season and only 19.18 per cent vegetables are grown in *kharif* season (BBS, 2005). Serious vegetables scarcity occur in summer period (May to September) and price become high in this season and consumption of vegetables are low as well. Amaranth grows in summer season and a quick growing vegetable. Therefore, it may contribute to supply vegetable in scarcity period and help to increase in vegetable consumption of the people in Bangladesh. Vegetables consumption in Bangladesh is 70g per capita per day whereas FAO recommendation is 200g per capita per day (Mandal, 1992). Tender leaves and stems of the stem amaranth are used as vegetables. Leaves and stem contains food energy of about 43 calorie per 100g edible portion, which is higher than common vegetables except potato and taro leaf (Chowdhury, 1967). Hence it is quick growing vegetable so nitrogenous fertilizer plays an important role to grow well. Proper nitrogenous fertilizer application is needed for this crop, because farmers of Bangladesh do not use optimum dose of the fertilizer, due to lack of fertilizer recommendation (Hossain, 1996).

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Spacing is another factor that differs in different species, variety, soil fertility, climate, method of planting, incidence of insects and disease, etc. hence, before making any definite recommendation a comprehensive investigation is needed. The work, therefore, undertaken to investigate the optimum dose of nitrogenous fertilizer and optimum spacing for maximum yield of stem amaranth.

MATERIALS AND METHODS

The plants of branched stem amaranth were grown at Horticulture Farm in Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh. The experiment was carried out during summer season (March 15, 2004 to May 15, 2004). Seeds of stem amaranth were collected from the Department of Horticulture and Postharvest Technology, SAU, Dhaka. Seeds were sown on March 15, 2004 in the plot as per treatment and layout. Manure and fertilizers were applied as per recommendation by Rashid (1999). The doses were 15 t/ha cow dung, 250 kg/ha Triple Superphosphate (TSP) and 260 kg/ha Muriate of Potash (MP). The total amount of cow dung was applied during land preparation. Entire amount of Muriate of potash (MP) and Triple Superphosphate (TSP) was applied at the final land preparation. The experiment was laid out in a spilt-plot Randomized Complete Block Design with three replications. The two factors were used in the experiment, viz., three different spacing (S_1=20cm×20cm, S_2=20cm×30cm, and S_3=20cm×40cm) and four levels of nitrogen (N_0=control, N_1=100kgN/ha, N_2=150kgN/ha, and N_3=200kgN/ha). The treatments combination were S_1N_0 (20cm×20cm and control N), S_1N_1 (20cm×20cm and 100kgN/ha), S_1N_2 (20cm×20cm and 150kgN/ha), S_1N_3 (20cm×20cm and 200KgN/ha), S_2N_0 (20cm×30cm and control N), S_2N_1 (20cm×30cm and 100kgN/ha), S_2N_2 (20cm×30cm and 150kgN/ha), S_2N_3 (20cm×30cm and 200kgN/ha), S_3N_0 (20cm×40cm and Control N), S_3N_1 (20cm×40cm and 100kgN/ha), S_3N_2 (20cm×40cm and 150gkN/ha) and S_3N_3 (20cm×40cm and 200kgN/ha). Data were collected from the ten randomly selected plants for each treatment combination and replication, such as, plant height (cm), leaf length (cm), average number of leaves per plant, average number of branches per plant, stem girth (cm), average branch girth (cm), average plant weight (g) and marketable yield (t/ha). The means were separated by Duncan's Multiple Range Test (DMRT).

RESULT AND DISCUSSION

Plant height

The effect of spacing on plant was statistically significant, because the plant height increased with the wider spacing than the closer spacing (Table 1). The tallest plant (57.67cm) was found from the widest spacing (S_3) which was followed by others and the shortest plant (41.83cm) was found from the closed spacing (S_1). This might be caused mainly by the increased in number of plants per unit area, which might compete for light, temperature and fertilizer nutrients. Jhon (1992) and Diaz-Ortega *et al.* (2004) reported the same trend of the present study.
Marked variation was noticed among the different levels of nitrogen in respect of plant height. The tallest plant (65.44cm) was found from the highest dose of nitrogen (N_3) which was followed by others and the shortest plant (38.0cm) was found in the control dose of nitrogen (N_0). It was revealed that the plant height increased with the increased in nitrogen dose, this is might be caused that nitrogen stimulates vegetative growth. This result is similar to that of other scientists like Subhan (1989); Rahore *et al.* (2004); Keshar, *et al.* (1981); Ramchandra (1978); Purushothman (1978) and Mathai (1978).
There had a remarkable variation of plant height among the twelve treatment combinations (Table 3). The tallest plant (74.0cm) was found from the widest spacing and the highest dose of nitrogen

(S_3N_3) and the shortest plant (30.67cm) was found from the lowest spacing and control nitrogen (S_1N_0) which was statistically similar to that of S_1N_1. The second highest plant was recorded from S_2N_3.

