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VARIABILITY AMONG YARD LONG BEAN HYBRIDS FOR POD CHARACTERS UNDER OPEN FIELD AND RAINSHELTER

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ABSTRACT
Analysis of variance of ten yard long bean hybrids along with one commercial hybrid check (NS 634) for pod yield plant^{-1} and related characters *viz*., earliness to flowering, percentage fruit set, days to harvest and crop duration was carried out as two separate experiments in open field and rainshelter in order to identify hybrids suitable for open field and rainshelter cultivation. Hybrid VS 50 x VS 13 recorded maximum fruit set percentage under both open field and rainshelter (66.55 % and 56.80 % respectively), with VS 50 x VS 26 (55.27 per cent) and VS 34 x VS 50 (55.05 per cent) being on par in rainshelter. It was observed that the hybrid VS 34 x VS 50 recorded highest pod yield (1058.20 and 689.67 g plant^{-1}) followed by hybrid VS 50 x VS 26 (973.27 and 674 g plant^{-1}) under open field and rainshelter respectively. Hence, based on the observations, VS 34 x VS 50 and VS 50 x VS 26 were identified as best hybrids for both open field and rainshelter cultivation.

INTRODUCTION

Yard long bean (V. *unguiculata* subsp. *sesquipedalis* (L.) Verdcourt), a trailing type of vegetable cowpea (2n = 24), is a member of the Fabaceae family, grown for its long, tender and succulent pods. It is also a rich source of protein, calcium, iron, riboflavin, phosphorus, potassium, vitamin A and vitamin C (Yamaguchi, 1983). It is a popular vegetable grown far and wide in the homesteads of Kerala, which accounts for its variability in this region. Despite its wide variability, crop improvement works in yard long bean have been limited. Utilization of recombination variations by means of hybridization is less in cowpea since it is self-pollinated and the dehiscence of anthers takes place before anthesis (Nair and Mehta, 2014).

As farmers shift to high yielding crops and varieties, cowpea landraces and diversity may be lost (Khan and Viswanatha, 2016). Cowpea, being a self pollinated crop, hybridization can be utilized to create variability. Hybridization is one of the most important techniques for crop improvement and the success of any hybridization programme is directly related to the genetic diversity of the genotypes selected as parents. Meena *et al*. (2015) observed that genetic variability and diversity is of major significance to the plant breeder in framing a successful breeding programme. Greater role of non additive components in the inheritance of seed yield and related characters was reported by Patel *et al*. (2013), emphasizing the scope of heterosis breeding for exploitation of vigour in cowpea. Generation mean analysis among cowpea genotypes revealed that the dominance component is higher in magnitude than additive component for yield and related characters and hence, these characters can be improved through heterosis breeding (Gupta *et al*., 2017). In combining ability analysis among V. *sesquipedalis* X V.*unguiculata* crosses, Vyjayanthi and Vellayani Jyothika exhibited good general combining ability for grain yield and yield components and hence, these lines can be utilized for exploitation of heterosis in hybridization programs (Selvakumar *et al.,* 2014). So far, public sector F_1 hybrids in yard long bean with high yield, quality, uniformity and resistance to pests and diseases are unavailable, which forces farmers to rely on private sector hybrid seeds, paying inordinate prices. Khan *et al*. (2015) opined that development of high yielding early varieties with resistance to biotic and abiotic stresses requires more attention in cowpea research.

In Kerala, production of vegetables during monsoon season is limited by heavy rainfall, associated pests and diseases. During this time, the state depends on neighboring states to meet its demand for vegetables. Therefore, protective structures like rainshelters, which can protect crops from excess rainfall effectively, have gained popularity. The climate of Kerala does not support completely covered structures instead, partially covered structures like rainshelter are identified to be more economical among small and marginal farmers. Rainshelter is a less expensive naturally ventilated tent, open at sides, made using GI pipes, wooden or bamboo poles, and the temperature rises by 2-4 degrees inside. Gokul and Hakkim (2016) compared the performance of cowpea under polyhouse, rainshelter and open field and recommended that growing cowpea (var. Vellayani Jyothika) inside the rainshelter will be more profitable than growing it inside naturally ventilated polyhouse. Hence, this study was undertaken to identify high yielding yard long bean hybrids and to check their suitability for rainshelter cultivation.

