



Original Research Article

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Role of Chelated Micronutrient and their Salts for Improving Crop Production of Wheat (*Triticum aestivum L.*)

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A field experiment on evaluating micronutrients chelates on wheat (*Triticum aestivum L.*) crop was conducted during Rabi season. The field trial was sown consequently for three years 2012-13, 2013-14 and 2014-15 at the Agricultural Research Station Farm, Sriganganagar (Rajasthan), laid out in Randomized Block Design, consisted 9 treatments with 4 replications it was observed that the best results were reported for grain yield, straw yield, thousand grain weight and ear length of wheat crop in treatment T₂ Zn HEDP (17%) – 3 gm/liters of water, maximum grain yield (49.42 q/ha), straw yield (83.72 q/ha), thousand grain weight (41.56 gm.) and ear length (11.97 cm.) were found to be significant. A balanced fertilization program with macro and micronutrients in plant nutrition holds the key for improving the growth and food grain production of crop.

Introduction

Wheat (*Triticum aestivum L.*) is an annual plant belongs to family Poaceae (Gramineae) is the most important cereal crop in the world and is the third major cereal produced in the world, following maize and rice (FAO, 2013). Wheat is cultivated since pre-historic times in the world. From all possible records, it seems that its center of origin is South Western Asia. In India it is the second important staple cereal food. As a *Rabi* season (winter season, sowing is done in autumn and harvesting in summer) crop, wheat played vital role in stabilizing the food grain production in the country (Hand Book of Agriculture by ICAR, 2010). Uttar Pradesh, Haryana, Punjab, Rajasthan are the

major wheat producing states and accounts for almost 80% of total production in India. Wheat contains more protein [8-15% (grain), 8-13% (flour)] than other cereals. Wheat proteins are of special significance (Yadav *et al.*, 2010). Besides their significance in nutrition, these are principally concerned with providing the characteristic substance ‘gluten’, which is very essential for bakers. Wheat straw is good source of feed for livestock in our country.

Wheat is grown not only in tropical and sub-tropical zones but also in the temperate zones. The optimum temperature range for ideal

germination of wheat seed is 20-25°C. For vegetative growth, 16-22°C is the optimum temperature. Wheat plant requires about 14-15°C optimum average temperature at the time of maturity. Wheat can be grown successfully in those regions where annual rainfall varies from 25 to 150 cm. A well distributed winter rainfall of 15-20 cm is required for rainfed cropping. Wheat plant requires medium (50-60%) humidity for their growth, but at the time of maturity, crop requires less humidity.

Wheat, though grown on a wide variety of soils, prefers fertile, well-drained medium textured loams to clayey loams. A good crop of wheat can also be raised in sandy loams and black soils (Hand book of Agriculture by ICAR, 2010). Soil should be neutral (6-8 pH) in reaction. Under dry conditions, heavy soils with good drainage are best owing to their better moisture retention properties. Soils with electrical conductivity of saturation extract >6 dS/m and exchangeable sodium percentage >40 are not suitable for economical yield realization. The soil depth should be greater than 25 cm for wheat cultivation. The normal time for sowing of high-yielding cultivars in irrigated areas begins in early November. Usually, a seed rate of 100 kg/ha is sufficient under favorable conditions of normal sowing. By adopting improved technology, the crop may yield 5-6 t grain and 7-8 t straw/ha from dwarf wheat varieties under irrigated conditions.

A balanced fertilization program with macro and micronutrients in plant nutrition is very important in the production of high yield with high quality products (Babaeian *et al.*, 2012). The amount of micronutrients required by cereal crops is very small but it is essential for a healthy growth and life cycle completion. In India 47% of soils are potentially deficient in Zn, 12% in Fe, 3% in Mn (Text Book of Soil Science by ICAR, 2014). Micronutrients are involved in numerous physiological processes that are essential for plants. Micronutrients

consist of six essential elements: iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B) and molybdenum (Mo) (Hand Book of Agriculture by ICAR, 2010), (Rawashdeh *et al.*, 2015). These elements present in very small amounts in both soils and plants, but their role is regularly as important as the primary or secondary nutrients. Micronutrients such as iron, manganese and zinc have important roles in plant growth and yield of cereal crops. They are playing an important function in growth and development of plant. Actually, their necessary function in plant nutrition and rising soil productivity makes their significance ever greater. Micronutrient (Fe, Zn, and Mn) significantly improve the plants height, number of spike per plant, number of grain per spike, 1000-grain weight, grain yield, biological yield and harvest index. Micronutrients have prominent affects on dry matter, grain yield and straw yield in wheat (Cakmak *et al.*, 2010).

