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Response of Wheat Plants Grown in Alluvial Soil to Foliar Spraying of Some Nutrients and Yeast

[1]Mahmoud Mohamed EL-Sayed and [2]Ahmad M. A. Abd El-Monem

[1]Soil and Water Sci. Dept., Fac. of Agric., Al-Azhar Univ., Assiut, Egypt.
[2]Agronmy Dept., Fac. of Agric., Assiut Univ., (New valley) Egypt.

ABSTRACT

A field experiment laid in a split-plot design with three replications was conducted on a clay loam soil located at The Experimental Farm, Fac. of Agric., Al-Azhar Univ., Assuit, Egypt during two growing winter seasons of 2012/13 and 2013/14 to study the effect of foliar application of some nutrient (sulfur, S, copper, Cu and manganese, Mn) and yeast on wheat yield and its quality. The nutrients were assigned to the main plot, while yeast was distributed randomly in the sub plot, respectively. The foliar application of a mixture of sulfur, copper, manganese elements and/ or yeast on wheat plants realized a positive effect on their quantity and quality. The best treatment was the combination of mixture elements sprayed once with yeast sprayed twice (N_1Y_2 treatment) since it realized the highest wheat yield (grain + straw) that being 10.40 ton/ fed. followed by the combination of mixture elements and yeast sprayed twice (N_2Y_2 treatment) that gave wheat yield 10.30 ton/ fed. The highest value of water use efficiency was recorded in treatment N1Y2 (1.74 kg/m3) and in treatment N2Y2 (1.68 kg/m3). Those treatments increased wheat yield by almost 40 % compared to control treatment. Also, these treatments realized the highest protein content that being 15.79 and 15.05% for N_1Y_2 and N_2Y_2 treatment, respectively. The protein content increased by 24.72 and 18.88% for the corresponding treatments compared to the control one.

Key words: Wheat, S, Cu and Mn foliar spraying, Yeast, Water use efficiency.

Introduction

Wheat is considered the most strategic crop for Egypt and some other developing countries. Increasing wheat production is a national target for Egyptian to fill the gap between wheat consumption and production. Great attention and efforts have been paid by the Egyptian government and scientists to narrow this gap. Wheat is the major source of plant based human nutrition and a part of daily dietary need in one form or another (Khan *et al*., 2000). Micronutrients play a pivotal role in the yield improvement. They are needed in trace amounts but their adequate supply improves nutrients availability and positively affects the cell physiology that is reflected in yield as well (Taiwo *et al*., 2001; Adediran *et al*., 2004 and Rehm and Sims, 2006). Micronutrient deficiency has become a major constraint for crop productivity that may either be primary, due to their low total contents or secondary, caused by soil factors that reduce their availability to plants (Sharma and Chaudhary, 2007).

Khan *et al*. (2006) reported that Cu, Fe, Mn and Zn contents of leaf, straw and wheat grain increased with the application of mineral fertilizers. Kumar *et al*. (2009) depicted that Cu fluxes and its interactions with other micronutrients such Mn affects the growth and yield of wheat plants while Cu excess may induce the deficiency of other micronutrients and adversely affect the yield. Sulfur is one of the essential nutrients for plant growth and it accumulates in plant tissue by about 0.2 to 0.5% on dry matter basis. It is required in similar amount as that of Phosphorus. Elemental S and sulphate fertilizers increased wheat grain yield by 36% (Riley *et al*., 2000; De Kok *et al*., 2002 and Ali *et al*., 2008).

Dry yeast is a natural bio-substance suggested to have stimulating, nutritional and protective functions when used on vegetables. Foliar application of yeast was found to increase growth, yield and quality of many vegetable crops. Yeasts have been reported to be enriched source of phytohormones (especially cytokinins), vitamins, enzymes, amino acids and minerals. It was also reported about its stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation. Yeast extract is a natural component contains many of the nutrient elements and cytokininis, which is safe and non-pollutant. It has a considerable amounts of amino acids; mineral elements, carbohydrates, reducing sugars, enzymes and vitamins B1,2,3,12 (Mahmoud, 2001; Khedr & Farid, 2002; Kabeel *et al*., 2005 and Fawzy, 2007). The main objective is to study the effect of the foliar applications by some nutrients, yeast and their interactions on wheat plants, its quality and Water use efficiency.

Corresponding Author: Mahmoud Mohamed EL-Sayed, Soil and Water Sci. Dept., Fac. of Agric., Al-Azhar Univ., Assiut, Egypt.

