VARIABILITY STUDY OF BIOFORTIFIED BREAD WHEAT GENOTYPES FOR GRAIN ZINC AND IRON CONCENTRATION, YIELD AND YIELD ASSOCIATED TRAITS AT KHUMALTAR, LALITPUR, NEPAL

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Introduction

- Bread wheat *(Triticum aestivum* L.) is a widely cultivated cereal grain of Poaceae family. It is the second most important food crop worldwide after rice. World wheat harvest of the year 2016 was 749,460,077 tons in 220,107,551 ha land area[3].
- In Nepal, wheat is the third major cereal crop after rice and maize in the area of production and productivity but second staple grain after rice in consumption. During 2016/17 wheat was grown in 735,850 ha land area with the production of 1,879,191 metric tons and yielding 2,554 kg/ha[6].
- Micronutrient deficiency affects more than 2 billion people worldwide. In Nepal about 35% of women of reproductive age found anemic during 2011 which increased to 41% in 2016 and 50% of children were also found anemic[4,5]. More than 3/4 of apparently healthy women were found to be zinc deficient even in Bhaktapur adjoining district of capital of Nepal[1].
- About 50% of children in Nepal suffer from stunting and the government has recognized the need for zinc supplementing in stunted children. The economic cost of malnutrition mainly mineral and vitamin deficiency was estimated 2-3 % of GDP (US$ 250 to 375 million) every year in Nepal[9].
- Biofortification of cereal crops increases the micronutrient concentration in the daily dietary intake and is the best prevention against micronutrient deficiencies. Wheat has been ideal for biofortification due to its significant role in ensuring food security[8]. Four biofortified bread wheat varieties namely, Zincol 2016 in Pakistan, Zinc Shakti, WB02 and HPBW-01 in India has been released[8] but no biofortified bread wheat is released in Nepal till date.

Objective

- To study variability of biofortified wheat genotypes for grain zinc and iron content, yield and yield associated traits
- To identify the genotype with high grain zinc and iron content without compromising grain yield

Materials & Methods

Fig 1: Evaluation of biofortified wheat during field condition

- The bread wheat genotypes, 47 biofortified with significantly improved Zn and Fe concentrations and desirable agronomic traits, 2 commercial checks from CIMMYT along with 1 local check WK 1204 from ABD, NARC were tested in Alpha Lattice design with 2 replications at the farm of Agriculture Botany Division, NARC, Khumaltar.
- Trial was conducted under irrigated condition with all package of practice followed for wheat crop cultivation.
- Data of days to maturity, number of effective tiller per m^2, plant height, peduncle length, grain yield, thousand grain weight, Grain zinc and iron concentration were recorded at field and laboratory.

Micronutrient sampling and analysis

- Grain samples were analyzed with a bench-top, non-destructive, energy-dispersive X-ray fluorescence spectrometry (EDXRF) instrument (model x-supreme8000, Oxford Instruments plc, Abingdon, UK) in BHU, Varanasi, India (Paltridge et al., 2012).

Statistical Analysis

- The descriptive statistical analysis of variance (ANOVA) was estimated using R-Studio version: 3.3.0, broad sense heritability estimated as Falconer, 1960, Correlation was estimated using META R software, UPGMA Clustering was done in Minitab 18.0.

Results

Table 1. Descriptive statistics of biofortified wheat genotypes for grain yield, yield attributes and micronutrient concentration

	DM	PH (cm)	PL (cm)	TN	TGW (gm)	GY (T/ha)	FeC (ppm)	ZnC (ppm)
Grand Mean	174.15	103.7	16.4	311	52.9	6.53	39.8	42.5
Range	163-183	93-113	9.9-25.5	162-424	44.8-66.2	3.7-8.1	32.5-49.9	33-53.4
CV	1.15	4.11	9.08	12.49	6.56	9.52	9.89	10.47
LSD	4.045	8.62	3.01	78.49	7.01	1.256	7.95	8.99
F-value	11.21	2.17	10.89	3.43	2.97	3.56	2.08	2.57
F test	***	**	***	***	***	***	**	**
SEM	0.52	0.54	0.36	6.06	0.49	100.72	0.49	0.62
Heritability	83.62	36.91	83.19	54.9	49.29	56.12	35.15	43.99

