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Screening of *Sesbania* accessions based on early biomass yield

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Abstract

Soft, succulent and readily decomposable *Sesbania* biomass is one of the best sources of organic matter and nitrogen for improvement of poor, nutrient deficit soils. To select high biomass yielding *Sesbania* accession(s), an experiment was conducted at Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, following a randomized complete block design with three replications. Seeds of 105 accessions from 3 *Sesbania* species—*S. sesban, S. bispinosa and S. cannabina*, were sown in the field @ 60 kg/ha on 23 April 2016. The unit plot size was 3×2 m^2 with a spacing of 50 cm (row-row) × 15 cm (plant-plant). Data on different yield descriptors were recorded at every 10 day intervals up to 60 days after sowing (DAS). *Sesbania sesban* produced higher biomass yield at the early growth stages (up to 20 DAS), however, *S. bispinosa* produced higher biomass at the later stages followed by *S. cannabina* and *S. sesban*. Therefore, *S. sesban* can be grown in a very short rotation [*Boro* rice-(*dhaincha*)-Jute-T. *Aman* rice-Mustard and/or *Boro* rice-(*dhaincha*)-T. *Aus* rice-T. *Aman* rice-Mustard]; and *S. bispinosa* for a longer period [*Boro* rice-(*dhaincha*)-T. *Aman* rice-Mustard] to maximize organic matter addition to the soil. Ten accessions of *S. bispinosa* performed better and produced biomass above 30 g/plant (*c*. 80 t/ha) within 60 DAS. These accessions could be selected for further study for their decomposability, organic matter accumulation, N_2-fixing ability and may be processed to release as recommended cultivar(s).

Introduction

In Bangladesh, soil organic matter content is below 1% in more than 60% of cultivable lands compared to an ideal minimum value of 3% and decreasing day by day (Anon., 2012). As a result, land faces a threat to crop production and cultivable lands lose its productivity (Alam and Salahin, 2013). Moreover, soil fertility has caused exhaustion in Bangladesh due to intensive land use and mostly monoculture of rice crop without green manuring. In this situation cultivable lands become worse and crop production goes downward (Anon., 2012). This poor soil may become fertile after 10–12 years continuous cultivation and incorporation of *Sesbania* green manure (Carroll and Somerville, 2009). *Sesbania* sp. is a quick growing green manure crop which has extreme tolerance to both drought and waterlogged conditions (Heering and Gutteridge, 1992). It is soft, succulent and readily decomposable in soil (Dhaka *et al*., 2014), but become woody at the later stage of growth i.e. 60 or more days after sowing (Pandey *et al*., 2013). It could also be grown as ground cover, providing wood, firewood and other uses in traditional agroforesty systems (Ndoye *et al*., 1990) and other utilizations such as fuel, bio-energy and fiber sources, live support fencing as well (Heering and Gutteridge, 1992; Veasey *et al*., 1999; Sarkar *et al*., 2017). Three *Sesbania* species *viz*. *S. sesban* (L.) Merr., *S. bispinosa* (Jacq.) W. Wight [former *S. aculeata* (Wild.) Poir.] and *S. cannabina* (Retz.) Poir., are commonly used as green manure crops in Bangladesh (Ahmed *et al*., 2009). *Sesbania bispinosa* sometimes produces *c*. 80 t/ha biomass at 60 days during monsoon season (Chanda *et al*., 2017).

