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Yield Response of Soybean (Glycine Max) on Different Fertilization Rates

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Abstract:
Soybean is an important source of food, protein, and oil, and hence more research is essential to increase its yield under different conditions, including stress, Pagano, 2016. This study aims to (1) increase the productivity of soybeans per hectare from a baseline data of 1.37 MT per hectare with the use of inorganic fertilizers; and (2) to develop a production guide for farmers to adopt the technology that increases the productivity of Soybeans per hectare. It was conducted at the Northern Mindanao Agricultural Crops and Livestock Research Complex (NMACLRC), Dalwangan, Malaybalay City, Bukidnon.
It remarkably showed that among the treatments, soybean crops exhibit variations in response to the different levels of fertilizers with different nitrogen efficiency. Treatments showed the presence of nitrogen at the desired level gave the highest grain yield proportionate to its root length in terms of fresh roots. However, either without or even at the maximum level of nitrogen and other macro-nutrients (phosphorous and potassium), the soybean will not show its highest potential yield, thus, it is a mere fact that in the application of nitrogen in the soil, with only appropriate amount of nitrogen ion, the soybean plant will attain its optimum yield per hectare.

Chapter 1
Introduction

Soybean, scientifically known as Glycine max (L.) Merrill is a legume species belonging to the Fabaceae Family or Bean family. It's a significant agricultural commodity and the world's most crucial seed legume, contributing 25% to global vegetable oil production. It also provides about two-thirds of the world's protein concentrate for livestock feeding and is a valuable ingredient in formulated feeds for poultry and fish.
In the world, soybean is known as the "WONDER CROP" of the 20th century due to its versatility, making it one of the most valuable high-value crops. Soybean seeds contain approximately 40-45% protein, 20-25% edible oil, as well as a significant amount of vitamins A and E and minerals, making it a valuable component of many foods and feed preparations. Therefore, it has the potential to be a solution to hunger and malnutrition issues in the Philippines.
Soybeans have plenty of nutrients that make your bones stronger such as calcium, magnesium, phosphorus, vitamin D, and proteins, thus acting as antidiabetic agents, anti-cancer, help lower cholesterol, blood pressure, weight management, and many more, according to Dr. Singh, 2023.
Soybeans are a good source of protein, and they contain all the essential amino acids needed for human nutrition. They are also rich in fiber, vitamins (such as B vitamins), and minerals (including iron, calcium, and magnesium). It has various uses. The most common is the production of soybean oil, which is widely used for cooking and as an ingredient in many food products. The remaining meal after oil extraction is

often used as animal feed. Additionally, soybeans can be processed into products like tofu, soy milk, soy sauce, and tempeh, which are popular in many cuisines, especially in East Asia.

Soybeans have a mutualistic relationship with certain bacteria, typically Bradyrhizobium japonicum. These bacteria infect the root hairs of the soybean plant. Soybean nodules play a crucial role in the nitrogen-xing ability of soybean plants. These nodules are specialized structures that form on the roots of soybean plants through a symbiotic relationship with nitrogen-xing bacteria known as rhizobia. The infection of the root hairs leads to the formation of small, round structures called nodules. These nodules are a result of the plant's response to the presence of the rhizobia. Within these nodules, the bacteria convert atmospheric nitrogen (N2) into a form that the plant can use—ammonia (NH3) and then into ammonium ions (NH4+). This process is known as nitrogen fixation. Nitrogen is an essential nutrient for plant growth, and many plants, including soybeans, cannot use atmospheric nitrogen directly. The symbiotic relationship with nitrogen-xing bacteria allows soybeans to thrive in nitrogen-poor soils. The soybean plant benefits from this process by utilizing fixed nitrogen to support its growth and development. Nitrogen is a key component of amino acids, proteins, and other essential compounds in plants.

Understanding the formation and function of soybean nodules is important in agriculture, as it plays a role in sustainable farming practices and the management of soil nutrients. It contributes to the overall health of the soil and the success of soybean crops.

Soybean is an important source of food, protein, and oil, and hence more research is essential to increase its yield under different conditions, including stress, Pagano, 2016.