Materials and Methods

A field experiment was conducted at The Agric. Exp. Farm of Al-Azhar Univ., Assiut, Egypt during 2012/13 and 2013/14 winter seasons. The current work aimed to study effect of the foliar application frequency (none, once and twice) by mixture of some nutrients (S, Cu and Mn) at a rate of 1.2 kg/ fed. to get a concentration of 15.3, 6 and 26% for the corresponding nutrients and yeast. Yeast has been the development of a strain of yeast in 2 liters of liquid Media was then eased 10 times the water to obtained yeast extracts according to Fehr *et al*. (1971). The experiment was laid out in split plot design with three replicates. The main plots were devoted to nutrients. The split units were assigned for yeast. All treatments were randomly distribution on the respective plots (Plot area was 50 m^2). Foliar applications of yeast and nutrients were made using a hand-held spray bottle with a volume of 4 L applied per plot. Foliar application (200 L/ fed) was sprayed twice; The first one after 45 days from sowing (before tillering stage) and the 2nd 30 days later. Foliar application treatments were as follows:-

- 0-0 = no nutrients nor yeast application (control, C).
- 1-0 = one foliar applications of nutrients (N_1).
- 2-0 = two foliar applications of nutrients (N_2).
- 0-1 = one foliar applications of yeast (Y_1).
- 0-2 = two foliar applications of yeast (Y_2).
- 1-1 = one foliar applications of nutrients + yeast (N_1Y_1).
- 1-2 = one foliar applications of nutrients + two yeast (N_1Y_2).
- 2-1 = two foliar applications of nutrients + one yeast (N_2Y_1).
- 2-2 = two foliar applications of nutrients + yeast (N_2Y_2).

Wheat seeds (*Triticum aestivum vulgar, CV Sids-12*) were sown on 3rd and 8th December 2012 and 2013, respectively in rows spaced 15 cm in alluvial soil. The relevant chemical and physical soil properties according to Page *et al*. (1982) and Klute (1986) are shown in table (1a & b). The plants were harvested manually after 140 days from planting. All the agronomic practices were applied as commonly used. The recommended NPK fertilizers were added at a rate of 80 kg N, 38 kg P_2O_5 and 50 kg K_2O/ Fed. The irrigation was practiced whenever the soil moisture depletion reached 60% of field capacity.

Table 1: Some physical and chemical properties of the field experiment.

A- Physical properties.

Soil depth (cm)	Particles distribution (%)			Texture class	OM (%)	$CaCO_3$ (%)	AW (%)	BD (g/cm^3)
	Sand	Silt	Clay					
0-30	25	40	35	Clay loam	1.21	3.40	22.00	1.30
30-60	25	41	34	Clay loam	0.70	2.25	21	1.40

OM = organic matter AW= available water BD= bulk density

B- Chemical properties:

Soil depth (cm)	SP	pH	EC (dS/m)	Soluble ions (meq./L)							SAR
				CO_3+HCO_3	Cl	SO_4	Ca	Mg	Na	K	
0-30	0	7.89	1.1	2.80	1.50	6	2.65	1.30	5.65	0.15	4.0
30-60	2	7.88	1.0	2.70	1.20	5.8	2.60	1.15	5.50	0.21	4.02

SP= saturation percent SAR= sodium adsorption ratio

Field capacity (FC) and permanent wilting point (PWP) were determined using the pressure cooker and pressure membrane apparatus. A saturated undisturbed and disturbed soil samples was equilibrated at suction pressures of 0.33 and 15 bar, respectively, according to Shawky (1967). The available water capacity (AWC) of a soil is the amount of water retained in the soil reservoir that can be removed by plants. This was calculated by the differences in water content at field capacity and permanent wilting point as follows:

AWC = FC – PWP

The values of Water use efficiency (WUE) for wheat and sunflower were calculated according to Vites (1965). as follows:

WUE = Seed yield (Kg/fed.) / Seasonal crop consumptive use (m^3/fed).

Field Water use efficiency (FWUE) is expressed as Kg seeds/m^3 of water applied.

Water application efficiency was calculated using the formula of James (1988) as follows:

$E_a = (R_z/ d_w)* 100$

$R_z = D (\theta_{fc} – \theta_i) /100$

Where Ea = efficiency of application %

Rz = amount of water stored in the root zone (mm)

dw = depth of applied water (mm)

D = root zone depth (mm)

θ_{fc} and θ_i = volumetric water content in percent at field capacity and prior to irrigation, respectively.

