Effect of Foliar and soil Application of sulfur on Growth, Yield, and Photosynthetic Pigments of the Wheat plant

Zhian R. Salih Maqsuda K. Mohammad Trefa Z. Sabir
University of Salahaddin- Erbil
College of education
Dept of Biology

Abstract

The present study was done to investigate the effect of foliar and soil application of pure sulfur (0, 5, 10, 15, 20, 25, and 30 ppm) on vegetative growth, yield, and photosynthetic pigments in leaves of wheat plant. A completely randomized design with three replications of each treatment was applied. The results showed that the vegetative growth and yield parameters (number of tiller/plant, number of leaves/plant, flag leaf area/plant, number of spike/plant, weight of spike, grain number, grain weight and shoot dry weight) were increased significantly with the concentration 15 and 20 ppm of sulfur compared to the control plants. Foliar and soil sulfur application significantly increased chlorophyll a, chlorophyll b, total chlorophyll, in the leaves and nitrogen and protein contents of seeds with increasing the concentration of the sulfur.

Keywords: Sulfur, Wheat, Foliar application, Growth, Photosynthetic pigments

Introduction

Wheat (*Triticum aestivam* L.) belongs to the genus Triticum, a member of poaceae family (1). Bread wheat is annual, grass plant (2). The plant consists of a central stem from which leaves emerge at opposite sides; tillers are produced on the main stem of plant (3). Wheat is one of the most abundant sources of energy and proteins for the world population used for preparation of bread and other baked products (4). Each l00 g of wheat kernels contain 340 calories, 13 gm H_2O, 11.7gm Proteins, 2.2 gm Fat, 72 gm total Carbohydrate, 2 gm Fiber, 1.7 gm Ash 40 mg Ca, 377 mg P, 3.5 mg Fe, 400 mg K, 0.55 mg Thiamine, 0.11 mg Riboflavin and 4.8 mg Niacin (5).

Sulfur is recognized as the fourth major nutrient after N, P and K. Quality of food grain is a complex phenomenon and may be influenced by several factors which may be genetic and/or environmental. N as well as S are utmost important constituents of plant proteins and are required throughout the crop growth period from vegetative stage to subsequent harvesting. Foliar fertilization, that is nutrient supplementation through leaves, is an efficient technique of fertilization which enhances the availability of nutrients. It has been observed that utilization of fertilizers especially urea applied through soil is not as effective as when it is supplied to the plants through foliage along with soil application (6).

Sulfur deficiency significantly effects the production and quality of wheat (7). Without adequate sulfur, crops can’t reach their full potential in terms of yield, quality or protein content; nor can they make efficient use of applied nitrogen (8). At high N fertilization by nitrogen and sulfur fertilization. Levels significant responses to sulfur fertilization were found which emphasized the need for precision application of sulfur in intensive wheat production systems. Continued use of N fertilizer without supplemental sulfur on low sulfur soils will reduce flour quality (9). Sulfur does not affect only N utilization and grain quality, but it also plays an important part in the formation of the baking quality (10).

Reproductive growth of wheat appears to be more sensitive to sulfur deficiency than vegetative growth, with decreased grain size under S limiting condition. In addition to the effects of yields, the sulfur status of wheat grain is an important parameter for the quality of wheat products (7). Sulfur deficiency in crop plants has been recognized as a limiting factor not only for crop growth and seed yield but also for poor quality of products, because S is a constituent of several essential compounds such as cysteine, methionine, coenzymes etc. It was also shown that sulfur application altered the amino acid composition with a greater proportion of sulfur containing cysteine and methionine (11).

The aim of this study is to investigative the effect of different concentration of sulfur on vegetative growth, yields and photosynthetic pigments in leaves of wheat which were applied by foliar and soil methods.

