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Influence of weather and growing environment on vegetable growth and yield

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An experiment was conducted at the Department of Horticulture, Agricultural College and Research Institute, Tamil Nadu Agricultural University, Madurai, Tamil Nadu, India to screen ten vegetables for cultivation under shadenet house (33% shade) and open field for year round production of vegetables. Tomato, eggplant, chilli, cucumber, cluster bean, radish, amaranthus, coriander, bhendi and capsicum were grown in the summer and winter. The influence of environmental variables temperature, relative humidity and light intensity were studied. Tomato, eggplant, chilli, cucumber, radish, amaranthus and coriander registered better performance for growth and yield during both seasons. Cluster bean performed well in the open field during both seasons. Relative humidity was always higher under shadenet house than in open field during both seasons. Light intensity in the shadenet house was lower than in the open field. Mean weekly temperature during summer and winter were higher under open field conditions than in the shadenet house. Lower temperature caused plant height, number of branches, internodal length, average fruit weight and yield per plant to be higher in the shadenet house than in the open field. Hence, the growing of tomato, eggplant, chilli, cucumber, radish, amaranthus and coriander under shade house conditions will be more profitable irrespective of the seasons.

Key words: Shadenet cultivation, season, quality.

INTRODUCTION

Growing vegetable demand could be achieved through bringing additional area under cultivation crops, using hybrid crops, and adoption of improved agro-techniques. Protected cultivation of vegetables could be used to improve yield quantity and quality (Singh et al., 1999; Ganesan, 2004). Vegetables grown under field conditions are exposed to abiotic and biotic stress which affects productivity and quality. Protected cultivation has the potential to reduce biotic and abiotic stresses. A shadenet house can modify environmental conditions with reduced labor.

In southern India, the dry season is from April to June with a rainy season from June to October. In northern India the dry season is from April to July and the rainy season is from July to October (Ramesh and Arumugam, 2010). Winter is from November to February. Protected cultivation could possibly extend the growing season. Protected cultivation of vegetable crops suitable for domestic and export purposes could be a more efficient alternative for land use and other resources (Sanwal et al., 2004). However, profitability in protected cultivation depends upon the choice of structure, selection of crop,

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Table 1. Mean values of weather parameters (crop period) recorded during summer and winter seasons.

Seasons	Parameters	Shade	Open	t-value	P-value
Summer	Temperature (°C)	32.06	34.20	5.19	1.64^{-5}
	Relative humidity (%)	59.50	52.60	7.93	1.21^{-8}
	Light intensity (lux)	25867.01	34044.45	3.78	0.0007
Winter	Temperature (°C)	30.10	32.85	7.63	2.59^{-8}
	Relative humidity (%)	67.10	59.42	9.12	7^{-10}
	Light intensity (lux)	18333.74	25867.01	3.34	0.002

selection of varieties, production technology and market price. The protected cultivation could solve the problem of low productivity during extreme weather conditions. Therefore, in the present scenario of perpetual demand for vegetables and drastically shrinking land holdings, protected cultivation of vegetable crops suitable for domestic as well as export purposes is the best alternative for using land and other resources more efficiently (Sanwal et al., 2004). To date, there is not much work available on shade net cultivation of vegetables. There is an urgent need to assess the cultivation and suitability of different vegetables under shade net house to meet the growing demand of the vegetables. Thus, the investigation was aimed to determine the efficacy of shadenet cultivation compared to open field on growth, yield of vegetables during summer and winter season.

MATERIALS AND METHODS

The present investigation was conducted at the Department of Horticulture, Agricultural Collage and Research Institute, Madurai, India, during 2010 and 2011. Areas of the shadenet house and open field plots were each 500 m^2. Tomato, cv. Lakshmi (NP 5005); chilli pepper, cv. Sierra (MHCP 317); eggplant, cv. MEBH - 11; bell pepper, cv. Radhika; Bhendi, cv. No-64; radish, cv. Pusa Chetki – Long; coriander, cv. Greengold; cluster-bean, cv. Haritima; cucumber, local type, and amaranthus, cv. Thandukeeri were used.

