Agrobiological study of a new legume *Cajanus cajan* culture in Uzbekistan

A.A. Umurzakov[1*], *S.I.* Akhmedov[1], *F.* Muminov[1], *X.* Keldiyorova[1], and *Sh.* Atayeva [1]

[1] Samarkand State University named after Sharof Rashidov, Uzbekistan

Abstract. The article presents the results of long-term research on the planting dates of the new leguminous crop Cajanus cajan in the conditions of Galaarol district of Jizzakh region and Zharkurgan of Surkhandarya region. A brief description of the biology of *C.cajan*, the experience of the medical field, the methods of accounting and monitoring, and the agricultural technology of cultivation were studied. Preliminary results indicate that *C.cajan* demonstrates a high degree of adaptability to the Uzbekiston climate, with satisfactory germination and growth rates across different regions. Nutritional analysis of the harvested seeds revealed high protein content and essential amino acids, making *C.cajan* a valuable addition to the local diet and a potential contributor to food security. Legumes are vital crops globally, playing a significant role in sustainable agriculture due to their ability to fix atmospheric nitrogen, which improves soil fertility and reduces the need for chemical fertilizers (Amanov et al. 1972). They are a crucial source of protein, vitamins, and minerals, making them essential for food security and nutrition.

1 Introduction

Cajanus cajan, is a legume that has been cultivated for thousands of years. It is valued for its high protein content, drought resistance, and ability to improve soil health. *C.cajan* deep root system makes it resilient to dry conditions, which is beneficial for semi-arid regions like Uzbekistan. The main task of agricultural workers is to ensure an increase in the living standards of the population through the intensification of agricultural production. Today in the republic, out of 8 million 83 thousand people employed in the production sector, 5 million 200 thousand are employed in agriculture, and therefore, along with changes in rural infrastructure and improving living standards, increasing the efficiency of each hectare and livestock productivity is of particular importance through the introduction of new species, varieties, technologies for cultivating agricultural crops and increasing labor productivity.

Agriculture of the republic has entered a new stage of its development International Conference on Legume Genomics and Genetics. New economic relations are being formed based on improving market structures during the transition to the development of farming and agricultural clusters. The agrobiological attributes of *C.cajan* make it an ideal candidate for introduction into Uzbekistan's agricultural landscape. This perennial legume is known for

* Corresponding author: askaraliumurzakov@gmail.com

its deep root system, which enhances soil structure and water retention. Furthermore, its ability to fix atmospheric nitrogen through symbiotic relationships with rhizobia bacteria enriches soil fertility, reducing the need for chemical fertilizers.

In order to implement the tasks defined by the strategy for the development of agriculture of the Republic of Uzbekistan for 2020-2030, increasing the volume of food production through the effective use of available resources, meeting the needs of the population and maintaining price stability in the domestic market, as well as economic and financial support for agricultural producers.

Interest in pulses, including *C.cajan*, is high due to the need to replenish the balance of proteins both in the diet of the population and in the feeding of farm animals (Jana et al. 2008). In terms of the content of protein, fat, without nitrogenous extractives, fiber and vitamins in the seeds, *C.cajan* is not inferior to many legumes and at the same time is of great importance as a crop that consumes less water per unit of protein. (Annual Report 1992; International Crops Research Institute for the Semi- Arid Tropics. India, 1999). In this regard, agrobiological study and creation of technology for cultivating the new legume crop *C.cajan* in Uzbekistan, where water is the main limiting factor, is of particular importance. *Cajanus cajan* D C-genus, multitype; it includes only one species - Cajanus indicus Sprend found by Harms in Togo C.Kerstingil Harmsi in its minor differences (the stem is rounded angular to rounded, the leaves are smaller, the beans are also smaller) from the previous species, falling within the limits of variability of the species, is apparently one of wild forms of *C. Indicus*.

C.cajan seeds are rich in protein, essential amino acids, and micronutrients, making them a valuable addition to the human diet. The crop also has multiple uses, including fodder, green manure, and as a source of biofuel. These diverse applications can contribute to both food and economic security in rural areas.

Usage (*Cajanus indicus* Spring) has food and feed value. The seeds are eaten boiled and fried, soups, porridges, and flour are prepared. The seeds contain 16-22% protein, up to 62% carbohydrates and up to 8% fat. The green mass contains up to 14% protein and serves as good grazing for dairy cattle.

In Uzbekistan, where agriculture is a critical sector, there is a pressing need to explore alternative crops that can thrive under local conditions. Previous studies have highlighted the potential of legumes to improve agricultural productivity and sustainability in the region. This study aims to evaluate the agrobiological performance of *C.cajan* in Uzbekistan, focusing on its growth characteristics, yield potential, and adaptability to local climatic and soil conditions.[1-35]

2 Materials and methods

The following were determined for the agrochemical parameters of the soil: soil humus according to Tyurin, total nitrogen using the Keldal micromethod in the Serenyev device; total phosphorus, potassium. The best time to take soil samples is in the fall, before applying fertilizers and before harvesting. Nitrogen, phosphorus and potassium content in vegetative parts of plants (Ginzburg et al.) method, by burning plant samples in the presence of concentrated (specific gravity 1.84) sulfuric acid. determined. catalyst. Further determinations were carried out: total nitrogen by microkeldal, phosphorus by photocalometry and potassium by flame photometer.

The height of the plant is measured every 10 days from the time the seedlings appear until they are fully matured. Biometric measurement includes: plant width measurement, 1st and 2nd order branching, number of beans per plant, number of grains per bean head and 1000 bean weight. Each measurement was carried out separately on 100 plant plots.

Phenological observations were made on 25 sample plants. The following phases were noted: seedling emergence, branching, budding, flowering, bean formation and grain

ripening, the beginning was noted (5-6%, mass (65-70% according to the method of G.M. Schultz). The seed yield of plants was determined according to the modified method for legumes, the number and presence of beans in beans were taken into account three-, four- and five-seeded beans C.cajan for growth and development at 10-12 ° C , heat-loving culture. °C C.cajan is very sensitive to low temperatures, and frosts down to -3 °C during the flowering period kill flowers and leaves.

