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Response of Soybean *(Glycin max L. Merr)* Growth, Nutrients Status and Yield to Sulphur rates with or without compost

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ABSTRACT

A field experiment was connected to study the effect of four levels of Sulphur (0, 200, 400 and 600 kg fed^{-1}) and banana compost at 20 ton fed^{-1} on growth, nutrients status and yield of soybean plants. Experiments were carried out in the Research and Production Station, National Research Centre, El-Nobaria Site, Beheara Governorate, Delta Egypt. During 2014 and 2015 seasons under drip irrigation system.

The obtained results revealed that addition of sulphur at 600kg fed^{-1} significantly increased plant growth, fresh and dry weights of shoots and roots contents of (N, P, K and SO_4) in the different parts of soybean plants, yield parameters, protein percentage and oil percentage of seeds as compared to the plants which untreated with sulphur. Banana compost significant increased all the growth and yield parameters as compared to control treatment. The interaction between sulphur and compost significant affected all the mentioned parameters. The highest values of all studied parameters were obtained by applied sulphur at 600 kg fed^{-1} with 20 ton fed^{-1}banana compost.

KEY WORDS: Banana compost, nutrients status, soybean, sulphur.

INTRODUCTION

Soybean *(Glycine max L.)* is one of the leading oil and protein containing crops of the world. The crop is about 90.19 m ha of land and annual production is approximately 220.5 m t in the world **(FAO, 2009).**

Organic materials such as crop residues, farmyard manure, town refuses, rice straw, cotton stalks, water hyacinth compost and peanut compost. Banana waste are available in abundance and reach tremendous amounts day after day. Accordingly, it seems logic to utilize by such residues through some types of profitable activities instead of their acting as environmental pollutants. Addition of composts improves soil chemical and physical properties. Increasing soil water holding capacity and improves soil structure and aggregates. Chemical properties including, decreasing soil pH, increase of cation exchange capacity and enhance of the availability of the most nutrients which are important for plant growth and agricultural production. Application rate in addition with chemical fertilization ranged between 10 to 20 tons fed^{-1} **(El- Kherbawy et al., 2005 and Abo-Sedra, 2006).**

Compost is a readily available fertilizer with beneficial effects on physical, chemical, biochemical and biological properties of the soils. Moreover, compost-based treatments can exert protective effects against plant diseases occurrence and/or stimulate an enhanced plant physiological status with improvements in quantity and quality of crop productions **(Loredana et al., 2015).**

Compost plays a crucial role in improving physical, chemical and biological properties of soils. Soil structure can be improved by the binding between soil organic matter and clay particles **(Hala Kandil, 1997).**

Sulphur (S) is an essential nutrient for all crops production. It is essential for protein synthesis and the formation of chlorophyll. Sulphur is required in the development of fertile canola flowers. Symptoms of sulphur deficiency vary between different crops. In canola, deficiency symptoms may begin as early as the one leaf stage **(Hall, 1999).** Elemental S° fertilizer should be surface applied period cultivation so it can be oxidized to plant available SO_4. The rate of S oxidation dependent many environmental factors **(Hala Kandil et al., 2011).**

Sulphur also plays very important role in plant; aids in stabilization of protein structure, involve in metabolic activities of vitamins, helps in synthesis of sulphur containing essential amino acids and coenzyme A, chlorophyll formation, takes part in N-metabolism and promotes nodulation for N_2 -fixation in legumes. It also gives rise to bold seeds in oil seeds. Soybean is a sulphur loving plant and like other oilseed crops, its sulphur requirement is more than that of many other crops for proper growth and yield. The response of soybean to sulphur application has been reported by several workers **(Rao and Ganeshmurthy, 1994).**

The aim of this experiment was conducted to study the effect of sulphur with and without banana compost on growth, yield parameter, and nutrients status of soybean plants.

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MATERIALS AND METHODS

Soil analysis:

A field experiment was carried out at the experimental farm of National Research Centre at El-Nobaria to study the interaction effect of sulphur and banana compost on growth, yield and other properties of soybean plants *(Glycine max L. Merr)* grown on the soil of the Research and Production Station, the National Research Centre at El-Nobaria. Physical and chemical properties of the field soil were determined according to the standard methods outlined thereafter and results of analyses are presented in Table (1).

Table (1): Some physical and chemical properties of El-Nobaria soil.