Experiments were arranged in randomized block design replicated three times. Ten plants were used in each replication. Standard horticultural practices (TNAU Crop Production Guide, 2013) and plant protection measures were followed. Soil inside the shade net house was turned to a depth of 20 to 25 cm. One month prior to planting, weeds and stubble were removed and the soil brought to a fine tilth by ploughing 3 to 4 times with cultivator. Fumigation was with 2% formaldehyde to control soil borne pathogens. After application of formaldehyde, the soil was covered with black polythene for one week and then removed. Application of the fungicides Topaz at 0.5 $mL \cdot L^{-1}$, Tilt at 1 $mL \cdot L^{-1}$, Ridomil MZ at 2 $g \cdot L^{-1}$ and of Vitavax at 2 $g \cdot L^{-1}$ was carried out for control of powdery mildew, dieback, fruit rot and sclerotium rot.

Air temperature, relative humidity and light were recorded from time of transplanting to last harvest in both shadenet house and open field. Temperature and relative humidity above the plant canopy was measured using a sensor in a temperature and humidity meter. The amount of light above the plant canopy was measured using a sensor in a TES Digital Light Meter (model 1332A). Growth and yield of vegetables were determined. The independent t-test was used to separate means.

RESULTS AND DISCUSSION

Growth, development, productivity and post-harvest quality of any crop largely depend on the interaction between the plant genetics and the environmental conditions under which they are grown. Every plant species has its own specific inherent characters (such as color, size, and growth rate, storability, cooking and processing qualities). Mean weekly temperature during summer and winter season were higher under open field than in the shadenet house (Table 1). The lower temperature increased plant height, number of branches, internodal length, average fruit weight and yield per plant were higher inside the shadenet house than in the open field condition. This agrees with findings of Ganesan (2004) and Ramesh and Arumugam (2010) under a polyhouse.

Influence of weather under shadenet and open field

The lowest yield of capsicum under open field might be due to high temperature. This agrees with Hawthron and Pollard (1957). Relative humidity was always higher under shadenet house than in open field during both seasons (Table 1). However, Nimje and Shyam (1993) observed that the relative humidity was higher inside the greenhouse than in the open field which influenced tomato growth and yield. The yield of sweet pepper was higher under shadenet house due to high relative humidity, which enhanced vegetative growth and improved fruit production. These results agree with findings of Priya et al. (2002a). Tomato, eggplant, capsicum, radish, amaranthus and coriander had higher yield under shadenet house due to light compensation for higher photosynthesis. Similar results were reported by Quaglitto (1976) and Priya et al. (2002b) in sweet pepper. Since, cluster bean, bhendi and cucumber are tropical crops, the requirement for light is more than chilli. This agrees with findings of Krishna-Mohan et al. (1993), who suggested that under 25% shade formation of photosynthates and their partitioning and distribution for the final sink were reduced resulting in poor yield in chilli. The light intensity in the shadenet house was lower than in the open field (Table 1). Kaname and Itagi (1973), Ganesan (2004), Ramesh and Arumugam (2010) found

Table 2. Influence of growing environments on growth and yield of tomato.

Tomato	Shadenet condition				t - value	P- value	Open condition				t - value	P- value
	Mean		SD				Mean		SD			
	Summer	Winter	Summer	Winter			Summer	Winter	Summer	Winter		
Plant height (cm)	150.25	200.69	18.17	8.37	13.80	5.19^{-17}	52.41	90.96	6.22	8.34	20.27	6.41^{-27}
Number of branches	19.79	14.36	4.52	3.21	5.35	1.95^{-6}	9.73	11.46	2.11	3.32	2.40	0.01
Number of leaves	599.63	1178.0	16.75	75.75	17.23	4.12^{-20}	254.83	370.0	10.00	41.00	5.82	9.81^{-7}
Internodal length(cm)	11.75	14.52	2.49	1.51	5.20	3.94^{-6}	6.96	9.54	1.04	0.81	10.64	2.87^{-15}
Earliness (days)	37.33	41.23	1.34	2.64	7.18	1.41^{-9}	28.46	30.53	1.47	2.08	4.43	4.17^{-5}
Fruit circumference(cm)	16.98	18.40	0.32	0.47	13.45	1.76^{-19}	15.96	15.04	0.26	0.52	8.52	8.14^{-12}
Number of fruits	58.36	73.10	4.38	5.44	11.54	2.56^{-16}	45.03	50.16	5.72	2.58	4.47	6.21^{-5}
Fruit weight (g)	100.92	106.50	4.07	4.10	5.27	2.02^{-6}	88.93	92.80	3.48	3.64	4.21	8.99^{-5}
Yield (kg / plant)	5.75	7.78	4.82	6.40	13.83	2.19^{-19}	3.19	4.65	5.11	2.75	6.96	1.31^{-8}
Chlorophyll content (%)	53.58	43.86	2.29	2.72	14.94	3.4^{-21}	49.55	50.71	2.25	3.43	1.54	0.12
Leaf area (mm^2)	6867.26	6679.97	1264.14	1436.66	0.53	0.59	1978.63	1929.01	350.92	433.08	0.48	0.62
Leaf area index	1.90	1.90	0.35	0.41	0.001	0.99	0.56	0.55	0.10	0.10	1.05	0.95

similar results for tomato cultivation under protected cultivation.

