Society for Advancement of Wheat and Barley Research
ICAR-Indian Institute of Wheat & Barley Research
Karnal - 132 001, India

Journal of Wheat Research

8(2):57-61

Homepage: http://epubs.icar.org.in/ejournal/index.php/JWR

Short Communication

Impact of micronutrients foliar spray on value addition in wheat

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Article history: Received: 05-11-2016, Revised : 01-12-2016, Accepted: 02-12-2016

Citation: Mohan D, SC Gill and RK Gupta. 2016. Impact of micronutrients foliar spray on value addition in wheat. *Journal of Wheat Research* **8**(2):57-61.

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Improvement in yield and quality is paramount in wheat breeding. Besides genetic attributes, some non-genetic factors have also been successfully tried to enhance wheat yield. In this endeavor, application of micronutrients like iron, zinc, manganese, copper has been widely reported in wheat (Ali *et al*., 2009; Khan *et al*., 2010; Zain *et al*., 2015). Enhanced density of these micro-nutrients in wheat grain has been advocated to address hidden hunger (Cakmack *et al*., 2004; Welch and Graham, 2004). Bio-fortification efforts in India have provided couple of genotypes with enhanced zinc content in the wheat grains. Besides grain yield, enhanced micronutrient content in the soil or in the grains, has also resulted in higher protein content (Mohan *et al*. 2009; Zeidan *et al*., 2010). Micronutrients are involved in numerous physiological processes that are essential for plants. Copper plays an important role in the metabolism of N compounds. Manganese, along with Zn, has an effect on protein biosynthesis by adjusting the activity of peptidases and controlling protein metabolism (Hänsch and Mendel, 2009). Although micronutrients grain density in different zones, impact on grain quality, location effect and the approach to harness these grain qualities had been addressed in the Indian wheats (Mohan *et al*., 2009 & 2013; Mohan and Gupta, 2008), there is no study on the impact of their foliar application in grain quality characteristics. The present investigation is an exploratory study to gauge the impact of sprayed micronutrients on some grain quality parameters.

In the seed multiplication plots, 0.5 percent foliar spray of five salts namely iron sulphate, copper sulphate, zinc sulphate, manganese sulphate and borax was applied at 35 and 55 days after sowing for two crop seasons i.e. 2013-14 and 2014-15, and comparison was made with the untreated checks by Students t-test. Since foliar spray was done in the multiplication field on the genotypes under evaluation in the station and coordinated trials, the study material differed each year. Genotypes involved during 2013-14 were DBW 98, BBW 146 and DBW 146 whereas DBW 157, DBW 162, DBW 168 and DBW 170 were tested during 2014-15. For grain yield, the plot yield was taken into consideration (plot size: 5.52m^2). Grain protein (at 14% grain moisture), sedimentation value, grain hardness index, flour extraction rate, bread loaf and bread quality score were the quality parameters and observations were recorded on two samples of each treatment.

Comparison of the sprayed study material with the unsprayed revealed that some changes did occur in the quality characteristics (Table 1). In 2013-14 crop season, there was no significant gain in yield, protein content, gluten strength (sedimentation value) and extraction rate but there was significant improvement in grain harness index. Numerical increase was witnessed in loaf volume and quality score of the bread, too. Though yield and sedimentation value remained unaffected in 2014-15 crop season too, significant improvement could be noticed in grain protein content, loaf volume and quality score of the bread. Improvement in grain harness index happened in 2014-15 also but with numerical gain.

Table 1. Effect of micronutrients spray on wheat yield and quality characteristics

Parameter	2013-14		2014-15	
	Control mean	Treated mean	Control mean	Treated mean
Observations	6	30	8	40
Yield per plot# (g)	2902	3111	2766	2764
Protein at 14% grain moisture (%)	12.2	12.3	12.2	13.6**
Grain hardness index	73	79**	40	44
Sedimentation value (ml)	45	43	44	43
Extraction rate (%)	68.1	68.3	70.3*	69.5
Bread loaf volume (cc)	533	542	543	570*
Bread quality score	7.25	7.38	6.49	6.89*

* & ** denote significant at P 0.05 and 0.01, respectively; # plot size: 5.52m²

It was obvious that response to micronutrients spray was different in the two study years. Since genotypes differed each year, it was difficult to assign the reason of differential response which could be environment (crop seasons) or genetic (genotypes). It was observed all the three genotypes studied in 2013-14 had hard grain texture (grain harness index: 73-74) whereas in 2014-15 crop seasons, two genotypes were soft (grain harness index: 26 and 32) and two were semi hard (grain harness index: 43 and 58). The study material handled during 2014-15 crop season was divided in two groups and response to spray of micronutrients was re-examined (Table 2). In this investigation, the semi-hard grains exhibited no response, neither quality nor quantity but the soft grain material registered significant improvement in protein content and bread quality. As happened in 2013-14, there was no shift in sedimentation value in both the categories during 2014-15. Improvement in grain hardness (from 50 to 59) and decline in extraction rate (from 70.8 to 69.5%) was visible in the semi-hard group but the impact was non-significant. In the soft-grain category however, both the parameters remained unaltered. It was obvious that response to micronutrients spray was character specific. Some parameters like sedimentation value remains unaffected by this environmentally induced variation whereas some others traits like extraction rate, protein content and bread quality register influence in a specific grain texture or genetic makeup.