Materials and Methods

This study was carried out in the glass house of biology department College of Education-Sciences departments University of Salahaddin-Erbil, during 23 November / 2011 to 15th April / 2012 to study the effect of sulfur on growth, yield and photosynthetic pigments in leaves of wheat plants(*Triticum aestivum* L.). The plastic pots with diameter of 24cm and 21cm in depth were used in the experiment. Each pot was filled with 7 kg of dried sandy clay soil. In each pot 3 seed were sown, NP fertilizer were added before sowing as Di-ammonium phosphate (DAP) which contain 18% N and 46% P at the level of 50 ppm and 30 ppm K as potassium chloride 52.34 % K. Sulfur solution was prepared by dissolving 1 gm of pure sulfur in few milliliters then completed to 1000 ml with D.W and then a series of concentration 0, 5, 10, 15, 20, 25, and 30 ppm were prepared from the stock solution. Two drops of tween 40 were added to each spray solution. Foliar application of sulfur was carried out twice after tillering and flowering from sowing in early morning hours by small handed sprayer and soil sulfur applicated at the same time. Total nitrogen was determined by Kjeldahl method (12). Total protein was calculated by multiplying the total nitrogen by the factor 6.25 (13). The photosynthetic pigments (chlorophyll a, and chlorophyll b were estimated by the spectrophotometric method recommended by (14).

The data were statistically analyzed according to completely randomized designs (C.R.D) with three replications. The statistical analyses were carried out using SPSS program (version 13.0). Duncan test was used to compare between the means treatment.

Results and Discussion

Tables (1 and 2), showed the effect of soil and foliar application of sulfur on vegetative growth and yields of wheat. There are significant increases in number of tiller/plant, number of leaves /plant, flag leaf area/plant, number of spike/plant, weight of spike, grain number, grain weight and shoot dry weight with increasing the concentration of the sulfur in compare with the control groups and the higher growth and yields were observed with the concentration of 15 and 20 ppm of sulfur. Deficiency of sulfur has been recognized as a limiting factor for crop production in many regions in the world. The sulfur requirement of wheat is about 15-20 kg/ha for optimum growth. Reproductive growth of wheat appears to be more sensitive to sulfur deficiency than vegetative growth, with decreased grain size under sulfur-limiting conditions (15).

Decreasing sulphur deposition from the air, and the use of more concentrated phosphate fertilizers that contain less sulphur, has led to reports of sulphur deficiencies in winter wheat. Sulphur deficiency significantly effects the production and quality of winter wheat (16). Without adequate sulphur, crops can't reach their full potential in terms of yield, quality or protein content; nor can they make efficient use of applied nitrogen (8). At high nitrogen fertilization levels significant responses to sulphur fertilization were found which emphasised the need for precision application of sulphur in intensive wheat production systems. Continue use of nitrogen fertilizer without supplemental (17). Sulphur deficiency in crop plants has been recognized as a limiting factor not only for crop growth and seed yield but also for poor quality of products, because sulphur is a constituent of several essential compounds such as cysteine, methionine, coenzymes, thioredoxine and sulfolipids. It was shown that sulphur application altered the amino acid composition with a greater proportion of sulphur containing cysteine and methionine (11).

Sulphur deficiency decreases grain size and baking quality because of formation of disulfide bonds formed from the sulphydryl groups of cysteine. This affects the viscoelasticity of dough (7). The baking quality of wheat was improved by sulphur application, showing high correlation between loaf volume and the sulphur content of grain and thus improving rheological properties (extensibility) of dough (11). Sulphur deficit may result in harder grain; the dough made from such grain is usually stiff and is not elastic (10). Recent studies have also shown that bread making quality correlated more closely with grain sulphur concentration than with nitrogen concentration (16). A synergistic effect between the applied nitrogen and sulphur fertilizers appears to increase nitrogen and sulphur assimilation in wheat grain and may improve bread making qualities. When nitrogen and sulphur fertilizers were applied simultaneously, flour protein content and dough strength, swelling and extensibility were increased (18).

The effects of sulfur on nitrogen and protein contents of the seeds were showed in table (3). There are significant increases in nitrogen and protein contents of the seeds with concentrations 15, 20, 25 and 30 ppm. Sulfur is an essential component in the synthesis of amino acids required to manufacture proteins. Sulfur is also required for production of chlorophyll and utilization of phosphorus and other essentials nutrients. Sulfur ranks equal to nitrogen for optimizing crop yield and quality. It increases the size and weight of grain crops and enhances the efficiency of nitrogen for protein utilization. Sulfur increases yield and protein quality of forage and grain crops along with production and quality of fiber crops (19). Sulfur does not affect only nitrogen utilization and grain quality, but it also plays an important part in the formation of the baking quality (20). Another biologically ubiquitous element, playing critical structural roles in several amino acids and in compounds involved in electron transfer in photosynthetic and respiration. Sulfur is also a structural component of specialized enzyme related molecules (21).

