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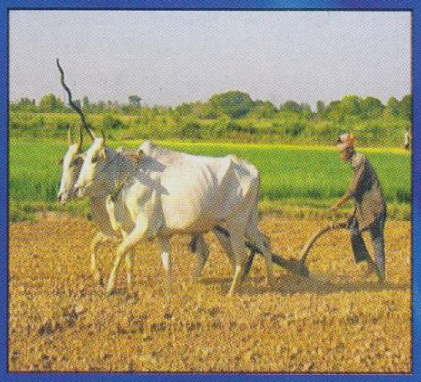

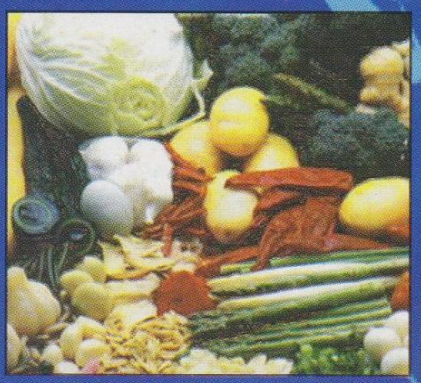

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EFFECT OF NITROGENOUS FERTILIZER AND SPACING ON STEVIA LEAF YIELD AS FIELD CROP

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Abstract

The experiment was carried out at the Agronomy Field Laboratory of BAU, Mymensingh the period from March to July 2008 to study the yield variation of Stevia (*Stevia reba* under different levels of fertilizer and spacing. Five levels of fertilizer viz. no fertiliz decomposed cow dung @ 10 ton/ha, 200 kg urea/ha, 230 kg urea/ha, 260 kg urea/ha a spacing viz. 50 cm × 40 cm, 40 cm × 40 cm were used as treatments. The experiment v out in a split plot design with three replications. The results showed that different le fertilizer and spacing exerted significant influence on different yield components like t weight plant^{-1}, leaf dry weight plant^{-1}, leaf dry weight plot^{-1} and ha^{-1}. In most cases co (F_2) gave best leaf yield which was sometimes statistically identical with F_3 (200kg urea 25 days interval). The plot receiving highest dose of fertilizer (F_5) performed worst toxicity of fertilizer. Out of two spacing wider spacing (S_1=50 cm × 40 cm) yielded bet closer spacing (S_2=40 cm × 40 cm) but when yield plot^{-1} and ha^{-1} was calculated that spacing produced higher yield contributing characters and yield. Total leaf yie significantly influenced by combined effect of fertilizer dose and spacing at 0.1% l probability. The highest total leaf dry weight per ha was 1033.56 kg per ha and low 340.04 kg per ha obtained from F_2S_2 and F_5S_2 respectively. Four harvesting was done at intervals during the experimental period. First harvesting produced average yield with the of time yield increased distinctly.

Key words: Stevia, fertilizers, spacing, leaf yield, field crop

Introduction

Stevia is a calorie free natural sweetener, botanically known as *Stevia rebaudiana* Bert. The sweetness in leaves due to presence of a sweetening agent stevioside what is 300 times sweeter than sucrose (Geuns, 2003). Stevia appears to be used as a substituting of saccharine (Lewis, 1992). Stevia is an antibacterial, anticandidal, antifungal, antiviral, cardiotonic (tones, balances, strengthens the heart), diuretic, hypoglycemic, vasodilator, sweetener, hypoglycemic, hypotensive (lowers blood pressure), obesity, heartburn cavities, and depression activity (Frederico, *et al.,* 1996). It is used in confectionary, soft drinks, beverages sector for culinary purpose (Geuns, 2003). *Stevia rebaudiana* Bert. is one of 154 members of the genus Stevia and one of only two that produce sweet steviol glycosides (Robinson 1930, Soejarto *et al.* 1982 and Soejarto *et al.* 1983). Diabetic is a serious problem throughout the world. In our country about 5.9% of total population (aged may be from 20-69 years) are suffering from this disease. But the most alarming message is, numbers of children aged from 8 to 20 years old are also suffering from this serious disease. Under this situation stevia can help these large number of people and in addition to this stevia can contribute to our national economy.

