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Productivity and Economic Efficiency of Soybean Production Under Different Fertilization Methods in the Soil and Climatic Conditions of the Southern Region of Uzbekistan

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Citation: Shokhabbos Kizi, K. S. Productivity and Economic Efficiency of Soybean Production Under Different Fertilization Methods in the Soil and Climatic Conditions of the Southern Region of Uzbekistan. American Journal Of Botany And Bioengineering 2026, 3(10), 1-10.

Received: 13th Jul 2026

Revised: 28th Aug 2026

Accepted: 15th Sep 2026

Published: 05th Oct 2026



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Abstract: This article investigates the productivity and economic efficiency of soybean production under different fertilization methods in the soil and climatic conditions of the southern region of Uzbekistan. The study focuses on evaluating the effects of mineral, organic, and combined fertilization systems on soybean growth, development, yield formation, and production efficiency. Particular attention is given to the relationship between fertilizer application methods, soil fertility, climatic conditions, and the biological productivity of soybean crops. The research evaluates key production indicators, including plant growth characteristics, number of pods, seed yield, and yield per unit area, as well as economic indicators such as production costs, gross income, net profit, and profitability level. The results indicate that the appropriate selection and balanced application of fertilizers can significantly improve soybean productivity while contributing to more efficient use of production resources. The study also demonstrates that fertilization practices adapted to the specific soil and climatic conditions of southern Uzbekistan can increase the economic returns of soybean cultivation and strengthen the sustainability of crop production. The findings provide practical recommendations for improving soybean cultivation technologies, optimizing fertilizer use, reducing unnecessary production costs, and increasing the profitability and competitiveness of soybean production in the region.

Keywords: soybean, protein, oil, grain, economic efficiency, fertilization, region, gross income, costs, price per 1 kg, soums.

Introduction

Usage. Due to continuously increase the production of food and animal feed in recent years, the expansion of soybean grain production has been causing. The main products from soybean are soybean flour and soybean oil. Flour is used in food for the preparation of confectionery, fillers, for the production of substitutes for meat, milk, cheese, an diabetic products. Soybean oil is used in food, for the preparation of mayonnaise, margarine, butter for salad. Paints, soap, varnishes, inks, rubber products are produced from waste products of not processed soybean oil. Many scientists and

industrialists believe that "soybean is food, fodder and the future" [1]. The problem of production of high-grade vegetable protein is solved with the help of soybean [2].

The main purpose of soybean cultivation is as follows:

1. To improve human nutrition. In many countries where soy is sown, it becomes the only source of protein for the food industry;
2. To increase the productivity of livestock. With constant feeding of animals with soybean feed, the daily weight gain doubles, the fattening period is reduced by 10-15 days to get a weight gain of 100 kg of live weight and the product quality improves;
3. For industrial products. Different products are used from soy products unused in the food industry and in animal husbandry – building boards, fabrics, and artificial fertilizers [3].

The **soybean**, **soy bean**, or **soya bean** (*Glycine max*) [4] is a species of legume native to East Asia, widely grown for its edible bean. Soy is a staple crop, the world's most grown legume, and an important animal feed [5].

Soy is a key food source, owing to its high protein and oil content. Soybean oil is widely used in cooking, as well as in industry. Traditional unfermented food uses of soybeans include edamame, as well as soy milk, from which tofu and tofu skin are made. Fermented soy foods include soy sauce, fermented bean paste, natto, and tempeh. Fat-free (defatted) soybean meal is a significant and cheap source of protein for animal feeds and many packaged meals. For example, soybean products, such as textured vegetable protein (TVP), are ingredients in many meat and dairy substitutes [6]. Soy-based foods are traditionally associated with East Asian cuisines, and still constitute a major part of East Asian diets, but processed soy products are increasingly used in Western cuisines.

