Indian J. Plant Genet. Resour. 33(1): 85–89 (2020)
DOI 10.5958/0976-1926.2020.00012.1

SHORT COMMUNICATION

Exploiting Genetic Diversity for Identification of Protein Dense Seed Parent in Pearl Millet

Mukesh K Berwal[1]*, Preeti Goyal[1], LK Chugh[2], Ramesh Kumar[2] and Dev Vart[2]
[1] *Scientist, Plant Biochemistry, ICAR-Central Institute for Arid Horticulture, Bikaner–334006, Rajasthan, India*
[2] *Bajra Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar–125001, Haryana, India*

(Received: 03 January, 2018; Revised: 27 September, 2019; Accepted: 14 October 2019)

The present study was carried out to identify the protein dense pearl millet parental lines amongst 46 advanced inbred lines and designated B-lines (counterpart of CMS lines) during kharif 2013 & 14. Analysis of variance indicated significant differences between the tested genotypes during both the seasons. Protein content of these inbred lines varied from 8.62 (TPBL-11-109) to 16.03% (HBL-0620) with an average value of 11.38% and 9.92% (HBL-94/54-1) to 15.38% (HBL-0620), while designated B-line ranged from 11.09 % (HMS 26B) to 18.75% (HMS 18B) with an average value of 14.56% and 11.07% (HMS 33B) to 17.89% (HMS 18B) with an average value of 12.00% grown during *kharif-2013 & 14* respectively. On the basis of two years mean performance, four inbred lines and 11 designated B-lines were selected as potential parental lines with ≥13% protein content, for development of protein rich pearl millet hybrids or composites.

Key Words: Pearl millet, Inbreds, CMS lines, Protein content

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is an important food and fodder crop and is the life line of animal husbandry dominated farmer's economy of dry land areas in India and Africa. In India, it is grown over an area of 7.90 million hectares with total production of 9.20 million tones and productivity of 1161 kg/ha (Anonymous, 2013). The major pearl millet growing states in order of area are Rajasthan, Maharasthra, Gujarat, Uttar Pradesh and Haryana. These states account for 87% of the total area under cultivation. In Haryana, area under this crop during *kharif-2013-14* was 4.04 lakh hectare, with total production of 8.31 lakh tonnes and productivity of 2057 kg/ha (Anonymous, 2014).

Higher protein content with good proportion of essential amino acids and lipid content greatly enhances the nutritional value of pearl millet food and feed stuff (Sullivan *et al.,* 1990) and it also show very good antioxidant potential (Berwal *et al*., 2016). In high protein lines starch and soluble sugars decreased by 40% and fat content by 20%. The total amino acid composition of high protein lines remained normal except for a 16% decrease in lysine. However, the high protein lines gave a high value for utilizable protein but low digestible energy which may be due to high dietary fibre fraction (10%) (Singh *et al*., 1987). The cultivars developed for high protein content showed increase in prolamine content which resulted in lower proportions of glutalin, albumin and globulin fractions (Jambunathan and Subramanian, 1988). Thus the high protein varieties should be preferred from a nutritional point of view compared to low protein varieties, in spite of negative correlation between protein content and protein quality. However, information about status of protein content in inbred lines, designated B-lines, high-yielding hybrids and populations will be helpful for breeding high protein pearl millet hybrid. Cultivars of high-protein content could be potential sources for the development of protein dense pearl millet hybrids/ composites.

Materials and Methods

The present study was carried out to observe the variability for protein content in advanced inbred lines and designated B-line (counterpart of CMS lines) developed at CCS HAU, Hisar and ICRISAT, Hyderabad. A total number of 92 genotypes including 46 each of inbred lines and designated B line were grown in randomized

**Author for Correspondence: Email- mkbiochem@gmail.com*

block design with two replications and 10 cm intra-row and 45 cm inter-row spacing at Research Farm of CCS HAU, Hisar during *kharif*-2013 and selected 33 lines during kharif-2014 as well. Grain samples were taken from each entry in both the replications and analyzed for protein content according to micro-Kjeldahl method (AOAC 1990) and for converting the N% in protein % a crop specific conversion factor 5.7 was used. Analysis of variance for randomized block design was carried out for protein content according to as described Panse and Sukhatame (1957). To assure the data quality w.r.t. recovery % and repeatability for quality control, two released hybrid variety samples were used as positive control.

