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Poultry manure effects on yield and some agronomic components of Soybean (*Glycine max* L.) under Khost agro-ecological conditions, Afghanistan

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Abstract

Soybean [*Glycine max* (L.) Merrill], which has the highest protein content of all food crops, is the world's leading source of protein and oil. Soybeans are commonly consumed by humans in the form of soymilk, soy protein, tofu, infant formula, miso, natto, soy flour, and soy sauce. They are a popular protein-rich food source in most Asian countries. Worldwide, approximately 85% of soybean's produce has been processed into soy food. While in developing countries like Afghanistan, limited farmers used inorganic fertilizers in soybean fields through the high cost, marketing problems and poor economic conditions. If we have alternative resources for soil fertility like organic manure, this problem can somewhat be solved. The objective of this study was to test the effects of different levels of poultry manure on the yield and yield components of the soybean crop. The field experiment was conducted in 2019 in Almara Village of Nadar Shah Kot District of Khost Province. Soybean variety LD04-13265 was grown with four levels of manure (0, 1, 2, and 4 tons ha^{-1}) using Randomized Complete Block Design with three replicates. Results revealed that manure invariably influenced most parameters under study. The highest grain yield (1212.95 kg ha^{-1}) was obtained with 4 tons ha^{-1} (T3) followed by T2 and T1 (1145.16 and 1138.24, respectively). Poultry manure also had positive effects on the agronomic characters. Plant height, number of branches, pods $plant^{-1}$, seed pod^{-1} were among the most affected. Correlation analysis revealed significant positive correlations among the grain yield and yield components but non correlation was found for 100 seed weight with other observed parameters. As per the results of this research, 4 tons of poultry manure is the optimum amount to be used for soybean production.

Keywords

Soybean, Poultry manure, Yield and Yield components

Introduction

Soybean [*Glycine max* (L.) Merill] is a summer annual plant that belongs to the *Leguminosae* family originated from Eastern Asia (Berk, 1992). It is a protein-rich crop with other nutrients essential for human health (Dalanin, 2015). Soybean's protein is alike to animal's protein such as meat, milk, and eggs and its leftovers are good for livestock feeding (Sopha, 2017). In 2003, Nutrition Education International (NEI) introduced soybeans to the Agriculture system of Afghanistan to save the children life because undernourishment contributed to high newborn and maternal death rates in Afghanistan (NEI, Afghanisatn), unfortunately insecure conditions and weak extension program through the government caused the less area of cultivation with low yield. On the other hand the high cost of inorganic fertilizer, marketing problems and poor economic condition can cause limited farmers in Afghanistan to use inorganic fertilizers in their fields. Tesfa et al. (2001) observed that the use of inorganic fertilizers in developing countries is insignificant as most of the smallholder farmers cannot afford even a single bag to apply to their crops. Moreover, increase in the prices of chemical fertilizers, lack of consistency in feeding the soil and endangering human health caused the increase of the use of organic manure for soil fertility (Mokhtariniya and Siadat, 2011). Demand for sustainable agriculture is to use natural resources for sustain crop production, soil productivity and for a better environment. In intensive cropping systems the

continuous use of inorganic fertilizers leads to increased soil acidity and nutrient imbalance which adversely affects soil health because of their susceptibility to losses through gaseous form and by leaching (Amoah *et al.*, 2012).

As we know, there are many factors for high yield of soybean such as soil fertility, agronomic practices, genetically improved variety, pest control and so on. Organic fertilizers like farm manure, poultry manure, compost, green manure and other are the substances that contribute to soil fertility and these types of resources are available for farmers in many areas. Plant Nitrogen needs are met by soil Nitrogen as well as chemical fertlizer. Through building soil organic amendment and mineralizable soil Nitrogen, crop production is less dependent on Nitrogen additions resulting in more sustainable agro - ecosystems (Spargo et al., 2011). Parallel soybean crop can enhance soil fertility and productivity through nitrogen fixation by symbiotic bacteria (Almaz, 2017). Poultry manure in addition to provid essential neutrients for soil fertility, it augment the biological activity of microorganisms for mineralization of compound substances (Blair et al., 2014).

The use of poultry manure can help in soil with water holding capacity, soil aeration and improved soil structure that causes the high yield of soybean (Passos, 2014). Investigation by Baghadai et al. (2018) indicated that there was no difference among the NPK fertilizer and poultry manure who tried on soybean within silage corn intercrop system.

Therefore, the current research was conducted to determine the effects of different levels of poultry manure on yield and some agronomic components of soybean under the Khost agro – ecological conditions.

