



Effect of spacing and pruning on growth, yield and economics of long melon (*Cucumis melo* var. *utilissimus*) under naturally ventilated polyhouse

AWANI KUMAR SINGH¹, NAVED SABIR¹, GOGRAJ SINGH JAT¹, JOGENDRA SINGH¹,
VEERPAL SINGH¹, AJEET SINGH¹, ANIL KUMAR¹ and JUGENDRA KUMAR¹

ICAR-Indian Agricultural Research Institute, New Delhi 110 012, India

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ABSTRACT

The present experiment was conducted in naturally ventilated polyhouse structure at CPCT, ICAR-IARI, New Delhi for off-season cultivation of long melon (*Cucumis melo* var. *utilissimus*) during 2016 and 2017 under five plant spacing and five branch pruning methods. Plant spacing and pruning methods revealed significant positive influence on yield and net return. Fruit yield decreased with increasing plant spacing and it was found maximum in closer spacing of 50 cm × 20 cm. The net return and B:C ratio also followed similar trends. Among different pruning methods, node branch pruning method (P₃) gave highest yield (76.35 q/1000m²) with maximum net return of ₹ 81020/1000m² and BC ratio 1:1.36 compared to other pruning intensity or no pruning (control). Pruning method involving three nodes per branch was statistically at par in net return and BC ratio with two-nodes per branch method. Study showed that off-season cultivation of long melon under polyhouse structure is a good option to farmers for generating more income and employment.

Keywords: Long melon, Plant spacing, Protected structure, Polyhouse, Pruning methods

Long melon, commonly known as *kakari* (*Cucumis melo* var. *utilissimus*) is cultivated in north India during summer months. It is grown in river beds and *Diara* lands in sub-tropical and milder zones, covering the states of Bihar, Uttar Pradesh, Madhya Pradesh and Rajasthan, etc. It requires temperatures of 25–30°C, relative humidity of 60–70% and sun shine between 700–800 w/m² during its growing period. The crop is available in summer months and eaten fresh to beat the heat. It is good source of water, minerals and vitamin C. It is also used as salad, vegetable and preserved in the form of sweets. Fruits are long (40–50 cm), straight, thin; light green in colour and cylindrical in shape. The supply of fruits is restricted to summer months only but the demand of fruits in the cities and towns continues up to early winter. The supply of *kakari* fruits is highly unlikely during off-season (from rainy months to early winter months) because of heavy losses in yields due to various biotic and abiotic stresses prevalent in these months under open field conditions. Off-season cultivation in polyhouse structure is suitable option for farming community to produce quality fruits for fetching more income. Success of long melon cultivation under net house may give high yield and more

return. However, limited information is available on long melon cultivation under polyhouse structure. Therefore, the present study was undertaken during off-season (September to March) to assess the response of long melon variety Chandrlekha to spacing and pruning methods under naturally ventilated polyhouse structure.

MATERIALS AND METHODS

The experiment was conducted at the Centre for Protected Cultivation Technology (CPCT), ICAR-IARI, New Delhi, during September–March, 2016 and 2017. Long melon variety Chandrlekha was grown under five plant spacing and five pruning methods. Various plant spacing's, viz. S₁ (50 cm × 20 cm), S₂ (50 cm × 30 cm), S₃ (50 cm × 40 cm), S₄ (50 cm × 50 cm) and S₅ (50 cm × 60 cm) were used for comparison. Similarly various pruning methods, viz. P₀ (control: no pruning), P₁ (all branches pruned: single stem cultivation), P₂ (all branches retained, pruned after 1st node), P₃ (all branches retained, pruned after 2nd node) and P₄ (all branches retained, pruned after 3rd node). Butterfly designed polyhouse made of GI pipes with double span and natural ventilation was used. Polyhouse used had a side height of 3 m gutter height 4 m center height and 6 m length × width 25 × 20 m covered with white colour UV stabilized (200 micron thick) transparent, anti drip and anti dust polythene on top of roof area, side cover by 40 mesh nylon insect-proof net, 50% anti-sun screen net and shade net. Side cover curtains were made up of 100 micron thick UV stabilized transparent polyethylene. Polyhouse

Present address: ¹ICAR-Indian Agricultural Research Institute, New Delhi. *Corresponding author e-mail: singhawani5@gmail.com.

was manually controlled to maintain the temperature and humidity within optimum limits with the help of 50% shading capacity, silver colour, anti-sun screen net and green colour shade net, rolling side poly curtain and roof ventilation windows. The experiment was laid down in completely randomized block design with three replications and 25 treatment combinations.