At harvesting, five plant samples were picked and kept in a paper bag for traits recorded (plant height, spike length, grain weight/ spike, grain number/ spike and seed index. Four square meter from each plot were harvested and left one week until fully air dried and grain and straw yields were used to estimate yield ton /fad. Nitrogen was extracted by K-sulphate and determined using the microkjeldahl method according to Jackson (1973). Protein percentage was calculated by multiplying the N % by 6.25 (Hymowitz *et al*. 1972). Obtained data were statistically analyzed as outlined by Gomez and Gomez (1984) using means of "MSTAT-C" computer software program package according to Freed *et al*. (1989).

Results and Discussion

Plant height

Data shown in Table (2) revealed that foliar application of nutrients realized highly significant influence on plant height. The plant height increased by 7.83 and 3.89% when treated once and twice by nutrients, respectively compared to control treatment. Plant height treated by nutrient spray once was superior to that treated twice. This may be due to the timing of 2nd spraying inhabited plant height and / or higher nutrient doses slow down plant growth Kumar *et al*. (2009).

Table 2: Some wheat plant traits response to nutrients and yeast foliar application.

Treatments	Plant height (cm)	Spike length (cm)	Grain Number/spike	Grain weight/spike (g)
C	98.56	11.99	71.61	2.87
N1	106.28	12.13	70.00	3.16
N2	102.39	12.14	67.00	3.38
Average	104.34	12.14	68.50	3.27
Y1	105.00	12.02	69.56	3.19
Y2	104.17	12.58	69.56	3.36
Average	104.59	12.30	71.25	3.28
N1Y1	110.50	11.88	68.00	3.13
N1Y2	103.50	12.65	72.83	3.28
Average	107.00	12.27	70.42	3.21
N2Y1	108.33	12.00	64.83	3.21
N2Y2	103.33	12.52	62.17	3.30
Average	105.83	12.26	63.50	3.26
F-Test	**	N.S.	**	*

Also, plant height was highly significant responded to yeast foliar applications (Table 2). The plant height increased by 6.53 and 5.69% when yeast sprayed once and twice, respectively compared to control treatment. There was no significant difference in plant height as a result of repeated yeast spray. On average basis, plant height almost responded equal when plant treated by nutrients or yeast spray.

Using a mixture of nutrients and yeast as a foliar application realized higher plant height than that when spared each material separately. The highest values of plant height were obtained when wheat plants sprayed by nutrients and yeast once (110.50 cm) and nutrients twice and yeast once (108.33 cm). This means that foliar application of nutrients is the dominant effective factor that might shadow the effect of yeast spray.

Spike characters:

Data shown in Table (2) revealed that foliar application of nutrients or yeast to wheat plant exerted a highly significant influence on grain number/ spike and significant influence on grain weight/ spike. While**,** foliar application of nutrients or yeast to wheat plant realized no significant effect on spike length. Spike length responded to foliar application of yeast twice more than other treatments. The spike length increased by 4.92, 5.50 and 4.42% when wheat plants treated by yeast twice, nutrients once & yeast twice and both nutrients & yeast twice, respectively (Table 2). Most foliar application treatments pressed down the grain number/ spike compared to control treatment. Wheat plants sprayed twice by nutrients or yeast realized the highest value of spike grain weight compared to the control treatment. The spike grain weight increased by almost 17 % when plants treated twice by either nutrients or yeast (Table 2). The mixture spray of nutrients and yeast depressed the spike grain weight compared to that sprayed by nutrients or yeast separately.

Seed index (weight of 100 grain):

The combined data in Table (3) show that the foliar application of nutrients or yeast did not exert any significant effect on wheat seed index. In general, the 2nd foliar application of nutrients or yeast realized an increase in wheat seed index compared to only one foliar application of any used material. Also, yeast foliar application was superior to that of nutrients. On average basis, wheat seed index increased by 2.31 and 3.70%

by foliar application of nutrients and yeast, respectively. Wheat seed index positively responded to the foliar application by both materials especially when wheat plants sprayed twice. Wheat seed index increased by 4.63 and 6.94% in N_1Y_2 and N_2Y_2 treatment, respectively compared to control treatment.

Protein content:

Data in Table (3) show that the foliar application of nutrients or yeast did not exert any significant effect on protein content compared to control treatment. On average basis, protein content increased by 7.90 and 9.04% by foliar application of nutrients and yeast, respectively. Protein content positively responded to the foliar application by both materials. Protein content increased by 24.72 and 18.88% in N_1Y_1 and N_2Y_2 treatment, respectively compared to control treatment. Similar results have also been reported by Khan *et al*. (2006) and Fawzy, (2007).

