Improving nutritional status, yield and fruit quality of Barhi Date palm cultivar by using different levels of elemental sulphur fertilization under Soba Conditions

Fatima A.El-Rauof
Associate Professor, Horticultural Crop Research Center, Khartoum, Sudan.

Dawoud H.D
Professor, Horticultural Crop Research Center, Khartoum, Sudan.

Abstract – This study was carried out for three successive seasons {2011-2014}to investigate the effect of soil application of elemental sulphur on the growth rate , fruit quality , yield , nutrient levels in the leaves of Barhi date palm cultivars under Soba condition . The results revealed that significantly greater values of growth, fruit weight, yield, total and reducing sugar percent, protein, leaf N, P, K, Ca, Mg, Cu, Zn, Mn and Fe. The experimental design was randomized complete block design, three replicates, four trees per plot; the significant variation between treatments was determined by Duncan's multiple range tests at 5%.

Index Terms – Date palm improving Nutrion program.

1. INTRODUCTION

Date palm one of the most important fruit crop growing in the Sudan , which needs a lot of research efforts to increase , it's yield quantitatively and qualitatively. In Sudan date palm is traditionally grown entirely on the limited light soil along the banks of the rivers and vallies. These soils are light, highly fertile and renewed annually by the flood, thus fertilization is not common. Recently, however cultivation of date palm extended to high terrace soils which are characterized by calcareous soil or alkaline soil reaction with soil pH 8.3-8.8.

2. RELATED WORKS

The effect of sulphur fertilization on growth, quality and yield of many crops have been reported by [3], [17] and [36] .In addition to the direct nutrition effect of sulphur on plant growth, this element may have a number of beneficial side effects. The acidifying effect of sulphur on calcareous or high pH soil may increase the availability of other essential nutrients [21]. Reported that the application of sulphur resulted in an increase in the up-take of Phosphorus, Iron , and Potassium, also [4] stated that the application of sulphur to Al Hassa with high pH values reduced its pH and increase the availability of phosphorus. Several investigators reported that sulphur fertilizer increase the protein content of the crop, [22], [10] and [12]. Soil pH was significantly decreased by sulphur application as reported by [6], [34], Also [30] found that soil pH acidification resulted in a progressive decrease in soil pH and an increase in Phosphorus up-take by Fasulia. [29] Found a positive correlation between sulphur and the growth rate, quality and macro and micro nutrient levels in the leaves of Snap bean [36]. Reported that sulphur application resulted in reducing soil pH and increased the uptake of N, P, K, Ca, Mg, Fe, Mn, Zn and Cu. So the main objective of this work was to study the effects of different levels of elemental sulphur fertilizer on the growth rate, fruit quality, nutrient levels in the leaves of Barhi and the pH levels of the treated area.

3. PROPOSED SYSTEM (Materials&Methodes)

The experiment was conducted during 2011/12 and 2013\2014 on mature Barhi date palm cultivar growing in private date palm orchard at Soba ,South Khartoum , in clay calcareous with soil pH 8.8, Five treatments of sulphur application were used on 72 trees ,the design of experiment were randomized complete block design ,with three replications, each plot consisted of 4 trees .The study started in November 2011 .and repeated on the same trees for the following years the sulphur fertilizer was applied in the form of elemental sulphur in a trench one meter far around the stem,(10 cm depth,10cm width) then irrigated directly-All the cultural practices for the experimental orchard done as recommended by A.R.C.The irrigation water from artesian well, bubbler irrigation method was used.

