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Effect of growing conditions on seed yield and quality of cucumber (*Cucumis stivus*) hybrid

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ABSTRACT

The present investigation was carried out at Centre for Protected Cultivation Technology (CPCT) farm at Indian Agricultural Research Institute (IARI), New Delhi during summer and *kharif* seasons 2011 under naturally ventilated polyhouse, insect proof net house and open field conditions to study the influence of different growing conditions on seed yield and quality of cucumber (*Cucumis sativus*) hybrid (Cv Pant Shankar Khira 1) seed production. The seed parent and pollen parent were grown in 3:1 ratio. Water and nutrients were provided through drip fertigation in all three conditions. In all three growing conditions, vine length and number of leaf nodes were significantly more in *kharif* season compared to summer season. Number of fruit developed to maturity was significantly more in *kharif* (2.15) than summer (1.90). The vine length, number of leaves, fruit weight, fruit length and fruit width were significantly higher under naturally ventilated polyhouse and insect proof net house compared to open field in both of the seasons. The number of seeds/fruit was significantly higher in insect proof net house (204.15) and naturally ventilated polyhouse (188.35) as compared to open condition (126.05). The seed yield/fruit, seed yield/plant and seed yield per 1000 m^2 were significantly higher in *kharif* season as compared to summer. Whereas higher seed yield was recorded in insect proof net house followed by naturally ventilated polyhouse and open field condition. The seed quality attributes, viz. germination percentage, seedling length, seedling dry weight, vigour index I and II and seed moisture content immediately after harvest were also significantly superior in naturally ventilated polyhouse and insect proof net house in comparison to open field conditions. The benefit-cost ratio (BCR) is higher in insect proof net house (1:2.25) followed by open condition (1:1.12) naturally ventilated polyhouse (1:0.37).

Key words: Cucumber, Germination, Hybrid seed production, Insect proof net house, Naturally ventilated polyhouse, Pant Shankar Khira 1, Seed yield and Vigor indices

Cucumber (*Cucumis sativus* L.) is one of the most important crop among the cucurbits which is widely cultivated in India. The cucumber along with gherkin was cultivated on an area of 20.90 lakh/ha with a production of 65.33 million tonnes and an average yield of 31 251 kg/ha (FAO 2011). In India, it was cultivated on an area of 25 104 ha with a production of 1.60 lakh tonnes and an average productivity of 6412 kg/ha (FAO, 2011). The low productivity in India may be either due to limited availability of high yielding varieties/hybrid, high incidence of insect pest and diseases during crop production and seed production in particular.

The production and productivity of cucumber can be increased in different ways, e.g. bringing additional area under vegetable crops, using hybrid seeds, use of improved agro-techniques. Another potential approach is perfection and promotion of protected cultivation of vegetables (Singh 1998). The use of F1 hybrids is one of the means to meet ever increasing demand for cucumber.

Hybrid seed production in North Indian conditions cannot be organized successfully due to high incidence of insect pest and diseases. Therefore, attaining economic yield is a difficult task in *kharif* season under open field. Contrarily to the summer season, *kharif* is considered to be better and safer for hybrid seed production but plant growth and development are greatly affected by changing environmental conditions and relatively early onset of high temperature hamper the production of female flower, fruit set and fruit development. So, the successful hybrid seed production can be carried out under protected structures which give several advantages over traditional seed production like higher seed yield, less/zero incidence of pest and diseases, less labour work etc. It also provides an option for off- season seed production too. Till today very less information is available on production of hybrid seeds of cucumber under protected conditions. Therefore the present investigation was planned to study the growth

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behavior, flowering, fruit development and seed production parameters under naturally ventilated polyhouse, insect proof net house and open field conditions in cucumber.

MATERIALS AND METHODS

The field experiment was conducted during summer 2011 and *kharif* 2011 at Centre for Protected Cultivation Technology (CPCT) and Division of Seed Science and Technology, Indian Agriculture Research Institute (IARI), New Delhi which is located at 28°35″N latitude and 77°12″E longitude and at an altitude of 228.6 m above mean sea level. It has a semi-arid and sub-tropical climate characterized by extreme hot summer and cold winter. The hybrid selected for the experiment was Pant Shankar Khira 1, which was developed from GBPUAT, Pantnagar. The seedlings of parental line were raised inside the high-tech nursery in multi-celled plastic plug trays having cell volume of 20 cubic centimeters by using soil less media consisting of cocopeat, vermiculite and perlite in the ratio of 3:1:1 (on volume basis). The 20 days old seedlings were transplanted during summer 19 Feb 2011 and *kharif* 29 July 2011 under different growing conditions, viz. naturally ventilated polyhouse, insect proof net house and open field. A naturally ventilated saw-tooth polyhouse was designed by Indo-Israel Project of the Indian Agricultural Research Institute, New Delhi during the year 2004-2005 and fabricated by an Indian company, Sriroz consultants Pune (India) with a fabrication cost of US$ 11-12/m^2 (₹ 500/m^2). Insect proof net house was fabricated by using 40 mesh UV stabilized nylon net, white in colour with double door facility, with $2m^2$ waiting area and having length 60m, width 6m, height 2m was used for raising hybrid seed crop.