Materials and Method

Study area

The field experiment was carried out in Almara Village, Nadar shah kot District, Khost, Afghanistan (altitude of 1386 m above sea level) during the 2019 growing season, Fig 1. Soil of the experimental site was sandy loam with 7.7 pH degree. Metrological data (Temperature and rainfall) was recorded for each month, Figure 2.

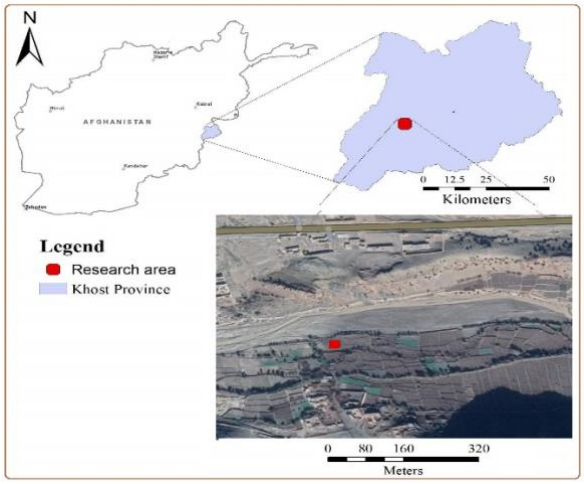

Figure 1. Map and View of study area

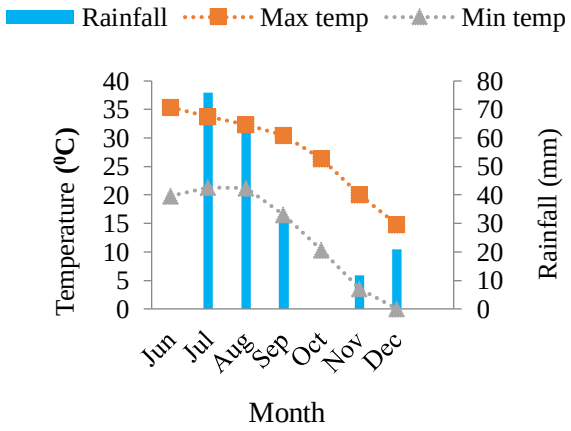

Figure 2. Climatic chart for growing season (Jun – Dec. 2019)

Treatments and experimental design

Four levels of poultry manure (T0= 0 ton ha^{-1}, T1= 1 ton^{-1}, T2= 2 ton ha^{-1} and T3= 4 ton ha^{-1}) were used as treatments to determine the effects on soybean variety (LD04- 13265 USA). The experimental design was Randomized Complete Block with three replications.

Sowing

The Soil for the experiment was plowed with plough about 20- 25 cm with poultry manure to mix with soil for immediate decomposition before planting. The individual plot size was 2m x 3m ($6m^2$). The soybean crop was grown by hand on both ridges of the furrow, space between the ridges was 40 cm and apart from the crop was 20 cm. All the other agriculture practices are done according to the need of the plant during the growing season.

Data Collection Methodology

From each plot five crops were randomly selected and tagged, then the data for the following parameters were measured.

Plant height (cm): Plant height was measured from the surface of soil to the top at the full pod stage.

Number of branches: Number of branches were recorded also in the Full pod stage.

Number of Pods $plant^{-1}$: After the harvest, total pods from the five plants were collected then the mean was recorded for each plot.

Number of seeds pod^{-1}: From the above sample, after the threshing number of seeds were divided on the number of pods then the mean was observed.

100 seeds weight (g): Randomly 100 seed from the five plants yield were weighted and recorded as 100 seed weight.

Grain yield (kg ha^{-1}): Grain yield of these five plants was converted to the total number of plants in the plot and then converted to hectares.

Data analysis using software

Analysis of variance was found with R software (R i386 4.0.2) include the Duncan's multiple range test (5%) to separate significant differences in the means of the treatments.

Result and Discussion

Plant height (cm): Result from the research indicated that the effects of different poultry manure

were significant (Table 1). Maximum plant height (70.10) observed at T3 treatment followed by T2 and T1 and the minimum plant height (60. 33) recorded at T0 (control) Fig 2(a). This may be due to the macro nutrients that are in the content of poultry manure which are released from the manure by decomposing for the plant growth during the growth period. This result is in harmony with (Chiezey & Odunze, 2009) who found maximum plant height with increasing of poultry manure level and (Cevheri & Yilmaz, 2018). He recorded the maximum plant height at 2000Kg ha $^{-1}$ cattle manure followed by 1500, 1000, 500 and 0 kg ha^{-1}.