Iron has many important functions in plant growth and development, such as involvement in the biosynthesis of chlorophyll, respiration, chloroplast development and improves the performance of photo systems. It is an essential part of many enzymes. Iron also participates in the oxidation process that releases energy from sugars and starches and in responses that convert nitrate to ammonium in plant. It plays an essential role in nucleic acid metabolism (Hand Book of Agriculture by ICAR, 2010; Rawashdeh *et al.*, 2015). Mn utilized in enzyme activation, electron transport and in disease resistance (Khan *et al.*, 2010). Zn has been a key element for getting higher yields. Zinc is important to membrane integrity and phytochrome activities. Zinc is essential for sugar regulation and enzymes that control plant growth. Zn is a vital element for wheat growth and it activates some enzymes such as carbonic anhydrase, dehydrogenase, proteins and peptidase (Hafeez *et al.*, 2013).

Materials and Methods

The experiment on evaluating micronutrients chelates on wheat was conducted during Rabi season. The field trial was sown consequently for three years in field no. 25, 38, and 25 on 05.12.2012, 20.11.2013 and 29.11.14 respectively at Agricultural Research Station Farm, Sriganganagar which is comes under zone I b of Rajasthan. The Irrigated North-Western Plain Zone (I b) comprises of Sriganganagar and Hanumangarh districts of Rajasthan, is located between 28.4° to 30.3° N latitude and 72.3° to 75.3° E longitude. Total geographical area of zone I b is 2.06 million hectares in which 55 per cent of the cultivated area comes under canal command. Cotton-wheat under light textured soils and paddy-wheat under flood plain soils are the prime crop sequences in the zone I b. In the canal command area *Torrifluvents*, *Torripsamments* and *Calciorthids* are major soil groups. In the present paper, findings of research on status of zinc and its availability, response and requirement to crops (wheat, cotton and kinnar), production system (Wheat-Cotton), carried out over a span of time at Agricultural Research Station, Sriganganagar have been summarized. Initial studies have shown zinc deficiency in both rotation and further systematic survey established varying degree of zinc deficiency in *Torrifluvents*, *Torripsamments* and *Calciorthids* soil group falling under zone, the deficiency of zinc is correlated with high pH, low organic carbon content, CaCO_3 content and coarser nature of these soil groups. Under low (<0.60 ppm Zn) and medium (0.60 to 1.20 ppm Zn) status of available zinc in soils @ 24 kg/ha and 12 kg/ha ZnSO_4 respectively has recommended for wheat crop in Zone I b of Rajasthan (Prakash *et al.*, 2002).

The treatment consisted of nine combination of chelated micronutrients and their salts T₁: Control, T₂: Zn HEDP (17%) – 3 gm/liters of

water, T₃: Fe DTPA (7%) - 3 gm/litre of water, T₄: Mn EDTA (13%) - 3 gm/litre of water, T₅: Multi Micronutrient - 3 gm/litre of water, T₆: Soil application - 6 kg Zn/ha, T₇: Zinc sulphate spray @ 0.5 %, T₈: Iron sulphate spray @ 1.0 %, T₉: Manganese sulphate @ 0.5%. The trial was laid out in a randomized block design with four replications; wheat crop seed rate is 100-120 kg ha^{-1} . Raj.-1482 variety of wheat was used for sowing every year. All the agronomic practices were carried out uniformly to raise the crop. The wheat crop was harvested on 30.04.2013, 25.04.2014 and 19.04.2015, respectively. The foliar spray of chelated micronutrients and their salts of treatment protocol were given at vegetative stage and Flag leaf initiation. The 1st spray has been done on in January every year at Vegetative stage and 2nd spray on February and March every year at Flag leaf stage accordingly sprays of Zn HEDP (17%), Fe DTPA (7%) and Mn EDTA (13%) were applied on wheat crop. Similarly spray of Zn, Fe and Mn through their inorganic salts and that of multi-micronutrient mixture was also sprayed every year. During the course of experiment initial soil analysis data of the experimental soil were taken and these data given in table 1. These initial soil analysis of the experimental soil (Table 1, Mean of 3 years) showed that soils were neutral normal with regard to pH (Av. 8.22) and electric conductivity was 0.19 dS $^{-m}$. Soils were low in organic carbon content (Av.0.13%) and also low in available P_2O_5 (Av. 15.52 kg/ha) and high in available K_2O (Av. 350 kg/ha). The DTPA extractable Zn content in soil was low 0.44 ppm (<0.60 ppm critical limit) falling in deficient range of availability, similarly Fe content in soil was also low 3.46 ppm (<4.5 ppm critical limit) and Mn content in soil was normal 3.82 ppm (<3.5 ppm critical limit). Wheat crop data were recorded for grain, straw yield, ear length, thousand grain weights given in tables 2, 3, 4 and 5.

