Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(6): 2445-2448
Received: 13-09-2018
Accepted: 15-10-2018

Adarsha GS
Department of Soil Science and Agricultural Chemistry, College of Agriculture, UAS Raichur, Karnataka, India

Veeresh H
Asst. Professor Department of Soil Science and Agricultural Chemistry, College of Agriculture, UAS Raichur, Karnataka, India

Narayana Rao K
Professor and Head Department of Soil Science and Agricultural Chemistry, College of Agriculture, UAS Raichur, Karnataka, India

Ashok Kumar Gaddi
Asst. Professor (Soil Science), ARS, Siruguppa, Bellary, Karnataka, India

Basavanneppa M
Professor and Head (Agronomy) ARS, Siruguppa, Bellary, Karnataka, India

Correspondence
Adarsha GS
Department of Soil Science and Agricultural Chemistry, College of Agriculture, UAS Raichur, Karnataka, India

Effect of foliar application of micronutrients on quality parameters of maize (*Zea mays* L.) in vertisol

Adarsha GS, Veeresh H, Narayana Rao K, Ashok Kumar Gaddi and Basavanneppa M

Abstract
Maize protein is deficient in lysine and tryptophan but has fair amounts of sulphur containing amino acids (methionine and cysteine). Nutritional enhancement of maize protein can be achieved by supplying trace elements with major nutrients either through soil or foliar application. Thus to know the effect of foliar application of micronutrients on quality of maize was conducted during *kharif* 2017 at Agricultural Research Station, Siruguppa, Karnataka. The experiment was laid out with nine treatments replicated three times in randomized block design. The results of the experiments revealed that the treatments had significant effect on nutrient content in grain and quality parameters. The treatments that received NPK @ 200:100:75 kg ha^{-1} (Farmers' practice) along with foliar spray of Grade-I either @ 2.5 ml L^{-1}, 5.0 ml L^{-1} or 10 ml L^{-1} recorded comparatively higher protein content in grain samples than the other treatments. However, the highest protein content was recorded in treatment with Farmers' practice plus foliar spray of Grade-I @ 10 ml L^{-1} at 40 and 60 DAS. The highest tryptophan and lysine content was also recorded in the same treatment. The results also showed that nutrient content in corn grain could be increased through foliar application of micronutrients along with soil application of major nutrients.

Keywords: Protein, tryptophan, lysine, foliar spray, grade-I

Introduction
In nutritive value maize is quite similar to other cereal grains. In fact, it is somewhat superior to wheat flour and only to a small extent below rice. These are the three cereal grains most consumed by people throughout the world. The problem with maize lies in the diet of which it is a component, a diet mostly deficient in the kind of supplementary foods necessary to upgrade the nutrients ingested in relatively large amounts of maize. Maize-consuming populations would be nutritionally better off if the maize consumed had the lysine and tryptophan. In general maize protein is deficient in lysine and tryptophan but has fair amounts of sulphur containing amino acids (methionine and cysteine). Several essential metal ions are redox- active that is the basis for their occurrence as catalytically active cofactors in many enzymes. Other metals (like zinc) fulfill in addition to their catalytic role, a structural role in stabilizing proteins. Moreover micronutrients are constituent of a particular protein, constituents of several enzymes and components of metabolic activity sites. Among the essential micronutrients zinc is a component of ribosome where protein synthesis takes place and it is also responsible tryptophan amino acid synthesis. One or other way micronutrient elements play their role in metabolic activities and either directly or indirectly involved in enhancement of quality parameters in crops. The field survey under the e-sap project (at UAS Raichur) on nutrient constraints in various crops grown in northern dry zone of Karnataka during 2014-15 has revealed prevalence of widespread nutrient deficiencies in maize more particularly that of micronutrients such as Zn, Fe, Mn and B. the reason may be attributed to prioritized use of fertilizers containing only major nutrients coupled with less and less use of organic manures by farmers. In addition to the above, the adverse soil environmental factors also come in the way of plant uptake and utilization of soil applied nutrients. On the other hand, foliar application of these micro nutrients could eliminate the impact of these factors and result in rapid absorption. It is acknowledged that foliar fertilizer use efficiency is about 20 times more effective in comparison to soil applied micronutrients. Moreover, numerous studies have also confirmed positive response of many crops in this aspect. However, no significant research has been carried out to assay the usefulness and impact of foliar solution mixtures containing multiple micronutrients as per the standards and grades prescribed by the KSDA, Govt. of Karnataka. Keeping this in view, the investigation was carried out to study by