The farming system of Bangladesh is mainly rice based, but the weather of our country is highly favourable to cultivate different types of crops. It is difficult to change the farming pattern of our country. But through changing the farming pattern we can not only increase our farmer's income but also we can gain food sufficiency. Stevia is a new crop in Bangladesh. It has been introduced by Bangladesh Sugarcane Research Institute (BSRI) in 2001 from Thailand. Stevia was least affected by biotic and abiotic factors like high rainfall, frost, and infestation by insects and diseases. Different levels of fertilizer and spacing exerted significant influence on leaf yield of stevia. Higher content of stevioside was found in the regenerated crop in January, during the second year of plant growth. With improved management practices, there is further scope for improvement in stevioside content ((Megeji et al. 2005). In Bangladesh condition actually we know nothing about cultivation of stevia as field condition. No any Agronomic research was carried out to know the recommendation of fertilizer dose, proper growing season, spacing, soil condition etc. To find out the answer of the above mentioned questions, enormous research will be needed for this crop.

Materials and Methods

A field experiment was conducted at the Agronomy Field Laboratory of Bangladesh Institute of Nuclear Agriculture, Mymensingh during the period from March to July 2008 to study the yield variation of Stevia (*Stevia rebaudiana*) under different levels of fertilizer and spacing. The experimental site was located at 24°77' N latitude and 90°52' E longitude at

an elevation of 18 m above the sea level. The experimental area was characterized by non-calcareous dark grey floodplain soil belonging to the Sonatola Soil Series under the Old Brahmaputra Floodplain (AEZ-9) (UNDP and FAO 1988). Soil of the experimental site was more or less neutral with a pH value of 6.8, low in organic matter content and fertility level. The land type was medium high with silty loam texture. The experimental site was under the subtropical climate, which was characterized by high temperature, high humidity and heavy precipitation with occasional gusty winds during April to September and Scanty rainfall associated with moderately low temperature from October to March. Five levels of fertilizer viz. $F_1 = 0$, $F_2 = 10$ ton/ha, $F_3 = 200$ kg urea/ha, $F_4 = 230$ kg urea/ha, $F_5 = 260$ kg urea/ha and two spacing viz. 50 cm × 40 cm, 40 cm × 40 cm were used as treatments. The experiment was laid out in a split plot design with three replications. Spacings were allocated in the main plots and application of Nitrogen was allocated in the respective sub plots. The plot size was 4 m^2 (2 m x 2 m). The replications were 1m apart and the plots within the replications were 0.5 m apart from each other. The total number of plots was 30. For sampling 5 plants/plot were prefixed for data collection at 30, 55, 80 and 105 DAT. Harvested plants/plot were firstly dried in normal temperature and finally in the oven. Data on yield and yield attributes were recorded from finally harvested whole plants of each 4 m^2 plot. Data were recorded from the parameters viz., total dry weight $plant^{-1}$, leaf dry weight $plant^{-1}$, leaf dry weight $plot^{-1}$ and ha^{-1}. The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package MSTAT-C. The mean difference among the treatments was adjudged with Duncun's Multiple Range Test (Gomez and Gomez, 1984).

Result and Discussion

Effect of Spacing

Effect on Leaf Dry Weight per Plant

Only the leaf dry weight per plant at 55 DAT varied significantly at 5 % level of probability and S_1 (3.74) produce more dry weight per plant compared to S_2 (3.09) (Table 1).

Effect on Leaf Dry Weight per Plot

Spacing used is the experiment has significant effect on leaf dry weight per plot at 5 % level of probability. 38.33 g leaf dry weight was obtained from S_2 which was significantly higher than S_1 (33.21 g) at 30 DAT. Though leaf dry weight per plant was higher in S_1 but leaf dry weight per plot is lower compared to S_2 due to accommodation of more plants in S_2 per unit area as well as plot. Leaf dry weight per plot at 80 DAT was significantly varied at different spacing at 1 % level of probability. S_2 produce significantly higher (102.95 g) amount of total dry weight per plot compared to S_2 (85.19 g) (Table 1).

Effect on Leaf Dry Weight per Hectare

Leaf dry weight per ha was significantly affected at 5 % level of probability by spacing at 30 DAT. S_2 gave 95.65 kg leaf dry weight per ha which was significantly higher than 82.99 kg obtained from S_1. Spacing affect leaf dry weight per ha at 80 DAT at 1 % level of probability. S_2 gave 257.40 kg leaf dry weight per ha where as S_1 gave 213.10 kg. From this result it could be concluded that the plant may be plant more densely (Table 1).

