



## Effects of organic and mineral fertilizers on growth and yield of soybean (*Glycine max* L. Merrill)

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### Abstract

A field experiment was conducted at the Demonstration Farm, College of Agricultural Studies, Sudan University of Science and Technology, Shambat to investigate the effect of different types of fertilizers on growth and yield of soybean (*Glycine max* L. Merrill). The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. The soybean genotype used was 1905E. The fertilizers treatments consisted of four types of fertilizers: Urea 46% N (180 kg/ha), Compost (2.5 ton/ha), Chicken manure (2.5 ton/ha) and *Jatropha* seeds cake (2.5 ton/ha). Untreated control was used as comparison between plant treatments. The results showed that chicken manure fertilizer had significant effect on stem diameter, number of branches, plant height and number of leaves at 45, 60 and 75 days after sowing. *Jatropha* seeds cake fertilizer had significant different on plant weight as compared to the control. The results showed that chicken manure and nitrogen fertilizers were significantly increased the number of seeds per pod as compared to the control. There were no significant difference among fertilizers treatments on pods weight per plant, number of seeds per plant, 100 seeds weight, seeds production and harvest index%.

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## Introduction

Soybean (*Glycine max* L. Merr.) is one of the most important crops that have the potential to provide the world's increasing demand for food and forage. Fertilizer is any organic or inorganic material of natural or synthetic origin that is added to a soil to supply one or more plant nutrients essential to the growth of plants. Commercial nitrogen fertilizers are a cost-effective means of supplementing soil supplied nitrogen growth and is necessary for sustaining high crop yields. Soybean nitrogen (N) requirements are met in a complex manner, as this crop is capable of utilizing both soil N (mostly in the form of nitrate) and atmospheric N (Through symbiotic nitrogen fixation) (Vera *et al.*, 2002).

Manure is a readily available organic source of essential plant nutrients. It is used primarily as a source of plant nutrients (Mullins *et al.*, 2002). Moreover, manure is a source of energy for soil biota and thus influences many of the biological processes of soil. Chicken manure is considered to have fertilizing properties, intermediate between mineral fertilizers and farmyard manure, and it has an appreciable residual effect (Woomer and Swift, 1991). In Sudan, soybean is a new crop, struggling to introduce in irrigated and rain-fed farming to increase human nutrition, improve soil fertility and provide a high-protein feed source for livestock (Ibrahim, 2011). Under Sudan conditions, soybean express different results due to application of different source of fertilizes (Yagoub *et al.*, 2012). *Jatropha* has exceptional potential to produce bio-diesel due to its adaptation to local environments, fast growth rate and potential for income generation. Increased production of bio-diesel contributes to increased production of bio-waste-seed cake, which is relatively high in total nitrogen, phosphorous, and potassium as well as organic matter content compared to chicken and cattle manure (Tigere *et al.*, 2006). Accordingly, the use of *jatropha* cake is worth highlighting as a potential bio-fertilizer. Therefore, the effects of compost, *Jatropha* seeds cake and chicken manure and chemical fertilizer on soybean growth and grain yield were evaluated.

## Materials and methods

### *Experimental site*

The experiment was conducted in the Demonstration Farm of the College of Agricultural Studies, Sudan University of Science and Technology at Shambat. Shambat is located at longitude 32.35"E and latitude 15.31"N, within the semi-desert region (Adam, 2002). The soil of the site is described by Abd elhafiz (2001) as loam clay characterized by a deep cracking, moderately alkaline clays, and low nitrogen content and pH (7.5- 8) and high exchangeable sodium percentage (ESP), in subsoil. Climate of the locality has been described by (Adam 2002) as semi-desert and tropical with low relative humidity. The mean annual rainfall is about 160mm, and the mean maximum temperature is more than 40°C in summer and around 20°C in Cool season. Solar radiation is about 400- 500calcm<sup>-2</sup>day<sup>-1</sup>.