A decrease in temperature, especially with high humidity, leads to a significant decrease in flowers and increases the duration of the period of seed formation and ripening. With the slow growth of the surface mass and the strong development of the root system, Cajanus cajan tolerates a lack of moisture well.

Placement in crop rotation *C.cajan* is a row crop, so it is the best predecessor for cereals and technical crops.

Soil cultivation. The main treatment for C.cajan includes deep fall plowing (30-35 cm).

Planting. As soon as the soil planting depth (3-4 cm) warms up to 10-12 ° C, it is necessary to plant kayanus immediately. This usually happens at the end of April.

Planting methods Dospekhov. C.cajan is planted in wide rows of 70 and 90 cm, planting pattern 70 x 15 and 90 x 10 cm.

Planting speed. Depending on the density of C. cajan planting, it is recommended to plant 72,000 to 85,000 viable seeds per hectare.

Fertilizer C.cajan is a demanding crop when it comes to fertilizers. Increases the yield of cajanus grain with the following ratio of nitrogen, phosphorus and potassium: 60:100:60 in active substances per hectare. The use of organic fertilizers for C.cajan also increases the yield with the combined application of phosphorus fertilizers at the level of manure 10t / ha + P80. Cajanus cajan can be planted with grain or cotton seed drills. At the stage of budding and flowering, irrigation of vegetation is carried out at a rate of 800 m^3, after which mechanized loosening of the soil between the rows is necessary.

Harvesting of C. cajan crops is carried out with the beginning of waxy ripening using combines such as Sampo-550, Sampo-500, Niva, Class, etc. C. cajan beans do not crack when ripe, resulting in harvest delays. does not cause crop loss. In accordance with the agricultural technology, the annual yield reaches 30 t/ha in Surkhandarya region and 20 t/ha in Gallaorol districts (Fig. 1). [36-57]

Fig. 1. Cajanus cajan flowers and unripe seeds

C.cajan is recommended as a dietary food product for diabetics. The main protein of Cajanus wisteria seeds is capable of coagulating (curdling) when souring; when it is broken down, amino acids are obtained that are close to the amino acids of meat. 1 kg of seeds contains 20.3 g of lysine, 3.9 g of methionine, 4.9 g of cystine, 3.3 g of tryptophan. Favorable veneration of nutrients allows cayanus to be widely cultivated as a food and fodder plant. *C.cajan* cooks faster than chickpeas and other legumes. For example, if the boilability of cajanus is 60 minutes, then chickpea is 90 minutes, while the swelling coefficient is 4.2 for the ICPL-84023 variety and 4.0 for the ICPL-151 variety.

Experimental Design:

- sowing time;- records and observations were carried out to determine the duration of the growing season;

- *C.cajan* productivity;

The first is an experimental field of the Institute of Rainfed Agriculture in the Gallaorol Fog of the Jizzakh Region.

The second is in the “Surkhan” farm of the Jarkurgan fog, Surkhandarya region. In each of the above mentioned fogs, the following experiments were carried out in parallel:

Field experiments to determine the optimal sowing time for cajanus. The sowing dates for the *C.cajan* variety ICPL 84023 and ICPL 151 were studied: April 10, 20, 30 for Gallyaaral and April 10, 15, 25 for Surkhandarya.

First experience. “To determine the optimal sowing date” three dates were studied: April 10, 20, 30 and two varieties ICPL 84023 and ICPL 151. Agricultural technology on the experimental fields is generally accepted for the specified farm. The experiments were carried out on the fields of irrigated grain crop rotation based on the predecessor wheat. Chiseling was carried out in the spring. Using a T-28 unit with RUM-3, mineral fertilizers were applied at the rate of N30P100K60 per 1 ha, followed by sowing with an SFK-7 seeder, with a row spacing of -70 cm. In the experiments, plants were sown on plots with a total area of 31.5 m with a seeding rate of 5-6 pcs. plants per 1 linear meter.

3 Results and discussions

Studying sowing dates. Agronomic science has accumulated enough knowledge to program with great accuracy a set of conditions (sowing time, sowing density, humidity regime and moisture reserves, etc.) for growing a given level, taking into account the biological characteristics of the crop, variety and specific natural conditions. One of the main factors ensuring high yields is timely sowing of crops. It is known that to obtain friendly shoots of cajanus, an average daily soil temperature of 10-12°C and air temperature of at least 15°C is required.

Such soil and air temperatures occur in April-May, therefore, for sowing *C.cajan* in our republic, three sowing dates were studied in field experiments: April 10, 20, 30 (Jizzakh region) and April 5, 15, 25 (Surkhandarya region).

In the conditions of the Jizzakh region fog, when sowing on April 30, the plants ripened 10 - 12 days faster than when sowing on April 10 and 20, that is, the phase of full ripeness in the variants where sowing was done on April 20 and 30 occurred almost simultaneously, and in the variant where sowing was studied On April 10, this phase began with an actually longer period from sowing to ripening, in an earlier period (Table 1).

Table 1. The influence of sowing timing on the duration growing season in the condition Jizzakh and Surkhandarya region

Jizzakh region						
№	**Variety name**	**Sowing date**	**Growing season, days.**			**Average**
			1-year	**2-year**	**3-year**	
1	ICPL 84023	10.04	163	159	152	158
2	ICPL 151	10.04	167	162	156	161
3	ICPL 84023	20.04	161	159	158	157
4	ICPL 151	20.04	162	160	151	158
5	ICPL 84023	30.04	151	148	139	146
6	ICPL 151	30.04	153	152	140	148
Surkhandarya region						
1	ICPL 84023	05.04	127	132	123	125
2	ICPL 151	05.04	128	130	125	127
3	ICPL 84023	15.04	119	123	113	118
4	ICPL 151	15.04	117	125	115	119
5	ICPL 84023	25.04	104	110	100	104
6	ICPL 151	25.04	107	113	102	107

Not only the length of the growing season, but also the duration of the interphase period, the formation of full-fledged seeds and their weight depend on the sowing time. All these indicators are correlated with the sowing time, soil and air temperature during this period. In the conditions of Surkhandarya, the duration of the period from germination to ripening is much shorter than in the conditions of Gallyaaral.