The average yield of soybean per hectare is only 1370 kilograms according to PSA, 2019 while it reached 1620 kilograms recorded in NMACLRC in 2020 under a controlled environment. It means that there is a difference in productivity according to the specific site/environment as the same with other commodities depending on the area and soil nutrients.

Despite all of these advantages, soybean yields only an average of 1.30 MT per hectare, which leads to a very low level of production in the nation. As a result, the majority of the soybeans grown in the nation are imported from other Asian nations such as China, the United States of America, Australia, and the European Union.

Thus, this study focused on the productivity of soybeans and is relevant to the farmers as an additional source of income during lean months or off-season.

OBJECTIVES :

This study aims to:

1. increase productivity of soybean per hectare from a baseline data of 1.37 MT per hectare with the use of inorganic fertilizers; and
2. to develop a production guide for farmers to adopt the technology that increases the productivity of Soybeans per hectare.

Location of the study:

The study was conducted at Northern Mindanao Agricultural Crops and Livestock Research Complex (NMACLRC), Dalwangan, Malaybalay City, Bukidnon.

Chapter 2

Review of Related Literature

The average yield of soybean per hectare is only 1370 kilograms according to PSA, 2019 while it reached

1620 kilograms recorded in NMACLRC in 2020 under a controlled environment. It means that there is a difference in productivity according to the specific site/environment as the same with other commodities depending on the area and soil nutrients.

Between 1961 and 1965, the average global yield of soybeans doubled, rising to 2.31 metric tons per hectare between 2005 and 2007 (Masuda & Goldsmith, 2009).

According to Zhou, Z, et.al. (2022), soil fertilizer management influenced the feeding activities of soil fauna, and these responses were closely related to soil nutrition. Organic fertilizer application greatly enhanced soil fauna feeding activity, and then inorganic nitrogen fertilizer reduced the soil fauna feeding activity.

At any given time, 95 to 99 percent of the potentially available nitrogen in the soil is in organic forms, either in plant and animal residues, in the relatively stable soil organic matter, or in living soil organisms, mainly microbes such as bacteria. This nitrogen is not directly available to plants, but some can be converted to available forms by microorganisms. A very small amount of organic nitrogen may exist in soluble organic compounds, such as urea, that may be slightly available to plants, according to Mosaic Crop Nutrition (MCN), 2023.

Legume plant roots are a major source of food energy for bacteria like Rhizobia, which can x substantially more nitrogen annually—some of them by well over 100 pounds per acre. The amount of nitrogen that Rhizobia xes is released for use by the host bean plant when it is more than what the microorganisms require. Well-nodulated legumes already receive enough nitrogen from the bacteria, which is why they rarely react to the addition of nitrogen fertilizer, (MCN, 2023).

To determine the recommendation for the application of inorganic fertilizers (complete and urea), this study investigated the effect of different amounts of fertilizer (complete and urea) in soybean production.

Chapter 3
METHODOLOGY

Experimental Design and Treatments:

The study was laid out using Completely Randomized Design (CRD) with four (4) treatments replicated (3) three times. Analysis of variance (ANOVA) was carried out to determine the significant differences among treatments using the Statistical Analysis Software (SAS).

Treatments:

T1 – control (no fertilizer)
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)

Establishment of experiment and treatment application

Treatment of fertilizer based on the recommendations per hectare of soybean with a planting density of 333,000 hills per hectare with different fertilizer rates of 60-30-30, 90-45-45, and 120-60-60 per hectare at a distance of 20 plants per linear meter (- 0.1m x 0.3 m = 20 plants per linear meter).

Land preparation

The soil was obtained from a land previously planted with vegetables.

Fertilizer Application

The amount of complete fertilizer was weighed using a weighing scale based on its amount for treatments 2, 3, and 4. The weighed amount was then applied half during planting and side dress during

the early vegetative stage of a soybean plant. Another amount of urea was applied during V4 to provide some margin safety in case weather and soil conditions delay N movement to the roots.

Seed Germination and Sowing of the seeds

A paper tissue germination test was conducted to assess the germination rate of 100 soybean seeds. The result shows that the germination rate of the chosen seeds was 96%. After knowing the germination test, the seeds will be sown on the prepared plot.

