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Influence of varieties and spacing on yield and economics during off-season cucumber production under protected condition in North Indian plains

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Abstract

The trials were conducted under polyhouse condition at Precision Farming Development Center, Division of Agricultural Engineering, IARI, New Delhi, during off-season (October -March) 2001 - 2004 (three season). The soil was sandy loam and having pH 8.0. Crop was transplanted 20 days age group seedling during last week of September in all season. The experiment was carried out in randomized block design with three replication and 20 treatments combination. The Fertilizers was applied in the farm of FYM @ 200q/ha and NPK @ 75, 60, 60 kg/ha, respectively. The four cucumber cultivar *i.e. Priya, Poinsett, Indum-9531*, *Pusa Sonyog*-F1 (IARI) and five spacing *viz*, 20cm x 20cm, 40cm x 40cm, 50cm x 50cm, and 60cm x 60cm were used for conducting experiment. The performance of three season's pooled data of cucumber cultivar under different spacing were statistically analyzed. The result revealed that the *Priya* cultivar showed significantly higher yield 15.40kg/m^2, fresh weight of fruit per plant 3.05kg, individual weight of fruit 339.60g, fruit length 27.24cm, diameter 7.50cm, number of fruits per plant 9, the net return Rs. 118.42/ m^2 and C:B ratio1:2.78 than *Poinsett, Pusa Sonyog* and *Indum-9531* in all season. The variety *Priya* showed enhanced cucumber yield 20.78%, 93.71% and 126.47% higher than Poinsett, *Pusa Sonyog* and Indum-9531 varieties. The variety *Priya* exhibited maximum plant height, number of main branch, bio-mass, number of female flower, early fruit setting, maximum number of fruit picking and harvesting period, which is minimized, disease incidence and un marketable fruits among the all verities. The 30cm x 30cm spacing showed significantly higher fruit yield (24.21kg/ m^2), net income Rs.217.50/ m^2 and B: C ratio 1:3.94 followed by all other spacing. However, wider spacing 50cm x 50cm produce maximum number of fruits per plant (10), individual fruit length (28.56cm), weight (323.40g) and diameter (6.60cm) were recorded respectively. The weight of fruits per plant was also higher (3.25kg) as compare to all closer spacing in all season. The 30cm spacing was produce cucumber yield 101.75%, 82.58%, 89.14% and 149.84% higher form 20,40,50and 60cm spacing. The finding of the experiment concluded that we can obtaine higher yield and net return during off-season fresh cucumber under polyhouses conditions by *Priya* variety at optimal spacing of30cm x 30cm.

Keywords: Cucumber, Offseason, Protected cultivation, Yield, Spacing

Introduction

Polyhouse is a protective structure against biotic and a-biotic stress which is enhanced production and productivity from per unit area under control microclimatic conditions. Prevailing low temperature and frost injury during winter (off-season) are limiting factors for growing cucumber in north Indian plain. (More and Chandra, 1998). A polyhouse structure showed superior performance for off-season production of cucurbitaceous crop in winter season and gave maximum yield with quality produce as compared to open field condition (Sharma *et al*., 2005). To make cucumber cultivation successful in winter under polyhouses is a viable solution. Off-season cucumber cultivation is beneficial for peri urbon farmers of the country. The polyhouse cultivation technology is becoming increasingly popular now a days. It is quite feasible and cost-effective after 2-3 years of cultivation. The cost of construction of polyhouse higher during the first year and the cost decrease accordingly season wise Rs. 35-40/m^2. Cucumber belongs to genus *Cucumis*, species *sativus* and family cucurbitaceous and it is a monoceous plant, bearing male and female flower separately on the same plant. The cucumber (*Cucmis sativus*.) is a rich source of vitamins and minerals and has multiple uses like as salad, vegetable pickles and medicines. Cucumber is an important commercial vegetable and available only

