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Seed yield and quality as influenced by growing conditions in hybrid seed production of bitter gourd (*Momordica charantia* L.) cv. Pusa Hybrid-1

G. S. Jat[1*], Balraj Singh[2], B. S. Tomar[1], Jogendra Singh[1], Hanuman Ram[1] and Mukul Kumar[3]

[1]Division of Vegetable Science, Indian Agricultural Research Institute, New Delhi-110012, INDIA
[2]Agriculture University, Jodhpur-342001 (Rajasthan), INDIA
[3]Krishi Vigyan Kendra, Raisen-464551 (M.P.), INDIA
[*]Corresponding author. E-mail: singhgograj@gmail.com

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Abstract: The present investigation was carried out under insect proof net house (IPN) and open field condition (OFC) at Centre for Protected Cultivation Technology and Seed Testing Laboratory of Division of Seed Science &Technology, IARI, New Delhi in bitter gourd cv. Pusa Hybrid-1 during summer season because under open field condition the seed yield and seed quality of bitter gourd drastically reduced due to viral diseases and fruit fly in kharif and early onset of high temperature, unseasonal rains during summer, which restricts the hybrid seed production of bitter gourd under north Indian condition. The observations on seed yield & quality characters and physical properties of seed were recorded. The quality attributes were evaluated immediately after harvest and after 8 months of ambient storage and their results were compared. The experimental results revealed that total number of seed per fruit (46.7), number of filled seed per fruit (45.3), seed yield per fruit (9.41g), seed yield per plant (27.28g), and seed yield per hectare (232kg) were significantly higher under IPN in comparison to OFC. Among the physical parameters of seed, seed width (0.81cm) & seed coat (0.79g) weight recorded significantly higher in IPN. The seed quality attributes immediately after harvest was also significantly superior under IPN compared to OFC except for germination %. The hybrid seed produced under IPN conditions could maintain their superiority for quality traits even after 8 months of its ambient storage. The seed yield and seed quality attributes were comparatively superior under IPN conditions. The seed crop grown under IPN overcomes the threat of insect vectors, viral diseases and unfavourable climatic conditions and helps in attaining the better seed yield and quality.

Keywords: Insect proof net house, Open field, Seed Quality, Seed yield

INTRODUCTION

Momordica charantia L. (2x=2n=22), commonly known as bitter gourd or bitter melon, is an economically important member of cucurbitaceae family, cultivated in India, China, Malaysia, Africa, and South America (Miniraj *et al.,* 1993). Compared with other cucurbitaceous crops, it is highly valuable for its nutritive content like proteins, carbohydrates, vitamins, and minerals primarily ascorbic acid and iron (Behera *et al.,* 2004; Miniraj *et al.,* 1993), as well as various medicinal properties (Alam *et al.*, 2009). The fruit and juice have been used as treating diabetes (Baynes *et al.*, 1995). It can be grown in both seasons for commercial production, but seed production, especially hybrid seed production which requires vigorous growth, higher number of female flower, higher fruit set, better fruit development and maturation in seed parent (Basu *et al*., 2013). Hybrid seed production under north Indian condition cannot be organised successfully in open field condition because of high incidence of viral diseases and white fly attack in kharif season. Besides this, in spring summer the plant growth and development are greatly affected by changing environmental conditions, early onset of high temperature, unseasonal rains during summer (April-June), sudden increase in temperature hamper the production of female flower, fruit set and fruit development, resulting in low seed yield and seed quality. Thus, attaining economic yield is a difficult task in hybrid seed production under north Indian condition. The seed crop grown under IPN overcomes the threat of insect vectors, viral diseases and unfavourable climatic conditions (Flemine X. *et al.,* 2012). In order to ensure better quality and higher seed yield the present investigation was planned and undertaken with the objectives to compare the effect of growing conditions on the seed yield and seed quality contributing characters including physical properties of seed immediately after harvest and after 8 months of ambient storage.