MATERIALS AND METHODS

Ten yard long bean hybrids were selected based on the specific combining ability and *per se* performance and seeds of the ten hybrids were produced in a crossing block. The details of the hybrid combinations are given in table 1. The hybrids were then evaluated in open field and rainshelter as two separate experiments along with a commercial hybrid check (NS 634). Both experiments were laid out in randomized block design with three replications in the Department of Vegetable Science, College of Agriculture, Vellayani, Trivandrum during September to February 2017. In both the experiments, ten plants were grown in furrows spaced 1.50 m apart with a spacing of 45 cm between plants. The crop was raised according to the package of practices recommendations (KAU, 2016). Observations *viz.*, fruit set percentage, number of days to first flowering, yield per plant, days to first harvest and crop duration were recorded from five plants per treatment, each selected randomly. Fruit set percentage of the observational plants was determined by dividing the number of fruits set by number of flowers X 100 (Wubs *et al*., 2009). The mean percentage obtained in each treatment was taken as the true fruit setting percentage of plants. Earliness to flowering and harvest of the observational plants were calculated by counting the number of days from the date of sowing to first flowering and first harvest respectively and average was worked out. Weight of green pods harvested from each observational plant was expressed in kilograms to determine pod yield per plant. Duration of the crop was calculated by counting the number of days from the date of sowing to the drying up of vines (Resmi, 1998). The data obtained was then subjected to analysis of variance as suggested by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

Analysis of variance for earliness to flowering (Table 2) recorded significant variation among hybrids in the range of 47.67 to 58.52 days in open field. Similar results were recorded by Khandait *et al*. (2016) in cowpea. Under rainshelter, the variability among hybrids for days to first flowering was non significant. However, on an average, rainshelter grown hybrids exhibited early flowering *i.e.,* 48.96 days after sowing against 51.07 days in open field. Early flowering inside protected structures was earlier reported by Kumar and Arumugam (2010) and Gokul and Hakkim (2016) in vegetables. Earliest flowering was noticed in the commercial check hybrid NS 634 (47.67 days) in open field, with which the hybrids VS 34 x VS 50 (48.60 days), VS 50 x VS 13 (48.73 days), VS 50 x VS 38 (49.00 days), VS 50 x VS 16 (49.13 days) and VS 50 x VS 26 (50.13 days) were on par. Under rainshelter conditions, VS 34 x VS 50 (44.99 days) was the earliest.

Percent fruit set varied considerably from 66.55 per cent (VS 50 x VS 13) to 50.60 per cent (NS 634) in open field (Table 2). Under rainshelter also, fruit set was maximum in VS 50 x VS 13 (56.80 per cent), with VS 50 x VS 26 (55.27 per cent) and VS 34 x VS 50 (55.05 per cent) being on par. Fruit set percentage was lower than that recorded by Litty (2015) in yard long bean under polyhouse (77.82 percent) and Chandrakar *et al*. (2016) in vegetable cowpea (67.43 percent). According to Rubatzky and Yamaguchi (1997), yard long bean is a warm season crop and grows well at an optimum temperature range of 27 to 30ºC. Sarutayophat *et al*. (2007) opined that yard long bean is quite sensitive to unfavorable conditions like high temperature, dry weather *etc.* Hence, decreased fruit set percentage in open field as well as rainshelter can be attributed to the higher temperature regime that prevailed during the cropping period (31.5 to 33.6ºC) and critically low rainfall (monthly average of 6.15 mm only). High negative correlation between pod set percentage and temperature was earlier reported by Iwami (1951) in beans. Fruit set percentage was lower under rainshelter (52.80 per cent) than open field (58.12 per cent). The in-house microclimate of rainshelter is higher by 2 to 4ºC

Table 1: List of hybrid combinations evaluated

Parents	Hybrid combinations
VS 34 X VS 50	Githika x Kakamoola local
VS 50 X VS 26	Kakamoola local x Vellayani Jyothika
VS 34 X VS 13	Githika x Neyyattinkara local
VS 50 X VS 13	Kakamoola local x Neyyattinkara local
VS 50 X VS 16	Kakamoola local x Pattom local
VS 16 X VS 38	Pattom local x Palayam local
VS 54 X VS 26	Thirupuram local x Vellayani Jyothika
VS 34 X VS 54	Githika x Thirupuram local
VS 13 X VS 26	Neyyattinkara local x Vellayani Jyothika
VS 50 X VS 38	Kakamoola local x Palayam local

Table 2: Mean performance of ten hybrids and check for days to first flowering and fruit set percentage in open field and rainshelter

Treatments	Days to first flowering		Fruit set (%)	
	OP	RS	OP	RS
VS 34 X VS 50	48.60	44.99	64.21	55.05
VS 50 X VS 26	50.13	48.00	62.06	55.27
VS 34 X VS 13	54.13	46.47	56.93	54.06
VS 50 X VS 13	48.73	50.93	66.55	56.80
VS 50 X VS 16	49.13	47.20	57.15	51.84
VS 16 X VS 38	52.73	50.32	58.56	50.14
VS 54 X VS 26	52.50	53.91	58.94	49.19
VS 34 X VS 54	50.67	49.42	55.96	50.96
VS 13 X VS 26	58.52	55.32	54.01	52.07
VS 50 X VS 38	49.00	46.62	54.33	54.70
NS 634(check)	47.67	45.40	50.60	50.75
Mean	51.07	48.96	58.12	52.80
CD (0.05)	2.880	NS	1.098	1.925

(OP- Open field; RS- Rainshelter)

Table 3: Mean performance of ten hybrids and check for pod yield, days to harvest and crop duration under open field and rainshelter