Particle size distribution				Field capacity (%)
Sand (%)	Silt (%)	Clay (%)	Soil Texture	
82.6	14.6	2.8	Sandy loam	14.4

Chemical properties						
EC dsm^{-1}	pH (1:2.5)	$CaCO_3$ (%)	O.M (%)	Cobalt (ppm)		
				Soluble	Available	Total
0.18	8.0	4.17	0.12	0.34	1.67	7.66

Soluble cations (meq L^{-1})				Soluble anions (meq L^{-1})			
Ca^{++}	Mg^{++}	K^{+}	Na^{+}	CO_3^{-}	HCO_3^{-}	Cl^{-}	$SO_4^{=}$
2.5	1.4	0.268	1.18	-	1.60	0.6	2.04

Total N (mg/100g)	Available (mg/100g)		Available micronutrients (ppm)			
	P	K	Fe	Mn	Zn	Cu
15.1	1.30	12.3	4.47	2.61	1.44	4.0

Particle size distribution and soil texture along with soil moisture constants of the representative soil samples collected from Research and Production Station, National Research Centre (El-Nobaria) were determined according to **Klute, (1986).** Contents of organic matter and $CaCO_3$ as well as EC and pH along with soluble cations and anions were evaluated according to **Black *et al.*, (1982).** Total N and available P, K, Fe, Mn, Zn and Cu were also determined according to **Jackson (1973).**

The experimental work:

Each experimental unit consists of five ridges, 3.5 meter in length and 60 cm in width (10.5 m^2). Irrigation system was drip irrigation. P was added to all plots at 31 kg P ha^{-1} as calcium super phosphate 6.77% P along with during seed bed preparation. Nitrogen was applied to plots as urea (46% N) at a rate of 120 kg N ha^{-1} at the beginning of growth. Potassium was added coal as potassium sulfate (40 % K) at a rate of 120 kg K_2O ha^{-1} during growth. Sulphur was added at four rates (0, 200, 400 and 600 kg fed^{-1}). Banana compost addition at 20 ton fed^{-1} with during seed bed preparation. Banana compost was prepared by the method of **Abdel-Moze and Wanas (2001).** Some properties of the prepared compost are presented in Table (2).

Table (2): Chemical contents of banana compost.

O.M %	Total N %	C/N ratio	pH (1:2.5)	EC dSm^{-1}	Available nutrients %		Micronutrients (mg kg^{-1})			
					P	K	Fe	Mn	Zn	Cu
24.1	**0.78**	**17.9**	**6.9**	**2.7**	**0.47**	**2.16**	**30.0**	**9.0**	**3.8**	**0.85**

Seeds of soybean *(Glycine max L. Merr)* were inoculated prior to sowing with the specific strain of *rhizobium leguminosarum* and were sown at the rate of 180 kg ha^{-1}.

The treatments were arranged in a randomized complete block design factorial, with two factors and three replications. Normal practices were followed for the crop. Plants were thinned to two plants per hill after three weeks from sowing. Samples of ten soybean plants from each plot were taken, 90 days after sowing to determine plant height, number of leaves per plant, number of branches per plant, fresh weight and dry weight. At harvest, the following data were recorded: Number of seeds per pod, number of seeds per plant, weight of pods per plant and seed and straw yields. All the soil and plant analyses were determined using the methods described by **Jackson (1973), A.O.A.C. (1970) and Cottenie *et al,* (1982).** Total protein of soybean seed was calculated as total N % × 6.25. All data were subjected to statistical analysis according to procedure outlined by **Snedecor and Cochran, (1982)**.

RESULTS AND DISCUSSION

One of goals of Researcher in Egyptian is increase the production from agricultural area unit. In Egypt, oil crops occupies only about 1.83 % of the total cropped area **(Abd El-Hady, 2004).**

Effect of sulphur and banana compost on growth parameters of soybean plant. The results in Table 3 show that all sulphur treatments (0, 200, 400 and 600 kg S fed^{-1}) significantly promoted growth parameters of soybean plants as compared to control.