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during their season. To make it available in off-season is become quite necessary. It is possible only when, than they are cultivated in polyhouses and give the maximum profit to the farmers. Cucumber is cultivated throught out the world and requires temperature and humidity in the range of 25 -30^{0}C and 70-80%, respectively which is not usually available in the plains especially in winter, when the environmental conditions are highly fluctuating. Hence, Cucumber is cultivated under polyhouse condition in the plains and having great potential for export. The present trend of expansion of vegetables in the India for export and processing will enhance the cucumber production. But an Improvement of cultural practices will boost production for domestic consumption, processing and export. Hence, the present study was proposed with the objective of the suitable variety and optimum spacing under polyhouse condition in the plain regions of India during off-season. Vegetable cultivation plays an important role in fitting into the traditional cropping system to make it more remunerative. Small and marginal farmers can earn more from limited holding by intensive vegetable cultivation. After the green revolution period, India has achieved sustainable growth in vegetable production and ranks next to china in overall production. However, vegetables are highly susceptible to insects-pest, which cause losses of 30 - 40% in vegetables yield. (Satpathy *et.al.,* 1998, Singh 1998). Cucumber cultivation in northern India is hampered due to extremes of the temperature. During October to march completely the off-season crop in northern India. To develop cultivation practices for cucumber when crop can not be grown using traditional methods is necessary. Very limited information (Pant *et al.,* 2001) is available in India on cultivation of cucumber under polyhouse conditions. Therefore, an attempt has been made in present study to find out the suitable variety and optimum spacing of cucumber for cultivation under polyhouse conditions in Northern plain of India.

Materials and Methods

The experiment was conducted at the Precision Farming Development Centre, Division of Agricultural Engineering, IARI, New Delhi, during 2001 - 2004 (three seasons). The four cucumber cultivar *i.e. Priya, Poinsett, Indum-9531*, *Pusa Sonyog* F1 (IARI) and five spacing *viz*, 20cm x 20cm, 30cm x 30cm, 40cm x 40cm, 50cm x 50cm and 60cm x 60cm were used for conducting experiment under 22m×23m size multi-span polyhouse structure covered with 200 micron thick UV stabilized transparent polyethylene. The polyhouse was provided with an evaporative cooling system through exhaust fan and cooling pad. This was thermostatically controlled to maintain the temperature and humidity within optimum limits. The experiment was laid out in randomized block design with three replications and 20 treatments. The seed of the cultivars were treated with fungicide (*Trichoderma*) as a disinfectant and sown in the 10x5cm size poly-bags in the same polyhouse nursery during second week of September in all the season. The seedlings were transplanted in the polyhouse when they were about 20 day's old age. The plots were prepared 4.2m x 4.2m size for all spacing and then the full basal dose @ 200q/ha FYM, 60kg/ha Phosphate and 60kg/ha Potash were applied before 15 days of planting. While Nitrogen @ 175kg/ha was applied as top dressing at 20, 45, 65 and 85 days interval after transplanting. The nitrogen, phosphate and Potash were applied in the form of urea, SSP and Murate of potash. In the present experiment, the set point of temperature for operation of fan-pad system was 27^{0}C. The maximum and minimum temperature, relative humidity was recorded daily and converted in to monthly and hole period basis have been summarized in table 3. The temperature and relative humidity data inside and outside the polyhouse support the suitability of a fan-pad polyhouse for cucumber cultivation under northern plain condition.

Seedlings were transplanted in the late afternoon at the selected spacing and then immediately irrigated to reduce the stress on the plants during lost week of September in all three season. Use vertically cordon training method and pruning all primary branches after 2 nodes in all cucumber plant under weekly enterable after 20 days of planting. Since the varieties are monoceous, the freshly open pistilate flowers were hand pollinated during morning in between 8-9AM to each fruit set as daily. The crop was irrigated by flooding and the necessary cultural operation was done at weekly intervals. Trichoderma, Bavistin, Indofil M-45, Monocrotophas, and Neemgold pesticide were sprayed @ 0.5-1ml with one liter of fresh water at the time of infestation against fungal and insect-pests. Data was recorded on growth, yield and economic parameters, *viz*. Plant height, number of main branch, initiation of flowering, first picking start after transplanting, total number of pecking, total picking period, male and female flowers ratio, fresh weight of plant, bio-mass at last picking, per cent of plant mortality through diseases, unmarketable fruits, number of fruits per plant, diameter, length of fruits, individual fruit weight, per plant fruits weight, fruit yield (kg/m^2) during all the years. Fruits were picked from first week of November to second week of March during all the years. Data was analyzed statistically. The cost of cultivation was calculated using the following formula and other details are presented in Table 1 and 2.