Soy was domesticated from the wild soybean (*Glycine soja*) in north-central China between 6,000 and 9,000 years ago [7]. Brazil and the United States lead the world in modern soy production. The majority of soybeans are genetically modified, usually for either insect, herbicide, or drought resistance. Three-quarters of soy is used to feed livestock, which in turn go to feed humans. Increasing demand for meat has substantially increased soy production since the 1980s, and contributed to deforestation in the Amazon.

History. Soybean is an ancient crop. Study the diversity of types and forms of soybean shows that they were formed mainly in other centers: Southeast Asia, Australia and East Africa. However, most scientists are inclined to the Chinese center of plant origin – China, Korea, India, and Japan. In Europe and the United States, soybeans first appeared in 1712. Heberlandt's book, Possibilities of Soybean Cultivation in Europe, published in 1878, helped spread soybeans in Europe. Currently, soybean is cultivated in many countries around the world. Sown areas are expanding, and yields are increasing from year to year.[8]

Global Production Landscape

For the 2025/26 season, worldwide production is projected to settle around **425 to 428 million metric tons**. That's yet another record, but the real story isn't the total - it's the distribution. Two countries, Brazil and the United States, account for nearly 70% of that entire harvest. Bring Argentina into the picture, and those three alone controls roughly 80% of global supply. That's a level of dependency that makes commodity traders nervous.[9]

The Top 10 Rankings

The table 1. below compiles official USDA FAS figures for the 2024/25 marketing year, with early 2025/26 projections included where available.

Table 1. World top 10 soybean producer countries [10]

Market	% of Global Production	Total Production (2025/2026, Metric Tons)
Brazil	42%	180.5 Million
United States	27%	115.99 Million
Argentina	11.5%	49.5 Million
China	4.9%	20.9 Million
Paraguay	2.8%	12.1 Million

Market	% of Global Production	Total Production (2025/2026, Metric Tons)
India	2.6%	11.03 Million
Russia	2.1%	9 Million
Canada	1.6%	6.92 Million
Ukraine	1.3%	5.5 Million
Bolivia	0.91%	3.9 Million
TOTAL		429.41 Million Metric Tons

Brazil – Pulling Further Ahead

Brazil isn't just holding the top spot - it's extending its lead. Forecasts for 2025/26 put national output between **175 and 177.6 million tonnes**, which works out to about 40% of everything grown worldwide.

Three factors explain Brazil's runaway success:

1. **Land availability:** Planted acreage has surpassed **48.5 million hectares**, and there's still room to expand into pasturelands.
2. **Double-cropping potential:** Tropical conditions in states like Mato Grosso allow farmers to plant soy right after harvesting a winter corn crop.
3. **Export logistics:** Major port upgrades along the northern arc (especially near Barcarena and Itaquí) have cut freight costs significantly.

The export figures back this up. In the first eleven months of 2025, Brazil shipped **104.79 million tonnes** overseas. Domestic crushing is also on the rise, projected to hit **58 million tonnes** for 2025/26, as the country builds out its own oil and meal processing sector.

United States – Holding Steady, Losing Share

The U.S. remains the second-largest producer, with 2024/25 output at **118.8 million tons**. But early glances at 2025/26 suggest a slight retreat to somewhere between 115 and 117 million tons.

In Uzbekistan, soybean is used in food, for feeding animals and for processing into butter, dairy products, and confectionery. The use of crop among the local population is expanding significantly. Such a diverse use of soy in the national economy is associated with the chemical composition of the grain. Grains contain 27-50% of protein, 17-25% of oil. In amino acid composition, soy protein is closer to animal protein (Table 2).

Table 2. Amino acid content in various foods, % of crude protein

Amino acids	Soybean	Egg	Corn
Arginine	5,8	6,4	4,0
Histidine	2,3	2,1	2,4
Lysine	5,4	7,2	2,5
Tryptophan	1,6	1,5	0,6
Phenylalanine	5,7	6,3	4,5
Threonine	4,0	4,9	3,6
Leucine	6,6	2,9	21,5
Isoleucine	4,7	8,0	3,6
Valine	4,2	7,3	4,6

Study area: natural soils, climatic conditions, and research methods

Natural conditions of the study region and soils of the experimental field.