Table 01. Effect of three different spacing on yield and yield contributing characters of stem amaranth

Treatments	Plant height (cm)	Leaf length (cm)	No. of leaf per plant	No. of branch per plant	Stem girth (cm)	Branch girth (cm)	Average plant weight (g)
S_1	41.83 c	7.56 c	19.83 c	6.42 c	1.28 c	0.65 c	160.0 c
S_2	52.58 b	14.93 b	32.17 b	10.50 b	1.53 b	1.01 b	321.3 b
S_3	57.67 a	21.71 a	75.58 a	13.67 a	1.90 a	1.31 a	375.0 a
%CV	5.78%	10.38%	7.29%	12.06%	5.27%	9.47%	9.21%
Level of significance	0.05	0.05	0.05	0.05	0.05	0.05	0.05

S_1=20cm×20cm, S_2=30cm×30cm and S_3=40cm×40cm
Means in the column followed by different letters differed significantly by DMRT at 5% level of significance

Leaf length

The leaf length of stem amaranth was statistically significant due to the effect of different spacing (Table 1). The longest leaf length(21.71cm) was found from the widest spacing (S_3) which was followed by others and the shortest leaf length (7.56cm) was found from the closed spacing (S_1). It was revealed that the leaf length was increased with the increased in the spacing and it might be caused by the increased in number of plant per unit area in the widest spacing. Jhon (1992) and Diaz-Ortega *et al.* (2004) reported the same trend of the present study.
Significant variation was found among the four levels of nitrogen doses in respect of leaf length (Table 2). The longest leaf length (20.19cm) was found from the highest dose of nitrogen (N_3) which was followed by others and the shortest leaf length (9.04cm) was found in the control treatment (N_0). It was revealed that the leaf length was increased with the increased in the nitrogen dose and it might be caused by the maximum dose of nitrogen helped to produce more leaf growth. This result is similar to that of other scientists like Subhan (1989); Rahore *et al.* (2004); Keshar, *et al.* (1981); Ramchandra (1978); Purushothman (1978) and Mathai (1978).
There had a significant variation of leaf length among twelve treatment combinations (Table 3). The largest leaf length (28.30cm) was found from the widest spacing and the highest dose of nitrogen (S_3N_3) and the shortest leaf length (5.70cm) was found from the minimum spacing and control nitrogen (S_1N_0) which was statistically similar to that of S_1N_1, S_1N_2 and S_2N_0. The second largest leaf (23.67cm) was found from S_3N_2 which was statistically similar to that of S_3N_1 and S_2N_3.

Average number of leaves per plant

Significant variation was observed among the spacing in respect of average number of leaf per plant (Table 1). It had been observed that the maximum average number of leaves per plant (75.58) was produced by the plant under the widest spacing (S_3) and the minimum average number of leaves per plant (19.83) was produced under the closed spacing (S_1). It was revealed that with the increase of the spacing helped to produce maximum number of leaf per plant and it

might be caused that more competition was occurred in the closest spacing than the widest spacing. Jhon (1992) and Diaz-Ortega *et al.* (2004) reported the same trend of the result.

Table 02. Effect of different levels of nitrogen on yield and yield contributing characters of stem amaranth

Treatments	Plant height (cm)	Leaf length (cm)	No. of leaf per plant	No. of branch per plant	Stem girth (cm)	Branch girth (cm)	Average plant weight (g)
N_0	38.00 d	9.04 c	21.33 d	6.44 c	1.18 d	0.60 d	183.9 d
N_1	44.89 c	13.98 b	41.89 c	9.56 b	1.44 c	0.90 c	246.7 c
N_2	54.44 b	15.72 b	49.44 b	11.11 b	1.72 b	1.12 b	304.4 b
N_3	65.44 a	20.19 a	57.44 a	13.67 a	1.94 a	1.33 a	406.7 a
%CV	5.78%	10.38%	7.29%	12.06%	5.27%	9.47%	9.21%
Level of significance	0.05	0.05	0.05	0.05	0.05	0.05	0.05