Influence of growing season/environment on growth and development of vegetables

Environment is the aggregate of all external conditions which influence growth and development of plants. Generally, crops are not profitable unless they are adapted to the region in which they are produced (Reddy et al., 1999). Among environmental factors, light intensity, temperature and relative humidity influence crop growth and development. Solar radiation consists of different wave-lengths of light, in which the visible portion is useful for crop growth; ultra-violet and infrared radiations are not beneficial for crop growth, as they change molecular levels which lead to cellular disorganization. Temperature is the major regulator of development processes. Higher temperatures have more adverse influence on net photosynthesis than lower temperatures leading to decreased production of photosynthates above a certain temperature (Reddy et al., 1999). Temperature can be controlled and regulated under protected conditions, and better growth of plants might be expected under protected culture. Relative humidity increases availability of net energy for crop growth and improves survival of crops under moisture stress conditions. Relative humidity reduces evaporation loss from plants which lead to optimum utilization of nutrients. It also maintains turgidity of cells which is useful in enzyme activity leading to a higher yield (Reddy et al., 1999).

The plant height, number of branches, number of leaves per plant, internodal length, leaf area and leaf area index were influenced by growing environment (Tables 2 to 11). In all, vegetables plant height was highest under shadenet house in both seasons compared to open field. This may be due to enhanced photosynthesis and respiration due to the favorable micro-climatic conditions in the shadenet house. This agrees with results of Ramesh and Arumugam (2010) on vegetables grown under poly house and Ryelski (1986) and El-Aidy et al. (1988) in sweet pepper under shadenet house. Numbers of branches per plant were higher under shadenet house in tomato, eggplant and chillies than in open field during both seasons. This might be due to the favorable micro-climatic conditions. Similar results were reported by Rylski (1986). Ramesh and Arumugam (2010) observed increases in numbers of branches per plant under poly house, in tomato, eggplant and chillies.

For cluster bean, bhendi and cucumber had more branches per plant in open field than in shadenet during both seasons (Tables 5, 6 and7). This indicates that this crop might require more light intensity and high temperature for better

Table 3. Influence of growing environments on growth and yield of eggplant.

Eggplant	Shadenet condition				t -value	P-value	Open condition				t-value	P- value
	Mean		SD				Mean		SD			
	Summer	Winter	Summer	Winter			Summer	Winter	Summer	Winter		
Plant height (cm)	127.43	131.73	5.59	4.46	3.28	0.001	91.2	99.87	5.63	6.38	5.57	7.04^{-7}
Number of branches	20.23	9.8	3.07	1.60	16.49	1.87^{-20}	15.13	10.4	2.09	1.77	9.44	2.50^{-13}
Number of leaves	165.43	150.03	16.04	11.04	4.33	6.9^{-56}	104.6	57.3	26.81	3.53	9.56	0.19^{-10}
Internodal length (cm)	9.98	12.34	0.72	0.93	10.93	2.0^{-155}	8.07	10.82	0.46	0.95	14.20	1.55^{-20}
Earliness (days)	36.63	42.90	7.51	1.91	14.02	8.23^{-20}	41.60	49.40	2.48	2.09	13.14	4.87^{-19}
Fruit circumference (cm)	13.91	15.64	0.52	0.67	11.06	1.30^{-15}	11.84	12.46	0.35	0.73	4.17	9.96^{-5}
Fruit length (cm)	11.88	12.68	0.35	0.53	6.88	4.57^{-9}	8.58	9.07	0.38	0.31	5.54	7.70^{-7}
Number of fruits	59.7	73.9	2.56	4.45	15.12	8.69^{-22}	48.36	53.93	2.78	4.26	5.98	1.45^{-7}
Fruit weight (g)	90.21	99.33	2.28	2.63	14.32	1.05^{-20}	88.45	88.79	2.52	1.94	0.58	0.56
Yield (kg/ plant)	4.86	7.34	1.86	4.92	25.76	1.90^{-33}	2.78	4.79	2.97	4.03	21.89	3.22^{-28}
Chlorophyll content (%)	39.33	35.96	1.69	1.35	8.49	9.13^{-12}	37.72	38.67	2.10	2.92	14.44	0.15
Leaf area ($mm^{2)}$	23538.03	22715.19	3168.16	2630.08	1.09	0.27	13327.17	12938.35	1005.72	1488.83	1.18	0.24
Leaf area index	6.55	6.53	0.88	1.15	0.001	0.99	3.77	3.75	0.31	0.51	0.20	0.83