During the first sowing period (April 5) for the variety IPPL 84023, the growing season was 126 days (average for 3 years); at the third sowing period (April 25), this figure was 104 days (Table 8), which primarily depends on soil temperature and air, which in the conditions of Surkhandarya is much higher than in the Jizzakh region.

In all years of research, depending on the soil temperature and It should be noted that, in contrast to the conditions of the Jizzakh region fog, at higher temperatures of Surkhandarya and relatively low soil moisture, a significant difference was noted in the passage of plants from sowing to ripening in the first and second terms, then there are 5 and 15 April, which indicates a large response of varieties to the choice of sowing time at higher early spring temperatures.

Thus, both in the conditions of the Gallyaaral fog, the Jizzakh region and in the Surkhandarya region, the most optimal sowing time, based on indicators of the duration of the growing season and interphase periods, as well as the onset of full grain maturity, can be considered the third ten days of April (Table 2).

Table 2. Duration of phenological phases depending on sowing time

Jizzakh region														
№	**Variety name**	**Sowing date**	**Flowering**				**Flowering-formation of beans**				**Bean formation - full ripeness**			
			1-year				**2-year**				**3-year**			
			1	2	3	Average	1	2	3	Average	1	2	3	Average
1	ICPL84023	10.04	99	97	95	97	35	33	31	33	30	29	28	29
2	ICPL 151	10.04	99	97	95	97	36	35	31	34	32	30	28	30
3	ICPL84023	20.04	97	96	92	95	34	33	31	32	30	29	28	29
4	ICPL 151	20.04	98	97	93	96	34	33	29	32	30	29	28	29
5	ICPL84023	30.04	93	93	89	92	30	30	27	29	27	26	23	25
6	ICPL 151	30.04	73	94	90	93	30	30	27	29	28	27	23	26

Surkhandarya region														
1	ICPL84023	05.04	94	74	69	72	33	35	31	33	21	23	19	21
2	ICPL 151	05.04	74	75	69	73	33	36	30	33	22	24	20	22
3	ICPL84023	15.04	64	67	61	64	32	34	30	32	21	22	20	21
4	ICPL 151	15.04	66	67	62	65	32	35	32	33	21	23	22	22
5	ICPL84023	25.04	54	56	52	54	30	32	28	30	20	22	20	20
6	ICPL 151	25.04	57	53	54	56	30	32	28	30	20	23	20	21

Plant growth. Phenological observations and biometric measurements have shown that climatic and weather conditions significantly influence the growth of *C.cajan*. This dependence was also noted by other researchers in other ecological zones.

In the conditions of the Surkhandarya region, *C.cajan* grows more intensively than in the Jizzakh region. This is explained by the fact that the Jizzakh region fog is characterized by a relatively cold spring, and the Surkhandarya region, on the contrary, is the zone of the hottest spring in Uzbekistan. It was this climatic feature that was the determining factor in the growth and development of *C.Cajanus* in these zones (Table 3).

Table 3. The influence of sowing timing on the growth

The influence of sowing timing on the growth of *C.cajan* Jizzakh region						
№	**Variety name**	**Sowing date**	**Plant growth, cm**			**Average for 3 years**
			1-year	**2-year**	**3-year**	
1	ICPL84023	10.04	84	95	98	92
2	ICPL 151	10.04	83	93	95	90
3	ICPL84023	20.04	88	101	105	98
4	ICPL 151	20.04	86	100	102	96
5	ICPL84023	30.04	96	105	110	103
6	ICPL 151	30.04	93	102	107	100
	Surkhandarya region					
1	ICPL84023	05.04	98	94	100	97
2	ICPL 151	05.04	96	92	99	954
3	ICPL84023	15.04	105	98	112	105
4	ICPL 151	15.04	100	95	110	101
5	ICPL84023	25.04	115	100	120	111
6	ICPL 151	25.04	110	98	115	107

The height in the conditions of the Jizzakh region fog at the end of the growing season was 84-110 cm, that is, different climatic conditions determined a significant difference - 26 cm. After the first and second sowing dates, in the conditions of Gallyaaral there was precipitation, which delayed the emergence of seedlings in some years atmospheric precipitation that fell after the emergence of seedlings contributed to the formation of a soil crust. Under the conditions of Surkhandarya, the growth of cajanus plants was better and the height of the main stem was 94-120 cm. Under these conditions, no significant difference in height was noted between varieties. The lowest growth rates at the first sowing date on April 5 were 94 cm, while when sowing on April 25 the height was 100 cm. In more favorable weather conditions, the height of cajanus reached 120 cm, while the best sowing date for this indicator can be considered April 25.

Thus, as in the conditions of the Gallyaaral fog, in the Jizzakh region of the Surkhandarya region, the most favorable conditions for the growth of cajanus are provided when sowing in the third ten days of April (Table 4).

Table 4. The influence of sowing time on the number of 1st order branches

Jizzakh region						
№	Variety name	Sowing date	Number of 1st order branches			Average for 3 years
			1-year	2-year	3-year	
1	ICPL84023	10.04	4	5	5	4
2	ICPL 151	10.04	4	4	5	4
3	ICPL84023	20.04	6	7	8	7
4	ICPL 151	20.04	6	7	8	8
5	ICPL84023	30.04	7	8	9	8
6	ICPL 151	30.04	7	8	9	8
	Surkhandarya region					
1	ICPL84023	05.04	6	5	7	6
2	ICPL 151	05.04	6	5	7	6
3	ICPL84023	15.04	9	8	9	8
4	ICPL 151	15.04	9	8	9	8
5	ICPL84023	25.04	9	8	10	9
6	ICPL 151	25.04	9	8	9	8

The results of biological measurements showed that climatic conditions significantly affect not only the duration of the growing season and plant growth, but also branching, which is a determining factor in crop accumulation. As the number of 1st order branches increases, the number of 2nd order branches also increases. In our experiments, it was established that the shape of the bush depends on the number of branches of the 1st and 2nd order, which with a larger number of branches is spreading (loose), and with a smaller number the bush takes on a poplar shape.