Net income = Gross income (Rs./m^2/season)-Cost of cultivation (Rs./m^2/season)

Benefit: Cost ratio (BCR) = Gross income (Rs./m^2/season)

Cost of cultivation (Rs./m^2/season)

Results and Discussion

The effect of varieties on the various observations is presented in Table 1 and 2. The variety *Priya* exhibited significantly the maximum plant height 316.80cm, number of main branch 12.20, total number of pickings 15, picking period 126 days, fresh weight of bio-mass per plant 754.20 g, number of fruits per plant 9, diameter of fruits 7.50 cm, length of fruit 27.24 cm, weight of individual fruit 339.60g, weight of fruits/plant 3.05kg, marketable yield 15.40kg/m^2, cost of cultivation 66.38 Rs./m^2, gross income Rs.184.80/ m^2, net income Rs.118.42m^2, benefit-cost ratio(BCR) 1:2.78/m^2 followed by the varieties *Poinsett, Indum 9531* and *Pusa Sonyog* during all seasons. Which variety *Priya* was enhance cucumber yield 20.78%, 93.71% and 126.47% higher from Poinsett, *Pusa Sonyog* and Indum-9531 varieties. However, early initiations of pistilate and staminate flowers 33 to 38 days, early picking started after 44 days, exhibited pistilate and staminate flowers ratio 45:55%, minimum incidence of disease and insect-pest 3.25% and un-marketable fruits 5.06% were observed on *Priya* cucumber as compared to all others varieties during all cropping season (Table 1 and 2).

Table 1. Effect of different variety and spacing on off-season cucumber growing in Polyhouse condition

Observations	Pooled data of three years during 2001 -2004										
	Treatments										
	Varieties					Spacing (cm)					
	Priya	Poinsett	Indum-9531	Pusa sanyog	C.D. at 5%	20x20	30x30	40x40	50x50	60x60	C.D. at 5%
Plant height (cm)	316.80	314.35	313.12	310.52	1.12	312.5	310.70	315.50	315.7	314.50	2.51
No. of main branch per plant	12.20	12.30	11.50	10.50	0.75	10.50	10.77	12.47	12.70	11.54	1.25
Initiation of male flowering after transplanting (days)	33	34	37	40	1.32	47.20	47.40	45.30	45.20	45.10	NS
Initiation of female flowering after transplanting (days)	38	40	43	46	1.12	43	43	41	41	41	1.25
First picking from transplanting (days)	44	47	52	53	1.52	50	51	48	49	47	NS
Total number of pickings	15	13	12	10	0.95	14	14	16	16	15	NS
Total picking period (days)	126	123	118	117	1.25	119	120	122	121	123	NS
Initiation of female and male flowers ratio (%)	45:55	35:65	30:70	31:74	**	30:70	30:70	40:60	40:60	35:65	**
Fresh weight of plant biomass (g/plant)	754.20	708.50	742.41	792.91	2.84	645.30	645.50	792.70	792.50	792.80	11.32
Plant mortality by incidence of plant diseases (%)	3.25	5.31	5.84	5.57	0.64	5.23	5.45	4.47	4.50	4.30	NS
Un-marketable fruits (%)	5.06	3.05	6.09	7.12	0.78	7.50	7.60	6.75	6.66	6.75	NS

NS – Non Significant, ** Not calculated

Table 2. Effect of different variety and spacing on off-season cucumber growing in Polyhouse condition

Observations	Pooled data of three years during 2001 -2004										
	Treatments										
	Varieties					Spacing (cm)					
	Priya	Poinsett	Indum-9531	Pusa sanyog	C.D. at 5%	20x20	30x30	40x40	50x50	60x60	C.D. at 5%
Number of fruits per plant	9	9	6	7	1.07	3	8	8	10	10	1.56
Diameter per fruit (cm)	7.50	5.65	4.95	4.75	1.35	3.80	5.40	5.50	6.60	6.30	1.98
Length per fruits (cm)	27.24	24.84	24.10	19.90	2.35	15.50	22.83	23.13	28.56	28.16	2.32
Weight of individual fruit (g)	339.60	280.42	290.70	224.40	0.32	160.10	275.20	276.15	323.40	320.30	0.37
Weight of marketable fruits kg/plant	3.05	2.52	1.32	1.57	0.21	0.48	2.20	2.21	3.25	3.20	1.05
Yield of marketable fruits kg/m^2	15.40	12.75	6.80	7.95	0.74	12.00	24.21	13.26	12.80	9.69	1.73
Cost of cultivation (Rs. m^2/ season)	66.38	65.08	63.88	62.90	-	80.50	73.11	61.05	55.17	52.95	-
Gross income (Rs./ m^2/season	184.80	150.0	81.60	95.40	-	144.00	290.61	159.12	153.56	116.28	-
Net income (Rs./m^2/season)	118.42	84.92	17.72	32.50	-	63.50	217.50	98.07	98.43	63.33	-
Benefit: cost ratio	2.78	2.30	1.28	1.52	-	1.79	3.94	2.60	2.78	2.19	-

