STUDIES ON THE INTERACTION EFFECT OF PRUNING METHODS AND TRAINING SYSTEMS ON GROWTH AND YIELD OF CUCUMBER (*CUCUMIS SATIVUS* L.) CV. MALINI GROWN UNDER PROTECTED CONDITIONS

ABSTRACT

Aim: To study the interaction effect of pruning methods and training systems on growth and yield of cucumber cv. Malini under protected conditions.
Study Design: The research plot was laid out in Factorial Randomized Block Design (FRBD).
Place and Duration of study: The experiment was conducted in green house at vegetable block, College of Horticulture, Mojerla. Duration of crops is 3 months.
Methodology: Research was carried out with 12 treatments and 3 replications
Results: Pruning methods and Training systems interaction was assessed for growth and yield characters of Cucumber (*Cucumis sativus* L.) Cv. Malini under protected conditions during rabi season. The treatments consists of four levels of pruning *i.e.,*P_1 (Removal of flower buds up to 45cm), P_2 (Removal of flower buds up to 60cm), P_3 (Removal of flower buds up to 75cm), P_4 (No Pruning) and three levels of training systems *viz*., T_1 (Single head training system), T_2 (Umbrella training system), and T_3 (Low middle training system). Growth and yield characters were studied. Data collected was statistically analyzed using analysis of variance (ANOVA) and separation of means for significant effect was done by the use of Least Significant Difference (LSD) at 5% of probability. The results showed that among the interaction treatments maximum numbers of fruits per vine (25.33), yield per vine (6.97 kg), yield per hectare (154.90 t/ha), marketable yield (150.10 t/ha) were recorded in P_3T_1 followed by P_2T_1.
Conclusion: Single head training system with pruning up to 75cm (P_3T_1) was found to be the best treatment and the treatment P_2T_1 was found on par with it.

Keywords: *Cucumber, Greenhouse, Pruning methods, Training systems, Marketable Yield.*

INTRODUCTION

"Cucumber (*Cucumis sativus* L.) is one of the most important and popular vegetable crops grown widely throughout the tropical and subtropical regions of the world. It is a thermophilic and frost-susceptible horticultural crop usually cultivated in fields during spring-summer periodor in greenhouses in different seasons".(Bacci et al., 2006)"It is a creeping vine, thatgrows on trellises wrapping around supports with thin spiraling tendrils. The plant has large leavesthatform a canopy over the fruit. The fruit is roughly cylindrical in shape, elongated with tapered ends, and is used as salads, pickles and as a culinary vegetable. The fruits and seeds possess cooling properties, and they aremostly referred toas super foods having no side effects" (More TA, 2015).

India has emerged as the origin of the finest country for cucumber cultivation in various aspects. Cucumber is cultivated in an area of 1,04,000 hectares and produces 16,03,000 metric tonnes(NHB 2019-20).

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 the plant density, maintaining the plant population is also one of the key factors for increasing the yields with good quality. For maintaining the plants pruning and training is done to cucumber plants. Moreover, cucumber crop exhibits overcrowding of vines within a short time due to its fast growth habit and this causes problems for performing various cultural operations. This problem can be overcome by following training and pruning which are the essentialoperations to get the higher yield with better quality fruits.

Al - Obeid (2007) studied "the effect of growth techniques (pruning method) on production of cucumber grown in greenhouses and stated that single stem method resulted in highest yield".

Sanjeev *et al.* (2014) experimented"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".

Considering the above points an investigation was done to study the interaction effect of pruning and training systems on Cucumber (*Cucumis sativus* L.) Cv. Malini under protected conditions.

MATERIALS AND METHODS

The experiment was carried out in green house at vegetable block, College of Horticulture Mojerla, Sri Konda Laxman Telangana State Horticultural University during the Rabi season of 2016-17. Seminis seeds supplied the seeds of the cucumber crop. The experiment was laid out in Factorial Randomized Block Design. with three replicationson raised beds of size 21m having dimensions of 100 x 40 x 50 cm (width, height anddistance between two beds). The experiment comprises twelve treatments with four levels of pruning methods and three levels of training systems. As per the study, the observations attributing to the growth and yield of the crop was recorded and subjected to statistical analysis were carried out in accordance to Panse and Sukhatme (1985).