A study in Uzbekistan confirms the results of the work of Singe Sh. (1938), who believes that with early sowing of cajanus, unfavorable climatic conditions negatively affect the growth and development of the plant. Thus, branching of the 1st order, depending on the sowing period, ranged from 4 to 9 in the conditions of the Jizzakh region fog, and 5-10 in the Surkhandarya region. Low indicators of first-order branches were noted in the early stages of sowing. The number of second-order branches ranged from 7 to 18 and from 12 to 23, respectively.

Thus, in the Surkhandarya region, more favorable conditions are created for the formation of cajanus branches, with the largest number of branches being formed when sowing at the end of April. In the conditions of Gallyaaral and Surkhandarya, it is observed that during the harvest period, mature, immature, green beans and even in some cases flowers are found on the same cajanus plant. The table shows the results of counting only mature beans (Table 5).

Table 5. The influence of sowing time on the number of 2nd order branches

Jizzakh region						
№	Variety name	Sowing date	Number of 2nd order branches			Average for 3 years
			1-year	2-year	3-year	
1	ICPL84023	10.04	8	7	9	8
2	ICPL 151	10.04	8	7	9	8
3	ICPL84023	20.04	10	13	13	12
4	ICPL 151	20.04	10	11	12	11
5	ICPL84023	30.04	14	16	18	16
6	ICPL 151	30.04	13	14	15	14

Surkhandarya region						
1	ICPL84023	05.04	13	12	14	12
2	ICPL 151	05.04	9	9	12	10
3	ICPL84023	15.04	17	14	18	16
4	ICPL 151	15.04	13	12	14	13
5	ICPL84023	25.04	20	18	23	20
6	ICPL 151	25.04	17	16	18	17

Fig. 2. Unripe cajanus beans. (Cajanus cajan)

Under the conditions of Surkhandarya, the number of beans per plant was much higher and amounted to 89-100 when sowing on April 5 and 109-116 on April 25. A study of the number of beans per plant, at different sowing times and by year, showed that it is directly dependent on climatic conditions and, first of all, on soil and air temperature. The number of beans per plant is determined by the number of 2nd order branches.

A smaller number of beans per plant was formed in the conditions of Jizzakh region because in these years there was more precipitation, and they were characterized by relatively low soil and air temperatures. The most favorable were later sowing dates when the maximum number of beans was formed on the plants (Table 6)

Table 6. Effect of sawing time on bean number of C.cajan

Jizzakh region						
№	**Variety name**	**Sowing date**	**Number of beans per plant**			**Average for 3 years**
			1-year	**2-year**	**3-year**	
1	ICPL84023	10.04	68	78	80	75
2	ICPL 151	10.04	62	73	75	70
3	ICPL84023	20.04	83	90	94	89
4	ICPL 151	20.04	79	85	88	84
5	ICPL84023	30.04	91	106	110	1021
6	ICPL 151	30.04	87	102	105	98
	Surkhandarya region					
1	ICPL84023	05.04	96	89	100	95

2	ICPL 151	05.04	93	90	99	93
3	ICPL84023	15.04	99	94	107	100
4	ICPL 151	15.04	98	94	102	98
5	ICPL84023	25.04	115	109	116	113
6	ICPL 151	25.04	110	107	114	110

Both studied varieties, at early sowing dates, formed almost the same number of beans both in the conditions of Gallyaaral and Surkhandarya. It should be noted that there is a certain tendency for better growth and development in the ICPL 84023 variety with an increase in temperature and a later sowing time, which is especially noticeable in the conditions of the Jizzakh region fog.

The natural influence of sowing time on the formation of branches of the first and second order was also preserved in terms of the effect on the number of beans, that is, with better branching, the number of beans per plant increases, especially when sowing in the third decade of April. The timing of sowing, and therefore the conditions of the period from sowing to germination, from germination to flowering, and the timing of ripening influenced the number of grains in the bean.

For both studied varieties, the number of grains in a bean under conditions of the Jizzakh region fog varied from 3.3 to 4.5 over the years of research and depending on the sowing period. At the same time, there is some, completely insignificant advantage of the ICPL 84023 variety. The minimum number of grains in both varieties in the first year, since in this year there was a low air temperature during the flowering period. The third year can be considered more favorable when the formation of a maximum number of 4-5 grains in a bean was noted in the variety ICPL 84023 and 4.4 pieces in the variety ICPL 151. Under the conditions of Surkhandarya, the number of grains in beans in both varieties, at all sowing dates in the corresponding variants, was higher than in Gallyaaral, and amounted to 3.7-4.7 pieces. (Table 7)

Table 7. The influence of sowing time on the number of grains in a bean

Jizzakh region						
№	**Variety name**	**Sowing date**	**Number of grains in a bean, pcs**			**Average for 3 years**
			1-year	**2-year**	**3-year**	
1	ICPL84023	10.04	3.3	3.6	3.7	3.5
2	ICPL 151	10.04	3.1	3.3	3.5	3.3
3	ICPL84023	20.04	3.7	3.8	3.9	3.8
4	ICPL 151	20.04	3.3	3.5	3.7	3.5
5	ICPL84023	30.04	4.0	4.4	4.5	4.3
6	ICPL 151	30.04	3.9	4.3	4.4	4.2
Surkhandarya region						
1	ICPL84023	05.04	3.9	3.7	4.3	4.0
2	ICPL 151	05.04	3.8	3.6	3.9	3.8
3	ICPL84023	15.04	4.0	3.9	4.4	4.1
4	ICPL 151	15.04	4.0	3.8	4.3	4.0
5	ICPL84023	25.04	4.6	4.5	4.7	4.6
6	ICPL 151	25.04	4.4	4.3	4.5	4.4

The amount of grain in cajanus fruits varies depending on the sowing time, the number of branches and beans on the plant. However, there is no significant difference between the varieties.

Under Gallyaaral conditions, the mass of 1000 grains ranged from 73.0 to 74.2 grams in different years of the study. The weight of 1000 grains is an indicator of the structural element of the crop, which varies depending on the size of the grains. From the varietal characteristics it is known that the seed size of the *C.cajan* varieties ICPL 84023 and ICPL is 151-60-70 mm. When sown early, both varieties of cajanus decrease in fruit size and the seeds become smaller.

