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Zinc Contents in the Seed of Some Domestic and Exotic Wheat Genotypes

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Abstract: The study was carried out to assess the Zn contents of prominent domestic wheat varieties and the varieties collected from different countries. The study reveals that Zn concentrations in the seed of different genotypes ranged between 10.3 to 34.7 μg g^{-1}. The highest Zn concentrations (34.7 μg g^{-1}) were recorded in the seed of wheat cultivar Pirsabak from Pakistan whereas the lowest concentrations were found in Turkish variety CBWF-96-151. Zinc contents within seed of genotypes under study ranged between 0.40 μg/seed to 1.39 μg/seed.

Key words: Zinc, seed, wheat genotypes, concentrations, cultivars

INTRODUCTION

Mineral nutrient reserves in the seed must be adequate to sustain growth until root system can takeover the nutrient supply function. During the early establishment phase, supply of mineral nutrients will come partly from soil. Therefore, large seed reserves of mineral nutrients are specially important for crops grown on soils that are deficient in one or more nutrients (Asher, 1987).

Micronutrient deficient soils are wide spread; many million hectares of arable land worldwide are deficient in one or more micronutrient elements (Welch *et al.*, 1991). For example Zn deficiency was reported for the soils of various characteristics: high and low pH, high and low organic matter, calcareous, sodic, sandy, wetland or ill drained and limed acid soils etc. (Takkar and Walker, 1993).

Most of the cultivated area of world including Pakistan is micronutrient deficient notably Zn. Such nutrient deficiencies usually exert indirect effect by decreasing parent-plant growth and development, thus resulting in seed of reduced vigor and viability. When such seed is resown on nutrient deficient soil, seedling vigor, vegetative growth and yield potential may be affected (Asher, 1987). The plants grown from large P reserves showed not only increased growth during an early establishment phase but the benefits were carried all the way through the growing period and were expressed as increased grain production in various crops (Bolland *et al.*, 1989).

The present study was initiated with the aim to assess the Zn contents of prominent domestic and exotic wheat varieties/cultivars collected from different countries facing the problem of Zn deficiency. The information gathered will provide an insight into the quality of the seed for human consumption and its resowing for better crop harvest.

MATERIALS AND METHODS

Collection of Seed: The study was conducted in the Department of Soil Science, University of the Reading, UK. Arrangements were made for the collection of seed from different organisations around the world engaged in research on cereals particularly on wheat. Six wheat cultivars were supplied by CIMMYT, Int. Mexico; these were: Wilgoyne (Antizana), Excalibur, Triden, Gatcher (S61 and S62), Songlen and Durati. These cultivars were originally bred in Australia. Three wheat cultivars: Excalibur, Songlen (bread wheat) and Durati (durum) were supplied by Professor Robin Graham (Waite Institute, University of Adelaide, Australia), but these cultivars were already in the germplasm bank from CIMMYT, Int. Mexico. Twelve wheat and barley genotypes were supplied by Plant Breeding International Plc., Cambridge, which included: Charger, Madrigal, Riband, Consort, Hereward, Rialto, Encore, Shango, Highbury (wheat) and the three barley cultivars were Tankard, Spy and Tyne. Eight cultivars were donated by CIMMYT, Turkey, with the identification: CBWF-96-19, CBWF-96-46, CBWF-96-49, CBWF-96-50, CBWF-96-108, CBWF-96-151, CBWF-96-168 and Kunduru. Nine wheat cultivars from Pakistan were supplied by the Barani Agricultural Research Institute, in Chakwal (Pakistan) with names as Bakhtawar, Chakwal-86, Inqulab, Pak-81, Pasban, Pirsabak-85, Pothwar-93, Rawal-87 and Rohtas-90. The seeds of all the cultivars collected were kept in a cold room at 4±1°C before use.

Seed Analysis: The following single acid wet digestion method was standardized for seed sample digestion and analysis.

Samples of ground material (0.500 ± 0.01 g) were weighed and transferred into an acid washed 100 ml Kjeldahl digestion tube. 10 ml of concentrated AnalaR nitric acid (69 %) was added to the tubes and thoroughly mixed. The glass bubble was placed on each tube and the samples were left overnight in the fume cupboard. By the next day, the tubes were placed in digestion block and heated continuously to 60 °C for 1 hour so that the sample can dissolve in the acid. The temperature was gradually increased to 110 °C after 1h heating at 60 °C. The samples were digested for further 6 hours at this temperature. The tubes were removed from the block, allowed to cool and then filtered in acid washed 100 ml volumetric flasks through a filter paper (Whatman 540). Successive rinsing of tubes was done with double deionised water and thus the volume of the flask was made up. The concentrations of Zn were determined by induced couple plasma spectrophotometer (ICP-AES).

