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Production and genetic characterization of interspecific hybrids between pearl millet *Pennisetum glaucum* (L.) × Napier grass *Pennisetum purpureum* (K.)

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Abstract

Pearl millet grains are valued as human food while its dry stover makes important livestock ration in crop-livestock farming system. Interspecific hybrids between cultivars of pearl millet *Pennisetum glaucum* (L.) with $2n = 2x = 14$ and its wild relative Napier Grass *Pennisetum purpureum* (K.) Schum with $2n = 4x = 28$, which have multicut behaviour, perennial nature, high biomass and drought tolerance traits for crop improvement, were obtained by cross hybridization. Several hybrid progenies were obtained and then examined based on the morphological traits at RVC, BAU, Ranchi. The F1 seed of each combination was harvested at maturity and the F1 seed was planted on raised nursery bed to remove the bajra like plants. The row to row and plant to plant spacing was 60 cm. All the recommended cultural practices were followed to raise the healthy crop. Thin napier lines were procured from PAU, Ludhiana. Several yield and yield attributing traits were recorded. The highest no. of slips were obtained by LN 3 (24) followed by LN 1 (20). In bajra, 10 forage A lines (male sterile lines) and 18 forage pollinators (OPVs) (recurrent lines) were procured from ICRISAT, Hyderabad. The characters recorded were days to 50% flowering, plant height, no. of tillers/plant, spike length and green fodder yield (q/ha). In case of male sterile line, the highest green fodder yield (q/ha) was recorded by ICMA 00444A4 (545 q/ha) followed by ICMA 07999A5 (430 q/ha) while in case of Forage pollinators (OPVs), the highest green fodder yield (q/ha) was recorded by ICMV 05222 (684 q/ha) followed by ICMV 1710 (623 q/ha). Different Hybrids were developed from crossing of Bajra x Bajra and Bajra x Napier on two different dates of sowing. The interspecific hybrids between Bajra x Napier in first date of sowing (16.8.20) were BxN1 (384 q/ha) BxN2 (379 q/ha) and BxN3 (456 q/ha). The Number of crosses developed between Bajra x Napier on two different dates of sowing i.e. 16.8.20 and 30.8.20. Several crosses were developed. Out of them, B2xB23 (656 q/ha) recorded highest yield followed by B2xB25 (546 q/ha). In the second date of sowing B6xB12 (634 q/ha) recorded highest yield followed by B2xB23 (578 q/ha).

Keywords: Genetic, characterization, interspecific, hybrids, pearl millet, napier

Introduction

Pearl millet (*Pennisetum glaucum* (L.) R. Br.] is a C_4 plant having a very high photosynthetic efficiency and dry matter production capacity. (Anderson, et al. 2008). It is usually grown under the most adverse agro-climatic conditions where other crops like sorghum and maize fail to produce economic yields. (Campbell, et al 2005) [3]. Besides, pearl millet has a remarkable ability to respond to favourable environments because of its short developmental stages and capacity for high growth rate, thus making it an excellent crop for short growing seasons under improved crop management. (Burton, G. W., 1944) [2]. It is a kharif crop which grows in hot and dry climates and it can be grown in areas where there is deficiency of rainfall. Pearl millet is often referred to as the “camel crop” as it is a tropical plant and also because of its ability to tolerate drought and. In India, there is 8.68 million ha area under pearl millet coupled with annual production of 8.61 million ha and has 999 kg/ha productivity. (Karforma, J., 2018) [4]. It is a diploid, annual, allogamous species with large chromosomes ($2n = 2x = 14$, AA) coupled with 4.72 pg genomic DNA content. (Martel, E., De, Nay. D., et al. 1997) [5]. Its bisexual flowers and protogynous habit of flowering (stigmas exerted before anthers) make it a plant which is readily self- or cross- pollinated. It belongs to the primary gene pool of genus *Pennisetum* and is well adapted to poor and infertile soils. Its forage has better nutritional quality in terms of crude protein (%) and dry matter digestibility (%) along with good palatability (Meena and Jain 2013) [7].

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Whereas Napier grass (*Pennisetum purpureum* Schumach.) is a perennial, allogamous species commonly known as elephant grass or Uganda grass. It has high productive potential, carrying capacity, nutrient quality and low water and nutrient requirements that have highlighted it as the chief tropical forages used for dairy grazing system enhancement. It can make use of otherwise uncultivated lands. It enhances the soil fertility and act as safeguard against soil erosion in arid areas. The napier seeds are very small and hence their use is restricted only for breeding purposes. The crop is commercially planted with two budded sets or rooted slips. One hectare requires about 35,000 -40,000/ha. (Meena, et al. 2017)^[6].

