Range Mgmt. & Agroforestry 34 (2) : 175-178, 2013
ISSN 0971-2070

Comparative performance of Indian and Japanese barnyard millet cultivars under varied fertility conditions for dual use in Indian Central Himalaya

Rashmi Yadav[1] and V. K. Yadav[2*]

G. B. Pant University of Agriculture & Technology, Hill Campus, Ranichauri-249 199, Tehri Garhwal, Uttarakhand

Present Address: [1]Germplasm Evaluation Division, NBPGR, New Delhi, [2]Indian Grassland and Fodder Research Institute, Jhansi-284003, India

*Corresponding author e-mail: vijayyadav777@gmail.com

Received: 1st June, 2013 Accepted: 22nd November, 2013

Abstract

Field experiments were conducted to evaluate the performance of four barnyard millet genotypes belonging to two different species *viz*. VL 207, VL 172 (*Echinochloa frumentacea*) and PRB 401, PRJ 1 (*E. utilis*) under four different soil fertility conditions (Absolute control, 50% of recommended dose of fertilizer, 75% of RDF and 100% of RDF) under mid Himalayan conditions (1850 m amsl) with a view to identify most suitable variety for dual purpose use. The results showed that there was gradual increase in plant height with increase in nitrogen fertilizer dose. Also, significant differences ($P<0.05$) were observed among the cultivars for total grain and fodder (kg/ha) yield. Genotype PRJ 1 had the highest grain and fodder yield (2143 and 6427 kg/ha, respectively) while the lowest was observed for VL 127 (1677 and 5182 kg/ha, respectively). PRJ 1also had the highest mean values of 1000- seed weight (4.8 g). The result showed that there were significant differences among the genotypes in response to fertility conditions and dual purpose cultivar PRJ 1 performed better even at low fertility conditions than other cultivars evaluated. The study concluded that genotypes PRJ 1 and PRB 401 belonging to Japanese barnyard millet had high potential as compared to Indian barnyard millet genotypes (VL 207 and VL 172) and can be recommended for cultivation in Uttarakhand hills as dual purpose crop for nutritional and fodder security.

Keywords: Barnyard millet, Dual purpose, Himalaya, Japanese barnyard millet

Introduction

Barnyard millet (*Echinochloa* spp.) is one of the important small millet crop grown for grain and fodder by the tribal and hill farmers for nutritional food security. In Uttarakhand barnyard millet, locally called as *jhangora* or *madira* is one of the few crops that are cultivated at high hills for dual purpose use as grain and fodder. The crop is cultivated on about 65,000 ha area ranging from 1200-2000 m amsl. *Echinochloa frumentacea* known as Indian barnyard millet is commonly cultivated species in the region, but due to poor grain and fodder yield farmers are reluctant to grow the crop. Non-availability of drought, cold and disease tolerant varieties suitable for rainfed and high hill conditions constitute an important factor responsible for poor yield. Introduction of new species, *Echinochloa utilis* (prev. *E. crusgalli ssp utilis*) was found superior to Indian barnyard millet cultivars in terms of yield and disease resistance (Yadav *et al*., 2010). High grain yield coupled with fodder yield under mid and high hills conditions make the variety PRJ 1 popular. PRJ 1 was developed through selection from an introduced material from ICRISAT, Hyderabad. Japanese barnyard millet (*E. utilis*) which is well adapted in the sub-temperate regions provides a viable alternative to rekindle the interest of farmers in the barnyard millet cultivation. The species thrives well even on marginal lands or under agricultural conditions where major cereals fail to give sustainable yields. Varieties belongs to *E. utilis* can be successfully cultivated up to an altitude 2500 m, where as *E. frumentacea* genotypes fails to set seeds on altitude more than 1900 m amsl due to prevailing low temperature (Yadav and Yadav, 2011). Besides providing nutritionally rich staple food, barnyard millet also provides good fodder, which is an important component of sustainable hill farming system. Barnyard millet stover is fed to animals, which contributes about 18 per cent of the total fodder consumption. Millet straw makes good fodder and contains up to 61% total digestible nutrients. The fodder also contains good amount of protein and digestible fibre. Fodder of the barnyard millet has been rated to be one of the best among the cereals (National Research Council, 1996). Experiments conducted in past to judge the potential for use as single / double cut dual purpose crop, Japanese barnyard millet genotypes showed considerable superior performance than Indian barnyard millet genotypes (Bandyopadhyay, 2009).