Kashkadarya region is located between the southwestern branches of the Zarafshan mountain range. The Kashkadarya River flows through the valley from northeast to southwest. The valley begins on the southwestern slope of the Hisar mountain range (highest point 4,145 m) and extends 310 km to the Karshi steppe. The valley consists mainly of plains, which descend and widen toward the west and southwest. The Kashkadarya valley occupies terraces 1–5 of the Kashkadarya River. These terraces are

covered with Quaternary proluvial and alluvial deposits. The oasis contains low residual mountains (Kosontog, Kungirtov, Aloviddintov, Maymanoktov).[11]

Because the Kashkadarya oasis lies in the south, its climate is dry and relatively hot. The average temperature is +1°C in January and +28–29°C in July; the minimum temperature reaches –25°C to –29°C, and the maximum reaches +46–48°C. Precipitation increases with elevation, from 200 mm on the plains to 450–500 mm on the mountain slopes. Most precipitation falls in winter and spring. The climate of the Kashkadarya basin reflects all the characteristics of a continental dry subtropical climate.

In the region, medium loamy (40.35%), light loamy (26.58%), and heavy loamy (23.04%) soils are widespread, together making up nearly 90% of irrigated land. Soils with such mechanical composition have good agronomic properties in terms of natural fertility and a number of chemical, physical, and water-physical characteristics. The field experimental site where the research was conducted is located 342 meters above sea level, at 33.32° north latitude and 65.52° east longitude.

Irrigated light-colored gray soils (sierozems) generally occupy leveled surfaces, so irrigation erosion is rare here and is observed only to a weak degree. By mechanical composition, the soils of the piedmont plains are medium and light loamy, sometimes weakly skeletal and weakly gypsiferous, while on alluvial fans they are medium and heavy loamy, underlain by gravel deposits at a depth of 1.5–2.0 m. The experimental field and analytical soil tests were conducted at the "Saidakbar Saidaxror" farm in Kasbi district, Kashkadarya region. The Table 3. soil of the experimental site is irrigated light-colored gray soil.[12]

Table 3. Agrochemical Properties of The Experimental Field Soil

№	Sampled layer depth, cm	Humus %	In general state, %			Mercurial phosphorus mg/kg	Exchangeable potassium (K ₂ O), mg/kg
			N	P	K	P ₂ O ₅	K ₂ O
1	0 – 30	0,820	0,017	0,156	1,48	26,0	216
2	30 – 50	0,676	0,056	0,148	1,31	19,5	186
3	50 – 70	0,260	0,032	0,103	1,18	10,2	165
4	70 – 100	0,105	0,010	0,061	1,01	5,0	80

Light-colored gray soils generally form the lower part of the gray soil belt and are distributed in the middle and lower parts of the plains. The upper limit of the area where light-colored gray soils occur corresponds to an elevation of 300–600 meters above sea

Light-colored gray soils (sierozems) are located on plains. Their humus content (0.81%) is very low, and they are highly carbonated and consist of medium and light loams. They are not sufficiently supplied with mobile phosphorus and exchangeable potassium.

The flat terrain of the light-colored gray soil zone makes it very favorable for development and irrigation. However, because these soils contain a lot of gypsum, they have poor ameliorative and agrotechnical properties. Owing to the low content of humus and nutrients, and to the dissolution of gypsum during irrigation, the upper soil layer repeatedly subsides and heaves, which disrupts it.

Analysis of weather observed in the study area

The climate of Kashkadarya region is characterized mainly by a hot, long, and dry summer, a short and cold winter, and a relatively humid spring. The weather is variable, with winds blowing from the desert toward the mountains. The region's sum of positive temperatures is +4900–5000 °C, the sum of effective temperatures is +2519–2980 °C, and the frost-free period lasts 213–233 days.

