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Evaluation some organic fertilizers on insect infestation of soybean plants and seed components

Mohamed Ibrahim Mogahed [1*], Saied Abd el-Tawab Abd el-Fattah El Sayed [1], Farid Abd El Aziz Hellal [1], Naglaa Mohamed Nazif [2], Magda Soliman Mohamed [3], Lobna Mohamed Abou-Setta [2]

[1] *Pests and Plant Protection Department, National Research Center, Egypt*
[2] *phytochemistry Department, National Research Center, Egypt*
[3] *Nutrition and Food Science, National Research Center, Egypt*

Abstract

A field experiment was conducted in North Sinai Governorate, Egypt to evaluate the effect of mixture of cow dung and poultry manure and compost with chemical fertilizer with recommended dose of NPK on insect infestation, yield and quality of soybean. The lowest insect infestation about 3.75% obtained on soybean plants treated with chemical fertilizer and increased to 5.5% with mixture of poultry manure and chemical fertilizer. The highest percentage ranged 8 -8.5% resulting from treating with mixture of each of cow dung and compost manure with chemical fertilizer compared to the control, which was 60 %. The highest yield achieved with chemical fertilizer followed by those treated with mixture of cow dung and mixture of poultry manure with chemical fertilizer, compared to control which was 180 kg/acre. Soybean cultivated with compost fertilizer showed the highest flavonoids content while those cultivated with cow dung fertilizer showed the lowest values. Soybeans that treated with compost and chemical fertilizer gives the highest levels of the P, K, Ca, Mg, Na and Zn, while, soybeans that treated with baladi and chemical fertilizer gives significant lowest levels of P, Na, Zn. The vitamins (A, E, B2 and C) in soybeans treated with mixture of compost and chemical fertilizer were the highest values in vitamins. The findings of this study indicated that organic manure in combination with the recommended dose of chemical fertilizers can be applied to achieve low infestation with insects, better yield and quality of soybean as save materials for human foods

Keywords: Soybean; Organic Fertilizers; Flavonoids; Microelements; Vitamins

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* Corresponding author. *E-mail address:* mogahedprof@hotmail.com

1. Introduction

It is well known that fertilizer management is an important factor for agricultural development. Therefore, organic manure is primarily used as a source of plant nutrients (Mullins et al., 2002) and have shown potential to provide satisfactory amounts of nutrients to plants (Diacono and Montemurro, 2010) .It was stated that use of chemical fertilizers in combination with bio-fertilizers, cow dung (CD) and chicken manure (PM) may increase productivity, thus increasing soybean production (Shirpukar et al., 2006),organic fertilizer may also stimulate the spread of a variety of microorganisms in the soil and play an important role in maintaining the environmental balance of rhizosphere. Unfortunately, many varieties of soybeans, Glycine max (L.) are exposed to various insect pests such as bean leaf beetle, *Cerotoma trifurcata* (Forster), the striped blister beetle, *Epicauta vittata* (F.) and moths of the bollworm, *Heliothis zea* (Boddie) (Clark et al., 1972) estimated the resistance of several varieties of soybean, *Glycine max* (L.) against these insect pests, and found that the least amount of pod damage was sustained on this cultivar, suggesting antibiosis to larvae. On the other hand, (Sriyanka and Reisig, 2016) reported that Kudzu bug is a pest that was present in the US Southeast and invaded and attacked soybeans. The management recommendation for insect pests is spraying soybeans with pyrethroids such as bifenthrin, but this method is not environmentally friendly, as this adversely affects beneficial insect groups.

The efforts of scientific researchers have focused on finding natural alternatives to suppressing insect pests that attack soybean varieties and their pathways to reduce costs. Many researchers have noted that organically grown grapes contain phenolic compounds, polyphosphates and higher antioxidant drugs than conventional ones. (Lee et al., 2003); (Shahidi and Naczk, 2004); (Wang et al., 2008) and (Lee and Cho, 2012). Flavonoid compounds in soybean have been extensively studied due to their potent biological activities *viz* estrogenic, antioxidants, antimutagenic and anticancer activities (Omah and Sitter, 2009).

Water-soluble vitamin (B and C) are involved in several biochemical reactions as enzyme cofactors or carriers and also cannot be biosynthesized in the human body (Fitzpatrick et al., 2012). Riboflavin (B2) has several roles as cofactors in the biochemical pathways, since it is a precursor of flavin adenine dinucleotide (FAD) and flavin mononucleotide (FMN), (Roje, 2007). Deficiency of riboflavin causes some health problems and may lead to cancer and cardiovascular diseases (Powers, 2003). The antioxidant role of vitamin C is an electron donor to help the body against radicals and pollutants (Iqbal Khan and Khattak, 2004). Fat-soluble vitamins (A and E), vitamin E is an antioxidant, responsible for terminating free radical chain reactions that result from the oxidation of PUFA (Ciocoiu et al., 2007). High levels of urease, phosphatase, and dehydrogenase activity under organically farmed soils have been observed (Reganold, 1988). So, we need balanced fertilization for crop production.