preparing Grade-I foliar solution containing Fe, Zn, Mn and B on "The effect of foliar application of micronutrients on quality parameters of maize (*Zea mays* L.)".

Material and methods

A field experiment was carried out in randomized complete block design with nine treatments replicated three times in black soil during *kharif* 2017 at Agricultural Research Station, Siruguppa, Bellary district, located in Northern Dry Zone (Zone-3) of Karnataka at 15º38' N latitude and 76º54' E longitude with an altitude of 373 meters above the mean sea level. The soil of experimental site is deep black with clay texture. Representative composite soil sample was drawn from the experimental site at 0-15cm soil depth before the initiation of experiment. The collected soil sample was air dried; ground to pass through 2 mm sieve and used for the analysis of various soil parameters by following standard laboratory methods and the results are presented in the Table 1.

Table 1: Physical and chemical properties of soil at the experimental site

Texture	pH	EC (dSm^{-1})	OC (%)	Available major nutrients (kg ha^{-1})			DTPA extractable micronutrients (mg kg^{-1})				Available B (mg kg^{-1})
				N	P_2O_5	K_2O	Fe	Mn	Zn	Cu	
Clay	8.05	0.22	0.48	167.21	57.59	241.54	7.63	15.53	1.54	2.12	3.06

The multi micronutrient mixtures (Grade I) was prepared as per Karnataka State Department of Agriculture recommendations i.e., Fe: 2%, Zn: 3%, Mn: 1% and B: 0.5%. This mixture was prepared in the laboratory by using laboratory grade chemicals viz., ferrous sulfate, zinc sulfate, manganese sulfate and boric acid respectively. The so prepared mixtures were preserved by adding a pinch of citric acid.

FYM (Farm Yard Manure) was applied to all the treatment plots before one week of sowing. Micronutrient mixtures (Grade-I) was applied through foliar at grand growth stage V9 (40 DAS) and tasseling stage (60 DAS). The treatments consisted of

T_1	:	Farmer's practice (200:100:75 NPK kg ha^{-1})
T_2	:	RDF (150:75:37.5 NPK kg ha^{-1} + $ZnSO_4$ and $FeSO_4$ @ 25 kg ha^{-1} each)
T_3	:	T_1 + Foliar spray of Grade-1 @ 2.5 ml per liter of water at 40 DAS and 60 DAS
T_4	:	T_1 + Foliar spray of Grade-1 @ 5 ml per liter of water at 40 DAS and 60 DAS
T_5	:	T_1 + Foliar spray of Grade-1 @ 10 ml per liter of water at 40 DAS and 60 DAS
T_6	:	T_2 + Foliar spray of Grade-1 @ 2.5 ml per liter of water at 40 DAS and 60 DAS
T_7	:	T_2 + Foliar spray of Grade-1 @ 5 ml per liter of water at 40 DAS and 60 DAS
T_8	:	T_2+ Foliar spray of grade-I @ 10 ml per liter of water at 40 DAS and 60 DAS
T_9	:	Absolute control

The good quality seeds of maize hybrid NK-6240 were sown at a depth of 5 cm with a spacing of 60 cm × 20 cm. It is a widely adapted hybrid with outstanding yield and stability from M/s. Syngenta seeds Ltd. Stable yielder across the environments and good responsive to high input management. Orange yellow semi dent with bold kernels with excellent tip, very uniform and appealing plant type. Five plants from the net plot area were randomly selected and they were tagged to record the quality parameters in corn grain after the harvest of crop.

