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THE EFFECTIVENESS OF GROWING MUNGBEAN AS A SUMMER CROP AFTER WINTER WHEAT HARVEST

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ABSTRACT--- *The paper highlights the impact of growing leguminous grain summer crops (in the example of mung bean) planted around winter wheat stalks under different dates and sowing rates on the formation of the mung bean seeds, yield and effects of mung bean in conditions of the takyr-like soils of the Kashkadarya region. The study showed that the number of legumes per plant of the summer crop mung bean planted around winter wheat stalks under the optimal planting date (20-30.06) was higher :by 6-8, grains inside the legumes by 2-3 and the weight of 1000 grains by 2–5 grams compared to those planted during late periods. The highest yield of 1.54 t ha-1 under plowing rates of 14 kg ha-1 of seeds was observed when mung bean was planted during the last ten days of June. The observed yield values were 0.49 t ha-1 higher compared to the trial with the planting rates of 10 kg ha-1 in the same period, and 0.42 t ha-1 higher compared to the trial with the 15 day late planting period (10-20.07). In early planting (20-30.06) of mung bean with the rate of 10-14 kg ha-1, the observed amount of protein in the grains was 17.3- 18.4% decreasing to 0.8-1.1% with the increase of the seed planting rate. With the same planting rates but during late planting dates, i.e., in mid-June, it was found that the amount of protein decreased to 1.7-2.3% compared to that in the early planting dates. Early planting of mung bean around winter wheat stalks raises profitability to the high levels: the net profit was 3,360,000 soums per hectare, while planting as early as possible is scientifically proven to be the correct strategy.*

Keywords--- *wheat stalks, legume, grain, mung bean, date, norm, protein content*.

I. INTRODUCTION

The formation of the Republic of Uzbekistan as an independent state has led to comprehensive change and development for the Uzbek people.The conditions of market relations require the development of the economy in a new direction, transition into a new system. Economic independence has led to radical changes in the agricultural system in the agro-industrial complex, which is the most important sector of the country’s economy. After independence, the system of agricultural production has changed, cotton monopoly has been abolished and the foundations for grain independence have been laid.

Uzbekistan is one of the most favorable regions for agriculture in the world due to its natural climate and soil conditions. The winter cereals are grown every year on more than one million ha of the irrigated land in the country. This means that once the winter wheat is harvested, there is an opportunity to grow summer crops on the same

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land area. In this regard, growing legumes, cereals and vegetables in the areas free of winter wheat, which meet the daily food needs of the population, will further strengthen food security in the country and fully meet the needs of the population in agricultural products.

In the soil and climatic conditions of Uzbekistan it is possible to obtain the winter wheat yields of 6-7 t ha, 1.5-2.5 t haof mung bean, soybean and kidney bean grown as summer crops and hence, increase the grain yields to 8.5-9.5 t haduring a season.This has been observed in many scientific experiments and on the example of advanced farms. From this point of view, the expansion of legumes in the areas after harvesting winter wheat will provide the population with nutritious and high-quality products, and livestock with cervitamine, mineral-rich nutrients and increase soil fertility. Among such legumes as summer crops, mung bean also has its place along with such crops as soybeans, kidney beans, peas.

Nowadays, legumes are planted as summer crops on 91.6 million ha worldwide, with an average grain yield of 1.2 t ha and a gross yield of 206.4 million tons. Legumes account for 5.3 million tons worldwide, and are considered as the second area-wise largest crops grown in the world after soybean (25 million ha). Legumes as summer crops are annually grown in Uzbekistan on more than 18-25 thousand ha.India is the leading producer and consumer of mung bean with the area of 65 % and the gross yield of 54 %[15]. Uzbekistan also plays an important role in the export of mung bean to the world market, exporting up to 67,000 tons of mung bean a year.

Based on this, the development of promising technologies for obtaining a rich and high-quality crop yields in agriculture, thereby increasing productivity, developing measures to increase agricultural production in the country, maintaining and increasing soil fertility through making the right choice of agricultural crops, implementing crop rotation that meets the demand for food products and provides high-quality yields of cotton, wheat and other agricultural crops, further improvement of the system of crop rotation, development and implementation into production of agrotechnologies for cultivation of main crops and legumes as summer crops grown in these crop rotation systems, remains at present an actual requirement.

