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VARIETIAL PERFORMANCE OF SPINACH BEET UNDER DIFFERENT ENVIRONMENTAL CONDITIONS

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ABSTRACT

The present investigation comprising five spinach beet varieties (Pusa Bharti, Pusa Harit, Arka Anupama, All Green and Delhi Green) were sown in net house and open field environmental conditions. Present investigation evidenced that net house growing condition was found superior with respect to days to germination (5.73 days), plant height (6.16 cm and 25.00 cm), minimum days for first, second and third cutting (38.20, 47.60 and 58.73, respectively), days to fourth, fifth, sixth cutting after third one (7.67, 15.20 and 25.20, respectively), cumulative yield (6.210 kg), yield per hectare (32.319 kg) and protein content (2.89%). In view of varietal performance, Pusa Bharti recorded early germination (5.33 days), plant height (6.79 cm and 27.19 cm), minimum days for first, second and third cutting (35.67, 46.33 and 57.67, respectively), days to fourth, fifth, sixth cutting after third one (7.17, 14.33 and 24.33, respectively), cumulative yield (9.120 kg) and yield per hectare (47.500 kg), protein (3.44 %) and ascorbic acid content (67.69gm/100g). Variety Pusa Bharti under net house condition achieved higher growth, yield and quality attributes of spinach beet.

INTRODUCTION

Maximization of crop yields requires the combination of an optimum genotype with suitable environment, because productivity of crop in a particular area depends on the overall climate (Buttery and Buzzel, 1984). Protected cultivation is proving a successful tool to reduce the dependency on environment which creates several constraints in vegetable production and is regarded as an environmentally sustainable system (Singh *et al.*, 2005a). Protected cultivation or controlled environment agriculture (CEA) is a concept of modifying the natural environment for optimum plant growth (Sirohi, 2002). It comprises of manipulation of abiotic factors like air and root zone temperature, relative humidity, light, air velocity, atmospheric concentration of carbon dioxide (CO₂), root zone oxygen, nutrient concentration and moisture supply to the crop growth and development. The aim of protected cultivation is to achieve independence of climate as well as weather and to allow crop production in areas where the natural environment limits or prohibits production (Lorenzo *et al.*, 2005). Under open field condition, it is very difficult to grow vegetables successfully in the summer season due to very high incidence of biotic and abiotic factors.

Spinach beet is the most common leafy vegetable grown during winter and summer season in India. The leaves and tender stem of Spinach beet are rich in protein, minerals, carbohydrates, vitamin 'A' and 'C'. It is also a rich source of magnesium, phosphorus, sodium, riboflavin, potassium, sulphur and nicotinic acid.

By adopting low-cost protected technologies like insect-proof net house, shade net house and naturally ventilated greenhouses are highly suitable for successful cultivation of common and high-value vegetables both during summer and rainy season (Singh, *et al.*, 2010). Khan, *et al.* (1996) has also suggested that the cultivation under net houses should be adopted for making its cultivation a profitable venture.

Till date number of Spinach beet varieties has been released but very little work has been done for the North- Gujarat agro-climatic region for leaf production, hence, evaluation of suitable variety is required. In the farmers of North-Gujarat are also equipping with different types of protected structures. With the introduction of liberalized and farmer friendly government policy *i.e.* subsidy on protected structures, the area under protected structures is increasing rapidly. There is need to test the varieties of spinach beet under different environmental conditions under North- Gujarat agro-climatic region. So, Experiment was planned with the following objectives:

To find out the effect of different environmental conditions on growth, yield and quality parameters of spinach beet.

To find out the performance of different varieties of spinach beet on growth, yield and quality parameters under net house and open field condition.

To assess the combined effect of different growing conditions and different varieties of spinach beet.

