

Effect of Fertilizers on Soybean Yield

Sunjidmaa O*, Dorligsuren E., Ph.D, Tuul D., Ph.D., Bayarsukh N., Ph.D

Institute of Plant and Agricultural Sciences, Mongolia

**Corresponding Author: Sunjidmaa O, Institute of Plant and Agricultural Science, Mongolia*

ABSTRACT

*In order to determine the effect of various fertilizers on the yield of soybean (*Glycine Hispida L*), the *Rhizobium Japonicum* bacteria fertilizer which are selected from local strains, the mineral fertilizers $P_{40}K_{40}$, $N_{20}P_{40}K_{40}$, and Humate fertilizers were used for the experiment. The experiment conducted in the experimental farm of Elite seed, LLC in Selenge province of Mongolia in 2018-2019.*

The result of the experiment showed that the seed germination of soybean in the field was 47% in the control and whereas the germination under different fertilizers were high by 7-22% than control. The grain yield of soybean under fertilizer range from 0.82-1.71 t/ha which were higher by 0.32-0.48 t/ha than control that showing various effects of different fertilizers to soybean yield.

Keywords: *Rhizobium japonicum, mineral, inoculation, humate*

INTRODUCTION

Soybean (*Glycine Hispida L*) like other leguminous crops has specific ability to live in symbiosis with microorganisms, fixing a nitrogen from the atmosphere and accumulating in the soil as well as creating protein-rich products consisting.

Although legume plants have a common biological feature that restores soil fertility and productivity as improving the soil conditions, the amount of nitrogen taken up from these sources depends on many biotic and abiotic factors, e.g., the rhizobium species, cultivar, as well as weather and agricultural practices.

In particular, in regions which have an extreme continental climate with long, cold winters and short summers and the most precipitation falls in summer, the ability of bacterial nitrogen fixation in legume nodules (a stem or rhizome) is limited as well as it adversely affects the crop growth and, consequently an yield [2].

Therefore, one of the necessary measures of advanced technology to increase the efficiency of cultivation of legumes such as soybeans is an inoculation of seeds by rhizobium bacteria during sowing and application of other fertilizers in appropriate way.

Also, for the further development of ecology oriented agriculture, the biological improvement of soil fertility and the adaptability of the crop needs to be increased [1, 4].

In order to increase the efficiency of soybean cultivation by fertilizer application in the central cropping zone of Mongolia, the following objectives were set in the experiment:

1. To determine effect of fertilizers on soybean germination
2. To determine effect of fertilizers on yield and yield component

METHOD

Location of the experimental plantation: The experiment conducted in 2018-2019, at the experimental farm of Elite seed, LLC in Khushaat soum of Selenge province in Mongolia. The field has the typical chestnut soil. The soybean has been grown under irrigated condition and selected fertilizers were used during the sowing. The field experiment was performed according to the following methodology.

Experimental plots

1. Control /non fertilizer/
2. $P_{20}K_{20}$
3. $N_{10}P_{20}K_{20}$

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4. Humate fertilizer (2.5 l/t seed)
5. Rhizobium biofertilizer (10 l/t seed)

Size of the Experimental Plantation Site: The size of the experiment plot is 80 m² (3.2x25), in 3 replications. Before sowing soybean seed inoculated by bacterial and humate fertilizers. The mineral fertilizers were applied to the field plot by the doses specified in the experimental protocol.

Cultivation of Experiments: Selected soybean varieties such as Severnaya-4 and Sibiryachka were planted at a depth of 5-6 cm with row distance of 38 cm by seed drill CH-14 at the rate of 100 kg/ha in the middle and last 10 days of May.

RESULTS

Table1. Effect of fertilizers on soybean germination

№	Plots	Germination		Added from fertilizer	
		Number	%	Number	%
1	Control	38	47	-	-
2	P ₄₀ K ₄₀	46	58	8	11
3	N ₂₀ P ₄₀ K ₄₀	43	54	5	7
4	Humate	52	65	14	18
5	Rhizobium	55	69	17	22

Especially, the highest field germination recorded when soybean seed inoculated by the rhizobium bacteria. For example, positive effect of rhizobium fertilizer increased seed germination by 22% in comparison to control in field which was higher by 4-15% than other fertilizer options.

The effect of organic fertilizers to soybean seed germination in the field has been better than the effect of mineral fertilizers. The seed germination was high under the effect of humate fertilizer by 18% than control and by 9% than mineral fertilizer. However, soybean seed germination in the field also increased 11% under the phosphorus and potassium fertilizer (P₄₀K₄₀) combination and by 4% due to the effect of complete mineral fertilizer (N₂₀P₄₀K₄₀) combination.