The unavailability of land is one of the main constraints for green manure crop cultivation in Bangladesh. A total of 294 cropping patterns exist at the farm level in different agro-ecological zones of Bangladesh (Anon., 2012). The major cropping patterns mostly consist of rice based cereal crops; more than 60% of the total cropped area is covered by (*Boro*) Rice-Fallow-Rice (T. *Aman*) cropping pattern (Haque, 1998; Anon., 2012). Another existing popular cropping pattern is Winter Vegetables/Mustard-*Boro* rice-T. *Aman* rice in Bangladesh. In these cropping patterns, land remains fallow for more or less 80 days after *Boro* rice harvest (Haque *et al*., 2001; Khan *et al*., 2004). Four crops based cropping patterns (*Boro* rice-T. *Aus* rice-T. *Aman* rice-Mustard or *Boro* rice-Jute-T. *Aman* rice-Mustard) require 345–351 days excluding seedling age of rice crop and the land area remains fallow only for 14–20 days in a year (Mondol *et al*., 2015; Rahman *et al*., 2015). During the turnover period between *Boro* rice harvest and succeeding crop cultivation, the land remains fallow for 14–80 days. The short fallow period could be utilized by cultivating high biomass producing *Sesbania* accessions at the early growth stages; and high biomass producing *Sesbania* accessions at the later growth stages may be cultivated during long fallow period in order to improve soil health and fertility. Hitherto, the National Seed Board of Bangladesh has not so far recommended any cultivar of *dhaincha* (*Sesbania* spp.) for green manure production (Sarwar *et al*., 2015). The present study was, therefore, undertaken to screen out the *Sesbania* accessions based on biomass yield at different days after sowing to fit in the 20–60 days fallow period after *Boro* rice harvest.

Materials and Methods

An experiment was conducted at Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, for the screening of *Sesbania* accessions on the basis of their biomass yield during 10–60 days after sowing (DAS). A randomized complete block design was followed with three replications. The unit plot size was 3 × 2 m^2 and seeds were sown @ 60 kg/ha with the spacing at 50 cm (row-row) × 15 cm (plant-plant). Seeds of 105 *Sesbania* accessions (90 accessions belong to *S. bispinosa*, 9 accessions to *S. cannabina* and 6 accessions to *S. sesban*) were collected from 19 districts of Bangladesh (detail collection information available upon request). Seeds were sown in the experimental field on 23 April, 2016.

The quantitative data *viz*. plant height, base diameter, root length, fresh and dry weight of root & shoot, and total biomass weight, were recorded at 10 days interval up to 60 DAS. The data were taken as the mean value of 10 representative samples per accession. Plant height was measured using a meter scale and base diameter was measured by a digital slight caliper with a precision of 0.1 mm to 150 mm (Ribeiro *et al*., 2015). Sample fresh and dry weights were taken by a digital balance and fresh samples were dried at 72°±2° C for 72 hrs. Data were analyzed with Excel application to determine the arithmetic mean, standard deviation, coefficient of variance, and range among the accessions (*de* Melo *et al*., 2016).

Results and Discussion

Biomass yield and other yield contributing parameters of *Sesbania* species varied and increased significantly up to 60 days after sowing (DAS). Plant height of *Sesbania* species—*S. bispinosa*, *S. cannabina* and *S. sesban*, varied among the species and the longest plant was observed in *S. sesban* (11.9 cm) followed by *S. bispinosa* (10.1 cm) and *S. cannabina* (9.53 cm) at 10 DAS (Table 1). Shreelalitha *et al*. (2015) collected two wild legumes, *S. bispinosa* and *S. speciosa* from mangroves of south India and found that the shoot length of *S. bispinosa* was 3.8 cm and of *S. speciosa* was 7.1 cm at 10 DAS. The plant height may differ due to their genetic make-up and environmental effects as well. At 20 DAS, the highest plant height was also observed in *S. sesban* followed by *S. cannabina* and *S. bispinosa*. The result revealed that *S. sesban* performed better at the early growth stages than *S. bispinosa* and *S. cannabina.* On the contrary, *S. bispinosa* produced the longest plant and the shortest one in *S. sesban* from 30 to 60 DAS (Table 1). The plant height may differ due to the genetic make-up of the *Sesbania* spp. (Sarwar *et al*., 2015). Veasey *et al.* (1999) found similar result in *Sesbania* species and reported that the plant height (mean value of 17 *Sesbania* species) were 8.95, 30.78, 60.55 and 86.07 cm at 17, 32, 47 and 62 DAS, respectively.