Care and Maintenance

Plants were monitored daily at early stages and every week or as the need arose as they matured. Watering of plants was done using a bottle sprayer and watered early in the morning. Proper removal of weeds was done. Manual control of weeds, pests, and diseases was done regularly.

Harvesting and Drying

From the eld, soybean plants were uprooted manually. The harvested plants were bundled and marked separately, dried, and weighed.

Data Gathered

Root length of soybean

The root length of the soybean was measured using a one-meter ruler stick. The longest root hair was the basis of measurement measured from the base to the tip per treatment.

Plant Height (cm)

The plant height was measured from the soil surface to the highest point of the arch of the uppermost leaf whose tip is pointing down in all treatments.

Pod Length (cm)

The pod length was measured using a ruler. Pod length was measured from the base of the pod to the tip per treatment.

Number of pods per plant

The pods per plant were collected by counting the pods per plant. All the pods were manually counted.

Number of tillers

The number of tillers per plant was also collected by counting manually from each treatment or plot. (there is only one plant per plot that was counted).

Weight of seeds (g)

The weight of all the seeds per plant was taken from each treatment and Weighted using a digital weighing scale.

Shelling Recovery (%)

The shelling recovery was determined by one (1) soybean plant represented per treatment. It was weighed and recorded. The soybean pods were shelled and cleaned before weighing. The shelling recovery was computed using the formula:

$$\text{Shelling recovery} = \frac{\text{shelled X 100}}{\text{unshelled}}$$

Grain Yield per Hectare (kg/ha)

The actual yield was determined after collecting and recording data per treatment. The grains were shelled, dried, and cleaned before weighing. The yield (kg/ha) was computed as follows:

Grain Yield per Hectare (kg/ha) = (yield per plant (kg) x 250,000 plants per hectare)

Assumption: with the distance of 40cm*10cm, then (10,000/.04) the total plant per hectare would be 250,000 plants per ha

Chapter 4

Results and Discussions

The findings are presented according to the sequence of the specific problems of this study stated in Chapter 1.

Table 1. Root performance of Soybean on the efficacy of fertilizers on different levels

	Mean	
Treatment	Root Length	Grain Yield
T1 - control (no fertilizer)	9.83	2041.67
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)	12.13	2700
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)	10.67	1816.67
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)	11.83	1466.67
F-Test	ns	s
C.V.	11.8602	21.82465
n.s.- non - significant	*significant	

The root performance of soybean on the efficacy of Fertilizer at different levels of complete and urea is shown in Table 1. Grain yield was included to determine the impact of Fertilization on the growth of soybeans. The result showed that T2 has the highest root length with a mean of 12.13 which also gave the highest grain yield of 2700 kg per hectare. Whereas, T1 gave the least root length with the mean of 9.83. Root performance of soybean crops with different levels of fertilization statistically showed a non-significant difference in root length but with significant differences in grain yield. The longer roots produced by the plants also achieved higher yield potential.

Greater soil exploration by bigger root systems allows plants to acquire more water and nutrients. This enhanced absorption of nutrients and water may help boost plant development and harvests. The root length of T2 is longer, which allows plants to absorb more nitrogen from the soil (MCN, 2023).

A strong root system is an important factor for high yields. There is a positive correlation between root weight and above-ground biomass and ultimately yield. Under high planting density, a medium root system with more root distribution is more likely to result in a high yield (Guo, S., 2022). Therefore, a variety with higher total root density may allow for greater absorption of water and nutrients which could result in higher grain yield.

Table 2 shows the yield and yield parameters of soybeans on the efficacy of Fertilizer application with different levels of complete fertilizer and urea. Analysis of variance showed a significant variation in the number of tillers, weight of seeds, and yield while plant height, number of pods, weight of pods per plant, and shelling recovery as not significant.

Based on the result, T3 (0.54 g/hill complete + 0.82 g/hill urea) showed the highest plant height of 64.3 cm. This was followed by T2 (0.36 g/hill complete + 0.41 g/hill urea) with 60.3 cm, T4 (0.71 g/hill

complete + 1.22 g/hill urea) with 54.3 cm, and T1 with 52.3 cm. The shortest height was noted in T1 (control- no fertilizer) at 52.3 cm.

