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Impact of management practices on vegetative and reproductive characters of muskmelon (*Cucumis melo* L.) grown under shade net

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Abstract
An experiment was conducted to evaluate the different management techniques for growth and yield of muskmelon (*Cucumis melo* L.) grown under shade net condition during 2017-18 and 2018-19 at farmer field of Goggha village of Basava Kalyan taluk of Bidar district, Karnataka, India. The experiment was designed in Split-split plot technique with two retention of of one stem and two stems per vine as the main treatments, with retention of one fruit, two fruits and three fruits as three sub treatments and followed by foliar spray of fertilizers and only water as four sub-sub treatments. The vine did not responded significantly for any of the treatment for vine length, leaf blade length and leaf blade width. For the leaf area and leaf area index the main treatment of two stem per vine has significant effect on both leaf area with a maximum of 1042 and 1248 and 1250 cm^2, and leaf area indexwith 2.32, 2.78 and 2.87 respectively at the 20, 40 and 60 DAT.The treatment combinations of Main plot, sub plot and sub-sub plot had no significant influence on leaf area and leaf area index. Significantly highest yield was noticed in two stem per vine with 2.84kg, three fruits per vine with 2.77 kg and 2.91 kg for foliar spray with sulphate of potash @ 0.5%. for the fruit yield per meters squire again the main treatment two stems per vine has given highest yield of 3.7 kg m^{-2}, among various number of fruit retention three fruits per vine has resulted in the highest yield of 3.60 kg m^{-2}. Among the foliar spray, sulphate of potash @ 0.5% spray treatment yielded highest fruit yield of 3.78 kg m^{-2}. Similarly for fruit yield per hectare, the two stem, three fruit and foliar spray of sulphate of potash @ 0.5% has proved to be the super treatment by yielding 37.07, 36.11 and 37.98 kg ha^{-1} respectively.

Keywords: Management practices, vegetative, reproductive characters, muskmelon, *Cucumis melo* L.

Introduction
The concept of climate change has brought significant variation in yield of the horticultural crops. Its influence has been observed to be detrimental than the beneficial. Fruits crops are being the major component of horticulture, the performance of which is severely affected. The study of fruit crops under different climatic condition under which the fruit performance would be comparatively better. In this regard muskmelon being a fruit influenced by the change in the climate would be one among the examples to be considered for the study under different climatic condition such as shade net. The muskmelon is an important horticultural crop in arid and semi-arid regions, due to its good adaptation to the soil and climatic conditions (Kusvuran *et al.*, 2012) [4]. Muskmelon is gaining importance among the farmers due to its short duration, high production potential with high nutritive value, taste, and delicacy and also its suitability for cultivation under rain fed and irrigated conditions almost throughout the year. The muskmelon productivity is very low as compared to other vegetables in India. This may be due to pre-mature flower drop, lack of initiation of more female flowers in proportion to male flowers, inadequate source-sink relationship and poor translocation of photo-assimilates at later stages of crop growth. Although, the average potential yield of melons is 60 t ha^{-1}, the actual yield of muskmelon ranges from 12.5 to 20.0 t ha^{-1} depending on the management practices (Nempalsingh *et al.*, 2004) [5]. This gap certainly indicates that there is a great scope for improving the productivity by using suitable varieties coupled with modified growing conditions and management practices. In this situation, horticultural production under protected systems is an alternative to traditional field production, especially in highly profitable crops (Pardossi *et al.*, 2002) [7]. The development of muskmelon plants under greenhouse conditions compared to those developed in field, have many advantages such as precocity, increased yield and water and fertilizer use efficiency (Preciado-Rangel *et al.*, 2011).

Material and methods

The experiment consisted of twenty four treatments combination including training system fruit load and foliar spray of nutrients. The experiment was objectivised to standardize the training system, optimum number of fruit load per vine and foliar spray with suitable nutrient to enhance vine growth and fruit yield under shade net condition. The muskmelon vines were supported by the trellising structure to grow vertically. The main treatments were (T_1) training system with retention of one stem or (T_2) two stems per vine with retention of (F_1) one, (F_2) two and (F_3) three fruits per stem as sub treatments followed by the foliar spray of nutrient using different sources viz. (S_1) water spray, (S_2) 19:19: 19 @ 1.0%, (S_3) potassium nitrate @ 0.5% and (S_4) sulphate of potash @ 0.5%. The statistical design of split-split plot technique was employed for layout and analysis of data to draw the conclusions. The observation on growth parameter and yield parameters at various stages of its crop growth as influenced by the treatment were recorded which are depicted in the tables.