The longest root was found in *S. cannabina* (4.30 cm) and shortest one in *S. sesban* (2.91 cm) at 10 DAS (Table 2). Shreelalitha *et al*. (2015) observed in two wild legume *Sesbania* spp. from mangroves of south India and reported that the root length of *S. bispinosa* was 1.8 cm and *S. speciosa* was 2.5 cm at 10 DAS. At 20 DAS, the highest root length was produced in *S. sesban* followed by *S. bispinosa* and *S. cannabina*. However, the highest root length was found in *S. bispinosa* followed by *S. sesban* and *S. cannabina* from 30 to 60 DAS (Table 2). The root length among the species may differ due to the genetic make-up (Sarwar *et al*., 2015).

The highest base diameter was obtained from *S. sesban* and lowest both in S. *bispinosa* and *S. cannabina* at 10 and 20 DAS (Table 3). However, the highest base diameter was found in *S. bispinosa* followed by *S. sesban* and *S. cannabina* between 30 and 40 DAS. Nevertheless, highest base diameter was observed in S. *bispinosa* (1.01 cm) followed by *S. cannabina* (0.90 cm) and *S. sesban* (0.85 cm) at 50 and 60 DAS (Table 3). Rahman *et al*. (2016) reported that the highest base diameter was 0.92 cm and lowest was 0.79 cm when *S. bispinosa* crop harvested at 60 DAS. The base diameter varied due to the genetic make-up and environmental effects (Sarwar *et al*., 2015; Rahman *et al*., 2016).

Table 1. Plant height (cm) of *Sesbania* spp. at different days after sowing (Mean±Sd)

Species	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
S. bispinosa	10.1±0.70	12.2±2.07	38.3±8.14	66.7±10.9	91.3±18.8	140.1±27.5
S. cannabina	9.53±1.06	12.7±2.60	32.8±4.88	60.1±7.99	88.7±25.8	127.0±30.8
S. sesban	11.9±1.37	13.8±0.63	30.5±12.2	44.2±11.7	75.0±24.7	97.5±7.74

Table 2. Root length (cm) of *Sesbania* spp. at different days after sowing (Mean±Sd)

Species	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
S. bispinosa	4.03±0.85	6.68±1.37	11.8±1.79	15.3±1.51	18.1±2.81	23.2±2.77
S. cannabina	4.30±1.19	6.60±1.70	10.0±2.23	14.6±1.19	18.3±2.35	23.2±2.72
S. sesban	2.91±0.51	7.76±1.30	11.0±1.74	14.1±1.22	17.6±0.96	20.2±2.96

Table 3. Base diameter (cm) of *Sesbania* spp. at different days after sowing (Mean±Sd)

Species	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
S. bispinosa	0.05±0.01	0.10±0.02	0.32±0.07	0.48±0.08	0.70±0.15	1.01±0.15
S. cannabina	0.05±0.01	0.09±0.02	0.26±0.06	0.41±0.06	0.61±0.14	0.90±0.17
S. sesban	0.07±0.01	0.12±0.02	0.29±0.07	0.42±0.09	0.57±0.87	0.85±0.16

Other biomass yield contributing characters i.e., fresh and dry weight of shoot & root, are presented in Fig. 1. *Sesbania bispinosa* produced the highest shoot fresh weight at 60 DAS followed by *S. cannabina* and *S. sesban* (Fig. 1A). The root fresh weight was double at every 10 days interval from 30 to 60 DAS in all the species (Fig. 1B). Shoot dry weight of *S. bispinosa* was doubled from 30 to 40 DAS, tripled from 40 to 60 DAS. The growth trend of shoot biomass was different in *S. cannabina* and *S. sesban.* In both *S. cannabina* and *S. sesban*, shoot dry weight was increased 3 times from 30 to 50 DAS, and two & a half times between 50 to 60 DAS (Fig. 1C). The root dry weight of *S. bispinosa* and *S. cannabina* became two and a half times higher, but doubled in *S. sesban*, at every 10 days interval from 30 to 60 DAS (Fig. 1D). These variations in root growth may be occurred due to genetic make-up of *Sesbania* spp. (Sarwar *et al*., 2015). Manh *et al*. (2003) reported that the initial growth of *Moringa oleifera* and some leguminous crops is slow and gradually increases within course of time.