MATERIALS AND METHODS

The experiment was conducted at Horticulture Instructional Farm, C. P. College

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of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar and District- Banaskantha. Experiment was laid out in Split Plot Design with three replications. In the present experiment five varieties of Spinach beet were evaluated under two environments *viz.*, net house (C₁) and open field (C₂) condition and varieties with five levels *viz.*, Pusa Bharti (V₁), Pusa Harit (V₂), Arka Anupama (V₃), All Green (V₄) and Delhi Green (V₅) thus, making total ten treatment combinations. The varietal seed were procured from various reputed research stations. Experimental field was manured uniformly with well rotten farm yard manure @ 25 t ha⁻¹ and also with recommended dose of NPK *i.e.* 80:30:00kg ha⁻¹. Different varieties were sown as per treatment combination in the paired row system on the flat bed with the spacing of 20 cm x 5 cm. Sprinkler irrigation system was followed in both the growing conditions. The green leaves were harvested in early morning when they attained a marketable stage. Data on growth parameters (Days taken for germination, plant height at 20 DAS and at first cutting and days to various cutting) and yield, protein content, ascorbic acid and chlorophyll content were recorded and analyzed to evaluate the treatments. Ten plants from each plot were tagged to record the observation. The chlorophyll content of green leaves was recorded with help of SPAD meter. The Protein content was determined by the Lowry's method (Lowry *et al.*, 1951). The ascorbic acid was determined by the Indophenols' method (Rangana, 1977). The recorded data were subjected to statistical analysis using the analysis of variance technique (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

Growth parameters

As visualized from the data presented in Table 1 the Growth parameters studied *viz.*, day taken for germination and plant height were influenced significantly as a result of treatment of growing conditions. Early germination in net house (5.73 days) while late in open field (7.00 days) grown plants. The plant height was at 20 DAS and first cutting after sowing under net house was found to have significantly higher *i.e.* 6.16 cm and 25.00 cm, respectively. Plants in the natural environment *i.e.*, open field were recorded of 4.51 cm and 23.32 cm height at 20 DAS and first cutting after sowing, respectively. The minimum days for first cutting (38.20), days to second cutting (47.60), days to third cutting (58.73), days to fourth cutting after third one (7.67), days to fifth cutting after third one (15.20) and days to sixth cutting after third one (25.20) under net house growing condition.

Among all the cultivars, early germination was recorded by Pusa Bharti (5.33 days) and it was statistically at par with Arka Anupama (5.50 days) while late germination was recorded by Delhi Green (7.50 days). Pusa Bharti recorded maximum plant height at 20 DAS (6.79 cm) and first cutting (27.19 cm) after sowing which was significantly superior to all other varieties. Minimum value of plant height at 20 DAS and first cutting after sowing obtained with Delhi Green that of 4.00 cm and 21.46 cm, respectively. The Pusa Bharti recorded minimum days for first cutting (35.67), days to second cutting (46.33), days to third cutting (57.67), days to fourth cutting after third one (7.17), days to fifth cutting after third one (14.33) and days to sixth

Table 1: Effect of different varieties on growth parameters of Spinach beet under net house and open field condition

Treatments	Days taken for germination	Plant height at 20 DAS	Plant height at first cutting	Days to first cutting	Days to second cutting	Days to third cutting	Days to fourth cutting after third one	Days to fifth cutting after third one	Days to sixth cutting after third one
Growing Condition(C)									
C ₁	5.73	6.16	25.00	38.20	47.60	58.73	7.67	15.20	25.20
C ₂	7.00	4.51	23.32	41.20	53.27	64.00	8.67	17.67	27.67
S.Em. ±	0.17	0.10	0.26	0.28	0.54	0.40	0.16	0.34	0.34
C.D. at 5%	1.03	0.58	1.58	1.72	3.31	2.45	0.99	2.07	2.07
Varieties (V)									
V ₁	5.33	6.79	27.19	35.67	46.33	57.67	7.17	14.33	24.33
V ₂	6.50	5.49	24.34	39.50	49.50	61.83	8.17	16.00	26.00
V ₃	5.50	5.90	25.05	38.00	49.50	59.17	7.67	14.50	24.50
V ₄	7.00	4.48	22.78	41.33	52.33	62.67	8.67	17.00	27.00
V ₅	7.50	4.00	21.46	44.00	54.50	65.50	9.17	20.33	30.33
S.Em. ±	0.26	0.13	0.25	0.31	0.33	0.38	0.19	0.49	0.49
C.D. at 5%	0.78	0.39	0.76	0.93	1.00	1.13	0.56	1.47	1.47
INTERSECTION C X V									
C ₁ V ₁	4.67	7.71	28.93	34.00	44.33	55.00	6.33	12.67	22.67
C ₁ V ₂	6.00	6.20	24.88	38.00	47.00	59.00	7.67	14.00	24.00
C ₁ V ₃	5.00	6.89	25.40	37.00	47.00	56.33	7.00	13.00	23.00
C ₁ V ₄	6.00	5.52	23.54	39.00	48.67	59.33	8.33	15.33	25.33
C ₁ V ₅	7.00	4.47	22.24	43.00	51.00	64.00	9.00	21.00	31.00
C ₂ V ₁	6.00	5.87	25.45	37.33	48.33	60.33	8.00	16.00	26.00
C ₂ V ₂	7.00	4.78	23.79	41.00	52.00	64.67	8.67	18.00	28.00
C ₂ V ₃	6.00	4.90	24.71	39.00	52.00	62.00	8.33	16.00	26.00
C ₂ V ₄	8.00	3.44	22.01	43.67	56.00	66.00	9.00	18.67	28.67
C ₂ V ₅	8.00	3.54	20.67	45.00	58.00	67.00	9.33	19.67	29.67
S.Em. ±	0.37	0.18	0.36	0.44	0.47	0.53	0.26	0.69	0.69
C.D. at 5%	NS	0.55	1.08	1.32	1.41	1.60	NS	2.07	2.07