Results and Discussion

Vine length

No significant difference for vine length was observed among the treatments at all the stages (20, 40 and 60 DAT). High Ervine length of 39.23, 199.17 and 223.75 cm was recorded in T_2 (two stem per vine). This higher length might be because of thinning the branches on the main stem of vine might have diverted the resources and compensated the vegetative growth of the stems. Among the treatment combinations of number of fruits per vine and the foliar spray with fertilizers have not influenced much on the vine length (Table1).

Table 1: Effect of training systems, fruit load and foliar sprays of fertilizers on vegetative growth parameters at different growth stages of muskmelon grown under shade net condition

Treatment	Vine length (cm)			Leaf blade length (cm)			Leaf blade width (cm)		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
Main plot (No. of stems per vine) (T)									
T_1: One stem per vine	28.08	144.96	222.95	7.03	8.20	8.30	8.63	9.10	9.44
T_2: Two stem per vine	39.23	199.17	223.75	7.21	8.35	8.33	8.73	9.36	9.50
S.Em. ±	0.11	22.51	0.32	0.21	0.12	0.02	0.17	0.05	0.04
CD at 5%	0.70	NS	NS	NS	NS	NS	NS	NS	NS
Sub plot (No. of fruits per stem) (F)									
F_1: One fruit per stem	27.89	227.26	223.04	7.06	8.23	8.46	8.58	9.28	9.47
F_2: Two fruits per stem	27.86	144.36	222.93	7.17	8.21	8.31	8.65	9.21	9.48
F_3: Three fruits per stem	27.65	144.56	224.08	7.13	8.24	8.40	8.80	9.24	9.47
S.Em. ±	0.03	27.57	0.25	0.10	0.12	0.07	0.07	0.08	0.02
CD at 5%	NS	NS	0.81	NS	NS	NS	NS	NS	NS
Sub-Sub plot (Foliar sprays) (S)									
S_1: Spray with water	27.71	182.48	222.60	7.14	8.34	8.40	9.19	9.25	9.47
S_2: 19:19:19 @1.0%	27.55	144.45	223.07	7.10	8.23	8.42	9.12	9.21	9.45
S_3: 13:0:45 @ 0.5%	27.73	182.60	223.98	7.60	8.25	8.47	9.18	9.25	9.47
S_4 : 0:0:50 @ 0.5%	27.97	178.71	223.74	7.16	8.10	8.28	9.22	9.46	9.50
S.Em. ±	0.03	31.84	0.23	0.13	0.21	0.08	0.08	0.03	0.03
CD at 5%	NS	NS	0.65	NS	NS	NS	NS	NS	NS
Interaction (T × F × S)									
S.Em. ±	0.07	77.99	0.55	0.32	0.52	0.19	0.20	0.07	0.06
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

DAT-Days after transplanting NS-Non significant

Leaf blade length and width

Among the treatments of training system, number of fruits load and foliar sprays were noticed in the leaf blade length the difference was non-significant.The minimum leaf blade length was 7.03 cm and highest was 8.65 cm.The influence of different treatment combinations of training system, fruit load and foliar spray with fertilizers and their interaction was non-significant effect on the width of the leaf at 20, 40 and 60 DAT of the crop growth stages. The minimum leaf width was 8.63cm and highest was 9.50cm.

Leaf area and Leaf area index

Significant difference in the leaf area was recorded at different stages of crop growth (Table 2). An increasing leaf area was observed as the crop age advanced. Among the main plot treatment, (T_2) two stems per vine has leaves with higher leaf area of 1042.44, 1250.50 and 1247.69 cm^2at 20, 40 and 60 DAT respectively. Among the fruit load per stem and foliar sprays with fertilizers have shown non-significant influence on leaf area. Shivaraj *et al.* (2018) [10] in their study on effect of training and pruning in cucumber under protected conditions, reported the highest leaf area. The maximum leaf area might be due to increase number of leaves due to two stems. However the effect of treatment number of fruit retention, foliar spray with fertilizers and interaction of treatments on leaf area was not significant.