According to the analysis of long-term seasonal weather data for Karshi district, where the research was conducted, annual precipitation is 238.7 mm and the mean annual air temperature is 13.1 °C.

During the 2022–2024 seasons of the research, the mean daily air temperature during the sowing-to-emergence period of the crops was observed to be in the range of 7.4–14.5 °C. In October 2021, the mean

daily air temperature was 13.4 °C; in that month the lowest air temperature was 11.4 °C and the highest was 14.9 °C. The mean relative humidity that month was 47%, and the mean wind speed was 8 m/s.[13] Besides temperature, which is important for agricultural crops, including soybean, precipitation during the season also matters. Precipitation in the October–December period was 38.8 mm in 2021, 65.0 mm in 2022, and 41.0 mm in 2023. The data show that autumn precipitation in 2022 was the highest of the research years, indicating a larger reserve of soil moisture. Conversely, the lowest precipitation for this season was recorded in 2021.

In the spring (January–May) season of the research years, precipitation was 136.9 mm in 2022, 37.5 mm in 2023, and 194.2 mm in 2024. The data show that spring precipitation in 2024 was the highest of the research years, indicating a larger reserve of soil moisture. Conversely, the lowest precipitation for this season was recorded in 2023.

In the March–May period, precipitation in 2023 was 16.7 mm, which differed sharply from 2022 and 2024. Thus, total precipitation over the season was 175.7 mm for the 2022 crop, 102.5 mm for the 2023 season, and 194.2 mm for the 2024 season.

Materials and Methods

This research was conducted in 2022–2024 on the fields of the "Sadakbar Saidaxror" farm in Kasbi district, Kashkadarya region, on light-colored gray soils (sierozems). The experiment consisted of 24 variants, arranged in 3 replications in three tiers. Each plot was 7.2 m wide and 33.3 m long, so one variant covered a total area of 240 m², of which 120 m² was the accounting area. The total area of the experiment, including protective zones and paths, was 1.72 hectares.

Soil, water, plant, and grain analyses were carried out in the laboratories of the "Technology of Production and Processing of Agricultural Products" department of Karshi State Technical University. Before the experiment was set up, soil samples were taken from the plowed and sub-plowed layers of each variant for agrochemical analysis and analyzed in the laboratory. Soil samples were analyzed according to the methods of "Methods of Agrochemical, Agrophysical and Microbiological Research in Irrigated Cotton-Growing Regions" (1963). Humus content was determined by the I.V. Tyurin method (GOST 26213). Nitrate nitrogen was determined by the ion-selective method (GOST 13496-10). Total nitrogen, phosphorus, and potassium were determined in a single sample by the method of I.M. Maltseva and L.P. Gritsenko. Mobile phosphorus was determined in a 1% ammonium carbonate solution by the B.P. Machigin method. Exchangeable potassium was determined on a flame photometer by the P.V. Protasov method. Water-soluble salts and dry residue were determined by the generally accepted method (GOST 26423-85), and pH was measured in aqueous extract with a potentiometer.

The soybean varieties were sown on the main area in April according to the research program. The field research used the local soybean varieties "Toshkent" and "Madad".

In the field experiments, "Toshkent" and "Madad" were grown with three mineral fertilizer rates: control (no fertilizer), N60P45K30, and N120P90K60. For suspension (foliar) feeding there were four variants: control (no fertilizer), urea (standard), Kalifos, and SAKO fertilizers.[14]

Phosphorus and potassium fertilizers were applied at 100% of the set annual rate during pre-sowing soil preparation. Nitrogen fertilizer was applied at its set annual rate before the first irrigation, that is, at the beginning of the budding-flowering phase.

