GROWTH PATTERN AND BIOMASS YIELD OF *STEVIA REBAUDIANA* (BERT.) GROWN UNDER POLYHOUSE CONDITIONS IN RELATION TO CLIMATE CHANGE.

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Abstract: Climate change affects the earth's temperature, precipitation, hydrological cycles, frequency and intensity of heat waves and many extreme events, which has a great impact on agricultural production. On the wake of the climatic change, polyhouse farming is the only way to protect crops and manage a better yield than in normal climatic condition. It protects crops from wind, rain, radiation, and precipitation, etc again it facilitates the farmers not to depend on the monsoon for the cultivation but allow scheduling of the production according to the market needs.

A polyhouse experiment was conducted during winter season of 2011 at Government P.G College, Noida to study the effect of polyhouse condition on the growth pattern and biomass yield in *Stevia rebaundiana* (Bert.). The experiment was laid out in two different environmental conditions as Polyhouse environment and the other one is Control (open field) environment. Forty five days old Stevia seedlings are planted with row spacing 40-45 cm and between each plant 25 cm in well prepared field of both the environments in the month of january-2011 and the crop was established successfully. The studies on growth pattern, leaf area and biomass yield were made after an interval of 15 days from the date of transplantation till four month stage. In the present study it is revealed that polyhouse environment trigger the production of plant material especially leaf numbers, leaf fresh weight, plant height and total biomass considerably over open climatic condition, where the growth of the plant is ceased in the January as crop was frost-susceptible.

Keywords: Climate change, market needs, polyhouse, protect crops, *Stevia rebaudiana*

INTRODUCTION

The World Health Organization (WHO) estimated that 80% of the population of developing countries still depends on traditional medicines, mostly '*Green Drugs*' for their primary health care needs. India is one of the major exporters of crude drugs and share about 75-80 percent of the total export market. Thus 'Green medicine' made the situation more and more grim. But climate change i.e. temperature, seasonal patterns, weather events, hydrological cycles, frequency and intensity of heat waves and many extreme events has a negative impact on agricultural production and it will become much more intense and frequent in the future. Further medicinal and aromatic plants (MAPs) are not immune to these effects. On the wake of the climatic change, polyhouse farming is the only way to protect crops and manage a better yield than in normal climatic condition. It protects crops from wind, rain, radiation, and precipitation, etc again it facilitates the farmers not to depend on the monsoon for the cultivation but allow scheduling of the production according to the market needs.

Stevia rebaudiana Bertoni is a herbaceous perennial plant of the Asteraceae family. It is native to Paraguay, now the crop is being cultivated in Brazil, Israel, Thailand, United States, China, and in few states of India. The fresh leaf itself 30 - 45 times (Mowrey, 1992) and the main active components, stevioside are 200 – 300 times (Bridel and Lavielle, 1931) and rebaudioside-A is 400 times (Cramer and Ikan, 1986) sweeter than sugar. Its medicinal uses include regulating blood sugar, preventing hypertension, treatment of skin disorders and prevention of tooth decay. The concentration of stevioside and rebaudioside-A usually range from 8–12 % and 1-3% of leaf dry weight respectively. The amounts of active principles are depending on total biomass yield which is further depends on the climatic feature, method of agro-techniques, water management and also fertilizer applications. However, very limited or no information is available regarding the effect of polyhouse condition on growth pattern, leaf area and biomass yield in Stevia in relation to climatic change. In view of the above facts, the present investigation was undertaken to recommend the application of polyhouse technology on the growth pattern, leaf area and biomass yield in Stevia plant.

MATERIAL AND METHOD

Forty five days old stevia seedlings were planted in a well prepared field in the botany garden of Government post graduate, college, Noida, India with row spacing 40-45 cm and distance between each plant 25 cm during 2011. Simultaneously the seedlings are also planted in polyhouse for monitoring the growth and yield attributes of stevia plant under these climatic conditions. Then the plants were allowed to grow for a period of 105 days The growth pattern i.e. Shoot length, root length, leaf length, leaf number, total leaf area and biomass yields are recorded periodically at an interval of 15 days.

Table 1. Comparison of growth pattern of *Stevia rebaudiana* under polyhouse and control conditions.

		Age of Plants (Days)			
	Parameters	**60**	**75**	**90**	**105**
Control	Plant Height (cm)	7.4	13.2	17.8	29.5
	Root Length (cm)	11.0	13.5	19.0	21.0
	No of Leaves	14.0	17.0	32.0	102.5
	Leaf Length (cm)	3.1	6.5	9.0	9.2
	Leaf area (cm^2)/Plant	30.2	71.0	101.2	380
	No of Branches	-	-	11	20
Polyhouse	Plant Height (cm)	8.6	14.6	25.0	38.0
	Root Length (cm)	18.0	22.0	24.0	28.0
	No of Leaves	24.4	50.5	64.4	218.2
	Leaf Length (cm)	4.0	8.3	10.0	10.2
	Leaf area (cm^2)/Plant	47.3	167.4	292.6	1508
	No of Branches	-	10	19	58

Table 2. Comparison of biomass yield of *Stevia rebaudiana* under polyhouse and control conditions.