The growth rate of the leaves was obtained by periodic reading of a measuring tape attached to a young leaf. As the leaf elongated, it was pulled past the head of a nail driven into the tree trunk. [5] The total yields were obtained by weighing, picked fruits, excluding field culls. Samples of 50 dates were collected from each bunch of each palm at the picking. The samples were weighed, measured and graded after they have been wiped free of dirt and calyxes removed, total sugars reducing sugars and protein were determined by the method used by [2].Sulphur was determined in pinnae ,samples collected from each tree in treatment plots. The method used was the same as described by [1]. Each leaf sample consisted of twelve pinnae, four taken from the mid portion of the blade

of each of the three youngest mature leaves. These leaves are described as 'Top head' by [23] The samples were dried in a forced draft oven at 80°c, ground in a wiley mill and analyzed for Nitrogen by the standard kjeldahl method recommended by [1] Phosphorus was determined using Vandate-moly bdate-yellow method. Sulfur was determined using Barium sulphate method described by [1], iron was determined using Dry Ashingo-phenanthorline method Atomic Absorption Spectrophotometer was used to determine the other nutrients as recommended by [1]. Soil samples for pH yearly taken from the root zone area of the treated trees. The experiment was laid out in a randomized complete block design, with three replicates. The treatments means were separated by Duncan's multiple range tests at 5%level.

4. RESULTS AND DISCUSSIONS

The data in table (1a and b) show the effect of various sulphur treatments on the growth rate, fruit quality, and yield of Barhi. , the rate of leaf growth was increased as a result of sulphur application, this is in line with The findings of [11], [35] and [8], fruit weight (g) also increased with the increase of sulphur application [25] reported that the increase in fruit weight as a result of sulphur fertilizer may be due to the increase of dry matter and this theory may justify the positive correlation between the yield and Sulfur application. All the experimental findings were in line with [19], [3] and [25] Sulfur is a vital constituent of all plant proteins and of some plant hormones. Sulphur deficiencies slow down protein synthesis for two reasons. The S-containing amino acids are vital constituents of protein.

Other amino acids may accumulate if S is deficient furthermore, S is essential for the action of enzymes involved in nitrate reduction as reported by [2]. Sulphur-deficiency slows the formation of all amino acids. Sulphur –deficient plants therefore, tend to accumulate nitrate nitrogen in their tissues.

Several investigators reported that sulphur fertilizer increased the protein content of many crops [27]; [18] :[22] [10] and [12] and [29] found that application of sulfur increased seed protein content of wheat, maize, rice, snap beans [15]. Observed that in black gram Sulphur deficiency reduced the yield, quality and protein content of seeds.

Also the data in table (1a&b) shows effect of Sulphur on total, reducing sugar of Barhi fruits, data show the positive correlation between the sugar and the sulphur fertilizer Also this finding may due to the effect of sulphur on N level in Barhi leaf, Sulphur increase the uptake of N in many crops Also this findings are in agreement with [13].

Data in table (2a&b) show the effect of Sulphur on the nutrient levels and show positive correlation between N, P, K, Mg, Ca, Cu, Mn, fe and Zn. This may be due to the acidifying effect of sulphur on calcareous or high pH soil 21] reported that:the application of sulphur resulted in an increase in the uptake of N, P, K, Ca, Mg, Fe, Zn, Cu and Mn .Some research workers with sulphur reported that the uptake Nitrogen, Phosphorus and Potassium was increased with Sulphur application, subbrroa and [25].

Data presented in table (2a&b) showed that soil pH was significantly affected by Sulphur fertilizer application, soil pH was significantly lowered by Sulphur application as reported by [6] and [34]. This decrease in soil pH might possibly due to the formation of sulphuric acid in the soil as a result of sulphur oxidation which is an acidifying process [8]. Reported that sulphuric acid is a good source of Sulfur when applied in alkaline soil because it reduced soil pH improves the availability of other nutrients to plants and has an effect on microorganisms' activities.

5. CONCLUSIONS

The results obtained in the study, clearly indicated that,-within the tested levels of elemental sulphur fertilizer, the highest leaf elongation, fruit quality, yield, macro and micro nutrients levels in the leaves of Barhi date palm cultivar was produced form 400 g elemental sulphur per tree to the soil, Accordingly, this practices is proposed to recommended to date palm growers at South Khartoum area (Soba).