The experiment was arranged in a Randomized Complete Block Design (RCBD) with four replications to study the effect of different fertilizers on growth and yield of soybean. The land was prepared by disc plough, disc harrowed, and leveled ridging up from north to south, and the spacing between ridges was 70cm and between holes was 25cm. The size of the plot was 3×3.5m<sup>2</sup> consisting of four ridges of 2.5m length. Sowing was done manually on the shoulder of the ridges on the 16<sup>th</sup> July 2012.

### *Plant materials*

The Seeds were obtained from College of Agricultural Studies, Sudan University of Science and Technology at Shambat, genotype (1905 E).

### *Fertilization treatments*

The treatments consist of four types of fertilizers urea: 46% N (180kg/ha), compost (2.5 ton/ha)), *Jatropha* seed cake (2.5 ton/ha), chicken manure (2.5 ton/ha) in addition to un-inoculated control. The fertilizers were applied in a line of the ridges and immediately irrigated.

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## *Data collection and analysis*

### *Growth Parameters*

#### *Plant height (cm)*

Five plants from each plot were randomly selected and tagged, plant height was measured from a point immediately above the soil surface to the top of the plant, and then the mean of height per plant was obtained in cm. at 45, 60 and 75 days after sowing.

#### *Number of leaves per plant*

Randomly five plants were selected, all the leaves were counted and the mean number of leaves per plant was obtained at 45, 60 and 75 days after sowing.

#### *Stem diameter (cm)*

Five plants from each plot were taken and the diameter in the middle of the plant was measured using striping and a ruler and then the mean stem diameter were estimated at 45, 60 and 75 days after sowing.

#### *Number of branches*

From tagged plants the mean number of branches per plant was counted after 75 days after sowing.

### *Yield and yield components*

#### *Plant weight (g)*

The weight of tagged plants was measured and the mean of weight of plant was obtained.

#### *Number of pods per plant*

The tagged plants were harvested. Number of pods for the five plants was counted and then the mean number of pods per plant was obtained.

#### *Weight of pods per plants (g)*

Weight of Pod was measured from five harvested tagged plants.

#### *Number of seeds per pod*

From the harvested plants, pods were threshed and then number of seeds per pod was counted.

#### *Number of seeds per plant*

The total number of seeds was counted from the five tagged harvested plants and then means number per plant was determined.

#### *Weight of seeds / plant (g)*

From the above samples, weight of seeds per plant was obtained.

#### *100- Seed weight (g)*

A sample of 100- seeds was taken from five plants; yield of each plot was then weighed to determine 100- seed weight for each treatment.

#### *Harvest index (H.I)*

It was calculated by using the following equation:

$$H.I = \frac{GY}{BY} \times 100$$

Where

H.I = Harvest index

GY = Grain Yield (g)

BY = Biological Yield (g) (Dagash, 2003).

#### *Yield (kg / ha)*

Plants on one meter length from each ridges of the plot of each treatment were harvested, sun – dried, weighed to obtain the biological yield. The pods of the harvested plants were threshed and seeds were collected. The grain yield / unit area was converted into kg / hectare according to the following equation:

$$\text{Yield (kg/ha)} = \frac{\text{plot yield (m}^2\text{)} \times 10000}{1000 \times 1000}$$

### *Statistical analysis*

The collected data were subjected to standard statistical analysis. The procedure of analysis of variance and mean separation were followed according to the description of Gomez and Gomez (1984). The data was analyzed by MSTAT-C Statistical Package at 5%.

## **Results**

### *Growth attributes*

Plant height (cm): Plant height showed significant differences in response to fertilizers, irrespective to times (Table 1).

Soybean treated with chicken manure fertilizer obtained the highest mean (40.17cm). It increased plant height by 18, 17 and 27% after 45, 60 and 75 DAS, respectively as compared to the control. Control recorded the lowest plant height.

Number of leaves: From the statistical analysis of variance, it was clear that there were no significant difference among fertilizer treatments on number of

leaves, at 45 days after sowing. Significant difference was obtained at 60 and 75 days after sowing (Table 2). Chicken manure fertilizer sustained the largest number of leaves at 60 and 75 days as compared to the control. It increases the number of leaves by 30% and 21% as compared to the untreated control. The lowest number of leaves was scored by the control treatment.