Table 4. Influence of growing environments on growth and yield of chilli.

Chilli	Shadenet condition				t-value	P-value	Open condition				t -value	P-value
	Mean		SD				Mean		SD			
	Summer	Winter	Summer	Winter			Summer	Winter	Summer	Winter		
Plant height (cm)	83.43	158.99	18.27	8.86	20.37	2.15^{-23}	60.45	78.68	7.66	6.09	10.19	1.54^{-14}
Number of branches	14.63	10.5	2.91	1.65	6.74	2.18^{-8}	9.36	8.73	2.38	1.83	1.14	0.25
Number of leaves	202.86	515.56	8.34	18.75	83.45	2.34^{-46}	157.23	379.06	18.54	44.26	25.31	4.87^{-33}
Internodal length (cm)	7.78	13.83	1.32	1.55	16.21	5.12^{-23}	6.85	7.48	0.47	0.94	3.27	0.001
Earliness (days)	28.66	29.55	1.84	2.01	1.73	0.08	36.76	37.60	1.52	1.77	1.95	0.05
Fruit circumference (cm)	3.01	3.35	0.27	0.19	5.48	9.42^{-7}	2.81	2.18	0.18	0.15	14.22	1.45^{-20}
Fruit length (cm)	10.88	12.10	0.35	0.33	13.73	6.94^{-20}	8.85	12.10	0.31	0.33	38.81	3.39^{-43}
Number of fruits	78.76	115.53	3.03	9.49	20.19	6.36^{-28}	64.06	85.8	3.43	4.90	19.89	1.39^{-27}
Fruit weight (g)	10.07	10.58	0.39	0.56	4.04	0.0001	8.85	12.10	0.31	0.33	38.81	3.39^{-05}
Yield (kg / plant)	0.79	1.22	3.97	1.13	19.48	3.92^{-27}	466.25	721.84	26.82	48.00	25.45	3.62^{-33}
Chlorophyll content (%)	54.11	52.23	2.48	4.19	2.10	0.03	56.45	56.14	3.02	3.92	0.35	0.72
Leaf area (mm^2)	2132.1	2083.74	576.18	572.83	0.34	0.73	1003.1	975.97	79.52	134.65	0.95	0.34
Leaf area index	0.78	0.79	0.19	0.21	0.02	0.78	0.37	0.36	0.03	0.05	0.10	0.87

Table 5. Influence of growing environments on growth and yield of bhendi.

Bhendi	Shadenet condition				t - value	P-value	Open condition				t -value	P-value
	Mean		SD				Mean		SD			
	Summer	Winter	Summer	Winter			Summer	Winter	Summer	Winter		
Plant height (cm)	225.12	205.87	14.23	7.63	6.52	5.70^{-8}	173.52	136.39	7.61	9.75	16.43	6.99^{-23}
Number of branches	2.90	4043	0.71	1.07	6.52	1.84^{-8}	4.00	8.66	0.69	1.62	14.45	6.94^{-21}
Number of leaves	58.36	60.16	9.85	6.01	0.85	0.39	54.03	78.50	5.15	18.49	6.98	3.15^{-9}
Internodal length (cm)	15.87	13.19	1.02	0.90	10.74	2.06	14.67	8.74	0.52	0.95	29.66	9.57^{-37}
Earliness (days)	36.33	38.2	1.76	1.76	4.08	0.0001	42.43	45.36	2.31	1.37	5.96	3.03^{-7}
Fruit circumference (cm)	5.06	5.5	0.24	0.22	7.17	1.49^{-9}	4.72	4.98	0.16	0.28	4.21	8.93^{-5}
Fruit length (cm)	15.19	14.08	0.37	0.51	9.67	1.05^{-13}	13.82	11.85	0.28	0.37	22.81	2.14^{-29}
Number of fruits	49.76	45.26	2.26	6.88	3.40	0.001	46.76	64.7	1.61	16.49	5.92	1.79^{-7}
Fruit weight (g)	24.17	24.48	0.48	1.22	1.30	0.19	22.15	22.04	3.34	0.97	0.17	0.85^{-5}
Yield (kg / plant)	1.20	1.10	5.43	1.67	2.99	0.004	1.03	1.42	1.61	3.52	5.46	1.02^{-6}
Chlorophyll content (%)	52.00	50.23	1.83	5.03	1.81	0.07	46.28	54.78	1.18	5.28	8.59	6.19^{-12}
Leaf area (mm^2)	16770.13	6329.67	2558.42	2979.21	0.61	0.54	9459.1	8366.25	861.60	766.36	5.19	2.8^{-6}
Leaf area index	8.28	8.29	1.26	1.58	0.02	0.97	5.86	5.81	1.03	1.26	0.15	0.87

