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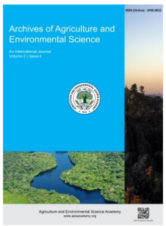

ORIGINAL RESEARCH ARTICLE

CrossMark

Evaluation of eight isabgol (*Plantago ovata* Forsk.) germplasm performance grown under different climatic conditions in Bangladesh

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ABSTRACT

The extent of genetic diversity in the crop plants is of prime concern to plant breeders and germplasm curators. Therefore, a study was employed to determine the genetic diversity and to evaluate the performance of eight genotypes of isabgol (*Plantago ovata* Forsk.) through analysis of morpho-physiological and yield attributing characteristics. All the germplasm was collected from different areas of Bangladesh. The experiments were conducted at the research field of Regional Spices Research Centre, Magura during the rabi season, 2019-20 to characterize phenotypically and to evaluate the performance of different isabgol germplasm. The experiments were laid out in randomized complete block design with three replications. The highest plant height (42.33 cm), number of tillers per plant (7.33), number of leaves per plant (74), length of leaf (30.00 cm), number of spikes per plant (29.0), length of spike (4.03 cm), 1000 seeds weight (2.0 g) and seed yield (823 kg ha^{-1}) of isabgol was found from the germplasm PO-001 and the lowest plant height (39.67 cm), number of tillers per plant (6.33), number of leaves per plant (69.33), length of leaf (26.33 cm), number of spikes per plant (23.0), length of spike (3.67 cm), 1000 seeds weight (1.87 g) and seed yield (705 kg ha^{-1}) of isabgol was found from the germplasm PO-007. On the basis of this field trail in terms of seed yield and other important agronomic characteristics the genotypes PO-001 can be chosen for future breeding material to release a commercial variety in Bangladesh climatic conditions.

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INTRODUCTION

Nearly 200 species consist of Plantaginaceae family under the genus of Plantago (Rahn, 1996) most of which are predominantly cross-pollinated in nature. Although the center of diversity of plantago is deemed to be positioned somewhere in central Asia, some species have now become widespread far and wide with utmost concentration in temperate areas. Species of Plantago are small herbs, mostly growing as weeds, while some are exploited in varied modes in local medicines, two taxa namely *Plantago ovata* Forsk. and *P. psyllium* L. is economically imperative. These are annual medicinal plant cultivated for their mucilaginous seed husk which is pharmaceutically rated among the most effective laxatives. Isabgol is valued for its seeds and husk which is used in indigenous and traditional medicine system all over the world (Lal *et al.*, 2009). It is nearly stem less softly hairy plant with large narrowly linear, 7.5 – 20 cm long and about 0.6 cm broad leaves appearing in whorled due to short terete stem. The spikes are 1.2 to 4 cm long and about 0.5 cm broad, cylindrical to ovoid in shape and bear 45 to 69 flowers.

The flowers are bisexual, tetramerous, anemophilous and protogynous and as such favouring out-crossing. The fruit is an ellipsoidal capsule, about 8 mm long, boat shaped, and containing smooth rosy-white seeds. The seed epidermis is made of polyhedral cells whose walls are thickened by a secondary deposit which is the source of mucilage (Chopra, 1930). The coating of the seed provides the husk on mechanical milling.

Isabgol has been used in medicines since ancient times, but it has only been cultivated as a medicinal plant in recent decades (Gupta, 1987; Wolver *et al.*, 1994; Handa and Kaul, 1999). Its seed contains mucilage, fatty oil, large quantities of albuminous matter, the pharmacologically inactive glucoside, namely Aucubin ($C_{13}H_{19}O_8H_2O$) and a plantiose sugar (Chevallier, 1996). Isabgol seed husk has the property of absorbing and retaining water which accounts for its utility in stopping diarrhea. It is a diuretic, alleviates kidney and bladder complaints, gonorrhea, arthritis and hemorrhoids (Zargari, 1990; Ansari and Ali, 1996). It is laxative and mainly used as a dietary fiber. The use of soluble fiber cereals is an effective and well-tolerated part of a prudent diet for treatment of mild to moderate hypercholesterolemia and for reducing blood glucose (Abraham and Mehta, 1988; Anderson *et al.*, 1990). Its soluble content is almost eight times more than that of oat's bran. The diet fibers extracted from the plant possess pharmaceutical properties and can be used in producing low calorie food (Theuissen, 2008).

Since it is an introduced crop to Bangladesh, the gene pool available in the country is very narrow and within the species of *P. ovata*, the variability for economically important traits is narrows (Lal *et al.*, 2000). The nearly stagnant yield of isabgol is due to narrow genetic base and use of traditional breeding techniques with little or no understanding of genetic architecture of the plants (Lal *et al.*, 2009). In the scenario of increasing demand and lack of improved varieties, there is immediate need to develop high-yielding varieties of this crop having better husk quality and to look at suitable locations for growing this crop in other states of the country.

