www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(8): 419-423

www.thepharmajournal.com
Received: 17-06-2021
Accepted: 20-07-2021

Moti Ram Natwaria
Department of Genetics and Plant Breeding, College of Agriculture, Swami Keshawanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

PC Gupta
Department of Genetics and Plant Breeding, College of Agriculture, Swami Keshawanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Sohan Lal Kajla
Department of Genetics and Plant Breeding, College of Agriculture, Swami Keshawanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Corresponding Author:
Moti Ram Natwaria
Department of Genetics and Plant Breeding, College of Agriculture, Swami Keshawanand Rajasthan Agricultural University, Bikaner, Rajasthan, India

Assessment of genetic divergence in pearl millet [*Pennisetum glaucum* (L.) R. Br.]

Moti Ram Natwaria, PC Gupta and Sohan Lal Kajla

Abstract
The present investigation was carried out to assess genetic divergence in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. Sixty F_1 hybrids were evaluated with three standard check hybrids in randomized block design in three replications with two different environments created through number of irrigations at Agricultural Research Station and College of Agriculture, Bikaner during *Kharif* 2018. Observations were recorded on twelve different characters namely, days to 50 per cent flowering, days to maturity, plant height, total number of tillers, number of effective tillers, flag leaf area, ear head length, ear head diameter, test weight, dry stover yield, grain yield and harvest index. Results of divergence study revealed that crosses were grouped into 19 clusters using D^2 statistics, indicates the presence of high degree of genetic divergence among the hybrids. Such hybrid serves as source of high heterotic response during selection programme. Cluster I contained the maximum number of crosses (35) followed by cluster V (7), cluster III (5) and in rest of the clusters, there was only one cross in each cluster. The maximum intra cluster distance was observed within cluster V. The maximum inter cluster distance was observed between cluster XII and cluster XVII, whereas minimum inter cluster distance was observed between cluster IV and cluster VIII. Hence, hybrid from these clusters, when used as parents in breeding programme may gives more productive results.

Keywords: Pearl millet, divergence, intra and inter cluster distance

Introduction

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is popularly known as bulrush millet, cattail millet or spiked millet, bajra, dukhn and as mhunga or mahango in different parts of southern Africa and Asia, is an important drought tolerant coarse grain cereal crop. It is a major crop in arid and semi arid region of the world. It appears to have originated in Sahel zone of West Africa (Vavilov, 1950 and Murdock, 1959) [16, 12], which is known to be the crop's main center of diversity, from where it spread to India and other countries. Due to protogynous flowering type, it is highly cross-pollinated, diploid (2x=14) annual C_4 crop of family Poaceae (Gramineae), which is robust and quick growing rainy season cereal crop with large stem, leaves, heads, tall and vigour, with very high grain potential of 15-20 quintal per hectare.

Pearl millet accounts for almost half of global millet production and contributes to food security in regions of Africa and Asia. As the grain has towering levels of protein content with balanced amino acids, CHO and fat which are prime in the human dietary and its nourishing value is considered to be akin to rice and wheat. 100 grams of pearl millet grain contains nutritional values as 360 calories energy, 12g moisture, 12g protein, 5g fat, 2g mineral, 1g fiber, 67g carbohydrate, 42mg Calcium, 242mg phosphorus and 8mg iron (Malik, S., 2015) [11]. Pearl millet grains are cooked like rice or chapattis are prepared out of its flour. As a food crop, pearl millet grain own the peaked amount of calories per 100 g (Burton *et al.*, 1972) [4], which is mainly supplied by carbohydrates, fats and proteins (Flech, 1981) [5]. Its mineral content is also comparable with other cereals. Among them, Fe content ranging from 18 to 135 ppm and Zn varying from 22 to 92 ppm (Rai *et al.*, 2012) [14]. Pearl millet provides the main source of nutritious staple food grain, high-energy feed grain (for milch and draft animals, as well as for poultry, fish and other monogastric livestock) and green and dry fodder for ruminant livestock. The green fodder is more palatable because it does not have HCN content as that of sorghum (Hanna *et al.*, 1999) [7].

It is one most important cultivated cereal in the world, ranking after rice, wheat, maize, barely and sorghum in terms of area planted to these crops (Khairwal *et al.*, 2007) [9]. It covers an estimated 30 m ha worldwide and is grown in more than 30 countries with the majority of this area in Asia (>10 m ha), Africa (about 18 m ha), and Americas (>2 m ha) (Gupta *et al.*, 2015)

[6]. It is extensively cultivated over large area in dry regions of Asia (most of the acreage is in India) and Sahel region of Africa (Nigeria having larger acreage followed by Niger, Mali, Chad and Tanzania).

