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Full Length Research Paper

Seed position effect on grains micronutrient content of ten wheat genotypes

Mohsen. Moussavi Nik[1], Mahdi. Babaeian[2]* and Abolfazl. Tavassoli[2]

[1]Department of Agriculture, Zabol University, Zabol, Iran.
[2]Department of Agriculture, Bojnourd Branch, Islamic Azad University, Bojnourd, Iran.

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The characteristics of seeds obtained from nine varieties of wheat (*Triticum aestivum*) from different position were evaluated. A field experiment was set up in a farmer`s field at Coonalpyn, in 2010. Nine varieties of *T. aestivum* L. (BT-Schomburg, Excalibur, Genaro. Halberd, Janz, Machete, Molineux, Oxley and Trident) and one of *Triticum durum* (Yallaroi) were sown in a randomized block design with four blocks. Accumulation of nutrients in seed in different tillers did not follow a similar trend for all nutrients. Zinc (Zn) content in seed on main tillers was greater in middle spikelets, outer sidle florets (MSPK-OF) compared to the same position on secondary tillers. Other nutrients showed different patterns of accumulation in seed from different positions on the main tiller. The amount of Zn was similar in seed from basal spikelets (BSPK) and upper spikelets (USPK) in both tiller orders.

Key words: Wheat, seed position, micronutrient content, genotype.

INTRODUCTION

Studies of nutrient utilization by genotypes is an important factor for the evaluation of the breeding value of varieties and crosses that yield the most for each unit of fertilizer applied (Akintoye et al., 1999; Chaillou et al., 1994). This phenomenon is important in view of the rising cost of inorganic fertilizers on global basis.

Seeds play an important role in determining the success of wheat culture. Thus, selection of good quality seeds is considered a primary factor in ensuring high yields. Environmental conditions during seed filling will affect the supply of assimilates and other materials to seed in different positions in the head. The position of a seed or fruit on a plant can affect its morphology, mass and dormancy/germination characteristics (Gutterman, 2000; Baskin and Baskin, 2001; Moravcová et al., 2005), and these responses are described as 'position-dependent effects' (Cheplick and Sung, 1998; Moravcová et al., 2005). Variations in seeds characters are from subterranean versus aerial flowers of amphicarpic plants (Baskin and Baskin, 2001) or from flowers produced at different or parts of the same inflorescence (Datta et al., 1970), or inflorescences at different positions on a plant or heights on the stem (Baskin and Baskin, 2001) or positions in a bur (Baskin and Baskin, 2001) or fruit (Maun and Payne, 1989). These differences may be due to resources not being allocated equally to all seeds or seeds produced at one position developing under different environmental conditions than those produced at another position, including differences in physiological age of the mother plant at the time seeds are produced (Baskin and Baskin, 2001). Adam et al. (1989) found that seeds from the top of the plants were heavier than seeds from the bottom and showed faster seedling growth and a higher standard germination, but there were generally no differences in conductivity. Kernels from different spike positions are synthesized at different times, and they have different nutrients contents (Levi and Anderson, 1950). Tashiro et al. (1988) highlighted the early pollination and seed set in primary branches and suggest that seeds on the primary branches have a greater sink effect, thereby obtaining carbohydrates from the sources at a faster rate. Another experiments shows soybean (*Glycine max*) seeds that develop in the upper one-fourth of the plant which contain a higher concentration of protein and lower concentration of oil than seeds from the lower one-fourth of the plant (Collins and Cartter, 1956).

*Corresponding author. E-mail: Mahdi_bbn@yahoo.com.