The first foliar feeding by suspension was done at the beginning of the pod-setting phase, at 6 kg/ha with urea, 1.5 l/ha with Kalifos, and 1.5 kg/ha with SAKO. The second was done at the beginning of ripening of the first pods, at 10 kg/ha with urea, 2.5 l/ha with Kalifos, and 2.5 kg/ha with SAKO.

Field and laboratory experiments followed the methodological manual of the All-Russian Institute of Plant Industry (VIR, 1985). Phenological observations and biometric analyses followed the methodological manual of the State Commission for Variety Testing of Agricultural Crops.

To determine the yield structure, 100-plant samples were taken from the marked plots of each variant and replication before harvest. In the laboratory, based on 10 model plants from each replication, the following were recorded: plant height, number of pods per stem, number of seeds per pod and their weight, and number of seeds per plant and their weight.

Yield was determined in all variants from a 5 m² area at 3 points of each plot, harvested entirely by hand. Yield was recorded to an accuracy of 0.1 kg. Grain samples were taken from the experimental plots to determine moisture, and yield was adjusted to standard grain moisture (14%).

To determine the technological quality of the grain in the laboratory, seed samples of the varieties were selected using an MLN device in accordance with GOST 13586.3-83, and the analyses were conducted according to "Methods and Recommendations for Assessing Grain Quality".[15]

Results

On the samples obtained, grain moisture was determined according to GOST 13586.5-93 using Wile-55, Wile-65, Delmhorst, and Pfeuffer instruments. The 1000-grain weight was determined according to GOST 10842-89 by weighing grains counted with a Sontador device. Grain test weight (nature) was determined according to GOST 10840-64 with a Purka scale.

The Table 4. costs of growing soybean on one hectare were calculated according to the regulatory documents, prices, and purchase prices accepted in the republic. Economic efficiency was calculated according to the methodology for determining the economic efficiency of agricultural research results. The accuracy of yields obtained across the experimental variants and replications was mathematically processed in computer programs using B.A. Dospekhov's analysis of variance method.

To determine the economic efficiency of soybean production, total revenue was found by multiplying the grain yield of each variant by the purchase price. Net profit was found by subtracting costs from total revenue. Profitability was found by dividing net income by costs. In line with the purpose of the experiment, the technological factors recommended for production must be confirmed by economic indicators.

In developing optimal mineral fertilizer application elements to improve soybean agrotechnology's, determining economic efficiency requires accounting for all agrotechnical factors used in growing the crop: pre-sowing and sowing costs, irrigation, fertilization, control of weeds, diseases and pests, and harvesting costs.

Within the experiment on improving soybean agrotechnology's through root and foliar feeding of soybean grown on light-colored gray soils, a study was conducted on the basis of economic efficiency to determine the costs of agrotechnical measures in growing the soybean varieties. This study was developed at the "Technology of Production and Processing of Agricultural Products" department of Karshi State Technical University, using the wage and other payment regulatory documents accepted for soybean production (Table 5).[16]

Resource norms, costs, and wages were developed on the basis of the following documents: Presidential Decree No. PF-5708 of 17 April 2019 "On measures to improve the system of state governance in agriculture"; the assignment in Annex 3, item 10 of Resolution No. PQ-307 of 6 July 2022 "On organizational measures to implement the Innovation Development Strategy for 2022-2026", concerning the development of "Model technological maps for the cultivation of agricultural crops and production of output for 2022-2026"; and the tasks set in the minutes of the Cabinet of Ministers meeting No. 03-03/1-1520 of 22 January 2022. The work is based on the technological map approved by Minutes No. 8/1 of the Board of the Ministry of Agriculture of 20 December 2022. Resource prices were set according to the purchase prices of resources used for the 2024 crop.

Costs differed depending on the agrotechnical measures applied (excluding differences between varieties). Costs per hectare were as follows:

1. No mineral fertilizer (control): 8,130.2 thousand soums.
2. No mineral fertilizer, urea suspension (standard): 8,940.0 thousand soums.
3. No mineral fertilizer, Kalifos suspension: 9,040.0 thousand soums.
4. No mineral fertilizer, SAKO suspension: 8,695.0 thousand soums.

