Research Note
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ASSOCIATION OF GRAIN IRON CONTENT WITH GRAIN YIELD AND OTHER TRAITS IN SORGHUM (*Sorghum bicolor* L. Moench)

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Sorghum (*Sorghum bicolor* L. Moench), the fifth most important cereal crop in the world after wheat, maize, rice and barley, is a major cereal staple food and forage crop of the semi-arid tropics of Indian sub-continent and several African regions. In Andhra Pradesh, it covers an area of 0.28 m ha with an annual production of 0.44 m t and productivity of 1420 kg ha^{-1} (CMIE, 2009). Sorghum is the second cheapest source of energy in the form of starch (63.4 - 72.5 %) and micronutrients such as iron (Fe) and zinc (Zn) after pearl millet.

In order to realize the potential impact of the micronutrient-dense cultivars, the high-yielding varieties / hybrids with farmer's preferred traits such as early maturity and large seed size coupled with increase in micronutrient concentration in grain must be made available for commercial cultivation (Kumar *et al*., 2010). Information about the association of micronutrients such as grain iron with grain yield and other important traits can help the breeders to devise a suitable breeding strategy for enhancing micronutrient density in sorghum cultivars. However, limited information is available on the character association of grain iron content with grain yield and other important traits and also the direct and indirect effects of grain yield and other important traits on grain iron content. Hence, an attempt was made in the present investigation to analyse and determine the traits having greater interrelationship with grain iron utilizing correlation and path analysis.

The present investigation was carried out using four parental lines (IS 2263, IS 13211, IS 10305 and SPV 1359) and 12 hybrids generated by crossing the parents in a full-diallel fashion during *postrainy* season, 2011-12 in Randomized Block Design (RBD) with three replications under high fertility conditions (80 N : 40 P) on vertisols at ICRISAT farm in Patancheru, located at an altitude of 545 m above mean sea level, latitude of 17.53° N and longitude of 78.27° E. Each genotype was grown in four rows of 2 m length with 75 cm spacing between the rows and 10 cm between the plants. All the recommended agronomic practices were followed for raising a good crop. The data were recorded on four important traits *i. e.*, plant height, days to 50 % flowering, 100-grain weight and grain yield. The cleaned seeds of each genotype were used to measure the iron content with Oxford X-supreme 8000 model X-ray flourescence analyzer (XRF). Correlation coefficients were calculated at phenotypic level using the formulae suggested by Falconer (1981). The direct and indirect effects at phenotypic level were estimated by taking grain iron content as dependent variable, using path coefficient analysis as suggested by Dewey and Lu (1959).

In the present investigation, plant height, 100-grain weight and grain (Table 1) exhibited non-significant and lower magnitude of negative association with grain iron, while days to 50 % flowering showed non-significant positive correlation with grain iron content. Plant aspect score recorded significant positive correlation with grain iron content. Reddy *et al.* (2005) earlier obtained statistically significant negative but a rather weaker correlation of grain iron content with grain yield and poor association of agronomic traits such as days to 50 % flowering and plant height with grain iron content and indicated the possibility of developing micronutrient-dense cultivars in desired maturity duration and plant height background with little compromise in grain yield. Reddy *et al.* (2010) also reported weak association of grain iron with agronomic

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Table 1. Phenotypic correlation co-efficient matrix of grain iron content with grain yield and other traits

Character	Plant height	Days to 50 % flowering	Plant aspect score	100-grain weight	Grain yield	Correlation with grain iron
Plant height	1.000	0.377**	-0.696**	0.877**	0.811**	-0.133
Days to 50 % flowering		1.000	-0.191	0.370**	0.472**	0.224
Plant aspect score			1.000	-0.757**	-0.767**	0.372**
100-grain weight				1.000	0.901**	-0.097
Grain yield					1.000	-0.177
Grain iron						1.000

* indicates significance at 5 % probability *i.e.*, r=>0.2845

** indicates significance at 1 % probability *i.e.*, r=>0.3683

Table 2. Phenotypic path matrix showing direct and indirect effects of various agronomic traits on grain iron

Character	Plant height	Days to 50 % flowering	Plant aspect score	100-grain weight	Grain yield	Correlation with grain iron
Plant height	**-0.167**	0.125	-0.366	0.651	-0.376	-0.133
Days to 50 % flowering	-0.063	**0.331**	-0.101	0.275	-0.219	0.224
Plant aspect score	0.116	-0.063	**0.526**	-0.562	0.356	0.372**
100-grain weight	-0.146	0.123	-0.398	**0.743**	-0.418	-0.097
Grain yield	-0.135	0.157	-0.403	0.670	**-0.464**	-0.177

Residual effect = 0.836

and grain traits indicating possible positive outcomes from breeding for high grain iron content in varied agronomic backgrounds. The non-significant correlation of 100-grain weight with grain iron content in pearl millet populations was earlier reported by Gupta *et al.* (2009), who further indicated that breeding for higher levels of micronutrients could be achieved without compromising the improvement for larger grain size. They also obtained negative correlation between seed yield and iron content in pearl millet populations indicating that selection for iron can be accomplished without compromising on grain yield. Banziger and Long (2000) found negative correlation of grain iron content with grain yield in maize. The non-significant association of iron content with grain yield in rice was earlier reported by Nagesh *et al.* (2012).

Out of the five traits taken for path analysis, 100-grain weight had maximum positive direct effect (0.743) on the grain iron content followed by plant aspect score (0.526) and days to 50 % flowering (0.331), while, grain yield and plant height showed negative direct effects on the grain iron content (Table 2). All the characters studied in the present investigation showed positive indirect effect through 100-grain weight and days to 50 % flowering indicating that direct selection for grain size might be helpful in improving the grain iron content. Negative indirect effects of 100-grain weight through other characters were more prominent than its positive direct effect on the grain iron content thus resulting in its negative correlation with grain iron content and in such a situation direct selection for grain weight should be practiced to reduce the undesirable indirect effect. Days to 50 % flowering exhibited a positive direct effect and a positive non-significant association with grain iron content. Hence selection for this trait may be rewarding during the development of iron rich cultivars in sorghum. A very high residual effect (0.836) revealed that some more characters closely related with grain iron content need to be included apart from the characters studied in this investigation.

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