As part of fulfilling this task, it is therefore important to determine the timing and planting rates of mung bean as summer crop around the winter wheat stalks as a source of high-quality nutrients that increase soil fertility in the desert regions of the Kashkadarya region in the system of crop rotation of cotton and cereals.

II. LITERATURE REVIEW

Mung bean (*Phaseolus* aureus *Piiper*. According to the latest classification, *Vigna radiate (L) Wilzek*) is a legume-grain crop with a high nutritional value. V. N. Stepanov [11], P. P. Vavilov and others [3], S. M. Moustafoev [6] called mung bean “Golden bean” and noted that it is very drought tolerant and can be grown for grain and green manure.

K. Z. Zokirov and H. A. Jamolkhanov [4] called mung bean "Asian beans", G.V. Bodner and G.T. Lavrinenko [2] called it "Asian pea". H.N. Atabaeva [1] called the mung bean "Asian beans". Apparently, the mung bean is named differently in different literature sources. Nevertheless, its Latin name is uniformly accepted as *Phaseolus aureus*.

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[1]https://nuz.uz/ekonomika-i-finansy/

According to scientific literature, when mung bean is grown as a summer crop around winter wheat stalks, approx. 30-40 t ha of green biomass can be harvested and when plowed into the soil, this biomass enriches one ha land with 100 kg of pure nitrogen and organic matter equal to the annual amount of decomposed manure. During the entire growing season, mung bean leaves 2.5–3 tons of root and stalk remnants in the soil. It also increases soil fertility by forming 20-30 tubers in the roots [7; 8; 12; 13; 14].

When legumes are planted as summer crops, they not only provide themselves with nitrogen during the growing season, but also leave up to 90-100 kg of pure nitrogen in the roots, hence creating favorable conditions for the survival of soil microorganisms.

If mung bean is planted after winter wheat around the wheat stalks in an optimal time by a special agrotechnology under conditions of limited water supply, the grain yield will be 1.86-1.93 t ha^{-1}, and the accumulation of natural nitrogen in the soil will increase significantly [9].

Leguminous crops also have a positive effect on the yield of successively planted crops. The obtained average yield of grain in conditions of light sierozem soils of the Namangan region around winter wheat stalks was 1.4-1.5 t ha^{-1}, and additional yields of 0.24 t ha^{-1} of cotton grown in the following years were obtained.

III. RESEARCH METHODS.

The research was carried out in the field and laboratory conditions, based on "Methods of State variety testing of agricultural crops" (1964, M: Kolos), "Methods of agrochemical analysis of soil and plants" (1973, Tashkent), "Methods of agrophysical research” (1973, Tashkent), "Methods of soil microbiology and biochemistry" (Moscow, 1991), "Methods of conducting field experiments" (UzCRI, Tashkent, 2007).

A mung bean variety "Durdona" created at the Uzbek Research Institute of Botany and

included in the State Register in 2011, was used in the experiment. There are no analogues of this variety in terms of fast ripening in the country. The yield reaches 2.08 t ha-1 when planted in double-row furrow plots. The weight of 1000 seeds is 60 g, the protein level in the seeds is 18.7%, starch 1.7%. The seeds are larger than the regionalized mung bean varieties. The mung bean combines well with vegetable and grain crops in the crop exchange system, improving soil fertility. This crop is suitable for planting in spring and summer seasons, and high yields can be obtained.

Field experiments were conducted in conditions of takyr-like soils of the Kashkadarya Scientific Experimental Station of the Cotton Breeding, Seed Production and Agrotechnologies Research Institute (CBSPARI). The soil texture of the experimental field is medium loam, slightly saline takyr-like, with the groundwater levels at 2.5-3.0 meters below ground surface.

IV. RESEARCH RESULTS

It is known that the weight of a crop is determined by the quantity and quality of the accumulated productive elements. The grain yield of mung bean also depends on the productive elements formed in the plant, i.e. the number of legumes and the weight and quality of the grains. When mung bean is planted as a summer crop around winter wheat stalks, it is necessary to determine the optimal planting timing and seed rates in order to obtain high quality yields. This is because the effect of physiological processes during the formation of grains in legumes is strong when mung bean is planted around wheat stalks at different dates and in different seed rates, as a result of which some grains are fully formed and some remain immature. For this reason, the grain formation of the mung bean grown at different times and norms around wheat stalks has also been studied.

Studies of the effect of planting timing on the formation of legumes in plants showed that the number of legumes per plant in the early stages (30.06) was 6-8 more than in the late planting (15.07).