The study was conducted to discover the right mix of organic and inorganic fertilizers in order to achieve better productivity and quality of soybean ingredients and assess their suitability as food for humans.

2. Materials and methods

2.1. Description of field experiments

A field experiment was conducted in North Sinai Governorate, Soybean were grown in the size one acre. to study the response of soybean yield and seed components to organic fertilizer applications. The unit plot size was 4.0m × 2.5m. The treatments were randomly distributed. Operations agricultural Service (plow - fertilization- Planning) were conducted for the processing of soil for planting. After final land preparation, the soil was fertilized at rates of 55, 160, 110 and 97 kg ha^{-1} of urea, triple super phosphate, muriate of potash and gypsum, respectively. Cow dung and poultry manure was also used at 10 and 3 t ha^{-1}, respectively. Seeds were sown and cultured. The cultivation of soybean seeds in some lines away from some of the 50 and 75 cm. seeds in every line of 2 to 3 cm, and put the seeds in the soil depth of 2 to 5 cm. Weeding, gap filling, thinning, irrigation and pesticide application were done as and when necessary.

The nitrogen fertilization was applied as Urea (46%) at rates of 65 and 130 kg fed^{-1} at two equal doses. Where, the first dose of fertilizer added during soil preparation.

The rest of N fertilizer applied before the third irrigation. While, the phosphorous fertilization was applied during seed bed preparation in the form of calcium super phosphate (15.5%) at rates 75, 150 kg fed^{-1}, which considered as 50% and 100%, of recommended dose fertilizers. Potassium sulphate (46% K_2O) was applied at rates 25, 50 kg /fed^{-1} in two equal doses after 40 and 80 days from sowing has been added to organic and chemical fertilizers in the soil.

Experimental soil was subjected to mechanical and chemical analyses according to the method described by (Page et al., 1982). The physical and chemical analysis were presented in (Table 1). At the end of season, plants were harvested and data on yield and yield contributing parameters were collected from crop samples.

Table 1. Some Physical and chemical properties of studied soil

Particle size distribution (%)				Chemical properties				
Sand	Silt	Clay	Textural class	Soil pH (1:2.5)	EC (dS m^{-1})	EC (S.P)	TDS (ppm)	Organic matter (%)
48.37	48.91	2.34	Sandy Loam	7.5	0.34	4.63	218	0.37
Cations (meq /l)				Anions (meq / l)				CaCO3
Na^+	K^+	Ca^{++}	Mg^{++}	CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	(%)
2.82	0.33	3.10	1.16	0.00	0.173	2.15	5.09	1.03

2.2. Target insect pests and sampling

Soybean plants have been monitored and tested weekly until harvest to record percentages of insect infestation and codified in the tables to analyze statistically. The impact on productivity per acre resulting seeds to explore the impact of composting organic fertilizers as compared to chemical fertilizer to seed components and assess their suitability as food for humans by the following methods:

2.3. HPLC analysis of flavonoid compounds

Ten grams of the dried, defatted powdered plant materials cultivated with different fertilizers were separately extracted with 80% methanol, filtered and evaporated. The residues were separately dissolved in Methanol of HPLC grade and filtered through millipore filter (0.45 μm membrane filter) prior to be injected into HPLC column. All flavonoids were quantified using the external standard method. Quantification was based on peak area (DAD) (Mattila et al., 2000).

2.4. The minerals content

The minerals content of soybean was determined according to Braun (1987) and (Chapman and Prtt, 1978). One gram of each sample was ashed in an oven at 500 ˚C then dissolved in 50 ml of 10% (V/V) HCl. The minerals content of sample solutions were measured by a Varian Model Spectra AA220 Flame Atomic Absorption Spectrophotometer, with an air-acetylene and hollow cathode lamps run under the conditions recommended by the manufacturer (Varian Australia Pty., Ltd., Musgrave, Vic.3171, and Australia). The wavelength, slit width and burner height were adjusted according to suitable conventional values for each tested element (Ca, P, K, Na, Zn, and Mg). The minerals levels in the tested soybeans were detected using (AAS).