Results and Discussion

Quality parameters of maize

The analysis results of protein, lysine, tryptophan contents in grain samples and the data on protein yield due to foliar application of micronutrients showed a statistical significant and the results are presented in Table 2.

Protein (%) and Protein yield (kg ha^{-1})

The treatment that received NPK @ 200:100:75 kg ha-1 (Farmers' practice) along with foliar spray of Grade-I @ 10 ml L-1 (T5) recorded the higher protein content (8.75) in grain samples and it was on par with T8 (8.40), T1 (8.17), T4 (8.12) and T3 (8.02) while the lowest protein content was recorded in T9 (4.96). The highest protein content may be attributed to the higher quantity of nitrogen application under farmers' practice. Along with nitrogen, foliar applied micronutrients may have also responsible for increased protein content (Table 2 and Figure 1). Similar findings and observations were also reported by Mohsin et al. (2014), Khattak et al. (2015) with soil and foliar fertilization of zinc in wheat and Harender et al. (2018) with different dose of plant nutrients.

On the other hand, the highest protein yield was recorded in T8 (913.52) which was on par with T5 (908.85), T4 (843.77) and T6 (822.14). The lowest protein yield was recorded in T9 (267.54). Although the highest protein content was recorded in T4, the treatment T8 was recorded highest protein yield due to highest grain yield (Fig. 1)

Amino acids (g per 16 g of N or percentage of protein)

The lysine and tryptophan content in corn grain were significantly influenced by foliar application of micronutrients at different concentrations (Table 2 and Fig. 1). The lysine content in grain increases with increase in the concentration of foliar spray of micronutrients mixture along with RDF and soil application of ferrous sulfate and zinc sulfate. However, the lysine content was recorded highest in the treatment which received RDF + Soil application of FeSO4 and ZnSO4 at 25 kg ha-1 each along with foliar spray of micronutrient Grade-I @ 10 ml L-1 and the lowest lysine content (2.45) was recorded in treatment that received 200:100:75 kg NPK ha-1. In farmers' practice the lesser lysine content was observed might be due to excess quantity of nitrogen application which was accompanied by significant decrease in lysine content (Imamul, 1983).

Comparatively the higher tryptophan content in grain was recorded by the treatments which received foliar spray of micronutrient Grade-I @ 10 ml L-1 at 40 and 60 DAS with irrespective of nitrogen application (Table 2). However, the highest tryptophan content was recorded in T5 (1.884) which was on par with T8 (1.875) and the lowest tryptophan content in grain was recorded in T9 (1.158). The increase in tryptophan content might be due to application of zinc at higher concentration which is involved in IAA production (Precursor of tryptophan synthesis). Similar findings and observations were reported by Imamul (1983) and Radulov et al. (2010).