- Three season average pooled and sealing price of cucumber = Rs 12 /kg during 2001-2004
- Number of plants according spacing in cm - 20x20 =25, 30x30 =11, 40x40 = 6, 50x50 = 4, 60x60 = 3 plant

Table 3. Three season daily basis pooled data of temperature and RH% converted in monthly average and hole period data under polyhouse and ambient field Condition.

Months	Pooled data of 2001 -2004							
	Polyhouse condition				Ambient condition			
	Temperature °C		RH%		Temperature o_C		RH%	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
September	29.70	21.50	70.60	38.80	36.8	16.70	88.50	32.30
October	27.30	20.50	72.50	40.40	35.20	15.30	90.70	30.30
November	24.50	12.70	82.30	45.50	30.50	7.50	95.50	33.30
December	18.70	9.70	90.60	53.30	10.70	5.30	99.20	60.60
January	20.30	11.20	90.40	50.50	15.20	5.70	98.50	44.40
February	26.40	16.30	80.30	48.80	32.50	9.50	72.40	42.20
March	31.70	19.80	73.50	53.30	35.60	12.30	62.30	29.90
All season Mean	25.50	15.96	80.02	47.23	28.07	10.32	86.72	39.00

This could be due to the fact that the variety *Priya* has a better genetic vigor and hence exhibited maximum growth-development, initiation of maximum female flowers and good physiological activity. The maximum growth, development and physiological activity produced more female flowering and fruiting and thus, increased number and weight of fruits per plant, which in turn the maximum fruit yield and also provided more net returns. Similar finding has been reported by (More 1998, Chandra *et al*. 2000, Singh *et. al.* 2002, Shrivastva *et al*. 2005, Arora *et al*. 2005, Sharma *et al*. 2005).

The spacing 30cm x 30cm also recorded significant positive effect on marketable fruits yield 24.21kg/m^2, gross income Rs.290.61/m^2, net income Rs.217.50/m^2 and BCR 1: 3.94/m^2 as compared to all other spacing (Table 2). Which is 30x30cm spacing was produce cucumber yield 101.75%, 82.58%, 89.14% and 149.84% higher form 20, 40, 50 and 60cm spacing. Due to fact that optimum plant spacing having maximum plant per unit area and optimal plant population increased total number of fruits (number of fruits per plant x total number of plant/ m^2) produced maximum yield. The maximum yield also enhanced net return. Similar theme observed by (More *et al*. 1998, Chandra *et al*. 2000, Singh *et al.*2002, Singh *et al*. 2005).

The wider spacing 50×50cm was exhibited significantly maximum but near to almost similar 60×60cm on introducing number of fruits per plant 10, Diameter of fruit 6.60cm, length of fruit, 28.56cm, individual fruit weight 323.40g, weight of marketable fruits 3.25kg/ plant, plant height 315.70cm, number of main branch 12.70, early female flowering after 41days, fresh weight of biomass per plant 792.70g, and early flowering with more female flower per cent were recorded maximum as compared to closer spacing 20cm to 40cm during all year (Table 1 and 2). This may be due to fact that wider spacing because it provides a more space between plants to plant. Due to which plants could uptake maximum nutrients, sunlight, aeration and physiological activity like better crop growth rate etc. These factors exhibited maximum growth and development of plant, which produced maximum numbers of fruits, weight, diameter and yield per plant, but lesser population as compared to closer spacing, which decreases the yield and net income from per unit area. Similar finding observed that on the wider spacing increase in crop Physiological growth and yield attributes, increasing fruit numbers and weight kg per plant was reported by (More *et al.*1998, Singh *et al*. 2005, Chandra *et al.* 2000).