Total Leaf Dry Weight per Hectare

Total leaf dry weight per ha was significantly affected by spacing at 0.1 % level of probability. Maximum amount of total leaf dry weight per ha (650.9 kg) was from S_2 (40 cm × 40 cm) and minimum (572.6 kg) from S_1 (50 cm × 50 cm) (Table 1).

Effect of Different Levels of Fertilizers

Effect on Total Dry Weight per Plant

Total dry weight per plant at 55 DAT was significantly varied at different levels of fertilizers at 5% level of probability. Maximum total dry weight per plant (8.3 g) was obtained from cow dung 10t ha^{-1}. The minimum amount of total dry weight per plant (3.13 g) was obtained from F5. Total dry weight per plant at 80 DAT was significantly varied at different levels of fertilizers at 0.1% level of probability. Maximum total dry weight per plant (8.680 g) was obtained from cow dung which was statistically similar with F_3. The minimum amount of total dry weight per plant (3.99 g) was obtained from F_5 (Table 2).

Effect on Leaf Dry Weight per Plant

Leaf dry weight per plant at 30 DAT was significantly varied at different levels of fertilizers at 1% level of probability. Maximum leaf dry weight per plant (2.09 g) was obtained from cow dung which was statistically similar with F_3. The minimum amount of leaf dry weight per plant (1.20 g) was obtained from F5. Different levels of fertilizers have significant effect on leaf dry weight per plant at 55 DAT at 0.1% level of probability. Maximum leaf dry weight per plant (5.87 g) was obtained from cow dung. The minimum amount of leaf dry weight per plant (1.79 g) was obtained from F_5. Leaf dry weight per plant at 80 DAT was significantly varied at different levels of fertilizers at 0.1% level of probability. Maximum leaf dry weight per plant (6.73 g) was obtained from cow dung which was statistically similar with F_3. The minimum amount of leaf dry weight per plant (2.35 g) was obtained from F_5 (Table 2).

Effect on Leaf Dry Weight per hectare
Maximum amount of leaf dry weight per ha was calculated by multiplying the yield per plot Leaf dry weight per ha was affected by different levels of fertilizers at 1 % level of probability. Maximum amount leaf dry weight per ha (117.2 kg) was obtained from plots received cow dung which was statistically similar with F_3. Minimum amount of dry weight per plot (67.58 kg) was obtained from F_5. Dry weight per ha showed significant variation at 0.1 % level of probability. Maximum amount of dry weight per plot (331.8 kg) was obtained from F_2 and minimum (91.18 kg) was from F_5. Leaf dry weight per ha was significantly varied from different levels of fertilizers at 0.1 % level of probability. Maximum amount of leaf dry weight per ha (381.8 kg) was obtained from cow dung and minimum (129.5 kg) was produced from F_5 (Table 2).

Effect on Total Leaf Dry Weight per hectare
Total leaf dry weight per ha is the amount obtained from the summation of leaf dry weight per ha of all periodic harvesting (four harvesting). Maximum amount of total leaf dry per ha (928.4 kg) was obtained from F_2 (cow dung) and minimum was from F_5 (384.2 kg) (Table 2).

Effect of Interaction of Fertilizer and Spacing
Effect on Total Dry Weight per Plant
The total dry weight per plant at 55 DAT was significantly influenced by the combined effect of fertilizer and spacing at 5% level of probability. Maximum amount of total dry weight per plant (9.50 g) from F_2S_2 and minimum (2.24 g) from F_5S_2. The total dry weight per plant at 80 DAT was significantly influenced by the combined effect of fertilizer and spacing at 5% level of probability. Maximum amount of total dry weight per plant (9.49 g) from F_2S_2 and minimum (2.66 g) from F_5S_2 (Table 3).

Effect on Leaf Dry Weight per Plant
The combined effect of fertilizer and spacing has significant influence on the leaf dry weight per plant at 55 DAT at 5% level of probability. Maximum amount of leaf dry weight per plant (6.31 g) from F_2S_2 which was statistically similar with F_2S_1 and minimum (1.10 g) from F_5S_2. The combined effect of fertilizer and spacing has significant influence on the leaf dry weight per plant at 80 DAT at 1% level of probability. Maximum amount of leaf dry weight per plant (6.8 g) from F_2S_2 which was statistically similar with F_2S_1 and minimum (1.76 g) from F_5S_2 (Table 3).

