Original Research Article

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 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. 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, Pruning methods, Training systems, Marketable Yield.*

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important and popular vegetable crops grown extensively throughout the tropical and subtropical region of the world. It is a thermophilic and frost-susceptible horticultural crop usually cultivated in fields during spring-summer period (Bacci *et al*., 2006) or in greenhouse in different seasons.Cucumber is a creeping vine, grows on trellises wrapping around supports with thin spiralling tendrils. The plant has large leaves, form a canopy over the fruit. The fruit is roughly cylindrical in shape, elongated with tapered ends and is used as salad, pickle and also as culinary vegetable. The fruits and seeds possess cooling properties and it is mostly referred as super food having no side effect (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 hectare and produces 16,03,000 metric tonnes.

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 important operations to get the higher yield with better quality fruits.

Comment [AO1]: It doesn't mention in the method?

Comment [AO2]: To make it easier to understand : The results showed that among the….

Comment [AO3]: Does have units?

Comment [AO4]: Suggestion : A Single head training system with pruning up to 75cm (P3T1) was the best treatment and the treatment P2T1 was on par with it.

Comment [AO5]: "Widely"

Comment [AO6]: regions

Comment [AO7]: greenhouses

Comment [AO8]: The cucumber

Comment [AO9]: Suggest : that Grows on trellises, wrapping……

Comment [AO10]: Spiralling or spiraling?

Comment [AO11]: large leaves that form a canopy

Comment [AO12]: Just suggestion : The fruit is roughly cylindrical, elongated with tapered ends, and used as salad, pickle, and culinary vegetables.

Comment [AO13]: Suggestion : The fruits and seeds, mostly called superfoods, possess cooling properties and have no side effects

Comment [AO14]: Better to remove.

Comment [AO15]: hectares

Comment [AO16]: Production of cucumber or Cucumber Production?

Comment [AO17]: Key or Critical ? Which better?

Comment [AO18]: Is?

Comment [AO19]: To? Or on?

Comment [AO20]: Pruning, which

Comment [AO21]: Just suggestion : which are essential to getting a 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) conducted an experiment on response of parthenocarpy c cucumber to fertilizers and training systems under naturally ventilated polyhouse in sub tropicalcondition 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. The seeds of the cucumber crop were supplied by Seminis seeds. The experiment was laid out in FRBD with three replicationson raised beds of size 21m having dimensions of 100 x 40 x 50 cm (width, height&distance between two beds). The experiment comprises of 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).

METHODOLOGY FOLLOWED FOR THE EXPERIMENT

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 *viz*. T1 (Single head training system), T2 (Umbrella training system) and T3 (Low middle training system).

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	

Table 1. Interaction effect of pruning methods and 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
P_1 T_1	95.08	204.75	292.92	346.40	484.87	627.09	31.50	36.60

Comment [AO22]: Cucumber production ?

Comment [AO23]: Single stem or single-stem ?

Comment [AO24]: Suggestion :experimented on the response

Comment [AO25]: Sub tropical or sub-tropical?

Comment [AO26]: 2016-17?

Comment [AO27]: Suggestion : Seminis seeds supplied the seeds of the cucumber crop.

Comment [AO28]: Better use : ,

Comment [AO29]: Remove of

Comment [AO30]: Suggestion : As per the study, the observations

Comment [AO31]: I don't get it, what is the meaning of training systems *viz?* maybe you can give describe above

Comment [AO32]: why is this data placed here? not in the results section?

$P_1 T_2$	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

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

Comment [AO33]: Is this right this data placed here? Not in result?

RESULTS

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

Comment [AO34]: With the use?

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 significanton vine length.

Comment [AO35]: Based on what?

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 fruitswas 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 treatmentT_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.

Comment [AO36]: Non-significant or insignificant? Which better?

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 in accordance with that of Suthar *et al.* (2007) in cucumber.

Comment [AO37]: More suitable : These results were similar to those of Suthar *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 bySanjeev*et al.* (2014).

Among the yield parameters P_3T_1recorded 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.

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. Owing to the results, we can clearly recommend pruning and training to the farmers for getting higher and quality yield. 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.

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.