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Morphological Characterization of Yardlong Bean for Pod Borer Infestation

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ABSTRACT

The yardlong bean is a popular vegetable among the people of Asia. However, pod borer infestation is one of the major setbacks of growing this vegetables. This insect not only reduce the yield of the crops, but also compromise the wulaity of the vegetable. Therefore, to devise an effective control measure, its characterization is important. In order to assess the resistance of several yardlong bean types to pod borer attacks, an experiment was conducted at the experimental farm of Bangladesh Agricultural University, located in Mymensingh, Bangladesh, from September 2022 to April 2023. The study included nine yardlong bean varieties. The experiment was arranged with five replications using a completely randomized design (CRD). Eighteen parameters including plant height, main branch, secondary branch, leaf number, flower number, fruit number and fruit color were used to distinguish and differentiate the nine fabaceae genotypes. Among the varieties, BARI Borboti Yardlong Bean-2 produced the highest yield of 98.57 g per plant. A comparison of the BARI Borboti-2 variety's dry seed output and other characteristics showed that it had the highest total number of pods per plant (8.40), the lowest infestation rate (13%) by pod borers, and the maximum quantity of dry seeds (15 g). In most cases, the Lubna variety had the worst performance. The majority of the types had the second lowest infection infestation. According to the current investigation, BARI Yardlong Bean -2 showed the best performance and demonstrated better overall performance like flower color, pod color, length, breadth, and seed color varying among the varieties fewer pod borer infestations.

1. Introduction

The yardlong bean is one of the most significant leguminous vegetables in Asia (Benchasri and Bairaman, 2010). It is also known as the asparagus bean, string bean, snake bean, or snake pea. This bean was first cultivated in West Africa, and it is now widely grown across Southeast Asia, including Malaysia, the Philippines, Indonesia, and Thailand, where it can be grown year-round (Benchasri and Bairaman, 2010). The ideal growing temperature for yardlong beans ranges between 27 to 30 °C, and it is better able to withstand heat and dryness than other common beans such as lima bean. Usually, the yardlong bean is harvested while still young and consumed as a green vegetable (Peyrano et al., 2013). The yardlong bean is frequently known as "poor man's meat" as the pods are high not only in protein (23–32% of seed weight) but also in lysine, tryptophan and a significant number of critical vitamins and minerals including folic acid and vitamin B (Pandey et al., 2020).

Yardlong bean growers face serious losses at pod harvest caused by *M. vitrata* infestation and consequently employ an array of agronomic management regimes such as application of conventional insecticides which cause adverse effects on the environment and human health, but fail to achieve a satisfactory level of control (Srinivasan and Ramasamy, 2019).

Other sprays found promising on crops include neem (Dreyer and Ascher, 1987) and petroleum oil (El-Tom, 1987). The most significant and harmful pests of yardlong beans are thought to be the aphid, jessed, pod borer, and epicanthal beetle. Considerable research has been conducted on the extent of the infestation, the losses they have sustained, and the current management techniques as well as others both domestically and internationally. Uddin et al. (2013) were conducted investigation on intensive yardlong bean growing areas of Bangladesh to know the pest incidence and their level of infestation on yardlong bean.

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In the studied areas there were at least nine out of ten insect pests at different growth stages, which were aphid, pod borer, thrips, red mite, leaf miner, leaf beetle, green sting-bug, jute hairy caterpillar, hooded hopper and semi-looper in descending order. It was revealed that aphid and pod borer were the major insect pests in the study areas.

Globally, which much is known regarding *M. vitrata* infestation on cowpea and pigeon pea (Jackai,1981; Karel, 1985), a knowledge gap exists with regard to *M. vitrata* infestation of yardlong beans. Thus, there is a paucity of information regarding damage potential, distribution and population dynamics which are cornerstones for the implementation of successful management strategies. To suppress the population of the pest, farmers in Bangladesh frequently require application of control measures to protect their crops (Rahman and Rahman, 1988; Begum, 1993). But still now the farmers are highly depending on chemical insecticides to control the pest infestation on yardlong beans.

Insecticides commonly used, however, are not specific and they frequently kill natural enemy populations and may cause upset and resurgence of other pest populations (Debach and Rosen, 1991; Pedigo, 1999). In addition, development of insect biotypes resistant to the commonly used insecticides is not uncommon (Debach and Rosen, 1991; Pedigo, 1999).