In our country, it is grown in arid and semi-arid areas of central and western regions. The utmost pearl millet producing states are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana, covering nearly 90% acreage. It is grown on 9.13 million ha in India with a midpoint productivity of 1237 Kg/ha. (Anonymous, 2018a) [2]. Rajasthan alone occupies 4.15 million hectares area, which is 55% of the national acreage. The total production of pearl millet in Rajasthan is 3.76 million tonnes, which is 47.7% of the national production with an average productivity of 906 kg/ha. (Anonymous, 2018b) [3]. In Rajasthan, mojor pearl millet producing districts are Alwar, Sikar, Bharatpur, Karauli, Jaipur, Dausa, Dholpur, Jhunjhunu, Sikar, Nagaur, Swaimadhopur, Barmer, Bikaner, Jaisalmer and Churu.

Genetic diversity is the principal requirement for any crop improvement programme. The genetic distance between pair of genotypes provides the basis for grasping the structure of the diversity of any intra-species population. It assembles an all-to-all matrix to set out the distance between each sequence pair of genotypes, thereby directing plant breeder in their selection procedure (Adewale *et al*., 2011) [1]. The multivariate analysis is a functional tool for selecting the parents for hybridization and has been efficiently demonstrated by former workers (Hazra *et al*., 1992; Nath *et al*., 2009) [8, 13]. D^2 statistic is an effective tool to compute genetic divergence among genotypes in any crop developed by Mahalanobis (1936) [10].

Material and Method

The experiment was conducted using 60 F_1 hybrids in randomized block design (RBD) with three replications in two environments during *Kharif*, 2018, one at research farm, ARS, Beechhwal, Bikaner (E_1), while another at research farm, College of Agriculture, Bikaner (E_2). These environments were created through different irrigation and fertilizer levels. The research farms are situated between $27^0$11' N latitude and $71^0$54' E longitudes at an altitude of 228.5 meters above mean sea level. This region falls under agro-climatic zone 1C of Rajasthan. The climate of the region is typically hyper-arid with an average rainfall is about 260 mm, received during July-September.

The experimental material comprised of 60 hybrids and three commercially cultivated hybrids (HHB-67 Improved, RHB-177 and MPMH-17) as checks. Each hybrid consisted of two rows of 4 meter length. The spacing between rows was 60 cm and between plants was 15 cm. Observations were recorded on twelve different characters namely, days to 50 per cent flowering, days to maturity, plant height, total number of tillers, number of effective tillers, flag leaf area, ear head length, ear head diameter, test weight, dry stover yield, grain yield and harvest index. Data recorded on above characters were subjected to calculate genetic divergence using D^2 statistics given by P. C. Mahalanobis (1936) [10].

Results and Discussion

The study of genetic divergence among 60 hybrids of pearl millet along with 3 checks was assessed by employing D^2 statistics analysis for tweleve characters. All the crosses were grouped into 19 clusters following Tocher method (Rao, 1952) [15]. Cluster I contained the maximum number of crosses (35) followed by cluster V (7), cluster III (5) and in rest of the clusters, there was only one cross in each cluster (Table 1).

The results of table 2 showed that the range was wider for the trait dry stover yield per plant followed by the traits, plant height and grain yield per plant and narrow range for the characters ear head diameter followed by effective tillers per plant and total number of tillers per plant. Days to 50% flowering ranged from 46.00 days (cluster VII) to 50.00 days (cluster XVII and cluster XIX), days to maturity ranged from 66.00 days (cluster XVIII) to 77.00 days (cluster XIX), plant height ranged from 136.84 cm (cluster III) to 174.60 cm (cluster IV), total number of tillers per plant ranged from 2.00 (cluster II) to 4.47 (cluster XI), number of effective tillers per plant ranged from 1.33 (cluster XIII) to 3.03 (cluster V), flag leaf area ranged from 68.23 cm (cluster IX) to 114.03 cm (cluster XI), ear head length ranged from 18.07 cm (cluster XII) to 30.20 cm (cluster XVII), ear head diameter ranged from 1.96 cm (cluster XVI) to 3.04 cm (cluster XII), test weight ranged from 7.28 gm (cluster XIII) to 10.10 gm (cluster XII), dry stover yield per plant ranged from 25.12 gm (cluster VII) to 66.40 gm (cluster XI), grain yield per plant ranged from 8.37 gm (cluster XIII) to 25.89 cm (cluster XIX) and harvest index ranged from 24.13% (cluster XIII) to 35.40% (cluster VII).