RESULTS

Zinc concentrations: Zinc concentrations in the seed of different wheat genotypes ranged between 10.3 to 34.7 μg g^{-1} on dry weight basis (Table 1). The highest Zn concentrations (34.7 μg g^{-1}) were recorded in the seed of genotype from Pakistan named Pirsabak, whereas the lowest Zn concentrations of 10.3 μg g^{-1} were exhibited by Turkish genotype CBWF-96-151. Australian and English varieties proved to be the higher accumulator of Zn compared to Pakistani and Turkish wheat genotypes. Durum varieties i.e. Durati and Kunduru also stored significant amount of Zn. Barley varieties Tankard, Spy and Tyne were also good Zn absorber, however Spy absorbed significantly lower Zn (15.8 μg g^{-1}) as compared with other two barley varieties. The lowest Zn concentrations in the seed of Turkish varieties suggest either severity of Zn deficiency problem in the region or lower Zn efficiency of these varieties. These results are in agreement to those obtained by Rengel and Graham (1995).

Zinc Contents: Zinc contents per seed have been presented in Table 2. The genotypes exhibited significant variations in Zn contents of their single seed. Zinc contents within the seed ranged between 0.40 to 1.39 μg, when calculated on oven dry weight basis. As with Zn concentrations, Zn contents were also comparatively higher in the seed of Australian and English genotypes than Turkish and Pakistani varieties. However, these Zn contents didn't correlate with the Zn concentrations (Table 1) in corresponding seed. The Turkish varieties had the lowest Zn contents in their seed, which ranged between 0.40 to 0.99 μg/seed. Australian cultivars manage to accumulate Zn between 0.64 to 1.39 μg/seed. These results are similar to those of Mc Cay-Buis *et al.* (1995).

Table 1: Zinc concentrations in the seed of wheat and barley cultivars used in study

Cultivar	Zn (μg g^{-1})	Cultivar	Zn (μg g^{-1})
Australian genotypes		**Pakistani genotypes**	
Wilgoyne	28.6bc	Bakhtawar	21.1fghi
Excalibur	21.3fghi	Pasban	17.5jklmn
Trident	27.8bc	Chakwal-86	18.1ijklm
Gatcher S61	30.7b	Pak-81	21.8efgh
Gatcher S62	29.4b	Inqulab	18.8hijkl
Songlen	15.1fghi	Rohtas-90	16.3jklmn
Durati	27.8bc	Rawal-87	19.7ghijk
English Genotypes		Pothwar-93	15.5lmnop
Charger	22.7efg	Pirsabak-85	34.7a
Madrigal	27.1c	**Turkish genotypes**	
Riband	28.3bc	CBWF-96-50	16.2lmn
Consort	21.3fghi	CBWF-96-151	10.3q
Hereward	21.3fghi	CBWF-96-19	16.5jklmn
Rialto	19.8fghij	CBWF-96-168	15.4lmnop
Encore	21.3fghi	CBWF-96-49	15.2lmnop
Shango	22.1fghi	Kunduru	16.2lmn
Highburry	26.4cd	CBWF-96-46	14.2nop
Barley	CBWF-96-108		12.3opq
Tankard	26.3cd		
Spy	15.8lmno		
Tyne	25.2cde		
lsd (P = 0.05)	3.5		

Table 2: Zinc contents in the seed of wheat and barley cultivars used in study

Cultivar	Zn (μg/seed)	Cultivar	Zn (μg/seed)
Australian genotypes		**Pakistani genotypes**	
Wilgoyne	1.34	Bakhtawar	0.72
Excalibur	0.64	Pasban	0.56
Trident	0.78	Chakwal-86	0.52
Gatcher S61	1.07	Pak-81	0.65
Gatcher S62	1.15	Inqulab	0.68
Songlen	0.66	Rohtas-90	0.62
Durati	1.39	Rawal-87	0.83
English genotypes	Pothwar-93	0.57	
Charger	1.09	Pirsabak-85	1.28
Madrigal	0.92	**Turkish genotypes**	
Riband	1.33	CBWF-96-50	0.63
Consort	1.07	CBWF-96-151	0.40
Hereward	1.02	CBWF-96-19	0.59
Rialto	0.93	CBWF-96-168	0.45
Encore	1.07	CBWF-96-49	0.71
Shango	1.28	Kunduru	0.99
Highburry	0.87	CBWF-96-46	0.53
Barley	CBWF-96-108		0.41
Tankard	1.29		
Spy	0.74		
Tyne	0.93		

DISCUSSION

Seed size is an important determinant of seedling vigor and early growth of cereals (Mian and Nafziger, 1992); large seeds produce improved crop stand, which out-yield the crops derived from small seeds (Grieve and Francois, 1992). Alongwith seed size the seed quality (higher seed quality expressed as higher seed content) results in improved vegetative growth and grain yield (Rengel and Graham, 1995) when sown in Zn deficient medium. The present study shows that Zn concentrations did not correlate with Zn content/seed because of the difference in seed size and weight. The heavier seeds of genotypes from Australia and UK have higher Zn contents/seed but Zn concentrations in respective seeds were lower due to the dilution of nutrients (Imtiaz, 1999). This reserved seed Zn is readily mobilized from seed reserves for seedling growth and about 70% of reserved Zn is water extractable (Khan and Weaver, 1989). All the genotypes used in study are best suited for normal cultivation as Zn concentrations of at least 5 to 10 μg g^{-1} are required for normal growth. However, *cv.* Pirsabak-85 and Rawal-87 emerged as better cultivars to be grown in Zn deficient conditions.

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