Table 6. Influence of growing environments on growth and yield of cucumber.

Cucumber	Shadenet condition				t - value	P- value	Open condition				t - value	P- value
	Mean		SD				Mean		SD			
	Summer	Winter	Summer	Winter			Summer	Winter	Summer	Winter		
Plant height (cm)	375.92	405.87	30.20	15.50	4.83	1.75^{-5}	345.76	366.81	27.68	27.89	2.93	0.004
Number of branches	8.75	10.6	2.35	1.40	3.8	0.0004	9.6	11.46	2.29	1.30	3.86	0.0003
Number of leaves	64.43	78.9	9.82	7.22	6.49	2.04^{-8}	54.66	58.76	8.15	4.78	1.21	0.22
Internodal length (cm)	13.68	10.6	2.07	1.40	6.74	1.38^{-8}	14.22	11.46	1.00	1.30	9.16	1.35^{-12}
Earliness (days)	33.46	37.26	2.19	1.74	7.43	5.47^{-10}	28.40	31.50	1.92	1.92	6.24	5.46^{-8}
Fruit circumference (cm)	14.54	14.60	1.31	1.32	0.17	0.86	12.93	12.26	0.65	0.44	4.62	2.59^{-5}
Fruit length (cm)	20.16	19.47	1.51	1.29	1.91	0.06	16.31	17.7	0.89	0.88	6.00	1.33^{-7}
Number of fruits	29.30	25.83	2.01	2.39	6.06	1.20^{-7}	26.96	21.40	2.17	2.02	10.25	1.19^{-14}
Fruit weight (g)	230.57	218.11	6.35	5.69	7.99	6.24^{-11}	215.46	208.56	4.08	5.50	5.50	1.08^{-6}
Yield (kg / plant)	6.75	5.63	4.85	5.39	8.45	1.23^{-11}	5.80	4.46	4.62	4.47	11.44	1.67^{-16}
Chlorophyll content (%)	38.14	37.48	3.48	3.55	0.72	0.47	29.34	35.78	2.63	3.94	7.43	5.54^{-10}
Leaf area (mm^2)	21119.43	20578.39	2220.05	3412.29	0.72	0.46	12696.77	11860.73	1318.77	945.97	2.82	0.006
Leaf area index	2.11	2.01	0.22	0.32	0.007	0.99	1.35	1.35	0.17	0.23	1.004	0.99

Table 7. Influence of growing environments on growth and yield of cluster bean.

