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Short communication

Identification of pearl millet (*Pennisetum glaucum* (L.) R. Br.) germplasm with unique popping quality in the national genebank collections of India

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Abstract

Popping is an important trait that can add to commercial value of pearl millet for utilization as nutrition rich and low cost popped snacks. The purpose of the present study is to evaluate and identify possible donor for this novel trait in Indian pearl millet germplasm conserved in the national genebank. The study revealed sufficient variability for this trait in the landraces as well as improved genotypes. Positive association between expansion ratio and pop size suggested feasibility to develop germplasm combining both the attributes. The identified promising accessions (IC283734, IC283908 and IC283744) for the popping trait may be utilized in future breeding programme for introgression of popping trait into elite cultivars.

Key words: Pearl millet, *Pennisetum,* germplasm, popping, puffing, box plot, correlation

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is cultivated in a diverse environmental conditions including environments with frequent drought events and poor soil fertility. At global level, it is the fifth most important cereal crop after rice, wheat, maize and sorghum. India ranks first both in terms of area (9.3 m ha) and production (9.3 m t), with an average productivity of 1044 kg/ha (Agricorp.nic.in/ agristatistics.htm). The trends in area, production and productivity of pearl millet suggest that the area has increased marginally (2%) during the last two years while productivity has gone up by 19% (Yadav 2001).

The pearl millet grain has higher protein and fat content than wheat or rice and its amino acid composition is more appropriate for human nutrition than that of wheat or polished rice. It is rich in vitamin B-complex, potassium, phosphorus, magnesium, iron, zinc, copper and manganese. Pearl millet is a rich source of energy (361 kcal/100g) which is comparable with commonly consumed cereals such as wheat (346 kcal/100g), rice (345 kcal/100g), maize (125 kcal/100g) and sorghum (349 kcal/100g) (Anonymous 2003). Its grains are gluten-free, but have some inherent anti-nutritional factors, like phytic acid, polyphenols etc. Being the important food for marginal and poor farmers its utility can be enhanced through diversified food. Although maize is the most popular cereal that can be popped but there are several other crops like sorghum and rice (Murgesan and Bhattacharya 1986; Murty et al. 1986; Li et al. 2004) that make a nourishing and light popped snack and promises to add value to underutilized crops for resource poor farmers. Therefore, popping trait is a potential area to be studied in the case of pearl millet as these grains can also be popped. Therefore, the present study was aimed to evaluate and search the unique germplasm/genetic stock for popping trait, so that the novel germplasm can be used for genetics study as well as trait introgression into elite cultivars.

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National Bureau of Plant Genetic Resources (NBPGR) maintains 8,913 accessions of pearl millet under long-term conservation in the national genebank (NGB). These accessions are being characterized and evaluated in phased manner for agronomic and trait specific evaluation so that the trait specific germplasm can be utilized in crop improvement programme. A total of 224 germplasm from NGB were characterized and evaluated in augmented block design during *kharif* 2011. Among these, 24 diverse pearl millet germplasm accessions were selected for analysing popping characteristics along with 8 improved parental lines, 3 hybrids (Pusa605, Pusa415, Pusa322) and 4 composites (PC443, Pusa612, Pusa322 and Pusa621) in collaboration with the Division of Post Harvest Technology, Indian Agricultural Research Institute, New Delhi. The pearl millet germplasm belonged to Andhra Pradesh (Sodha, Jawari Sodha, Bohu Sodha and Punasa Ganti landraces), Rajasthan, Karnataka (Sajje landrace) and Gujarat (Gantlu landrace).

Optimum processing conditions (Patel 2011) used for popping were: 16% moisture content, 4 h tempering time and 270-280°C popping temperature. The important popping characteristics like popping yield (Malleshi and Desikacher 1981), puffing index and expansion ratio were determined as given below.

$$\text{Popping yield (\%)} = \frac{\text{Weight of popped grains}}{\text{Weight of sample (popped + unpopped) grains}} \times 100$$

Puffing index was calculated as the ratio of the bulk density of the raw material and the bulk density of the product (Hoke et al. 2007). Higher puffing index indicates higher volume of the product. Expansion ratio was determined as the ratio of size of popped grain to the size of raw grain (Mariotti et al. 2006). Statistical analysis was done using SAS Macro developed by IASRI, New Delhi for augmented design analysis. Pearson correlation coefficient analysis and Box Plot analysis was performed using IBM SPSS Statistics software package.