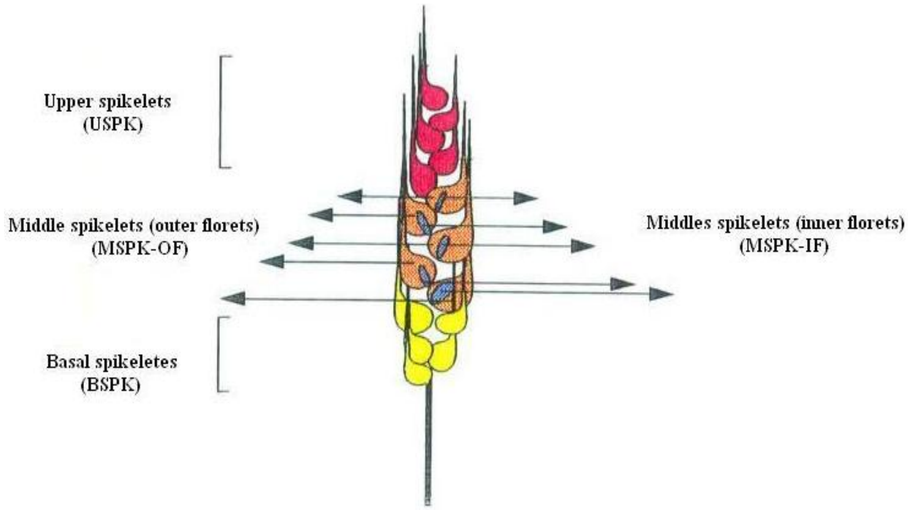

Figure 1. Diagram of a wheat spike illustrating the nomenclature for floret and spikelet used in this experiment.

In wheat, seed protein concentration is higher in seeds from the mid part of the spike than from the basal and distal parts, irrespective of seed size (Levi and Anderson, 1950).

The present study was therefore, undertaken to identify the genotypic differences in the grain nutrients content of 10 genotype, and seed position effect on micronutrient content in south of Australia.

MATERIALS AND METHODS

Seed preparation

A field experiment was set up in a farmer`s field at Coonalpyn, in 2010. Nine varieties of *Triticum aestivum* L. (BT-Schomburg, Excalibur, Genaro. Halberd, Janz, Machete, Molineux, Oxley and Trident) and one of *Triticum durum* (Yallaroi) were sown in a randomized block design with four blocks. The seed bed was prepared by the farmer. The equivalent of 50 kg seed/ha was planted with 100 kg/ha of 19:13:0 N: P: K fertilizer on 20 July, 2010. Weeds were controlled using 11/ha Trifluralin at seeding. At maturity, a sample (50 cm long) from the central two rows was taken from the middle of each plot and heads were divided into those on main tiller and those on secondary tillers. Twenty (20) heads of each genotype were selected at random from each of the main and secondary tillers and seed was plucked from the heads and separated into four fractions, namely those from the basal spikiest, those from the outer florets of the middle spikelet's, those from the inner florets of the middle spikelet's and those from the upper spikelet's. Each of the basal and the middle parts contained five spikelets and the rest were attributed to the upper part (Figure 1). In the basal and upper spikelet's, the two outer florets were bulked; for the middle spikelets, the outside two florets were kept separate (Figure 1). Seed weight and nutrient content were determined for each fraction. Three replicates with six seeds were digested in nitric acid (70%) and analyzed using inductively coupled plasma spectroscopy. Automatic Kjeldahl analysis was used to determine nitrogen content in the other subsample of seed and was converted to protein content using the conventional conversion factor for wheat of 5.7.

Nutrients were mixed thoroughly into the soil. Plastic pots, 15 cm in diameter, were lined with polyethylene liners and filled with 2 kg of soil. Soil moisture was kept constant by addition of distilled water daily to avoid water stress. Seed were surface - sterilized by washing in 70% ethanol for 1 min and soaking in 1% sodium hypochloric for 5 min. Five (5) seeds were sown per pot at 2.5 cm depth. Emergence commenced 4 days after sowing; it was counted daily until all seedlings had emerged. Plants were sprayed with Beleton (1 g/L) to control powdery mildew (*Erisiphs graminis*) when plants had four leaves. Emergence efficiency was calculated on plant and after 4 weeks, were washed to remove soil from the roots under running tap water and rinsed for 30 s in distilled water. Fresh weight of seedling (shoot = root) was determined before separating into shoot and root. All plant samples were dried at 80°C for 24 h. Dry weight of shoots and roots was determined and samples were analyzed for nutrient as described previously.

