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Characterization of *dhaincha* accessions based on morphological descriptors and biomass production

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Abstract

Forty five accessions of *dhaincha* germplasms were collected from different parts of Bangladesh and characterized on the basis of morphological descriptors and biomass production ability. Thirty eight accessions were identified as *Sesbania bispinosa*, four as *S*. *cannabina* and two as unidentified *Sesbania* spp. One accession as *S*. *rostrata* was included for comparison. Both at seedling and maturity stages, wide and significant differences were observed among the accessions of different *dhaincha* germplasms for their biomass production capability and other morphological descriptors. At the seedling stage, total dry mass (TDM) production varied from 10.2 to 41.6g 30-plants^{-1}. At the maturity stage, plant height, total number of branches and base diameter of *dhaincha* germplasms varied from 347.5–474.7cm, 10.4–23.7, and 1.9–4.9cm, respectively. The highest amount (4.10kg 10-plants^{-1}) of above-ground TDM was produced in one accession of unidentified *Sesbania* sp. followed by *S*. *rostrata* and one accession of *S*. *cannabina* (3.85kg 10-plants^{-1}), and the lowest TDM (0.9kg 10-plants^{-1}) was measured in two accessions of *S*. *bispinosa*. It may be concluded that the biomass production capability of at least two accessions of local *Sesbania* germplasms were higher/comparable to that of exotic *S*. *rostrata*. It will be too early to make a conclusive remark based on only a few *dhaincha* germplasms. A detailed study with a large number of germplasms collected from whole Bangladesh is obviously needed to reach in a precise conclusion.

Keywords: *Dhaincha* accessions, Characterization, Morphological descriptors, Biomass production

Introduction

Dhaincha (*Sesbania* spp.) belongs to the family Leguminosae (sub-family Papilionoideae), and is well known for its diversified use in Bangladesh. Three species of *Sesbania viz*. *S. sesban* (L.) Merr., *S*. *bispinosa* (Jacq.) Wight and *S. cannabina* (Retz.) Poir., are commonly known as *dhaincha* in Bangladesh (Prain, 1903; Ahmed *et al*., 2009). It is an ideal green manure crop as it is quick-growing, succulent, easily decomposable with low moisture requirements, and add maximum amounts of organic matter and nitrogen in the soil (Palaniappan and Siddeswaran, 2001). To lesser extents they are grown for animal feed and fodder (Shahjalal and Topps, 2000; Hossain and Becker, 2001), ground cover, providing wood, firewood and other uses in traditional agroforesty systems (Ndoye *et al*., 1990). It grows well even in marginal lands with little or no input. It showed a luxuriant growth in soil with a high electrical conductivity up to 10 mS cm^{-1}, and some of the *Sesbania* spp. have been recommended for reclamation of saline and sodic soils (Chavan and Karadge, 1986). Long time (10/12 yrs) cultivation of *dhaincha* would combat desertification of marginal lands, e.g., char land, saline area, etc., and rehabilitate degraded lands into productive crop lands for intensive food crop agriculture (Carroll and Somerville, 2009). *Dhaincha* also showed its potentiality as a raw material for paper pulp (Jahan *et al*., 2009). Researchers, recently, have found that the leaves of *dhaincha* are a good source of Pinitol, an anti-diabetic compound (Misra and Siddiqui, 2004).

Dhaincha has a yield potential of up 20t DM ha^{-1} year^{-1} under appropriate cultivation (Factsheet – *Sesbania sesban* <http://www.tropicalforages.info/key/Forages/Media/Html/Sesbania_sesban. htm>). However, in Bangladesh condition, *dhaincha* produces only 1.5t DM ha^{-1} in a period on 90 days (Bokhtiar *et al*., 2003). Along with the native *Sesbania* spp., an exotic species *S*. *rostrata* is also used as green manure crop in Bangladesh. However, we do not have any *dhaincha* cultivar recommended by the National Seed Board for specific use yet. Selection is one of the oldest breeding procedures for genetic improvement and high yielding cultivar development (Chahal and Gosal, 2002). Agromorphological, molecular and nutritive characterization of *Sesbania* has been reported by several researchers (Evans and Rotar, 1987; Heering *et al*., 1996a, b; Hossain and Becker, 2001; Joshi-Saha and Gopalakrishna, 2007). Hitherto, there is no report on morphological characterization of *dhaincha* for the varietal improvement

