



# Influence of Environmental Factors, Growing Conditions and Seasonal Variations on Vegetative, Yield and Quality Characters of Cucumber (*Cucumis sativus* L.) Varieties

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**Abstract:** The cultivation of cucumber is a major problem under open environmental conditions because it is highly susceptible to biotic and abiotic conditions. The present study involves the cultivation of two monoecious cucumber varieties Swarna Sheetal and Solan Srijan under open and protected conditions in two seasons for vegetative, yield and quality. The maximum vegetative growth attributes such as vine length at 30, 45, 60, final harvest stage and maximum leaves and branches were in the summer season crop of the Solan Srijan variety. Economic yield maximum in the summer crop of Solan Srijan variety compared to the Swarna Sheetal. Solan Srijan variety given the maximum amount of ascorbic acid in winter season under protected conditions and a lesser amount of acidity was in the Swarna Sheetal in the winter season under open environmental conditions. The summer season has recorded maximum temperature influences the vegetative growth as well as yield under protected conditions. Thus, growing environmental conditions and seasonal variations are important factors that could be effective on the vegetative, yield and quality characters of cucumber varieties.

**Keywords:** Monoecious, Protected condition, Solan Srijan, Swarna Sheetal

Cucumber (*Cucumis sativus* L.) is a prominent vegetable crop distributed across the world (Soleimani et al 2009) and is indigenous to South Asia, specifically the warm and humid environment of the Himalayas in Northwest India and Northern Africa. Cucumber responds best in conditions of high temperature, humidity and light intensity with an adequate supply of water and nutrients. Open field grown vegetables are susceptible to abiotic and biotic stress, which reduces the quality and productivity of cucumbers. Protected farming can minimize both biotic and abiotic stresses. The dry season in southern India lasts from April to June, while the rainy season lasts from June to October. In northern India lasts from April to July, while the rainy season lasts from July to October (Ramesh and Arumugam 2010). Temperature, relative humidity and rainfall are the primary climatic elements that influence cucumber development with a significant extent of yield. A greenhouse microclimate is the combination of climatological elements that form around a live plant. It is essential to monitor and maintain these factors at their optimal levels for improved crop growth and yields. The heating system, ventilation and fogging system, lighting and shading system, fertigation system and may all be used to regulate the greenhouse environment. Thus, the investigation aimed to determine the influence of climatic

factors and seasonal variability in the cultivation of cucumber in the naturally ventilated poly house compared to an open field on the growth, yield and quality of cucumber fruit.

## MATERIAL AND METHODS

**Experimental details:** The study was conducted at field conditions of Horticultural College and Research Institute, Periyakulam, TNAU, Tamil Nadu, located at a longitude of 10° 13' North and 77° 59' East. It is located at an altitude of 289 m above mean sea level (MSL). The crop was raised in two seasons *i.e.*, the summer and winter seasons of 2022 under open fields and protected conditions. Two monoecious cucumber varieties *i.e.*, Swarna Sheetal and Solan Srijan seeds are collected from Indian Council Agricultural Research (ICAR) Institutes and these seeds were used as planting material for this study. The standard cultivation practices were followed.

**Meteorological observations in protected and open field conditions:** Weather data were recorded at weekly intervals during the summer and winter months of the cropping period. Weekly means of data on temperature (°C), and relative humidity (%) were obtained from the nearby Agrometeorological Observatory, Horticultural College and Research Institute, Periyakulam for the period of study. In

protected conditions, the temperature was regulated through the timely opening and closing of the top shade net, fan and pad system and fogging for improved plant growth, because the temperature is a primary regulator of development processes. During the growing season, relative humidity was moderate and it was regulated chiefly by foggers, cooling fan pad system and shade net.

**Estimation of total soluble solids (°Brix):** Macerated juice from mature cucumber was placed over the prism of a Digital Pocket Refractometer Pal-1, Atago (range 0 to 32) and the brix value was recorded the process was repeated three times for each sample and the mean value was calculated.