Table2. Effect of Fertilizers Yield Component

№	Plots	Plants, m ²	Per plant pods		Seed of per pod		1000-grain weight, g	Seed weight, g/m ²
			number	weight, g	number	weight, g		
1	Control	18.6	8	3.4	2	0.15	138.5	92.7
2	P ₄₀ K ₄₀	23.5 ^{ab}	8	3.0	2	0.16	153.5	113.5 ^{ab}
3	N ₂₀ P ₄₀ K ₄₀	22.5 ^{ab}	9	4.0	2	0.15	143.7	136.6 ^{ab}
4	Humate	24.6 ^{ab}	7	3.3	2	0.14	162.7	131.7 ^{ab}
5	Rhizobium	27.9 ^a	9	4.2	2	0.15	165.7	148.8 ^a
	SRD _{0,5}	6.5						46.8

Effect of Fertilizers on Soybean Germination

Use of fertilizers during sowing increased supply of nutrients from the beginning of the growth and it facilitated good uniform seed germination.

The seed germination estimated at 0.8 million seeds per hectare. According to our study the uniform germination of soybean obtained in 30 days after sowing, and the effect of fertilizers were different.

Experiment result shows that the soybean germination under control ranged from 32.5 to 60.0%, however, it is increased by 14.6% on average due to the positive effects of various fertilizers at sowing.

Effect of Fertilizers on Soybean Yield Components

According to the analysis on the soybean yield components the number of plants per unit plot was 18.6, the 1000 grain weight 138 g and seed weight 92.7g, and these values increased under the fertilizer application by 6, 17.9 and 39.9, respectively.

Especially under the effect of rhizobium fertilizers, the above values of the yield component were the highest and the value of plant number per plot increased by 9.3, the 1000 grain weight by 27.2 g and seed weight by 56.1 g compared to the control as well as under the effect of other fertilizers above values increased by yield component values increased by 4.3, 27.2g and 21.5 g, respectively.

Effect of Fertilizers on Soybean Yield

The number of pods per plant is 7-9, the weight of pods per plant is 3.3 - 4.0g also the number of seeds per pod is 2, seed weight in single pod is ranged from 0.14 to 0.16g. Under the effect of rhizobium fertilizers, the average number of pods per plant and weight increased by 1 and 1.4g respectively and as an effect of a complete mineral (N20P40K40) fertilizer the seed weight in single pod was increased slightly (0.01g) compared to control.

Under the climate condition of our country, the application of fertilizers during sowing and

Table3. Soybean yields

№	Plots	Yield, t/ha		Average, t/ha	Added from fertilizer	
		2018	2019		t/ha	%
1	Control	1.0 ^c	0.8 ^b	0.9	-	-
2	P ₄₀ K ₄₀	1.2 ^{abc}	1.0 ^{ab}	1.1	0.2	22.5
3	N ₂₀ P ₄₀ K ₄₀	1.55 ^{ab}	1.2 ^{ab}	1.4	0.4	47.3
4	Humate	1.5 ^{ab}	1.1 ^{ab}	1.3	0.4	43.0
5	Rhizobium	1.7 ^a	1.3 ^a	1.5	0.6	60.2
SRD_{0,5}		6.1	3.9			

Application of inoculated rhizobium fertilizer during sowing of soybean increased the grain yield significantly. The yield was 1.49 t/ha which was highest under the effect of Rhizobium fertilizer which is higher by 0.56 t/ha compared to control and by 0.21 t/ha than other fertilizer effect.

In the central cropping zone of Mongolia which has light chestnut soil, the cultivation of soybean requires appropriate application of fertilizers especially the rhizobium bacterial fertilizer is very effective for the stable production.

DISCUSSION

The number of local and international researchers expressed significance of bacterial inoculation and various fertilizer application for sustainable production of soybean.

According to the research conducted by Yaroshenko.B in 2018, one of the important technological activities to increase the symbiotic potential of soybean crops is the application of fertilizers during sowing. In particular, in dry and low rainfall weather the sowing seed with different levels of inoculation improves the ability of soybeans to withstand adverse climatic conditions, supports its growth and development as well as increasing the chances of stable yield formation [6].

Sowing seed with different levels of inoculation by bacterial fertilizers shall reduce the use of

increase of the nutrient supply can improve soybean yield and yield components.

Effect of Fertilizers on Soybean Yields

According to the experiment the soybean grain yield ranged between 1.03-1.71 t/ha in 2018 and 0.82-1.26 t/ha in 2019 and the yield increased by 0.48 t/ha in 2018 and by 0.32 t/ha in 2019 as an effect of fertilizers.

In addition, under the effects of various fertilizers, an increase in soybean yield was by 0.4 t/ha or 43.2% compared to control.

nitrogen fertilizer by 50-200kg, and increase the yield by 10-40% as well as it allows reduction of the nitrate nitrogen contained in the plant biomass.

Research conducted by Dorligsuren E. in 2015-2017, The study revealed that when soybean seeds inoculated by fertilizers before sowing it could reduce the crop duration by 2-4 days, and increase the field germination by 3.7-8.7%, seed yield by 0.10-0.42 t/ha and protein content by 0.3-2.6% [3].

CONCLUSION

1. The positive effect of rhizobium fertilizer increased soybean seed germination in field by 22% in compared to control as well as by 10% compared to other fertilizer options.
2. The soybean grain yield increased by 0.3-0.48 t/ha from the application of fertilizers and the highest increase of 0.56 t/ha recorded by the influence of inoculated rhizobium fertilizer.

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