It was observed that depending on the planting rates and timing, the number of ripened beans in both mung bean varieties increased with the increase of seed planting rates and decreased with the delay of planting periods.

Planted at the end of June and the rate of 10 kg of seeds per ha, ripened legumes of the summer crop mung bean in the days of October constituted 25.3%, while planted at the rate of 14 kg ha-1, the ripened legumes were 30.4%. Similarly, the ripened legumes of mung bean planted in the second decade of July were 21.6 and 26.1%, respectively.

The results of the study showed that as the number of seedlings decreased, that is, as the seed planting rates became lower, the change in the number and weight of grains inside legumes did not differ significantly. With the planting rate of 10-14 kg ha-1 of the Durdona variety, the number of grains per legume ranged from 9.6 to 13.3. In the early planting period (30.06), at the planting rate of 10 kg ha-1 the average number of grains in legumes was 11.7, at 12 kg ha-1 12.6 and at 14 kg ha-1 13.3.

Also, the timing of planting mung bean also had an effect on the number of grains in the legumes. Data analysis showed that the average number of grains in the legumes planted at the end of June (30.06) with the rate of 14 kg ha-1 around winter wheat stalks were 13.3, while those planted in early July (10.07) with the same planting rate - 12.6, and planted in the middle of June (15.07) - 10.6. The number of grains per legume with a subsequent delay of planting timing was reduced to 0.7-2.7.

Studies to determine the weight of grains in legumes have shown that the weight of 1,000 grains depends on planting timing. Analyses showed that planting mung bean at the end of June (20-30.06) with the rates of 10, 12 and 14 kg ha-1 results in a grain weight of 1000 grains 60.0, 56.0 and 58.0 grams, respectively. It was found that the weight of 1000 grains decreases as the planting rate increases. These patterns were also observed during the remaining planting periods of the experiment.

The experiments indicated that the planting timing also affected the weight of 1000 grains. The grain weight per 1000 grains is higher in early planting periods compared to that in the late planting. The results indicate that when mung bean is planted on June 30th, the weight of 1000 grains is 60.0, 56.0 and 58.0 g according to the planting rates, while become 59.0, 58.0 and 56.0 g, respectively when planted on July, 10th. Also, planting mung bean around winter wheat stalks in mid-July (10-10.07), results in the weight of 1000 grains to be 57.0; 55.0; 53.0 g, which was found to be 2–5 g less than that in the early planting periods.

Planting of the Durdona variety during the last ten days of June around winter wheat stalks allowed obtaining 1.05-1.54 t ha-1 of the grain yield, on July 10th 0.96-1.36 t ha-1 and on July 15th – 0.81-1.12 t ha-1. The highest results were observed in the trial 3, in which mung bean was planted in the last ten days of June at a rate of 14 kg of seeds per ha, yielding 1.54 t ha-1. In this trial, with a planting rates of 10 kg ha-1, an additional yield was 0.49 t ha-1 compared to the trial 1, and 0.42 t ha-1 compared to the trial 9, with planting seeds 15 days later (Table 1).

Among leguminous crops, mung bean stands out in terms of nutritional value. This is because the protein content of the mung bean is 24-28%, and its digestibility is on average 86% [15]. The amount of protein in this crop varies according to variety, place of growth, climate conditions, applied fertilizers and agrotechnological activities. In cases when the mung bean is grown as a summer crop around winter wheat stalks, the protein content in the grain will be higher.

Table 1: Productivity of mung bean (Durdona variety) planted around winter wheat stalks at different timing and rates

Trial	Planting time	Planting rate, kg	Yield, t ha^{-1}	Additional yield relative to planting rate, t ha^{-1}	Additional yield relative to planting timing, t ha^{-1}
Trial 1	30.06.	10	10,5	-	
Trial 2		12	12,6	+2,1	
Trial 3		14	**15,4**	+4,9	
Trial 4	10.07.	10	9,6	-	-0,9
Trial 5		12	12,7	+3,1	+0,1
Trial 6		14	13,6	+4,0	-1,8
Trial 7	15.07.	10	8,1	-	-2,4/-1,5
Trial 8		12	10,0	+1,9	-2,6/-2,7
Trial 9		14	11,2	+3,1	-4,2/-2,4
Compared to the planting period when the planting rate is 10 kg				LSD $_{0,5}$ 1,48 t ha^{-1} 2,9 %	
Compared to the planting period when the planting rate is 12 kg				LSD $_{0,5}$ 2,62 t ha^{-1} 4,5 %	
Compared to the planting period when the planting rate is 14 kg				LSD $_{0,5}$ 2,71 t ha^{-1} 2,4 %	

According to M.I. Smirnova-Ikonnikova [10], the amount of protein in legumes varies depending on the type and variety as well as the timing and planting rates, so the development of advanced agro-techniques suitable for various soil and climatic conditions is required in order to create the high-protein varieties.