The average intra and inter cluster distance were calculated from the D^2 values of the respective crosses within and between the clusters. Perusal of Table 3 indicated that the intra cluster distance ranged from 0.00 to 9.88 and inter cluster distance ranged from 7.18 to 34.29. The maximum intra cluster distance was observed within cluster V. The maximum inter cluster distance was observed between cluster XII and cluster XVII, whereas minimum inter cluster distance was observed between cluster IV and cluster VIII. In accordance with current findings, it is suggested that hybrids, which fall in these clusters has wider diversity may fruitful for further breeding improvement programme.

Table 1: Clustering pattern of different crosses in different clusters

Cluster	Number of crosses	Crosses
I	35	ICMA-88004 X (BIB-45, BIB-53, BIB-60, BIB-75, BIB-78, BIB-85, BIB-102, BIB-145, BIB-147, BIB-149, BIB-163, BIB-167, BIB-173), ICMA-93333 X (BIB-60, BIB-75, BIB-78, BIB-85, BIB-137, BIB-141, BIB-149,BIB-164, BIB-170, BIB-173, BIB-179), ICMA-97111 X (BIB-45, BIB-60, BIB-75, BIB-85, BIB-90, BIB-102, BIB-147, BIB-149, BIB-163, BIB-164, BIB-170)
II	1	ICMA-97111 X BIB-78
III	5	ICMA-97111 X (BIB-137, BIB-141, BIB-145, BIB-167, BIB-173)
IV	1	MPMH-17
V	7	ICMA-88004 X BIB-90, ICMA-93333 X (BIB-45, BIB-46, BIB-167), ICMA-97111 X (BIB-46, BIB-53, BIB-179)
VI	1	ICMA-88004 X BIB-141
VII	1	ICMA-88004 X BIB-46

VIII	1	RHB-177
IX	1	ICMA-88004 X BIB-179
X	1	ICMA-88004 X BIB-170
XI	1	ICMA-93333 X BIB-145
XII	1	ICMA-88004 X BIB-137
XIII	1	ICMA-93333 X BIB-102
XIV	1	HHB-67 (imp.)
XV	1	ICMA-88004 X BIB-164
XVI	1	ICMA-93333 X BIB-163
XVII	1	ICMA-93333 X BIB-147
XVIII	1	ICMA-93333 X BIB-90
XIX	1	ICMA-93333 X BIB-53

Table 2: Mean values of crosses present in different clusters for different characters

Cluster	Days to 50% flowering	Days to maturity	Plant height	Total number of tillers/plant	Effective tillers/plant	Flag leaf area	Ear head length	Ear head diameter	Test weight	Dry stover yield/plant	Grain yield/plant	Harvest index
I	49.02	71.08	149.62	3.17	1.89	90.07	23.70	2.64	9.14	34.95	13.84	28.29
II	50.33	72.33	142.67	2.00	1.47	101.40	24.80	2.67	9.83	25.68	11.92	31.77
III	51.20	73.73	136.84	3.43	2.01	101.51	22.69	2.67	9.00	31.79	12.72	28.35
IV	49.00	71.00	174.60	2.40	1.47	112.27	22.93	2.95	8.67	31.77	10.27	24.47
V	49.05	71.10	150.85	4.08	3.03	103.35	24.80	2.81	9.99	48.46	22.74	32.12
VI	51.00	73.00	147.53	2.73	1.60	68.40	23.13	2.87	9.76	25.56	9.20	26.70
VII	46.00	68.00	149.60	3.47	2.13	78.50	21.40	2.59	9.01	25.12	13.76	35.40
VIII	47.67	69.67	172.87	3.80	1.87	107.27	24.13	2.52	9.15	34.41	16.00	32.27
IX	52.33	76.00	163.67	2.20	1.40	68.23	21.33	2.57	8.85	29.92	12.83	29.73
X	51.00	73.00	169.80	4.20	2.47	82.60	24.27	2.73	8.91	27.70	10.56	27.63
XI	51.00	73.00	165.73	4.47	2.67	114.03	24.27	2.56	9.94	66.40	24.45	26.87
XII	46.33	68.33	148.20	2.93	1.40	86.83	18.07	3.04	10.10	28.75	11.82	29.13
XIII	46.33	68.33	162.93	3.20	1.33	89.10	24.53	2.75	7.28	26.36	8.37	24.13
XIV	46.33	68.33	170.33	2.13	1.60	105.35	22.40	2.15	9.02	37.62	12.65	25.13
XV	50.67	72.00	151.07	3.87	1.73	80.97	21.80	2.95	10.09	49.72	24.13	32.73
XVI	49.00	72.00	158.40	2.87	1.40	107.40	24.93	1.96	9.98	53.81	18.58	25.67
XVII	53.00	76.33	167.67	3.20	1.60	110.47	30.20	2.61	9.72	60.53	22.88	27.47
XVIII	44.00	66.00	153.93	2.87	1.73	80.80	28.13	2.49	9.53	44.14	23.52	34.77
XIX	53.00	77.00	147.07	4.20	3.00	100.50	22.47	2.95	9.73	53.14	25.89	32.80

