Research Note
The J.Res. ANGRAU 42(1) 77- 80, 2014

ASSOCIATION STUDIES OF GRAIN IRON AND ZINC CONCENTRATIONS WITH YIELD AND OTHER AGRONOMIC TRAITS USING F_2 POPULATIONS OF TWO CROSSES IN SORGHUM (*Sorghum bicolor* L. Moench)

K.T. RAVI KIRAN, K. RADHIKA, A. ASHOK KUMAR AND V. PADMA
Department of Genetics and Plant breeding, College of Agriculture,
Acharya N.G Ranga Agricultural University, Rajendranagar, Hyderabad-500 030

Date of Receipt : 12.06.2013 Date of Acceptance : 26.11.2013

Micronutrient malnutrition affects more than one-half of the world's population, especially women and pre-school children (Nestel *et al*., 2006). World Health Organization (WHO) of the United Nations estimated that mal nutrition is an underlying cause of 53% of all deaths in children under five years of age and recognized that the two micronutrients iron and zinc and pro-vitamin A (â-carotene) are limiting (Ma *et al*., 2008). Sorghum [*Sorghum bicolour* (L.) Moench], being the staple food and fodder crop in parts of semi-arid region of the world and the second cheapest source of energy (63.4 - 72.5 % starch) and micronutrients such as iron (Fe) and zinc (Zn) after pearl millet, if enriched with iron and zinc concentrations, can address the micronutrient requirements of the undernourished populations. Moreover, the poor and vulnerable groups in the society, particularly in India depend upon sorghum for their calorie and micronutrient requirement in the absence of access and affordability to nutrient-rich foods like vegetables, fruits and animal products. A study on association of grain iron and zinc concentrations with agronomic traits is needed to help the breeder in devising a suitable breeding strategy for the enhancement of micronutrient density in sorghum. Hence, this study was undertaken at ICRISAT, Patancheru with an aim to analyze the relationships of grain iron and zinc concentrations with grain yield and other agronomic traits in sorghum.

The experimental material consisted of F_2 populations of two crosses IS13205 x SPV1359 and IS13205 x IS23464, which were selected based on diallel analysis carried out previously involving parents with diverse levels of grain iron and zinc concentrations. The two populations were evaluated during *post rainy* season, 2012-13 at ICRISAT, Patancheru. Each population was grown in eight rows of 2 m length with a spacing of 75 cm between rows and 10 cm between the plants making the plot size of 1.5 m^2. Two seeds were planted/hill and thinned later to single seedling/hill to obtain a population stand of nearly 120 plants in each population. The populations were control pollinated by selfing (by bagging the panicles before they shed the pollen/ stigmas come out).

The crop was supplied with a fertilizer dose of 80 kg N and 40 kg P_2O_5 per hectare and nitrogen was applied in three split doses. Recommended and usual cultural practices were adopted to raise a good crop. Data were recorded on plant height, panicle length, panicle width, grain yield plant^{-1} and 100 grain weight on 50 randomly selected plants in each population. Micronutrient analysis was done using the selfed seed of 50 panicles of each population by ICP-OES method. Precautions were taken at each step to avoid contamination of grain with dust particles and any other extraneous matter. Simple correlation coefficients were calculated using the formulae given by Falconer (1981).

In the present study, the segregating population i.e., F_2 of two crosses was utilized for calculation of correlation coefficients between the traits for each cross separately. The correlation matrix of various agronomic traits with grain iron and zinc concentrations is presented in the Table 1. In the cross IS13205 x SPV1359, panicle length showed significant positive correlation with panicle width (r = 0.651), grain yield plant^{-1} (r = 0.425) and grain zinc concentration (r = 0.328). However, the correlation was strong with panicle width and weaker with grain zinc concentration as indicated by the correlation coefficient estimates. Grain iron concentration showed highly significant positive correlation with grain zinc concentration (r = 0.538).

email: rkravikirankt@gmail.com

Table 1. Simple correlation matrix of grain iron and zinc concentrations with other agronomic traits in F_2 progenies of two crosses of sorghum during *rabi*, 2012 at ICRISAT.

	Plant height (cm)	Panicle length (cm)	Panicle width (cm)	Grain yield plant^{-1} (g)	100 grain weight (g)	Grain iron concentration (mg kg^{-1})	Grain zinc concentration (mg kg^{-1})
IS13205 x SPV1359							
Plant height (cm)	1.000	0.116	0.008	0.172	0.197	-0.227	-0.023
Panicle length (cm)		1.000	0.651**	0.425**	-0.006	0.094	0.328*
Panicle width (cm)			1.000	0.135	-0.025	-0.105	0.062
Grain yield plant^{-1} (g)				1.000	0.142	0.181	0.127
100 grain weight (g)					1.000	-0.053	-0.199
Grain iron concentration (mg kg^{-1})						1.000	0.538**
Grain zinc concentration (mg kg^{-1})							1.000
IS13205 x IS23464							
Plant height (cm)	1.000	0.179	0.024	0.179	0.042	0.267	0.266
Panicle length (cm)		1.000	0.242	0.093	0.005	0.007	0.008
Panicle width (cm)			1.000	0.161	-0.102	0.099	0.057
Grain yield plant^{-1} (g)				1.000	-0.390*	0.083	0.002
100 grain weight (g)					1.000	0.133	0.165
Grain iron concentration (mg kg^{-1})						1.000	0.753**
Grain zinc concentration (mg kg^{-1})							1.000