Materials and Methods

Thin Napier lines were procured from PAU, Ludhiana. No. of Entries: 6, Plot Size: 6x3.6 m², Fertilizer: 80:40:20 NPK Kg/ha, Spacing: 60cm x 60cm and Date of sowing: 10.7.20. The characters recorded were Days to 50% flowering, Plant height, No. of tillers/plant, Spike length and no. of slips obtained. For Bajra, 10 forage A lines (male sterile lines) and 18 forage pollinators (OPVs) (recurrent lines) were procured from ICRISAT, Hyderabad. Plot Size: 14x4 m², Fertilizer: 40:20:20 NPK Kg/ha, Spacing: 50 cmx10cm, Design: LXT, First Date of sowing: 9.7.2020 and Second Date of sowing: 20.7.2020. The characters recorded were Days to 50% flowering, Plant height, No. of tillers/plant, Spike length and Green fodder yield (q/ha).

Crossing techniques

Cumbu (Bajra) is naturally cross pollinated (Allogamous). Wind is the chief agent of pollination (anemophily). Adaptations for cross pollination is Protogyny. Anthesis commence from 1/3rd of the apex of spike and proceeds both ways. Stigma emerges first and anthesis is over within 2-3 days. This is followed by the first male phase in which the anthers from the perfect florets emerge out. On the fifth day of anthesis the 2nd male phase begins in which anthers from the staminate florets emerge. Anthesis time 8 pm -2 am.

Crossing

Emasculation in Cumbu is laborious and difficult due to the small size of the flowers and the late maturity of the anthers when compared to the stigma. About four-fifths of the upper portion of the spike is removed and the rest is bagged before the styles appear to prevent contamination. Flowers are pollinated by dusting them with fresh pollen obtained from the desired male plant or by shaking a spike which is shedding pollen over the exposed stigmas.

Characterization of interspecific hybrids

The F1 seed of each combination was harvested at maturity and the F1 seed was planted on raised nursery bed to remove the bajra like plants. The row to row and plant to plant spacing was 60 cm. All the recommended cultural practices were followed to raise the healthy crop.

Results and Discussion

For collection of germplasm, thin Napier lines were procured from PAU, Ludhiana

The characters recorded were Days to 50% flowering, Plant height, No. of tillers/plant, Spike length and No. of slips obtained. The highest no. of slips were obtained by LN 3 (24) followed by LN 1 (20) (Table 1).

Bajra lines were procured from ICRISAT, Hyderabad

10 forage A lines (male sterile lines) and 18 forage pollinators (OPVs) (recurrent lines) were crossed to produce interspecific hybrids. The characters recorded were Days to 50% flowering, Plant height, No. of tillers/plant, Spike length and Green fodder yield (q/ha)

In case of male sterile line in first date of sowing (9.7.2020), the highest green fodder yield (q/ha) was recorded by ICMA 00444A4 (545 q/ha) followed by ICMA 07999A5 (430 q/ha) while in case of Forage pollinators (OPVs), the highest green fodder yield (q/ha) was recorded by ICMV 05222 (684 q/ha) followed by ICMV 1710 (623 q/ha) (Table 2).

In case of male sterile line in second date of sowing (20.7.2020), the highest green fodder yield (q/ha) was recorded by ICMA 08999A5 (534 q/ha) followed by ICMA 10888A5 (420 q/ha) while in case of Forage pollinators (OPVs), the highest green fodder yield (q/ha) was recorded by ICMV 1615 (400 q/ha) followed by ICMV 1617 (312 q/ha) (Table 3).

Different Hybrids were developed from crossing of Bajra x Bajra and Bajra x Napier on two different dates of sowing

The interspecific hybrids between Bajra x Napier in first date of sowing (16.8.20) were BxN1 (384 q/ha) BxN2 (379 q/ha) and BxN3 (456 q/ha)

The Number of crosses developed between Bajra x Bajra on two different dates of sowing i.e. 16.8.20 and 30.8.20. Altogether six crosses were developed. Out of them, B2xB23 (656 q/ha) recorded highest yield followed by B2xB25 (546 q/ha). In the second date of sowing B6xB12 (634 q/ha) recorded highest yield followed by B2xB23 (578 q/ha) (Table 4).

Table 1: Thin Napier from PAU, Ludhiana

Sl. No.	Characters of Thin Napier from PAU, Ludhiana				
	Days to 50% flowering	Plant height (cm)	No. of tillers/plant	Spike length (cm)	No. of slips obtained
LN 1	61	300.6	22	17.9	25 (II)
LN 2	60	312.8	20	16.8	12
LN 3	60	320.6	23	21.6	28 (I)
Local germplasm	63	280.9	21	18.9	11
Local germplasm	62	306.5	22	16.8	12

Table 2: Yield attributing traits of Male sterile and restorer lines for first date of sowing