The highest total biomass yield was observed in *S. sesban* and the lowest was in both *S. bispinosa* and *S. cannabina* at 10 DAS (Table 4). The result revealed that *S. sesban* produced higher biomass at the early growth stages (up to 20 DAS) comparatively that of other two species. After 20 DAS, it produced lower biomass compared to *S. bispinosa* and *S. cannabina* (Table 4). We can raise-up high biomass yielding *S. sesban* accessions for green manure in four crops based cropping patterns e.g., *Boro* rice-(*Dhaincha*)-Jute-T. *Aman* rice-Mustard, *Boro* rice-(*Dhaincha*)-T. *Aus* rice-T. *Aman* rice-Mustard, etc. Among the *S. sesban* accessions, number 81, 82 and 85 produced higher amount of biomass than three other accessions (#66, 70 and 79) (up to 20 DAS; data not shown here). On the other hand, *S. bispinosa* produced the highest biomass yield followed by *S. cannabina* and *S. sesban* at 30 to 60 DAS. After *Boro* rice harvest land remains fallow more or less 80 days in (*Boro*) Rice-Rice (T. *Aman*) cropping pattern (Khan *et al*., 2004). The higher biomass yielding *S. bispinosa* accessions may be grown after *Boro* rice harvest, and the long fallow period in (*Boro*) Rice-(*Dhaincha*)-Rice (T. *Aman*) or (*Boro*) Rice-(*Dhaincha*)-Rice (T. *Aman*)-Winter vegetables/Mustard cropping patterns could be utilized for green manure production. Accession number 5, 30, 31, 44, 71, 77, 78, 86, 90, and 109 of *S. bispinosa* produced higher biomass (above 30 g/plant) at 60 DAS (Table 5). Among these accessions, number 77 produced highest biomass (33.51 g/plant) followed by number 44 (32.85 g/plant) and number 90 (32.67 g/plant). At 60 DAS, the total biomass yield ratio among these three *Sesbania* species—*S. bispinosa*, *S. cannabina* and *S. sesban* was 3:2:1, respectively (Table 4). Ten high biomass yielding *Sesbania* accessions, all are belong to the species *S. bispinosa*, are selected for further studies to be released as recommended cultivar(s) (Table 5). Rajbhandari (1984) observed that the crop *S. bispinosa* harvested at 24, 36 and 48 DAS resulted in fresh biomass yield of 2.2, 11.5 and 26.3 t/ha, respectively. Fownes and Anderson (1991) reported that above ground biomass (shoot+leaf) of *S. sesban* were 2.1, 9.5, 18.0, 21.2 and 25.3 g/plant at 5, 9, 11, 13 and 15 week, respectively.

Table 4. Biomass (g/plant) of *Sesbania* spp. at different days after sowing (Mean ±Sd)

Species	10 DAS	20 DAS	30 DAS	40 DAS	50 DAS	60 DAS
S. bispinosa	0.008±0.001	0.112±0.045	1.23±0.578	2.56±0.927	7.27±2.97	18.63±6.28
S. cannabina	0.008±0.001	0.093±0.036	0.786±0.406	2.03±0.812	5.79±2.93	14.05±6.83
S. sesban	0.014±0.04	0.118±0.029	0.708±0.493	1.34±0.635	2.75±0.90	6.48±2.23