Treat-ment	Leaf length /cm/year			Fruit weight(g)			Fruit Volume (cc)		
Season	2011	2012	2013	2011	2012	2013	2011	2012	2013
100 g	21d	20d	22d	6.7d	6.8d	6.7d	5.70d	5.6c	5.7d
200 g	28c	28c	29c	7.2c	7.1c	7.3c	6.12c	6c	6.2c
300 g	33b	34b	32b	9.3b	9.1b	9.2b	7.82b	7.7b	7.8b
400 g	36a	37a	36a	11a	10.9a	11.1a	9.35a	9.3a	9.3a

500 g	37a	36a	36a	9.4b	9.3b	9.5b	7.99b	7.9b	8.0b
control	17e	15e	17e	5.3e	5.2e	5.1e	4.42e	4.3d	4.33e

* Means within columns followed by the same letter are not significantly different at p: 0.05 according to new Duncan's multiple range test.

Table 1-a. Effect of different levels of elemental Sulfur on growth rate, fruit quality of Barhi date palm cultivar under Soba conditions,

Treat-ment	Leaf length /cm/year			Fruit weight(g)			Fruit Volume (cc)		
Season	2011	2012	2013	2011	2012	2013	2011	2012	2013
100 g	21d	20d	22d	6.7d	6.8d	6.7d	5.70d	5.6c	5.7d
200 g	28c	28c	29c	7.2c	7.1c	7.3c	6.12c	6c	6.2c
300 g	33b	34b	32b	9.3b	9.1b	9.2b	7.82b	7.7b	7.8b
400 g	36a	37a	36a	11a	10.9a	11.1a	9.35a	9.3a	9.3a
500 g	37a	36a	36a	9.4b	9.3b	9.5b	7.99b	7.9b	8.0b
control	17e	15e	17e	5.3e	5.2e	5.1e	4.42e	4.3d	4.33e

* Means within columns followed by the same letter are not significantly different at p: 0.05 according to new Duncan's multiple range test.

Table 1-a. Effect of different levels of elemental Sulfur on fruit quality of Barhi date palm cultivar under Soba conditions.

Treat-ment	Protein			Sugar%					
	2011	2012	2013	2011		2012		2013	
Season				R	T	R	T	R	T
100 g	2.8c	2.70bc	2.90c	53d	58e	58c	59d	52d	57d
200 g	2.9c	2.9b	2.85c	54c	59bc	59b	60c	53c	59c
300 g	3.1c	3.2ab	3.0c	55b	92b	62b	63b	54b	62b
400 g	3.82a	3.91a	3.85a	56a	65a	65a	66a	55a	65a
500 g	3.5b	3.5ab	3.4b	56a	65a	65a	66a	55a	65a
control	2.1d	2.od	2.2d	50e	52b	52d	53e	49e	52e

Table 1-b. Effect of different levels of elemental Sulfur on fruit quality of Barhi date palm cultivar under Soba conditions.

Means within columns followed by the same letter are not significantly .Different at p: 0.05 according to new Duncan's multiple range test R : Reducing sugar .T : Total sugar

Treatment	Macronutrients %					micronutrients PPM			
	N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
100 (g)s	**1.5 d**	**0.12 c**	**0,52 e**	**1.02 d**	**o.27 d**	**1350 e**	**388 e**	**43 e**	**59 e**
200 (g)s	**1.7 c**	**0.12 c**	**0.55 d**	**1.05 e**	**0.3 c**	**2114 d**	**492 d**	**51 d**	**74 d**
300 (g) s	**1.8 c**	**0.14 c**	**0.61 c**	**1.07 c**	**0.35 b**	**2156 e**	**409 c**	**87 c**	**104 c**
400 (g)s	**2.0 b**	**0.18 b**	**0.8 b**	**1.12 b**	**0.40 b**	**4202 b**	**570 b**	**11 b**	**135 b**
500 (g)s	**2.2 a**	**0.25 a**	**0.92 a**	**1.21 a**	**0.45 a**	**4488 a**	**1192a**	**480a**	**185 a**
Control	**1.0 e**	**0.06 d**	**0.31 f**	**0.6 e**	**o.17 e**	**230 f**	**45 f**	**20 f**	**17 f**

* Means within columns followed by the same letter are not significantly different at p: 0.05 according to new Duncan's multiple range test.