in Bangladesh. Biosystematics studies could be began by utilizing existing resources; however, for continued selection for plant breeding purposes, the lack of provenance-type germplasm collections from Bangladesh and even in Asia is a serious inadequacy (Evans and Rotar, 1987). Therefore, the present research has been conducted to collect and characterize the native *dhaincha* germplasms as a very first step to develop or recommend appropriate cultivar(s) for specific purpose(s) e.g., green manure, animal feed, pulp production, reclamation saline and/or sodic soil, etc.

Materials and Methods

A field survey was conducted at different parts of Bangladesh *viz*. Jhinaidaha, Chuadanga, Jasshore, Khulna, Nilphamari, Tangail, Potuakhali, in and around Bangladesh Agricultural University (BAU) campus to collect the *dhaincha* germplasms (Table 1).

A field experiment was conducted at the Field Laboratory of Department of Crop Botany, BAU, Mymensingh following complete randomized design (CRD) in 2 x 3 m^2 plot at the spacing of 15 cm × 50 cm (plant-plant×row-row) to study growth and compare biomass yield of collected *dhaincha* germplasms. Seeds were sown in the experimental field on 29 April 2014. Experimental data were collected 35 days after sowing (DAS) at the seedling, and maturity stages (80% pod attained to characteristic colour). Thirty plants per plot were used for data collection. Base diameter was measured at 5cm above the ground level. For biomass yield, seedlings were oven dried at 72 ± 2^0 C for at least 24 hrs, mature plants were sun dried properly. Botanical identification based on morphological descriptors was done at the Plant Systematics Laboratory of the same Department following standard taxonomic procedures (Ahmed *et al*., 2009).

The collected data were analyzed statistically following the analysis of variance (ANOVA) technique using the Excel program in Microsoft 2007.

Results and Discussion

A total of forty five accessions of *dhaincha* germplasms, including one accession of the exotic introduced species *Sesbania rostrata*, have been collected from different parts of Bangladesh (Table 1). The *S. rostrata* accession was included for comparison. Based on morphological descriptors, thirty eight accessions of the collected *dhaincha* germplasms have been identified as *S. bispinosa* (syn. *S*. *aculeata* (Willd.) Pers.; Fig. 1A), four as *S*. *cannabina* (Fig. 1B), and two as unidentified *Sesbania* spp. (Table 1). The unidentified *Sesbania* accessions showed a relatively wider variation in floral and fruit morphological descriptors, which might be due to natural hybrid nature of these two accessions. The unidentified *Sesbania* accessions need further critical examination for proper identification.

Both at seedling and maturity stages, wide and significant differences were observed among the different *dhaincha* germplasms in the biomass production capability along with other morphological features (Table 2). At the seedling stage, total dry mass (TDM) production varied from 10.2 to 41.6g 30-plants^{-1} (#009 and #050, respectively), however, it was interesting that these *dhaincha* germplasms were failed to maintain their better initial growth (Table 2). On the contrary, some accessions of *dhaincha* germplasms performed better at later stage in spite of their poor initial growth. In an earlier experiment (Heering *et al*., 1996b), a large variation in dry matter yields per plant was observed in several accessions, though many accessions could not sustain their high level of production and the yields were, therefore, markedly lower at the second cut.

At the maturity stage, plant height, total number of branches and base diameter of *dhaincha* germplasms varied from the minimum 347.5cm, 10.4 and 1.9cm, respectively to the maximum 474.7cm, 23.7 and 4.9cm, respectively. The highest amount of above-ground TDM (4.10kg 10-plants^{-1}) was produced in one accession of unidentified *Sesbania* sp. (#027) followed by *S*. *rostrata* (#105) and one accession of *S*. *cannabina* (#025) (3.85kg 10-plants^{-1}), and the lowest (0.9kg 10-plants^{-1}) TDM in two accessions of *S*. *bispinosa* (Table 2). The wide variation in different morphological descriptors and biomass yield might be due to genetic make-up and/or inherent character of respective accession and/or species (Joshi-Saha

and Gopalakrishna, 2007). Variation for above-ground DM yield between accessions of *dhaincha* germplasms evidencing the existence of genetic variability and the possibility of selecting higher yielding accessions of *Sesbania* spp. (Veasey *at al*., 2001). Although we did not study any correlation between parameters, high and significant correlations were found between plant dry matter yields and height and diameter, justifying the inclusion of these characters in the biomass estimation equations (Heering *et al*., 1996b). Significant variations were also observed in proximate analyses of fodder samples collected from different accessions of *dhaincha* germplasms (Ahsan *et al*., in preparation).