The data on leaf area index presented in Table 2 has varied among the main plot treatments were showed non-significant difference in the sub plot treatments and sub -sub plot treatments at 20, 40 and 60 DAT of crop growth stage. Among the treatments, two stems per vine had recorded higher leaf area index in pooled mean value of two years (13.90 at 20 DAT, 16.67 at 40 DAT and 16.64 at 60 DAT) of leaf area index. The trend remained same at all the stages of growth. The increased leaf area index might be due to increased density of stem in two stems per vine. The similar results were obtained by Nereu *et al.* (2014) [6] in cassava.

Table 2: Effect of training systems, fruit load and foliar sprays of fertilizers on leaf parametersat different growth stages of muskmelon grown undershade net condition

Treatment	leaf area ($cm^2 plant^{-1}$)			Leaf area index		
	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
Main plot (No. of stems per vine) (T)						
T_1: One stem per vine	737.00	924.61	932.00	1.67	2.06	2.17
T_2: Two stem per vine	1042.44	1250.00	1267.00	2.32	2.78	2.87
S.Em. ±	46.34	51.68	12.90	0.62	0.08	0.11
CD at 5%	285.89	35.05	79.60	3.81	0.47	NS
Sub plot (No. of fruits per stem) (F)						
F_1: One fruit per stem	880.00	1081.00	1127.00	1.96	2.40	2.50
F_2: Two fruits per stem	902.90	1093.00	1142.00	2.01	2.43	2.53
F_3: Three fruits per stem	910.00	1088.00	1150.28	2.02	2.42	2.47
S.Em. ±	18.29	16.81	8.43	0.24	0.22	0.17
CD at 5%	NS	NS	NS	NS	NS	1.06
Sub-Sub plot (Foliar sprays) (S)						
S_1: Spray with water	895.00	1103.00	1127.00	1.99	2.45	2.54
S_2: 19:19:19 @1.0%	893.00	1086.00	1046.00	1.99	2.42	2.59
S_3: 13:0:45 @ 0.5%	895.00	1086.89	1099.00	1.99	2.42	2.48
S_4 : 0:0:50 @ 0.5%	908.00	1074.50	1137.00	2.02	2.39	2.47
S.Em. ±	25.56	22.34	10.76	0.34	0.30	0.14
CD at 5%	NS	NS	NS	NS	NS	NS
Interaction (T × F × S)						
S.Em. ±	62.62	54.73	26.37	0.84	0.73	0.35
CD at 5%	NS	NS	NS	NS	NS	NS

DAT-Days after transplanting NS-Non significant

Fruit yield per vine

Among the main plot the practice of (T_2) two stems per vine resulted in significantly higher fruit yield of 2.84 kg followed by (T_1) single stem per vine 2.45 kgvine^{-1}as depicted Table 3.The significantly higher yield per vine was obtained with 2.84 and2.45 kg in the vine trained with two stems per vine and in one stem per vine respectively. The influence on fruit yield per vine due to sub- plot treatment (number of fruits per stem) was found significant. The fruit load with three fruits per vine had given significantly the higher yield per vine with (2.77 kg) and F_2 (two fruits per stem) was on par by producing the fruit yield 2.56 kg. Effect of foliar spray with different fertilizers had given significant variation in fruit weight. The foliar spray with the sulphate of potash @ 0.5% had given highest fruit weight of 2.91 kg vine^{-1}. The interaction of training system and fruit retention had also contributed significantly towards fruit weight per vine. The significantly higher weight of fruits were obtained in the training system with one stem and two fruits per stem (3.07 kg of fruits per vine) and was followed by (T_1F_3) training with two stems and two fruits per stem was 2.82 kg vine^{-1}.The influence on the fruit yield per vine due to the interactions of training system and foliar spray was found significantly highest fruit yield per vine was obtained from the T_2S_3 by producing fruits of 2.89 kg vine^{-1}.The fruit yield per vine was found to be influenced significantly by interaction of fruit load and foliar spray throughout the experiment. The significantly highest yield per vine was recorded in F_3S_4 (three fruits per stem, foliar spray with sulphate of potassium @ 0.5%) 3.07 kg vine^{-1}and in F_3S_3 alone found on par (2.83 kg vine^{-1}).The overall interaction of the entire main plot, sub-plot and sub-sub plot treatment combination was found to be significant with respect to fruit yield per vine. In the pooled mean the highest fruit yield per vine was observed in $T_2F_1S_4$ (training with two stems, one fruit per stem, sulphate of potash @ 0.5%) by producing fruits of 3.30 kg per vine, was on par with $T_1F_3S_4$ (3.14 vine^{-1}), $T_2F_1S_3$ (3.13 vine^{-1}), $T_2F_1S_2$ and $T_2F_2S_4$ (3.05 vine^{-1} each) Ultimately the treatment combination of T_2F_1 S_4 found to be most efficient to produce higher yield of fruits per vine. The result obtained by Gobeil and Gosselin (1989) [2] in cucumber, Changping *et al.* (2009) [1] melons are in line with the present study.