All data were analyzed using the SUPER analysis of variance (ANOVA) statistical computer program. Means were compared using the least square difference (LSD) ($P < 0.05$).

RESULTS AND DISCUSSION

Micronutrients content

Because of the many interactions which can occur between the main effects of this experiment, genotype, tiller order and seed position results are tabulated in the most appropriate way to show only the highest order interaction which is significant. Manganese (Mn) accumulation in seed was affected by interactions between tiller order, seed position and genotype, seed position (Tables 1 and 2, Figure 2). The Mn accumulation in seed was similar in basal spikelets (BSPK) in both tiller orders, while the seed Mn in middle spikelets, inner florets (MSPK-IF) and middle spikelets, outer sidle florets

Table 1. Nutrient content of seed from various positions on the head from different tillers in wheat.

Seed position	Mn (mg/seed) Tiller		Zn (mg/seed) Tiller	
	Main	**Second**	**Main**	**Second**
BSPK	520	500	520	540
MSPK-IF	440	360	460	400
MSPK-OF	610	510	640	600
USPK	430	440	500	500
LSD 5%	60		30	

BSPK, Basal spikelets; MSPK-IF, middle spikelets, inner florets; MSPK-OF, middle spikelets, outer sidle florets; USPK, upper spikelets. Data were averaged over the 10 genotypes because interaction with tiller order was not significant.

Table 2. Nutrient content of seed of wheat collected from various positions on the head.

Genotype	Fe (mg/seed) Seed position				Fe (mg/seed) Seed position			
	BSPK	**MSPK-IF**	**MSPK-OF**	**USPK**	**BSPK**	**MSPK-IF**	**MSPK-OF**	**USPK**
BT schomburgk	470	380	430	420	430	310	410	320
Excalibur	530	520	740	440	630	490	620	420
Genaro	590	690	670	340	570	450	620	460
Halberd	530	310	510	490	750	420	840	700
Janz	400	310	410	410	240	190	270	200
Machete	640	410	600	680	810	830	1170	930
Molineux	360	310	450	350	320	260	330	290
Oxley	440	310	520	390	460	340	400	290
Trident	440	310	470	480	660	490	650	500
Yallaroi	430	360	650	500	250	220	310	240
LSD 5%		140				140		

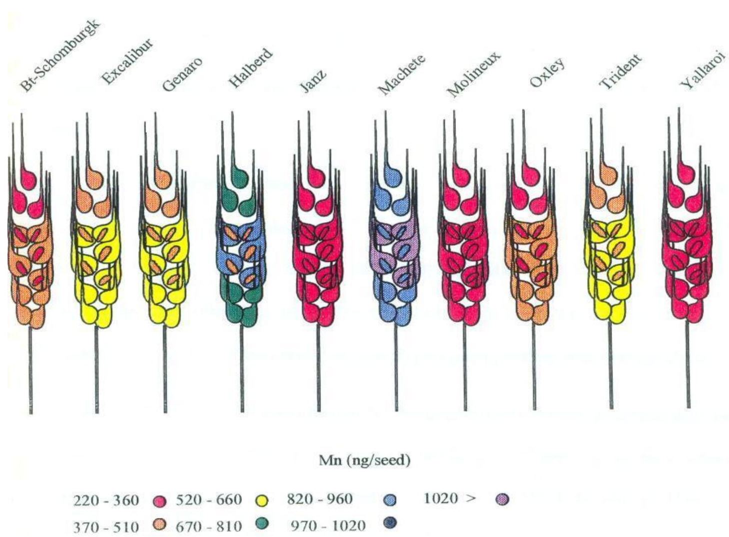

Figure 2. Interaction between seed position and genotype for seed Mn content. The categories have been chosen to take account of significant differences (Data from Table 2).