2.5. Water soluble vitamins

The extraction method was used according to (De Arruda et al., 2013). One g of soybean flour was mixed with 10 ml of 0.1 M HCl and then was boiled for 30 min. The pH of the sample solution was adjusted to 4.6 after cooling. The solution was cooled and transferred to 25 ml volumetric flask and was made up with de-ionized water, then filtered and put in a vial prior to HPLC analysis. The analysis done using Hewlett packared (series 1050) equipped with auto-sampling injector.

2.6. Determination of fat-soluble vitamins (A and E)

One gram of pyrogallic acid, 70 mL ethanol, and 30 mL (50%) KOH were added to the ground soybean seeds (5 g), stirred, and refluxed for 40min using a water bath at 50 ± 2^{o}C. Extracts were obtained three times using various volumes of ether concentrations (50mL, 30mL and 20mL). Double-distilled water was used to remove KOH alkalinity of the extract, which was dehydrated over anhydrous sodium sulfate. Further, the extract was concentrated to approximately 5 mL by using a water bath (50 ± 2^{o}C), diluted to10 ml by using methanol, filtered and finally subjected to HPLC (Hewlett packared (series 1050) equipped with auto-sampling injector) analysis at wavelength 325 nm for vitamin A and at wavelength 292 nm for vitamin E (Sami et al., 2014).

Vitamin C: 0.5 g of sample was homogenized with 10 ml of metaphosphoric acid solution 3% (w/v) for one minute, then filtered and washed several times. The filtrate is quantitatively transferred into a 25 ml volumetric flask and 3% metaphosphoric acid solution is added up to the 25 ml, then investigated by HPLC at wavelength 254 nm (Puwastien et al., 1999).

Statistical analysis: The experiment was laid out in a randomized complete block (RCB) design with replications. Mean number of insect pests caught by the traps on each sample was analyzed by repeated measures ANOVA test. Analysis of variance was done with the help of computer package program according to (Gomez and Gomez, 1984) and the mean differences among different treatments were adjudged by LSD Test.

3. Results

3.1. Insect infestation

The data recorded in Table (2) describes that the lowest percentage of insect infestation about 3.75% obtained on those soybean plants treated with chemical fertilizer. Soybean plants treated with mixture of poultry manure with chemical fertilizer caused insect infestation amounted to 5.5%. while treated soybean plants with mixture of waste baladi (livestock) with chemical fertilizer and those treated with mixture of compost manure with chemical fertilizer due to insect infestation 8% compared to the control, which accounted by 60% of insect infestation.

Table 2. Effect of organic and inorganic fertilizers on insect infestation and the yield of soybean crop

Treatment	Average percentage of insect infestation of soybean plants during the growing season ±SD					Productivity (kg /axre ±SD
	M. testulalis	*N. viridula*	B. *tabaci*	*S. littoralis*	Average insect infestation (%)	
Control (without NPK)	50 ± 7.9	20 ± 3.5	100 ± 7.1	70 ± 7.9	60 ± 30.0	180 ± 29.2
Chemical fertilizer NPK	20 ± 0.7	1.0 ± 0.0	6.0 ± 1.0	6.0 ± 1.2	3.75 ±2.5	650 ± 7.1
Compost + NPK	3.0 .± 0.7	6.0 ± 1.4	12 ±1.2	13 ± 1.9	8.50 ± 4.4	480 ± 7.9
Baladi fertilizer (livestock) + NPK	4 ± 1.2	4 ± 1.2	10 ± 1.6	14 ±1.6	8.00 ± 4.5	520 ± 7.9
Poultry manure + NPK	2.0 ± 0.7	3 ± 1.0	7 ± 1.6	10 ±1.9	5.5 ±3.5	525 ± 5.0
Average insect injury (%)	2.75 ±0.95	3.50 ±2.08	8.75 ±2.75	10.8 ± 3.59	6.44 ± 2.22	543.7 ±73.6

Regardless of the quality of the tested fertilizers, the highest average percentage of insect infestation appeared on treated soybean plants causing cotton leaf worm, *S. Littoralis* (10.1%) followed by cotton whitefly, *B.tabaci* (7.2 %) then green bug, *N. viridula* (3.1 %) and borer of papper pods, *M. testulalis* (2.0%). As for relationship quality, chemical fertilizer productivity was the highest yield (650 kg/acre) followed by those fertilized with mixture of poultry manure and chemical fertilizer (525 kg/acre) and then fertilization with mixture of compost baladi manure (cow dung) and chemical fertilizer (520 kg/acre). The less productive for the crop soybean plants treated with mixture of compost and chemical fertilizer (480 kg/acre) compared to control (without fertilization) was produced about 180 kg/acre. The statistical analysis of obtained data showed that there is a high significant difference between the average percentages of insect infestation of soybeans plants where the value of F = 7.52 and L.S.D. = 35.09.