Thirty plants were randomly selected in all three growing conditions for recording the observations, viz. vine length at 30 and 45 days (cm), number of leaf nodes at 30 and 45days, days to first female flowering, numbers of flowers pollinated, number of fruit set, number of fruit developed to maturity, fruit length (cm), fruit weight (g), fruit width (cm), 100 seed weight (g), number of seed/fruit, seed yield/fruit (g) and seed yield/1000 m^2. Similarly the laboratory tests were carried out at post graduate laboratory, Division of Seed Science & Technology, IARI, New Delhi which includes germination (%) (ISTA 2011), moisture content (%), seedling length (cm), seedling dry weight (mg), vigour index-I and II (Abdul-baki and Anderson 1973) and electrical conductivity (Dadlani and Agarwal 1987). The quantitative data generated were analyzed statistically by using SAS 9.2 for testing the heterogeneity of means adopting the independent 't-test' procedures.

RESULTS AND DISCUSSION

Growth characters

The results pertaining to vine length and leaf node of summer and *kharif* 2011. Showed the significant difference for vine length for growing conditions and seasons. The higher vine length was observed at 45 DAT under naturally ventilated polyhouse in *kharif* season (191 cm) and lower vine length in open field condition in summer season (103 cm). The number of leaves per vine was higher in *kharif* season in naturally ventilated polyhouse (25.50). The higher vine length and number of leaf node under naturally ventilated polyhouse and insect proof net house condition attributed to the stimulation of cellular expansion and cell division due to diffused light and congenial relative humidity and temperature in protected structures. The similar result was reported by El- Aidy *et al*. 1983 in tomato. This was also due to better assimilative power of the crop grown in insect proof net house compared to open field grown crop and is in agreement with Singh *et al.* (2009) in parental lines of pumpkin hybrid Pusa Hybrid-1.

Flower and fruit attributes

The average numbers of flowers pollinated were higher in *kharif* season (9.66) compared to summer (9.00) because of better growth of vine in *kharif* season resulted the production of more number of flowers. The number of fruit set and number of fruit develop to maturity were at par under insect proof net house (4.30 and 2.50, respectively) and naturally ventilated polyhouse (4.25 and 2.45, respectively) but, significantly lower in open field condition (2.85 and 1.12, respectively) depicted in Fig. 1. The number of flowers pollinated, number of fruit set and fruit developed to maturity were not only influenced by climatic factors like temperature, relative humidity, light intensity but also influenced by biotic factors like pests and diseases. The fruit set and fruit developed to maturity was low in open condition because of high incidence of cucumber mosaic virus and red pumpkin beetle. The results are in conformity with Wang *et al.* (2007) and Singh and Sirohi (2006). The average fruit weight, fruit length and fruit width were higher in *kharif* season (646.16 g, 21.36 cm and 7.36 cm respectively) compared to summer season (597.87 g, 19.86 cm and 7.30 cm, respectively). The highest average fruit weight was under insect proof net house (711.75 g) followed by naturally ventilated polyhouse (654.55) as compared to open condition (499.75 g) sown in Table 1. The higher fruit weight and fruit length under insect proof net house and naturally ventilated polyhouse might be due to better photosynthetic efficiency of plant in comparison to open field conditions and an increased quantity of chlorophyll (Collard *et al.* 1977, El-Aidy *et al.* 1983).