N_0=control, N_1=100kgN/ha, N_2=150kgN/ha, N_3=200kgN/ha

Means in the column followed by different letters differed significantly by DMRT at 5% level of significance

The average number of leaves per plant increased significantly with the increased in the nitrogen application (Table 2). The maximum average number of leaves per plant (57.44) was recorded from the plant under the application of the highest dose of nitrogen (N_3) and the minimum (21.33) was recorded from plant under the control treatment (N_0). It was revealed that the average number of leaves per plant was increased in the highest nitrogen dose which might be caused by the nitrogen helped to vegetative growth of the plant. This result is similar to that of other scientist like Subhan (1989); Rahore *et al.* (2004); Keshar, *et al.* (1981); Ramchandra (1978); Purushothman (1978) and Mathai (1978).
The average number of leaves per plant differed significantly among the twelve treatment combinations (Table 3). The maximum average number of leaves per plant (99.33) was found from the widest spacing and the highest nitrogen application (S_3N_3) which was followed by others and the minimum (11.0) was observed in the closed spacing and the control nitrogen treatment (S_1N_0). It was revealed that the number of leaves per plant was increased with the increased in both spacing and nitrogen application and it might be caused that it was leafy vegetable and production of leaves was influenced by the nitrogen application and as well as inter plant competition was lower compare to the widest spacing.

Average number of branches per plant

It had statistically significant difference among the different spacing in respect of average number of branches per plant (Table 1). The highest average number of branches per plant (13.67) was produced by the plant under the widest spacing (S_3) and the minimum (6.42) was recorded from plant under the closest spacing (S_1). This result revealed that the average number of branches per plant decreased with the closer spacing. This might be due to increase of population, competition for space, air, water, and food which resulted less number of branches per plant. Jhon (1992) and Diaz-Ortega *et al.* (2004) reported the similar trend of the result.

Table 3. Combined effect of spacing and nitrogen on yield and yield contributing characters of stem amaranth

Treatments	Plant height (cm)	Leaf length (cm)	No. of leaf per plant	No. of branch per plant	Stem girth (cm)	Branch girth (cm)	Average plant weight (g)
S_1N_0	30.67 h	5.70 e	11.00 j	4.00 h	0.90 i	0.47 h	100.0 h
S_1N_1	34.33 h	7.33 e	17.00 i	6.33 g	1.17 h	0.57 gh	140.0 gh
S_1N_2	47.67 ef	6.16 e	23.33 gh	7.00 g	1.47 fg	0.67 fg	180.0 fg
S_1N_3	54.67 d	11.03 d	28.00 fg	8.33 fg	1.60 ef	0.90 e	220.0 f
S_2N_0	40.00 g	8.30 e	18.67 hi	7.00 g	1.17 h	0.63 gh	175.0 fg
S_2N_1	48.00 ef	12.87 d	30.00 ef	10.00 ef	1.40 g	0.83 ef	290.0 e
S_2N_2	54.67 d	17.33 c	35.00 e	11.00 de	1.67 de	1.17 d	343.3 d
S_2N_3	67.67 b	21.23 b	45.00 d	14.00 bc	1.90 bc	1.40 bc	476.7 b
S_3N_0	43.33 fg	13.13 d	34.33 e	8.333 fg	1.47 fg	0.70 fg	276.7 e
S_3N_1	52.33 de	21.73 b	78.67 c	12.33 cd	1.77 cd	1.30 cd	310.0 de
S_3N_2	61.00 c	23.67 b	90.00 b	15.33 b	2.03 b	1.53 b	390.0 c
S_3N_3	74.00 a	28.30 a	99.33 a	18.67 a	2.33 a	1.70 a	523.3 a
%CV	5.78%	10.38%	7.29%	12.06%	5.27%	9.47%	9.21%
Level of significance	0.05	0.05	0.05	0.05	0.05	0.05	0.05

S_1N_0=20cm×20cm and control N, S_1N_1=20cm×20cm and 100kgN/ha, S_1N_2=20cm×20cm and 150kgN/ha, S_1N_3=20cm×20cm and 200KgN/ha, S_2N_0=20cm×30cm and control N, S_2N_1=20cm×30cm and 100kgN/ha, S_2N_2=20cm×30cm and 150kgN/ha, S_2N_3=20cm×30cm and 200kgN/ha, S_3N_0=20cm×40cm and Control N, S_3N_1=20cm×40cm and 100kgN/ha, S_3N_2=20cm×40cm and 150gkN/ha and S_3N_3=20cm×40cm and 200kgN/ha