Table 3: Wheat quality and yield response to nutrients and yeast foliar application.

Treatments	Seed index	Protein %	Grain yield (ton/fad.)	Straw yield (ton/fad.)
C	4.32	12.66	3.08	4.29
N1	4.34	13.58	3.48	5.54
N2	4.50	13.74	3.76	5.55
Average	4.42	13.66	3.62	5.55
Y1	4.46	13.86	3.65	5.64
Y2	4.51	13.75	3.76	5.78
Average	4.48	13.81	3.71	5.71
N1Y1	4.41	15.08	3.74	6.15
N1Y2	4.52	15.79	3.96	6.44
Average	4.47	15.44	3.85	6.30
N2Y1	4.51	14.25	3.77	6.47
N2Y2	4.62	15.05	3.82	6.48
Average	4.57	14.65	3.80	6.48
F-Test	N.S.	N.S.	*	*

Grain yield:

The combined data in Table (3) show that the foliar applications of nutrients or yeast exert a significant effect on wheat grain yield. In general, the 2nd foliar application of nutrients or yeast realized an increase in grain yield compared to only one foliar application of any used material. Also, yeast foliar application was superior to that of nutrients. On average basis, grain yield increased by 17.53 and 20.29% by foliar application of nutrients and yeast, respectively. Grain yield positively responded to the foliar application by both materials especially when wheat plants sprayed twice. Grain yield increased by 28.57 and 24.03% in N_1Y_2 and N_2Y_2 treatment, respectively compared to control treatment. Similar results have also been reported by Mahmoud, (2001), Ali *et al.* (2008) and Nadim *et al*. (2012).

Straw yield:

Data in Table (3) show that the foliar applications of nutrients or yeast exert a significant effect on wheat straw yield. In general, the 2nd foliar application of nutrients or yeast realized an increase in straw yield compared to only one foliar application of any used material. Also, yeast foliar application was superior to that of nutrients. On average basis, straw yield increased by 29.25 and 33.10% by foliar application of nutrients and yeast, respectively. Straw yield positively responded to the foliar application by both materials especially when wheat plants sprayed twice. Straw yield increased by 50.12 and 51.05% in N_1Y_2 and N_2Y_2 treatment, respectively compared to control treatment.

Water application efficiency:

The seasonal amount of irrigation water applied (IWA) practiced by was almost the game for all treatment being around 2970 m^3 /fed. (Table4). Also the seasonal amount of water consumptive use by wheat plants was almost some for all treatments being around 2280 m^3/fed. (Table 4). The obtained results showed that the water application efficiency was about 76.70 % which is considered quite high for flooding irrigation. This may be attributed to controlled irrigation that almost was practiced whenever the soil moisture depletion reached 60 %of field capacity.

Data in table (4) and figure (1) showed that the average value of field water use efficiency (FWUE) ware 1.22 and 1.25 kg/m^3 for application of nutrients and yeast, respectively. On average basis FWUE increased 17.31 and 20.19% for the corresponding treatments compared to control treatment. The highest value of FWUE was recorded in treatment N_2Y_2 (1.29 kg/m^3).

Water use efficiency (WUE) was significant affected by nutrients and yeast application (Table 4) and figure (2). On average basis the values of WUE were 1.49 and 1.63 kg/m^3 for application nutrients and yeast,

respectively. It increased by 17.78 and 20.74 for the corresponding treatments compared to control one. The highest value of WUE was recorded in treatment N_1Y_2 (1.74 kg/m^3) and in treatment N_2Y_2 (1.68 kg/m^3).

Table 4: Water use efficiency as affected by foliar application of some nutrients and yeast on wheat plants.