Table 2. Effect of micronutrients spray on soft and semi-hard wheat lines planted during 2014-15

Parameter	Semi-hard grain		Soft grain	
	Control mean	Treated mean	Control mean	Treated mean
Observations	4	20	4	20
Yield per plot# (g)	3014	2914	2518	2614
Protein at 14% grain moisture (%)	12.8	13.4	11.6	13.8**
Grain hardness index	50	59	29	28
Sedimentation value (ml)	47	47	42	39
Extraction rate (%)	70.8	69.5	69.8	69.4
Bread loaf volume (cc)	541	554	544	585**
Bread quality score	6.64	6.82	6.34	6.95*

*and ** denote significant at P 0.05 and 0.01, respectively; # plot size: 5.52m²

Differential varietal response to micronutrients has been reported in wheat for traits like grain yield and grain protein (Mekkei and El Haggan Eman, 2014). To understand more about the genotypic response, all seven genotypes of the study material were examined individually (Table 3). In this comparison, sedimentation value was excluded as the overall impact was non-significant. Bread quality was also represented by loaf volume only as results in the Table 2 had shown similar pattern in loaf volume and bread quality score. It was observed that in grain yield maximum response (11%) was observed in DBW 146, a genotype which had lowest yield amongst all the genotypes under testing. Immense jump in grain protein was recorded in DBW 168 (16%) and DBW 170 (22%), the two soft grain genotypes of average protein levels (11.6-11.7%). Grain hardness improved substantially in DBW 162 from 43 to 62. Drop in hardness index could be observed only in one entry i.e. DBW 170, otherwise it either improved or remained stationary in test entries under study. Similarly, the bread quality (loaf volume) was benefitted by foliar application of the micronutrients and the increase was maximum (7 to 8%) in the soft grain material i.e. DBW 168 and DBW 170. Differential genotypic response was evident in extraction rate where the response to micronutrients was negative (2.6 to 2.7%) in DBW 146 and DBW 170, positive (2.3%) in DBW 98 and static in rest of the lines. With these results, there was enough reason to believe that the benefits incurred from micronutrients' spray vary from genotype to genotype.

Table 3. Wheat germplasm response to micronutrients spray

Genotype	Plot yield# (g)		Grain protein* (%)		Hardness index		Loaf volume (cc)		Extraction rate (%)	
	Control	Treated	Control	Treated	Control	Treated	Control	Treated	Control	Treated
2013-14										
DBW 98	3388	3609	11.2	11.7	74	79	488	514	67.1	68.6
DBW 145	2941	3144	12.6	12.3	73	81	545	547	68.9	69.2
DBW 146	2326	2582	12.7	12.8	73	78	568	564	68.3	67.1
2014-15										
DBW 157	2965	2821	13.9	14.4	58	57	573	571	69.8	69.2
DBW 162	3063	3077	11.6	12.4	43	62	510	538	71.7	69.9
DBW 168	2532	2511	11.6	13.4	26	29	533	577	70.7	70.3
DBW 170	2503	2716	11.7	14.2	32	27	555	594	68.9	68.5

*# Plot size: 5.52m²; * protein content at 14% grain moisture*

Like genotypes, influence of each micronutrient can't also be the same. Factorial analysis revealed that significant treatment differences existed in some quality parameters during 2014-15.(Table 4.) Differences in treatment effect had been reported in wheat grain yield by several workers but differential response in grain quality was new a dimension in this investigation. Every treatment was effective in raising the protein content but Cu, Bo and Mn occupied the 1st non-significant group. Bo was the best treatment for protein content in the preceding year also. Fe registered no impact on grain hardness but the other four micronutrients were equally effective. In loaf volume also, influence of Fe was minimum in comparison to the other four micronutrients. Influence on extraction rate could be noticed in Cu sprayed material only and the magnitude of impact depended upon the original levels. It improved the flour recovery from 68.1 (check) to 69.1% in 2013. When the original levels of flour recovery were high (70.3%) as noticed in 2014-15 crop season, there was difference between the check and Cu sprayed genotypes. Improved protein and gluten properties by spray of iron sulphate had been reported in wheat from Chile (Shahrokhi *et al.*, 2012). Similar studies in Poland had advocated that spray of different micronutrients with NPK fertilizers in wheat had influenced ω, α/β, and γ gliadins, HMW and LMW glutenin subunits, improved gliadin: glutenin ratio, grain hardness, protein content and even sedimentation value.