The plants were arranged on the beds as per the treatments which includes four levels of pruning *viz*. P_1 (Removal of flower buds up to 45cm), P_2 (Removal of flower buds up to 60cm), P_3 (Removal of flower buds up to 75cm) and P_4 (No Pruning) and three levels of training systems, T1 (Single head training system), T2 (Umbrella training system) and T3 (Low middle training system).

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".Sanjeev et al. (2014)

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".Sanjeev et al. (2014)

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".Sanjeev et al. (2014)

Treatment details:

T_1:	$P_1T_1T_4$: P_2T_1		T_7:	P_3T_1		T_{10}:	P_4T_1
T_2:	P_1T_2	T_5: P_2T_2	T_8:	P_3T_2	T_{11}:	P_4T_2	
T_3:	P_1T_3	T_6: P_2T_3	T_9:	P_3T_3	T_{12}:	P_4T_3	

RESULTS

The data of vegetative, flowering and fruiting traits were statistically analysed to test their significance and results of these data have been presented in Table 1 and 2.

VEGETATIVE AND FRUIT PARAMETERS

The plant height at all intervals of growth period is significantly higher in P_2 (291.80 cm). Whereas in case of training systems, T_1 (293.79 cm) recorded highest vine length. The interaction between pruning methods and training systems was observed to be non significant on vine length.

Leaf area determined 90 days after sowing was significantly different in all the treatments of interaction. But the treatment P_2 T_1 recorded highest leaf area (640.39 cm^2) and it was on par with P_3T_1 (638.89 cm^2).

Among various treatments of pruning P_2 (30.90) took lowest number of days to first flowering. Whereas training and interaction treatments were found to be non significant for the same parameter.

The results related to days taken to 50 % flowering was found non significant in all the treatments of pruning, training and interaction effect.

Meanwhile, the number of days taken to first harvest and number of fruits per vine were significantly different among pruning and training systems P_2 (23.77),T_1 (23.08) recorded the maximum values for the parameter number of fruits per vine. While, interaction effect was found non-significant for both the parameters.

Pruning treatments were found significant for the parameters fruit length, fruit diameter and fruit weight. Maximum data recorded is from P_2 treatment (20.85cm), (5.61cm), and (274.02g) respectively. For the same parameters the training treatments and interaction effect were found non-significant.

YIELD PARAMETERS

Various levels of pruning, training systems and interaction effect were found significant for all the yield parameters.

Maximum yield per vine, per plot, per hectare and marketable fruits was recorded in P_2 (6.40 kg), (70.14 kg), (141.68 t) and (137.15 t) respectively and it was on par with P_3 (5.80 kg), (63.10 kg) and (128.26 t). For training systems, the treatment T_1 recorded maximum yield per vine (5.98 kg), yield per plot (65.80 kg), yield per hectare (133.08 t) and marketable fruits (128.02 t).

Among treatments of interaction effect P_3T_1 recordedmaximum yield per vine (6.97 kg), per plot (76.68 kg), per hectare (154.90 t) and marketable yield (150.10 t) and it was on par with the treatment P_2T_1.

Deformed fruits parameter was found non-significant for all the treatments of pruning, training and interaction effect.

DISCUSSION

The longest vine length was reported in P_3T_1 might be due to the pruning and training treatments which lead to the diversion of nutrients to the main shoot, resulted in the exposure of pruned plant to light conditions which rather improved the photosynthetic activities of the plant. These results were similar to those ofSuthar *et al.* (2007) in cucumber.

Maximum leaf area was recorded in P_2T_1 might be due to better interception of sunlight into the canopy structure which resulted in wider leaf area. Similar results were reported by Hao *et al.* (2010) in cucumber.

The days to first flowering and 50 % flowering though found to be non-significant, P_2T_1 recorded lowest number of days. This may be due to the highest vine length and maximum leaf area. The results are in accordance with the findings of Suthar *et al.* (2007) and Kumar *et al,* (2014).