Cluster bean	Shadenet condition				t -value	P- value	Open condition				t - value	P-value
	Mean		SD				Mean		SD			
	Summer	Winter	Summer	Winter			Summer	Winter	Summer	Winter		
Plant height (cm)	201.52	205.86	19.49	8.79	1.11	0.27	219.40	216.77	16.74	5.76	0.81	0.42
Number of branches	3.47	2.46	1.10	0.73	3.86	0.0003	3.96	3.06	1.03	0.98	3.46	0.001
Number of leaves	62.50	74.00	23.42	5.14	2.62	0.01	63.06	75.86	11.55	5.53	5.47	2.27^{-6}
Internodal length (cm)	6.28	6.16	0.71	0.30	0.82	0.41	8.53	6.91	1.26	0.29	6.81	1.06^{-7}
Earliness (days)	51.46	58.50	2.20	1.88	13.25	3.37^{-19}	43.6	49.46	3.37	1.92	7.64	1.53^{-9}
Fruit circumference (cm)	2.83	2.55	0.30	0.30	3.52	0.0008	3.00	2.79	0.23	0.19	3.89	0.0002
Fruit length (cm)	9.96	11.08	0.36	0.40	11.12	6.57^{-16}	10.14	12.02	0.69	0.51	11.91	3.15^{-17}
Number of fruits	103.66	96.23	6.05	5.27	5.07	4.36^{-6}	121.53	117.0	4.52	3.32	4.42	4.32^{-5}
Fruit weight (g)	5.89	5.74	0.36	0.20	1.95	0.05	6.04	5.99	0.32	0.22	0.64	0.51
Yield (kg / plant)	0.61	0.55	0.47	0.39	5.13	3.41^{-6}	0.73	0.70	0.45	0.35	0.31	0.002
Chlorophyll content (%)	58.39	55.89	4.54	3.60	2.35	0.02	55.42	52.96	3.22	3.56	2.80	0.006
Leaf area (mm^2)	15144.6	14700.79	1661.70	2023.44	0.92	0.35	9267.63	9007.84	1575.60	9760.89	0.60	0.54
Leaf area index	16.82	16.84	1.84	2.66	0.003	0.99	10.28	10.36	1.68	2.03	0.003	0.99

Table 8. Influence of growing environments on growth and yield of radish.

Radish	Shadenet condition				t -value	P-value	Open condition				t -value	P-value
	Mean		SD				Mean		SD			
	Summer	Winter	Summer	Winter			Summer	Winter	Summer	Winter		
Plant height (cm)	37.71	66.82	4.08	3.45	29.80	7.29^{-37}	22.95	39.11	3.48	3.38	18.34	8.00^{-26}
Number of leaves	15.2	14.73	2.29	1.36	0.95	0.34	13.46	10.32	2.48	1.55	5.91	3.22^{-7}
Fruit circumference (cm)	14.03	14.31	1.01	1.30	0.88	0.37	9.53	8.65	0.69	0.54	5.50	8.68^{-7}
Fruit length (cm)	25.26	26.91	3.20	3.95	1.77	0.08	15.13	16.65	13.5	1.54	4.04	0.0001
Fruit weight (g)	263.47	225.06	4.08	1.93	4.65	3.36^{-5}	179.33	146.99	18.99	5.26	8.98	2.19^{-10}
Yield (kg / plot)	22.31	25.70	26.02	29.01	4.76	1.33^{-5}	10.50	11.68	12.40	12.73	3.65	0.0005
Chlorophyll content (%)	33.84	34.89	8.00	3.76	0.64	0.51	30.09	31.94	3.14	4.42	1.86	0.06
Leaf area (mm^2)	19841.87	19290.25	1505.44	2453.43	1.04	0.29	11923.9	11550.03	1336.17	1433.98	1.044	0.300
Leaf area index	141.40	132.30	51.85	17.99	0.90	0.36	81.15	81.10	8.57	12.52	0.02	0.98

growth and development (Marcelis and Baan Hofman-Eijer, 1993). Numbers of leaves per plant was highest under shadenet house in all vegetables during summer and winter seasons. This might be due to taller plants, increased number of secondary branches and the beneficial micro-climate in the shadenet house. Similar results were reported by Nimje and Shyam (1993) in sweet pepper and eggplant. The maximum

Table 9. Influence of growing environments on growth and yield of amaranthus.

Amaranthus	Shadenet condition				t -value	P- value	Open condition				t - value	P-value
	Mean		SD				Mean		SD			
	Summer	Winter	Summer	Winter			Summer	Winter	Summer	Winter		
Plant height (cm)	67.366	88.09	3.56	4.60	19.19	4.78^{-26}	33.2	39.11	4.16	4.0	5.28	2.00^{-6}
Number of leaves	74.00	30.36	5.14	3.22	39.36	9.55^{-39}	18.5	20.33	2.78	1.95	2.94	0.004
Yield (kg/ plot)	16.76	25.58	19.18	28.80	13.95	3.42^{-20}	7.80	11.67	8.96	1.32	13.24	3.52^{-19}
Chlorophyll content (%)	27.85	25.87	1.79	2.21	3.79	0.0003	31.90	31.81	2.78	3.95	0.09	0.92
Leaf area (mm^2)	7061.7	6933.19	1528.19	1545.65	0.32	0.74	3191.26	3113.73	1069.43	1011.85	0.28	0.77
Leaf area index	23.54	23.55	5.09	5.79	0.001	0.99	10.63	10.64	3.56	3.78	0.003	2.00

Table 10. Influence of growing environments on growth and yield of coriander.