The present investigation was carried out to compare the performance of release varieties and advance lines of both the species for grain and fodder yield, and fodder quality aspects under varying fertility conditions to identify best species, genotype and fertility level for production of barnyard millet for rain-fed mid hill conditions of Indian Central Himalaya.

Materials and Methods

***Location of the site*:** The field experiments were conducted during 2009 and 2010 *kharif* cropping seasons at G.B. Pant University of Agriculture & Technology, Hill Campus, Ranichauri, Tehri Garhwal, Uttarakhand, located between 30°18ôN latitude, 78° 24ôE longitude at 1827 m above MSL. The region lies under humid temperate type with an average crop season rainfall of 898.5 mm distributed over 53 days. The region includes barnyard millet, finger millet and rice based cropping systems. The previous crop taken on the site of the study was wheat during r*abi* season. Analysis of composite soil (0-15cm depth) samples showed that the soil is silty clay loam in texture with pH 5.8, low in available nitrogen (180 kg/ha), medium in available phosphorous (14 kg/ha) and high in available potassium (389 kg/ha). The depth of soil was up to 1 meter.

***Experimental design*:** The experimental site was cleared, packed and tilled before planting was done. The experimental design was set up in a factorial randomized block design and replicated three times during both cropping seasons. Barnyard millet was sown in the second week of May and harvested in the first week of October using a seed rate of 10 kg/ha with plant spacing of 25 cm x 10 cm. Proper plant populations were maintained by recommended gap filling practices on fourth day of emergence of seedlings. Weed control was done twice by hand weeding.

***Planting materials*:** The barnyard millet genotypes used for study belonged to two different species viz. *E. frumentacea* (VL 207, VL 172) and *E. utilis* (PRB 401, PRJ 1). Out of these except PRB 401 which was an advanced breeding line, all others were released varieties of barnyard millet for Uttarakhand hills. The genotypes were planted under four different soil fertility conditions (Absolute control, 50% of recommended dose of fertilizer (RDF is 40:20:20, N: P: K), 75% of RDF and 100% of RDF) under mid Himalayan conditions (1850 m amsl).

***Data collection and analysis*:** Percentage of plant emergence was recorded by counting the number of emerged seedlings at 7 days after planting. Before flowering commenced, 6 plants were randomly selected from the two middle rows in each plot and tagged for data collection at various stages of growth and development. Days taken for 50 % flowering, days for maturity and 1000 seed weight were assessed on plot basis whereas other parameters *viz*. plant height (cm), productive tillers/plant, ear length and grain weight/ear were measured on randomly selected plants. Grain yield and fodder yield were computed on plot basis and pooled to get mean over the years. The important fodder quality attributes were assessed by the procedures described by AOAC (1990). Analysis of variance and Duncanÿs Multiple Range Test were used to evaluate differences in pooled data over the years for yield contributing and quality traits and for fodder and grain yield year-wise as per methods suggested by Gomez and Gomez (1984).

Results and Discussion

Analysis of Variance revealed significant differences among genotypes and doses of fertilizers for all the characters included in the study except for fodder quality attributes. For all the traits *E. utilis* genotypes *viz*. PRB 401 and PRJ 1 showed better performance as compared to *E. frumentacea* genotypes. The percentage emergence of all four genotypes were highest at highest dose [N_4 (100% RDF)], however PRJ 1 had the highest percentage emergence, followed by PRB 401 and VL 172, while VL 207 had the lowest percentage emergence (Table 1). There was gradual increase in plant height with plant age and significant differences were observed among the cultivars at maturity. Plant height ranged from 125.6 cm to 99.5 cm at maturity. PRJ 1 and PRB 401 had the highest mean values for plant height when compared to other cultivars tested (Table 1).