The effect of sulfur on photosynthetic pigments of the leaves were observed in table (4), there are significant increases in the chlorophyll a, chlorophyll b and total chlorophyll in the leaves of the plants treated with 20, 25, and 30 ppm of sulfur concentration compare with the control and other treated groups. Sulfur aids in the synthesis of oils and appears to be associated with chlorophyll synthesis. Sulfur is a constituent of ferridoxin and of some lipids found in chloroplast. Sulfur bridges (-S-S-) have an important role in determining protein structure and sulphydryl groups (-SH) are often part of the active centres of enzymes (22).

(23) Reported a negative correlation between leaf chlorophyll and leaf sulfur concentration in a Mediterranean forest. Sulfur is predominantly absorbed from the soil solution as sulfate anion (SO_4^{2-}) by plants and transported to chloroplasts in expanding leaves, where most S reduction is reported to occur (24). The formation of yield is affected by the content of chlorophyll in leaves. A typical sign of sulphur deficiency is the decrease of chlorophyll in young leaves. In the trials on break-stony soil there was a clear distinction between the variants of sulphur fertilized and non-fertilized trial plots. At the ear emergence stage the chlorophyll content of wheat leaves increased due to different sulphur application

rates in the conditions of 2004 by 42-54% and in 2005 by 14-26%. Of yield structure elements the number of productive sprouts, the number of grains per ear and the 1000-grains mass are of importance, as they affect the yield (25).

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Table (1): Effect of soil and foliar application of sulfur on vegetative growth of Wheat

Concentration of sulfur (ppm)	Plant height (cm^2)	Number Of tiller/plant	Number of leaves/plant	Flag leaf area/plant (cm^2)
Control (0)	51.00 [a]	1.33 [a]	9.33 [b]	27.86 [a]
5	52.45 [a]	2.00 [a]	9.33 [b]	33.10 [a]
10	50.75 [a]	2.00 [a]	11.00 [b]	40.47 [b]
15	50.33 [a]	3.00 [b]	12.00 [b]	41.90 [b]
20	53.24 [a]	2.66 [b]	9.00 [b]	43.77 [b]
25	49.00 [a]	2.00 [a]	4.00 [a]	40.70 [b]
30	49.33 [a]	2.00 [a]	2.33 [a]	40.97 [b]

Table (2): Effect of soil and foliar application of sulfur on yields of wheat

Concentration of sulfur (ppm)	Length of spike (cm^2)	Number of spike /plant	Weight of spike (gm)	Grain number/ spike	Grain weight (gm)	Shoot dry weight (gm)
Control (0)	8.86 [a]	0.61 [a]	1.89 [a]	52.00 [a]	1.13 [ab]	1.95 [a]
5	9.66 [a]	0.77 [a]	1.67 [a]	42.00 [a]	1.89 [b]	2.26 [a]
10	9.44 [a]	0.94 [a]	2.66 [b]	65.00 [b]	1.76 [ab]	4.83 [b]
15	10.26 [a]	1.23 [b]	3.66 [c]	70.00 [b]	2.92 [c]	5.84 [c]
20	9.26 [a]	1.31 [b]	3.66 [c]	87.00 [c]	2.78 [c]	5.82 [c]
25	10.58 [a]	1.17 [b]	3.00 [c]	117.00 [d]	1.65 [b]	4.50 [b]
30	8.77 [a]	1.20 [b]	2.70 [b]	110.00 [d]	1.72 [b]	4.25 [b]

Table (3): Effect of soil and foliar application of sulfur on seed nitrogen and protein contents of wheat

Concentration of sulfur (ppm)	Nitrogen (mg/100gm)	Protein (mg/100gm)
Control (0)	16.59 [a]	94.56 [a]
5	17.24 [a]	98.28 [a]
10	16.39 [a]	93.47 [a]
15	18.25 [ab]	104.05 [ab]
20	20.13 [b]	114.75 [b]
25	22.60 [b]	128.83 [b]
30	22.65 [b]	128.89 [b]