MATERIALS AND METHODS

The present experiment was carried out during March-May, 2010 at CPCT farm, IARI, New Delhi, India under two growing conditions viz. IPN and OFC. The insect proof net is made up of UV stabilized white colour, 40 wire mesh insect proof nylon net, with dou-

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ble door facility and having dimensions 60m × 6m × 2m. Drip fertigation facilities were laid in both the growing conditions. The experimental material consists of parental line of bitter gourd hybrid Pusa Hybrid -1. The seeds of parental lines were obtained from the Division of Vegetable Science, IARI New Delhi**.** The seedlings of parental lines were raised in 1½" size conical plug tray with soil-less medium in a modern nursery at CPCT farm. After seed sowing the plug trays were placed in the germination room at a temperature of 20 $^{\circ}$C and relative humidity at around 100%. Twenty days old seedlings of both parental lines were transplanted in the ratio of 3:1 (3 female line: 1 male line) following block method on raised beds under both conditions. The total numbers of female plants were 180 and male plants 60 under IPN and same number of female and male plants were also planted in OFC. Thirty plants were randomly selected in seed parent as well as pollen parent under both growing condition for recording observations. All the recommended agronomic practices were followed to raise a healthy crop. The male flowers in seed parent were pinched off regularly before the anthesis and the female flowers likely to be opened on next day were covered with white butter paper bag during evening (5-7 pm) to avoid out crossing or sib pollination. The male buds from pollen parents were protected and collected in early morning on next day and pollination was performed through hand pollination (Tomar *et al.,* 2009, Vishwanath, 2007). The meteorological observations on temperature, relative humidity and light intensity were recorded during the entire period of experiment (Table1) and during flowering period of the crop on weekly basis (Table2). The mature (bright yellow coloured) fruits were harvested and seeds were extracted manually. The mucilage of the seeds was removed by rubbing the seeds with sand followed by washing with running water. The seeds were dried separately under shade for one day followed by sun light. The observations on number of seeds per fruit, number of filled seeds per fruit and number of unfilled seed per fruit were carried out by counting the seeds. The seed yield per fruit and seed yield per plant were calculated using an electronic weighing balance of 0.001g precision, 100 seed weight was recorded by counting 100 seeds of mixed 3-5 fruit seeds from harvested fruits and weight was recorded. The seed length and width were calculated by averaging the length and width of ten randomly selected seeds. The seed length and seed width were counted by using graph paper technique. The cotyledon weight and seed coat weight were calculated after removing the seed coat of ten randomly selected seeds from each harvested fruits and weighing separately using an electronic balance.

The observations for germination % were carried out at Seed Testing Laboratory, Division of Seed Science & Technology, IARI, New Delhi following the International Seed Testing Association (ISTA) procedure. The electrical conductivity was measured using a digital conductivity meter (Dadlani and Agrawal, 1987). Ten normal seedlings were randomly selected for measuring seedling length. The root length (from collar region to tip of root) and shoot length (from collar region to tip of shoot) were taken and were added to get the seedling length and the average of ten seedling length was calculated and expressed in cm. The fresh weight of seedlings was calculated by recording the fresh weight of ten normal seedlings from each harvested fruits. Seedlings dry weight was calculated by drying the ten seedlings covered with butter paper for 48 hours in hot air oven maintained at 60^{0}C. Seed vigour index-I was calculated using the procedure suggested by Abdul Baki and Anderson, 1973 and expressed in whole number. The quantitative data generated were analysed statistically for testing the heterogeneity of means adopting the t- test procedures. The probability was worked out at 5% (p=0.05) wherever t- value is non-significant, it is denoted by NS.

RESULTS AND DISCUSSION

Seed yield contributing characters: Seed yield is a multifaceted characteristic influenced by number of seeds / fruit, seed yield / plant, seed yield / hectare and also by environmental factors as well as the growing conditions. The observations for number of seeds per fruit showed significant difference between growing conditions. The number of seeds / fruit (46.70), number of filled seeds / fruit (45.30) was significantly higher in IPN than under OFC. A significant difference was also observed for number of unfilled seeds / fruits which were only 1.40 in IPN than 3.70 under OFC (Table 3). A highly significant difference was recorded for seed yield / fruit (9.41g), seed yield per plant (27.28g), seed yield per hectare (232Kg) in IPN comparison to OFC and it may be due to the higher pollen viability and better post fertilization growth and devel-

Table 1. Mean monthly meteorological data during crop duration (February – May, 2010).