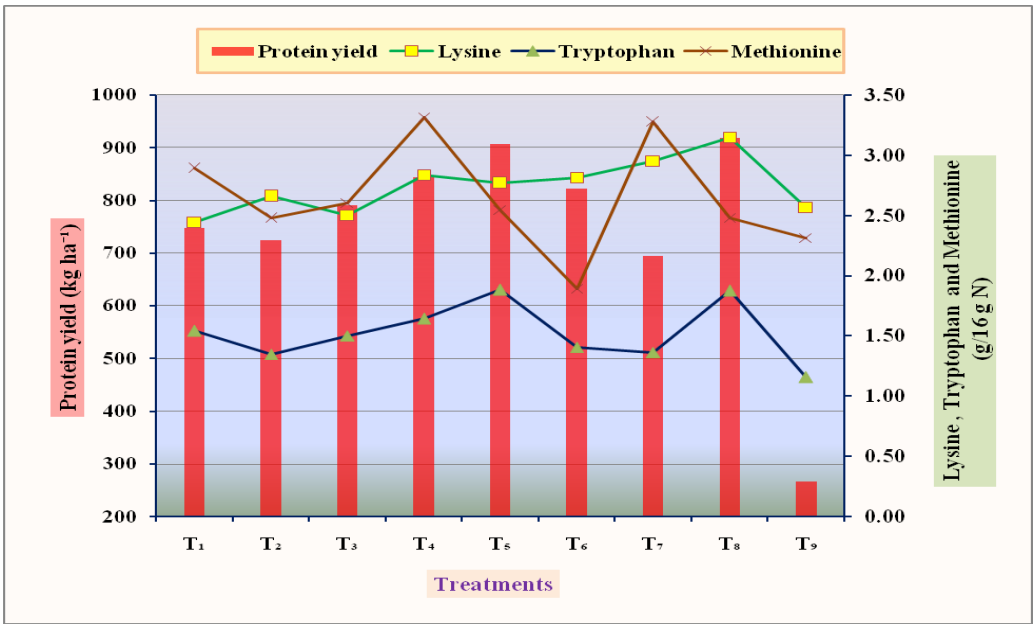

Fig. 1: Protein yield, Lysine, tryptophan and methionine content of maize grain as influenced by various treatments

Concentration of major nutrients in grain samples

Major nutrient content in grain sample as influenced by various treatments showed a significant effect and results are presented in Table 3 and Fig. 2.

The treatment T5: Farmer's practice (200:100:75 kg NPK ha-1) and foliar spray of Grade-I @ 10 ml L-1 was recorded the higher per cent of nitrogen content (1.40) in grain which was on par with T1 (1.31), T3 (1.28) and T6 (1.26). The lowest nitrogen content in grain was recorded in T9: Absolute control (0.79). The highest phosphorus content in grain was recorded in T3: T1+ Foliar spray of Grade-I @ 2.5 ml L-1(0.30) and it was on par with T1 (0.29). The lowest phosphorus content in grain was recorded in T9 (0.19). On the other hand, the treatment T4: T1+ foliar spray of Grade-I @ 5 ml L-1 recorded maximum potassium content in grain which was on par with T1 (0.36). The lowest potassium content was recorded in T9 (0.25).

Increased nitrogen in grain might be due to positive interaction with B and Zn. B has an effective role in translocation of N compounds in plant. However, the concentration of P and K in grains recorded comparatively higher in farmers' practice with irrespective of concentration of foliar spray (Table 3). It might be due to antagonism between P and Zn, P and Fe and K and B. These observations are in agreement with Mohsin et al. (2014) [5].

Table 2: Effect of various treatments on quality parameters of maize

Treatments	Protein (%)	Protein yield (kg ha^{-1})	Lysine	Tryptophan
			(g per 16 g N or Percentage of protein)	
T1	8.17	747.29	2.457	1.541
T2	7.58	724.50	2.660	1.350
T3	8.02	790.57	2.503	1.502
T4	8.12	843.77	2.847	1.641
T5	8.75	908.85	2.777	1.884
T6	7.88	822.14	2.827	1.408
T7	7.15	693.40	2.953	1.364
T8	8.40	913.52	3.150	1.875
T9	4.96	267.54	2.577	1.158
S. Em±	0.28	31.39	0.021	0.011
CD at 5%	0.83	94.12	0.064	0.033

Note: T1: Farmers' practice (200:100:75 NPK kg ha^{1}), T2: RDF + ZnSO4 and $FeSO_4$ @ 25 kg ha^{-1} each), T3: T1+ Foliar spray of Grade-I @ 2.5ml L^{-1}, T_4: T_1+ Foliar spray of Grade-I @ 5ml L^{-1}, T_5: T1+ Foliar spray of Grade-I @ 10ml L^{-1}, T_6: T_2+ Foliar spray of Grade-I @ 2.5ml L^{-1}, T_7: T_2+ Foliar spray of Grade-I @ 5ml L^{-1}, T_8: T_2+ Foliar spray of Grade-I @ 10ml L^{-1}, T_9: Absolute control. Stage of spray: 30 DAS and 60 DAS Grade-I: Fe-2%, Zn-3%, Mn-1% and B-0.5%

Concentration of micronutrients in grain samples

The analysis results of grain sample for micronutrient concentrations showed a statistically significant data with the exception of copper (Table 3 and Fig. 2).