**Estimation of ascorbic acid (mg/100 g):** The dye solution was prepared by mixing 50 mg dye with 42 mg sodium hydrogen carbonate in 150 ml of hot distilled water. 20 g oxalic acid was added to 500 ml distilled water (A) and thoroughly mixed. After that, added 100 mg of ascorbic acid to 100 ml of solution A (B) and mixed well. After that, 90 ml of oxalic acid was added to 10 ml of solution B. Titrated with dye solution until light pink colour appeared after removing 5 ml and adding 10 ml oxalic acid (4 per cent). Crushed the fruit and extracted a clear 15 ml juice, then 100 ml oxalic acid (4 per cent) was added to each and mixed thoroughly. Then, take 5 ml and add 10 ml oxalic acid (4 %) was added to it. Then titrate with dye solution until a bright pink colour appeared.

$$\text{Ascorbic acid} = \frac{0.5 \text{ mg}}{V_1} \times \frac{V_2 \text{ (ml)}}{5 \text{ ml}} \times \frac{100}{\text{weight of the sample}} \times 100$$

**Determination of acidity (%):** Acidity was calculated by titrating the cucumber juice with 0.1 N Sodium hydroxide (NaOH) using Phenolphthalein as an indicator and expressed as per cent acidity.

$$\text{Acidity (\%)} = \frac{\text{Equivalent weight of acid} \times \text{Normality of NaOH} \times \text{Titre value}}{\text{Weight of sample}} \times 100$$

## RESULTS AND DISCUSSION

**Vegetative growth parameters:** Plant growth attributes of two cucumber varieties *i.e.*, Swarna Sheetal and Solan Srijan showed significant differences in two seasons (summer and winter) under two growing conditions *i.e.*, open and protected conditions. Under the open environmental conditions, Solan Srijan variety had the maximum vine length at 30<sup>th</sup>, 45<sup>th</sup>, 60<sup>th</sup> day and at the final harvest stage (209.6 cm) during the summer season crop. In protected conditions, Solan Srijan variety were recorded maximum vine length at the 30<sup>th</sup> day, 45<sup>th</sup> day, 60<sup>th</sup> day and at final harvest stage (256.51 cm) in summer season crop. The maximum vegetative growth was obtained under protected condition compared to open environmental condition while summer season crop gave maximum vegetative growth compared to open

environmental condition. When compared to open condition, in protected condition, there was significant difference in sunlight received and radiated out which enhanced the internal temperature and also better and increased photosynthesis resulting in greater vegetative growth and maximum temperature recorded in summer season of protected condition. Solan Srijan variety had the maximum number of branches per plant (2.31) under open field environmental conditions in the summer season crop and lower number of branches per plant (1.73) was in Swarna Sheetal variety in winter season crop. Under controlled atmosphere condition, Solan Srijan variety had the maximum number of branches per plant under summer season crop and lower number of branches (1.98) was in Swarna Sheetal variety in winter season crop (Fig. 1). In general, plants tend to reduce surface area to minimize evapotranspiration. But in protected condition such situation may not arise. Hence, the plants vigorously grew by way of putting forth a higher number of branches and leaves. This might be the reason for having higher number of branches under protected conditions.

**Flowering parameters:** Solan Srijan variety recorded maximum number of leaves per plant (73.2) in the summer season crop and Swarna Sheetal variety had lower number of leaves (57.5) in the summer season crop. Under controlled atmosphere conditions, Solan Srijan variety recorded greater number of leaves (91.66) in summer season crop compared to the winter season crop (89.11) and lower number of leaves (68.48) was in summer season crop of Swarna Sheetal variety compared to winter season crop (69.91) (Fig. 1). The variation in the number of leaves among ten varieties at different stages of growth might be owing to the distinct varietal inherent genetic makeup of a specific variety, resulting in variations in phenotypic expression. Protected condition supported the growth of the variety by altering the natural habitat and microclimatic conditions around the plants. The number of leaves varied greatly. Similar trends in the total number of leaves were observed by Ahmed et al (2004) in cucumber and Olaniyi et al (2010) in tomato.