Fruit length, fruit diameter and fruit weight might be affected by dry matter partitioning, because of these pruning and training systems drastic changes are seen canopy architecture in umbrella and low middle training systems at a relatively younger stage appeared to be unfavourable for dry matter partitioning to fruits sink. Similar results were reported by Sanjeev *et al.* (2014) and Premalatha *et al.* (2006) in cucumber.

Among the yield parameters P_3T_1 recorded minimum days for first harvest and highest number of fruits per vine this was due to the wider leaf area which lead to enhanced photosynthetic activities resulted in a greater number of fruits per vine. Similar results were reported by Sanjeev *et al.* (2014).

Among the yield parameters P_3T_1 recorded the maximum values for all the parameters, this might be due to longest vine length, maximum leaf area, a greater number of fruits per vine, per plot comparing to other treatments. These results are in conformity with the findings of Suthar and Ram (2006), Sanjeev *et al.* (2014), Al- Habri *et al.* (1996) and Vikram *et al.* (2017) who reported that the yield of the plant increases as we increase the height of pruning operation we perform.

The same treatment of interaction P_3T_1 recorded maximum yield of marketable fruits and minimum percentage of deformed fruits because the fruits were subjected to open conditions which resulted in less incidence of pest and diseases and favoured the production of higher marketable yield when compared to other methods. The present results were inconsistent with the reports of Suthar *et al.* (2007) and Al- Habri *et al.* (1996) in cucumber.

Table 1. Interaction effect of pruning methods and training systems on vegetative attributes 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
P_1 T_1	95.08	204.75	292.92	346.40	484.87	627.09	31.50	36.60
P_1 T_2	92.17	200.14	286.07	350.80	485.97	626.13	31.70	36.70
P_1 T_3	92.01	202.01	288.03	345.10	485.80	624.68	31.90	36.70
P_2 T_1	97.31	217.97	294.55	352.40	505.77	640.39	30.80	36.10
P_2 T_2	103.43	205.09	291.48	347.50	496.72	633.25	30.90	36.20
P_2 T_3	99.77	207.11	289.39	345.70	497.61	634.47	31.20	36.30
P_3 T_1	108.19	205.86	302.43	349.00	502.54	638.89	31.60	36.30
P_3 T_2	98.21	202.88	288.19	344.70	488.11	630.90	31.90	36.40
P_3 T_3	97.22	203.55	282.01	344.00	487.15	633.18	31.90	36.50
P_4 T_1	89.87	198.21	285.28	339.50	485.88	602.27	32.30	36.40
P_4 T_2	87.97	196.64	280.40	342.00	477.81	601.83	32.30	36.60
P_4 T_3	88.17	197.50	278.36	340.10	476.28	601.42	32.40	37.10
SEm ±	2.38	0.97	3.30	3.33	4.56	1.10	0.26	0.24
CD at 5 %	NS	S	NS	NS	NS	S	NS	NS

DAS- Days after Sowing

Table 2. Interaction effect of pruning methods and 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 (%)
$P_1 T_1$	46.60	20.66	21.36	5.70	270.00	5.60	61.30	123.80	118.50	4.35
$P_1 T_2$	47.34	19.66	20.30	5.37	248.48	4.87	52.35	118.43	112.93	4.65
$P_1 T_3$	47.02	20.00	19.97	5.47	303.59	6.00	66.10	133.52	127.76	4.34
$P_2 T_1$	46.40	24.66	21.33	5.60	265.43	6.50	71.40	144.22	140.87	2.31
$P_2 T_2$	46.70	23.66	20.43	5.77	272.82	6.35	69.86	141.13	136.10	3.60
$P_2 T_3$	46.90	23.00	20.79	5.47	279.36	6.30	69.16	139.70	134.50	3.72
$P_3 T_1$	47.67	25.33	20.70	5.67	283.27	6.97	76.68	154.90	150.10	3.11
$P_3 T_2$	47.35	20.33	20.11	5.47	244.24	4.90	54.30	109.64	104.70	4.53
$P_3 T_3$	47.23	21.00	21.06	5.60	258.78	5.40	59.50	120.22	115.29	4.26
$P_4 T_1$	48.63	21.66	19.57	5.05	226.76	4.92	54.15	109.40	102.63	6.27
$P_4 T_2$	48.97	19.33	18.50	4.65	252.84	4.84	53.60	108.26	101.33	6.61
$P_4 T_3$	48.90	22.66	19.03	4.90	218.62	4.90	53.94	108.98	101.83	6.64
SEm ±	0.30	1.26	0.55	0.18	18.57	0.34	3.91	7.90	7.32	0.45
CD at 5 %	NS	NS	NS	NS	NS	S	S	S	S	NS