Results and Discussions

Data presented in Table 1, 2, 3 and 4 showed a statistically significant and marked variation in protein content of the genotypes of each group (inbreds and designated B-lines). protein content of inbred lines grown during *kharif-2013* varied from 8.62 to 16.03% with an average value of 11.38%. HBL 0620 (16.03%), HTP 94/54 (13.59%), HBL 0902-5 (13.11%), HBL 72 (13.11%) and HBL 0843-4 (12.90%) were identified as the promising inbreds for protein content (Table 1). During *Kharif*-2014, protein content of the selected lines varied from 9.92% to 15.38% with an average value of 12%. Except HBL 0843-4, (Table 3) whose protein content showed a difference of more than 2%, all other selected lines for other characters showed similar protein content as was observed during *Kharif*-2013. Thus on the basis of two years mean performance, four inbreds (with protein content > 13%) have been finally selected for high protein content viz. HBL 0620 (15.70 %), HTP 94/54 (13.31%), H 77/833-2-202 (13.38%) and HBL 0809 (13.38%). Protein content in designated B-line ranged from 10.11% (HMS 26B) to 16.68% (HMS 18B) with an average value of 13.24% grown during *Kharif*-2013 (Table 2). A total number of 17 designated B-line viz. HMS 16B, HMS 18B, HMS 20B, HMS 39B, HMS 40B, HMS 41B, HMS 42B, HMS 44B, HMS 45B, HMS 46B, HMS 49B, HMS 55B, HMS 56B, HMS 57B, HMS 58B, HMS 60B and ICMA 95222 exhibited significantly higher protein content than released hybrids

Table 1. Protein content (%) of pearl millet inbreds grown during *kharif*-2013

S.No.	Pedigree	Protein (%)	S.No.	Pedigree	Protein (%)
1	B08/2013	11.52^{de}	24	HBL-0854	11.80^{d}
2	Brs-10-2	12.60^{c}	25	HBL-0902-1	12.09^{cd}
3	Brs-10-6	12.01^{cd}	26	HBL-0902-5	13.11^{bc}
4	Brs-10-7	11.69^{de}	27	HBL-0904-1	9.43^{fg}
5	DPHBL-11-123	12.24^{c}	28	HBL-0904-2	10.90^{e}
6	EBLT-11-101	10.31^{f}	29	HBL-0906-2	12.66^{c}
7	EBLT-11-114	9.07^{g}	30	HBL-0906-3	11.37^{de}
8	HBL- 0703	11.64^{de}	31	HBL-1108	8.92^{g}
9	HBL-0508	10.48^{ef}	32	HBL-112/H12/1011	11.60^{de}
10	HBL-0510-2	10.19^{f}	33	HBL-1120	10.85^{e}
11	HBL-0547	10.10^{f}	34	HBL-34	10.82^{e}
12	HBL-0561	11.20^{e}	35	HBL-72	13.11^{b}
13	HBL-0620	16.03^{a}	36	HBL-828-1	10.19^{f}
14	HBL-0706	12.85^{bc}	37	ICMB-88006	11.90^{d}
15	HBL-0802	11.29^{de}	38	LPBL-10/112	9.06^{g}
16	HBL-0809	12.87^{bc}	39	LPBL-10/120	11.10^{e}
17	HBL-0825-1	10.78^{e}	40	TPBL-11-109	8.62^{g}
18	H-1305	10.75^{e}	41	94/54-1	10.08^{f}
19	HBL-0828-2	10.40^{ef}	42	G-73/107	10.53^{ef}
20	HBL-0832	12.87^{bc}	43	HTP-94/54	13.59^{b}
21	HBL-0843-2	11.82^{de}	44	HBL-11	11.64^{de}
22	HBL-0843-4	12.90^{bc}	45	H-77/833-2-202	13.42^{b}
23	HBL-0847-3	9.59^{fg}	46	78/711	11.56^{de}
	C.D. (p <0.05)	0.79		C.D. (p <0.05)	0.79
	SE(d)	0.39		SE(d)	0.39
	C.V. (%)	2.44		C.V. (%)	2.44

Table 2. Protein content pearl millet designated B-lines (CMS lines) grown during *kharif* 2013

S.No.	Pedigree	Protein (%)	S.No.	Pedigree	Protein (%)
1	HMS 7B	13.15^{g}	24	HMS 42B	14.78^{d}
2	HMS 7B-1	14.66^{d}	25	HMS 44B	16.08^{b}
3	HMS 13B	13.10^{gh}	26	HMS 45B	14.14^{e}
4	HMS 14B	13.17^{g}	27	HMS 46B	16.08^{b}
5	HMS 16B	14.22^{e}	28	HMS 49B	13.71^{f}
6	HMS 18B	16.68^{a}	29	HMS 50B	12.94^{gh}
7	HMS 20B	14.08^{e}	30	HMS 51B	11.80^{jk}
8	HMS 21B	11.18^{l}	31	HMS 52B	11.75^{jk}
9	HMS 22B	11.64^{jk}	32	HMS 53B	13.04^{gh}
10	HMS 23B	10.92^{l}	33	HMS 55B	14.04^{e}
11	HMS 26B	10.11^{m}	34	HMS 56B	13.95^{ef}
12	HMS 28B	11.06^{l}	35	HMS 57B	15.03^{cd}
13	HMS 29B	11.43^{k}	36	HMS 58B	13.95^{e}
14	HMS 30B	11.85^{j}	37	HMS 59B	13.10^{gh}
15	HMS 32B	13.25^{fg}	38	HMS 60B	14.08^{e}
16	HMS 33B	12.53^{i}	39	HMS 61B	13.59^{fg}
17	HMS 34B	13.53^{f}	40	ICMB-843-22	13.32^{g}
18	HMS 36B	12.68^{i}	41	ICMB-89111	12.64^{i}
19	HMS 37B	11.92^{k}	42	ICMB-95222	13.34^{g}
20	HMS 38B	13.04^{gh}	43	ICMB-97111	12.13^{j}
21	HMS 39B	14.27^{e}	44	ICMB-94555	14.22^{e}
22	HMS 40B	13.78^{f}	45	ICMB-94222	10.40^{m}
23	HMS 41B	15.31^{c}	46	ICMB-843-22	13.32^{g}
	C.D.	0.39		C.D.	0.39
	SE(d)	0.19		SE(d)	0.19
	C.V.	1.47		C.V.	1.47