**Yield parameters:** The open environmental condition Solan Srijan variety had the maximum fruit length (19.56 cm) in the summer season crop and Swarna Sheetal variety recorded lowest fruit length (15.43 cm) in winter season crop compared to the summer season crop (16.66 cm). Under the protected environmental condition, Solan Srijan variety grown crop recorded maximum fruit length (20.06 cm) compared to Swarna Sheetal variety in summer season crop (17.83 cm). The variation in fruit length might be caused by genetics, environmental factors or crop vigour. The results agreed with the findings of earlier workers in cucumber crop

(Yadav et al 2012, Ullah et al 2012, Kumar et al 2013, Patel et al 2013). The highest fruit diameter (4.43) and fruit volume (176.33) was in Swarna Sheetal variety grown in summer season crop compared to winter season crop (4.21, 174.54 cm<sup>3</sup>, respectively). Under protected environmental condition, the maximum fruit diameter (4.53 cm) was in Swarna Sheetal

variety grown in summer season crop and higher fruit volume (184.87) was in Solan Srijan variety grown in summer season crop. Varietal differences and growing conditions were the reasons for the variation observed. Similar trend was observed by earlier workers in cucumber (Ullah et al 2012, Kumar et al 2013, Patel et al 2013, Rawat et al 2014).

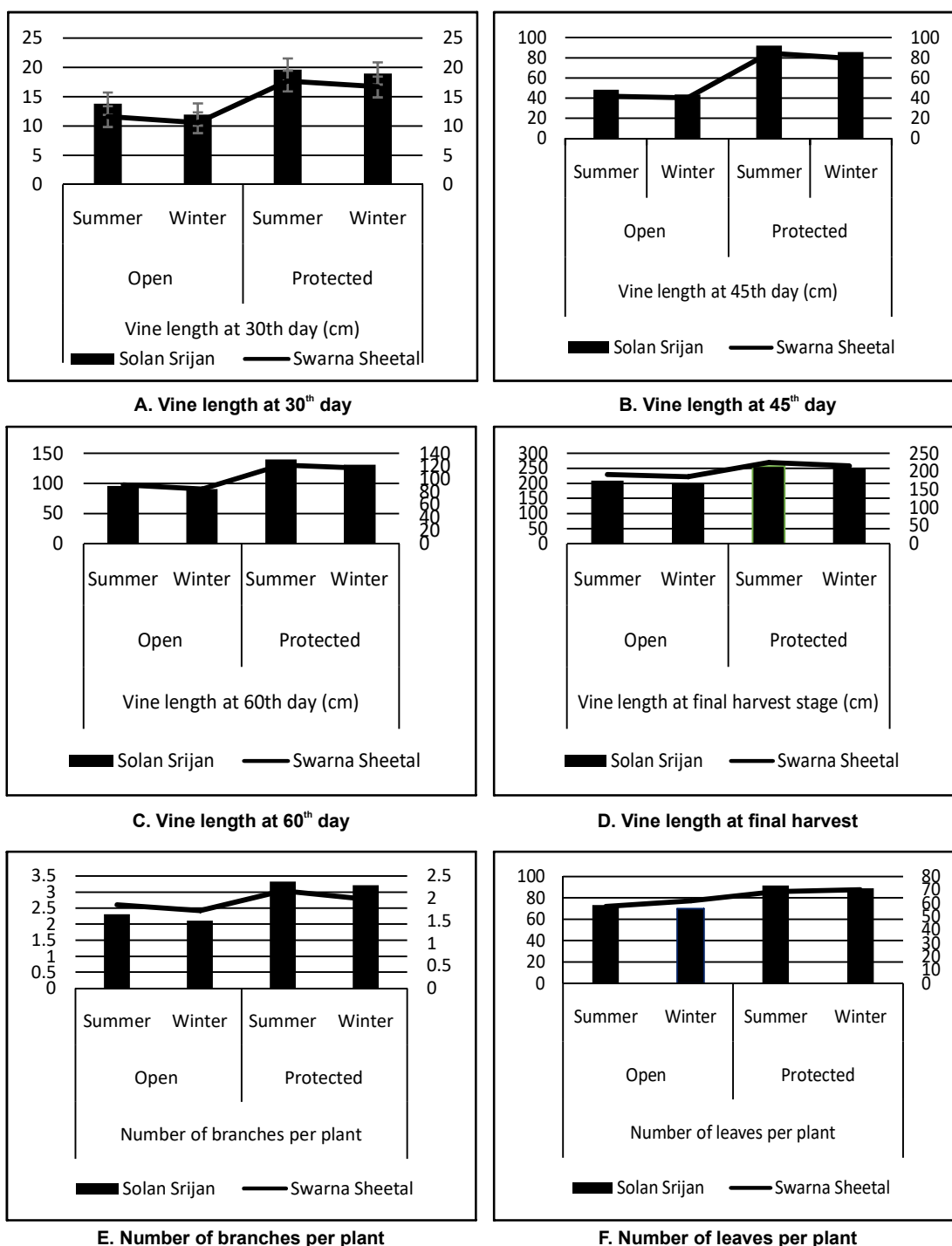


Fig. 1. Effect of growing conditions and seasonal variations on vegetative parameters of cucumber varieties