Means in the column followed by different letters differed significantly by DMRT at 5% level of significance

There had a remarkable variation of average number of branches per plant due to the different doses of nitrogen application (Table 2). The maximum average number of branches per plant (13.67) was produced by the plant under the highest nitrogen dose (N_3) and the minimum (6.44) was recorded from the plant under the control treatment (N_0). It was revealed that the number of branches per plant was increased with the increased in the application of nitrogen. This might be due to nitrogen fertilizer enhance the initiation of branches and more nitrogen helped to more production of branches. This result is similar to that of other scientist like Subhan (1989); Rahore *et al.* (2004); Keshar, *et al.* (1981); Ramchandra (1978); Purushothman (1978) and Mathai (1978). Statistical variation was found among the twelve treatments combination in respect of average number of branches per plant (Table 3). The maximum average number of branches per plant (18.67) was observed in the widest spacing and the highest nitrogen application (S_3N_3) which was followed by others and the minimum (4.0) was recoded from the plant under the treatment combination S_1N_0. It was revealed that the average number of branches of per plant was increased with the increase in spacing and increased in application of nitrogen fertilizer.

Stem girth

There was significant variation was found among the spacing in respect of stem girth (Table 1). The highest stem girth (1.90cm) was found from the widest spacing (S_3) which was followed by other and the minimum (1.28cm) was found from the closest spacing (S_1). It was revealed that with the increased of spacing the increased in stem girth. This might be due to the effect of competition of population for air, water, temperature and food. Jhon (1992) and Diaz-Ortega *et al.* (2004) reported the similar trend of the result.

There had a remarkable variation of stem girth as affected by different levels of nitrogen (Table 2). The maximum stem girth (1.94cm) was recorded from the plant under the highest does of nitrogen application (N_3) and the lowest (1.18cm) was recorded from the plant under the control treatment (N_0). This result showed that the stem girth increased with the increased in nitrogen application. This might be caused that nitrogen enhanced vegetative growth and more nitrogen helped more vegetative growth. This result is similar to that of other scientist like Subhan (1989); Rahore *et al.* (2004); Keshar, *et al.* (1981); Ramchandra (1978); Purushothman (1978) and Mathai (1978).

A combined effect also showed significant variation on stem girth among the treatments combination (Table 3). The maximum stem girth (2.33cm) was observed in the widest spacing and the highest nitrogen application (S_3N_3) and the minimum (0.90cm) was found from S_1N_0 which was not statistically similar with S_2N_0.

Average branch girth

Significant variation was found among the three spacing in respect of average branch girth (Table 1). The highest average branch girth (1.31cm) was observed in the widest spacing (S_3) and the lowest (0.65cm) were recorded from the closest spacing (S_1). It was revealed that with the increased of spacing the increased in average branch girth. This might be due to the effect of competition of population for air, water, temperature and food. Jhon (1992) and Diaz-Ortega *et al.* (2004) reported the same trend of the result.

The four levels of nitrogen varied significantly in respect of average branch girth (Table 2). The result revealed that the branch girth increased with the increased in the application of nitrogen. The maximum branch girth (1.33cm) was found in the highest level of nitrogen (N_3) which was followed by others and the minimum (0.60cm) was found in the control treatment (N_0). It might be caused that nitrogen enhanced the vegetative growth of plant and branch girth as well. This result is similar to that of other scientist like Subhan (1989); Rahore *et al.*. (2004); Keshar, *et al.* (1981); Ramchandra (1978); Purushothman (1978) and Mathai (1978).

Similar to stem girth, the branch girth varied significantly among the twelve treatments combination (Table 3). The maximum average branch girth (1.70cm) was found from the widest spacing and the highest nitrogen application (S_3N_3) and the minimum (0.47cm) was found from S_1N_0 which was statistically similar to that of S_1N_1, and S_2N_0.

Average plant weight

The different spacing varied significantly in respect of average plant weight (Table 1). The plant perfromed the maximum average weight (375.0g) in the widest spacing (S_3) and the minimum (160.0g) from the closest spacing (S_1). This result showed that the average plant weight was found increasing with the wider spacing. This is due to the less competition for air, water, light and food in the wider spacing than the closest spacing. Jhon (1992) and Diaz-Ortega *et al.* (2004) reported the same trend of the result.