Treatments	Pod yield (g plant^{-1})		Days to harvest		Crop duration	
	OP	RS	OP	RS	OP	RS
VS 34 X VS 50	1058.20	689.67	58.97	53.83	128.27	139.60
VS 50 X VS 26	973.27	674.00	60.67	57.77	126.33	136.60
VS 34 X VS 13	761.33	576.80	63.07	55.30	130.40	141.40
VS 50 X VS 13	951.07	583.67	58.10	59.80	128.07	139.87
VS 50 X VS 16	894.53	520.60	59.90	59.30	130.53	140.53
VS 16 X VS 38	700.93	430.87	62.17	61.20	125.07	142.33
VS 54 X VS 26	721.00	464.87	62.43	64.80	124.33	139.13
VS 34 X VS 54	705.87	479.53	60.93	60.33	125.47	141.20
VS 13 X VS 26	668.53	468.33	69.87	63.50	125.07	138.93
VS 50 X VS 38	652.47	556.27	60.10	56.43	129.20	140.67
NS 634(check)	561.93	534.87	58.42	56.47	124.80	137.67
Mean	786.28	543.59	61.33	58.98	127.05	139.81
CD (0.05)	127.671	33.910	2.468	2.032	1.001	1.694

(OP- Open field; RS- Rainshelter)

than outside as reported by Kamaruddin (2007). Sharif *et al*. (2008) observed that the internal environment of rain shelter depends on radiant heat received by it and excessive radiation causes heat stress in plants grown inside and depresses its physiological functions. Fruit abortion can be caused by unfavorable conditions like temperature stress (Guilioni *et al*., 1997) and low light conditions (Aloni *et al*., 1996).

The hybrids varied significantly with respect to pod yield per plant. The variability ranged from 1058.20 to 561.93 g in open field and from 689.67 g to 430.87 g under rainshelter (Table 3). The results also get corroborated with Hossain *et al*. (2013) and Lakshmi (2016) in yard long bean. Average pod yield per plant was higher in open field (786.28 g) than rainshelter (543.59 g). Lower fruit set percentage and reduction in light intensity may have resulted in the yield reduction under rainshelter. Wubs *et al*. (2009) observed that fluctuations in fruit yield are strongly and positively correlated with fluctuations in fruit set. Greater yield under open conditions in yard long bean was earlier reported by Ranasinghe (1999) compared to 40 and 60 per cent shade. The monthly average rainfall received during the period of study was only 6.15 mm. Earlier studies reveal that the benefit from rainshelter cannot be realized when seasonal rainfall is relatively low which may result in lower yield of yard long bean under rainshelter conditions (Palada and Ali, 2007). In addition, greater incidence of aphids and cowpea aphid borne mosaic virus inside rainshelter than open field may also have contributed to the yield reduction. Among all the treatments, VS 34 x VS 50 was the highest yielder under both conditions (1058.20 and 689.67 g plant^{-1} under open and rainshelter respectively) which was on par with VS 50 x VS 26 (973.27 g plant^{-1} and 674 g plant^{-1} under open field and rainshelter respectively).

Days to first harvest also exhibited significant variation in the range of 58.10 days to 69.87 days in open field and 53.83 days to 64.80 days under rainshelter (Table 3). Days to harvest in the range of 44.43 to 61.03 days were earlier reported by Mandavi (2005) in cowpea. Litty (2015) observed that polyhouse grown yard long bean recorded 40.65 to 45.89 days to first harvest from sowing. In the present study, rainshelter grown plants were ready for harvest earlier (58.98 days) than open field grown plants (61.33 days). Early harvest under polyhouse was also reported by Chandra *et al*. (2000). Earliest harvest was observed in VS 50 x VS 13 (58.10 days) and VS 34 x VS 50 (53.83 days) in open and rainshelter respectively. NS 634 (58.42 days), VS 34 x VS 50 (58.97 days), VS 50 x VS 16 (59.90 days) and VS 50 x VS 38 (60.10 days) were on par in open field and VS 34 x VS 13 (55.30 days) was on par under rainshelter.

Crop duration varied significantly among the hybrids under study from 130.53 to 124.33 days in open field and from 142.33 to 136.60 days under rainshelter (Table 3). Litty (2015) also observed significant variability for crop duration in the range of 115.87 to 143.27 days among thirty yard long bean accessions grown under polyhouse conditions. Mean crop duration under rainshelter was significantly higher (139.81 days) than open field (127.05 days) and similar reports were given by Srivastava *et al*. (2011) in cauliflower, Rajasekharan (2015) in cucumber and Litty (2015) in yard long bean. Crop duration was longest in VS 50 x VS 16 (130.53 days) in open field which was on par with VS 34 x VS 13 (130.40 days). Under rainshelter, VS 16 x VS 38 (142.33 days) recorded longest duration, and was on par with VS 34 x VS 13 (141.40 days), VS 34 X VS 54 (141.20 days) and VS 50 x VS 38 (140.67 days).

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