Table 1. Mean square of ANOVA for the Growth, Yield and Yield attributes of soybean

Source of Variance	DF	Plant height	No. Branches plant^{-1}	No. Pods plant^{-1}	No. Seeds plant^{-1}	100 seeds weight	Grain yield
		MS	MS	MS	MS	MS	MS
Replication	2	2.33	1.96	2.61	0.005	0.003	351.64
Poultry Manure	3	48.22**	3.79**	38.48**	0.056**	0.03^{NS}	13994.97**
Error	6	0.55	0.09	0.56	0.002	0.02	41.03
Total	11	13.87	1.44	11.27	0.017	0.02	3903.12

DF: Degree of Freedom MS: Mean Square **: Significant at 1% level of probability NS: Non - Significant

Number of branches: Analysis of the variance showed that the effects of poultry manure were significant on soybean branches (Table 1). The more numbers of branches were recorded on T3 compared to T2, T1 and T0 and there was no– significant difference among the T2, T1 and T0 {Fig 2(b)}. The high number of branches in T3 might be due to a suitable supply of available nutrients at suitable time from poultry manure which helped in the production of branches during the growth stage. This result is in line with the finding of Yagoub et al. (2015) who observed the maximum number of branches in 2.4ton ha^{-1} of chicken manure among the nitrogen fertilizer, compost and Jatropha.

Number of pods plant^{-1}: The analysis of variance indicated significant difference for the trait of pods plant^{-1} (Table 1). The maximum number of pod plant^{-1} (33.9) was recorded at T3 followed by T2 and T1 (30.63 and 27.23, respectively) and the minimum was recorded at T0 (control) Fig 2 (c). This is due to the higher number of branches produced by more of poultry manure (4 tons ha^{-1}).

Number of seed pod^{-1}: Analysis of the variance revealed significant effects of poultry manure for seed pod^{-1} (Table 1). Means for the seed pod^{-1} showed that the highest number of seed pod^{-1} was produced by T3 (2.75) treatment which was 5%, 23% and 28% higher than T2, T1 and T0, respectively Fig 3(a).

100 seeds weight (g): Table 1 indicated that there were non-significant effects of poultry manure on 100 seeds weight. Means of T1 and T2 were closely higher than T0 and T4 {Fig 3(b)}. This finding is equal with Khaim et al. (2013) who founded that 3 ton poultry manure ha^{-1} produced light (12.50 g) weight of 100 seeds than 1 and 1.5 ton ha^{-1} poultry manure with 75% and 50% of recommended dose of commercial fertilizers, respectively and disagreement with Chiezy and Odunze (2009) who found non-significant effects of poultry manure for 100 seed weight among the treatments.

Grain yield (Kg ha^{-1}): Grain yield is the output of fertile branches, number of pod plant^{-1}, number of seeds plant^{-1} and so on. The effects of different levels of poultry manure were significant on yield of soybean (Table 1). High mean of grain yield (1212.95) was observed in T3 followed by T2 and T1 (1145.16 and 1138.24, respectively) and low was recorded in T0 (1046.65) Fig 3 (c). This may be due to the releasing of supplementary nutrients by decomposing of poultry manure during the growth stages of soybean. This result is supported by Mamia et al. (2018) who noticed maximum yield (2166) in poultry manure + 75% recommended dose of fertilizer against to Vermi – Compost and Bio fertilizer with recommended dose of fertilizer and sole dose of fertilizers and also harmony with Yagoub et al (2015), the result showed that chicken manure produced maximum yield over the compost, Nitrogen and Jatropha amount of manure respectively.

Correlation among soybean yield and yield components

The correlation among yield and yield components of soybean crop in this study is given in Fig 5. It is seen from the figure that there are positive correlation among the yield and yield components and within yield components without 100 seeds weight with all parameters. There is positive correlation among the plant height and branches (NO)(r= 0.67*), plant height and pods plant^{-1}(r=0.85***), plant height and seed pod^{-1}(r=0.84***), plant height and total yield (r= 0.93***), branches (NO) and pod plant^{-1} (r=0.83***), branches (NO) and seed pod^{-1}(r= 0.66*), branches (NO) and total yield(r= 0.77**), pods (NO) and seed pod^{-1}(r= 0.88***), pods (NO) and total grain yield(r= 0.86***) and seeds pod^{-1} and total yield (r= 0.77**).