Treatment	Grain yield ton/fed	Irrigation water applied (m3/fed.)	Water consumptive use (m3/fed.)	Water application efficiency %	Field water use efficiency (kg/m3)	Water use efficiency (kg/m3)
C	3.08	2970	2288	76.7	1.04	1.35
N1	3.48				1.17	1.53
N2	3.76				1.27	1.65
Average	3.62				1.22	1.59
Y1	3.65				1.23	1.60
Y2	3.76				1.27	1.65
Average	3.71				1.25	1.63
N1Y1	3.74				1.26	1.64
N1Y2	3.96				1.33	1.74
Average	3.85				1.30	1.69
N2Y1	3.77				1.27	1.65
N2Y2	3.82				1.29	1.68
Average	3.80				1.28	1.67
F- Test	*				*	*

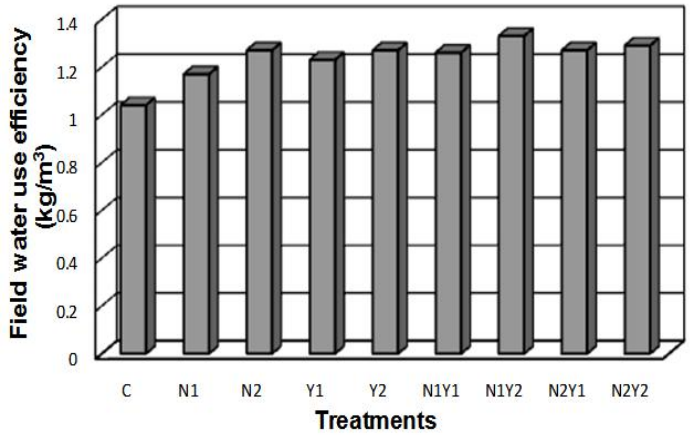

Fig. 1: Field water use efficiency as affected by foliar application of some nutrients and yeast on wheat plants.

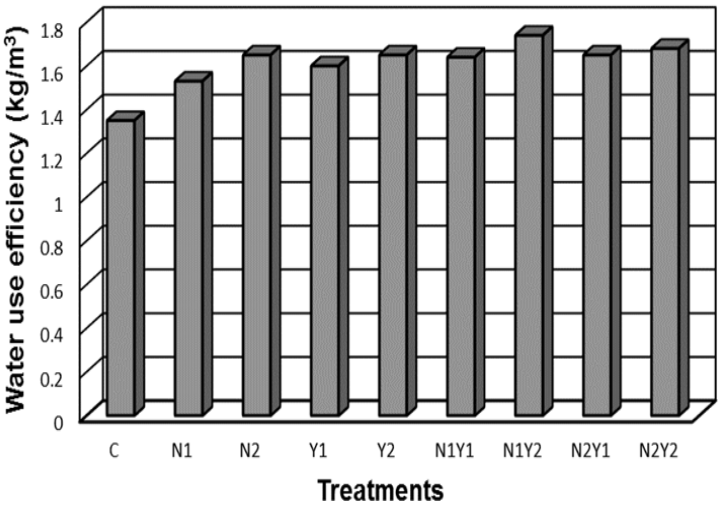

Fig. 2: Water use efficiency as affected by foliar application of some nutrients and yeast on wheat plants.

Conclusion

It might be concluded that spraying a mixture of sulfur, copper, manganese elements and/ or yeast on wheat plants realized a positive effect on their quantity and quality. The best treatment was the combination of mixture elements sprayed once with yeast sprayed twice (N_1Y_2 treatment) since it realized the highest wheat yield (grain + straw) that being 10.40 ton/ fed. followed by the combination of mixture elements and yeast sprayed twice (N_2Y_2 treatment) that gave wheat yield 10.30 ton/ fed. Those treatments increased wheat yield by almost 40 % compared to control treatment. The highest value of water use efficiency was recorded in treatment N1Y2 (1.74 kg/m3) and in treatment N2Y2 (1.68 kg/m3). Also, these treatments realized the highest protein content that being 15.79 and 15.05% for N_1Y_2 and N_2Y_2 treatment, respectively. The protein content increased by 24.72 and 18.88% for the corresponding treatments compared to the control one.

References

Adediran, J.A., L.B. Taiwo, M.O. Akande, O.J. Idowu and R.A. Sobulo, 2004. Application of organic and inorganic fertilizer for sustainable yield of maize and cowpea in Nigeria. J. Plant Nut, 27(7): 1163-1181.

Ali, R., M.J. Khan and R.A. Khattak, 2008. Response of rice to different sources of Sulfur (S) at various levels and its residual effect on wheat in rice-wheat cropping system. Soil Environment, 27(1): 131-137.

De Kok, L.J., A. Castro, M. Durenkamp, C.E.E. Stuiver, S. Westerman, L. Yang and I. Stulen, 2002. Sulphur in plant physiology. Proceedings No. 500, The International Fertilizer Society, York, 1-26.

Fawzy, Z.F., 2007. Increasing productivity of head lettuce by foliar spraying of some bio- and organic compounds. Egypt. J. Appl. Sci., 22(10A): 237-247.