The 20 days old seedlings of *kakari* (var. Chandralekha) were transplanted in the polyhouse structure. The soil was sandy loam with pH 8 and EC up to 2 micro mho. The experimental plots size was 1 m × 2.5 m. Compost @ 200 q/1000 m² and 50% of NPK dose (25:17:26 kg/1000 m²) was incorporated in the plots as basal dose before 15 days of planting. Remaining 50% of NPK was applied in the form of water soluble fertilizer (20:20:20 NPK) through drip-fertigation system twice in a week. The application of water soluble fertilizer started after 2 weeks of transplanting. The concentration of applied nutrients used was gradually increased from 100 ppm, 150 ppm and then 200 ppm with increasing age of the crop. Before planting the seedlings of *Kakari* crop, the soil of experimental plots was disinfected from soil-borne diseases by solarization technique. Double lateral line of 2 LPH capacities with 14 mm drip irrigation system was installed in all plots before transplanting. The drip irrigation system was operated by low-pressure or gravity pressure technique. Two separate water tanks @ 500 l capacity were kept on the height and width of 1.5 m × 1 m made by cemented platform and these tanks were connected from water source. Vertical cordon trimming method was used to prune the *kakari* plant at weekly interval after 20-25 days of transplanting. Daily operation of pollination by hand was compulsory during morning hours (7-9 AM). The infestation of fungal and insect pest on crop was controlled by need based *Trichoderma viride* or bavistin, Indofil M-45, regent, confidor, dicofol, neemgold pesticides @ 0.5-1 g or ml per litre water.

Four plants were tagged in each plot for weekly data recording. The data on plant growth, flowering and yield traits were recorded (Table 1). All kind of dead plants from transplanting to last day and % of unmarketable fruits from first picking to last picking was calculated. The yield contributing factors (fruits per plant, fruit diameter, length of fruits, fruit weight (kg/plant) were recorded and expressed as kg/m² and quintal per 1000 m². The data were analyzed using standard statistical methods (SPSS-21). Fruit yield of long melon per 1000 m² was calculated on the basis of fruit weight per plant multiplied by number of plants per square meter multiplied by 700 m²; because of crop area of 700 m² is generally covered with crop in 1000 m² under protected net house structure.

Yield (q/1000 m²) = (Fruit weight kg/plant × number of plants/m² × 700 m²) ÷ 100.

Gross income = Total yield × Cost of fruit

Net income = Gross income – Cost of cultivation

Benefit: cost ratio (B:C) = $\frac{\text{Gross income}}{\text{Cost of cultivation}}$

RESULTS AND DISCUSSION

Monthly mean values of temperature and relative humidity inside the polyhouse vis-a-vis ambient condition calculated from daily records for two years. The maximum and minimum mean temperature from September to March under polyhouse was 30.47°C and 13.90°C whereas relative humidity recorded was 83.34% and 44.60% respectively. The maximum and minimum mean temperature for the similar period under ambient condition was 27.77 and 12.09°C, whereas relative humidity recorded was 88.35% and 48.17% respectively. The higher humidity might be due to low circulation of atmospheric air inside polyhouse. Similar findings were reported by Margal *et al.* (2016), Jat *et al.* (2015 & 2016), Singh *et al.* (2017).