Table (4): Effect of soil and foliar application of sulfur on photosynthetic pigments of the leaves of wheat

Concentration of sulfur (ppm)	Chlorophyll a µg /gm	Chlorophyll b µg /gm	Total chlorophyll (a+b) µg/gm
Control (0)	0.705 [a]	0.115 [a]	0.815 [a]
5	0.925 [a]	0.135 [a]	1.060 [a]
10	0.975 [a]	0.175 [a]	1.155 [a]
15	0.990 [a]	0.185 [ab]	1.190 [a]
20	1.230 [b]	0.200 [b]	1.410 [b]
25	1.440 [b]	0.280 [b]	1.720 [b]
30	1.500 [b]	0.290 [b]	1.795 [b]

کاریگەری گۆگرد بە پرژان لەسەر گەلاو زیادکردنی بۆ ناو خاك بەیەکەوە لەسەر گەشە ، بەرهەم وە ڕەنگەکانی ڕۆشنەپێکهاتن لەڕووەکی گەنم

پوختە

ئەم توێژینەوەیە ئەنجام درا بۆهەڵسەنگاندنی کاریگەری گۆگرد بە پرژان لەسەر گەلاو بۆ ناو خاك بەیەکەوە بەبەکارهێنانی گۆگردی پاکژ بەخەستی (سفر ، ٥ ، ١٠ ، ١٥ ، ٢٠ ، ٢٥ ، ٣٠ بەش لە ملیۆن) لەسەر سەوزەگەشە ، بەرهەم وە ڕەنگەکانی ڕۆشنەپێکهاتن لەڕووەکی گەنم . دیزاینی هەرەمەکی تەواو بە سێ دووبارە بۆ هەر مامەلەیەك بە کارهات. ئەنجامەکان نیشانیان دا کەوا پێوەرەکانی سەوزە گەشەو بەرهەم (ژمارەی لکەکان ، ژمارەی گەلاکان ، ڕووبەری گەلای ئالا ، ژمارەی گوڵە گەنمەکان ، کێشی گولەگەنمەکان ، ژمارەی دەنکەکان ، کێشی دەنکەکان وە کێشی سەوزی ووشك) بەشێوەیەکی بەرچاو زیادی کرد لەهەردوو خەستی ١٥ وە ٢٠ بەش لە ملیۆن بەبەراوورد لەگەل کۆمەلەی مامەلە نەکراو. بەکارهێنانی گۆگرد بە پرژان لەسەر گەلاو بۆ ناو خاك بەیەکەوە بووە هۆی زیادبوونێکی بەرچاو لە کلۆرۆفیل a , کلۆرۆفیل b وە کلۆرۆفیلی گشتی لەگەلا وە نایترۆجین و پرۆتین لە تۆودا. ئەم زیادبوونەش زیاد دەبێت بە زیادکردنی خەستی گۆگردەکە.

تاثير التسميد الورقي و الارضي للكبريت على النمو , الحاصل و صبغات التركيب الضوئي في نبات الحنطة

الخلاصة

تم اجراء هذه الدراسة لتقييم دور الكبريت بطريقة الرش و الاضافة الى التربة معا باستخدام الكبريت النقي و بتراكيز (صفر، ٥ ، ١٠ ، ١٥ ، ٢٠ ، ٢٥ ، ٣٠ جزء في المليون) على النموالخضري، الحاصل و صبغات التركيب في نبات الحنطة. تم تطبيق التصميم العشوائي الكامل و بثلاث مكررات لكل معاملة . اظهرت النتائج بان قياسات النمو الخضري و الحاصل (عدد الافرع ، عدد لاوراق ، مساحة ورقة العلم ، عدد السنابل ، وزن السنابل ، عدد البذور ، وزن البذور و الوزن الخضري للنبات) قد ازدادت معنويا عند التراكيز ١٥ و ٢٠ جزء في المليون مقارنة مع نباتات السيطرة. التسميد الورقي و اضافة الكبريت الى التربة معا زادت معنويا من كلوروفيل a ، كلوروفيل b و الكلوروفيل الكلي في الاوراق و محتوى البذور من النايتروجين و البروتين وزادت هذه بزيادة تركيز الكبريت.