There was no significant effect of spacing on the days of flowering, fruit setting, fruit picking, total picking, harvesting period and total crop period, percentage of incidences of plant diseases, and unmarketable fruits were at par in all the spacing (Table 1). This may be attributed to the fact that polyhouse provided micro climate in side to the plants which induced vigorous plant activity almost similar and minimized disease and insect incidence on the plants and fruits as compared to open field conditions. This finding is supported by (Singh *et al.* 2003, Singh *et al.* 2005), who reported that microclimate control in polyhouses implies superior quality of produce, free from pathogens, insect pest, and insecticide residues and also reported by (Sathpathy *et al.* 1998 and Singh, 1998).

सारांश

कद्दू वर्ग की सब्जियों में खीरा महत्व पूर्ण फसल है। जिसकी मांग बाजार में वर्ष भर बनी रहती है। लेकिन अक्टूबर से मार्च माह के मध्य इसका उत्पादन मैदानों में न के बराबर होता है। इसलिए खीरे का बेमौसम उत्पादन पालीहाउस में किया जाये तो पूरे वर्ष भर प्राप्त किया जा सकता है। पाँच सौ वर्ग मीटर क्षेत्रफल वाले बहुस्तरीय पालीहाउस में खीरे की चार प्रजातियाँ जैसे कि, प्रीया, प्वाइनसेट, इण्डम–9531 एवं पूसा संयोग का परिक्षण विभिन्न दूरीयों पर जैसे– 20×20 से.मी., 30×30 से.मी., 40×40 से.मी., 50×50 से.मी. और 60×60 से.मी. पर लगाया गया। इस परिक्षणों को आर.वी.डी. में तीन आवृत्ति एवं 20 उपचारों के साथ सितम्बर अन्त सप्ताह में पौध रोपण किया गया था। इस परिक्षण में 2001–2004 तक के तीन वर्षो के आंकड़ों को संगठित कर विष्लेषण किया गया जिससे पता चला कि बेमौसम में खीरा उत्पादन करने हेतु मैदानी क्षेत्रों के पालीहाउस में

प्रीया प्रजाति का औसतन फलों की उपज 15.40 किलोग्राम प्रतिवर्ग मीटर, फलों का वजन प्रति पौध 3.05 किलोग्राम, प्रतिफल वजन 339.60 ग्राम, फल की लम्बाई 27.24 से.मी. मोटाई 7.50 से.मी., प्रति पेड़ फलों की संख्या 9 और शुद्ध लाभ रु. 118.42 प्रति वर्ग मीटर प्रीया प्रजाति से सबसे ज्यादा प्राप्त किया गया, जबकि प्वाइनसेट, पूसा संयोग और इण्डम–9531 प्रजातियां क्रमशः सभी आंकड़ों में कम पायी गयी। जबकि विभिन्न रोपण दूरीयों में 50×50 से.मी. रोपण दूरी पर फलों की लम्बाई, मोटाई फल का वजन और प्रति पौध फलों का वजन सबसे ज्यादा पाया गया। जबकि कुल उत्पादन में 30×30 से. मी. दूरी 24.21 किलोग्राम फल उत्पादन, एवं रु. 217.50 शुद्ध लाभ प्रति वर्ग मीटर की दर से प्राप्त करके अन्य रोपण दूरीयों में उत्तम पायी गयी। जब प्रजातियों एवं दूरीयों का आपस में उत्पादन का तुलनात्मक प्रतिशत निकाला गया तो पाया गया कि खीरे की प्रिया प्रजाति, प्वाइनसेट से 20.78 प्रतिशत, पूसा सयोंग से 93.71 प्रतिशत एवं इण्डम–9531 से 126.47 प्रतिशत ज्यादा उत्पादन किया। ठीक इसी प्रकार 30 से.मी. रोपण दूरी 20 से.मी. रोपण दूरी से 101.75 प्रतिशत, 40 से.मी. से 82.58 प्रतिशत, 50 से.मी. से 89.14 प्रतिशत, एवं 60 से.मी. से 149.84 प्रतिशत ज्यादा उत्पादन प्राप्त किया गया। इस प्रकार मैदानी पालीहाउसों में बेमौसम खीरा उत्पादन हेतु प्रीया प्रजाति का 30×30 से.मी. दूरी पर लगाना सर्वोत्तम एवं लाभकारी पाया गया।

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