Seed yield contributing characters

The data presented in the Table 1 showed significantly higher values for number of fruits/plant, number of seeds/ fruit, seed yield/fruit, seed yield/plant and 100 seed weight in *kharif* season compared to summer and under different growing conditions the insect proof net house and naturally ventilated polyhouse revealed significantly higher results for all seed yield contributing characters compared to open condition. The highly significant difference was noted in number of fruits/plant which was highest under insect proof net house (2.50) followed by naturally ventilated polyhouse

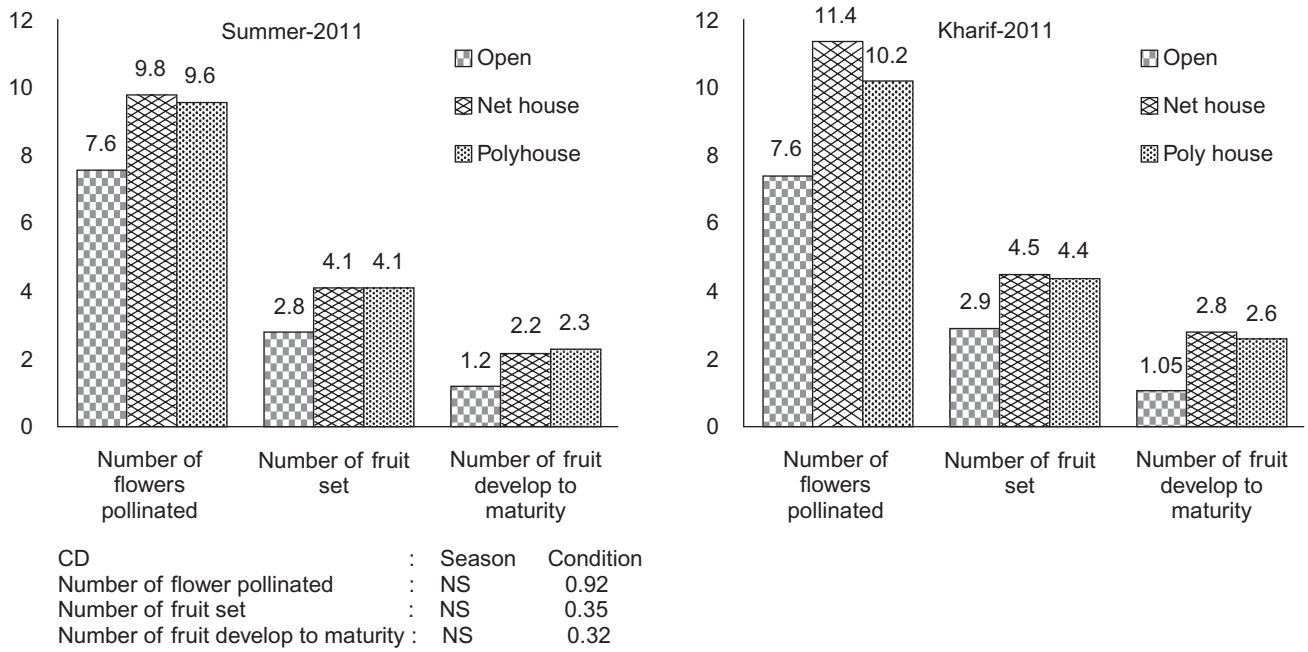

Fig 1 Effect of growing conditions and season on flowering behavior of cucumber (Pant Shankar Khira 1) during 2011.

Table 1 Effect of growing conditions and season on fruit attributes and seed yield of cucumber (Pant Shankar Khira -1) during 2011.

Growth conditions	Fruit weight (g)			Fruit length (cm)			Fruit width (cm)		
	Summer	*Kharif*	Mean	Summer	*Kharif*	Mean	Summer	*Kharif*	Mean
Open	491.00	508.50	499.75c	19.10	19.80	19.45b	6.30	6.40	6.35c
Net house	673.00	750.50	711.75a	21.20	22.40	21.80a	8.10	8.20	8.15a
Polyhouse	629.60	679.50	654.55b	19.30	21.90	20.60b	7.50	7.50	7.50b
Mean	597.87b	646.16a		19.86b	21.36a		7.30	7.36	
	Season	Condition	Interaction	Season	Condition	Interaction	Season	Condition	Interaction
CD(P=0.05)	45.03	55.15	NS	0.74	0.91	NS	NS	0.57	NS
SE (d)	22.51	27.57		0.37	0.45			0.27	
	Number of seeds/fruit			*Number of fruits/plant*			*Seed yield/fruit (g)*		
Open	120.00	132.10	126.05c	1.20	1.05	1.12 b	3.32	3.26	3.29b
Net house	194.30	214.00	204.15a	2.20	2.80	2.50 a	5.56	5.76	5.66a
Polyhouse	178.40	198.30	188.35b	2.30	2.60	2.45 a	5.42	5.73	5.57a
Mean	164.23b	181.46a		1.90	2.15		4.77	4.91	
	Season	Condition	Interaction	Season	Condition	Interaction	Season	Condition	Interaction
CD(P=0.05)	11.84	14.5	NS	NS	0.32	NS	NS	0.35	NS
SE (d)	5.92	7.25			0.16			0.17	