Table 1. Taxonomic identity of collected accessions of *dhaincha* germplasms

Acc. No.	Collection site	Species
001	Jhinaidaha, Mahespur, Mothura Seed Production Farm	*S. bispinosa*
002	Jhinaidaha, Mahespur, Kushabhanga	*S. bispinosa*
003	Chuadanga, Jiban-nagar, Tetulia	*S. bispinosa*
004	Jhinaidaha, Mahespur, Kushabhanga	*S. bispinosa*
005	Chuadanga, Jiban-nagar, Pakhila Seed Production Farm	*S. bispinosa*
006	Jhinaidaha, Mahespur, Kushabhanga Seed Production Farm	*S. bispinosa*
007	Jhinaidaha, Mahespur, Kushabhanga	*S. bispinosa*
008	Jhinaidaha, Mahespur, Kushabhanga	*S. bispinosa*
009	Jhinaidaha, Mahespur, Kushabhanga	*S. bispinosa*
010	Jhinaidaha, Mahespur, Karincha Seed Production Farm	*S. bispinosa*
011	Jhinaidaha, Mahespur, Kushabhanga Seed Production Farm	*S. bispinosa*
012	Jhinaidaha, Mahespur, Karincha	*S. bispinosa*
016	Nilphamari, Palashbari, Toronibari	*S. cannabina*
021	Tangail, Kaliganj	*S. bispinosa*
022	Potuakhali, Dumki, PSTU Campus	*S. bispinosa*
024	Mymensingh, Sadar, Churkhai	*S. bispinosa*
025	Mymensingh, Sadar, Shikarikanda	*S. cannabina*
026	Mymensingh, Sadar, Digharkanda	*S. cannabina*
027	Mymensingh, Sadar, Chor Gobordia	*Sesbania* sp.
028	Mymensingh, Sadar, Agronomy Farm, Bangladesh Agricultural University	*S. cannabina*
029	Khulna, Chuknagar, Chuknagar Bazar	*S. bispinosa*
030	Khulna, Hogladanga, Batiahata	*S. bispinosa*
031	Khulna, Rupsha, Alaipur	*Sesbania* sp.
032	Khulna, Dighalia, Kumar gati	*S. bispinosa*
033	Khulna, Dumuria, Badurgacha	*S. bispinosa*
034	Khulna, Rupsha, Pitthavoeque	*S. bispinosa*
035	Mymensingh, Sadar, Kalibari Chor	*S. bispinosa*
036	Mymensingh, Sadar, Bhagnamari Chor	*S. bispinosa*
037	Mymensingh, Sadar, Beltoly	*S. bispinosa*
038	Jhinaidaha, Mahespur, Mathura	*S. bispinosa*
039	Jhinaidaha, Mahespur, Gangadaspur	*S. bispinosa*
040	Jhinaidaha, Dattanagar, Gokulnagar Seed Production Farm	*S. bispinosa*
041	Chuadanga, Jiban-nagar, Porapara	*S. bispinosa*
042	Chuadanga, Jiban-nagar, Pathila	*S. bispinosa*
043	Jasshore, Keshobpur	*S. bispinosa*
044	Jhinaidaha, Mahespur, Sankorpur	*S. bispinosa*
045	Jhinaidaha, Mahespur, Hanifpur	*S. bispinosa*
046	Chuadanga, Jiban-nagar, Baka	*S. bispinosa*
047	Chuadanga, Jiban-nagar, Zadobpur	*S. bispinosa*
048	Jhinaidaha, Mahespur, Pirgacha	*S. bispinosa*
049	Jhinaidaha, Mahespur, Kushadanga	*S. bispinosa*
050	Jhinaidaha, Mahespur, Karincha	*S. bispinosa*
051	Jhinaidaha, Mahespur, Kushumpur	*S. bispinosa*
052	Chuadanga, Jiban-nagar, Hushorkhali	*S. bispinosa*
105	Nilphamari, Domar, Sonaroy, Koilagila	*S. rostrata*