Growth characters: Plant height, number of leaves per plant, number of branches per plant, biomass weight, root length and fresh root weight per plant increased significantly with increased plant spacing from S₁ (50 cm × 20 cm) to S₅ (50 cm × 60 cm) (Table 1). These factors are responsible for influencing maximum growth and development of plants (Singh *et al.* 2015 and 2016). Plant spacing also influenced fruit setting percent significantly. Male-females flower ratio was recorded maximum (75:25) on wider spacing (S₅), successive fruit (%) recorded maximum (39%) but almost at par in the spacing S₁ to S₄, showing no significant difference between spacing to spacing treatments. However, wider spacing S₅ produced maximum female flowers per plant but influence lower % of successive fruit setting (36%) and showing significant effect with 4.32% difference between closer to wider spacing. The female flowers were increased with increasing of spacing (S₁ to S₅). Data on increasing of spacing (Table 1) showed around 4.32% difference between spacing increasing towards closer to wider spacing. Due to the fact that wider spacing (50 cm × 60 cm) produced maximum marketable fruits and less number of fruits was recorded from other closer spacings. Similar findings were also reported by Oga and Umekewe (2016) and Singh *et al.* (2016). Data revealed that increased plant spacing significantly decreased the percent of unmarketable fruits and plant mortality (Table 1). The unmarketable fruits were less (3.82%) in wider spacing (S₅) but higher (6.08%) in closer spacing (S₁). Similar trend was observed in case of plant mortality (Sing *et al.* 2003, 2005, 2016). The reasons might be minimum competition between plant for space, nutrients, water and light etc. There was no significant effect of spacing on flower initiation days, first fruit picking days and total number of fruit pickings. But, the initial flowering and first fruit picking were delayed by 5 and 4 days, respectively, at spacing S₁ than S₄ and S₅. Total number of fruit picking increased with increased spacing (Table 1). Also reported similar results by Davi and Verma (2014) and Singh *et al.* (2003, 2005, 2016). Maximum plant height was recorded when all branches of plants were pruned (P₁) followed by P₂, P₃, and P₄. The reason of more height at P₁ might be nutrient availability only to main stem in the absence of branches. Pruning methods significantly influenced the number of branch (14.56), number of leaves

Table 1 Effect of different spacing and pruning methods on growth characters of long melon under naturally ventilated polyhouse structure during off-season (pooled data of 2016 and 2017)

Treatment	Initiation of flowering (days)	First picking start (days)	Total number of picking	Total picking period (days)	Plant height (m)	Number of leaves	Number of branch	Fresh wt. of green biomass (kg)	Length of fresh roots (cm)	Fresh wt. of roots (gm)	% of male and female flower ratio	% of success fruit setting	% of success fruit setting	% of unmarketable fruits	% of plant mortality
<i>Plant spacing's</i>															
S ₁ (50×20cm)	29	37	14	85	2.45	58.50	9.79	0.85	24.38	85.35	83:17	39	61	21.18	13.04
S ₂ (50×30cm)	26	35	15	92	3.13	76.94	12.52	1.12	25.74	89.04	82:18	38	62	22.20	11.13
S ₃ (50×40cm)	25	34	16	98	3.51	84.67	14.02	1.26	28.49	93.51	81:19	39	61	23.36	8.85
S ₄ (50×50cm)	24	33	17	104	3.56	85.62	14.24	1.6	31.51	98.78	80:20	39	61	25.03	8.02
S ₅ (50×60cm)	24	33	17	104	3.80	92.13	15.20	1.84	34.36	98.82	79:21	36	64	25.05	8.04
CD at 5%	NS	NS	NS	3.70	0.52	1.35	0.43	0.12	0.80	1.08	NC	0.32	0.35	0.32	0.40
<i>Pruning methods</i>															
P ₀ (Control/no pruning)	27	36	12	87	3.10	123.87	14.56	1.55	23.08	81.92	85:15	46	54	19.69	11.63
P ₁ (All branch pruning)	24	32	15	90	3.64	36.39	12.39	0.81	33.20	107.41	84:16	34	66	20.55	8.28
P ₂ (One node pruning)	25	34	16	100	3.37	60.67	13.48	1.25	32.10	97.69	82:18	44	56	21.99	8.84
P ₃ (Two node pruning)	26	35	18	103	3.22	77.36	12.89	1.37	29.17	90.76	79:21	37	63	25.59	9.55
P ₄ (Three node pruning)	26	35	18	102	3.11	99.56	12.45	1.46	26.93	87.7	75:25	31	69	28.99	10.76
CD at 5%	NS	NS	NS	3.18	0.04	1.95	0.01	0.14	0.31	1.45	NC	1.08	0.86	0.75	0.07