Consequently, the efforts for generating genetic variability for its improvement are met with limited success. There is no recommended isabgol variety so far in our country. Because of its commercial importance as well as distinctness of local germplasm, our efforts to collect the indigenous isabgol germplasm from the native lands and evaluate them through morphological markers to distinguish them from each other and are similar in their yield potential. One of the ways to search variability for its improvement is through the evaluation of indigenous and exotic germplasm. The selection of such germplasm must be based on certain scientific principles that can be obtained only through systematic study on various aspects in these genotypes. Information available in these aspects is scanty and unreliable. The selected germplasm has agronomic interest, because some of them may be a source of valuable traits for future isabgol breeding and to improve seed quality, disease resistance, heat and cold tolerance, photosynthetic rates, early vigour, and micronutrient acquisition. The crop improvement in any crop will require a thorough understanding of physiology of the crop along with its genetics and agronomic requirements. Hence, the present study was undertaken to investigate the morpho-physiological and yield characteristics of some collected in Bangladesh.

MATERIALS AND METHODS

The research was carried out at the experimental field of Regional Spices Research Centre, Magura during rabi season, 2019-20 to evaluate the performance of different Isabgol germplasm and to select the promising one(s) for releasing as a variety. The experimental site represents agro-ecological zone (AEZ)-11 recognized as to high Ganges river floodplain. The land was medium high and the soil was clay loam in texture. The unit plot size was 0.8 m × 5 m. Eight germplasm *viz.*, PO-001, PO-002, PO-003, PO-004, PO-005, PO-006, PO-007 and PO-008 collected from different parts of Bangladesh were evaluated for their morpho-physiological and yield performances. The seeds were continuously sown on 26th November, 2019 with maintaining 40 cm apart rows. The crop was fertilized with cowdung 5 t ha^{-1}, N 80 kg ha^{-1}, P 35 kg ha^{-1}, K 68 kg ha^{-1}, S 20 kg ha^{-1}. The entire quantity of cowdung, TSP, MoP and gypsum was applied during final land preparation and urea was applied in two splits at 30 and 50 days after sowing. One light irrigation was given just after sowing to ensure optimum soil moisture for germination. Another, three irrigations were given at 20, 50 and 80 days after sowing. Three weeding were given at 15, 40 and 80 days after sowing. Two spraying with Amister Top (Azoxistrobin + Difeniconazol) @ 2g/L were applied at 40 and 80 days after sowing to escape from disease. The crop was managed by recommended package of intercultural practices. The crop was harvested when the spike turned reddish-brown colour and lower leaves dried up and start yellowing of upper leaves. The Observations on different morphological and yield attributing characters viz., % germination, days to germination (d), plant height (cm), number of tiller/plant, number of leaves/plant, leaf length (cm), root length (cm), 1st emergence of spike (days), days to 50% flowering, number of spikes/plant, length of spike (cm), number of seeds/spike, 1000 seeds weight (g), weight of seeds/plant (g) and seed yield (kg/ha) were recorded from five randomly selected plants from each replications. Collected data were statistically analyzed using MSTAT-C computer package program. Difference between treatments was assessed by Duncan's Multiple Range Test at 5% level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Morpho-physiological, yield and yield attributing characteristics of different Isabgol germplasm

The mean performance of eight isobgul germplasm for all the morpho-physiological and yield attributing characters are presented in (Tables 1, 2 and Figures 1, 2) showed significant

Table 1. Morphological characteristics of different isabgol germplasm in Bangladesh.

Germplasm	% germination	Days to germination	No. of tiller/ plant	No. of leaves/ plant	Leaf length (cm)	Root length (cm)
PO-001	90.52	4.8	7.67	74.40	30.00	16.5
PO-002	86.33	5.6	6.40	70.32	28.33	15.2
PO-003	82.43	5.9	6.00	68.25	26.67	14.4
PO-004	80.44	5.9	5.80	65.77	25.00	14.0
PO-005	79.80	6.2	5.70	66.40	24.67	13.5
PO-006	77.20	6.8	5.25	62.90	24.33	13.2
PO-007	68.33	6.5	5.10	67.42	23.00	13.0
PO-008	65.44	6.8	5.00	65.90	23.67	13.2
Grand mean	78.81	6.06	5.86	67.67	25.70	14.12
Maximum	90.52	6.8	7.67	74.4	30	16.5
Minimum	65.44	4.8	5	62.9	23	13
SEm	1.780	0.236	0.942	1.546	1.064	1.005
CD at 5%	5.204	0.672	1.054	4.840	2.762	1.656

Table 2. Yield and yield attributing characteristics of different isabgol germplasm in Bangladesh.