Month	Temperature (^{0}C)			Relative humidity (%)			Total rain (mm)	Wind speed (Kmph)	Sun shine (hrs)	Evaporation (mm)
	Max	Min	Mean	Max	Min	Mean				
Feb	23.6	11.3	17.4	87.9	37.9	62.9	6.1	2.2	7.6	2.1
Mar	30.9	14.5	22.7	79.0	30.1	54.5	4.0	1.6	7.9	4.9
April	36.1	21.3	28.7	45.5	24.3	34.9	1.8	4.9	8.9	8.0
May	38.3	24.2	31.2	54.3	36.2	45.2	30.4	4.7	11.7	9.7

Source: Centre for Protected Cultivation Technology, IARI, New Delhi.

Table 2. Weather conditions during flowering period of the crop (average on weekly basis during April, 2010).

Growing conditions	Temperature(^{0}C)			Relative humidity (%)			Light intense (lux)
	Max	Min	Mean	Max	Min	Mean	
Insect proof net house							
First week	27.0	16.2	21.6	74.0	21.6	47.8	436 x 100
Second week	33.1	17.9	25.5	47.5	29.3	38.4	400 x100
Third week	34.4	22.0	28.2	48.4	22.1	35.2	406 x100
Fourth week	36.1	26.1	31.1	36.9	20.8	28.8	430 x 100
Open field							
First week	28.7	16.9	22.8	68.9	23.5	46.2	494 x100
Second week	35.1	18.4	26.7	44.8	26.1	35.7	798 x100
Third week	35.4	22.8	29.1	45.9	22.8	34.3	770 x100
Fourth week	37.7	27.9	32.8	36.7	22.6	29.8	803 x100

Table 3. Effect of growing conditions on seed yield and physical properties of seeds of bitter gourd cv. Pusa Hybrid-1 during summer season (Feb- May, 2010).

Characters	IPN	OFC	Level of significance
Number of seeds per fruit	46.70	23.80	**
Number of filled seeds per fruit	45.30	20.10	**
Number of unfilled seeds per fruit	1.40	3.70	**
Seed yield per fruit (g)	9.41	4.81	**
Seed yield per plant (g)	27.28	7.29	**
Seed yield per hectare (kg)	232.00	54.00	**
100 seed weight (g)	14.80	13.80	NS
Seed length (cm)	1.40	1.35	NS
Seed width (cm)	0.81	0.75	**
Seed coat weight (g)	0.79	0.58	**
Cotyledon weight (g)	0.79	0.81	NS

NS non-significant, * Significant at P= 0.05, ** Significant at P=0 .01, IPN-Insect Proof Net house, OFC-Open Field Condition.

Table 4. Effect of growing conditions on seed quality characters immediately after harvest and eight of ambient storage of bitter gourd cv. Pusa Hybrid-1.

Characters	IPN	OFC	Level of significance
Electrical conductivity (ds/m)	0.13	0.18	**
Germination (%)	98	98	NS
Seedling length (cm)	36.68	22.18	**
Seedling fresh weight (g)	11.81	10.111	*
Seedling dry weight (mg)	1.034	0.8214	**
Seed vigour index I	3594.60	2112.88	**
Seed vigour index II	101.332	80.495	**
Germination (%)	98	98	NS
Seedling length (cm)	32.52	22.52	**
Seedling fresh weight (g)	9.683	9.382	NS
Seedling dry weight (mg)	0.94	0.80	**
Seed vigour index I	3186.96	2206.96	**
Seed vigour index II	92.61	78.30	**

NS non-significant, * Significant at P= 0.05, ** Significant at P=0 .01, IPN-Insect Proof Net house, OFC-Open Field Condition.

opment of the fruits and is in agreement with the result obtained in multiplication of parental lines of pumpkin under IPN (Singh *et al.,* 2009; Flemine *et al.,* 2012; Basu *et al.,* 2013). Shade house conditions are more favourable for higher seed yield and quality (Yadav and Malabasari, 2014). Highly significant differences in seed yield/fruit, seed yield/plant under IPN were due to higher number of filled seed/fruit and number of matured fruit/plant. Though 100 seed weight showed non-significant difference in both growing conditions, but it was numerically higher in IPN (14.80g) compared to OFC (13.80g) and it could be due to size grading of seeds (Table 3).