Fruit weight attribute showed a significance difference among the growing conditions and growing seasons. Under open grown condition, the maximum fruit weight (241.03 g) was in Solan Srijan variety of summer season crop and lowest fruit weight (174.87 g) was in Swarna Sheetal variety in winter grown crop. Under protected (naturally ventilated poly house), Solan Srijan variety recorded maximum fruit weight (247.33 g) in summer season grown crop compared to Swarna Sheetal variety (199.89 g). This could be due to the genetic trait of individual variety and also optimum temperature and humidity in polyhouse condition. Bisht et al (2010), Hossain et al (2010) and Kumar (2014) also reported the similar findings. Under open field environmental condition, the maximum in yield per plant (1.28 kg) and yield per ha (23.46 t/ha) was in Solan Srijan variety of summer season grown crop and the lowest yield per plant (0.71 kg) and yield per ha (16.68 t/ha) was in winter season crop of Swarna Sheetal variety. Protected (naturally ventilated poly house) grown crop given maximum yield in two seasons compared to open field condition. The maximum yield per plant (2.44 kg) and yield per ha (44.73 t/ha) was in Solan Srijan of summer season grown crop. The increased yield under protected condition might be related to superior crop performance in terms of several yield contributing characters

such as per cent fruit set and the number of fruits per vine in polyhouse (Fig. 2). Rajasekar et al (2013) also reported that protected cultivation recorded increased yield in many vegetables including cucumber.

**Biochemical parameters:** The maximum content of TSS (3.79 °Brix) was recorded in Solan Srijan variety under protected in summer season compared to winter season (3.33 °Brix). In open environmental field 3.42 °Brix of TSS content was in Solan Srijan variety in summer season crop. These results were in accordance with the findings of Chandra et al (2003) under protected condition, while Cantore et al (2008), Ahmet and Vedat (2009) reported under open field condition. Solan Srijan variety had maximum (4.49 mg/100 g) content of ascorbic acid in winter season under protected grown environmental condition and in open field grown environmental condition, Solan Srijan variety had the maximum ascorbic acid (4.36 mg/100 g) content in winter season. The reduction in ascorbic acid is due to the formation of dehydro ascorbic acid by the ascorbinase enzyme. The above research results are in full agreement with the earlier work of Thangam and Thamburaj (2008) and Caliman et al (2010) under greenhouse condition and Kumar et al (2007) reported similar observations under open grown condition. Acidity values differ from season to season. The maximum

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

Growing conditions	Temperature (°C)				Relative humidity (%)			
	Summer		Winter		Summer		Winter	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
Open	34.8	29.3	27.8	21.4	79.5	67.4	62.4	59.3
Protected	38.5	31.6	28.3	22.3	91.4	74.8	71.6	63.4

**Table 2.** Impact of seasonal variations and growing conditions on fruit length, diameter and volume attributes of cucumber varieties