High of plant, number of branches per plant, number of leaves per plant, fresh and dry weights of soybean plants grown on El-Nobaria soil treated with sulphur with and without banana compost are presented in Table (3). Data show that all growth parameters are significantly increased by using the sulphur with or without banana compost addition comparing with the control. The highest increased obtained in sulphur at 600 t ha^{-1} with banana compost. These increases may be due to the increased rhizosphere aggregates stability which might have favored the beneficial microbes which in turn could have contributed to improve biomass. Such increases also could be due to the positive effect of compost on improving nutritional status and nutrients release and hence their availability to the growing plants as well as improving soil physical properties **(Caravaca et al., 2002).** All sulphur treatments with banana compost reveal that significantly increased all the growth parameters compared to sulphur treatment without banana compost. These results are agree with obtained by **Hala Kandil et al., (2011)** they found that sulphur enhances growth compared to NPK fertilizers alone.

Table (3): Effect of Sulphur with and without compost on growth parameters of soybean plant.

Sulphur treatments	Plant hight (cm)	No. of branch per plant	No. of leaves per plant	Fresh weight (g)	Dry weight (g)
Without banana compost					
Control	24.3	1.65	6	13.82	2.21
200	28.1	1.68	8	16.48	2.63
400	34.3	1.76	9	20.33	3.25
600	45.4	1.88	11	24.11	3.86
	33.0	**1.74**	**8.5**	**18.69**	**2.99**
With 20 ton ha^{-1} banana compost					
Control	29.8	1.69	10	21.7	3.29
200	35.7	1.73	13	25.1	3.81
400	44.8	1.85	16	29.5	4.47
600	51.6	1.98	18	35.8	5.42
Mean	**40.5**	**1.81**	**14.3**	**28.03**	**4.25**
LSD at 5 %	0.03	0.05	0.12	0.54	0.034

The obtained data in Table (4) indicate that all yield parameters increased with sulphur applied and the highest value of plant high, number of pod per plant, weight of pod per plant, number of seed per pod, weight of 100 seeds and yield per Fadden of soybean were obtained when 600 kg fed^{-1} sulphur with banana compost was used. These results agree with those obtained by **Hala Kandil and Nadia Gad (2012)** who found that all sulphur sources and rates gave promotive effect on canola growth and oil production compared with control. Increasing sulphur levels in plant media from 50 up to 300 kg fed^{-1} increased canola growth and oil seed yield as well as seed quality.

Table (4): Effect of sulphur with and without compost on yield parameters.

Sulphur treatments	Plant hight (cm)	No. of pod per plant	Weight of pod per plant (g)	No. of seed per pod	Weight of 100 seeds (g)	Yield (kg fed^{-1})
Without banana compost						
Control	38.9	20	17.0	2.15	12.1	476.0
200	42.1	24	20.5	2.56	15.3	574.0
400	44.6	31	26.3	2.89	18.5	736.4
600	48.9	37	31.5	3.25	20.9	882.0
Mean	43.6	28	23.8	2.71	16.7	667.1
With 20 ton ha^{-1} banana compost						
Control	41.3	36	40.3	2.35	17.2	1128.4
200	48.9	39	49.5	2.96	20.7	1386.0
400	56.8	42	58.7	3.34	24.5	1643.6
600	64.3	47	65.7	3.98	27.4	1839.6
Mean	52.8	41	53.5	3.15	22.5	1499.4
LSD at 5 %	0.93	0.88	0.75	0.05	0.07	35.84

Concerning N, P, K and S content in seeds of soybean plants in Table (5) showed that the application of banana compost increased the content of N, P, K and S. The addition of 600 kg fed^{-1} sulphur with banana compost gave a significant beneficial effect on macronutrients (N, P, K and S) in grains of the soybean plants compared to control. These results agree with those obtained by **Hala Kandil and Nadia Gad (2012)** who stated that sulphur addition had a primitive effect for better status of N, P and K in canola.

The highest values of macronutrients in seeds were found at 20 ton ha^{-1} banana compost with 600 kg fed^{-1} sulphur. Generally, data show that the content of seeds from N, P, K and S values were higher than those of control.

Data presented in Table (5) show that the application of sulphur with banana compost to the soil improved the availability of macronutrients in seeds content. These results harmony with those reported by **Malhi *et al.* (2007)** who stated that sulphur increased nutrients in canola seeds.

Table (5): Effect of sulphur with and without compost on macronutrients and micronutrients content in seeds of soybean.

