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Studies on the Effect of Training Systems on Cucumber (*Cucumis sativus* L.) cv. Malini Grown under Protected Conditions

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This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was conducted during 2016 and 2017 in Greenhouse at Vegetable Research Block, College of Horticulture Mojerla, Sri Konda Laxman Telangana State Horticultural University, Mulugu to clear the delusion among the farmers on the effect of different training systems on cucumber grown under protected conditions. The experiment comprised of a total of twelve treatments; Three training systems *viz*., T_1 (Single Head Training System), T_2 (Umbrella Training System), and T_3 (Low Middle Training System) were followed. Training T_1 was best in regards to vegetative and yield attributing traits. Among the treatments of training the maximum numbers of fruits per vine (23.08), yield per vine (5.90 kg), yield per hectare (133.08 t/ha),

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marketable yield (128.02 t/ha) and lowest percentage of deformed fruits (4.01%) were recorded in T_1. Data on vine length and leaf area at different intervals of growth phase were recorded and results indicated that they differed significantly for both parameters T_1 recorded highest value. The results obtained showed the maximum output from single head training system (T_1) indicating its significance.

Keywords: Greenhouse; cucumber; training systems; vine length; yield.

1. INTRODUCTION

Cucumber (*Cucumis sativus* L.) is an important summer vegetable crop grown in tropical and temperate regions of the world. It belongs to the family cucurbitaceae and is native to Southern Asia [1]. It is the fourth important vegetable crop after tomato, cabbage and onion in Asia [2]. It is used as salad, pickle and captioned as super food having no side effect. Cucumber is a primary source of vitamins and minerals [3]. Production of cucumber in India is mainly restricted to open field cultivation, certain biotic and abiotic stress conditions reduce the yield and quality of the fruits. The protected vegetable cultivation technology can be utilized for year-round production of high-value cucumbers with high yield and quality.

In India cucumber is cultivated in an area of 82,000 hectares and produces 12.6 lakh metric tonnes of cucumber With a production of 62.04 thousand metric tonnes, Telangana stands in 8th place among all other states of the country.

Production of cucumber under protected conditions emphasizes the need to maintain proper plant density, to boost up the production per unit area by utilizing the applied nutrients in available space, along with plant density, maintaining the plant population is also one of the key factors for increasing the yields with high quality and for maintaining the plants, pruning and training is done to cucumber plants An appropriate training system will not only facilitate better management and uniform light interception to the plants, but also will permit early flowering, fruiting, higher yield and higher yield of marketable fruits [4].

Generally, farmers cultivating cucumber in Telangana grow the plants by trailing the vines on overhead wires or trellies without following any training system and allow a greater number of fruits which affect the quality and yield of fruits. Training improves plant's ability to obtain the sun light needed for growth, adequate air movement around the plant reduces the risk of fungus and insect problems. Manipulation of canopy architecture through pruning and training together with appropriate spatial arrangements has been identified as key management practices for getting maximum, marketable yields from greenhouse crops [5].

Al-Harbi et al. [6] studied the influence of training systems and growing media on growth and yield of cucumber cultivars. They reported that training the plants on a single stem resulted in longest vine length, maximum leaf area and yield as compared to umbrella training system. Kumar et al. [7] conducted an experiment on response of parthenocarpic cucumber to fertilizers and training systems under naturally ventilated polyhouse in sub-tropical condition and reported that single stem training system recorded higher yield under naturally ventilated polyhouse.

Keeping the above-mentioned factors in consideration this investigation was carried out to study the effect of training on cucumber cultivar Malini grown under protected conditions.

2. MATERIALS AND METHODS

The present investigation was conducted during 2016 and 2017 in Greenhouse at Vegetable Research Block, College of Horticulture - Mojerla, SKLTS Horticultural University, Mulugu. The area of the research land is 357 m^2. The experiment comprised of a total of twelve treatments with three levels of training systems *viz*., T1 (Single Head Training System), T2 (Umbrella Training System) and T3 (Low Middle Training System). The experiment was laid out, following Completely Factorial Randomized Block Design (CFRBD) with three replications. Observations were recorded for fourteen different characteristics related to vegetative, fruit and yield attributing traits These observations recorded were vine length (cm), leaf area (cm^2), days taken to first flowering, days taken to 50% flowering, days taken to first harvest, number of fruits per vine, fruit length (cm), fruit diameter (cm), fruit weight (g), yield per vine (kg), yield per plot (kg), yield per hectare (t/ha), marketable

yield (t/ha) and deformed fruits (%) The data recorded for various characters were subjected to statistical analysis were carried out in accordance to Panse and Sukhatme [8].

3. METHODOLOGY FOLLOWED FOR TRAINING SYSTEMS

3.1 Single Head Training System

In Single Head Training System, the vines were trained on to the overhead wire, with a single stem. All the flower buds and lateral branches were removed from the base of the vines up to the height of 60cm and fruits were allowed on the main stem at the rate of one per axil. When the main vine reaches the overhead wire, it is winded with the wire and then allowed to grow towards the ground Robert et al. [9].

3.2 Umbrella Training System

In Umbrella Training System, all the flowers and lateral branches were removed up to a height of 60cm from the ground level. One fruit per axil is then allowed on the main stem up-to overhead wire. When the main vines reach the overhead wire, the growing point was clipped and then two healthy vigorous branches were allowed to grow along the wire up to 15cm in opposite directions. These were then trained to grow downwards with a fruit in each axil.