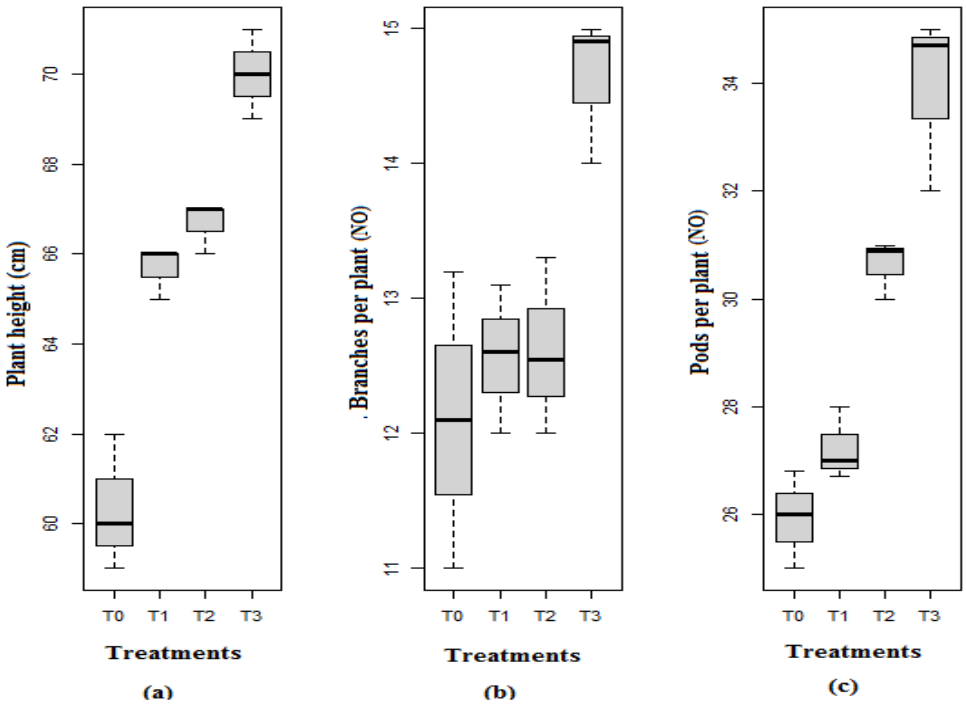

Figure 3. Response of (a) plant height (cm), (b) branches plant^{-1}(NO) and (c) pods plant^{-1} (NO) to different level of Poultry manure.