Physical properties of seed: The observations on seed length and cotyledon weight showed non-significant difference under both growing conditions, but seed width showed significant difference, it was 0.81cm in IPN and 0.75cm in OFC. The observations for seed coat weight showed significantly higher difference, it was 0.79g in IPN comparison to OFC (0.58g) (Table 3). Among the physical parameters, seed width and seed coat weight have shown significant difference and

were higher in IPN and may be due to the better development and maturation of fruit under IPN because of more fruit width and fruit length and it may be because of better photosynthetic efficiency of plant in comparison to OFC and increased quantity of chlorophyll (Collard *et al.,* 1977; El-Aidy, 1983) where as in OFC it was affected by incidence of viruses and higher light intensity.

Seed quality attributes immediately after harvest: The observed value for electrical conductivity was significantly lower in IPN (0.13ds/m) than OFC (0.18ds/m) which indicates the sound development of seed and considered to be highest quality seeds. A non-significant difference was recorded for germination percentage which was 98 % under both growing conditions immediately after harvest, but seedling length was significantly higher in IPN (36.68cm) compared to OFC (22.18cm) (Table 4). A significant difference was recorded for seedling fresh weight, which was higher in IPN (11.81g) than OFC (10.11g). Seedling dry weight was also significantly higher in IPN (1.03mg) compared with OFC (0.82mg). A highly significant difference was recorded for seed vigour index-I, which was superior in IPN (3594.60) in comparison with open field conditions (2112.88). Similarly seed vigour index II showed significantly higher difference under IPN (101.33) than in OFC (80.49) (Table 4). Similarly the seed quality attributes under insect proof net house, immediately after harvest was significantly superior over open field seed crop (Anonymous, 2008). Poly house conditions are more favourable for higher hybrid seed yield and seed quality in bottle gourd (Pham *et al.,* 2007). Insect proof net house condition is highly suitable for quality seed production of brinjal in north Indian plains (Singh *et al.,* 2006).

Seed quality attributes after eight month of ambient storage condition of seeds: After eight month of ambient storage of seeds there was non-significant difference for germination percentage which was 98 % under both growing conditions. A highly significant difference was recorded for seedling length and it was 32.52cm in IPN and 22.52cm in OFC, but for seedling fresh weight, a non-significant difference was recorded, it was 9.68g in IPN and 9.38g under OFC. Highly significantly difference was recorded for seedling dry weight in IPN (0.94mg) compared to OFC (0.80mg). A highly significant difference was noticed for seed vigour index-I in IPN (3186.96) in comparison to OFC (2206.96). Similarly for seed vigour index-II, highly significant difference was recorded between IPN (92.61) and OFC (78.30) (Table 4). In pumpkin seed yield/fruit, seed yield/plant, seed yield/ha, seed width, seed coat weight and seed quality attributes were also significantly higher under insect proof net house immediately after harvest as well as after 8 months of ambient storage in comparison to open field, (Xavier, 2010). The seed quality is normally judged by germination percentage, seed vigour index and electrical conductivity of the seed. The observations for seedling length, fresh seedling weight and dry seedling weight were significantly higher under IPN in comparison to OFC, may be due to the higher photosynthetic efficiency and better assimilation of food reserve in seed. Similarly the electric conductivity of the seeds obtained from IPN was significantly lower than open field crop, has indicated the sound development of seed. The seed production carried out under IPN conditions showed better performance even after eight months of ambient storage except for germination percentage and fresh seedling weight which had shown non-significant differences.

Conclusion

It was concluded that seed yield and seed quality characters including physical parameters of seed i.e. number of seed per fruit (46.7), number of filled seed per fruit (45.3), seed yield per fruit (9.41g), seed yield per plant (27.28g), and seed yield per hectare (232kg) were significantly higher under IPN in comparison to OFC were significantly superior under IPN over open field grown crop. The seed quality attributes immediately after harvest of the seeds as well as after 8 months of its ambient storage could maintain their superiority. This superior performance of seed yield and seed quality under IPN showed that the use of IPN in bitter gourd hybrid seed production could be quite effective in reducing the incidence of virus and other insects pests like whiteflies, leaf miners etc. Thus, it is quite clear that hybrid seed production of bitter gourd could be done under insect proof net house for obtaining maximum seed yield, seed quality and economic returns during summer under North Indian plains.

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