Genotypes VL 207 and VL 172 took more time for flowering and maturity as compared to PRB 401 and PRJ 1. Amongst all genotypes, PRJ 1 was earliest in 50% flowering (66.58 days) and maturity and was harvested in the first week of October, which showed its suitability for taking successive wheat crop. Maximum length of ear was also observed for the genotype PRJ 1 (15.95 cm) which was followed by PRB 401 (15.47cm) and for the number of productive tillers per plant. Genotypes PRJ 1 and PRB 401 of Japanese barnyard millet performed better than other cultivars of Indian barnyard millet evaluated (Table 1). Highest grain yield/ ear (3.78 g) and 1000 seed weight (4.8 g) was also observed for the genotypes PRJ 1 than PRB 401 (3.69 g and 4.6 g, respectively).

Genotypes PRJ 1 produced significantly higher grain yield (2143 kg/ha) than PRB 401(1949 kg/ha) and other genotypes evaluated (table 2). This increase in yield might be correlated with the significantly higher yield attributing characters (productive tillers/plant, ear length and grain weight/ear) of PRJ 1. The cultivar PRJ 1 also produced significantly higher fodder (stover) yields. The straw yield of PRB 401 was at par with PRJ 1. Indian barnyard millet varieties produced significantly lower grain and fodder yield (Table 2). The superior performances of Japanese barnyard millet *(E. utilis*) genotypes may be attributed to their high vigour and thick stem and adaptability to the cooler climate. Fodder quality parameters indicated the presence of sufficient crude protein and fibre for using barnyard millet stovers for fodder purpose in maintenance ration. Highest crude protein and crude fat was observed for PRB 401 which was followed by PRJ 1 (Table 3). These findings are similar with earlier recommendations of Muldoon *et al.,* (1984) who had suggested for utilizing *E. utilis* as fodder crop under cool climate conditions.

Table 1. Effect of genotypes and N levels on growth and yield attributes of barnyard millet (mean of 2 years)

Treatments	Percentage Emergence (%)	Plant height (cm)	Days to 50 % flowering	Days to maturity	Main ear length (cm)	Productive tillers/plant	Grain weight /ear(g)	1000-Grain weight (g)
Genotypes								
VL 207	69.74	99.5	79.83	151.91	14.09	3.2	3.25	4.2
VL 172	70.94	108.4	82.00	144.91	14.57	3.3	3.59	4.4
PRB 401	75.19	110.6	70.66	119.33	15.47	3.6	3.69	4.6
PRJ 1	80.32	125.6	66.58	115.50	15.95	3.9	3.78	4.8
CD (P=0.05)	4.63	4.18	1.37	1.42	0.266	0.32	0.24	0.19
Nitrogen levels (kg/ha)								
N_0-Absolute control	62.81	89.0	67.91	125.41	13.74	3.1	3.12	3.8
N_2- 50% of RDF	69.82	105.2	74.25	131.33	14.50	3.3	3.34	4.3
N_3-75% of RDF	78.22	107.5	75.41	135.50	15.68	3.6	3.61	4.5
N_4- 100% of RDF	85.34	111.3	81.50	139.41	16.16	3.7	3.64	4.6
CD (P=0.05)	4.63	4.15	1.37	1.42	0.266	0.32	0.25	0.18

Table 2. Effect of different levels of nitrogen on yield of barnyard millet varieties

Treatments	Grain Yield (kg/ha)			Dry Fodder Yield (kg/ha)		
	2009	2010	Mean	2009	2010	Mean
Varieties						
VL 207	1846	1696	1771	5712	5375	5544
VL 172	1590	1763	1677	4969	5395	5182
PRB 401	1949	1949	1949	5624	5520	5572
PRJ 1	2128	2158	2143	6374	6480	6427
SEm±	29.30	32.67	30.99	18.39	10.44	14.0
CD (5%)	84.64	94.37	89.51	53.10	30.17	42.0
Nitrogen levels (kg/ha)			1469	4649	4650	4650
N_0-Absolute control	1482	1455				
N_2- 50% of RDF	1758	1794	1776	5195	6245	5720
N_3-75% of RDF	2085	2055	2070	6290	5326	5808
N_4- 100% of RDF	2188	2261	2225	6545	6549	6547
SEm±	29.30	32.67	30.98	18.39	10.44	14.00
CD (5%)	84.64	94.37	89.50	53.13	30.17	42.00

Table 3. Mean of fodder quality of attributes of barnyard millet genotypes (on dry matter % basis)