Thus, as an alternative to sole reliance on insecticide, the use of resistant cultivars and other non-chemical methods would provide avenues towards safer pest control practices. Assessment of genetic diversity based solely on phenotypic traits poses inherent limitations. Morphological characteristics, while important, are highly influenced by environmental conditions and the developmental stage of the plant. Factors such as soil quality, temperature, humidity, and management practices can significantly alter the expression of these traits, making it difficult to distinguish genetic differences from environmentally induced variations. Moreover, phenotypic plasticity often masks the true genetic potential of the germplasm, leading to challenges in accurately characterizing and selecting desirable traits. The primary objectives of this study are to evaluate genetic diversity among collected germplasm using a combination of morphological, physiological, and molecular markers, and to identify traits associated with enhanced resistance to environmental stressors and pest infestations. By integrating phenotypic assessments with genotypic analyses, the study aims to provide a comprehensive understanding of the genetic potential of the germplasm, which will be instrumental in breeding programs and the development of resilient crop varieties.

2. Materials and Methods

2.1. Materials used for genotyping

Nine germplasm of yardlong bean including 4 local varieties, collected from different parts of Bangladesh and 5 high yielding varieties, collected from the Laal Teer Company (www.lalteerseeds.com) and Bangladesh Agricultural Research Institute (BARI), Gazipur, Dhaka (Table 1) were using in the trial.

Table 1. List of yardlong bean genotypes used in the experiment

Genotypes	Sources	Genotypes
Ufshi	Local area	Ufshi
Kk-45	Local area	Kk-45
China short	Local area	China short
Chitra	Local area	Chitra
Mallika	Laal Teer seed Co.	Mallika
Kegarnatki	Laal Teer seed Co.	Kegarnatki
Lubna	Laal Teer seed Co.	Lubna
BARI Borboti-1	BARI	BARI Yardlong Bean-1
BARI Borboti-2	BARI	BARI Yardlong Bean-2

2.2. Experiment site and duration

The experiment was carried out at the field laboratory of the Department of Entomology, Bangladesh Agricultural University, Mymensingh during September 2022 to April 2023. The site is characterized with the sub-tropical climate with low temperature, humidity and rainfall with occasional gusty winds in the Rabi season.

2.3. Experimental design and layout

The experiment was conducted in pots and the experimental pots were laid out in Completely Randomized Design (CRD) with three replications.

2.4. Pot culture

Seeds were sown at a depth of not more than 5 mm in each pot with drainage holes and after that soil were placed and 50% compost from vermicomposting was blended with 50% garden soil. Additionally, 30g of muriate of potash and 30g of triple super phosphate were combined. The seeds were tightly packed and irrigated to prevent disturbance. Germination took two to three weeks, and seedlings were cultivated for four to six weeks before transplantation. When the seedlings were 4-6 inches tall, they were ready for transplantation. Careful transplantation was done, ensuring the root ball remained intact. Three seedlings per pot were transplanted, and the plants were kept 4-5 inches apart. After 40-55 days, buds and flowers began to form.

2.5. Data collection

There were nine Fabaceae genotypes and eighteen characteristics were utilized to identify and separate them: plant height, main branch, secondary branch, leaf number, flower number, fruit number, and fruit color. Nine different types were chosen, and their specific morphological traits were noted alongside average statistics. Plant height, growth habit, number of branches per plant, days until 50% flowering, days until fruit setting, and other relevant data were recorded. This included the number of pods on a plant, pod dimensions (width, length, weight), pod color, number of seeds per plant, seed shape, color of the dry seed, fresh weight of 100 seeds, dry weight of 100 seeds, number of healthy and infected pods per plant, infestation percentage, and pod production per plant.

Figure 1. Genotypes of yardlong bean under the family Fabaceae (picture taken after 14 days of germination). The genotypes of Fabaceae exhibited noticeable differences in early growth stages, as illustrated in Figure 1, which shows the seedlings 14 days after germination. This figure provides a comparative view of the morphological traits among the studied genotypes.

2.6. Statistical analysis

The analysis of variance (ANOVA) followed by the least significance difference (LSD) tests of the collected data were presented at 5% probability using MSTAT-C Software.

3. Results

3.1. Genotypic evaluation on morphology of yardlong bean:

The study analyzed different varieties of asparagus beans, with the Ufshi having the highest mean height (46.13 cm) and the Lubna having the lowest (26.66 cm). Chitra and KK-45 beans had similar mean heights (45 cm), while BARI barbati-1 and Borboti-2 had similar heights (43 cm). The Mallika variety had the highest height, while China short and Kegarnatki had the same height (Table 2).

According to the study, BARI Borboti-2 has the highest mean number of branches (10 per plant), whereas BARI Borboti-1 and China short beans have the lowest mean number of branches (5.60 per plant) (Table 2). Significant differences were observed in the number of days required for 50% flowering among the varieties studied, with the China short variety requiring the most time (68 days), followed by BARI Borboti-1 (68 days), and Lubna (54 days). The study showed that except for Kegarnatki beans and China short types, 96.4% of the accessions had an unpredictable growth habit. This indicates that dwarf yardlong beans and yardlong beans have distinct growth habits (Table 2).