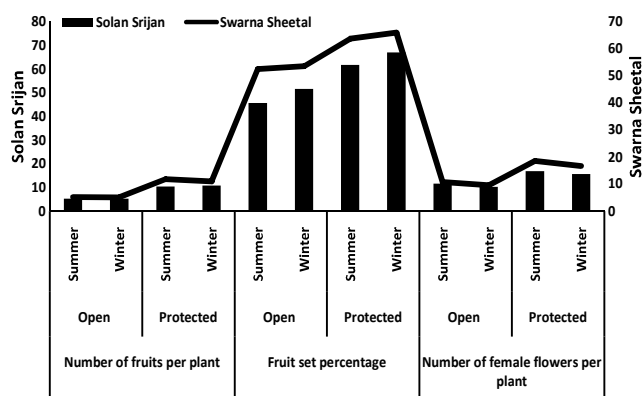
Varieties	Fruit length (cm)				Fruit diameter (cm)				Fruit volume (cm <sup>3</sup> )			
	Open		Protected		Open		Protected		Open		Protected	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Solan Srijan	19.56 <sup>a</sup>	17.90 <sup>ab</sup>	20.06 <sup>a</sup>	17.99 <sup>ab</sup>	3.56 <sup>ab</sup>	3.43 <sup>ab</sup>	3.66 <sup>ab</sup>	3.46 <sup>c</sup>	163.66 <sup>c</sup>	159.66 <sup>c</sup>	184.87 <sup>a</sup>	176.93 <sup>ab</sup>
Swarna Sheetal	16.66 <sup>ab</sup>	15.43 <sup>c</sup>	17.83 <sup>ab</sup>	16.81 <sup>ab</sup>	4.43 <sup>a</sup>	4.21 <sup>a</sup>	4.53 <sup>a</sup>	4.24 <sup>a</sup>	176.33	174.54 <sup>ab</sup>	183.51 <sup>a</sup>	181.56 <sup>a</sup>

**Table 3.** Impact of seasonal variations and growing conditions on yield attributes of cucumber varieties

Varieties	Fruit weight (g)				Yield per plant (kg)				Yield per hectare (t/ha)			
	Open		Protected		Open		Protected		Open		Protected	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Solan Srijan	241.03 <sup>a</sup>	234.26 <sup>a</sup>	247.33 <sup>a</sup>	233.52 <sup>a</sup>	1.28 <sup>ab</sup>	1.23 <sup>ab</sup>	2.44 <sup>a</sup>	2.31 <sup>a</sup>	23.46 <sup>ab</sup>	22.54 <sup>ab</sup>	44.73 <sup>a</sup>	43.81 <sup>a</sup>
Swarna Sheetal	182.22 <sup>ab</sup>	174.87 <sup>c</sup>	199.89 <sup>ab</sup>	191.89 <sup>ab</sup>	1.13 <sup>ab</sup>	0.71 <sup>c</sup>	2.24 <sup>a</sup>	2.18 <sup>a</sup>	17.04 <sup>c</sup>	16.68 <sup>c</sup>	42.06 <sup>a</sup>	38.96 <sup>a</sup>

**Table 4.** Impact of seasonal variations and growing conditions on quality attributes of cucumber varieties

Varieties	Total soluble solids ( <sup>o</sup> Brix)				Ascorbic acid (mg/100 g)				Acidity (%)			
	Open		Protected		Open		Protected		Open		Protected	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Solan Srijan	3.42 <sup>a</sup>	3.16 <sup>a</sup>	3.79 <sup>a</sup>	3.33 <sup>a</sup>	4.36 <sup>a</sup>	4.21 <sup>a</sup>	4.11 <sup>a</sup>	4.49 <sup>a</sup>	0.39 <sup>a</sup>	0.33 <sup>a</sup>	0.33 <sup>a</sup>	0.31 <sup>ab</sup>
Swarna Sheetal	3.08 <sup>ab</sup>	2.98 <sup>c</sup>	3.13 <sup>ab</sup>	3.11 <sup>ab</sup>	3.33 <sup>ab</sup>	3.13 <sup>c</sup>	3.43 <sup>ab</sup>	3.06 <sup>c</sup>	0.29 <sup>ab</sup>	0.26 <sup>c</sup>	0.40 <sup>a</sup>	0.37 <sup>a</sup>

**Fig. 2.** Effect of growing conditions and seasonal variations on flowering parameters of cucumber varieties

acidity content (0.40%) was recorded in Swarna Sheetal variety under protected in summer season. In open field environment condition maximum acidity (0.39 %) was recorded in Solan Srijan variety in summer season. The reduction in acidity might be attributed to the chemical interactions between the organic constituents of the pulp induced by temperature and the action of different enzymes. Similar findings were also reported by Ahmet and Vedat (2009) reported under open-field conditions.

### CONCLUSION

Weather factors such as temperature, relative humidity and rainfall plays a major role in the production of cucumber. The maximum temperatures recorded in the summer season under the protected condition. It influences the maximum yield compared to open condition. Solan Srijan variety given longer fruits as well as maximum yield compared to Swarna Sheetal variety. The above investigation proved that cucumber as a summer season vegetable crop and its given maximum vegetative growth, yield and quality in summer season under protected condition.

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