Results and Discussion

Micronutrient plays an important role directly and indirectly in plant growth and crop production, like: Zinc is required for the formation of certain microbial enzymes. The metal has shown to be a specific inducer for pyruvic carboxylase in *Rhizopus nigricans* and of alcohol dehydrogenase. Zn activates enzymes carbonic anhydrase and dehydrogenase. Zn plays a role in photosynthesis, protein synthesis and nitrogen metabolism. Zn involved in auxin production in plants. Iron plays a key role in enzyme systems (Haem enzyme, catalase, peroxidase and cytochromes). It plays an important role in photosynthesis, nitrogen assimilation. Manganese has a primary role in the

tricarboxylic acid cycle in oxidation and reduction reactions. Mn is known to activate a wide variety of enzymes. It is involved in water splitting reaction during photosynthesis. It plays a role in photosynthetic O₂ evolution, carbohydrate and protein synthesis. Mn is important for the growth of lateral roots by its role in cell elongation. Mn may play an important role in nitrogen metabolism. So micronutrients like Zn, Fe, Mn is very important as likes as other macro and micronutrients for plant growth and effective crop production in different ways (Text Book of Soil Science by ICAR, 2014). The results given in tables 2, 3, 4 and 5 indicate some of the important parameters of grain yield, straw yield, thousand grain weight and ear length of wheat crop.

Table.1 Initial soil characteristics of experimental field (Average of 3 Year)

Cropped Fields ARS Farm, SGNR	pH	E. C. (1: 2.5)	Org. C.	Avail. P ₂ O ₅	Avail. K ₂ O	DTPA – Zn	DTPA – Fe	DTPA – Mn
	(1: 2.5)	mhos/cm	(%)	(kg/ha)	(kg /ha)	(ppm)	(ppm)	(ppm)
Mean of 3 years	8.22	0.19	0.13	15.52	350	0.44	3.46	3.82

Table.2 Effect of different treatments on grain yield of wheat

Treatments	Grain Yield (q/ha)			
	12-13	13-14	14-15	Pooled
T1: NP Control	37.20	47.54	43.48	42.74
T2: Zn HEDP (17%) – 3 gm/litre of water	41.58	53.88	52.82	49.42
T3: Fe DTPA (7%) - 3 gm/litre of water	40.33	53.36	48.82	47.50
T4: Mn EDTA (13%) - 3 gm/litre of water	42.35	54.48	50.23	49.02
T5: Multi Micronutrient – 3gm/litre of water	42.65	50.37	49.25	47.42
T6: Soil application – 6 kg Zn /ha	44.11	51.00	47.42	47.51
T7: Zinc sulphate spray @ 0.5 %	42.42	53.60	50.28	48.77
T8: Iron sulphate spray @ 1.0 %	43.51	53.09	48.64	48.41
T9: Manganese sulphate @ 0.5%	42.01	52.83	49.26	48.03
Sem+-	1.17	1.42	1.56	0.63
C.D. at 5%	3.42	4.14	4.56	1.80