The study found four main flower colors for yardlong beans: whitish purple, purple white, purple, and white. In Figure 3, the majority of genotypes had whitish purple flowers (44%), with some being purple-white (36%), and the rest being purple (20%). This supports Tantasawat et al.'s (2010) findings that 69.57% of yardlong bean genotypes had purple-white flowers. The pod color was found to be green in 52% of genotypes and light green in 36%. Only one genotype, Mallika, had a dark purple pod color (Figure 2). All genotypes had a dry seed color of brown, showing no variation in seed coat color. Seed shape did not vary, with most genotypes having kidney-shaped seeds (96%), except for Chitra, which had oval-shaped seeds. Seeds from different germplasm were shown in Figure 4.

The study measured pod lengths and breadths of different cultivars after harvesting. BARI barbati-1 had the highest pod length at 32.70 cm, followed by Chitra at 14.40 cm. Pod breadths were intermediate between 0.69 and 0.89 mm. Total pods plant-1 varied significantly among the genotypes, with BARI barbati-2 having the highest at 8.40 cm, followed by Ufshi at 8.40 cm, and Mallika at 2.60 cm. Seed pods-1 had significant variation among the genotypes, with BARI Borboti-2 having the highest number at 19.80 cm, followed by Kk-45 at 17.80 cm. Mallika had the lowest at 12.40 cm (Table 3).

The study investigated twenty different varieties of pod borer infections. Kk-45 pods had the highest infection rate (3.20), followed by Mallika (1.20), and BARI barbat-1 had the lowest (7.0). Kk-45 had the highest proportion of pod borer infection, with Mallika coming in second at 38.00% (Table 4).

The study found significant differences in the weight of single pods among twenty varieties, with Ufshi having the highest weight and Kk-45 having the lowest. Fresh and dried seed weights were also influenced by genotypes, with Bari Borboti-2 having the highest weight (26.20 g) and Mallika having the minimum weight (16.70 g). The least plastic character genotype showed the least plastic character, which is not affected by environmental changes. The highest pod yield was found in Bari Borboti-2 and Ufshi, while Mallika and Lubna had the lowest yields (Table 5).

The variation in color of flower or pod among the varieties were recorded might be due to the variation in their characteristics and also the changes in chemical function in plant during cultivation. Besides, pod borer infection also occurred on the changes in color, shape and growth habit of the different parts of yardlong bean in this study. Such the same observation was also reported by Jagadeesh et al. (2002) who also reported that the different genotypes of mungbean viz. GG (PBM), UG-562, AKU7, GPU-95-1 and UG-737 showed variation in color of plant parts due to similarly cause of the present findings. Oghiakhe et al. (1992) identified trichome density on pod wall surface as an important factor deciding pod infestation in cowpea by legume pod-borer.

The minimum and maximum number of total pods plant^{-1} varied in between 2 to 8. The variation in pod production might be the result of genotypic or environmental factors. Similar results were also observed in yardlong bean, as Sarutayophat et al. (2007) reported that the number of pods per plant varied significantly ranging from 10 to 38.

Result showed that there was significant difference in 100-seed weight. This result is agreement with Kamala et al. (2014). They reported that hundred seed weight varied from 7.3-23.2 g. The highest pod yield plant^{-1} was recorded in Ufshi and BARI Borboti-1 respectively. In contrast, the minimum yield plant-^{1} was found in the

Table 2. Effect of genotypes (accessions) on yield attributing characters of yardlong bean

Genotypes	Plant height (cm)	No. of branches/ plant	Days to flowering	Days to fruiting	Growth habit
Ufshi	46.13a	8.60abc	56.60c	66.20 cd	Indeterminate
KK-45	45.50a	9.40ab	64.80ab	76.00 b	Indeterminate
China short	39.16a	5.60 d	68.80a	80.80a	Determinate
Chitra	45.24a	10.0a	64.20b	77.00ab	Indeterminate
Mallika	40.02a	8.20 bc	56.60c	69.00 c	Indeterminate
Kegarnatki	39.06a	7.60 c	55.20c	66.20 cd	Semi determinate
Lubna	26.66 b	7.60 c	54.20c	62.20 d	Indeterminate
BARI Borboti-1	43.64a	5.60 d	66.80ab	74.00 b	Indeterminate
BARI Borboti-2	43.66a	10.0a	57.40c	65.00 cd	Indeterminate
Sig. level	**	**	**	**	-
LSD (0.05)	8.75	1.55	4.33	4.53	-
CV (%)	16.57	14.91	5.57	4.97	-