Table 2: Varietal performance of spinach beet on yield and yield attributes under net house and open field condition

Treatments	Yield of 1 st cutting (kg)	Yield of 2 nd cutting (kg)	Yield of 3 rd cutting (kg)	Yield of 4 th cutting (kg)	Yield of 5 th cutting (kg)	Yield of 6 th cutting (kg)	Cumulative yield of subsequent cutting (kg)	Yield per hectare (kg)
Growing Condition(C)								
C ₁	0.510	0.690	1.230	1.460	1.380	0.940	6.210	32.319
C ₂	0.340	0.460	0.780	1.160	1.170	0.760	4.660	24.292
S.Em. ±	0.008	0.02	0.02	0.03	0.03	0.02	0.07	0.347
C.D. at 5%	0.046	0.11	0.14	0.17	0.19	0.09	0.41	2.110
Varieties (V)								
V ₁	0.620	0.880	1.470	2.600	2.180	1.370	9.120	47.500
V ₂	0.510	0.690	1.070	1.220	1.430	1.080	5.990	31.210
V ₃	0.570	0.810	1.630	1.890	1.890	1.020	7.800	40.650
V ₄	0.280	0.300	0.570	0.540	0.490	0.390	2.560	13.310
V ₅	0.150	0.210	0.280	0.310	0.380	0.390	1.720	8.940
S.Em. ±	0.010	0.02	0.02	0.04	0.03	0.02	0.05	0.279
C.D. at 5%	0.031	0.05	0.06	0.12	0.08	0.06	0.16	0.830
Interaction C X V								
C ₁ V ₁	0.712	0.964	1.734	2.967	2.247	1.408	10.022	52.200
C ₁ V ₂	0.595	0.843	1.441	1.241	1.649	1.036	6.805	35.443
C ₁ V ₃	0.663	0.940	1.803	1.966	1.967	1.271	8.610	44.844
C ₁ V ₄	0.387	0.420	0.803	0.739	0.627	0.514	3.490	18.176
C ₁ V ₅	0.183	0.293	0.385	0.380	0.417	0.486	2.144	11.165
C ₂ V ₁	0.520	0.790	1.219	2.232	2.117	1.341	8.219	42.809
C ₂ V ₂	0.427	0.528	0.697	1.197	1.211	1.120	5.180	26.979
C ₂ V ₃	0.480	0.676	1.451	1.811	1.820	0.759	6.998	36.448
C ₂ V ₄	0.167	0.183	0.337	0.333	0.353	0.267	1.640	8.542
C ₂ V ₅	0.117	0.127	0.170	0.240	0.343	0.293	1.290	6.719
S.Em. ±	0.014	0.023	0.030	0.057	0.03	0.026	0.07	0.394
C.D. at 5%	0.043	0.07	0.080	0.17	0.11	0.080	0.23	1.180

Table 3: Varietal performance of spinach beet on quality parameters under net house and open field condition

Treatments	Protein content (%)	Chlorophyll content (SPAD meter reading)	Ascorbic acid (gm/100g)
Growing Condition(C)			
C ₁	2.89	14.39	64.88
C ₂	2.82	19.62	67.19
S.Em. ±	0.01	0.42	0.17
C.D. at 5%	0.06	2.58	1.05
Varieties (V)			
V ₁	3.44	17.76	67.69
V ₂	3.23	16.08	65.77
V ₃	3.22	20.54	66.97
V ₄	2.25	15.32	65.61
V ₅	2.13	15.32	64.12
S.Em. ±	0.01	0.47	0.22
C.D. at 5%	0.04	1.40	0.67
Interaction C X V			
C ₁ V ₁	3.46	16.00	66.36
C ₁ V ₂	3.26	13.20	63.59
C ₁ V ₃	3.29	16.58	65.55
C ₁ V ₄	2.25	12.76	64.60
C ₁ V ₅	2.20	13.39	64.28
C ₂ V ₁	3.43	19.51	69.02
C ₂ V ₂	3.21	18.96	67.95
C ₂ V ₃	3.15	24.51	68.39
C ₂ V ₄	2.25	17.87	66.63
C ₂ V ₅	2.07	17.24	63.97
S.Em. ±	0.02	0.66	0.32
C.D. at 5%	0.05	1.98	0.95

cutting after third one (24.33).