** – significant at 1 % level of probability *i.e.*, r= 0.40262

* – significant at 5 % level of probability *i.e.*, r= 0.31198

In the cross IS13205 x IS23464, grain yield plant^{-1} showed significant negative correlation with 100 grain weight (r = -0.390) whose magnitude was less. As in the previous cross, grain iron concentration showed highly significant positive correlation with grain zinc concentration (r = 0.753). Similar results of significant positive correlation coefficient between grain iron and zinc concentrations was also obtained by Graham and Welch (1996) in general, Kumar *et al*. (2010) and Gayathri *et al*. (2012) in sorghum, Nagesh *et al*. (2012) in rice, Feng *et al*. (2011) in wheat, Govindraj *et al.* (2013) in pearl millet, Chakraborthi *et al*. (2011) in maize. Highly significant positive correlation between grain iron and zinc concentrations indicated the possibility of simultaneous improvement of both the traits. This might be due to co-segregation of tightly linked genetic stocks governing the physiology of these micronutrients or might be due to the pleiotropic effect of genes.

No correlation of 100 grain weight and grain yield plant^{-1} with grain iron and zinc concentrations indicated that there would be no penalty on grain yield and seed size while breeding for grains rich in these micronutrients. Absence of association of grain iron and zinc concentrations with grain yield plant^{-1} was also observed by Nagesh *et al*. (2012) in rice, Chakraborthi *et al*. (2011) in maize and Gupta *et al*. (2009) in pearl millet. Similarly, no correlation of test weight with grain iron and zinc concentrations was also recorded by Gupta *et al*. (2009) in pearl millet and Wang *et al*. (2011) in wheat. However, negative correlation between grain yield plant^{-1} and grain iron and zinc concentrations was earlier reported by Wang *et al*. (2011) in wheat, Anandan *et al*. (2011) in rice and Kumar *et al*. (2009) in sorghum. Hence there is a need to further confirm the results of present study by using various types of populations such as inbreds, hybrids and OPVs.

REFERENCES

Anandan, A., Rajiv, G., Eswaran, R and Prakash, M. 2011. Genotypic variation and relationships between quality traits and trace elements in traditional and improved rice (*Oryza sativa* L.) genotypes. Journal of Food Science. 76 (4): 122-130.

Chakraborthi, M., Prasanna, B.M., Hossain, F and Anju M.S. 2011. Evaluation of single cross Quality Protein Maize (QPM) hybrids for kernel iron and zinc concentrations. Indian Journal of Genetics and Plant Breeding. 71 (4): 312-319.

Falconer, D.C. 1981. An introduction to quantitative genetics. Longman, New York. 67-68.

Feng, X.Y., Xing, X.H and Guo, A.D. 2011. Identification of germplasm with enriched micronutrients of wild emmer and progeny of wild emmer × common wheat. Chinese Journal of Eco-Agriculture. 19 (5): 1205-1209.

Gayathri, S.P.V.L., Radhika, K., Kumar, A.A and Janila, P. 2012. Association of grain iron and zinc content with grain yield and other traits in sorghum (*Sorghum bicolour* L. Moench). The Journal of Research, ANGRAU. 40 (3): 105-107.

Govindaraj, M., Rai, K.N., Shanmugasundaram, P., Dwivedi, S.L., Sharawat, K.L., Muthaiah, A.R and Rao, A.S. 2013. Combining ability and heterosis for grain iron and zinc densities in pearl millet. Crop Science. 53: 507-517.

Graham, R.D and Welch, R.M. 1996. Breeding for staple food crops with high micronutrient density. Agricultural strategies for micronutrients. Working paper 3. International Food Policy Research Institute, Washington, D.C., USA.

Gupta, S.K., Velu, G., Rai, K.N and Sumalini, K. 2009. Association of grain iron and zinc content with grain yield and other traits in pearl millet (*Pennisetum glaucum* (L.) R. Br.). Crop Improvement. 36 (2): 4-7.

Kumar, A.A., Reddy, B.V.S., Ramaiah, B., Reddy, P.S., Sahrawat, K.L and Upadhyaya, H.D. 2009. Genetic variability and plant trait association of grain Fe and Zn in selected core collection accessions of sorghum germplasm and breeding lines. Journal of SAT Agricultural Research. 7: 1-4.

Kumar, A.A., Reddy, B.V.S., Sahrawat, K.L and Ramaiah, B. 2010. Combating micronutrient malformation: Identification of commercial sorghum cultivars with high grain iron and zinc. SAT e Journal. 8: 1-5.

Ma, G., Jin, Y., Li, Y., Zhai, F., Kok, F.J., Jacobsen, E and Yang, X. 2008. Iron and zinc deficiencies in China: what is a feasible and cost-effective strategy?. Public Health Nutrition. 11 (6): 632-637.

Nagesh, Ravindrababu,V., Usharani, G and Reddy, T.D. 2012. Grain iron and zinc association studies in rice (*Oryza sativa* L.) F_1 progenies. Archives of Applied Science Research. 4 (1): 696-702.

Nestel, P., Bouis, H.E., Meenakshi, J.V and Pfeiffer, W. 2006. Biofortification of staple food crops. The Journal of Nutrition. 136: 1064-1067.

Wang, S., Yin, L., Tanaka, H., Tanaka, K and Tsujimoto, H. 2011. Wheat-*Aegilops* chromosome addition lines showing high iron and zinc contents in grains. Breeding Science. 61: 189-195.