Effect on Leaf Dry Weight per Plot
The interaction effect of fertilizer and spacing influenced leaf dry weight per plot at 55 DAT at 1 % level of probability. The highest leaf dry weight per plot (155.70 g) was obtained from F_2S_2 and lowest (24.10 g) from F_5S_2. Fertilizer and spacing significantly affect the leaf dry weight per plot at 80 DAT at 1% level of probability. There was a great deal of variation of leaf dry weight per plot at 80 DAT. The highest and lowest leaf dry weight per plot was obtained 171.0 g and 43.90 g from F_2S_2 and F_5S_2 respectively (Table 3).

Effect on Leaf Dry Weight per Hectare
Leaf dry weight per ha at 55 DAT was significantly influenced by the combined effect of fertilizer and spacing at 1% level of probability. The maximum and minimum leaf dry weight per ha was 390.0 kg and 60.37 kg obtained from F_2S_2 and F_5S_2 respectively. Leaf dry weight per ha at 80 DAT was significantly affected by combined effect of fertilizer and spacing at 1% level of probability. The highest yield (428.0 kg) was obtained from F_2S_2 and lowest (109.3 kg) from F_5S_2 (Table 3).

Total Leaf Dry Weight per Hectare
Total leaf dry weight per ha was the summation of three harvesting (30, 55 and 80). Total leaf yield was significantly influenced by combined effect of fertilizer dose and spacing at 0.1% level of probability. The highest total leaf dry weight per ha was 1033.56 kg per ha and lowest was 340.04 kg per ha obtained from F_2S_2 and F_5S_2 respectively (Table 3).
From the above result discussion it was showed that the total leaf yield was significantly influenced by combined effect of fertilizer dose and spacing at 0.1% level of probability. The highest total leaf dry weight per ha was 1033.56 kg per ha and lowest was 340.04 kg per ha obtained from F_2S_2 and F_5S_2 respectively. In the study four harvesting was done at 25 days intervals during the experimental period. For all maximum cases 55 and 80 DAT took place comparatively better results. First harvesting produced average yield with the passes of time yield increased distinctly.

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Table 1. Effect of spacing on yield of stevia

Spacing	Total dry wt			Leaf dry wt			Leaf Dry Weight /plot			Leaf Dry Weight/ ha			Total Leaf Dry Wt. / ha (kg)
	30 DAT	55 DAT	80 DAT	30 DAT	55 DAT	80 DAT	30 DAT	55 DAT	80 DAT	30 DAT	55 DAT	80 DAT	
S_1	2.78	6.13	6.87	1.62	3.74 a	4.19	33.21	73.87	85.19 b	82.99	184.53	213.10 b	572.6 b
S_2	2.60	5.34	6.29	1.53	3.09 b	4.21	38.33	78.47	102.95 a	95.65	196.14	257.40 a	650.9 a
Level of Significance	NS	NS	NS	NS	*	NS	*	NS	**	*	NS	**	***
CV(%)	11.33	18.51	16.30	13.73	18.66	11.67	13.57	14.07	13.82	13.50	14.12	13.83	7.15

*, ** and *** indicates significant at 5%, 1% and 0.1% level of probability respectively
Common letter(s) in the same column does not differ significantly, S1: Spacing1- 50cm X 40cm and S2: Spacing2- 40cm X 40cm

Table: 2 Effect of fertilizer on the leaf yield of stevia

Fertilizer levels	Total dry wt per plant			Leaf dry wt per plant			Leaf Dry Weight /plot			Leaf Dry Weight/ ha			Total Leaf Dry Wt. / ha (kg)
	30 DAT	55 DAT	80 DAT	30 DAT	55 DAT	80 DAT	30 DAT	55 DAT	80 DAT	30 DAT	55 DAT	80 DAT	
F_1	2.18	6.81 ab	7.14 ab	1.42 bc	2.96 c	3.02 b	31.87 b	67.67 c	69.57 c	79.62 b	168.8 c	173.7 c	507.7 c
F_2	3.06	8.3 a	8.680 a	2.09 a	5.87 a	6.73 a	47.05 a	132.6 a	152.2 a	117.2 a	331.8 a	381 a	928.4 a
F_3	3.01	5.94 bc	7.7 a	1.81 ab	4.33 b	6.09 a	42.37 a	95.92b	133.2 b	105.6 a	239.8 b	333.5 b	769.3b
F_4	2.82	4.52 cd	5.39 bc	1.36 c	2.1 d	2.81 b	30.58 b	48.15 d	63.52 c	76.53 b	120 d	158.6 c	469.1 c
F_5	2.39	3.13 d	3.99 c	1.2 c	1.79 d	2.35 b	26.98 b	36.55 e	51.92 c	67.58 b	91.18 e	129.5 c	384.2 d
Level of Significance	NS	**	***	**	***	***	**	***	***	**	***	***	***
CV(%)	11.33	18.51	16.30	13.73	18.66	11.67	13.57	14.07	13.82	13.50	14.12	13.83	7.15