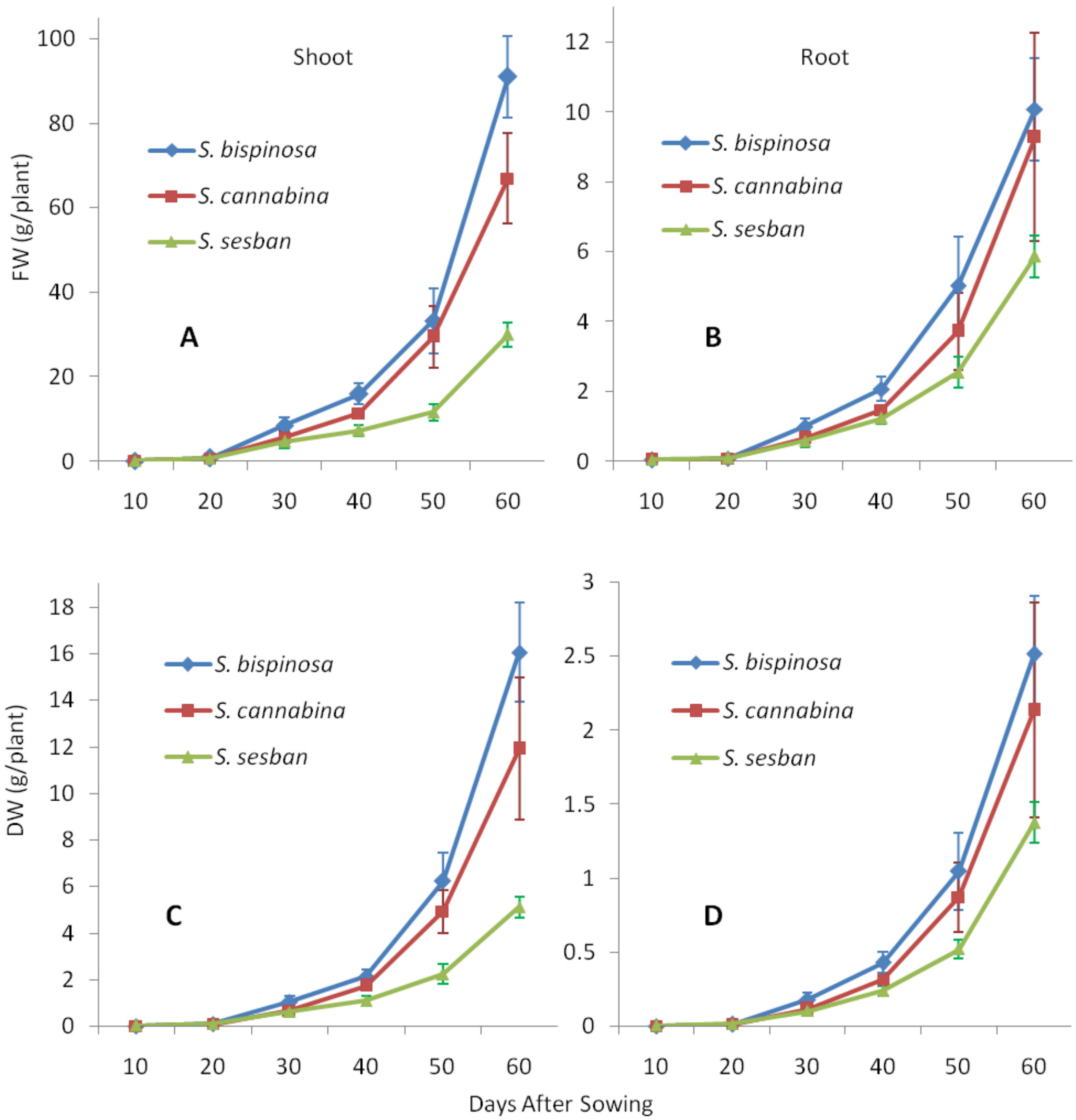

Fig. 1. (A) Shoot fresh weight (g/plant), (B) root fresh weight (g/plant), (C) shoot dry weight (g/plant), (D) root dry weight (g/plant) of *Sesbania* species at different days after sowing. Vertical bars showing the ±SEM (n=3).

Table 5. Biomass yield contributing descriptors of selected *S. bispinosa* accessions at 60 days after sowing

Accession No.	Plant height (cm)	Root length (cm)	Base diameter (cm)	Shoot weight (g/plant)		Root weight (g/plant)		Total biomass (g/plant)
				Fresh	Dry	Fresh	Dry	
05	165.00	24.30	1.10	117.60	26.74	12.44	3.37	30.11
30	151.90	25.60	1.15	111.26	26.21	13.82	4.74	30.95
31	168.30	24.45	1.27	141.22	24.55	20.24	5.84	30.39
44	186.10	25.20	1.51	195.00	29.50	13.26	3.35	32.85
71	184.70	24.42	1.24	150.00	27.10	14.27	4.09	31.19
77	192.60	25.10	1.28	180.00	29.50	14.73	4.01	33.51
78	178.20	28.63	1.22	165.00	27.13	13.82	3.77	30.90
86	162.00	26.12	1.14	114.75	27.97	14.88	3.61	31.58
90	185.00	24.40	1.19	161.61	28.16	16.44	4.51	32.67
109	180.00	23.20	1.15	185.00	26.85	14.33	4.30	31.15
CV (%)	7.38	5.83	9.50	20.00	5.47	14.69	18.03	3.55