Statistical significant variation was found among the different levels of nitrogen application in respect of average plant weight (Table 2). The maximum average plant weight (406.7g) was found under the highest nitrogen level (N_3) and the minimum (183.9g) from the control Treatment (N_0). It was revealed that the average plant weight is increasing in the higher levels of nitrogen application. This might be caused that nitrogen enhanced the vegetative growth of stem, leaf and branch which ultimately enhanced average plant weight. This result is similar to that of other scientist like Subhan (1989); Rahore *et al.* (2004); Keshar, *et al.* (1981); Ramchandra (1978); Purushothman (1978) and Mathai (1978).

It had significant variation among the treatment combination in respect of average plant weight (Table 3). The maximum average plant weight (523.3g) was found in S_3N_3 which was followed by others and the minimum (100.0g) was found from S_1N_0 which was statistically similar to that of S_1N_1. The second highest average plant weight (476.7g) was found from S_2N_3.

Marketable yield (ha)

The effect of spacing on marketable yield was statistically significant (Figure 1). The maximum marketable yield (53.53t/ha) was observed in S_2 which was statistically similar to that of S_3 and the minimum marketable yield (40t/ha) was found from S_1. most of yield contributing characters were highest in S_3 but yield was maximum in S_2, because number of plants per unit area is higher in S_2 than S_3 and minimum marketable yield was minimum in S_1 although the per unit area population is but due low spacing some plants were per plot were weak that reduced the marketable quality of stem amaranth. Jhon (1992) stated that the maximum marketable yield was found in the spacing of 20cm×30cm which was similar to the present investigation.

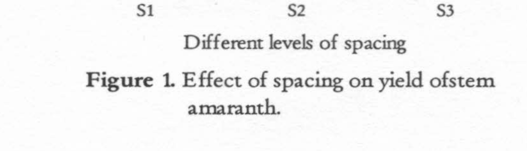

Figure 1. Effect of spacing on yield ofstem amaranth.

There had a remarkable variation of marketable yield as affected by different levels of nitrogen (Figure 2). The maximum marketable yield (66.48t/ha) was recorded from the plant under the highest does of nitrogen application (N_3) which was followed by others and the lowest (29.58t/ha) was recorded from the plant under the control treatment (N_0).

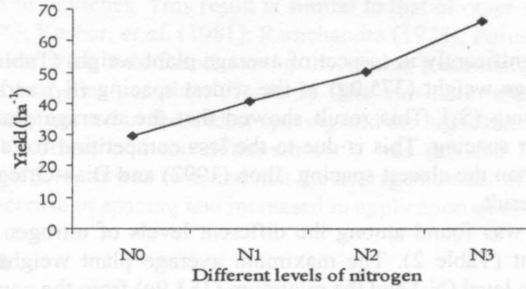

Figure 2. Effect of different levels of niotrogen on yiled of stem amranth.

This result revealed that the marketable yield increased with the increased in nitrogen application. This might be caused that nitrogen stimulates the vegetative growth and more nitrogen helps more vegetative growth resulting the highest marketable yield in N_3. This result is similar to that of Jhon (1992), Keshar, *et al.* (1981); Ramchandra (1978) and Purushothman (1978). Marked variation was noticed in respect of marketable yield among the treatments combination (Figure 3).

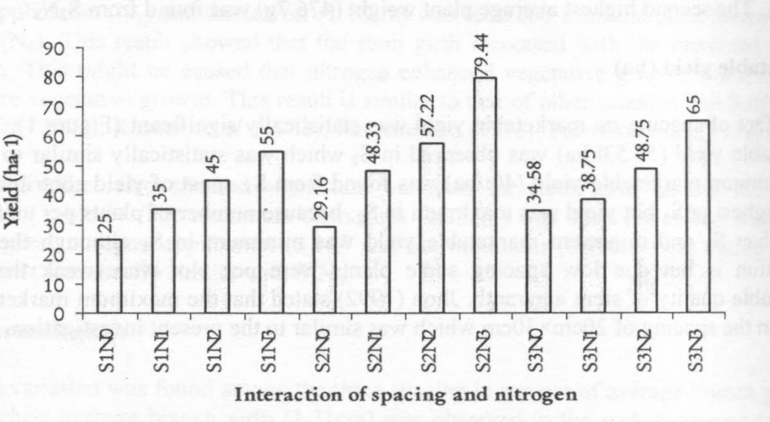

Figure 3. Effect of spacing and nitrogen on yield of stem amaranth.

The maximum marketable yield (79.44t/ha) was found in S_2N_3 and the minimum (25.0t/ha) was found from S_1N_0 which was statistically similar to that of S_2N_0.

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