Germplasm	1st emergence of spike (days)	Days to 50% flowering	No. spikes/ plant	Spike length (cm)	No. of seed/ spike	1000 seed weight (g)	Seed weight (g)/ plant
PO-001	60.3	70.2	29.5	4.03	93.8	2.008	5.65
PO-002	64.5	72.6	27.2	3.97	86.4	1.945	5.34
PO-003	65.8	74.5	26.5	3.77	82.8	1.890	5.22
PO-004	66.5	76.2	23.4	3.54	77.5	1.812	5.18
PO-005	66.5	76.8	23.8	3.42	74.6	1.790	5.32
PO-006	68.2	77.8	22.6	3.45	75.8	1.824	4.94
PO-007	65.5	74.2	23.2	3.35	70.2	1.782	4.78
PO-008	68.0	78.4	22.0	3.32	68.2	1.724	4.65
Grand mean	65.66	75.08	24.7	3.61	78.66	1.847	5.14
Maximum	68.2	78.4	29.5	4.03	93.8	2.008	5.65
Minimum	60.3	70.2	22	3.32	68.2	1.724	4.65
SEm	0.984	0.422	1.022	0.145	1.062	0.012	0.172
CD at 5%	1.332	1.220	2.984	0.862	4.022	0.024	0.492

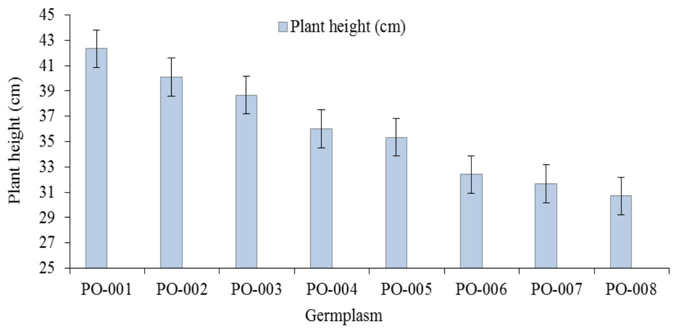

Figure 1. *Plant height of different Isabgol germplasm. Vertical bars represent standard error.*

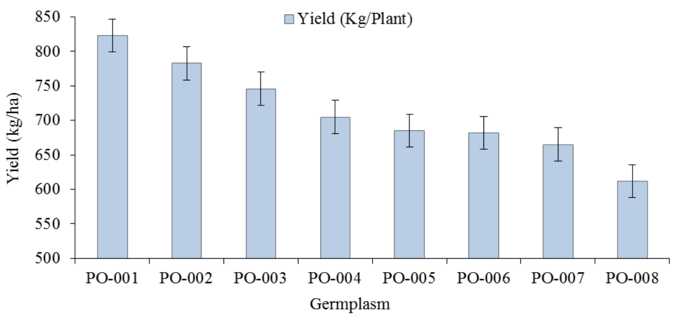

Figure 2. *Yield obtained by different Isabgol germplasm in Bangladesh. Vertical bars represent standard error.*

variation among the different genotypes. All the germplasm was a stemless or sub-caulescent softly hairy or woolly annual herb. Leaves were narrowly linear or filiform, entire or distantly toothed; flowers bisexual and favour out crossing, spikes were 3 -5 cm long and about 0.5 cm broad; seeds were ovoid-oblong, about 3 mm long, boat-shaped, smooth, yellowish brown, contain a membranous cover. The data revealed that amongst eight genotypes under study, the highest germination percent (90%) was found from PO-001 genotype and the lowest (65%) from PO-008 germplasm. The germplasm PO-001 has required lowest time (4.8 days) to take germination while the germplasm PO-008 has taken highest time (6.8 days) to germinate which was similar with PO-006 germplasm (6.8 days). The maximum plant height was recorded in the genotype PO-001 (42.33 cm) followed by PO-002 germplasm (40.10 cm) while as minimum plant height was recorded in the germplasm PO-008 (30.70 cm). This might be due to genetic constituents of genotypes, healthy root development and agro-climatic conditions. Besides these, the greater availability of nutrients in soil due to integrated fertilizer application through inorganic and organic sources might possibly have enhanced meristematic activity leading to increased plant height and dry matter accumulation. These results are in close conformity with finding of Sutaliya *et al.* (2003). The mean performances between various genotypes in Isabgol for different characters have also been reported by (Shelud-ko *et al.*, 1990).