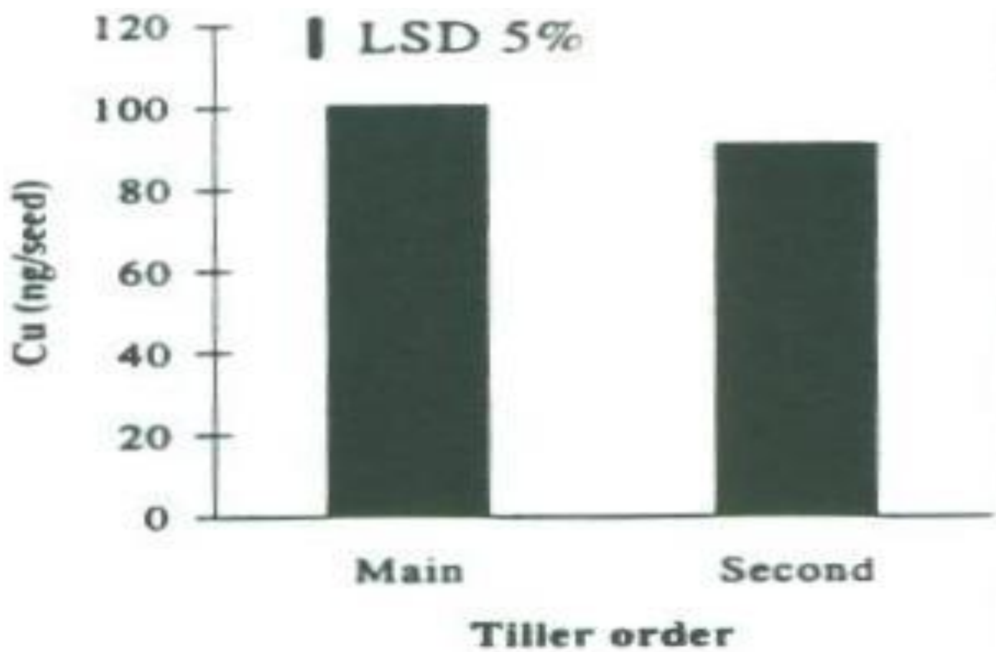

Figure 3. The effect of tiller order on Cu accumulation of seed. Data were averaged over different seed positions and 10 genotypes because interaction was not significant.

Table 3. The effect of genotype and tiller on Mn and B accumulation in seed.

Genotype	Mn (mg/seed)		B (mg/seed)	
	Tiller		Tiller	
	Main	Second	Main	Second
BT schomburgk	430	310	30	40
Excalibur	570	500		60
Genaro	530	520	70	70
Halberd	720	630	70	40
Janz	250	200	50	30
Machete	910	970	40	60
Molineux	320	280	60	30
Oxley	360	380	40	50
Trident	610	540	50	40
Yallaroi	310	200	60	70
LSD 5%	10		9	

(MSPK-OF) was higher in the main tiller than in the second tiller. Within each tiller, the seed in MSPK-OF accumulate more Mn in the seed from other position. Generally, the amount of Mn in the seed from MSPK-OF was 28, 21 and 8% higher than in the seed from MSPK-IF, USPK and BSPK, respectively. The interaction of genotype and seed position was caused by Mn accumulation in seed being similar for all position in the spikes of Ganz, Molineux and Yallaroi, but in Excalibur, Genaro and Mechete Mn was higher in seed from MSPK-IF than from USPK. Janz was a poor genotype for loading of Mn into seed, showing values 75% lower than those for Mechete (Table 2). The pattern of loading nutrient was different between genotypes. Figure 3 shows that BT-Schomburg and Oxley had a similar pattern but this was different from Excalibur, Genaro and Trident who, they were similar to each other in loading nutrient into the seed. Regardless of seed position, genotypes accumulated higher amount of Mn in seed on the main tiller in seed on the second tiller, except for Machete and Oxley which had the reverse (Table 3). Sodium (Na) accumulation in seed was influenced by the