Table 2. Morphological descriptors studied in different accessions of *dhaincha* germplasms

Acc. No.	Stem Colour	TDM 35 DAS (g 30-plants^{-1})	Plant Height (cm)	No. of Branches (plants^{-1})	Base Diameter (cm)	Above-ground TDM (kg 10-plants^{-1})
001	Green	30.8	459.1	14.1	3.1	2.30
002	Reddish Green	21.5	394.4	17.0	3.4	0.90
003	Green	15.4	368.8	16.0	4.2	0.90
004	Reddish Green	16.5	363.9	16.2	3.6	1.00
005	Green	28.9	474.7	20.1	2.7	1.80
006	Green	30.2	444.0	17.4	2.9	2.10
007	Green	12.8	441.9	12.3	3.1	1.75
008	Reddish Green	21.6	407.7	11.1	2.2	1.70
009	Light Green	10.2	365.8	12.8	3.1	2.00
010	Green	20.9	473.1	17.8	3.1	2.20
011	Reddish Green	17.7	456.2	17.6	2.9	2.45
012	Green	24.9	464.0	18.7	2.9	2.25
016	Green	19.8	347.5	13.0	1.9	1.10
021	Reddish Green	19.1	434.9	14.7	2.4	2.65
022	Reddish Green	28.2	394.5	10.4	3.2	2.75
024	Green	30.1	455.4	13.0	3.1	2.40
025	Green	26.1	416.1	12.1	2.4	3.85
026	Green	31.3	469.2	13.7	3.0	2.45
027	Green	24.2	389.9	12.7	2.4	4.10
028	Green	33.8	488.2	20.6	2.9	3.65
029	Reddish Green	25.1	424.2	11.8	2. 3	1.00
030	Green	29.2	445.4	16.4	2.5	1.60
031	Green	25.6	433.8	13.7	2.6	2.15
032	Green	30.0	463.5	14.2	3.1	1.50
033	Green	28.2	394.8	10.6	2.3	2.35
034	Green	26.5	469.9	14.9	2.8	1.80
035	Green	20.4	419.7	11.7	2.3	2.30
036	Green	17.8	442.7	16.2	2.7	2.10
037	Reddish Green	27.6	424.6	12.5	2.3	2.25
038	Green	19.8	435.0	13.0	2.5	2.30
039	Green	23.6	418.4	11.6	2.5	2.15
040	Green	14.3	464.2	14.1	3.0	1.95
041	Light Green	19.3	460.6	17.9	2.6	1.75
042	Green	14.6	424.7	12.3	2.4	1.85
043	Green	23.5	412.9	11.2	2.4	1.45
044	Green	27.2	417.9	11.6	2.6	1.75
045	Green	33.6	420.5	14.3	2.6	2.50
046	Green	23.9	452.2	12.5	3.2	1.10
047	Reddish Green	40.7	463.0	23.7	4.9	1.85
048	Green	26.9	450.2	15.3	2.7	2.22
049	Green	25.8	458.9	14.6	3.3	1.80
050	Green	41.6	460.0	11.5	3.1	2.45
051	Green	29.1	456.0	15.0	2.9	2.40
052	Reddish Green	34.1	457.2	15.4	2.7	1.75
105	Green	13.8	451.4	18.8	3.0	3.85
LSD		5.65	9.50	4.56	0.55	0.18
Level of Significant		***	**	***	***	***

TDM: Total dry mass; DAS: Days after sowing

Fig. 1. Flowering shoot of *Sesbania bispinosa* (A) and *S. cannabina* (B).

It may be concluded that the biomass production capability of at least two accessions of local *Sesbania* germplasms (#025 and 027) were higher/comparable to that of exotic *S. rostrata* (#105). It will be too early to make a conclusive remark based on only a few *dhaincha* germplasms. Therefore, a detailed study with a large number of germplasm collected from whole Bangladesh is obviously needed to reach in a precise conclusion.