Coriander	Shadenet condition				t -value	P- value	Open condition				t - value	P-value
	Mean		SD				Mean		SD			
	Summer	Winter	Summer	Winter			Summer	Winter	Summer	Winter		
Plant height (cm)	26.95	33.97	3.58	2.46	8.83	7.37^{-12}	NA	24.11	NA	NA	NA	NA
Number of leaves	53.9	172.96	6.21	6.74	71.07	4.14^{-58}	NA	74.00	NA	NA	NA	NA
Yield (kg / plot)	15.63	19.61	18.08	22.26	7.58	3.77^{-10}	NA	8.70	NA	NA	NA	NA
Chlorophyll content (%)	29.11	28.12	1.90	2.71	1.63	0.10	NA	28.65	NA	NA	NA	NA
Leaf area (mm^2)	999.13	979.36	226.58	269.76	0.30	0.75	NA	532.30	NA	NA	NA	NA
Leaf area index	3.33	3.34	0.75	0.85	0.05	0.95	NA	1.80	NA	NA	NA	NA

NA, Not available.

internodal length was under shadenet house in bhendi during summer, while cucumber had the highest internodal length during winter under shadenet house. This finding agrees with Ramesh and Arumugam (2010) under poly house condition. Earliness in was under shadenet house during summer and winter in all vegetables except radish. This might be due to accumulation of photosynthates which triggered early initiation of flowers. Similar findings were reported by Rui et al. (1989) in capsicum. In tomato and cluster bean earliness occurred in open field during both seasons.

This might be due to the micro-climate which was not sufficient for photosynthesis and accumulation of photosynthates (Suchindra, 2002). Leaf area per plant was highest under shadenet house compared to open field in all vegetables during summer season and winter. The exception was for coriander which had the most leaf area under open field during the winter. While the most leaf area was observed under shadenet house during summer season. The highest leaf area per plant was for tomato under shadenet house during summer and winter seasons. This might be due to leaf physiology and increased number of stomatoes and photosynthesis. These results agree with Papadopoulos and Ormrod (1991) in tomato. Amaranthus had the highest leaf area index during summer and winter seasons under shadenet house compared to open field. This might be due to accumulation of more photosynthates during the cropping period. Ultimately, the study revealed that the prospects of cultivation of tomato, brinjal, chilli, cucumber,

Table 11. Influence of growing seasons on the growth and yield of capsicum.

Capsicum	Summer				t -value	P-value	Winter				t - value	P-value
	Mean		SD				Mean		SD			
	Shade	Open	Shade	Open			Shade	Open	Shade	Open		
Plant height (cm)	NA	NA	NA	NA	NA	NA	89.50	NA	NA	NA	NA	NA
Number of branches	NA	NA	NA	NA	NA	NA	6.93	NA	NA	NA	NA	NA
Number of leaves	NA	NA	NA	NA	NA	NA	60.40	NA	NA	NA	NA	NA
Internodal length (cm)	NA	NA	NA	NA	NA	NA	8.18	NA	NA	NA	NA	NA
Earliness (days)	NA	NA	NA	NA	NA	NA	39.7	NA	NA	NA	NA	NA
Fruit circumference (cm)	NA	NA	NA	NA	NA	NA	22.93	NA	NA	NA	NA	NA
Fruit length (cm)	NA	NA	NA	NA	NA	NA	11.04	NA	NA	NA	NA	NA
Number of fruits	NA	NA	NA	NA	NA	NA	11.76	NA	NA	NA	NA	NA
Fruit weight (g)	NA	NA	NA	NA	NA	NA	155.48	NA	NA	NA	NA	NA
Yield (kg / plant)	NA	NA	NA	NA	NA	NA	1.92	NA	NA	NA	NA	NA
Chlorophyll content (%)	NA	NA	NA	NA	NA	NA	61.96	NA	NA	NA	NA	NA
Leaf area (mm^2)	NA	NA	NA	NA	NA	NA	4893.80	NA	NA	NA	NA	NA
Leaf area index	NA	NA	NA	NA	NA	NA	1.81	NA	NA	NA	NA	NA

NA, Not available.

radish, coriander and amaranthus under shadenet house are bright.

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