Conclusion

From the above discussion, it may conclude that higher biomass producing, at the earlier growing period, *S. sesban* accessions could be easily fitted and used as green manure crop in shorter fallow period (up to 20 DAS) of *Boro* rice-(*dhaincha*)-Jute-T. *Aman* rice-Mustard and/or *Boro* rice-(*dhaincha*)-T. *Aus* rice-T. *Aman* rice-Mustard or similar cropping patterns. Moreover, higher biomass producer, at the later growing period (30 to 60 DAS), *S. bispinosa* accessions can be fitted well when land is available for longer period in *Boro* rice-(*dhaincha*)-T. *Aman* rice-Mustard/Winter vegetables, or *Boro* rice-(*dhaincha*)-T. *Aman* rice, or similar cropping patterns. Based on biomass yield, three *S. Sesban* accessions (#81, 82 and 85; produced above 0.12 g/plant of biomass at 20 DAS) and ten accessions of *S. bispinosa* (#5, 30, 31, 44, 71, 77, 78, 86, 90, and 109; produced above 30 g/plant of biomass at 60 DAS) could be screened out. These higher yielding accessions would be processed further to release as recommended cultivar(s).

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References

Ahmed, Z.U.,Hassan, M.A., Begum, Z.N.T., Khondker, M., Kabir, S.M.H., Ahmad, M. 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.

Alam, M.K. and Salahin, N. 2013. Changes in soil physical properties and crop productivity as influenced by different tillage depths and cropping patterns. *Bangladesh J. Agril. Res*., 38: 289–299.

Anonymous. 2012. Fertilizer Recommendation Guide. 6th ed. Hassan, A.A., Jahiruddin, M., Noor, S., Sarker, M.J.U., Shah, A.L., Khan, M.M.K., Bokhtiar, S.M., Quddus, M.A., Hasan, M.N., Razia, S. and Satter, M.A. (eds), Bangladesh Agril. Res. Coun., Dhaka. p. 275.

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

Chanda, S.C., Prodhan, A.K.M.A. and Sarwar, A.K.M. Golam. 2017. Screening of *dhaincha* accessions based on biomass yield. Abs. AGROTECH-2017, Kalingpong, India. May 11–12, 2017. p: 1.

de Melo, P.A.F.R., Silva, K.B., Alves, E.U., *de* Medeiros, R.L.S., dos Anjos, Neto, A.P., Pinto, K.M.S., *de* Sousa, Leite, W. and Matos, V.P. 2016. Morphological analysis of fruits, seeds and seedling germination *Acacia farnesiana* (L.) Willd. *African J. Agril. Res*., 11: 2913–2919.

Dhaka, A.K., Kumar, S., Pannu, R., Ramprakash, K., Singh, B., Singh, K. 2014. Yield performance and economics of pearl millet (*Pennisetum glaucum*) influenced in seed crop of *dhaincha* (*Sesbania aculeata*). *Hariana J. Agron*., 30: 129–137.

Fownes, J.H. and Anderson, D.G. 1991. Changes in nodule and root biomass of *Sesbania sesban* and *Leucaena leucocephala* following copping. *Plant Soil*, 138: 9–16.

Haque, M.F., Razzaque, M.A., Akhteruzzaman, A. (eds) 2001. A compendium: Packages of Technologies. A handbook for Farming System Development. FSRD program. Bangladesh Agril. Res. Coun., Dhaka. p: 12.

Haque, M.S. 1998. Integrated nutrient management with inorganic and bio-fertilizers in legume based cropping patterns. *Proceedings of the National Workshop on Integrated Nutrient Management for Crop Production and Soil Fertility*. 24–25 March, 1998. BARC, Gazipur, pp: 99–109.