Table.3 Effect of different treatments on straw yield of wheat

Treatments	Straw yield (q/ha)			
	12-13	13-14	14-15	Pooled
T1: NP Control	76.00	85.00	55.44	72.15
T2: Zn HEDP (17%) – 3 gm/litre of water	87.11	98.47	65.57	83.72
T3: Fe DTPA (7%) - 3 gm/litre of water	75.57	96.46	60.48	77.50
T4: Mn EDTA (13%) - 3 gm/litre of water	75.98	91.68	65.29	77.65
T5: Multi Micronutrient – 3gm/litre of water	75.33	102.02	60.3	79.22
T6: Soil application – 6 kg Zn /ha	74.85	103.82	59.38	79.35
T7: Zinc sulphate spray @ 0.5 %	76.79	101.76	60.92	79.82
T8: Iron sulphate spray @ 1.0 %	76.52	94.89	63.82	78.41
T9: Manganese sulphate @ 0.5%	66.26	93.37	59.97	73.20
Sem+-	1.57	3.31	1.69	2.15
C.D. at 5%	4.59	9.66	4.92	6.40

Table.4 Effect of different treatments on thousand grain weight of wheat

Treatments	Thousand Grain Weight (gm.)			
	12-13	13-14	14-15	Mean
T1: NP Control	33.40	39.98	39.00	37.46
T2: Zn HEDP (17%) – 3 gm/litre of water	36.25	41.63	46.80	41.56
T3: Fe DTPA (7%) - 3 gm/litre of water	37.53	41.03	42.90	40.49
T4: Mn EDTA (13%) - 3 gm/litre of water	37.00	40.98	42.90	40.29
T5: Multi Micronutrient – 3gm/litre of water	35.80	41.34	44.60	40.58
T6: Soil application – 6 kg Zn /ha	37.75	40.74	41.70	40.06
T7: Zinc sulphate spray @ 0.5 %	37.50	41.46	44.50	41.15
T8: Iron sulphate spray @ 1.0 %	37.25	41.21	42.40	40.29
T9: Manganese sulphate @ 0.5%	35.20	41.80	45.70	40.90
Sem+-	0.85	0.30	1.30	0.55
C.D. at 5%	2.49	0.88	3.7	1.47

Table.5 Effect of different treatments on ear length of wheat

Treatments	Ear Length (Cm.)			
	12-13	13-14	14-15	Mean
T1: NP Control	11.53	12.41	9.4	11.11
T2: Zn HEDP (17%) – 3 gm/litre of water	12.25	13.25	10.4	11.97
T3: Fe DTPA (7%) - 3 gm/litre of water	11.83	12.93	9.8	11.52
T4: Mn EDTA (13%) - 3 gm/litre of water	12.25	12.73	9.7	11.56
T5: Multi Micronutrient – 3gm/litre of water	12.00	12.61	10.0	11.54
T6: Soil application – 6 kg Zn /ha	12.10	12.55	10.5	11.72
T7: Zinc sulphate spray @ 0.5 %	12.28	12.77	10.2	11.75
T8: Iron sulphate spray @ 1.0 %	11.85	12.80	10.2	11.62
T9: Manganese sulphate @ 0.5%	11.78	12.91	10.1	11.60
Sem+-	0.11	0.23	0.21	0.11
C.D. at 5%	0.33	N.S.	0.46	0.32

The grain yield, straw yield, thousand grain weight and ear length of wheat crop was significantly higher with spray of chelated micronutrients and salts over that of control. The maximum grain yield (49.42 q/ha) was found in the treatment T₂ that was significant but it is at par with treatments T₄, T₇, T₈ and T₉. The maximum straw yield (83.72 q/ha) was found in the treatment T₂ that was significant but it is at par with treatments T₃, T₄, T₅, T₆, T₇ and T₈. The maximum thousand grain weight (41.56 gm.) was found in the treatment T₂ that was significant but it is at par with treatments T₆ and T₇. The maximum ear length (11.97 cm.) was found in the treatment T₂ that was significant but it is at par with treatments T₃, T₄, T₇, T₈, and T₉. Grain yield, straw yield, ear length and thousand grain weights of wheat crop increased significantly with the application of Zn, chelated micronutrients and salts of micronutrients.

It was concluded from field trial that the application of Zn, chelated micronutrients and salts of micronutrients in the experiment the treatment combination T₂ Zn HEDP (17%) – 3 gm/liters of water, was found to be the best, in increasing grain yield (49.42 q/ha), straw yield

(83.72 q/ha), thousand grain weight (41.56 gm.) and ear length (11.97 cm.) of wheat crop. The treatment T₂ that was significantly higher as compared to other treatment combination.

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