3.2. Flavonoids

Table (3) revealed that ten flavonoids and flavonoid glycosides were detected and quatified in all samples of soybean cultivated with different fertilizers. Soybean defatted seeds cultivated with compost fertilizer showed very high content of naringin 1153.53 μg/100g. d.w. followed by that cultivated with poultry manure 972.95 μg/100g dw. Also, soybean grown with compost fertilizer contains quercetrin in relatively high content followed by that grown with chemical fertilizer.

Table 3. Flavonoids content (μg/100 g d.w.) in the seeds of soybean treated with different

Flavonoids	Treatment					
	Chemical fertilizer	Baladi fertilizer (cowdung) Fertilizer	Poultry manure fertilizer	Compost fertilizer	F-value	LSD $_{(0.05)}$
Naringin	534.20±3.2 d	598.02±1.4 c	972.95±1.1 b	1153.53±1.3 a	70325.64 ***	3.66
Rutin	100.76±1.9 c	154.44±0.7 b	187.37±2.4 a	187.76±2.1 a	1411.81 ***	3.56
Hesperdin	151.0±2.1 a	65.51±2.4 d	113.74±2.4 c	140.12±2.1 b	1086.39 ***	3.77
Quercetrin	522.96±1.1 a	425.09±2.2 d	443.69±2.5 c	576.30±1.6 a	2423.76 ***	4.66
Quercetin	27.83±2.3 b	16.43±1.1 c	111.77±1.8 a	25.74±1.6 b	1931.53 ***	3.30
Naringenin	2.70±1.4 b	2.15±0.2 b	1.65±0.1 b	4.31±0.6 a	6.25 *	1.50
Kampferol	4.25±0.9 b	7.40±0.7 a	4.73±0.12 b	4.69±0.7 b	17.65 ***	1.07
Hespertin	95.21±2.1 b	43.91±1.3 c	32.01±2.4 d	123.75±3.1 a	1095.07 ***	4.26
Apigenin	12.57±4.1 a	7.24±1.8 b	0.86±0.09 c	4.13±1.4 bc	13.53 **	4.42
7-OH- flavone	0.79±0.6	0.71±0.05	0.37±0.04	1.07±0.1	Ns	Ns

Soybean seeds cultivated with compost fertilizer showed the highest total flavonoids content (12894.1 μg/100g dried powdered plant material) while those cultivated with Baladi fertilizer (Cow dung) showed the lowest content of total flavonoids (1366.96 μg/100g D.w).

3.3. Nutrient content

As shown in Table (4) soybean that treated with mixture of compost and chemical fertilizer gives the highest levels of the tested minerals, P, K, Ca, Mg, Na and Zn. The values were highly significant in P (165 mg/g), K (544.5 mg/g), Zn (3.5 mg/g), significant in Na (2.2 mg/g), non-significant in Ca (14.9 mg/g) and Mg (9.3 mg/g) while soybean that treated with mixture of baladi (Cow dung) and chemical fertilizer gives significant lowest levels of P, Na, Zn, values are 175.5, 1 and 1.9 mg/g, respectively. Also, gives non-significant levels in Ca and Mg, values are 6.7 and 8.1 mg/g, respectively.

Table 4. Mineral contents of soybean seeds treated with different fertilizers

Treatment	Micronutrients					
	P	K	Ca	Mg	Na	Zn
Chemical fertilizer	165.0±12a	544.5±12 a	14.9±3	9±3	2.2±0.5 a	3.5±0.2 a
Baladi fertilizer (cowdung) fertilizer	39.0±4 c	175.5±7 c	6.7±2	8.1±2	1.0±0.04 b	1.9±0.05 c
Poultry manure fertilizer	79.0±6 b	343.0±9 b	9.9±4	8.2±2	2±0.3 a	2.3±0.3 bc
Compost fertilizer	90.0±8.2 b	330.5±11 b	10.9±5	8.7±3	1.2±0.2 b	2.5±0.4 b
F-value	126.19 ***	695.69 ***	Ns	Ns	10.90 **	19.01 ***
$LSD_{0.05}$	15.27	18.71	-	-	0.58	0.51

3.4. Vitamins

The levels of some tested vitamins in soybean that treated with the organic and inorganic fertilizers are found in Table (5) cleared that there were significant differences in the concentration of the tested vitamins occurred in the tested soybeans that treated with different types of fertilizers.