Table 2: Yield and yield parameters of the soybean on the efficacy of fertilizers on different levels

Treatment	Mean							
	Plant Height (cm)	Number of pods per plant	Number of tillers	Weight of pods per plant (g)	Weight of seeds (g)	Shelling Recovery (%)	% MC	projected Grain Yield per Hectare (kg/ha)
T1 - control (no fertilizer)	52.333	53	4.667	49.467	8.167 ab	0.1679	0.2633	2041.67
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)	60.333	71.333	6	63.2	10.8 a	0.1718	0.2567	2700
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)	64.333	58	5.333	41.1	7.27 ab	0.1843	0.2667	1816.67
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)	54.333	43	3.667	38.6	5.87 b	0.1613	0.2667	1466.67
F-Test	ns	ns	s	ns	s	ns		s
C.V.	13.70619	25.5759	14.382	28.53529	21.8247	19.65562	11.756	21.8247
n.s.- non - significant	*significant							

The highest number of pods was recorded in Treatment 2 with an average of 71 pods followed by Treatment 3 with 58 pods, Treatment 1 with 53 pods, and Treatment 4 with the lowest number of pods with 43 pods.

While, on the number of tillers, T2 had the highest number of tillers recorded with 6 tillers, T3 with 5 tillers, followed by T1 and T4 with 4 and 3 tillers, respectively.

The heaviest weight of pods per treatment was recorded in T2 with 63.2 grams. This was followed by T1 with 49.47g., and Treatment with 41.1g. and T4 has the lowest weight of 38.6g.

Moreover, the weight of their seeds showed significant differences among the treatments. Again, T2 weight of seeds with 10.8 grams, followed by T1 with 8.167g, then, T3 with 7.27g and T4 with 5.87g. only.

On the other hand, shelling recovery showed non-significant differences among treatments. T3 showed the highest recovery with 18.43%, while T4 had the lowest percent of 16.13%.

The data on the yield (kg/ha) revealed significant results among treatments, with T2 – 0.36 g/hill complete + 0.41 g/hill urea with 2.7MT per hectare, followed by the control Treatment with 2.04 MT, while T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45) and T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60) having 1.8 MT and 1.47 MT per hectares, respectively.

Appropriate nitrogen application could balance grain quality, while excessive nitrogen application would deteriorate taste quality. Nitrogen fertilizer application can promote starch biosynthesis and carbohydrate consumption and has a great influence on the grain filling of superior grains and inferior grains. Increasing nitrogen fertilizer can improve the metabolic ability of crops and promote the synthesis of various substances at the grain-filling stage, thereby affecting the grain formation process according to Zhao et al., 2022. This result indicates that the grain number of tillers is the main reason for the difference in yield of different fertilizer rates under both nitrogen conditions. The number of tillers was significantly higher

than that of a condition under the very high level of nitrogen applied.

In soybeans, the soil bacteria responsible for this process are called *Bradyrhizobia japonicum*. Each plant type that can fix Nitrogen (N), requires different bacteria, and if the soil does not contain that bacteria, it cannot fix N. Hence, N-fertilizers are not typically recommended for soybean production since soybeans can gather nitrogen from the environment very effectively. Therefore, it is more recommended to provide Phosphorus and Potassium to the crop for improved production, (Courses.n.d.).

Chapter 5

Summary, Conclusion, and Recommendations

This chapter presents the summary, conclusion, and the corresponding recommendations based on the results of the study.

The study was conducted with the following objectives: 1) to increase the productivity of soybean per hectare from a baseline data of 1.37 MT per hectare with the use of inorganic fertilizers, and 2) to develop a production guide for farmers to adopt the technology that increases the productivity of Soybean per hectare. The study was conducted at Northern Mindanao Agricultural Crops and Livestock Research Complex (NMACLRC), Dalwangan, Malaybalay City, Bukidnon.