The treatment T6 which received RDF+ Soil application of FeSO4 and ZnSO4 at 25 kg ha-1 + Foliar spray of Grade-I @ 2.5 ml L-1 recorded higher Fe (49.68), Mn (6.46), Zn (27.42) and B (7.28) content in grain which were superior over rest of the treatments. From these results we can conclude that foliar application increases the micronutrient content in grain. Similar findings were recorded by Bharti et al. (2013) and Rawashdeh and Sala (2015) [7].

Table 3: Concentration of major and micronutrients in grain samples of maize as influenced by various treatments

Treatments	Major nutrients (%)			Micronutrients (mg kg^{-1})				
	N	P	K	Fe	Mn	Zn	Cu	B
T_1	1.31	0.29	0.36	37.59	4.48	17.28	10.79	3.41
T_2	1.21	0.25	0.33	39.69	6.31	22.03	11.26	4.49
T_3	1.28	0.30	0.32	45.06	6.42	22.48	11.21	5.63
T_4	1.10	0.26	0.38	47.09	5.31	21.58	10.76	6.42
T_5	1.40	0.23	0.27	41.54	5.02	22.57	11.39	5.99
T_6	1.26	0.27	0.34	49.68	6.46	27.42	11.66	7.28
T_7	1.14	0.24	0.26	42.67	5.62	23.49	11.11	5.34
T_8	1.19	0.24	0.25	48.07	5.07	24.73	11.49	6.63
T_9	0.79	0.19	0.28	32.33	5.37	19.03	11.22	4.06
S. Em±	0.05	0.01	0.01	0.34	0.18	0.56	0.23	0.02
CD at 5%	0.14	0.02	0.02	1.03	0.54	1.68	NS	0.07

Note: T_1: Farmers' practice (200:100:75 NPK kg ha^1), T_2: RDF + $ZnSO_4$ and $FeSO_4$ @ 25 kg ha^{-1} each), T_3: T_1+ Foliar spray of Grade-I @ 2.5ml L^{-1}, T_4: T_1+ Foliar spray of Grade-I @ 5ml L^{-1}, T_5: T_1+ Foliar spray of Grade-I @ 10ml L^{-1}, T_6: T_2+ Foliar spray of Grade-I @ 2.5ml L^{-1}, T_7: T_2+ Foliar spray of Grade-I @ 5ml L^{-1}, T_8: T_2+ Foliar spray of Grade-I @ 10ml L^{-1}, T_9: Absolute control. Stage of spray: 30 DAS and 60 DAS Grade-I: Fe-2%, Zn-3%, Mn-1% and B-0.5%