** =Significant at 1% level of probability

Figure 2. Illustrates the variation among the three genotypes BARI Borboti-1, BARI Borboti-2, and Ufshi in terms of length and color

Figure 3. Variation in flower color among the three genotypes: Ufshi (purple white), Chitra (whitish purple), and Mallika (purple)

Figure 4. Variation in shape and color among the three genotypes: KK-45, BARI Borboti-1, and Lubna

Table 3. Effect of genotypes (accessions) on yield attributing characters of yardlong bean

Genotypes	Pod color	No. of pods/plant	No. of seeds/ plant	Pod length (cm)	Pod breadth (mm)	Dry seed color
Ufshi	Dark green	8.00ab	17.20ab	27.20 bc	0.82a	Brown
KK-45	Green	7.40ab	17.80ab	29.14 b	0.81a	Dark brown
Chitra	Green	4.00c	14.00de	14.40 e	0.89a	Brown
China short	Green	7.20ab	15.20bcd	27.60 bc	0.79ab	Brown
Mallika	Dark purple	2.60d	12.40ef	17.40 e	0.70 bc	Dark brown
Lubna	Light green	3.00cd	10.60f	16.60 e	0.66 c	Brown
Kegarnatki	Green	7.00b	16.80ab	21.40 d	0.85a	Dark brown
BARI Borboti-1	Light green	3.20cd	14.20cde	32.70a	0.69 bc	Light brown
BARI Borboti -2	Dark green	8.40a	19.0a	25.80 c	0.87a	Dark brown
Sig level	-	**	**	**	**	**
CV (%)	-	17.41	13.34	10.46	9.84	11.91

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); ** =Significant at 1% level of probability

Table 4. Effect of genotypes (accessions) on yield attributing characters of yardlong bean

Genotypes	Seed shape	Infested pods/plant	% Infestation
Ufshi	Kidney	1.00cd	13.65d
KK-45	Kidney	3.20a	40.60a
Chitra	Round	1.20 bcd	29.00b
China short	Kidney	1.80 bc	23.93bc
Mallika	Kidney	1.20 bcd	38.00a
Lubna	Kidney	1.20 bcd	24.66bc
Kegarnatki	Kidney	1.00 cd	15.16d
BARI Borboti-1	Oval	1.80 d	20.71cd
BARI Borboti-2	Kidney	1.00 cd	13.65d
Sig. level		**	**
CV (%)		51.30	23.67

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); ** =Significant at 1% level of probability

Table 5. Effect of genotypes (accessions) on yield attributing characters of yardlong bean

Genotypes	Pod weight(g)	Fresh weight of 100 seed	Dry weight of 100 seed(g)	Pod yield/Plant (g)
Ufshi	12.30a	20.97 c	10.60 bcd	92.96a
KK-45	8.42 d	21.77 bc	11.32 bc	61.75 bc
Chitra	9.39 d	21.18 c	9.90 cd	36.57 c
China short	10.74 c	21.56 c	11.03 bcd	77.64ab
Mallika	12.60a	16.70 e	8.278 e	33.39 c
Lubna	10.98 c	18.85 d	10.25 cd	33.03 c
Kegarnatki	12.12ab	23.52 b	11.86 b	85.07ab
BARI Borboti-1	10.74 c	18.23 de	9.57 de	34.69 c
BARI Borboti-2	11.06 bc	26.20a	15.06a	98.57a
Sig. level	**	**	**	**
CV (%)	7.82	6.77	11.47	38.74

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT); ** =Significant at 1% level of probability

genotype Lubna. Local Ufshi also showed higher significant performance on pod yield (93.96 g plant^{-1}) with the higher pod weight (12.30 g).This and present findings of the present study was also agreed by Dawoodi et al. (2010); Umbarkar et al. (2011).This finding(s) suggested that the local variety Ufshi may be replaced on HYV variety to maintain the optimum performance.

4. Conclusion

The study evaluated pod borer infestation and its impact on inflorescence and morphological characteristics of 7 local and 2 BARI released yardlong bean varieties at the Department of Entomology, Bangladesh Agricultural University. Results showed significant variation among the varieties, with flower color, pod color, length, breadth, and seed color varying among the varieties. The study also found that pod borer infection affected the changes in color, shape, and growth habit of different parts of yardlong beans. BARI Borboti-2 showed the highest performance in reducing pod borer infestation, with higher yields of green pods and dry seeds. The genetic characteristics of this variety were highly favorable to the regional conditions of the study area, influencing its growth and yield of yardlong beans and reducing pod borer infestation. The study concluded that BARI Borboti-2 and Ufshi showed higher affectivity on plant growth and booster yield by protecting plants from pod borer infestation.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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