The experiment was laid out using the Completely Randomized Design (CRD) with Four (4) Treatments at three (3) replications each. The treatments were the following:

T1 - control (no fertilizer)

T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)

T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)

T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)

The results in terms of root performance, the statistical analysis showed no significant variation among treatments in root length while significant variations were observed in the yield among treatments. The soybean crop applied with 0.36 g/hill complete + 0.41 g/hill urea had the highest root length and yield with 12.13cm and 2.7MT, respectively. With the absence of any fertilizer, it gave the shortest root length of 9.83cm but second in the highest yield of approximately 2.04MT per hectare, approximately.

On the other hand, yield and yield performance as to number of pods per plant, weight of pods per plant, and shelling recovery did not vary significantly among treatments. On the other hand, significant variation was observed in the number of tillers, weight of seeds, and grain yield per hectare.

In conclusion, it remarkably showed that among the treatments, soybean crops exhibit variations in response to the different levels of fertilizers with different nitrogen efficiency. Treatments showed the presence of nitrogen at the desired level gave the highest grain yield proportionate to its root length in terms of fresh roots. However, either without or even at maximum level of nitrogen and other macro-nutrients (phosphorous and potassium), the soybean will not show its highest potential yield, thus, it is a mere fact that in the application of nitrogen in the soil, with only appropriate amount of nitrogen ion, the soybean plant will attain its optimum yield per hectare.

Based on the recent findings, a similar study is therefore recommended to be conducted in an open field/area to evaluate further the response of soybean on different fertilization rates and further recommends the use of rhizobium inoculum for higher levels of research studies for nodules to be more visible due to beneficial bacteria for N-fixations to naturally happen in the plants.

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APPENDICES

Appendix Table 1. Mean of Root Length on the efficacy of fertilizers on different level

	REPLICATION				
treatment	I	II	III	TOTAL	Mean
T1 - control (no fertilizer)	9	11.5	9	29.5	9.8333333
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)	13.4	13	10	36.4	12.1333333
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)	10	10	12	32	10.6666667
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)	12	12	11.5	35.5	11.8333333

Appendix Table 1a. Analysis of Variance on Root Length on the efficacy of fertilizers on different level

SV	DF	Sum of Squares	Mean Square	F Value	Pr > F
treatment	3	10.19	3.39666667	1.95	0.1996
Error	8	13.9066667	1.73833333		
Corrected Total	11	24.0966667			

C.V. 11.8602 ns

Appendix Table 2. Mean of Plant Height on the efficacy of fertilizers on different level

	REPLICATION				
treatment	I	II	III	TOTAL	Mean
T1 - control (no fertilizer)	45	54	58	157	52.33333
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)	70	51	60	181	60.33333
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)	62	62	69	193	64.33333
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)	44	55	64	163	54.33333

Appendix Table 2a. Analysis of Variance on Plant Height on the efficacy of fertilizers on different level

SV	DF	Sum of Squares	Mean Square	F Value	Pr > F
treatment	3	273	91	1.45	0.2995
Error	8	502.666667	62.8333333		
Corrected Total	11	775.666667			

C.V. 13.70619 ns

Appendix Table 3. Mean of Pods per plant on the efficacy of fertilizers on different level

	REPLICATION				
treatment	I	II	III	TOTAL	Mean
T1 - control (no fertilizer)	58	52	49	159	53
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)	78	46	90	214	71.3333333
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)	68	58	48	174	58
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)	35	35	59	129	43

Appendix Table 3a. Analysis of Variance on pods per plant on the efficacy of fertilizers on different level

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
treatment	3	1250	416.666667	2.01	0.1916
Error	8	1660.666667	207.583333		
Corrected Total	11	2910.666667			

C.V. 25.57589 ns

Appendix Table 4. Mean of Number of tillers on the efficacy of fertilizers on different level						
	REPLICATION					
treatment	I	II	III	TOTAL	Mean	Grouping
T1 - control (no fertilizer)	5	4	5	14	4.6666667	ab
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)	7	5	6	18	6	a
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)	5	6	5	16	5.3333333	ab
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)	4	3	4	11	3.6666667	b

Appendix Table 4a. Analysis of Variance on pods per plant on the efficacy of fertilizers on different level

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
treatment	3	8.9166667	2.97222222	5.94	0.0196
Error	8	4	0.5		
Corrected Total	11	12.916667			