Treatments	Crude protein	Crude fibre	Crude fat	Acid Insoluble Ash
Genotypes				
VL 207	4.95	30.83	1.60	2.66
VL 172	5.59	29.57	1.46	2.69
PRB 401	6.25	30.75	1.88	2.98
PRJ 1	5.96	29.30	1.91	2.79
SEm±	0.039	0.201	0.018	0.022
CD (P=0.05)	0.113	0.581	0.052	0.064
Nitrogen levels (kg/ha)				
N_0-Absolute control	5.20	30.80	1.63	2.62
N_2- 50% of RDF	5.46	30.58	1.65	2.80
N_3-75% of RDF	5.94	30.22	1.69	2.80
N_4- 100% of RDF	6.16	28.22	1.87	2.90
SEm±	0.039	0.201	0.018	0.022
CD (P=0.05)	0.114	0.581	0.052	0.064

The highest expression of different yield contributing traits *viz.* percent emergence, plant height, ear length, number of productive tillers/plant, grain yield/ ear and 1000 seed weight was observed at 100% of recommended dose of nitrogen *i.e.* 40 kg N /ha which was followed by 75% of RDF. The lowest growth parameters were recorded for control. Application of 100% RDF also produced significantly higher grain and fodder yield during both the years. The gradual increase in grain and fodder yield for all the genotypes was observed with the increasing fertilizer doses but the incremental enhancement was comparably higher in Japanese barnyard millet genotypes (PRB 401 and PRJ 1), which indicated their suitability for cultivation at 100 % RDF. Increase in yield and grain quality traits with the fertilizer doses were also reported by Gupta *et al*., (2012) in finger millet. The fodder quality parameters also showed increase across all the genotypes and produced better fodder quality at higher doses of fertilizer (Table 3).

The difference among barnyard millet cultivars observed in this study showed that barnyard millet has a broad genetic base with a tremendous variability which can be utilized by plant breeders for improving barnyard millet production in rain-fed areas. In conclusion, the study showed that PRJ 1 and PRB 401 genotypes of Japanese barnyard millet (*E. utilis*) performed consistently and significantly higher for all the parameters measured (yield attributing characters, grain and fodder yield, and fodder quality etc.) than the genotypes of Indian barnyard millet (*E. frumentacea*) evaluated. Better performance of these genotypes even under low input conditions (no fertilizer) indicating their suitability for cultivation in Indian central Himalayan condition where barnyard millet cultivation is taken under very low external inputs.

References

AOAC. 1990. *Official methods of analysis* (15th ed). Association of Analytical Chemists, Washington D.C. pp 66-88.

Bandyopadhyay, B. B. 2009. Evaluation of barnyard millet cultivars for fodder yield under single and double cut treatments at higher elevations of hills. *Agric. Sci. Digest.* 29:66-68.

Gomez, K. A. and A. A. Gomez. 1984. *Statistical procedures for agricultural research*. 2nd ed. John Willey and Sons, New York.

Gupta, N., A. K. Gupta, V. S. Gaur and A. Kumar. 2012. Relationship of nitrogen use efficiency with the activities of enzymes involved in nitrogen uptake and assimilation of finger millet genotypes grown under different nitrogen inputs. *The Scientific World Journal* 2012. 10p. ID 652731. DOI:10.1100/2012/625731.

Muldoon, D. K., J. L. Wheeler and Pearson. 1984. Growth, mineral composition and digestibility of maize, sorghum and barnyard millets at different temperatures. *Australian. J. Agric. Res.* 35: 367 ï 378.

National Research Council. 1996. *Lost Crops of Africa vol. I: Grains*. Board on Science and Technology for International Development. National Academy Press Washington, D.C. pp 43-58

Yadav, R. and V. K. Yadav. 2011. Barnyard millet: Amazing crop for nutritional security in Himalayan region. *Indian Farming* 61 (4): 6-9.

Yadav, V. K., R. Yadav, B. Kumar and N. Malik. 2010. *Success story of PRJ 1: Disease resistant high yielding variety of barnyard millet*. College of Forestry & Hill Agriculture, G B Pant University of Agriculture and Technology, Ranichauri, Tehri Garhwal, Uttarakhand.