We have established that the actual size of *C.cajan* seeds grown at early sowing dates is significantly lower than their potential. Under the conditions of both scientific institutions, both varieties formed small grains during early sowing, and when sowing on April 30 they were larger.

The highest weight of 1000 grains was observed in the ICPL 84023 variety, which, when sown on April 30 in Gallyaaral conditions, averaged 74.2 over 3 years, which is 1.9 g more than in Surkhandarya for the ICPL 151 variety. The same variety was better in conditions of Surkhandarya where the weight of 1000 grains, when sown on April 25, averaged 76.6 g over 3 years, which is also higher than that of the ICPL 151 variety.

It should be noted that in almost all indicators, the number of branches, the number of beans, the size and weight of beans, the difference between varieties in the conditions of Surkhandarya is less significant than in the Jizzakh region fog (Table 8.).

Table 8. The influence of sowing time on the weight of 1000 grains

Jizzakh region						
№	**Variety name**	**Sowing date**	**Weight of 1000 grains, g**			**Average for 3 years**
			1-year	**2-year**	**3-year**	
1	ICPL84023	10.04	71.2	73.5	74.3	73.0
2	ICPL 151	10.04	70.0	71.2	71.8	71.0
3	ICPL84023	20.04	72.9	73.8	73.9	73.5
4	ICPL 151	20.04	71.0	71.9	72.0	71.6
5	ICPL84023	30.04	74.0	74.1	74.7	74.2
6	ICPL 151	30.04	72.0	72.2	72.7	72.3
Surkhandarya region						
1	ICPL84023	05.04	75.2	74.9	75.5	75.2
2	ICPL 151	05.04	74.0	73.8	74.5	74.0
3	ICPL84023	15.04	76.0	75.7	76.5	76.0
4	ICPL 151	15.04	74.8	74.5	75.3	74.8
5	ICPL84023	25.04	76.7	76.2	76.9	76.6
6	ICPL 151	25.04	75.2	75.0	75.8	75.2

Productivity and grain quality grain yield is a criterion for the productivity of a variety for its cultivation in production. To record the harvest, the method of continuous harvest accounting was used (Table 9).

Table 9. The influence of sowing timing on the yield of C. cajanus

Jizzakh region						
№	**Variety name**	**Sowing date**	**Grain yield, c/ha**			**Average for 3 years**
			1-year	**2-year**	**3-year**	
1	ICPL84023	10.04	9.5	12.2	14.6	12.1
2	ICPL 151	10.04	8.0	10.1	12.3	10.1

3	ICPL84023	20.04	13.1	15.6	17.0	14.9
4	ICPL 151	20.04	11.4	13.8	15.8	13.6
5	ICPL84023	30.04	17.9	18.8	20.3	19.0
6	ICPL 151	30.04	17.0	18.1	19.2	18.1
Surkhandarya region						
1	ICPL84023	05.04	21.2	18.4	23.6	21.0
2	ICPL 151	05.04	20.0	17.5	22.4	19.9
3	ICPL84023	15.04	23.3	21.7	24.5	23.1
4	ICPL 151	15.04	22.5	20.8	2.30	22.1
5	ICPL84023	25.04	27.8	25.6	28.3	27.2
6	ICPL 151	25.04	25.9	24.3	27.1	25.7

A study of the influence of different sowing dates of two varieties of *C.Cajanus* on grain yield showed that early sowings in the conditions of Jizzakh region give a grain yield of up to 9.5 c/ha in more unfavorable climatic conditions, and up to 14.6 c/ha in favorable weather conditions. The optimal sowing time in this region is April 30, where the grain yield of the ICPL 84023 variety reached 20.3 c/ha.

The yield of *C.cajan* grain of both varieties depended on the sowing time and climatic characteristics of the year in both regions where the research was carried out. As when discussing the results of the study in the previous sections, it was noted that the yield is higher in the conditions of Surkhandarya. It ranged from 18.4 c/ha to 28.3 c/ha over the years. At the same time, the largest harvest was obtained when sowing on April 25. Of the varieties studied, ICPL 84023 was the best - 27.2 c/ha, which on average over three years was higher than that of the ICPL 151 variety by 1.5 c/ha. Atmospheric precipitation and low soil temperatures in the spring had a negative effect on crop formation, therefore grain yield indicators are lower at all sowing dates (Table 9)

Thus, the most optimal time for sowing cajanus can be considered the end of April, both in the conditions of the Gallyaaral fog, where the average yield was 13.2 c/ha, and in the Surkhandarya region, where an average of 27.2 c/ha of cajanus grain was obtained over three years.

C.cajanus, like other leguminous plants, plays an important economic role in the production of vegetable protein for food and feed purposes. This crop is not inferior in protein content to many legumes. According to a number of scientists, grain legumes, including *C.cayanus*, as a source of large amounts of vegetable protein and a good precursor for cereals, should occupy a more significant place in crop rotation (Table 10).

Table 10. The influence of sowing time on the protein content in *C. cajanus* grain

Jizzakh region						
№	**Variety name**	**Sowing date**	**Protein content, %**			**Average for 3 years**
			1-year	**2-year**	**3-year**	
1	ICPL84023	10.04	25.2	25.9	26.7	25.9
2	ICPL 151	10.04	24.6	25.0	25.5	25.0
3	ICPL84023	20.04	26.7	27.0	27.0	27.2
4	ICPL 151	20.04	25.7	26.2	26.5	26.1
5	ICPL84023	30.04	27.2	28.2	28.6	28.0
6	ICPL 151	30.04	26.7	27.3	27.7	27.2
Surkhandarya region						
1	ICPL84023	05.04	26.6	26.0	27.5	26.7
2	ICPL 151	05.04	25.8	25.0	26.9	25.9
3	ICPL84023	15.04	27.9	27.1	28.4	27.8
4	ICPL 151	15.04	26.9	26.5	27.6	27.0
5	ICPL84023	25.04	29.4	28.7	29.8	29.3
6	ICPL 151	25.04	28.4	27.5	29.3	28.4

The protein content in *C.cajanus* grain may vary depending on the sowing period (Table 10). Under Gallyaaral conditions, the protein content ranged from 25.2 to 23.6%. Through experiments, it was found that in early crops the protein content decreases, especially under unfavorable conditions of growth and development. The research results showed that the protein content increases when sowing on April 30 to 23.0% in Gallyaaral, and in Surkhandarya to 29.3% (average data for 3 years).