C.V. 14.38183 *Significant

Appendix Table 5. Mean of Weight of pods (grams) on the efficacy of fertilizers on different level					
	REPLICATION				
treatment	I	II	III	TOTAL	Mean
T1 - control (no fertilizer)	50	57.4	41	148.4	49.4666667
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)	60.6	48	81	189.6	63.2
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)	31	42.3	50	123.3	41.1
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)	54.4	19.3	42.1	115.8	38.6

Appendix Table 5a. Analysis of Variance on weight of pods (g.) on the efficacy of fertilizers on different lev

Source	DF	Squares	Mean Square	F Value	Pr > F
treatment	3	1107.3825	369.1275	1.96	0.1986
Error	8	1506.5867	188.323333		
Corrected Total	11	2613.9692			

C.V. 28.53529 ns

Appendix Table 6. Mean of Weight of Seeds on the efficacy of fertilizers on different level						
	REPLICATION					
treatment	I	II	III	TOTAL	Mean	Grouping
T1 - control (no fertilizer)	8.2	8.3	8	24.5	8.1666667	ab
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)	9.4	9	14	32.4	10.8	a
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)	7.3	7.5	7	21.8	7.2666667	ab
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)	8.1	3.9	5.6	17.6	5.8666667	b

Appendix Table 6a. Analysis of Variance on Weight of seeds on the efficacy of fertilizers on different level

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
treatment	3	38.8625	12.95416667	4.22	0.0458
Error	8	24.54	3.0675		
Corrected Total	11	63.4025			

C.V. 21.82465 *significant

Appendix Table 7. Mean of Shelling Recovery of soybean on the efficacy of fertilizers on different level

	REPLICATION				
treatment	I	II	III	TOTAL	Mean
T1 - control (no fertilizer)	0.16	0.14	0.2	0.503721	0.1679071
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)	0.16	0.19	0.17	0.515455	0.1718183
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)	0.24	0.18	0.14	0.552789	0.1842629
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)	0.15	0.2	0.13	0.483986	0.1613287

Appendix Table 7a. Analysis of Variance on Shelling recovery of Soybean on the efficacy of fertilizers on different level

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
treatment	3	0.0008377	0.00027924	0.25	0.8618
Error	8	0.0090725	0.00113406		
Corrected Total	11	0.0099102			

C.V. 19.65562 ns

Appendix Table 8. Mean of Mean of Percent Moisture Content on the efficacy of fertilizers on different level

	REPLICATION				
treatment	I	II	III	TOTAL	Mean
T1 - control (no fertilizer)	0.28	0.23	0.28	0.79	0.2633333
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)	0.29	0.22	0.26	0.77	0.2566667
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)	0.3	0.23	0.27	0.8	0.2666667
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)	0.28	0.24	0.28	0.8	0.2666667

Appendix Table 8a. Analysis of Variance on Percent Moisture Content on the efficacy of fertilizers on different level

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
treatment	3	0.0002	0.00006667	0.07	0.9746
Error	8	0.0076667	0.00095833		
Corrected Total	11	0.0078667			

C.V. 11.75581

Appendix Table 9. Mean of Projected Grain Yield per hectare on the efficacy of fertilizers on different level

treatment	REPLICATION					
	I	II	III	TOTAL	Mean	Grouping
T1 - control (no fertilizer)	2050	2075	2000	6125	2041.67	ab
T2 – 0.36 g/hill complete + 0.41 g/hill urea (recommendation: 60-30-30)	2350	2250	3500	8100	2700	a
T3 – 0.54 g/hill complete + 0.82 g/hill urea (recommendation: 90-45-45)	1825	1875	1750	5450	1816.67	ab
T4 – 0.71 g/hill complete + 1.22 g/hill urea (recommendation: 120-60-60)	2025	975	1400	4400	1466.67	b

Appendix Table 9a. Analysis of Variance on Projected Graing Yield per hectare on the efficacy of fertilizers on different level

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
treatment	3	2428906.3	809635.42	4.22	0.0458
Error	8	1533750	191718.75		
Corrected Total	11	3962656.3			

C.V. 21.82465 *Significant