Our study aimed to study variability for the popping related attributes in the pearl millet genotypes which showed significant difference in popping yield, puffing index, expansion ratio and popped size. The popping yield of genotypes varied from 48.23 to 83.82% with mean performance of 64.90%, puffing index from 5.37 to 10.55 with mean value of 8.21, popped size from 4.36 to 8.84 mm with mean value of 6.19 mm and expansion ratio from 2.12 to 3.95 with mean value of 2.57 (Table 1). The Pearson correlation coefficient was estimated to analyze the relationship between popping attributes. Popping yield was positively and significantly correlated with puffing index (0.569). Puffing index was significantly correlated with expansion ratio (0.445) and popping size (0.468) in positive direction and the correlation was high 0.629 between expansion ratio and popping size. Further as phenotypic selection for popping expansion and other related traits is laborious and time consuming, selection for popping yield will be easy with indirect selection of genotypes with increased puffing index. The positive association between expansion ratio and pop size suggested the feasibility to develop germplasm combining both attributes together.

Table 1. Mean, range, CV and promising genotypes/germplasm accessions for different traits

Trait	Mean	Range	CV(%)	Promising accessions
Popping yield (%)	64.90	48.23-83.82	14.02	K-560-230, 841-B, IC283908, IC283734, PPMI301, IC283763, IC283842, IC283745 (>70%)
Puffing index	8.21	5.37-10.55	14.58	IC283908, IC283734, IC332715, IC283847, Pusa415, IC283763, IC312753, IC283763, IC312753 (>9.0)
Expansion ratio	2.57	2.12 - 3.95	16.52	IC312753, IC283744, IC283893, Pusa 605, IC283734, PC443 (>3.0)
Pop size (mm)	6.19	4.36-8.84	16.62	IC283737, IC283734, IC283681, IC283908, IC312753, IC284848, IC283847, IC283744 (>7 mm)
Yield per plant (g)	75.64	33.45-169	23.34	IC283737, IC306463 (>150)
Seed size (g)	12.60	10.10-16.50	8.31	IC283734, IC283681, IC283692, IC283693, IC283842, IC283848, IC332715 (>14.00)
Spike length (cm)	23.72	14.03-41.30	20.20	IC283847, IC283842, IC283693, IC283734 (> 24)
Spike girth (cm)	2.30	1.32-3.35	15.94	IC 283692, IC 283737, IC283692, IC283693, IC283847 (>2.5)