Table 3: Effect of training systems, fruit load and foliar sprays of fertilizers on fruit yield per vine (kg) of muskmelon grown under shade net condition

T× F × S		Fruit yield per vine (kg)					Fruit yield (kgm^{-2})					fruit yield($t\ ha^{-1}$)				
		S_1	S_2	S_3	S_4	T × F	S_1	S_2	S_3	S_4	T × F	S_1	S_2	S_3	S_4	T × F
T_1	F_1	1.87	1.93	2.00	2.05	1.96	2.41	2.52	2.57	2.65	2.54	24.06	24.92	25.79	26.45	25.30
	F_2	2.21	2.43	2.70	2.91	2.56	2.89	3.17	3.54	3.79	3.35	28.65	31.51	35.11	37.91	33.30
	F_3	2.50	2.70	2.92	3.14	2.82	3.25	3.54	3.82	4.12	3.68	32.45	35.18	38.11	41.05	36.70
T_2	F_1	2.81	3.05	3.13	3.30	3.07	3.65	3.95	4.06	4.29	3.99	36.58	39.78	40.84	43.17	40.09
	F_2	2.46	2.61	2.81	3.05	2.73	3.24	3.42	3.69	3.97	3.58	31.92	33.98	36.65	39.84	35.60
	F_3	2.54	2.61	2.73	3.00	2.72	3.20	3.44	3.57	3.88	3.52	33.05	33.92	35.72	39.44	35.53
S		2.40	2.56	2.72	2.91	-	3.11	3.34	3.54	3.78	-	31.12	33.21	35.37	37.98	-
		T× S				T	T × S				T	T × S				T
T_1		2.19	2.35	2.54	2.70	2.45	2.85	3.08	3.31	3.52	3.19	28.39	30.54	33.00	35.14	31.77
T_2		2.60	2.76	2.89	3.12	2.84	3.37	3.60	3.77	4.04	3.70	33.85	35.89	37.73	40.82	37.07
		F × S				F	F×S				F	F × S				F
F_1		2.34	2.49	2.56	2.68	2.52	3.03	3.24	3.32	3.47	3.26	30.32	32.35	33.31	34.81	32.70
F_2		2.34	2.52	2.76	2.98	2.65	3.07	3.30	3.61	3.88	3.47	30.28	32.74	35.88	38.88	34.45
F_3		2.52	2.66	2.83	3.07	2.77	3.23	3.49	3.69	4.00	3.60	32.75	34.55	36.91	40.24	36.11

Interactions	S.Em. ±	C.D. at 5%	S.Em. ±	C.D. at 5%	S.Em. ±	C.D. at 5%
Training systems	0.02	0.13	0.01	0.08	0.22	1.36
Number of fruits	0.03	0.16	0.02	0.07	0.20	0.64
Foliar sprays	0.13	0.33	0.06	0.10	0.56	0.91
T × F	0.13	0.33	0.06	0.10	0.56	0.91
T× S	0.07	0.24	0.03	0.10	0.28	0.86
F × S	0.08	0.27	0.04	0.10	0.34	0.98
T ×F × S	0.11	0.39	0.05	0.15	0.48	1.38

T_1 – One stem per vine
T_2 -Two stem per vine
F_1- One fruit per stem
F_2-Two fruits per stem
F_3 -Three fruits per stem
S_1: Spray with water
S_2: 19:19:19 @ 1.0%
S_3: Potassium nitrate (13:0:45) @ 0.5%
S_4: Sulfate of potash (0:0:50) @ 0.5%