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References

Ahmed, Z.U., Hassan, M.A., Begum, Z.N.T., Khondker, M., Kabir, S.M.H., Ahmad, M. and Ahmed, A.T.A. eds. 2009. Encyclopedia of Flora and Fauna of Bangladesh, Vol. 8. Angiosperms: Dicotyledons (Fabaceae–Lythraceae). Asiatic Soc. Bangladesh, Dhaka. pp. 1-474.

Bokhtiar, S.M., Gafur, M.A. and Rahman, A.B.M.M. 2003. Effects of *Crotalaria* and *Sesbania aculeata* green manures and N fertilizer on soil fertility and the productivity of sugarcane. J. Agric. Sci. 140: 305-309.

Carroll, A. and Somerville, C. 2009. Cellulosic biofuels. Ann. Rev. Plant Biol. 60: 165-182.

Chahal, G.S. and Gosal, S.S. 2002. Principles and Procedures of Plant Breeding – Biotechnological and Conventional Approach. Narosa Pub. House, New Delhi.

Chavan, P.D. and Karadge, B.A. 1986. Growth, mineral nutrition, organic constituents and rate of photosynthesis of *Sesbania grandiflora* L. grown under saline soil. Plants Soil 93: 395-404.

Evans, D.O. and Rotar, E.P. 1987. *Sesbania* in Agriculture, Westview Trop. Agric. Series; No. 8. Westview Press, Boulder (USA).

Heering, J.H., Nokoe, S. and Mohammed, J. 1996a. The classification of a *Sesbania sesban* (ssp. *sesban*) collection. I. Morphological attributes and their taxonomic significance. Trop. Grass. 30: 206-214.

Heering, J.H., Nokoe, S. and Mohammed, J. 1996b. The classification of a *Sesbania sesban* (ssp. *sesban*) collection. II. Morphological attributes and their relation to biomass estimation. Trop. Grass. 30: 215-222.

Hossain, M.A. and Becker, K. 2001. Nutritive value and antinutritional factors in different varieties of *Sesbania* seeds and their morphological fractions. Food Chem. 73: 421-431.

Jahan, M.S., Rawshan, S., Banu, T., Chowdhury, D.N.A., Noori, A. and Al-Maruf. A. 2009. Effect of harvesting age on the chemical and morphological properties of dhaincha (*Sesbania aculeata*) and its pulpability and bleachability. BioResources 4: 471-481.

Joshi-Saha, A. and Gopalakrishna, T. 2007. Agromorphological and molecular variability in the genus *Sesbania*. Genet. Resour. Crop Evol. 54: 1727-1736.

Misra, L.N. and Siddiqui, S.A. 2004. Dhaincha (*Sesbania bispinosa*) leaves: A good source of antidiabetic (+)-pinitol. Curr. Sci. 87: 10.

Ndoye, I., Tomekpe, K., Dreyfus, B., *et al*. 1990. *Sesbania* and *Rhizobium* symbiosis: nodulation and nitrogen fixation. *In*: Macklin, B. and Evans, D.O. eds. Perennial *Sesbania* species in agroforestry systems. Nitrogen Fixing Tree Assoc., Wamanalo. pp. 31-38.

Palaniappan, S.P. and Siddeswaran, K. 2001. Regional overview on green manure in rice-based cropping systems. *In*: Gowda, C.L.L., Ramakrishna, A., Rupela, O.P. and Wani, S.P. eds. Legumes in rice based cropping systems in Tropical Asia: constraints and opportunities. Int. Crop Res. Inst. Semi-Arid Trop., Patancheru (India). pp. 126-135.

Prain, D. 1903. Bengal Plants, Vols. I & II. Indian Rep., 1981, B. Singh & M.P. Singh, India.

Shahjalal, M. and Topps, J.H. 2000. Feeding *Sesbania* leaves as a sole feed on growth and nutrient utilization in goats. Asian-Aus. J. Anim. Sci. 13: 487-489.

Veasey, E.A., Schammass, E.A., Vencovsky, R., Martins, P.S. and Bandel, G. 2001. Germplasm characterization of *Sesbania* accessions based on multivariate analyses. Genet. Resour. Crop Evol. 48: 79–90.