Figures sub scripted in interaction with conditions and seasons or subscripted in main effects by same alphabet are at par at 0.05 level of significance

(2.45) and open condition (1.27). The seed yield/fruit was at par under insect proof net house (5.66 g) and naturally ventilated polyhouse (5.57 g), but both are significantly higher as compared to open condition (3.29 g). The seed yield/1000 m^2 was significantly higher in *kharif* season (12.59 kg) compared to summer (10.30 kg) however, under protected conditions insect proof net house (15.02 kg) showed higher seed yield followed by naturally ventilated polyhouse (14.87 kg) and open field condition (4.45 kg). The similar results were obtained by Xavier (2010) in pumpkin hybrid seed production, Jat (2011) in bitter gourd hybrid seed production and Bihari (2012) in summer squash hybrid seed production under insect proof net house.

Seed quality attributes

The data on seed quality as influenced by growing methods and seasons are presented in Table 2. The germination percentage, seedling length, seedling dry weight, vigour index I and II were significantly higher in naturally ventilated polyhouse than open condition (90.75%, 31.08 cm, 0.10 g, 2 820 and 9.07, respectively) but it was at par under insect proof net house (90.12%, 31.17 cm,

Table 2 Effect of growing conditions and season on seed quality of cucumber (Pant Shankar Khira 1) during 2011.

Growth conditions	Germination (%)			Seedling length (cm)			Seedling dry weight (g)		
	Summer	*Kharif*	Mean	Summer	*Kharif*	Mean	Summer	*Kharif*	Mean
Open	63.63_b (80.25)	64.08_b (80.75)	63.85_b (80.50)	27.25	27.50	27.37 b	0.090	0.094	0.09 c
Net house	71.58_a (90.00)	71.80_a (90.25)	71.69_a (90.12)	31.10	31.25	31.17 a	0.111	0.106	0.12 a
Poly house	72.55_a (91.00)	72.04_a (90.50)	72.30_a (90.75)	30.92	31.25	31.08 a	0.100	0.100	0.10 b
Mean	69.25 (87.08)	69.30 (87.16)		29.75	30.00		0.11	0.10	
	Season	Condition	Interaction	Season	Condition	Interaction	Season	Condition	Interaction
CD (P=0.05)	NS	1.56	2.24	NS	1.13	NS	NS	0.002	NS
SE (d)		0.74	1.06		0.53			0.0001	
		Vigour index I			*Vigour index II*		*Electrical conductivity (mmho/g/cm)*		
Open	2186.81b	2220.62 b	2203.71b	7.22 d	7.59 c	7.40 c	12.15	12.40	12.27 a
Net house	2799.00 a	2820.31 a	2809.65a	9.99 a	9.56 a	9.77 a	10.60	11.07	10.83 b
Poly house	2813.72 a	2828.12 a	2820.92a	9.10 b	9.05 b	9.07 b	4.87	5.42	5.15 c
Mean	2599.84	2623.01		8.77	8.73		9.20 b	9.63 a	
	Season	Condition	Interaction	Season	Condition	Interaction	Season	Condition	Interaction
CD(P=0.05)	NS	79.02	111.70	NS	0.22	0.31	0.22	0.27	NS
SE (d)		37.62	53.19		0.10	0.14	0.10	0.12	

Figures sub scripted in interaction with conditions and seasons or subscripted in main effects by same alphabet are at par at 0.05 level of significance. The value in the bracket represents real values for corresponding transformed arc sine values.

0.12g, 2809 and 9.77, respectively). Among the growing environments the seeds grown in naturally ventilated polyhouse showed lowest electrical conductivity (5.15) followed by insect proof net house (10.83) and open field conditions (12.27). The less electrical conductivity under naturally ventilated polyhouse was due to well developed seed coat which releases less seed lechate as compared to open field grown seeds released more seed lechate.

Economics of hybrid seed production

The present study was designed with a view to analyze the comparative economic advantage for hybrid seed production under different growing conditions, viz. naturally ventilated polyhouse, insect proof net house and open field condition. The cost to benefit ratio worked out for all three conditions revealed the insect proof net house was more profitable (1:2.25) followed by open condition (1:1.12) and naturally ventilated polyhouse is uneconomical (1:0.37) because of more initial investment.

Based upon the results recorded in this experiment it could be concluded that for attaining better growth, flowering, fruit setting, fruit development, higher seed yield and seed quality attributes, the hybrid seed production of cucumber Pant Shankar Khira 1 should be undertaken under insect proof net house in *kharif* condition. The growing of seed crop under insect proof net house fetches higher net returns as compared to open field.

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