CONCLUSION

One of the key considerations for a successful intensive crop production is to maximize outputs while minimizing inputs. The farmers can control the loss caused by fast growth following proper pruning and training operations on the crop. Overcrowding of fruits on plant and fast growing nature of plant are the two problems seen in the farmer fields and this can be overcome by pruning up to 60cm and single head training system was found better for getting higher yields. While in case of interaction effect, single head training system with pruning up to 75cm (P_3T_1) was found to be the best treatment and the treatment P_2T_1 was found on par with it. According to the results, pruning of side vines and flowers up to 60cm or 75cm with single head training system is to be implemented by our farmers for better yields.

REFERENCES

Al-Harbi, A.R., Alsadon, A.A. and Khalil S.O. 1996. Influence of training system and growing media on growth and yield of cucumber cultivars. Alexandra Journal of Agricultural Research.41: 355-365.

Al-Obeid, S. 2007. Effect of growth techniques (pruning method) on the production of cucumber grown in greenhouses. Arab University Journal of agriculture science. 15(1): 19-27.

Bacci, L., Picanco, M.C., Gonring, A.H.R., Guedes, R.N.C. and Crespo, A.L.B. 2006. Critical yield components and key loss factors of tropical cucumber crops. Crop Protection. 25(10): 1117 – 1125.

Hao, X., Wen, G., Papadopoulos, A.P. and Khosla, S. 2010. A twin–head "V" High –wire greenhouse Cucumber production system for reducing crop start-up costs. Hort Technology.20(6): 963-970.

Kumar, Patel, N.B. and Saravaiya, S.N. 2014. Response of parthenocarpic cucumber to fertilizers and training systems under naturally ventilated polyhouse in sub tropical conditions. *International Journal of Current Research.* 6(8): 8051 – 8057.

More, T.A. 2015. Cucurbitaceous Vegetables (Cucumber). Textbook of Vegetables, Tuber and Spice crops. 254-261.

Panse, V.G and Sukhatme, P.V. 1985. Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi, India.

Premalatha, M.G.S., Wahundeniya, K.B., Weerakkody, W.A.P. and Wicramathunga, C.K. 2006. Plant training and spatial arrangement for yield improvements in greenhouse Cucumber *(Cucumis sativus* L.*)* varieties. Tropical Agricultural Research.18: 346-357.

Sanjeev Kumar, Patel, N.B. and Saravaiya, S.N. 2014. Response of parthenocarpic cucumber to fertilizers and training systems under naturally ventilated polyhouse in sub tropical conditions. International Journal of Current Research. 6(8): 8051 – 8057.

Suthar and Ram, M. 2006. Effect of pruning and ethrel application on vegetative growth and fruit yield of Cucumber under greenhouse condition. Haryana Journal of Horticultural Sciences.35: 92-95.

Suthar, M.R., Arora, S.K., Bhatia, A.K., Singh, V.P. and Malik, T.P. 2007. Effect of pruning and etheral application on flowering behavior of Cucumber (*Cucumis sativus.* L) under polyhouse conditions. Haryana Journal of Horticultural Sciences.36: 135-138.

Vikram, K.K., Ameta, K.D., Suresh kumar, T., Akshay,C., Suman, G. and Satveer yadav. 2017. Effect of spacing and training on growth and yield of polyhouse grown Cucumber (*Cucumis Sativus* L.). InternationalJournal of Current Microbiology and Applied Sciences. 6(8): 299 – 304.