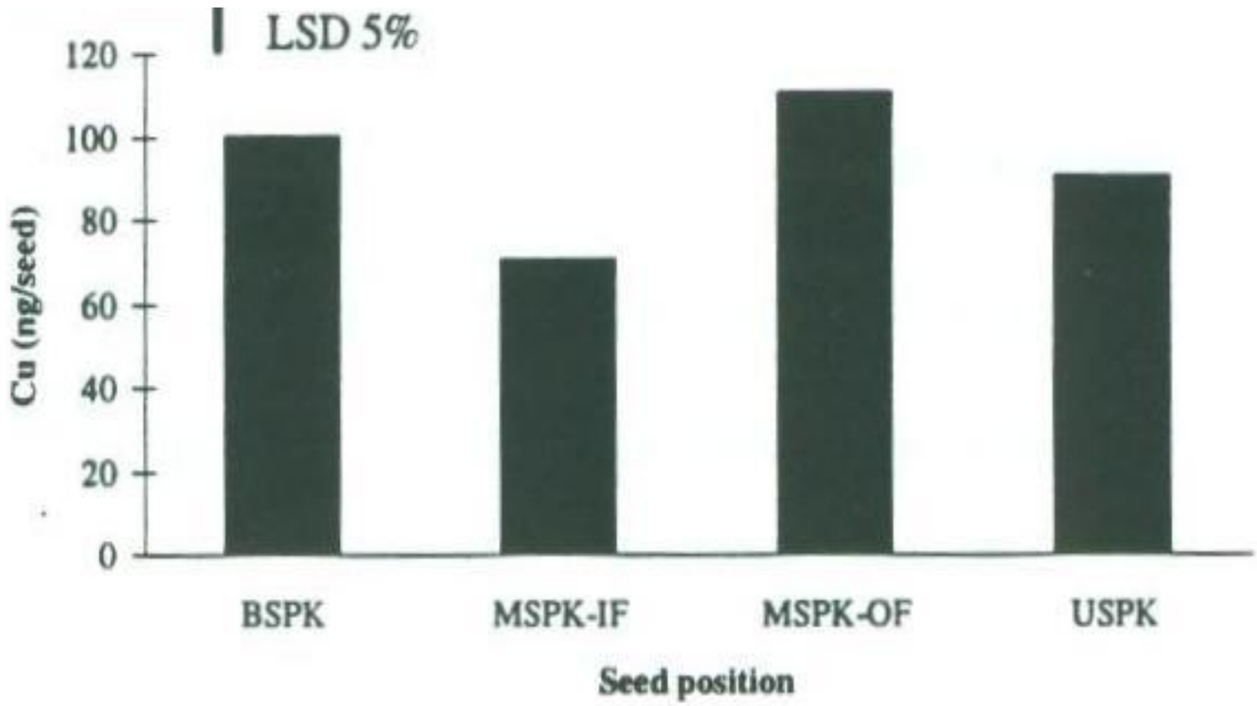

Figure 4. The effect of seed position on Cu accumulation in seed. Data were averaged over different tiller order and 10 genotypes because interaction was not significant.