Age of Plants (Days)

Leaf weight (g/plant)	**60**		**75**		**90**		**105**	
Contro	Fesh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
	0.726	0.092	1.343	0.228	4.841	0.775	8.289	1.789
Polyhouse	Fesh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
	0.796	0.108	2.243	0.409	5.161	1.196	33.987	5.882
% Variation over control	9.6	17.4	67.0	79.4	6.6	54.3	310	227.1

Stem weight (g/plant)	**60**		**75**		**90**		**105**	
Contro	Fesh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
	0.142	0.029	0.570	0.113	1.668	0.239	5.135	1.066
Polyhouse	Fesh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
	0.165	0.032	0.819	0.151	3.196	0478	28.201	4.356
% Variation over control	16.2	10.34	43.68	33.63	91.61	100	449.19	308.63

Biomass yield (above ground) (g/plant)	**60**		**75**		**90**		**105**	
Contro	Fesh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
	0.868	0.121	1.913	0.341	6.509	1.014	13.424	2.864
Polyhouse	Fesh	Dry	Fresh	Dry	Fresh	Dry	Fresh	Dry
	0.961	0.140	3.062	0.560	8.357	1.674	62.18	10.23
% Variation over control	10.71	15.70	66.06	64.22	28.39	65.09	363.26	257.47

RESULT AND DISCUSSION

Growth Pattern: The data for growth patterns of *Stevia rebaudiana* are exhibited in Table 1. There is a regular increase in plant height, root length, Leaf length, No of leaves, Leaf area and number of branches with the advancement of crop in both the environments. The highest value for plant height was found 28.81 percent increased in poloyhouse as compared to open environment. Highest value of plant height observed at 105 days of stage and this value observed 29.5 and 38 cm in open and polyhouse conditions respectively.The highest value for root length was found 33.33 percent increased in poloyhouse as compared to open environment and their highest value recorded as 21 cm and 28 cm in control and polyhouse conditions respectively.

Polyhouse conditions also shows (112.87%) more no of leaves production as compared to control. Leaf length and leaf area also observed more in polyhouse conditions and their value amounted to 10.2 cm and 1508 cm^2 in polyhouse and 9.2cm and 380 cm^2 in control condition. The more number of branches and early branching also observed in polyhouse conditions.

The above results indicate that polyhouse environment is favourable for stem elongation basically inter-nodal length as well as number of nodes increased followed by increased leaf number in polyhouse grown plants. It is high humidity, high temperature and enriched CO_2 concentration that resulted in the growth pattern of *Stevia rebaudiana*. Goudriaan and de Ruiter (1983) observed increased internode length in the polyhouse grown wheat plants. Spellerberg and Buemann (1985) working on various cultivates of *Acer palmatum* found that the shoot growth was superior in cutting rooted under plastic tunnels. Hartrath (1986) has recorded that the plastic house grown *Chrysanthemum cv.* Selma Tetra shows better stem height on quality as compared to the normal environmental conditions. The better root system in plastic home grown tomatoes and maize plants was reported by Konyaeva and Korzinnikova (1983) and Bosnjak (1988) respectively. The large surface area of leaves in polyhouse is due to more number of leaves. Each leaf in polyhouse expanded on demand of plant because light is diffused and requires more photosynthesis. Leaf quality, size, texture, shape, appearance and petiole length were observed much better in polyhouse conditions as compared to open field. Behera *et al*. (1990), Goyal (1991), Kumar (1994) and Gupta (2000) also emphasized on the variations in the growth of plants inside and outside the tunnel, mainly due to the variations in environmental factors like light intensity, temperature, humidity and a few other associated factors.

Biomass Yield: The (Table 2) showed the results of above ground biomass yield in *Stevia rebaudiana.* Fresh weight of leaves also increased with the advancement of crop age in both of the environments. Highest value of F.W. was observed at 105 day of stage and this value amounted 8.289 and 33.987 gm in control and polyhouse conditions respectively. The polyhouse environment showed (310 %) increase in the fresh weight of the leaves. Maximum value of leaf dry weight was observed at 105 day of stage and this value amounted 1.798 and 5.882 g/plant in open field and polyhouse conditions respectively. Saplings grown under polyhouse recorded (227.1%) more dry matter of the leaves as compared to the control environment conditions. There is a regular increment in the stem fresh weight under both the conditions, but polyhouse environment resulted (449.19 %) more fresh weight than control conditions at 105 day stage. Saplings grown under polyhouse environment showed more accumulation of dry matter content. Maximum value of dry weight was observed at 150 day of stage and this value amounted 4.066 and 4.356 g/plant in control and polyhouse conditions respectively. Above ground biomass of fresh weight are amounted to 13.42 g/ plant and 62.18 g/plant at 105 day stage in control and polyhouse conditions respectively and polyhouse conditions showed (363.26 %) more fresh weight over control. Above ground biomass of dry weight are amounted to 2.864 g/ plant and 10.231 g/plant at 105 day stage in control and polyhouse conditions respectively and polyhouse conditions showed (257.47 %) more fresh weight over control.The above results are confirmatory to the work of Samuelsen (1979) on Swedes turnip. He found out that the plant under polyhouse environment increased the total aboveground dry weight. Similarly Konyaeva and Korzinnikova (1983) working on tomato plants grown under polyhouse environment. They reported increase in aboveground dry matter. Goudriaan and de Ruiter (1983) also found 20 percent increase in dry matter for wheat and faba bean plants grown under polyhouse environmental conditions.Mittra *et al.* (1990) working on paddy, winter vegetables and flower (Zinnia and Cosmos) reported that dry matter accumulation was faster in plants inside the tunnel as compared to those grown outside.

CONCLUSION

Stevia rebaudiana is a unique medicinial plant which is mostly utilized as a sugar substitute for diabetic patients. It is estimated that about three crore Indians are currently suffering from diabetes and by 2025 India's contribution to the global diabetic population is expected to be a whopping eight crore, so there is a huge demand for Stevia. Again Climatic change has a great impact on agricultural production. On the wake of the climatic change, low cost polyhouse farming is the only way to protect crops and manage a better yield than in normal climatic condition. It protects crops from wind, rain, radiation, and precipitation, etc again it facilitates the farmers not to depend on the monsoon for the cultivation but allow scheduling of the production according to the market needs.

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