Table 4. Effect of different micronutrients on wheat yield and quality characteristics

Treatment	Plot yield# (g)		Grain protein* (%)		Hardness index		Loaf volume (cc)		Extraction rate (%)	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Control	2,902	2,766	12.2	12.2	73	40	533	543	68.1	70.3
Zn	3,425	2,750	11.9	13.7	81	46	532	576	67.8	69.4
Mn	3,052	2,823	12.2	13.8	74	44	553	566	68.2	69.1
Fe	3,040	2,766	12.2	12.8	82	41	536	557	68.3	69.4
Cu	3,042	2,750	12.4	14.0	79	44	545	576	69.1	69.9
Bo	2,999	2,732	12.7	13.9	82	45	543	574	68.0	69.4
CD (P 0.05)	146	NS	NS	0.3	NS	2	NS	19	NS	0.7

*# Plot size: 5.52m²; * protein content at 14% grain moisture*

In factorial analysis, genotype-treatment interactions were found significant in study material of 2014-15 and the parameters involved were protein content, grain hardness index and bread loaf volume. Pattern of such interactions observed in protein content and bread quality score is depicted in Fig1 for both the years. Response pattern against micronutrients was different in DBW 162 in comparison to other genotypes. In case of iron, response of DBW 157 was also indifferent. In bread quality, score recorded in DBW 162 against iron reflected a different pattern. Though interactions were non-significant in 2013-14 study material, differences in pattern of varietal response were conspicuous in these two grain quality attributes.

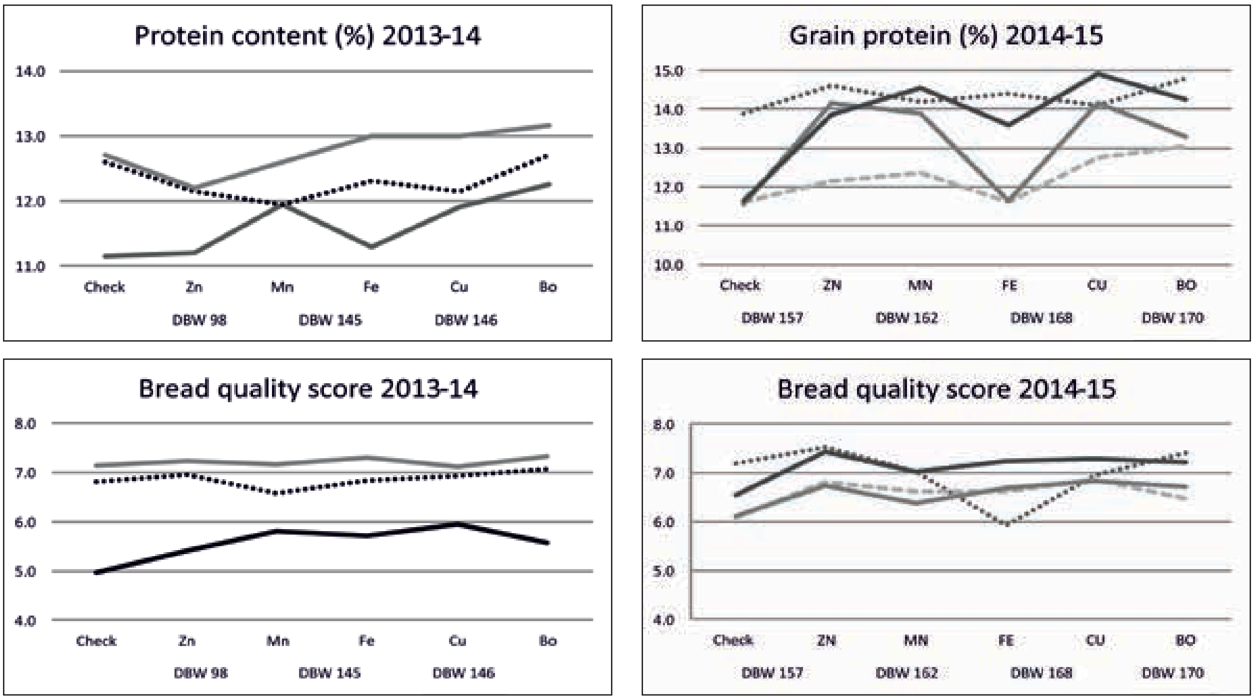

Fig. 1 Interaction effects of genotype-micronutrients on protein content and bread quality

Genetic improvement in grain quality of wheat is quite complex and the progression registered so far is quite restrictive. Since role of environments is always rated high in quality (Zhang *et. al.,* 2004; William *et al.,* 2008; Pena *et al.,* 2012; Mohan and Gupta, 2015), it also underlines the fact that such conditions if manipulated intentionally could be exploited to enhance value addition in wheat. Instead enriching soil with micronutrients, enrichment of these elements in wheat grains is better ensured by foliar application (Hamzeh and Florin, 2014; Rawashdeh, 2015). These non-genetic factors have been exploited to some extent in elevating protein content of wheat grains. If protein content is raised, it would definitely be of some benefit to quality of the dough or quality of the bread. Enhanced copper content in wheat grains is also reported to improve flour recovery in the Indian wheats (Mohan et. al., 2013). Though this study was preliminary, it gave enough indications that simpler tools like foliar application of certain micronutrients can be explored to improve nutritional and end-product quality in wheat. It would be quite useful if confirmatory results could be obtained by conducting multidisciplinary and multi-year experiments on more number of wheat genotypes.

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