Table 5. Vitamins content (μg/100 g d.w) in soybean seeds treated with different fertilizers

	Treatment					
Vitamins	Chemical fertilizer	Baladi fertilizer (cow dung)	Poultry manure	Compost fertilizer	F-value	LSD ($_{0.05}$)
			Fat soluble vitamins			
A	1355.9±25.2 a	383.8±15.3 c	423.2±20.3 b	82.4±2.4 d	2832.41 ***	33.77
E	0.06±0.01	0.04±0.01	ND	ND	Ns	-
			Water soluble vitamins			
C	1855.0±40.2 b	1951.3±35.3 a	1450.4±22.1 c	609.0±12.4 d	1280.17 ***	55.73
B2	0.053±0.02 d	1.9±0.04 a	1.1±0.03 c	1.4±0.04 b	1622.67 ***	0.063

Soybean plants treated with mixture of compost and chemical fertilizer produced the highest values between the other tested fertilizers treated soybean. Values are 13355.9 μg/g for vitamin A, 0.06 μg/g for vitamin E, 1855 μg/g for μg/vitamin C and 0.05 μg/g for vitamin B2. The vitamins (A, E, B2 and C) in soybeans treated with compost and chemical fertilizer treated soybeans were the highest values in vitamins between the other tested fertilizers.

4. Discussion

The current study showed that the use of 100% chemical fertilizers gave higher productivity than organic fertilizers in statistical terms. These results were consistent with the results obtained by. (Maheshbabu et al., 2008) who found that the application of the recommended dose of N: K: S with CD 5 t ha-1 increased grain productivity, in addition, nutrient dynamics in soybean showed that the use of 75% of the NPK mineral along with compost / compost / phosphocompost compound is an option for plant nutrition management.

A study in the US corn belt showed that during drought conditions, agricultural crops in organic farming often produced 70-90% conventional crops (Lockeretz et al., 1981).The current results showed that the use of chemical fertilizers in combination with compost, cow dung (CD) and chicken manure (PM) can be useful and is expected to be more efficient for the agricultural development of chemical fertilizers alone. The current findings support the findings of the experiments conducted by (Yamika and Ikawati, 2012), which found that the combination of organic and inorganic fertilizers increases seed productivity to 3.5 ton/ha. (Leminski and Da Silva, 2006) also (Corrêa et al., 2008) found that the yield of soybeans can be multiplied by organic additives such as flue dust, water lime, sewage sludge and lime.

The results of the current study showed that the sample of soybean plants grown with organic fertilizer showed the highest antioxidant flavonoids. These results were found to be consistent with what was published for analysis of total phenol content and antioxidant flavonoids in organic and traditional berries (Wang et al., 2008). Organic fertilizer showed the highest content of naringin, rutin, and quercetrin. While the chemical fertilizer showed the highest content of hesperedin and apigenin. However, Allu-Datt et al., (2013) only discovered rutin and hesperedin and quercetin with other phenols in the soybean.

Our results showed that soybeans treated with a combination of compost and chemical fertilizers gave the highest significant levels of P, K, Ca, Mg, Na and Zn while soybeans treated with municipal and chemical fertilizers gave low levels of P, Na, Zn, Also, gives insignificant levels in Ca and Mg. So, the data obtained indicate that the insect infestation is related to the quality of fertilization, and that the low rate of insect infestation is followed by high productivity and that the high rate of insect infestation leads to a decrease in production.

This study confirmed the effective role of the mixture of organic manure and chemical fertilizer on processed soybean plants to obtain good levels in the minerals and vitamins obtained in the resulting seeds. Indicating that the mixing of organic fertilizers with inorganic fertilizers has a significant impact on the productivity of soybeans in terms of quality and safe food for humans.

5. Conclusion

Chemical fertilizer was faster effective and stronger influence in soybean plants and its rapid growth to withstand insect infestation and gave higher yield than those treated with organic manures (poultry, cow dung and compost). The highest yield achieved when fertilizing only chemical fertilizers. The following production was occurred in soybean plants treated with mixture of compost manure and chemical fertilizer compared to control (without fertilization) which the higher average of percentage insect infestation and was the least production. All samples of deffated soybean cultivated with different organic fertilizers (chemical, cow dung, chicken and compost fertilizers) showed the presence of the following flavonoids, naringin, rutin, hisperidin, quercetrin, quercetin, narengenin, kampferol, hispertin, apigenin and 7-0H- flavones.

The results indicated that soybeans that treated with mixture of compost and chemical fertilizer gives the highest significant levels of the P, K, Ca, Mg, Na and Zn. The overall finding of this study indicated that organic manure in combination with the recommended dose of chemical fertilizers can be applied to achieve better yield and quality of soybean as save food for human. Therefore, co-application of fertilizer may reduce the need for chemical fertilizers, allowing small farmers to save part of the cost of production.

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