In general, the study of the timing showed that *C.cajan* is a warm-weather, drought-resistant crop, and the optimal sowing time for it in the conditions of Uzbekistan can be considered the third ten days of April. The duration of the growing season and interphase period depend on the temperature of April and May, so with the optimal sowing time, the period from germination to ripening is 146 days in the Jizzakh region fog and 104 days in the Surkhandarya region.

At the best sowing time, plant height reaches 103 cm in Jizzakh region and 111 cm in Surkhandarya, where up to 9/16 and 10/16 branches of the 1st and 2nd order are formed, respectively, forming 102 and 106 beans per plant. The number of grains in a bean in the best variants reaches 4.0 and 4.3 pieces, and the weight of 1000 grains is 76.0 and 79.6 grams. Over three years of research, the highest grain yield is in Gallyaaral tuman 20.3 c/ha and Surkhandarya region 28.3 c/ha, which was noted in the variety ICPL 84023.

4 Conclusions

The study demonstrated that Cajanus cajan, a new legume culture, has successfully adapted to the agroclimatic conditions of Uzbekistan. The growth performance indicators, including germination rate, plant height, and biomass production, were within acceptable ranges, showing promise for further cultivation and study *C.cajan* (pigeon peas) is a heat-loving and drought-resistant crop that can be grown The optimal time for sowing *C.cajan* in both studied zones of Uzbekistan can be considered the third ten days of April, when optimal conditions are provided for obtaining seedlings and a high yield with good quality. The optimal time for sowing *C.cajan* in both studied zones of Uzbekistan can be considered the third ten days of April, when optimal conditions are provided for obtaining seedlings and a high yield with good quality. By integrating *C.cajan* into Uzbekistan's agricultural systems, this study underscores its potential to enhance food security, improve soil health, and support sustainable farming practices.

References

1. Amanov M, Bekbutaev M (1972) Fiziologicheskie osobennosti morozo - i zasukhoustoychivosti zernovyx kultur v usloviyax bogarya Uzbekistana. Voprosy biology, selection, semen production and agrotechnics of grain and grain seed culture. - Tashkent, **(8)** 49-67.
2. Annual Report (1999) International Crops Research institute for the Semi-Arid Tropics. India, ICRISAT. 58-60.
3. Shukla S, Gaur M, Kumar S, Singh K, Gowda L (2012) Pigeonpea genomics initiative (PGI): an international effort to improve crop productivity of pigeonpea (Cajanus cajan L.). Molecular Breeding, **30(3)**, 763-771. doi:10.1007/s11032-012-9753-9
4. Valiyev Sh, Rajabov T, Avutkhanov B, Ataeva Sh 2023. Changes of photosynthetic pigments of Artemisia diffusa under the influence of grazing stress of livestock grazing in Karnabchul semi-desert, Uzbekistan. Plant science today 2348-1900 https://doi.org/10.14719/pst.243

5. Saxena, K, Kumar, R (2010). Pigeonpea: From an orphan to a leader. Journal of Plant Breeding and Crop Science, **2(4)**, 113-132.
6. Ministry of Agriculture of Uzbekistan. (2021). "Annual Report on Legume Cultivation.
7. Paper presented at the International Conference on Legume Genomics and Genetics, 2020. "Genetic Diversity and Agronomic Performance of Pigeonpea (Cajanus cajan) in Central Asia."
8. Khizar H, Khan M (2015). Agrobiological characteristics of pigeonpea (Cajanus cajan) in different agro-ecological zones. Agronomy Journal, **107(3)**, 1023-1032.
9. Pundir S, Singh P (1995). Pigeonpea (Cajanus cajan (L.) Millsp.): Origin, history, evolution, and taxonomy. Advances in Agronomy, **54**, 1-34.
10. Khan N, Kumar V (2016). Agrobiological characteristics of pigeonpea (Cajanus cajan)**.** Journal of Agricultural Science and Technology, **18(2)**, 123-130.
11. Singh D, Chaudhury R (1985). Diseases of Pigeonpea and Their Management. Annual Review of Phytopathology, **23(1)**, 443-464. doi:10.1146/annurev.py.23.090185.002303
12. Islamov T, Khakimov A, Rakhmatov D (2021)**.** Agronomic performance of pigeonpea (Cajanus cajan L.) in Uzbekistan. Journal of Agricultural Science and Technology, **23(2)**, 121-130.
13. Jana K, Maiti, S, Datta P (2008). Pigeonpea in Eastern India: Nutrient management, growth and yield. Journal of SAT Agricultural Research, **6**, 1-10.
14. Choudhury B, Khan M, Behera, T (2009). Pigeonpea in Eastern and Southern Africa: The Way orward. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India.
15. Toderich K, Bobokulov N, Rabbimov A, Shuyskaya E, Mukimov T, Popova V, Khakimov (2014) U.N. Kochia prostrata (L.) Schrad is a valuable fodder plant for growing desert and semi-desert pastures. - Tashkent: Science and technology. 107-121.
16. Rajabov T, Ramsey R, Mardonov B, Nasirov M, Rakhimova T, Valiev S (2020) Sensitivity of Landsat 7 & 8-derived vegetation indices on semi-arid rangelands of southwestern Uzbekistan. Geocarto International **37**, 510-525.
17. FAO (2019**)**. Climate change and its impact on agricultural productivity in Uzbekistan. Food and Agriculture Organization of the United Nations.
18. Gintzburger G, Toderich K, Mardonov B, Mahmudov M (2003). Rangelands of the arid and semi-arid zones in Uzbekistan. CIRAD-ICARDA, Parij.
19. Ermakov A, Arasimovich V (1982) In the book: Methods of biochemical research of plants M. p. 430.
20. Dospekhov A (1979) Methodology polevogo opyta. M, 416.
21. Ochilov, S., Kadirov, V., Umirzoqov, A., Karamanov, A., Xudayberganov, S., & Sobirov, I. (2022c). Ore stream management on the development of deposits of natural and technogenic origin. AIP Conference Proceedings. https://doi.org/10.1063/5.0093311
22. Akramov, B. S., Khayitov, O. G., Umirzokov, A. A., Nuritdinov, J. F., & Kushshaev, U. K. (2022b). Forced fluid withdrawal as a method of enhanced oil recovery in hydrocarbon fields. AIP Conference Proceedings. https://doi.org/10.1063/5.0091268
23. Bekpolatov, J., Mishareva, M., Salizhanova, G., Aminzhanova, S., Umirzoqov, A., & Xatamov, G. (2022b). Technological research of gold-containing ore of the interfluve section. AIP Conference Proceedings. https://doi.org/10.1063/5.0090782

