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Phenotypic and molecular diversity-based prediction of heterosis in pearl millet (*Pennisetum glaucum* L. (R.) Br.)

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Abstract: Genetic distances between hybrid parents based on phenotypic traits and molecular markers were investigated to assess their relationship with heterosis for grain and stover yield and other traits in pearl millet (*Pennisetum glaucum* [L.] R. Br.). Fifty-one hybrids developed using 101 hybrid parents (B and R lines) and showing a wide range of genetic distance between their parents based on eight phenotypic traits and 28–38 SSRs were evaluated in two sets for two seasons. The correlation between Euclidean distance (phenotypic distance, ED) and simple matching distance (molecular distance, SM) for parents of both sets was low but positive and significant (r = 0.2, P < 0.001).The correlation of ED in parents with better-parent heterosis for grain yield was similar in both sets (r = 0.38, P < 0.05). SM was not correlated with heterosis for grain yield in either set of hybrids. The results showed that phenotypic distance could be a better predictor of heterosis than molecular distance. The correlation between phenotypic distance and heterosis was not strong enough to permit the use of phenotypic diversity among parents as a major selection criterion for selection of parental lines displaying high levels of heterosis for grain and stover yield in pearl millet.

Keywords: Hybrid parents; Agronomic traits; Euclidean distance; Molecular markers; Simple matching distance

1 Introduction

Pearl millet (*Pennisetum glaucum* [L.] R. Br.) is a major food and fodder crop for farmers living on marginal agricultural lands in the arid and semi-arid tropics of Africa and Asia (largely India). Its grain serves as staple food and its stover is equally important for livestock in these marginal economies. In India, pearl millet breeding programs have been developing hybrids since the 1960s, and hybrids presently occupy about 5 Mha of the total of more than 8 Mha under cultivation, especially in higher-yielding environments. Hybrid adoption contributed to a crop productivity increase from 288 kg ha^{-1} during 1951–1955 to 1164 kg ha^{-1} during 2013–2014, registering an improvement of about 300% for pearl millet in India [1]. Although this order of productivity gain is quite impressive for a crop grown under low-input conditions in marginal environments, greater advances are possible if hybrids are developed based on heterosis prediction using parental information for genetic diversity. The level of genetic diversity between parents has been proposed as a predictor of F_1 hybrid performance and heterosis [2, 3]. This predictive method may help to identify more heterotic combinations, thus reducing costs associated with making crosses and field evaluation to select promising hybrids.

Conflicting results with respect to the relationship between genetic distance and heterosis have been reported in various crops. Some earlier work is in agreement with the classical theories of heterosis; Zhang et al. [4] in rice

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