Table (2 -a) : Effect of different levels of elemental Sulfur on nutrients levels in the leaves of Barhi date palm growing under Soba condition

Treatment	Soil pH			Yield/Kg/tree		
	1st	2nd	3nd	1st	2nd	3nd
100 (g)s	8.7 e	8.5 e	8.4 e	380d	374d	375d
200 (g)s	8.5 d	8.4 d	8.3 d	409c	403c	405c
300 (g) s	8.3 c	8.2 c	8.1 c	437b	431b	434b
400 (g)s	8.2 b	8.1b	8.0 b	459a	453a	455a
500 (g)s	8.1 a	8a	7.8 a	465a	459a	461a
Control	8.8 f	8.8 f	8.8 f	250e	245e	244e

* Means within columns followed by the same letter are not significantly different at p: 0.05 according to new Duncan's multiple range test.

Table 2 –b. Effect of different levels of elemental Sulfur on Soil pH and yield of Soba experimental area.

REFERENCES

[1] Chapman, H.D. and Pratt, P. F. (1961). Methods of analysis of soils, plants and waters. California University of California, PP 123-196.
[2] Nightingale, G.T. (1952) .Effect of sulphur deficiency on metabolism in tomato Plant physiol.7; 565-595.
[3] Dhillon, N. S. and Dev. G. (1978). Effect of elemental Sulphur application on soybean (Glycine maxmerril). Indition Soc. Soil Sci. 26(1)55-57.
[4] Khafaji M. S. Al-Barrak, and y. Abed Elhadi (1986) Use of sulphur for increasing the availability of some nutrients in soils under date palm cultivation Al-Hassaoasis college of agricultural and food sciences , King faisal university , Al- Hassa , Saudi Arbia second symposium on date palm (page 386-392).
[5] Aldrich, W.W. and Grawford , C.L. (1941) second report upon cold storage of date pollen – Date Grower's Ins. Report – 18:5
[6] Al-Ane, F; Abdelgwad ,M.and Naji, T(1977) .Iron and phosphorus availability in soil and barely yield as affected by sulphur application . Soils and Fert. Abstr (1981). 44:596.
[7] Anderson, A.j. and Spence, D. (1950)Sulphur in metabolism in legumes and non-legumes .Aust. J.Agric. Res. 3:431-449.
[8] Aulakh, M.s and Dev.G(1976)Relationship between pH and water soluble sulphate in some soil series in punjab. Indian J. Soc. Sci. 24:308-313 .