At the N60P45K30 rate, costs were:

1. Without suspension: 11,364.6 thousand soums.
2. Urea suspension: 14,649.4 thousand soums.
3. Kalifos suspension: 12,274.4 thousand soums.
4. SAKO suspension: 12,199.4 thousand soums.

At the N120P90K60 rate, costs were:

1. Without suspension: 13,910.6 thousand soums.
2. Urea suspension: 17,195.4 thousand soums.
3. Kalifos suspension: 14,820.4 thousand soums.
4. SAKO suspension: 8,965.0 thousand soums (Table 4).

Gross income per hectare, reflecting yield differences between varieties, was as follows (in thousand soums).[17]

Table 4. No Mineral Fertilizer

Suspension	Gross income, <i>thousand uzb soums</i>	
	Toshkent	Madad
Control	13,020	13,930
Urea (standard)	16,590	16,240
Kalifos	17,430	17,780
SAKO	17,150	17,570
N60P45K30		
Suspension	Toshkent	Madad
None	19,810	21,070
Urea	25,130	23,590
Kalifos	27,230	27,580
SAKO	25,060	25,270
N120P90K60		
Suspension	Toshkent	Madad
None	21,630	21,980
Urea	24,500	24,850
Kalifos	27,300	28,000
SAKO	25,690	26,460

The conditional net income per hectare, with no mineral fertilizer, was:

1. Control: 4,889.8 thousand soums for "Toshkent" and 5,799.8 for "Madad".
2. Urea suspension (standard): 7,650.0 for "Toshkent" and 7,300.0 for "Madad".
3. Kalifos suspension: 8,390.0 for "Toshkent" and 8,740.5 for "Madad".
4. SAKO suspension: 8,455.0 for "Toshkent" and 8,875.0 for "Madad".

Table 5. Economic indicators of soybean cultivation (2022-2024)[18]

№	Fertilizer rate	Suspension	Variety	Yield, c/ha	Cost, thousand soums	Price per 1 kg grain, soums	Gross income, thousand soums	Net income, thousand soums	Cost per 1 kg grain, soums
1	Control (no fertilizer)	Control (none)	Toshkent	18.6	8,130.2	7,000	13,020.0	4,889.8	4,371.1
2			Madad	19.9	8,130.2	7,000	13,930.0	5,799.8	4,085.5
3		Urea (standard)	Toshkent	23.7	8,940.0	7,000	16,590.0	7,650.0	3,772.2
4			Madad	23.2	8,940.0	7,000	16,240.0	7,300.0	3,853.4
5		Kalifos	Toshkent	24.9	9,040.0	7,000	17,430.0	8,390.0	3,630.5
6			Madad	25.4	9,040.0	7,000	17,780.0	8,740.0	3,559.1