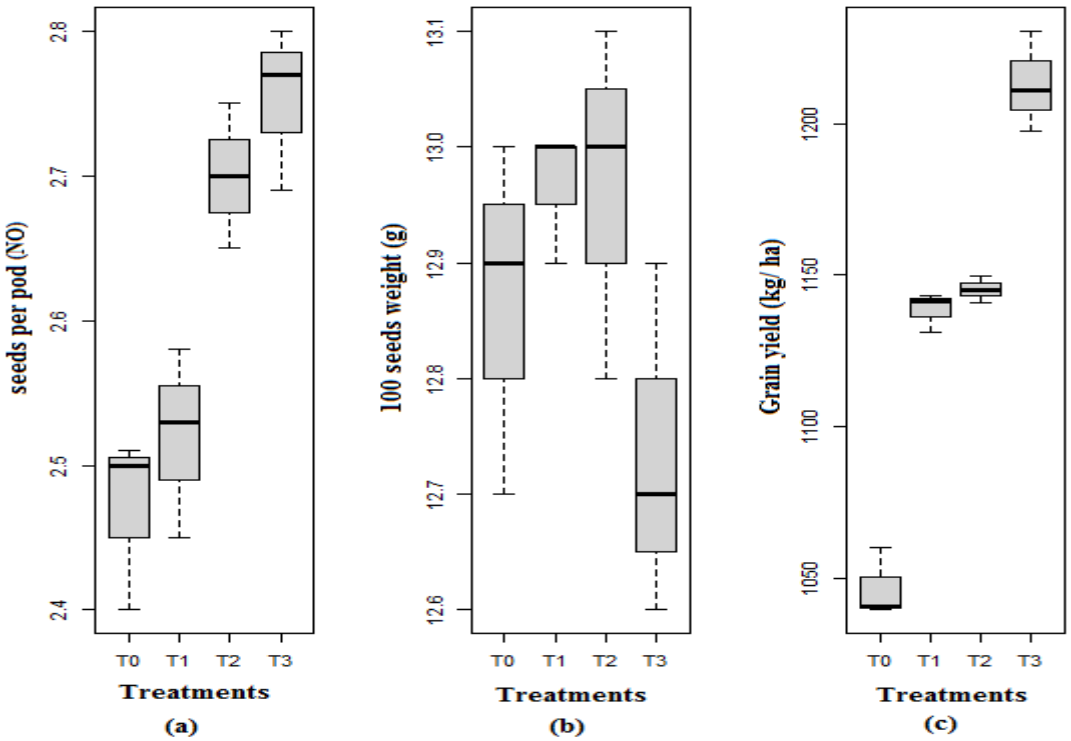

Figure 4. Response of (a) seeds pod^{-1} (NO), (b) 100 seeds weight (g) and (c) total yield (kg) to different level of poultry manure.

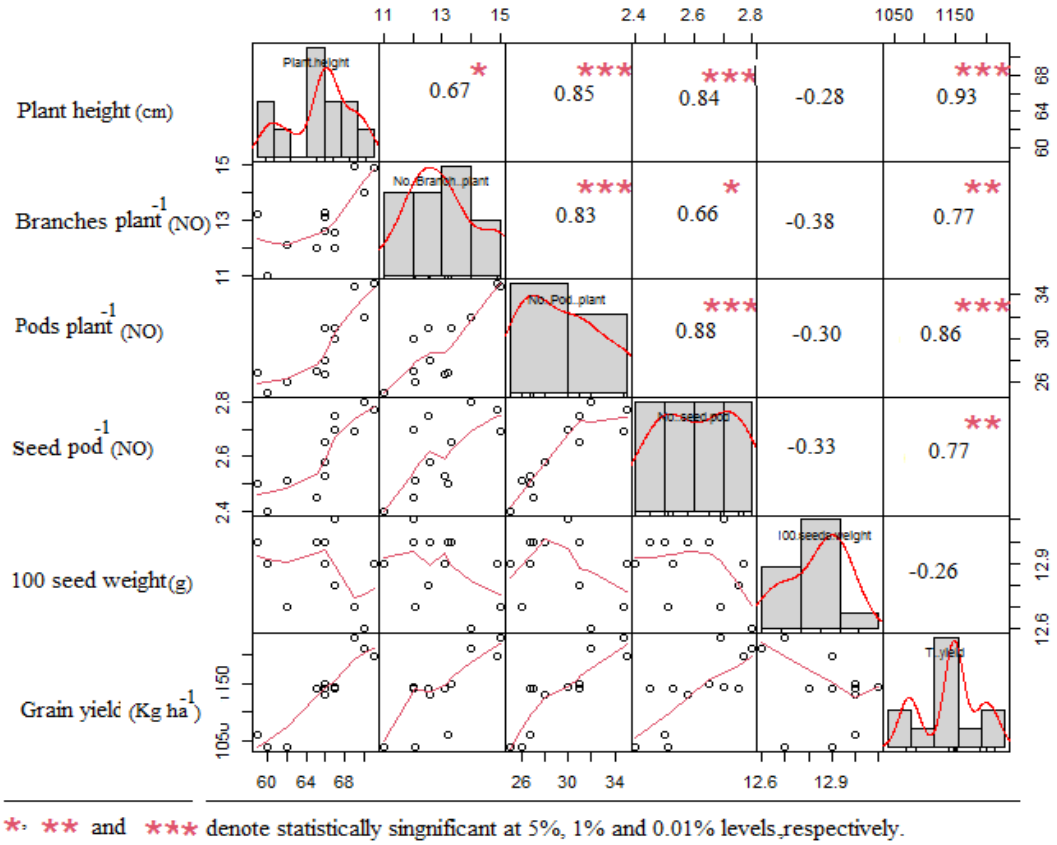

Figure 5. Correlation among yield and yield components

Conclusion

From the current study it may be determined that the effects of different levels of poultry manure were significant. The result showed that the soybean yield and yield components were greater with increasing poultry manure. T3 (4 ton poultry manure ha^{-1}) produced the maximum grain yield and yield components like fertile branches, pods $plant^{-1}$ and seeds pod^{-1} over the control. Likewise, soybean yield was positively correlated with yield components. So the sole application of 4 ton poultry manure ha^{-1} (without any recommended dose of inorganic fertilizer) is recommended for greater yield of soybean under the Khost Agro – Ecological conditions.

Compliance with Ethical Standards

Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

Author contribution

The contribution of the authors to the present study is equal.

All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

Ethical approval

Ethics committee approval is not required.

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Data availability

Not applicable.

Consent for publication

Not applicable.

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