[9] Aulakh, M.S;pasricha, N.s.and Dev. G. (1977) .The response of different crops to sulpher fertilization in Punjab .Fert .News, 22(9)32-36.
[10] Aulakh, M.S.and Pasricha, N.S(1980) . Effect of sulphur application on yield and protein content of green gram .Fert .News, 31(9)31-35 .
[11] Bahi, G.S. and Baddesha, H. S(1986) Effect of time of sulphuric application on the pod yield and protein content of the groundnut Indian J. Agric. Sci. 56(6)428-433 .
[12] Broomfield, A. R. (1973) .Uptake of sulphur and other nutrients by groundnuts. (*Arachis hypogaea* L) in Northern Nigeria. Expl. Agric. 9 (1) :55-58 .
[13] Das, S.K. and Data, N. P. (1973) Fertilization for increased production and grain quality. Fert. News 18(9)3-10 .
[14] Dawoud, H. D. and Salih, A. A. (1992). The optimum time to foliar chelate nutrients to foster grapefruit trees Under New Halfa conditions. A paper submitted to crop husbandry committee (1996). Agriculture Research Corporation.
[15] Dikson, T. and Aswir, c.t. (1974) .The role of sulphur in maintaining lucere yield in the lockyery valley. Aust. J. Exp. Agric.Anim. Husb. 14(69) :515-519 .
[16] Dube, S. D. and misra, P. H. (1970). Influence of sulphur on growth and content of the peas. S. J. Indian sco. Soil Scii. 18:375-378.
[17] Elgazzar, A. M; Elazzab, S. M. and Elsafy, M. (1979). Response of Washington Naval orange to foliar application of iron chelate. Alex. J. Agric. Res. 27(1); 19-26 .
[18] Joshi, D. C. and seth, S. P. (1975). Effect of sulphur and phosphorus application on characteristics, nutrient uptake and yield of wheat crop. J. Indian soc. soil sci. 23(2); 217-221.
[19] Laurence, R.C.N; Gibbons, R.W. and young, C.T. (19796). Changes in yield, protein, oil and maturity of groundnut cultivars with application of sulphur fertilizers and fungicides. J. Agric. Sci. (camb.) 86(2); 245- 250.
[20] Mathur, and Singh,H.G. (1976). Metabolic changes associated with the prevention of chlorosis by application of elemental sulphur and foliar sprays of squestrine (138-Fe) in *Pisum Sativum* Annuals. Botany, 40;833-836.
[21] Misra, N.M, and Dupe, S.D. (1966). Effect of sulphur fertilization on yield of onion, Fert.News.11, (10); 18-19, 33.
[22] Omer, A.M; Eldamaty, A. H; Hamid, H. and Elsherbini, A.E. (1970). Effect of gypsum on yield , quality and mineral constituent of peanut plant.J. Soil sci. (U. A. R.) 10;15-121
[23] Patil, J.D. (1981). Effect of B, S, and FYM on the yield and quality of Groundnut. J. Maharashtra Agric. Univ. 6[1] ; 17-18 .
[24] Reuther W. and Graword C.L. (1945). The effect of temperature and Bagging on fruit set dates. Date grows Inst. Rept . 23; 3-7.
[25] Singh, H.G. (1971). Sulphur application prevents Chlorosis and ensure larger crop yields on alkaline calcareous soil. Indian Farming, 21(1) :212-213.
[26] Singh, H.G.. and Singh, M.P. (1980) . Effect of foliar sulphuric acids on dry matter weight of plants Fert. News , 31(9): 23-30 .
[27] Singh, M. and singh , N. (1977). Effect of sulphur and selenium on oil raya containing amino acids and quality of oil in raya (*Brassica juncea coss*.) in normal and sodic soils . Indian PL. /physiol. 20(1) :56-62 .
[28] Singh , N; subbian , B.V. and Gupta , Y.P. (1970). Effect of the sulphur fertilization on chemical composition of groundnut and mustard . Indian J. Agron . 15(1) :24-28 .
[29] Subbarroa, A. and Gosh , A.B. (1981). Effect of intensive cropping and Fertilizer use on crop removal of S and Zn and Their availability in soil. Fertilizer Research 2:306-308.
[30] Dawoud, H. D. & Fatima Abd Alraouf Ahmed (1989). Annual Reports of New Halfa research station. Sudan. Agriculture Research Corporation.
[31] Elkaroui, M. O. H. (1969). Effect of soil acidification on phosphate availability in alkaline kuru soil. Annual report of the Hudeiba res. Station, Sudan.
[32] Elkarouri, M. O. H. (1981). Effect of elemental sulphur in the availability of phosphorus in saline sodic soil. South Khartoum Area, soba research station, Khartoum, Sudan.
[33] Elkarouri, S. M. (1970). Investigation of yellowing of fasulia. Annual report of the Hudeiba Res. Station, Sudan .
[34] Hatter, B. I.. and kochler, F. e. (1978) .Effect of levels of caco on oxidation of elemental sulphur and on plant uptake. Agronomy Abstracts. Ann. Meet. P. 154.
[35] Rathee, O.P. and chahal , R.S. (1977). Effect of phosphorus and sulphur Application on yield and chemical composition of groundnut in Ambala . Soils and Fert. Abstr. 42 (11) : 7132.
[36] Singh,B. and Singh , M . (1977). Sulphur status of hissar soil s and availability of sulphur as affected by application. soil and Fertl. Abstr.40 (5); 2241.

Authors

Dr: Fatima Abd Alraouf Ahmed is currently a drector of Horticultural crop center - Agricultural Research Corporation, Ministry of agriculture Sudan

Professor Dr. Dawoud Hussien Dawoud is currently a fruits&Ornamental Plants National coordinator, Agricultural Research corporation, Ministry of agriculture Sudan.