No	Fertilizer rate	Suspension	Variety	Yield, c/ha	Cost, thousand soums	Price per 1 kg grain, soums	Gross income, thousand soums	Net income, thousand soums	Cost per 1 kg grain, soums
7	N60P45K30	SAKO	Toshkent	24.5	8,695.0	7,000	17,150.0	8,455.0	3,549.0
8			Madad	25.1	8,695.0	7,000	17,570.0	8,875.0	3,464.1
9		Control (none)	Toshkent	28.3	11,364.6	7,000	19,810.0	8,445.4	4,015.7
10			Madad	30.1	11,364.6	7,000	21,070.0	9,705.4	3,775.6
11		Urea (standard)	Toshkent	35.9	14,649.4	7,000	25,130.0	10,480.6	4,080.6
12			Madad	33.7	14,649.4	7,000	23,590.0	8,940.6	4,347.0
13		Kalifos	Toshkent	38.9	12,274.4	7,000	27,230.0	14,955.6	3,155.4
14			Madad	39.4	12,274.4	7,000	27,580.0	15,305.6	3,115.3
15	N120P90K60	SAKO	Toshkent	35.8	12,199.4	7,000	25,060.0	12,860.6	3,407.6
16			Madad	36.1	12,199.4	7,000	25,270.0	13,070.6	3,379.3
17		Control (none)	Toshkent	30.9	13,910.6	7,000	21,630.0	7,719.4	4,501.8
18			Madad	31.4	13,910.6	7,000	21,980.0	8,069.4	4,430.1
19		Urea (standard)	Toshkent	35.0	17,195.4	7,000	24,500.0	7,304.6	4,913.0
20			Madad	35.5	17,195.4	7,000	24,850.0	7,654.6	4,843.8
21		Kalifos	Toshkent	39.0	14,820.4	7,000	27,300.0	12,479.6	3,800.1
22			Madad	40.0	14,820.4	7,000	28,000.0	13,179.6	3,705.1
23	SAKO		Toshkent	36.7	8,965.0	7,000	25,690.0	16,725.0	2,442.8
24			Madad	37.8	8,965.0	7,000	26,460.0	17,495.0	2,371.7

At the N60P45K30 fertilizer rate, net income was as follows. Without suspension it was 8,445.4 thousand soums for "Toshkent" and 9,705.4 for "Madad". With urea suspension it was 10,480.65 for "Toshkent" and 8,940.6 for "Madad". With Kalifos suspension it was 14,955.6 for "Toshkent" and 15,305.6 for "Madad". With SAKO suspension it was 12,860.6 for "Toshkent" and 13,070.6 for "Madad".[19]

Discussion

At the N120P90K60 rate, net income without suspension was 7,719.4 thousand soums for "Toshkent" and 8,069.4 for "Madad". With urea suspension it was 7,304.6 and 7,654.6. With Kalifos suspension it was 12,479.6 and 13,179.6. With SAKO suspension it was 16,725.0 and 17,495.0. (Table 5.)

When the profitability indicators are analyzed, the highest level was obtained with N60P45K30 plus Kalifos suspension: 121.8% for "Toshkent" and 124.7% for "Madad". Profitability was also high with SAKO suspension: 105.4% for "Toshkent" and 107.1% for "Madad". At the N120P90K60 rate, profitability was 55.5% for "Toshkent" and 58.0% for "Madad" without suspension. With urea suspension it was 42.5% for "Toshkent" and 44.5% for "Madad". These are considerably lower results, and they show that this variant is less effective in terms of profitability than the others.[20]

Conclusion

In the study of the effects of fertilization systems and suspension types, higher grain yields were recorded compared with the control treatment. The highest values were obtained when Kalifos was applied against the maximum N₁₂₀P₉₀K₆₀ and moderate N₆₀P₄₅K₃₀ fertilization backgrounds. Under

these conditions, grain yield increased by 20.3–20.4 t/ha in the “Tashkent” variety and by 19.5–20.1 t/ha in the “Madad” variety. These results scientifically demonstrate the superior effectiveness of Kalifos and SAKO’ suspensions compared with the standard Urea treatment. The highest profitability levels were recorded when Kalifos suspension was applied against the $N_{60}P_{45}K_{30}$ fertilization background. The profitability rate reached 121.8% in the soybean variety “Tashkent” and 124.7% in the “Madad” variety. The treatment with SAKO’ suspension also resulted in relatively high profitability, amounting to 105.4% and 107.1%, respectively. In contrast, the lowest profitability levels, ranging from 42.5% to 58.0%, were observed in the treatments with the higher mineral fertilizer rate of $N_{120}P_{90}K_{60}$, where no suspension was applied and Urea was used. These findings scientifically demonstrate that the application of modern Kalifos and SAKO’ suspensions against the $N_{60}P_{45}K_{30}$ fertilization background is a key factor in achieving the highest economic returns from soybean production.

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