For this reason, it is important to study the effect of planting times and seed rates on the protein amounts in mung bean grains grown as a summer crop around winter wheat stalks.

According to the research results, planting mung bean with the rate of 10-14 kg of seeds per hectare in the early period (20-30.06) causes the increased grain protein content of 17.3-18.4%, the difference between these planting rates is 0.8-1.1%.

Planting mung bean around winter wheat stalks with the rate of 10-14 kg of seeds per hectare in early July (1-10.07) allows obtaining the protein content in the grains of 15.8-16.4%. These protein contents were by 1.5-2.0% lower compared to those in the early period. At the same time, planting this summer crop around winter wheat stalks with the same rate in the second decade of July (10-20.07) allowed obtaining the protein contents of 15.6-16.1%. The difference of the protein contents was by 1.7-2.3% lower compared to that in the early sowing (Figure 1).

Studies by V.G. Klimenko [5] also show that the late planting of legumes is one of the reasons for a significant decrease in the protein amounts in the grain, the reason of which is seen in incomplete photosynthesis processes in plants because of lack of air temperature and light.

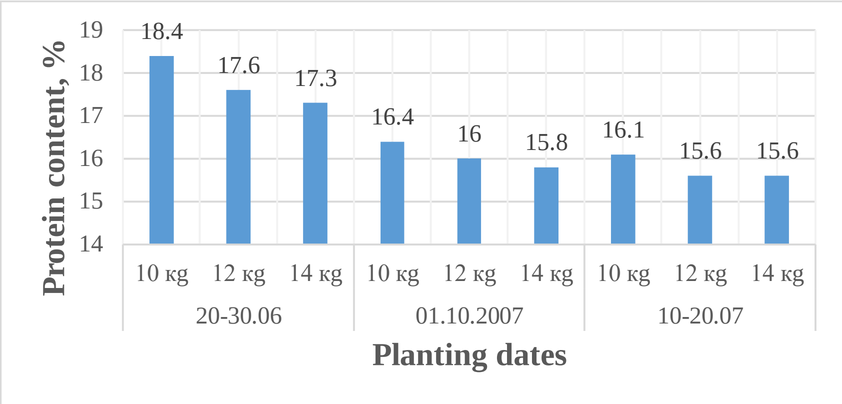

Figure 1: The amount of protein in the mung bean grown around wheat stalks at different times and rates (Durdona variety).

Prior to implement any of the proposed agro-technical measures, attention should be paid to its cost-effectiveness indicators. The recommended agro-technical measures can be introduced into production only when the economic efficiency is sufficiently high.

Data on economic efficiency were initially analyzed accounting for planting dates and showed that mung beans planted around winter wheat stalks in the last decade of June produced high economic efficiency and late planting was economically inefficient.

The net profit for growing mung bean around winter wheat stalks at the rate of 14 kg ha-1 at different timing was from 760,000 to 3,360,000 soums ha-1. The best yield of 1.54 kg ha-1 was obtained in the trial with the planting rate of 14 kg ha-1 at the end of June (20-30.06), the net profit was 3,360,000 soums ha-1 and profitability 77.4%.

This indicates that the yield is higher when mung bean is planted around winter wheat stalks in the early periods, and the sharp decline of the yield can be observed with planting late. This in turn shows that the summer crop mung bean should be planted in the field with wheat stalks as early as possible.

V. CONCLUSION

In conditions of takyr-like soils of the Kashkadarya region, planting mung bean as a summer crop around winter wheat stalks in late June (20-30.06) enables obtaining the highest number of legumes per plant, of grains in legumes and the weight of 1000 grains.

Thus, planting mung bean variety Durdona as a summer crop for seeds in conditions of takyr-like soils of the Kashkadarya region in the last ten days of June, in the rate of 14 kg of seeds per hectare are considered optimal and allow obtaining the highest productivity. Delays in planting dates and exceeding the seed planting rates have led to a decrease in grain protein content.

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