Table 3: Average intra and inter-cluster distance based on corresponding D^2 values

Clusters	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
I	40.96 (6.40)	70.39 (8.39)	87.60 (9.36)	86.11 (9.28)	161.54 (12.71)	79.21 (8.90)	69.05 (8.31)	88.54 (9.41)	143.28 (11.97)	90.82 (9.53)	249.64 (15.80)	180.09 (13.42)	155.75 (12.48)
II		00.00 (00.00)	87.23 (9.34)	149.57 (12.23)	255.04 (15.97)	61.30 (7.83)	117.93 (10.86)	199.09 (14.11)	158.76 (12.60)	252.49 (15.89)	532.68 (23.08)	211.70 (14.55)	531.76 (23.06)
III			63.20 (7.95)	199.93 (14.14)	219.63 (14.82)	173.97 (13.19)	185.23 (13.61)	166.41 (12.90)	206.78 (14.38)	161.03 (12.69)	296.87 (17.23)	345.21 (18.58)	385.72 (19.64)
IV				00.00 (00.00)	250.27 (15.82)	195.16 (13.97)	135.72 (11.65)	51.55 (7.18)	253.76 (15.93)	120.78 (10.99)	294.29 (17.16)	110.04 (10.49)	69.88 (8.36)
V					97.61 (9.88)	361.00 (19.00)	280.56 (16.75)	213.74 (14.62)	473.49 (21.76)	254.40 (15.95)	225.90 (15.03)	499.96 (22.36)	554.13 (23.54)
VI						00.00 (00.00)	146.41 (12.10)	365.19 (19.11)	83.72 (9.15)	103.42 (10.17)	759.00 (27.55)	114.06 (10.68)	351.56 (18.75)
VII							00.00 (00.00)	60.37 (7.77)	174.76 (13.22)	103.02 (10.15)	527.16 (22.96)	108.99 (10.44)	141.13 (11.88)
VIII								00.00 (00.00)	301.36 (17.36)	54.16 (7.36)	158.25 (12.58)	298.59 (17.28)	111.09 (10.54)
IX									00.00 (00.00)	170.30 (13.05)	717.70 (26.79)	364.81 (19.10)	438.48 (20.94)
X										00.00 (00.00)	285.27 (16.89)	413.30 (20.33)	154.00 (12.41)
XI											00.00 (00.00)	882.68 (29.71)	753.50 (27.45)
XII												00.00 (00.00)	331.24 (18.20)
XIII													00.00 (00.00)