Heering, J.H. and Gutteridge, R.C. 1992. *Sesbania sesban* (L.) Merrill. *In*: *'t* Mannetje, L. and Jones, R.M.(eds.). *Plant Resources of South East Asia*, No. 4: Forages, pp. 198–201. Pudoc, Wageningen, The Netherlands.

Khan, A.H., Rashid, H., Khatun, A., Quddus, M.A. and Gomosta, A.R. 2004. Rice farming system: improved rice-based cropping system for different ecosystems. Paper presented at the National Farming Systems Technology Inventory Workshop held at CERDI, Gazipur, July 17–19, 2004.

Manh, L.H., Dung, N.X. and Xuan, V.T. 2003. Biomass production of *Moringa oleifera* and some legumes in the hilly area of Tinh Bien district, An Giang Province. *In: Proc. Final Nat. Semin.-Works. Sustain. Livest. Prod. Local Feed Resour*. Preston R and Ogle B (eds.). HUAF-SAREC, Hue City, March 25–28. Retrieved September 23, 2017, from http://www.mekarn.org/sarec03/manhcantho2.htm

Mondol, R.I., Begum, F., Aziz, A. and Sharif, S.H. 2015. Crop sequences for increasing intensity and productivity. *SAARC J. Agri*., 13: 135–147.

Ndoye, L., Tomekpe, K. and Dreyfus, B.1990. *Sesbania* and *Rhizobium* symbiosis: nodulation and nitrogen fixation. *In*: Macklin, B. and Evans, D.O. (eds) Perennial *Sesbania* Species in Agroforestry Systems. Nitrog. Fix. Tree Assoc. Waimanalo, pp: 31–38.

Pandey, V.P., Chaudhary, V.P. and Gangwar, B. 2013. Green manuring; Boon for Rice Farmers, Organic Agriculture. National Innovation on Climate Resilient Agriculture Project, Project Directorate for Farming System Research, U.P. India. pp: 1–5. Retrieve on; 02/06/2016.

Rahman, M.H., Ahmed, S., Samanta, S.C. and Ahsan, S.M. 2016. Effect of seed rate on biomass production of *dhaincha* (*Sesbania aculeata*). *Asian-Aust. J. Biosci. Biotech*., 1: 316–322.

Rahman, M.M., Rahman, M.A., Ahmed, M., Uddin, M.M. and Choudhury, A.K. 2015. Improvement from Mustard-*Boro*-T. *Aman* cropping pattern to Mustard-*Boro*-Jute-T. *Aman*. *Bangladesh J. Agril. Res*., 40: 259–270.

Rajbhandari, N.K. 1984. The effect of age of two leguminous green manure crops on transplanted rice yield. M. Sc. (Ag.) Thesis, Univ. Philippines at Los Banos, Philippines.

Ribeiro, J.W.F., de Oliveira, A.K.M., Rodrigues, A.P.D.A.C. and Rondon, E.V. 2015. Germination and morphology of seed and seedlings of *Parkia gigantocarpa* Fabaceae: Mimosoidae. *Floresta*, 45: 303–614.

Sarkar, M., Sutradhar, S., Sarwar, A.K.M. Golam, Uddin, M.N., Chanda, S.C. and Jahan, M.S. 2017. Variation of chemical characteristics and pulp ability of *dhaincha* (*Sesbania bispinosa*) on location. *J. Bioresour. Bioprod*., 2: 24–29.

Sarwar, A.K.M. Golam, Islam, A. and Jahan, S. 2015. Characterization of *Dhaincha* accessions based on morphological descriptors and biomass production. *J. Bangladesh Agril. Univ*., 13: 55–60.

Shreelalitha, S.J., Sridhar, K.R. and Sukesh, S. 2015. Seed dormancy and germination in two wild genotypes of *Sesbania* of the southwest mangroves in India. *J. Agril. Technol*., 11: 895–902.

Veasey, E.A., Schammass, E.A., Vencovsky, R., Martins, P.S. and Bandel, G. 1999. Morphological and agronomic characterization and estimates of genetic parameters of *Sesbania* Scop. (Leguminosae) accessions. *Gene. Mole. Biol*., 22: 81–93.