Mean values of two seasons (2016-17 to 2017-18); NS: Non significant, NC: Not calculated; S₁ (50 cm × 20 cm), S₂ (50 cm × 30 cm), S₃ (50 cm × 40 cm), S₄ (50 cm × 50 cm), S₅ (50 cm × 60 cm); Pruning methods were P₀ (control: no pruning), P₁ (all branches pruned: single stem cultivation); P₂ (all branches retained, pruned after 1st node), P₃ (all branches retained, pruned after 2nd node) and P₄ (all branches retained, pruned after 3rd node).

Table 2 Effect of different spacing and pruning methods on yield and economic attributes of long melon under polyhouse structure during off-season (pooled data of 2016-17 and 2017-18)

Treatment	Number of fruits per plant	Diameter of per fruit (cm)	Length of per fruit (cm)	Weight per fruit (gm)	Weight of fruits kg/plant	Weight of fruits kg/m ²	Total yield q/1000 m ²	Cost of cultivation ₹/1000m ² (in lac)	Gross income ₹/1000 m ² (in lac)*	Net income ₹ /1000 m ² (in lac)	B.C. ratio
<i>Plant spacing</i>											
S ₁ (50×20cm)	6.0	2.41	55.36	271.25	1.36	12.22	85.52	206849	342070	117442	1.52
S ₂ (50×30cm)	6.4	2.77	58.68	282.65	1.52	11.76	82.32	206629	329291	104884	1.47
S ₃ (50×40cm)	6.6	3.02	60.08	296.46	1.66	9.19	64.32	206573	257272	32920	1.15
S ₄ (50×50cm)	7.4	3.71	64.37	337.86	2.11	8.41	58.84	206518	235356	11059	1.05
S ₅ (50×60cm)	7.4	3.71	64.37	337.86	2.11	7.00	49.03	206464	217319	-6924	0.87
CD at 5%	0.11	0.1	0.73	2.33	0.06	0.42	2.92	NC	NC	NC	NC
<i>Pruning methods</i>											
P ₀ (Control/no pruning)	6.0	2.61	52.68	268.14	1.38	7.58	53.05	206611	212195	-12195	0.95
P ₁ (All branch pruning)	6.2	3.57	67.78	339.14	1.85	10.16	71.14	206600	284562	60183	1.27
P ₂ (One node pruning)	7.3	3.06	63.26	313.14	1.92	10.91	76.35	206600	305399	81020	1.36
P ₃ (Two node pruning)	7.2	3.05	59.88	294.74	1.88	10.40	72.80	206611	291205	66816	1.30
P ₄ (Three node pruning)	6.9	2.95	57.68	285.14	1.72	9.53	66.69	206611	266758	42368	1.19
CD at 5%	0,08	0.03	0.4	1.35	0.03	0.16	1.09	NC	NC	NC	NC

*Mean data of two seasons (2016-17 and 2017-18); **Two years average of sale price of long melon @ ₹ 40/kg; NS: Non significant; NC: Not calculated; S₁ (50 cm × 20 cm), S₂ (50 cm × 30 cm), S₃ (50 cm × 40 cm), S₄ (50 cm × 50 cm), S₅ (50 cm × 50 cm); Pruning methods were P₀ (control: no pruning), P₁ (all branches pruned: single stem cultivation); P₂ (all branches retained, pruned after 1st node), P₃ (all branches retained, pruned after 2nd node) and P₄ (all branches retained, pruned after 3rd node).

(123.87), green biomass (1.55 kg), root length (29.17 cm) and root weight (107.41) per plant were found maximum in un-pruned plant or zero pruning (P₀) and minimum in P₁ (all branch pruned plant). These plant characters were increasing with decreasing pattern of branch node pruning.

