

HETEROSIS AND COMBINING ABILITY FOR GRAIN Fe AND Zn CONTENT IN PEARL MILLET (*Pennisetum glaucum* L. R. Br.)

LADUMOR, V. L.; *MUNGRA, K. D. AND SORATHIYA, J. S.

DEPARTMENT OF GENETICS AND PLANT BREEDING
JUNAGADH AGRICULTURAL UNIVERSITY
JUNAGADH – 362 001, GUJARAT, INDIA

**EMAIL: kdmungra@jau.in*

ABSTRACT

Pearl millet is short day, warm weather plant grown primarily for the grain production in the arid and semi-arid regions of Asia and Africa. Iron and zinc deficiencies have been reported to be a food related primary health problem affecting nearly two billion people worldwide. The experimental materials were comprised four testers (females), seven inbred lines (males) of pearl millet, their 28 hybrids and two standard checks (GHB 732 and Dhansakti). The experiment was conducted at Pearl Millet Research Station, Junagadh Agricultural University, Jamnagar in kharif 2017. The cross ICMA₁ 10222 x 130-SB-17 showed the highest heterobeltiosis over better parent in desirable direction and also recorded significant sca effect for the Fe and Zn content in pearl millet. The female ICMA₁ 12444 was identified as good general combiner for Fe and Zn content in pearl millet.

KEY WORDS: *gca, Heterobeltiosis, Fe, sca, Zn*

INTRODUCTION

Micronutrient malnutrition has been designated as the most serious world's population is at risk of deficiency in one or more essential mineral elements (White and Broadley, 2009; Stein, 2010). The concern is more crucial for developing countries, especially in children, given that the statistics of malnutrition in these countries are high. More than half of the total populations in developing countries are reported to be affected by micronutrient deficiency and therefore are more susceptible to infections and impairment of physical and psycho-intellectual development (Anon., 2005). The mineral elements most commonly lacking in human diets are iron (Fe) and zinc (Zn) (White and Broadley, 2009; Stein, 2010), whereas vitamin A and other essential minerals such

as Calcium (Ca), Copper (Cu), Magnesium (Mg), and Iodine (I) can be deficient in some population's diets as well (Genc *et al.*, 2005). These deficiencies are caused by habitual diets that lack diversity (over dependence on a single staple food); situations of food insecurity, where populations do not have enough to eat (Anon., 2002); and low intake of vegetables, fruits and animal & fish products that are rich sources of minerals. The widespread deficiencies of Fe and Zn in developing countries are mostly due to monotonous consumption of cereal-based foods with low concentration and reduced bioavailability of Fe and Zn (Graham *et al.*, 2001).

MATERIALS AND METHODS

The experimental material for the present investigation comprised of four testers (females) obtained from ICRISAT

and PMRS viz., ICMA₁ 10222, ICMA₁ 12444, JMSA₅ 20155, JMSA₅ 20171 and seven inbred lines (males) developed at PMRS viz., 54-SB-17, 118-SB-17, 127-SB-17, 128-SB-17, 130-SB-17, 153-SB-17 and 160-SB-17. The material was obtained from Pearl Millet Research Station, JAU, Jamnagar. The checks included in this experiment were GHB-732 (for yield) and Dhanshakti (for Fe and Zn content). All the lines were crossed with four testers in Line x Tester (L x T) mating design to obtain 28 cross combinations. Evaluation of single cross hybrids, parents and checks were done in the *Kharif*, 2017. The iron and zinc was analyzed at ICRISAT using a X- rays fluorescence spectrometry (XRF) machine. The heterobeltiosis and standard heterosis were estimated as per the procedure given by Fonseca and Patterson (1968) and Meredith and Bridge (1972), respectively. The analysis for the combining ability was carried out as the method of Kempthorne (1957).

RESULTS AND DISCUSSION

Estimation of HB and SH

Fe content

In the present investigation, out of 28 crosses, four crosses showed significant and positive heterosis over better parent, while none of the cross showed positive and significant heterosis over standard check for Fe content. The range of heterobeltiosis was from -27.04 per cent (JMSA₅ 20155 x 160-SB-17) to 27.03 per cent (JMSA₅ 20155 x 54-SB-17). The highest heterobeltiosis was recorded by the cross JMSA₅ 20155 x 54-SB-17 (27.03 %) followed by ICMA₁ 10222 x 130-SB-17 (24.19 %) and ICMA₁ 12444 x 128-SB-17 (17.70%) (Table 1).

Zn content

In the present investigation, out of 28 crosses, two crosses ICMA₁ 10222 x 130-SB-17 (13.76 %) and ICMA₁ 12444 x 127-SB-17 (9.77 %) showed significant and positive heterosis over better parent, while

none of the cross showed significant and positive heterosis over standard check for Zn content. The range of heterobeltiosis was from -21.80 per cent (ICMA₁ 10222 x 118-SB-17) to 13.76 per cent (ICMA₁ 10222 x 130-SB-17) (Table 1).