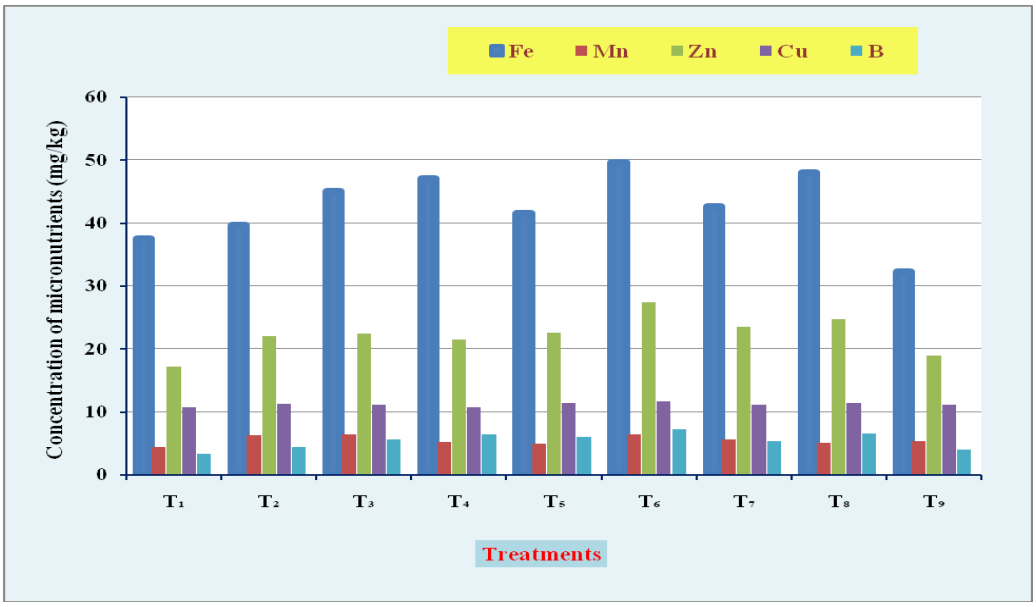

Fig 2: Concentration of micronutrients (mg kg^{-1}) in maize grain as influenced by various treatments

Conclusion

The quality parameters of maize such as protein, lysine and tryptophan were significantly influenced by foliar application of micronutrient. The treatment that received NPK @ 200:100:75 kg ha^{-1} (Farmers' practice) along with foliar spray of Grade-I 10 ml L^{-1} recorded higher protein content in grain samples than the other treatments. On the other hand the higher lysine and tryptophan content was recorded in RDF + $FeSO_4$ and $ZnSO_4$ at 25 kg ha^{-1} each with foliar spray of Grade-I @ 10 ml L^{-1}. The highest protein yield was recorded in treatment that received RDF + Soli application of $FeSO_4$ and $ZnSO_4$ at 25 kg ha^{-1} each with foliar spray of Grade-I @ 10 ml L^{-1}. This investigation also showed that the concentration of nutrients in corn grain could be increased by foliar fertilization of micronutrients at V9 and tasseling stage.

References

1. Bharti K, Pandey N, Shankhdhar D, Srivastava PC, Shankhdhar SC. Improving nutritional quality of wheat through soil and foliar zinc application. J Plant Soil Environ. 2013; 59(8):348-352.
2. Harender, Samar Singh, Kavinder, Kapil Malik, Naveen Rathi. Impact of Different dose of Plant Nutrient in Terms of Growth, Quality, Yield and Economics of Maize (*Zea mays* L.). Inter. J Plant & Soil Sci. 2018; 21(5):1-8.
3. Imamul Huq SM. Fertilizer effects on yield, nitrogen content and amino acid composition of maize grain. Agronomie, EDP Sciences. 1983; 3(10):965-970.
4. Khattak SG, Peter JD, Ahmad W. Effect of Zn as soil addition and foliar application on yield and protein content of wheat in alkaline soil. J Natn. Sci. Foundation Sri Lanka. 2015; 43(4):303-312.
5. Mohsin AU, Ahmad H, Farooq M, Ullah S. Influence of zinc application through seed treatment and foliar spray on growth, productivity and grain quality of hybrid maize. J Animal and Plant sciences. 2014; 24(5):1494-1503.
6. Radulov I, Sala F, Adina B, Crista F. Foliar fertilization influence on maize grain protein content and amino acid composition. Res. J Agril. Sci. 2010; 42(3):275-279.
7. Rawashdeh H, Sala F. Effect of some micronutrients on growth and yield of wheat and its leaves and grain content of iron and boron. Bulletin, USAMV series Agri. 2015; 72(2):503-508.