3.3 Low Middle Training System

In Low Middle Training System, all the flowers and lateral branches were removed up to a height of 70cm from the ground level and then 6 – 8 fruits were allowed. The vines were then left without any fruits until it reaches the overhead wire. When the main vine reached the overhead wire, the main stem was winded on to the cable up to 30cm and then growing point was clipped, then three healthy laterals were selected; one lateral is allowed to grow in the direction of the main stem along the wire for 20cm and the other two laterals in opposite direction of the main stem for 20cm and 30cm along the wire These three branches were allowed to grow downwards with a fruit each per axil.

4. RESULTS AND DISCUSSION

Data pertaining to various vegetative, fruit and yield contributing traits collected for the evaluation of treatments were statistically analyzed to test their significance levels and results of these data are presented given in tables 1 and 2.

Results showed that maximum vine length (293.79 cm), recorded in T_1 was due to the fact that the removal of laterals resulted in diversion of nutrients which lead to increased vine length. Similar results were reported by Kumar et al. [7] and Premalatha et al. [5]. The maximum leaf area found in T_1 (627.16) was due to better interception of sunlight into the canopy structure. Similar results were reported by Hao et al. [10]. The results obtained from days taken to first flowering and days taken to 50% flowering was observed to be non-significant which were similar to Dobrzanska et al. [11]. It is explicit from data that the days to first harvesting of cucumber was not significantly influenced by various levels of training Dimitrov et al. [12].

Results indicated that the number of fruits per vine was significantly influenced by various levels of training. The maximum number of fruits per vine (23.08) was recorded in T_1. This was due to more fruit set and more photosynthesis as plant produced longer vines and wider leaf area. There was non-significant influence of training on fruit length, diameter and weight. As these traits were influenced by dry matter partitioning, the changes in plant architecture in umbrella and low middle training systems appeared to be unfavourable for dry matter partitioning to fruit sink. Similarly, high leaf area might have affected the process under close spacing in single stem system, which is reflected in its higher value for these traits. This is also confirmed by the results of earlier experiments Kumar et al. [7], Lower and Edwards [13].

Training systems imparted significant influence on yield parameters. Maximum fruit yield per vine (5.98 kg), yield per plot (65.80 kg), yield per hectare (133.08 t/ha), marketable yield (128.02 t/ha) and lowest deformed fruits (4.01%) was obtained for treatment T_1.

The maximum yield in the treatment was due to certain yield promoting traits like vine length, leaf area, a greater number of fruits per vine and well exposure of fruits to light conditions and maintenance of canopy architecture through proper and timely training. The present investigation was inconsistent with the reports of Al- Harbi et al. [6], Kumar et al. [7], Kosson and Dobrzanska [14], Shirahmadi et al. [15], Tokatli and Ozgur [16] and Vikram et al. [17].

Table 1. Effect of training systems on vegetative traits of cucumber under protected conditions

Treatment	Vine length at 30 DAS (cm)	Vine length at 60 DAS (cm)	Vine length at 90 DAS (cm)	Leaf area at 30 DAS (cm^2)	Leaf area at 60 DAS (cm^2)	Leaf area at 90 DAS (cm^2)	Days taken to first flowering	Days taken to 50% flowering
T_1	97.61	206.69	293.79	346.80	494.76	627.16	31.50	36.35
T_2	95.44	201.18	286.53	346.20	487.15	623.00	31.70	36.40
T_3	94.29	202.54	284.44	343.7	486.71	623.40	31.80	36.60
SEm ±	1.19	0.48	1.65	1.66	2.28	0.55	0.13	0.12
CD at 5%	NS	S	S	NS	S	S	NS	NS

T_1 = Single head training system, T_2 = Umbrella training system, T_3 = Low middle training system, CD= Critical Difference, SEm= Standard error for mean

Table 2. Effect of training systems on fruit and yield attributes of cucumber under protected conditions

Treatment	Days taken to first harvest	Number of fruits per vine	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit yield per vine (Kg)	Fruit yield per plot (Kg)	Fruit yield per hectare (t/ha)	Marketable yield (t/ha)	Deformed fruits (%)
T_1	47.32	23.08	20.74	5.50	261.36	5.98	65.80	133.08	128.02	4.01
T_2	47.59	20.74	19.83	5.31	254.59	5.22	57.52	116.20	113.76	4.84
T_3	47.51	21.66	20.21	5.36	265.08	5.65	62.18	125.60	119.84	4.74
SEm ±	0.15	0.63	0.27	0.09	9.28	0.17	1.95	3.95	3.66	0.22
CD at 5%	NS	S	NS	NS	NS	S	S	S	S	S

T_1 = Single head training system, T_2 = Umbrella training system, T_3 = Low middle training system, CD= Critical Difference, SEm= Standard error for mean

5. CONCLUSION

From the results of the present study, it is evident that on the basis of overall performance of the training systems of cucumber, it may be concluded that the Single Head Training System reported highest vine length, wider leaf area, more number of fruits per vine, highest fruit yield per vine, yield per plot, yield per hectare, marketable yield and lowest deformed fruits (%). Therefore, it is recommended that Single Head Training System can be followed in cucumber under protected conditions.

Farmers cultivating cucumber by following this training system can increase their yield by two folds with better quality fruits. And those farmers who are cultivating cucumber in the vicinity of Hyderabad city can follow this training system which will be highly beneficial for them to get better yields and they can fetch more income by regulating the production in the market as well as many hotels and restaurants as it is popularly consumed as salad in most parts of the city.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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