Combining ability

Gene action

The mean squares due to lines x testers were significant revealing the importance of non-additive type of gene actions for the expression of Fe content (Table 2). The preponderance of non-additive gene action for Fe content has been reported by Arulselvi *et al.* (2009), Govindaraj (2011), Kanatti *et al.* (2014). The significance of mean squares due to male (lines) suggested the additive type of gene actions for the expression of Zn content. The preponderance of additive gene action for Zn content has been reported by Jeeterwal *et al.* (2017).

gca and sca effects

One female (ICMA₁ 12444) showed significant positive gca effect for Fe and Zn content. This parent was, thus, identified as good general combiners for Fe and Zn content. One male (127-SB-17) were good general combiner for Zn content. The results indicated that these genotypes possessed desirable genes for Fe & Zn content and can be effectively utilized in breeding programme aimed at developing desirable lines in pearl millet. Out of 28 crosses, three crosses showed significant and positive sca effects for Fe content. The highest positive and significant sca effect was exhibited by the cross JMSA₅ 20155 x 54-SB-17 followed by ICMA₁ 10222 x 130-SB-17 and JMSA₅ 20171 x 160-SB-17 (Table 1). Four crosses showed significant and positive sca effect for the Zn content. The highest positive and significant sca effect was exhibited by the cross ICMA₁ 10222 x 130-SB-17 followed by JMSA₅ 20171 x 160-SB-

17, JMSA₅ 20155 x 54-SB-17 and ICMA₁ 12444 x 128-SB-17.

CONCLUSION

Considerable amount of heterobeltiosis and significant sca effect was observed in cross ICMA₁ 10222 x 130-SB-17 for Fe and Zn content and therefore, this cross could be exploited further for obtaining desirable types for Fe and Zn content in pearl millet. The female ICMA₁ 12444 was identified as good general combiners for Fe and Zn content could be included in the hybridization programme for increasing Fe and Zn content.

REFERENCES

- Anonymous. (2002). Reducing Risks and Promoting Healthy Life. The World Health Report 58. World Health Organization, Geneva.
<http://www.who.int/whr/2002/en/> accessed on dated 15th May, 2017.
- Anonymous. (2005). World Health Report: Make every mother and child count. World Health Organization, Geneva.
<http://www.who.int/whr/2002/en/> accessed on dated 15th May, 2017.
- Arulselvi, S.; Mohanasundaram, K. and Selvi, B. 2009. Genetic analysis of grain quality characters and grain yield in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Crop Res.*, **37**(1/3): 161-167.
- Fonseca, S. and Patterson, F. L. (1968). Hybrid vigour in seven parental diallel cross in common winter wheat (*Triticum aestivum* L.). *Crop Sci.* **8**(1): 85-88.
- Genc, Y.; Humphries, J. M.; Lyons, G. H. and Graham, R. D. (2005). Exploiting genotypic variation in plant nutrient accumulation to alleviate micronutrient deficiency in populations. *J. Trace Ele. Medic. Bio.*, **18**(4): 319-324.
- Govindaraj, M. (2011). Genetics of grain iron and zinc concentration in pearl millet (*Pennisetum glaucum* (L.) R. Br.). Ph.D. Thesis (Unpublished) Submitted to Tamil Nadu Agricultural University, Coimbatore.
- Graham, R. D.; Welch, R. M. and Bouis, H. E. (2001). Addressing micronutrient malnutrition through enhancing the nutritional quality of staple foods: principles, perspectives and knowledge gaps. *Adv. Agron.*, **70**: 77-142.
- Jeeterwal, R. C.; Sharma, L. D. and Nehra, A. (2017). Combining ability and heterosis for grain iron and zinc content in pearl millet [*Pennisetum glaucum* (L.)]. *Int. J. Chem. Std.*, **5**(4): 472-475.
- Kanatti, A.; Rai, K. N.; Radhika, K.; Govindaraj, M.; Sahrawat, K. L. and Rao, A. S. (2014). Grain iron and zinc density in pearl millet: combining ability, heterosis and association with grain yield and grain size. *Springer Plus*, **3**(1), 763. (<http://www.springerplus.com/content/3/1/763>).
- Kemphorne, O. (1957) An Introduction to Genetic Statistics. John Wiley & Sons, Inc., New York.
- Meredith, W. R. and Bridge, R. R. (1972). Heterosis and gene action in cotton (*G. hirsutum* L.). *Crop Sci.*, **12**(3): 304 -310.
- Stein, A. J. (2010). Global impacts of human mineral malnutrition. *Pl. soil*, **335**(1-2): 133-154.
- White, P. J. and Broadley, M. R. (2009). Biofortification of crops with seven mineral elements often lacking in human diets—iron, zinc, copper, calcium, magnesium, selenium and iodine. *New Phytologist*, **182**(1): 49-84.

Table 1: Three best crosses on the basis of heterobeltiosis and sca effect for Fe and Zn content in pearl millet

Character	Best Crosses	
	Heterobeltiosis	sca Effects
Fe Content (ppm)	JMSA ₅ 20155 x 54-SB-17	JMSA ₅ 20155 x 54-SB-17
	ICMA ₁ 10222 x 130-SB-17	ICMA ₁ 10222 x 130-SB-17
	ICMA ₁ 12444 x 128-SB-17	JMSA ₅ 20171 x 160-SB-17
Zn Content (ppm)	ICMA ₁ 10222 x 130-SB-17	ICMA ₁ 10222 x 130-SB-17
	ICMA ₁ 12444 x 127-SB-17	JMSA ₅ 20171 x 160-SB-17
	-	JMSA ₅ 20155 x 54-SB-17

Table 2: Analysis of variance for combining ability and variance components for Fe and Zn content in pearl millet

Source of Variation	Replications	Testers (Females)	Lines (Males)	Lines x Testers	Error
d. f.	2	3	6	18	54
Fe content	25.76	334.75+	369.66+	316.99**	100.60
Zn content	105.86	111.98+	153.16*+	49.81	49.69

[MS received : July 12 , 2018]

[MS accepted : July 16, 2018]