Sl. No.	Designation	Days to 50% flowering	Plant height (cm)	No. of tillers/plant	Spike (Z length (cm)	Green fodder yield (q/ha)
Ist D/S: 9.7.2020						
Forage A lines						
1	ICMA 00444A1	42	150.5	3	16.7	320
2	ICMA 00999A1	65	105.8	2	21.4	288
3	ICMA 03222A1	62	85.5	2	16.4	320
4	ICMA 02666A4	69	76.1	3	17.5	375
5	ICMA 00444A4	49	171.4	6	19.5	545 (I)
6	ICMA 02555A5	50	170.1	5	15.1	357
7	ICMA 07999A5	56	124.4	5	20.6	430 (II)
8	ICMA 08999A5	56	124.4	5	20.6	460
9	ICMA 09888A5	42	150.5	3	16.7	320
10	ICMA 10888A5	65	105.8	2	21.4	288
Forage pollinators (OPVs)						
11	ICMV 05222	62	291.4	3	31.4	684 (I)
12	ICMV 05555	60	268.4	4	23.6	379
13	ICMV 05777	61	172	4	21.4	382
14	ICMV 15111	60	232.8	3	22.4	330
15	ICMV 1604	72	238.8	2	20.6	287
16	ICMV 1605	60	228.6	3	19.6	223
17	ICMV 1614	65	256.8	4	22.8	320
18	ICMV 1615	67	204.0	4	18.4	302
19	ICMV 1617	73	249.8	3	20.2	456
20	ICMV 1618	72	263	3	19.2	221
21	ICMV 1620	75	276.2	4	18.8	361
22	ICMV 1701	74	248.4	4	21.8	267
23	ICMV 1702	77	233.4	2	16.8	234
24	ICMV 1703	69	284.4	4	16.6	239
25	ICMV 1707	79	276.8	4	19.6	317
26	ICMV 1710	78	286.8	3	19.8	623
27	ICMV 05222	62	291.4	3	31.4	345 (I)
28	ICMV 1713	72	263	3	19.2	221

Table 3: Yield attributing traits of Male sterile and restorer lines for second date of sowing

Sl. No.	Designation	Days to 50% flowering	Plant height (cm)	No. of tillers/plant	Spike length (cm)	Green Green fodder yield (q/ha)
2nd D/S:20.7.2020						
Forage A lines						
1	ICMA 00444A1	42	150.5	3	16.7	320
2	ICMA 00999A1	65	105.8	2	21.4	288
3	ICMA 03222A1	62	85.5	2	16.4	320
4	ICMA 02666A4	69	76.1	3	17.5	375
5	ICMA 00444A4	55	111.4	5	18.5	418
6	ICMA 02555A5	42	150.5	3	16.7	320
7	ICMA 07999A5	52	103.4	6	14.0	320
8	ICMA 08999A5	49	171.4	6	19.5	534 (I)
9	ICMA 09888A5	50	170.1	5	15.1	357
10	ICMA 10888A5	56	124.4	5	20.6	420 (II)
Forage pollinators (OPVs)						
11	ICMV 05222	61	192.4	3	19.8	270
12	ICMV 05555	60	228.6	3	19.6	223
13	ICMV 05777	65	256.8	4	22.8	320
14	ICMV 15111	67	204.0	4	18.4	302
15	ICMV 1604	60	228.6	3	19.6	223
16	ICMV 1605	65	256.8	4	22.8	320
17	ICMV 1614	67	204.0	4	18.4	302
18	ICMV 1615	60	268.4	4	23.6	400
19	ICMV 1617	61	172	4	21.4	312
20	ICMV 1618	60	232.8	3	22.4	330
21	ICMV 1620	72	238.8	2	20.6	287
22	ICMV 1701	61	192.4	3	19.8	270
23	ICMV 1702	60	228.6	3	19.6	223
24	ICMV 1703	75	276.2	4	18.8	361
25	ICMV 1707	74	248.4	4	21.8	267
26	ICMV 1710	77	233.4	2	16.8	234
27	ICMV 1711	69	284.4	4	16.6	239
28	ICMV 1713	79	276.8	4	19.6	317

Table 4: Hybrids developed from crossing of Bajra x Napier and Bajra x Bajra

Sl. No	Days to 50% flowering	Plant height (cm)	No. of tillers/plant	Spike length (cm)	Green fodder yield (q/ha)
First D/S:16.8.20					
Bajra x Napier					
B X N1	61	172	4	21.4	384 (II)
B X N2	60	268.4	4	23.6	379
B X N3	73	249.8	3	20.2	456 (I)
Bajrax Bajra					
1x19	52	103	6	14	267
2x13	49	171	6	19.2	345
2x14	50	16.8	5	15	356
2x23	60	268.4	4	23.6	656 (I)
2x25	42	150.2	3	16.7	546
Second D/S:30.8.20					
1x16	62	291.4	3	31.4	567
2x12	60	268.4	4	23.6	589
2x13	61	172	4	21.4	456
2x14	60	232.8	3	22.4	234
2x21	72	238.8	2	20.6	456
2x23	61	192.4	3	19.8	578 (III)
5x14	67	204.0	4	18.4	456
6x12	73	249.8	3	20.2	634 (II)
9x13	72	263	3	19.2	347

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