Table 3. Protein content of selected pearl millet inbreds grown during *kharif-2013* and *kharif-2014*

S.No.	Pedigree	Protein (%)		
		Kharif-2013	Kharif-2014	Mean
1	HBL-0620	16.03	15.38	15.70
2	HTP-94/54	13.59	13.02	13.31
3	H-77/833-2-202	13.42	13.34	13.38
4	HBL-0843-4	12.90	10.97	11.94
5	HBL-0809	12.87	13.24	13.06
6	HBL-0706	12.85	12.98	12.91
7	DPHBL-11-123	12.24	11.06	11.65
8	HBL-11	11.64	12.38	12.01
9	HBL-112/H12/1011	11.60	10.53	11.07
10	LPBL-10/120	11.10	10.27	10.68
11	H-1305	10.75	12.55	11.65
12	G-73/107	10.53	10.62	10.58
13	94/54-1	10.08	9.92	10.00
14	LPBL-10/112	9.06	11.76	10.41
	C.D. ($p < 0.05$)		0.62	
	SE(d)		0.30	
	C.V. (%)		2.47	

and composites. Designated B-line exhibited very high protein viz., HMS 18B (16.68%) followed by HMS 44B (16.08%) and HMS 46B (16.08%). A total of 19 designated B-lines were selected for low and high protein content and grown during kharif 2014. Results of *Kharif-2014* presented in Table 4, showed that except HMS 39B (12.63%) and HMS 32B (11.06%), all other selected lined were comparable for protein content with *Kharif-2013* results. It varied from 10.10% (HMS 33B) to 16.32% (HMS 18B) with an average value of 12.34%. The average protein content of both the season for respective lines confirms the selection of promising CMS lines for protein content. Thus, on the basis of protein content recorded in grains produced during *Kharif*-2013 & 2014 both the seasons HMS 18B (16.50%), HMS 46B (16.08%), HMS 7B-1(14.15%), HMS 39B (14.27%), HMS 16B (13.61%), HMS 40B (14.63%), HMS 14B (13.26%), HMS 13B (13.12%), HMS 59B (13.34%), and HMS 53B (13.32%) are high protein designated B-lines. Large variations in protein content, from 6 to 21 percent, have also been observed

Table:4. Protein content (%) of Selected designated B-lines (CMS lines) of pearl millet grown during kharif 2013 and kharif 2014

S.No.	Pedigree	Protein %		
		Kharif-2013	Kharif-2014	Mean
1	HMS 18B	16.68	16.32	16.50
2	HMS 7B-1	14.66	13.63	14.15
3	HMS 39B	14.27	12.63	13.45
4	HMS 16B	14.22	13.00	13.61
5	HMS 40B	13.78	12.90	13.34
6	HMS 32B	13.25	11.06	12.16
7	HMS 14B	13.17	13.34	13.26
8	HMS 7B	13.15	12.50	12.83
9	HMS 13B	13.10	13.15	13.12
10	HMS 59B	13.10	13.59	13.34
11	HMS 38B	13.04	12.76	12.90
12	HMS 53B	13.04	13.61	13.32
13	HMS 36B	12.68	10.99	11.83
14	ICMA89111	12.64	10.62	11.63
15	HMS 33B	12.53	10.10	11.31
16	HMS 52B	11.75	10.27	11.01
17	HMS 21B	11.18	11.14	11.16
18	HMS 26B	10.11	10.44	10.28
	C.D.		0.62	
	SE(d)		0.30	
	C.V.		2.47	

earlier (Sawhney and Naik 1969; Uprety and Austin 1972). On the contrary, a lower variation in protein content (9-15%) in pearl millet genotypes was also reported Goswami *et al.* (1969; 1970). Grain protein content of pearl millet hybrids and varieties released in India ranges between 8.00 to 13.00 % (Berwal *et al.,* 2017).