*, ** and *** indicates significant at 5%, 1% and 0.1% level of probability respectively
Common letter(s) in the same column does not differ significantly
F1 : No fertilizer
F2 : 4 kg well decomposed cow dung per plot (4 m^2) per two harvest @ 10 ton/ha (Each harvesting was done at 25 days interval)
F3 : 80 g urea per plot (4 m^2) after each harvest at 25 days interval @ 200 kg urea/ha
F4 : 92 g urea per plot (4 m^2) after each harvest at 25 days interval @ 230 kg urea/ha
F5: 104 g urea per plot (4 m^2) after each harvest at 25 days interval @ 260 kg urea/ha

Table 3. Combined effect of fertilizer dose and spacing on the yield of stevia leaf

Treat-ment	Total dry weight				Leaf dry weight				Leaf dry weight/plot				Leaf dry weight/ha				Total leaf dry wt. /ha (kg)
	30 DAT	55 DAT	80 DAT	105 DAT	30 DAT	55 DAT	80 DAT	105 DAT	30 DAT	55 DAT	80 DAT	105 DAT	30 DAT	55 DAT	80 DAT	105 DAT	
F_1S_1	2.26	7.59ab	8.20a	2.06	1.59	3.44b	3.55c	1.30	31.83	74.10cd	74.67d	26.63	79.63	185.0cd	186.3d	66.63	518.5d
F_1S_2	2.11	6.02bc	6.06bc	1.92	1.26	2.47bc	3.54def	1.61	31.90	61.23de	64.47de	41.07	79.60	152.7de	161.0de	102.33	496.9de
F_2S_1	3.03	7.09b	7.86ab	2.19	2.18	5.44a	6.66a	2.06	44.30	109.5b	133.3bc	41.73	110.47	273.7b	334.0bc	104.03	823.3b
F_2S_2	3.08	9.50a	9.50a	1.99	1.99	6.31a	6.80a	1.50	49.80	155.7a	171.0a	36.10	124.00	390.0a	428.0a	90.30	1034a
F_3S_1	2.90	7.36b	7.61ab	2.22	1.65	5.14a	5.69b	1.96	34.57	91.07bc	115.3c	36.70	86.23	228.0bc	289.0c	91.43	696.3c
F_3S_2	3.12	4.51c	7.80ab	1.97	1.97	3.52b	6.49ab	1.43	50.20	100.8b	151.0ab	34.40	125.00	251.7b	378.0ab	86.00	842.3b
F_4S_1	3.08	4.61c	5.35c	2.07	1.40	2.18cd	2.16ef	1.91	28.40	45.70e	42.67e	41.57	71.07	114.0e	106.5e	103.90	396.4fg
F_4S_2	2.55	4.44c	5.42c	2.38	1.32	2.03cd	3.46cd	1.91	32.77	50.60e	84.37d	48.87	82.00	126.0e	210.7d	122.00	541.9d
F_5S_1	2.63	4.01cd	5.31c	2.44	1.28	2.48bc	2.93cde	1.81	26.97	49.00e	59.93de	35.23	67.53	122.0e	149.7de	87.97	428.4ef
F_5S_2	2.15	2.24d	2.66d	2.46	1.12	1.10d	1.76f	1.61	27.00	24.10f	43.90e	40.87	67.63	60.37f	109.3e	102.07	340.0g
Level of Sig.	NS	*	*	NS	NS	*	**	NS	NS	**	**	NS	NS	**	**	NS	***
CV (%)	11.33	18.53	16.30	21.85	13.73	18.66	11.67	28.58	13.57	14.07	13.82	25.89	13.50	14.12	13.83	25.65	7.15

*, ** and *** indicates significant at 5%, 1% and 0.1% level of probability respectively, NS = Non significant

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