**Table 1.** Effects of different fertilizers on plant height of soybean at 45, 60 and 75 days.

Treatments	Plant height (days)		
	45	60	75
Control	34.25	41.60	43.25
Nitrogen 180 kg / ha	31.60	47.27	45.57
Compost 2.5 t / ha	32.10	43.05	45.90
Chicken manure 2.5 t / ha	40.17	48.35	54.77
Jatropha 2.5 t / ha	32.30	41.25	41.60
CV%	14.75%	7.87%	10.75%
LSD	3.463	3.424	2.403

Stem diameter (cm): The effect of fertilizer treatments on stem diameter of soybean was presented in (Table 3). Analysis of variance showed significant difference among treatments at 45, 60 and 70 days after sowing. Application of chicken manure tended to be higher than those of the other treatments and the control, irrespective to the times. It increase stem diameter by 19, 00 and 00%. The lowest mean of stem diameter was scored by the nitrogen and the control treatments.

Number of branches: Different types of fertilizer showed significant difference on number of branches of soybean (Table 3). At 75 DAS, chicken manure

treatment gave the highest number of branches 2.50 as compared to the control. It increased the number of branches by 19% as compared to the untreated control.

#### Yield and yield component

Number of pods per plant: The effect of different fertilizer treatments on number of pods per plant was presented in (Table 4). Analysis of variance showed significant difference among treatments. The highest number of pods per plant was recorded in chicken manure (73.45) as compared to the untreated control. It increased the number of pods / plant by 17%.

**Table 2.** Effects of different fertilizers on number of soybean leaves at 45, 60 and 75 days.

Treatments	Number of Leaves (day)		
	45	60	75
Control	7.7	10.65	21
Nitrogen 180 kg / ha	6.5	10.75	21.55
Compost 2.5 t / ha	6.5	14	22
Chicken manure 2.5 t / ha	8	13.85	24.90
Jatropha 2.5 t / ha	8	12.90	21.15
CV%	14.29%	15.31%	13.90%

Number of seeds per plant: The analysis of variance revealed no significant difference for this characters (Table 4). The highest mean of this character was obtained by Jatropha treatment (141.10) while the lowest mean was displayed by compost (129.17) treatment albeit not significantly.

Number of seeds per pod: Significant differences were detected among fertilizer treatments on number of seeds per pod (Table 4). The largest number of seeds per plant was recorded by nitrogen fertilizer (2.60) as compared to the untreated control. It increased number of pods per plant by 8% as compared to the control.

Plant weight (g): Analysis of variance showed significant difference among fertilizers treatments on plant weight (Table 5). The largest plant weight was scored by Jatropha (26.05g) fertilizer as compared to the control. It increased the plant weight by 16% as compared to the control.

Pods weight per plant (g): The effect of fertilizer treatments on pods weight of soybean was presented in (Table 5). The analysis of variance showed no significant differences between treatments. The nitrogen fertilizer gave the highest average (17.23g) albeit not significantly while chicken manure gave the lowest weight (14.75g) as compared to the control.

**Table 3.** Effects of different fertilizers on stem diameter and number of branches of soybean.

Parameters	Stem diameter ( days)			Number of Branches (after 75 days)
	45	60	75	
Control	1.72	1.77	1.90	2.10
Nitrogen 180 kg / ha	1.77	1.75	1.92	1.40
Compost 2.5 t / ha	1.82	1.80	2.05	1.70
Chicken manure 2.5 t / ha	2.05	2.00	2.17	2.50
Jatropha 2.5 t / ha	1.80	1.92	2.05	1.80
CV %	13.52%	12.63%	14.68%	28.63%
LSD	0.17	0.16	0.20	0.38

Seeds weight per plant (g): The results showed that different treatments affected on the seeds weight/ plant (Table 5). The soybean crop applied with chicken manure fertilizer displayed a higher weight 8.90g as compared to the untreated control. It increased number of pods per plant by 31% as compared to the control.

100 seeds weight (g): The effect of fertilizers on 100 seeds weight of soybean is presented in (Table 5). The analysis of variance showed no significant difference between treatments. The highest mean of 100 seeds weight was recorded by nitrogen fertilizer 8.15g,

albeit not significantly while the lowest mean was recorded by Jatropha fertilizer (7g).