The best ratio (71:29) of maximum female and minimum male flowers was found on three node pruned branch (P₄). The fruit setting showed significant response to pruning and it was found highest (46%) in P₄ method of pruning. Un-marketable fruit percent was decreased significantly from complete branch pruning or branchless plant pruning. Plant mortality was high at P₀ and low at P₁ pruning methods. Similar finding was also reported by Oga and Umekewe (2016) and Ekwu *et al.* (2014). There was no significant effect of pruning methods on flowering initiation, days of first fruit picking and total number of fruit pickings (Table 1). Observations showed that number of fruit pickings was less (7) at P₀ and more (16) at P₃ followed by P₄ methods of pruning. Similar observation was recorded by Mardhana *et al.* (2017) and Utobo *et al.* (2010).

Yield and income: Yield of long melon crops was influenced by number of fruits per plant, fruit diameter, fruit length, and fruit weight (kg/plant). These characters of *kakari* crop were significantly influenced by plant spacing (Table 2). Number of fruits per plant, fruit diameter, fruit length, fruit weight (single and per plant in kg/plant) increased from close spacing (S₁) to wider spacing (S₄). Wider spacing of S₄ and S₅ were statistically at par with each other for these characters of long melon. Similar observations were also

recorded by Mohamed (2001) and Davi and Verma (2014), for yield attributes at increased spacing. However, fruit characters and total yield per 1000 m² showed reverse trends. This indicated that not only fruit characters but weight of fruits per square meter were dominant factors for higher yield, leading to higher gross return, net income and B : C ratio. The fruit characters increased with increasing plant spacing. The reasons might be due to more space, sunlight and nutrient availability per plant under wider spacing. These results are in confirmation with the finding of Singh *et al.* (2003, 2005, 2016). *Kakari* cultivation under insect proof net house structure gave maximum return (Gross income: ₹ 342070/, net income: ₹ 117442/ and B:C ratio: 1: 1.52) at close spacing S₁ (50 cm × 20 cm) followed by S₂, S₃ and S₄ spacing. Economic return obtained from *kakari* yield under widest spacing S₅ (50 cm × 60 cm) was negative with the loss of ₹ 6924/1000 m².

There was significantly close competition between P₁ and P₂ pruning methods on fruit diameter, fruit length, and single fruit weight, compared to other pruning methods (Table 2). However, number of fruits per plant, weight of fruits (kg/plant), fruit weight per square meter and fruit yield (kg/1000 m²) were recorded to be highest in P₃ and P₄. Due to the fact that 2 and 3 node branch pruning methods exhibited more number of fruits per plant, there was commensurately higher fruit weight (kg/plant) and total yield, and, thus, it enhanced total income (Table 2). The present finding is in line of basic principle of pruning as it intended to control the optimal number of leaves, thereby improving the yield.

Pruning was done as an attempt to create a better state of the plant, so that sunlight can enter the whole canopy of plant, increasing the availability of air circulation and CO₂ in the canopy. The excessive vegetative growth causes a suboptimal use of photosynthesis and led to decrease in the yield. The pruning of shoots and main stem might be able to inhibit the production of auxins in the main stem and increases cytokine hormone affecting the extension of the lateral branch (Coggins and Lovatt 2014). Pruning essentially reduces unproductive part of the plant so that the assimilation of the photosynthetic process is more widely allocated to enhance other plants growth processes such as cell enlargement. These findings were reported by Jat *et al.* (2011), Yu *et al.* (2013), Coggins and Lovatt (2014), Singh *et al.* (2016), Jat *et al.* (2017), Mardhiana *et al.* (2017).

The present findings confirmed that long melon (*Kakari*) var. Chandralekha can be grown successfully during off-season in polyhouse structure. Further, plant spacing and branch nodes pruning are critical for higher yield and net return. Close plant spacing (50 cm × 20 cm and 50 × 30 cm) produced higher fruit yield per unit area and gave more net return. The 2 or 3 branch node pruning were optimum and gave highest total yield and net returns. The study provided new information that branch/shoot node pruning from the main branch increase the earliness and quality (fruit weight, size) of long melon under polyhouse protected structure.

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