The maximum number of tillers per plant was exhibited in the germplasm PO-001 (7.67) which was followed PO-002 (6.40) and PO-003 (6.0) germplasm while as minimum value was observed in the genotypes PO-008 (5.00) and PO-007 (5.10). The mean performances between various genotypes of Isabgol for different characters have also been supported by (Hendry *et al*., 1992). The highest number of leaves/plant was counted from PO-001 germplasm (74.40) which was followed by PO-002 germplasm (70.32) on the other hand the lowest leaf number was counted from PO-008 germplasm (65.90). Highest leaf length (30.0 cm) and root length (16.5 cm) were also found from PO-001 germplasm and the leaf length (23.00 cm) as well as root length (13.0 cm) was recorded from the germplasm PO-007. The positive effect of combined nutrient application may be due to cumulative effect on growth and vigour of plants. The tillering behaviour of isabgol indicated that at the initial stage, tillers compete with main stem for nutrients and metabolites, while at later stage, they compete for light. Thus, greater uptake of nutrients provides less competition between main stem and tillers resulting in higher number of effective tillers with nutrient application. The improvements in yield attribute characters with balanced nutrient application are in close conformity with Singh (2000), Mann and Vyas (1999) and Repsiene (2001).

Days taken to first emergence of spike showed earliest in the germplasm PO-001 (60.3 days) followed by PO-002 (64.5 days), PO-007 (65.5 days) and PO-003 (65.8 days) respectively, while the genotypes PO-006 (68.2 days) showed maximum time for days taken to first emergence of spike. Days taken to 50 % flowering were earliest in the genotypes PO-001 (70.2 days) followed by PO-002 (72.6 days), PO-007 (74.2 days) and PO-003 (74.5 days). The germplasm PO-008 (78.4 days) took maximum time to come in 50% flowering. This might be due to individual varietal characters. The mean performances between various genotypes in Isabgol for days taken to flowering have also been reported by (Dubey *et al*., 2009). The maximum number of spikes per plant was observed for PO-001 germplasm (29.5) followed by PO-002 (27.2) and PO-003 (26.5) respectively, while the minimum number of spikes per plant was observed for PO-008 (22.0). Similar findings have also been observed by (Sharma *et al*., 2002). Longest spike was recorded from PO-001 germplasm (4.03) where rest of the germplasm gave more or less similar results in case of spike length. The maximum number of seeds per spike was found in germplasm PO-001 (93.8) followed by PO-002 (86.4), while the minimum number of seed was recorded in genotypes PO-008 (68.2). Thousand seed weight (TSW) which is very important yield component, showed wide variation among the species. It ranged between 2.008 g to 1.724 g (Table 2). The highest 1000 (thousands) seeds weight was recorded in germplasm PO-001 (2.008 g) and lowest was noticed in germplasm PO-008 (1.724 g). The differences in number of spikes per plant, number of seeds per spike and test weight of seeds in different genotype might be due to variation in germplasm, proper vegetative development and also for differences in soil and agro-climatic condition.

The seed yield per plant varied from 5.65 g to 4.65 g per plant. The highest seed yield per plant was found in germplasm PO-001 (5.65 g), which was significantly superior to all the genotypes. Some other genotypes like PO-002 (5.34 g), PO-005 (5.32 g), PO-004 (5.22 g) and PO-003 (5.18 g) also produced somewhat higher yield. But significantly lowest seed yield per plant was recorded in PO-008 (4.65 g). The higher yield of promising genotypes might be due to higher number of branches, which leads to the production of a greater number of spikes per plant that directly affect the production of higher seed yield. The seed yield data also supported by Beniwal *et al*., 2007; Jadhav *et al*., 2008 and Barfa *et al*., 2011. The highest total seed yield weighted from PO-001 germplasm (823 kg/ha) while the lowest yield was recorded from PO-008 germplasm (612 kg/ha). Similar findings have also been observed by Sangan *et al.* (1992).

Conclusion

Isabgol is commercially an important crop with different uses. However, scanty information is available concerning to morphology and genetic variability of Isabgol and its wild relatives. Results of present study indicated that there was a remarkable variation in different agronomic characteristics as well as seed yield per plant among the eight-germplasm studied. However, overall analysis of all the germplasm in terms of morpho-physiological and yield attributing parameters clearly reveals that the PO-001 germplasm was found to be the best in the agro-climatic condition of Bangladesh. Thus, PO-001 germplasm can be taken for the further investigation for commercial Isabgol cultivation by the breeder. In conclusion, genetic markers will be providing better information on genetic relatedness among the different *Plantago ovata* germplasm and this knowledge of genetic variation would provide an important contribution in *Plantago* breeding strategies for its yield improvement and disease resistance.

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Conflict of interest: The authors declare that there are no conflicts of interest.

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