Harvest index (%): There were no marked differences among treatments on harvest index (Table 5). Crop applied with compost fertilizer resulted in a greater harvest index than for any other treatment albeit not significantly.

Seed yield (kg/ ha): From the statistical analysis of variance it was clear that there were no significant difference among different types of fertilizers (Table 3).

**Table 4.** Effect of different fertilizers on numbers of seeds and pod of soybean.

Treatments	No. Pods per plant	No. Seeds per plant	No. Seeds per pods
Control	62.75	134.05	2.40
Nitrogen 180 kg / ha	68.70	130.97	2.60
Compost 2.5 t / ha	69.70	129.17	2.37
Chicken manure 2.5 t / ha	73.45	129.20	2.60
Jatropha 2.5 t / ha	66.10	141.10	2.35
CV%	12.47%	10.60%	8.57%
LSD	5.88	9.71	0.15

### Discussion

With increasing costs of chemical fertilizers, using organic amendments is an alternative method for the improvement of crop production and soil fertility maintenance. The results displayed that there were significant differences among the different treatments on the plant height of soybean. Soybean treated with chicken manure resulted in highest plants than other treatments. Mohsin Zafar *et al.*, (2011) indicated that a combination of 0.05 t/ha NPK and 10 t<sup>-1</sup> haof chicken manure resulted in taller maize plants than either 0.05 t ha NPK or

10 t haor chicken manure applied separately. The plants benefited from increased nutrient supply, which enhanced vegetative growth, and this indirectly affected plant height above the control. Applying livestock manure to soil can enhance soil fertility and crop growth. Furthermore, number of leaves per plant is significantly affected by chicken manure treatment at 60 days after planting. This result is in disagreements with that obtained by (Yagoub, 2012). Orellana *et al.* (1990) reported that application of fertilizers gave greater number of leaves and branches in soybean.

**Table 5.** Effects of different fertilizers on yield attribute of soybean.

Parameters	Plant Weight (g)	Pods Weight Per plant (g)	Seeds Weight Per plant (g)	100 Seeds Weight (g)	Harvest Index (%)	Seeds Yield (kg\ha)
Control	22.42	15.40	6.77	7.60	44.93	606.97
Nitrogen 180 kg / ha	25.50	17.22	7.95	8.15	38.54	567.30
Compost 2.5 t / ha	21.52	14.80	6.55	7.47	41.65	571.30
Chicken manure 2.5 t / ha	22.37	14.75	8.90	7.45	28.99	572.97
Jatropha 2.5 t / ha	26.05	15.85	7.05	7	38.59	556.30
CV%	15.10%	18.33%	31.18%	13.57%	23.57%	36.63%
LSD	2.45	1.97	1.59	0.70	12.52	144.90

It was clearly indicated that there is a need for adding organic manures to the soil, which increased the availability of nutrients considerably resulting in positive effect on growth parameters. These results are in agreement with the findings of Babalad (1999)

in soybean, who had obtained that there is a need of organics application along with inorganic fertilizers. Result showed that number of pods and numbers of seeds per plant were affected by chicken manure and jatropha treatments, respectively. Myint *et al.* (2009)

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reported that application of jatropha cakes stimulated plant growth and enhanced seed setting to a similar extent as chemical fertilizer. Furthermore, chicken manure and nitrogen treatments were significant effect on weight of seeds per plant. Seeds weight increased under nitrogen fertilization as indicated by Akbari *et al.*, (2001).

### Conclusions

From the results and findings of this study, we may conclude the following:-

1. The results showed that fertilizer treatments had significant differences on plant height, number of leaves of soybean.
2. Different types of fertilizers showed effects on the yield and yield components of soybean.
3. Chicken manure had positive influence on growth and yield of soybean which gave the highest means in most growth and yield attributes.
4. Soybean research in Sudan is scanty, especially in the area of fertilization, so more studies are needed in this area.
5. Different doses of each fertilizer type should be examined to determine the optimum dose.

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