Note: The values in parentheses represent the D-values i.e. $\sqrt{D^2}$

Clusters	XIV	XV	XVI	XVII	XVIII	XIX
I	126.56 (11.25)	184.41 (13.58)	253.76 (15.93)	239.01 (15.46)	293.09 (17.12)	374.03 (19.34)
II	158.25 (12.58)	361.76 (19.02)	266.01 (16.31)	317.19 (17.81)	448.16 (21.17)	566.91 (23.81)
III	269.28 (16.41)	322.20 (17.95)	277.55 (16.66)	297.56 (17.25)	761.20 (27.59)	239.63 (15.48)
IV	75.16 (8.67)	301.71 (17.37)	457.10 (21.38)	353.44 (18.80)	487.96 (22.09)	583.22 (24.15)
V	293.43 (17.13)	212.57 (14.58)	508.05 (22.54)	379.47 (19.48)	351.56 (18.75)	171.87 (13.11)
VI	460.10 (21.45)	148.84 (12.20)	704.37 (26.54)	498.18 (22.32)	504.90 (22.47)	603.19 (24.56)
VII	157.50 (12.55)	377.91 (19.44)	535.45 (23.14)	719.31 (26.82)	330.14 (18.17)	726.30 (26.95)
VIII	55.65 (7.46)	353.81 (18.81)	192.65 (13.88)	271.59 (16.48)	403.20 (20.08)	564.53 (23.76)
IX	282.57 (16.81)	380.64 (19.51)	379.86 (19.49)	321.12 (17.92)	576.00 (24.00)	268.30 (16.38)
X	291.72 (17.08)	330.87 (18.19)	567.39 (23.82)	370.94 (19.26)	749.11 (27.37)	513.47 (22.66)
XI	248.69 (15.77)	380.25 (19.50)	138.53 (11.77)	108.16 (10.40)	1162.81 (34.10)	430.97 (20.76)
XII	414.52 (20.36)	187.14 (13.68)	988.47 (31.44)	1175.80 (34.29)	659.46 (25.68)	875.56 (29.59)
XIII	272.58 (16.51)	521.66 (22.84)	840.42 (28.99)	629.00 (25.08)	316.84 (17.80)	1098.25 (33.14)
XIV	00.00 (00.00)	630.51 (25.11)	76.73 (8.76)	349.31 (18.69)	327.24 (18.09)	762.86 (27.62)
XV		00.00 (00.00)	804.85 (28.37)	525.32 (22.92)	362.14 (19.03)	290.02 (17.03)
XVI			00.00 (00.00)	76.91 (8.77)	713.95 (26.72)	676.52 (26.01)
XVII				00.00 (00.00)	635.54 (25.21)	383.37 (19.58)
XVIII					00.00 (00.00)	813.39 (28.52)
XIX						00.00 (00.00)

Note: The values in parentheses represent the D-values i.e. $\sqrt{D^2}$

References

1. Adewale BD, Adeigbe OO, Aremu CO. Genetic distance and diversity among some cowpea (Vigna unguiculata L. Walp) genotypes. International Res. Plant Science 2011;1(2):9-14
2. Anonymous. Agricultural Statistics at A Glance 2018, Directorate of Economics & Statistics, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Govt. of India 2018a, http://agricoop.gov.in.
3. Anonymous. Crop-wise fourth advance estimates of area, production and yield of various principal crop during 2018-19, Commissionerate of Agriculture, Directorate of Agriculture, Rajasthan, Jaipur 2018b, www.krishi.rajasthan.gov.in.
4. Burton GW, Wallance AT, Rachie KO. Chemical composition and nutritive value of (*Pennisetium glaucum* (L.) R. Br.) of grain. Crop Science 1972;12:187-189.
5. Flech H. Introduction to nutrition. Mac Millan Publishing Co. Indian 1981,49.
6. Gupta SK, Nepolean T, Sankar SM, Rathore A, Das RR, Rai KN. Patterns of molecular diversity in current and previously developed hybrid parents of pearl millet [*Pennisetum glaucum* (L.) R. Br.]. American Journal of Plant Sciences 2015;6:1697-1712.
7. Hanna, WW, Richardson MS, Wiseman BR, Bacon CW. Midge resistance and hydrocyanic acid content of sorghum bicolor. Florida Entomol 1999;82(2):354-356.
8. Hazra P, Som MG, Das PK. Selection of parents for vegetable cowpea breeding by multivariate analysis. Veg. Sci 1992;19:166-173.
9. Khairwal IS, Rai KN, Diwakar B, Sharma YK, Rajpurohit BS, Nirwan B. "Pearl millet," in Crop Management and Seed Production Manual. (Patancheru: International Crops Research Institute for the Semi-Arid Tropics) 2007,104.
10. Mahalanobis PC. On the generalised distance in statistics. Journal of Genetics 1936;41:159-193.
11. Malik S. Pearl millet-Nutritional values and Medicinal uses. International Journal of Advance Research and Innovative Ideas in Education 2015;1(3):2395-4396.
12. Murdock GP. A trica its people and their cultural history. Mac Graw Hill, New York 1959.
13. Nath, Vishwa, Lal H, Rai M, Rai N, Ram D. Hierarchical Clustering and Character Association Studies in Cowpea [Vigna unguiculata (L.) Walp.]. Indian J. Plant Genet. Resour 2009;22:22-25.
14. Rai KN, Govindaraj M, Rao AS. Genetic enhancement of grain iron and zinc content in pearl millet. Qual Assur Saf Crops Foods 2012;4:119-125.
15. Rao CR. Advanced Statistical Methods in Biometric

Research. John Wiley and Sons, Inc. New York 1952,390.
16. Vavilov NI. The origin variation immunity and breeding of cultivated plants. Chronica Botanica 1950;13(1):366.