Table 2. Genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients of yield, yield attributes and micronutrient concentration

	DTM	PH	PL	TN	TGW	GY	FeC	ZnC
DTM	1	-0.18	-0.61***	0.423**	-0.49***	0.367**	-0.469**	-0.13
PH	-0.04	1	0.36***	0.279*	0.051	0.53***	0.29*	0.7***
PL	-0.57***	0.22	1	-0.07	0.26	-0.12	0.6***	0.31*
TN	0.35*	0.16	-0.06	1	-0.9***	0.77***	-0.14	-0.08
TGW	-0.38**	0.04	0.243	-0.55***	1	-0.48***	0.49***	0.22
GY	0.35*	0.42**	-0.09	0.66***	-0.259	1	0.14	0.06
FeC	-0.3*	0.11	0.398**	-0.1	0.377**	0.02	1	0.81***
ZnC	-0.17	0.25	0.204	0.076	0.163	0.03	0.52***	1

DTM: Days to maturity; PH: Plant Height; TN: Number of effective tiller per m^2; TGW: Thousand grains weight; GY: Grain yield; FeC: Grain iron concentration; ZnC: Grain zinc concentration; Significant traits and correlations are denoted by * for p < .05, ** for p < .01, and *** for p < .001

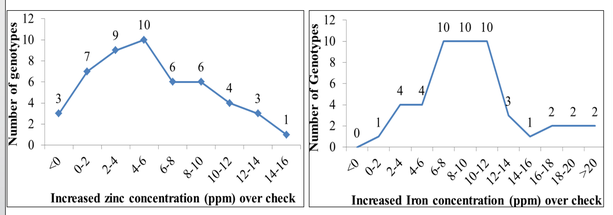

Fig 2: Grain Zinc and iron concentration of biofortified bread wheat genotypes over local check WK 1204

- Among the tested genotypes, 94% genotypes had grain zinc concentration higher than local check WK 1204 and 100% genotypes had grain iron concentration higher than WK 1204.

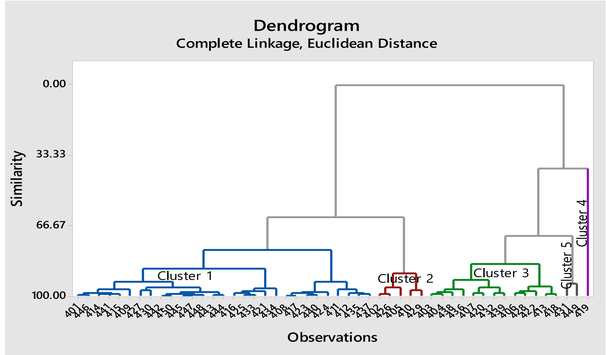

Fig 3: UPGMA clustering of the studied biofortified bread wheat genotypes based on yield, yield attributes and micronutrient concentration

Key Findings

- Genotypes 7HPYT402, 7HPYT426, 7HPYT405, 7HPYT410 and 7HPYT429 are identified for high grain zinc and iron concentration with high grain yield comparable to local check WK1204.
- The traits namely plant height and peduncle length may be considered as indirect selection criteria for improving grain Fe and Zn concentration. Indirect selection for grain yield could be carried out based on the number of effective tiller per m^2.
- Simultaneous improvement of both zinc and iron content without compromising grain yield is possible through wheat breeding.
- Genotype 7HPYT440 (CHIH95.2.6/4/BABAX/LR42//BABAX*2/3/SHAMA/5/2*BABAX/LR42//BABAX*2/3/TUKURU/6/KFA/2*KACHU) is identified as exceptionally highest yielding genotype for zinc (407 kg/ha), iron (335.7 kg/ha) and grain (7269 kg/ha) which can be recommended as a biofortified variety after further verification.

Conclusion

- Large variation was found among genotypes for the studied traits which provide an opportunity to improve the existing germplasms for targeted traits and environment.
- The genotypes having high grain iron and zinc concentration along with grain yield were identified and selected to utilize in breeding for high micronutrient containing genotypes to ensure the nutritional security in the country in future.

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