Fruit yield

There existed a significant variation in fruit yield per square meter of the cropped area as data depicted in Table 3.Treatment T_2 (two stems per vine) resulted in significant higher yield of 3.70 kg m^{-2}. However T_1 (one stem per vine) resulted in significantly lower fruit yield 3.19 kg m^{-2}. In sub plot treatment F_3 (three fruits per stem) have produced higher fruit yield of 4.00 kg m^{-2}.Sub- sub plot treatment of S_4 (spray with Sulphate of potassium @ 0.5%) emerged as a best practice to produce fruit yield with 3.78 kg. This implies that among the different foliar sprays S_4 (spray with sulphate of potassium @ 0.5%) was promising in increasing the yield. Interaction between training and fruit load had shown significant effect on the fruit yield m^{-2}. The T_2F_1 has yielded more per unit area with 3.99 kg m^{-2} which was followed by T_1F_3 by yielding 3.68 kg m^{-2}. Among the treatment combination of training system and foliar spray T_2S_4 has given maximum fruit yield m^{-2} with 4.04kg m^{-2} and followed by T_2S_3 with 4.04 kg m^{-2}.Interaction effect by the fruit load with foliar spray had significant influence on fruit yield per unit area. The treatment F_3S_4 has produced higher yield of 4.00 kg m^{-2} and was followed by F_2S_4 by producing 3.88 kg m^{-2}. The overall interaction of training system, fruit load and foliar spray with potassium the treatment combination of $T_2F_1S_4$ was found superior for production of higher yield m^{-2} by producing 4.29 kg m^{-2}. Hence practice of T_2 F_1 and S_4 (training with two stem per vine, one fruit per stem and foliar spray with Sulphate of potash @ 0.5%) would result in significantly increased fruit yield per square meter of cropped area. The assessment of yield per square meter area implies not only the effective utilization of cropped area, nutrients and natural resources available in it and has effectively utilized the natural resources reflecting in the increased yield per square meter area. Observation of Changping *et al.* (2009) [1] in melon found to be similar with present findings.

Fruit yield

Cultivation of a crop is the combination of various cultural practices aiming towards increase in the yield coupled with better quality fruits. In these concepts, Maintenance of two stems per vine has resulted in significant higher fruit yield of 37.07 t ha^{-1} per hectare. The retention of varied number of fruits also resulted in significantly higher yield 36.11 t ha^{-1} through F_3 (three fruits per stem) as depicted in Table 3.Application of fertilizers through S_4 (spray with Sulphate of potassium @ 0.5%) has led to harvest yield of 37.98 t ha^{-1}. The interaction effect of training and the fruit retention influenced significantly on fruit yield (t ha^{-1}). The highest yield was obtained through 40.09 t ha^{-1}.Among the training system and foliar spray, interaction of treatment combinations, T_2 S_4 found significantly high fruit yielding treatment by producing 40.82 t ha^{-1}. The treatment combinations of fruit load and foliar spray the treatment combination of F_3S_4 has yielded with production of 40.24 t ha^{-1}. Among the overall treatment combination of training system, fruit load and foliar spray with potassium the maximum yield was obtained in $T_2F_1S_4$ by yielding significantly higher yield of 43.17 t ha^{-1}. Hence it can be opined from the above results that the treatment $T_2F_1S_4$ proved best treatment combination to obtained higher yield with quality fruits.

The combined practice of T_2F_3 and S_4 (two stems per vine, three fruits per stem and Sulphate of potassium @ 0.5%) revealed that the cultivation of musk melon under shade net condition promised the significant increase in yield. Maintenance of two stems ultimately increased the bearing area in a vine. More number of fruits retained per stem induced the increased yield per ha. Rodriguez, *et al.* (2007) [9] reported from their study that higher yield muskmelon fruits can be achieved under protected condition. On the contrary it was observed that the average fruits in F_3 (three fruits per stem) observed to be the least. Hence retention of more number of fruits normally does not mean in increased yield and quality. Kashi and Abedi (1998) [3] in melon have opined similar in their study of fruit thinning and pinching on melon which is confirmative with present study.

Conclusion

The main treatment of two stem per vine has more influence on growth and yield parameters of muskmelon grown under shade net. Sub plot treatment of number of fruit retention and sprays with fertilizers have no much influence on vine length, leaf blade length and leaf blade width. For yield parameters like fruit yield per vine and yield per unit area, though the more fruits per vine have yielded highest but among the treatment combination two stem per vine one fruit per vine has yielded highest yield. Over all the treatment combination of two stem per vine with fruit load of one fruit per stem and foliar spray of sulphate of potash @ 0.5% proved to be promising practice for higher yield of fruits of musk melon grown under shade net condition.

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