Analysis of variance presented in Table 1 to 4 indicated significant differences between the tested genotypes. The inbred lines and CMS lines of these B-lines may extensively be used in development of high protein hybrids or composite seed of high protein B-line lines and following the random mating in isolation to form the high protein population and further improve the per se performance following recurrent selection. Pearl millet hybrids and population developed at CCS HAU, Hisar possessed the maximum protein content 12.85 % and 13.89 %, respectively. There is possibility to develop hybrid with more than 15% protein by extensively utilizing the CMS possessing more than 15% protein content. Further germplasm accession should be screened to identify the restorer with high protein content. Correlation of grain yield with protein is generally negative, but certain genotypes in specific combinations may give high yield and high protein (Dua and Kapoor, 1982). Therefore, it is possible to breed pearl millet hybrids with availability of high protein inbreds and CMS lines. High heterosis has been reported for protein content using CMS lines (Kumar *et al.,* 2003).

Conclusion

The inbred lines (HBL 0620, HTP 94/54, H 77/833-2-202, and HBL 0809) and designated B-lines (HMS 18B, HMS 46B, HMS 7B-1, HMS 39B, HMS 16B, HMS 40B, HMS 14B, HMS 13B, HMS 59B, HMS 38B, and HMS 53B) sowed consistently more than 13% average protein content, which could be potential parental lines for development of protein dense pearl millet hybrids/ composites.

References

Anonymous (2013) 3rd Advance Estimate. Economic Survey. 138.

Anonymous (2014) http://agriharyana.nic.in/ Stat-Info/Final estimates.

AOAC (1990) Official Methods of Analysis. Association of Official Analytical Chemists, Washington, D.C.

Berwal, MK, LK Chugh, Preeti Goyal, R Kumar and Vart Dev (2017) Protein, Micronutrient, Antioxidant Potential and Phytate Content of Pearl Millet Hybrids and Composites Adopted for Cultivation by Farmers of Haryana, India. *Int. J. Curr. Microbiol. App. Sci*. **6(3):** 376-386. doi: https://doi.org/10.20546/ijcmas.

Berwal MK, LK Chugh, Preeti Goyal and R Kumar (2016) Total Antioxidant Potential of Pearl Millet Genotypes: Inbreds and Designated B-lines. *Indian J. Agric. Biochem.* **29(2):** 201-204.doi 10.5958/0974-4479.2016.00032.0.

Dua RP and RL Kapoor (1982) Breeding strategy for improvement of protein content in pearl millet. *Indian J. Agric. Res.* **16**: 51-54.

Goswami AK, KL Sehgal and BK Gupta (1970) Chemical composition of bajra grains: III. Indian inbreds. *Ind. J. Nutr. Diet*. **7:** 5.

Goswami AK, KL Sehgal and KP Sharma (1969) Chemical composition of bajra grains: I. African entries. *J. Nutr. Diet*. **6**: 287.

Jambunathan R and V Subramanian (1988) Grain quality & utilization of sorghum & pearl millet, pp. 133-139. In: Biotechnology in Tropical Crop Improvement. (J.M.J. de Wet & T.A. Preston, eds.). ICRISAT, Patancheru, India.

Kumar A, HP Yadav, IS Yadav, PS Sabharwal and LK Chugh (2003) Heterosis for protein content in pearl millet (*Pennistum glaucum* (L) R. Br.). In Proc. Natl. Seminar on Processing and Utilization of Millets for Nutritional security. *CCS Haryana Agricultural University, Hisar, India.* October 7-8, 2003. p29.

Panse VG and PV Sukhatme (1957) Genetics and quantitative characters in relation to plant breeding. *Indian J. Genet.* **17**: 312-328.

Sawhney SK and MS Naik (1969) Amino acid composition of protein fractions of pearl millet and the effect of nitrogen fertilization on its proteins. *Ind. J. Genet. PI. Breed*. **29:** 395.

Singh P, U Singh, BO Eggum, KA Kumar and DJ Andrews (1987) Nutritional evaluation of high protein genotypes of pearl millet [*Pennisetum americana* (L.) R. Br.]. *J. sci. Food Agric*. **38:** 41-48. doi.org/10.1002/jsfa.2740380108

Sullivan TW, JH Douglas, DJ Andrews, PL Bond, JD Hancock, PJ Bramel-Cox, WD Stegmeier and JR Brethour (1990) Nutritional value of pearl millet for food and feed. In: Proceedings of International Conference on Sorghum Nutritional Quality. Purdue Univesity, Lafayette, USA.

Uprety D and A Austin (1972) Varietal differences in the nutrient composition of improved bajra (pearl millets) hybrids. *Bull. Grain. Tech*. **10**(4): 249.