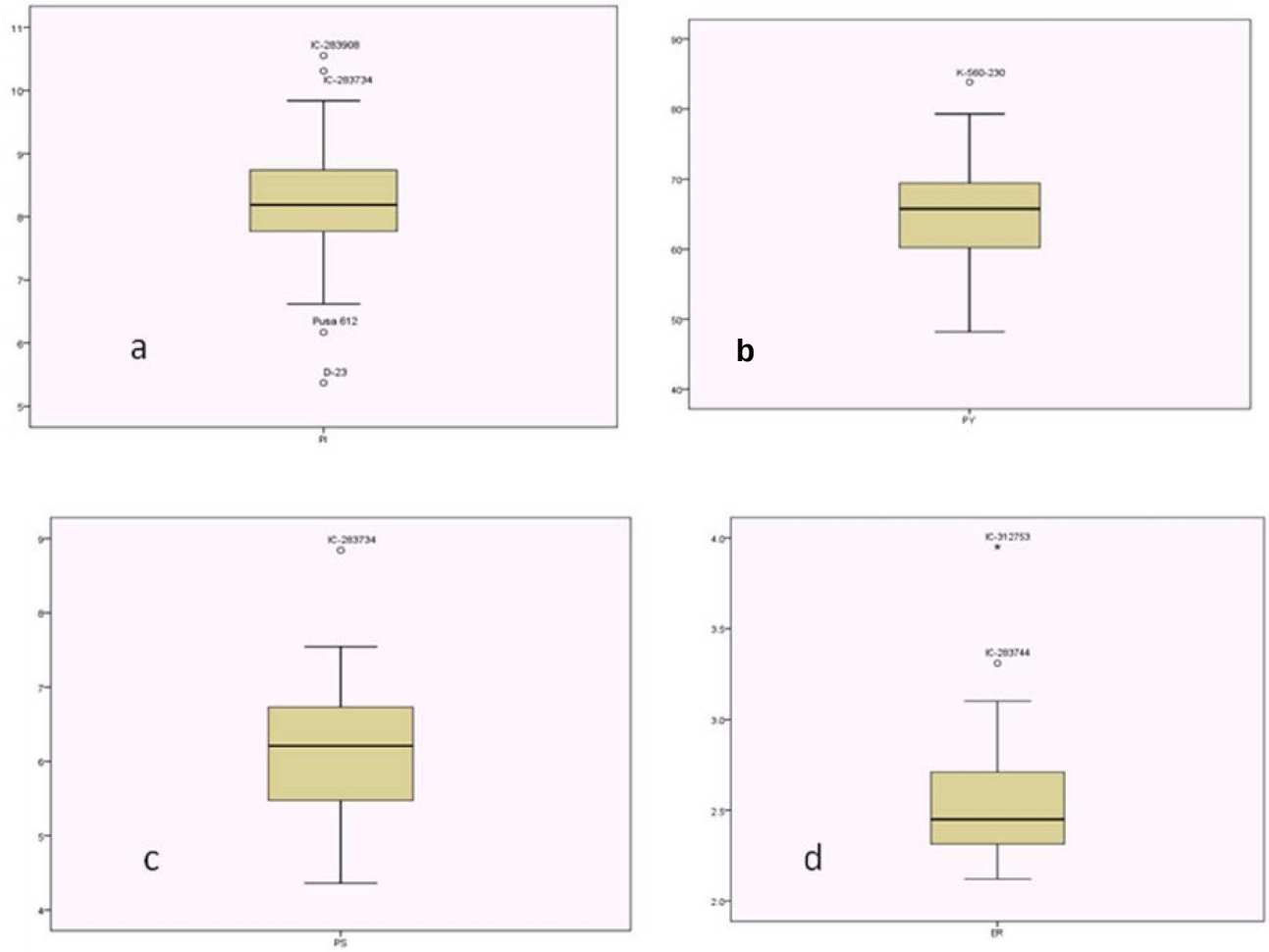

Fig. 1. Box plot depicting variation in popping traits; a = popping size, b = popping yield, c = puffing index and d = expansion ratio

Based on the size of the popped grains, the germplasm lines/varieties were categorized into 4 classes (>7 mm, 6-7 mm, 5-6 mm, and <5 mm). Eight germplasm lines namely, IC283737, IC283734, IC283681, IC283908, IC312753, IC284848, IC283847, IC283744 yielded in the highest popped size of more than 7 mm. Popping yield of these varieties/germplasm lines varied from 48.23 to 83.82%. The varieties/ germplasm lines were also categorized into 4 classes based on popping yield as <50%, 50-60%, 60-70% and >70%. Eight germplasm lines /varieties (*viz*., IC283734, IC283745, IC283763, IC283842, IC283908, 841B, K-560-230, PPMI301 had popping yield more than 70%. Similarly, based on puffing index too, 4 categories were made (<6, 67.5, 7.5-9, >9) and nine were having puffing index more than 9 (IC283734, IC283744, IC312753, IC283763, IC283847, IC283908, IC332715, Pusa605, Pusa415).

A close observation of the results revealed that IC283734, IC283908 were common in all classes with maximum popping trait (popped size >7, popping yield >70% and puffing index >9) whereas IC283744 had higher popped size and puffing index. The germplasm accession IC283734 had popped size of 8.84 mm, expansion ratio of 3.07 and popping yield of 76.23%. This accession also had early maturity (80 days), grain weight 14.3 g, spike length of 24 cm and spike girth of 2.5 cm. The box plot analysis also depicted the range of variation for the traits. It showed that accession IC283734 had high popping size and puffing index (Fig. 1). Similarly, accession IC283744 and IC312753 had significant and higher expansion ratio, K560-230 had high popping yield. For puffing index, accessions IC283734 and IC283908 may be used as donor parent and Pusa612 and D23 as recipient parent in genetics and inheritance study for this trait. These accessions can also be used for introgression of popping trait into

elite cultivars and gene discovery.

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