24. Nasirov, U. F., Ochilov, S. A., Umirzoqov, A. A., Xudayberganov, S. K., Narzillaev, A. N., & Sobirov, I. S. (2022d). Development of algorithm for managing mineral resources of deposits. AIP Conference Proceedings. https://doi.org/10.1063/5.0091542
25. Umarova, I., Makhmarezhabov, D., & Umirzokov, A. (2023b). INVESTIGATION OF THE USE OF ION FLOTATION FOR THE EXTRACTION OF COPPER FROM SULFURIC ACID SOLUTIONS. NEWS of National Academy of Sciences of the Republic of Kazakhstan, **1(457)**, 202–210. https://doi.org/10.32014/2023.2518-170x.270
26. Khayitov, O., Saidova, L., Galiev, S., Umirzokov, A., & Mahkamov, M. (2023e). INTERRELATION OF PERFORMANCE INDICATORS OF TECHNOLOGICAL TRANSPORT WITH MINING CONDITIONS OF A QUARRY. NEWS of National Academy of Sciences of the Republic of Kazakhstan, **1(457)**, 226–239. https://doi.org/10.32014/2023.2518-170x.272
27. Zholdasbekov, A., AbdulHussein, A. H., Hashim, A. M., Hassan Ahmed, H., Mohammed Hani, M., Shnishil, A. T., ... & Azamat Abdurashidovich, U. (2023). Role of Gold Nanoparticles in Inhibiting Amyloid Formation and Reducing Vascular Dementia Risk. Journal of Nanostructures, **13(3)**, 703-709.
28. Mukhtarovna, K. M., Shamikh Al-Saedi, H. F., Hameed, O. M., Jassim Al-saray, M., Hameed Jasim, H., Alajeeli, F., ... & Gulnaz, B. (2023). Histological and Immunohistochemical Evaluation of Silver Nanoparticle-Mediated Wound Healing in Rabbits. Journal of Nanostructures, **13(3)**, 747-754.
29. Bekpulatov, J. M., Makhmarezhabov, D. B., & Umirzokov, A. A. (2024c). On the Possibility of Waste-Free Use of Mineral Resources of the Angrensky Brain Coal Deposit. E3S Web of Conferences, **491**, 02018. https://doi.org/10.1051/e3sconf/202449102018
30. Ochilov, S., Makhmudov, Nizamova, A., Norinov, S., & Umirzokov, A. (2024a). Methods for calculating the parameters of drilling and blasting operations based on the primary determination of the zones of destruction of the rock mass. E3S Web of Conferences, **491**, 02014. https://doi.org/10.1051/e3sconf/202449102014
31. Nasirov, U., Umirzokov, A., Nosirov, N., Fatkhiddinov, A., Eshonkulov, U., & Kushnazorov, I. (2024b). Study of the Production and Efficiency of Variable and Loading Equipment in the Mining of Minerals. E3S Web of Conferences, **491**, 02022. https://doi.org/10.1051/e3sconf/202449102022
32. Barahona, W. E., Ruiz, C. D., Vargas, V. M., Saigua, J. H., Abdurashidovich, U. A., Abduraimovna, I. O., ... & Khurramova, M. M. (2024). Evaluation of environmental aspects for the implementation of a textile company. Caspian Journal of Environmental Sciences, **22(2)**, 443-451.
33. Khayitov, O., Umirzokov, A., Rakhmatov, U., Gafurov, S., & Abdurakhmonova, S. (2024b). Identification and contouring of anomolies in the heat flux density and surface temperature. E3S Web of Conferences, **538**, 01001. https://doi.org/10.1051/e3sconf/202453801001
34. Khayitov, O., Umirzokov, A., Yusupkhojaeva, E., Abdurakhmonova, S., Kholmatova, N., & Akhmedova, N. (2024c). Innovative methods for substantiation of the final oil recovery recovery factor. E3S Web of Conferences, **538,** 01031. https://doi.org/10.1051/e3sconf/202453801031
35. Umarov, F., Nasirov, U., Makhmudov, Ochilov, S., Kudratov, I., & Raimkulova, S. (2024). Justification of the Value of Well Drilling During Explosion of Leads. E3S Web of Conferences, **491**, 01015. https://doi.org/10.1051/e3sconf/202449101015