The interaction effect of varieties and growing conditions revealed that variety Pusa Bharti under net house condition

recorded highest plant height at 20 DAS and first cutting after sowing 7.71cm and 28.93 cm, respectively. Similarly it also contributes earliness in days for first cutting (34.00), days to

second cutting (44.33), days to third cutting (55.00), days to fourth cutting after third one (6.33), days to fifth cutting after third one (12.67) and days to sixth cutting after third one (22.67).

Vegetative growth parameters were found better in net house which might be due to favourable growing condition. According to Gupta (2010) favourable environment conditions especially temperature provides a platform for all basic physiological parameters such as photosynthesis, respiration, nutrient uptake, translocation, pigment formation, reproduction, elongation and many other which in turn cause the better vegetative growth of plants. Moreover favourable environmental conditions stimulate cell division and cell enlargement in the growing apex of the plant resulting in better growth (Dixit 2007). These results are in line with the findings of Yadav, *et al.* 2014 in grain amaranth.

Yield and yield attributes

In view of various growing conditions, net house condition showed significant impact on yield and yield attributes. The net house growing condition produced highest yield of 1st cutting (0.510 kg), yield of 2nd cutting (0.690 kg), yield of 3rd cutting (1.230 kg), yield of 4th cutting (1.460 kg), yield of 5th cutting (1.380 kg), yield of 6th cutting (0.940 kg), cumulative yield of subsequent cutting (6.210 kg) and yield per hectare (32.319 kg).

In comparison of different varieties, the variety Pusa Bharti recorded maximum yield of 1st cutting (0.620 kg), yield of 2nd cutting (0.880 kg), yield of 3rd cutting (1.470 kg), yield of 4th cutting (2.600 kg), yield of 5th cutting (2.180 kg), yield of 6th cutting (1.370 kg), cumulative yield of subsequent cutting (9.120 kg) and yield per hectare (47.500 kg).

The interaction effect of varieties and growing conditions revealed that variety Pusa Bharti under net house condition recorded highest yield of 1st cutting (0.712 kg), yield of 2nd cutting (0.964 kg), yield of 3rd cutting (1.734 kg), yield of 4th cutting (2.967 kg), yield of 5th cutting (2.247 kg), yield of 6th cutting (1.408 kg), cumulative yield of subsequent cutting (10.022 kg) and yield per hectare (52.200 kg).

Highest yield per plot under net house was due to prolonged harvesting span which resulted in maximum yield plot⁻¹ of first, second, third, fourth, fifth and sixth cutting and cumulative yield of subsequent cutting. Higher values of all the yield components and yield of spinach beet crop grown under net house than open field may be attributed to the better vegetative growth and early cutting under protected structure. Dixit (2007) nicely briefed the superiority of protected environment in yield maximization in vegetables. He stated that protected environment in the technique of providing favorable environmental or growth condition to the plants. It is rather used to protect plants from the adverse climatic conditions by providing optimum conditions of light, temperature, humidity, CO₂ and air circulation for the best growth of plants to achieve maximum yield.

The result of present experiment was in line with findings of Kale *et al.* (1997) on cucumber, Brenner (1998) on spinach beet crop, Ganesan (2002) on tomato crop and Yadav and Barholia (2015) in coriander.

Quality parameters

The highest protein content (2.89%) obtained under net house condition whereas maximum chlorophyll content (19.62) and ascorbic acid (67.19gm/100g) was recorded with open field condition. The various varieties performed significantly on quality parameters. The variety Pusa Bharti recorded maximum protein content (3.44 %) and ascorbic acid (67.69gm/100g) while chlorophyll content (20.54) acquired by variety Arka Anupama. The interaction effect of different varieties and growing conditions proved that variety Pusa Bharti under net house condition recorded highest protein content (3.46 %) whereas variety Arka Anupama recorded maximum ascorbic acid (68.39gm/100g) and chlorophyll content (24.51).

Singh, *et al.* (2005^a) have proved the role of micro-climate in improving quality parameters of spinach beet growing of crops under protection has many advantages but biggest advantage lies with off-seasonality and superior quality of the produce (Kumar, *et al.* 2007).

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