interaction tiller order × seed position and genotype × seed positions (Tables 1 and 3). Genotypes showed a different pattern of Na accumulation in different seed positions. For example, Exculibur, Halberd and Janzand Oxley had similar amount of Na in all positions, but BT-Schomburg, Genaro and Machete accumulated greater Na content in seed from the upper spikelets (USPK) than in seed from other positions. Among all genotypes, Yallaroi accumulated a greater Na content in seed than Trident. Seed produced on main tillers accumulated more Na than seed produced on secondary tillers. BT-Schomburg, Trident, Molineux and Yallaroi accumulated a large amount of Na in the seed of main tillers. Generally, seed from the MSPK-OF and USPK position contained higher amount of Na than seed from BSPK and MSPK-IF. The interaction between genotype × seed positions was caused by Trident and Oxley showing no differences in Na content in seed from different positions. Zinc (Zn) accumulation in seed was influenced by interactions between tiller order × seed position (Table 1). This interaction showed that the amount of Zn in the BSPK and USPK was similar in both tillers tested, but the MSPK-OF and MSPK-IF had more Zn in seed produced on the main tiller than on the second tiller. Seed from the MSPK-OF had the highest accumulation of Zn. The interaction genotypes × seed positions was not significant. Iron (Fe) accumulation in seed was affected by the interaction between genotype and seed position on the head (Table 2). Machete and Excalibur accumulated the greatest amount of Fe in seed and Molineux and Janz accumulated the least. BT-Schomburg, Janz and Molineux did not show any difference in Fe accumulation in seed position, while Exculibur and Yallaroi had high Fe in seed from MSPK-OF, and Genaro had high Fe in MSPKOF and BSPK. Other wheat genotypes had similar amount of Fe in BSPK, MSPK-OF and USPK. The amount of Fe decreased about 30 to 35% in seed from MSPK-IF in all wheat genotypes than seed from MSPK-OF. Boron (B) accumulation in seeds of wheat was affected by the interaction of genotype × tiller order (Table 3). Genotypes showed different B accumulation in tillers of the different order. BT-Schmburgk had the highest B in second tillers, Machete and Genaro had a similar amount of B in the seeds of both tiller orders, and Yallaroi and Tridient had the highest B in seed produced from the main tiller. B accumulation was 16% higher in seed on the main tillers than on second tillers. Copper (Cu) content of wheat seeds was influenced by genotype, tiller order and seed position on the head (Figures 4 and 5). Interaction was not significant. Among the genotypes, Machete accumulated the greatest Cu content in seed, and Yallaroi, as durum wheat, had the least. The amount of Cu in seed produced on the main tiller was 9% greater than that from seed of secondary tillers. MSPK-IF and USPK contained less Cu than seed from other potions on the head. The amount of Cu in MSPK-IF was lower than in other seed positions, while MSPK-OF accumulated the

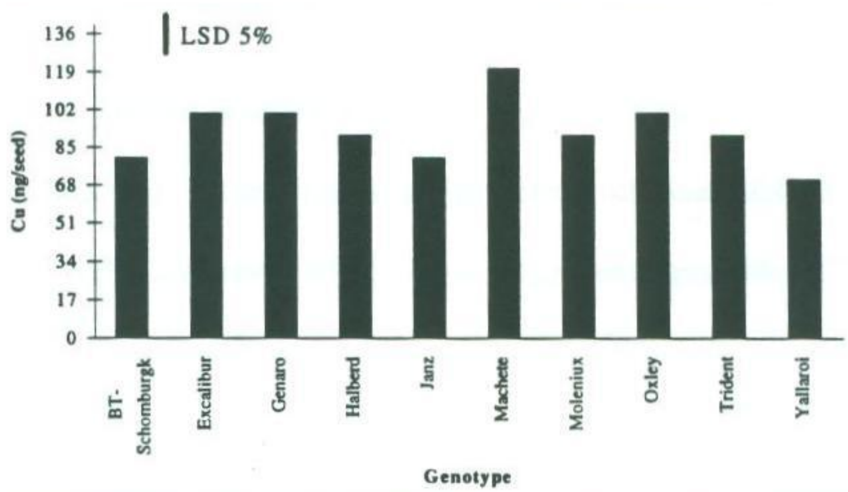

Figure 5. The effect of genotypes on Cu accumulation in seed. Data were averaged over different tiller order and seed position because interaction was not significant.

highest amount of Cu in the seed of all florets tested.

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