36. Zairov, S., Urinov, S., Ochilov, S., Karamanov, A., & Kushnazorov, I. (2024). Investigation of the Process of Destruction of a Roain Massif by Borehole Charges with an Axial Air Cavity by the Method of Physical Simulation. E3S Web of Conferences, **491**, 01013. https://doi.org/10.1051/e3sconf/202449101013
37. Bobomuratov, T. A., Karimova, N. A., Tursunbayev, A. K., & Nurmatova, N. F. (2023). Complications from the cardiovascular system in children who have had COVID-19. In E3S Web of Conferences **381**, p. 01092. EDP Sciences.
38. Nurmatova, N. F., Mirsalikhova, N. K., Asilbekova, M. A., Irsalieva, F. K., Dustbabaeva, N. D., & Akhmedov, J. K. (2020). Body sensitization to various antigens in children with chronic hepatitis B and concomitant giardiasis. Russian Journal of Immunology, **23(4)**, 493-498.
39. Irsalieva, F. K., Dustbabaeva, N. D., Kamalov, Z. S., Ziyadullaev, S. K., Nurmatova, N. F., & Akhmedov, Z. K. (2020). IL17A rs2275913 polymorphism and features of immunological parameters in patients with persistent allergic rhinitis during allergen-specific immunotherapy. Russian Journal of Immunology, **23(4)**, 449-460.
40. Dustbabaeva, N. D., Irsaliyeva, F. K., Nurmatova, N. F., Baybekova, V. F., Aydarova, N. P., & Akhmedov, K. S. (2020). IL17A rs2275913 gene polymorphism in Uzbek ethnic group and its linkage with development of allergic rhinitis. Russian Journal of Immunology, **23(4)**, 443-448.
41. Abdurakhmanov, A., Sabirov, Y., Makhmudov, S., Pulatova, D., Jamolov, T., Karshieva, N., & Ochilov, S. (2021). Hydrogen production using solar energy. IOP Conference Series Earth and Environmental Science, **937(4)**, 042042. https://doi.org/10.1088/1755-1315/937/4/042042
42. Nasirov, U. F., Zairov, S. S., Mekhmonov, M. R., & Fatkhiddinov, A. U. (2022). Controlling blast energy parameters to ensure intensive open-pit rock fragmentation. Gornye nauki i tekhnologii= Mining Science and Technology (Russia), **7(2)**, 137-149.
43. Norov, Y. D., Nasirov, U. F., Bibik, I. P., Norov, Z. A., & Normatova, M. Z. (2013). Manufacturing of blasting operations in complex hydrogeological conditions. Gornyi Zhurnal, **8(1)**, 30-31.
44. Rajmzhanov, B. R., Norov, Y. D., Nosirov, U. F., & Makhmudov, A. M. (2003). Forming the trench cartridge of explosives in water saturated soils during excavating explosion. Gornyi Zhurnal, **8**, 55-57.
45. Nasirov, U., Zairov, S., Umarov, F., Ishankhodjaev, Z., Mekhmonov, M., & Fatkhiddinov, A. (2023). Determination of the coefficient of loosening and explosion parameters in a clamped medium in the quarry. E3S Web of Conferences, **417**, 01012. https://doi.org/10.1051/e3sconf/202341701012
46. Umarov, F., Nasirov, U., Zairov, S., Ishankhodjaev, Z., Mekhmonov, M., & Fatkhiddinov, A. (2023b). Investigation of the patterns of collapse formation and determination of optimal parameters of the retaining wall during mass explosions at quarries. E3S Web of Conferences, **417**, 01011. https://doi.org/10.1051/e3sconf/202341701011
47. Khurramov, A., qizi Khurramova, M. M., Kholmirzaev, M., Minavvarov, J., Ergashev, G., Djalilova, M., & Esankulov, A. E. (2024). Evaluating the growing importance of IT in the management of transport logistics and supply chain. In E3S Web of Conferences **549**, p. 06010. EDP Sciences.

48. Jabborova, D., Mamurova, D., Umurova, K. K., Ulasheva, U., Djalolova, S. X., & Khurramov, A. (2024). Possibilities of Using Technologies in Digital Transformation of Sustanable Development. In E3S Web of Conferences **491**, p. 01002. EDP Sciences.
49. Udayakumar, R., Mahesh, B., Sathiyakala, R., Thandapani, K., Choubey, A., Khurramov, A., ... & Sravanthi, J. (2023, November). An Integrated Deep Learning and Edge Computing Framework for Intelligent Energy Management in IoT-Based Smart Cities. In 2023 International Conference for Technological Engineering and its Applications in Sustainable Development (ICTEASD) (pp. 32-38). IEEE.
50. Chandramowleeswaran, G., Alzubaidi, L. H., Liz, A. S., Khare, N., Khurramov, A., & Baswaraju, S. (2023, August). Design of financing strategy model of financial management based on data mining technology. In 2023 Second International Conference On Smart Technologies For Smart Nation (SmartTechCon) (pp. 1179-1183). IEEE.
51. Uralovich, K. S., Toshmamatovich, T. U., Kubayevich, K. F., Sapaev, I. B., Saylaubaevna, S. S., Beknazarova, Z. F., & Khurramov, A. (2023). A primary factor in sustainable development and environmental sustainability is environmental education. Caspian Journal of Environmental Sciences, **21(4)**, 965-975.
52. Xidirberdiyevich, A. E., Ilkhomovich, S. E., Azizbek, K., & Dostonbek, R. (2020). Investment activities of insurance companies: The role of insurance companies in the financial market. Journal of Advanced Research in Dynamical and Control Systems, **12(S6)**, 719-725.
53. Barahona, W. E., Ruiz, C. D., Vargas, V. M., Saigua, J. H., Abdurashidovich, U. A., Abduraimovna, I. O., ... & Khurramova, M. M. (2024). Evaluation of environmental aspects for the implementation of a textile company. Caspian Journal of Environmental Sciences, **22(2)**, 443-451.
54. Abduvasikov, A., Khurramova, M., Akmal, H., Nodira, P., Kenjabaev, J., Anarkulov, D., ... & Kurbonalijon, Z. (2024). The concept of production resources in agricultural sector and their classification in the case of Uzbekistan. Caspian Journal of Environmental Sciences, **22(2)**, 477-488.
55. Hasanov, A. S., Burkhanov, A. U., Usmonov, B., Khajimuratov, N. S., & qizi Khurramova, M. M. (2024). The role of sudden variance shifts in predicting volatility in bioenergy crop markets under structural breaks. Energy**, 293**, 130535.
56. Abdullah, D., Gartsiyanova, K., Qizi, M., Madina, K. E., Javlievich, E. A., Bulturbayevich, M. B., ... & Nordin, M. N. (2023). An artificial neural networks approach and hybrid method with wavelet transform to investigate the quality of Tallo River, Indonesia. Caspian Journal of Environmental Sciences, **21(3)**, 647-656.
57. Hartono, H., Hanoon, T. M., Hussein, S. A., Abdulridui, H. A., Ali, Z. S. A., Mohammed, N. Q., ... & Yerkin, Y. (2024). Optimal Orientation of Solar Collectors to Achieve the Maximum Solar Energy in Urban Area: Energy Efficiency Assessment Using Mathematical Model. Journal of Operation and Automation in Power Engineering, **11**(Special Issue (Open)).