Fehr, W.R., C.E. Caviness, D.T. Burmood and J.S. Pennington, (1971). Stages of development descriptions for soybean. Crop Sci., 11: 929–930.

Freed, R.S.P., S. Eisensmith, D. Goetz, V. Reicosky, W. Smail, P. Wolberg, 1989. User's Guide to MSTAT-C: A Software Program for the Design, Management and Analysis of Agronomic Research Experiments Michigan State University, East Lansing, ML, USA.

Gomez, K.A., A.A. Gomez, 1984. Statistical Procedures for Agricultural Research. 2nd ed., New York: John Wiley and Sons, Inc, 108-116.

Hymowitz, T.F., P. Collins, W.M. Walker, 1972. Relationship between the content of oil, protein and sugar in soybean seed. Agronomy J., 64: 613 – 616.

Jackson, M.L., 1973. Soil Chemical Analysis. 1st Edn., Prentice Hall Ltd., New Delhi, India, 498.

James, L.G., 1988. Principles of farm irrigation systems design. Washington State University, 543.

Kabeel, M.M., S.M.A. and M.A. Fayza, 2005. Effect of organic and biofertilizer on growth, yield and fruit quality of cucumber grown under clear polyethylene low tunnels. J. Agric. Sci. Mansoura Univ., 30(5): 2827-2841.

Khan, H., Z.U. Hassan and A.A. Maitlo, 2006. Yield and micronutrients content of bread wheat (*Triticum aestivum* L.) under a multi-nutrient fertilizer Hal-Tonic. Intl. J. Agric. Biol., 8(3): 366-370.

Khan, M.A., I. Hussain and M.S. Baloch, 2000. Wheat yield potential – current status and future strategies. Pakistan J. Biol. Sci., 3(1): 82-86.

Khedr, Z.M.A. and S. Farid, 2002. Response of naturally virus infected tomato plants to yeast extract and phosphoric acid application. Annals of Agric. Sci. Moshtohor. Egypt, 38(2): 927-939.

Klute, A., 1986. Methods of soil analysis. Part 1: Physical and mineralogical methods (2nd edition). American Society of Agronomy Inc., Madison, Wisconsin, USA.

Kumar, R., N.K. Mehrotra, B.D. Nautiyal, P. Kumar and P.K. Singh, 2009. Effect of copper on growth, yield and concentration of Fe, Mn, Zn and Cu in wheat plants (*Triticum aestivum* L.). J. Environ. Biol., 30(4): 485-488.

Mahmoud, T.R., 2001. Botanical studies on growth and germination of Magnolia (Magnolia grandiflora L.) Plants. M.Sc. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., 103.

Nadim, M.A., I.U. Awan, M.S. Baloch, E.A. Khan, K. Naveed and M.A. Khan, 2012. Response of wheat (*Triticum aestivum* L.) to different micronutrients and their application methods. The Journal of Animal & Plant Sciences, 22(1): Page: 113-119 ISSN: 1018-7081

Page, A.L. (Ed), 1982. Methods of Soil analysis. Part 2: Chemical and microbiological properties ,(2nd Ed). Am. Soc. At Agron. Inc. Soil Sci. Soc. Of Am., Madison, Wisconsin, USA.

Rehm, G. and A. Sims, 2006. Micro-nutrients and production of hard red spring wheat. Minnesota Crop News, Univ. of Minnesota.

Riley, N.G., F.J. Zhao and S.P. McGrath, 2000. Availability of different forms of sulfur fertilizers to wheat and oilseed rape. Plant and Soil, 222(1/2): 139-147.

Sharma, J.C. and S.K. Chaudhary, 2007. Vertical distribution of micronutrient cations in relation to soil characteristics in lower shivaliks of Solan district in North-West Himalayas. J. Ind. Soc. Soil Sci., 55: 40-44.

Shawky, M.E., 1967. Micro and macro pore-space distribution in profiles of typical Egyptian soils and factors affecting them. M.SC. Thesis, Fac. of Agric., Cairo Univ., A.R.E.

Taiwo, L.B., J.A. Adediran, M.O. Akande, V.A. Banjoko and G.A. Oluwatosin, 2001. Influence of legume fallow on soil properties and yield of maize in south-western Nigeria. J. Agric. Tropics & Subtrop. 102(2): 109-117.

Vites, F.G., 1965. Increasing water use efficiency by soil management. America Society Agronomy, Madison, Wisconsin, 259-274.