Sulphur treatments	(%)				(mg kg^{-1})			
	N	P	K	S	Fe	Mn	Zn	Cu
Without banana compost								
Control	1.83	0.25	0.71	0.15	37.5	25.9	20.1	17.5
200	1.95	0.37	0.83	0.76	39.1	26.8	23.4	19.4
400	2.41	0.44	0.95	0.95	41.3	28.8	26.8	21.2
600	2.76	0.49	1.06	1.22	43.7	30.7	29.2	23.5
Mean	2.23	0.39	0.89	0.77	40.4	28.1	24. 9	20.4
With 20 ton ha^{-1} banana compost								
Control	2.11	0.36	0.96	0.18	42.8	29.9	27.2	19.9
200	2.81	0.41	1.12	0.85	45.1	32.7	29.8	21.7
400	3.23	0.52	1.24	1.03	47.5	39.5	31.4	24.8
600	3.81	0.68	1.33	1.36	49.9	36.8	33.2	27.1
Mean	2.99	0.49	1.16	0.86	46.3	34.7	30.4	23.4
LSD at 5 %	0.01	0.03	0.04	0.02	0.11	0.16	0.13	0.09

Data in Table (5) show that sulphur application to the soil with compost improved the availability of macro and micronutrients. The highest values of N, P, K, S, Fe, Mn, Zn and Cu in seeds of soybean, were found by addition of 20 t ha^{-1} banana compost and of 600 kg fed^{-1} sulphur.

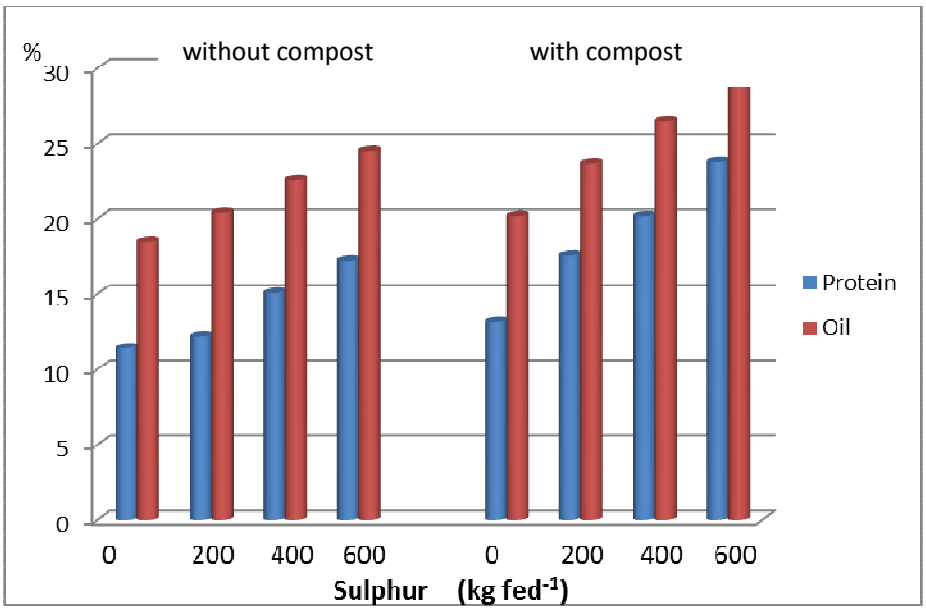

Fig. (1): Effect of sulphur with and without compost on content of protein and oil percentage in seeds of soybean.

Data in Fig. (1) and Table (3) show that all sulphur treatments enhanced oil yield (Kg fed^{-1}) of soybean seeds compared with control. Increasing sulphur rates increased oil seed yield. Sulphur at 600 Kg fed^{-1} gave the highest oil seed yield. It is evident that sulphur at 600 Kg fed^{-1} significantly increased canola oil seed yield compared to control by 32.43% and 45.04% respectively for sulphur without compost and with banana compost. These data are agrees with those obtained by **Malhi and Gill, (2002)** who found that sulphur addition in plant media increased oil concentration in canola seeds.

Data also reveal that applying the sulphur with banana compost highly increased (%) protein in grains at 20 ton/fed banana compost with 600 Kg fed^{-1} sulphur treatment compared to control.

In conclusion, the high concentration of sulphur (600 kg fed^{-1}) with banana compost had a primitive's effect on growth, nutrients status, oil, protein contents and yield of soybean.

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