TECHNOLOGY OF CHICKPEA CULTIVATION IN DRY-STEPPE AREA

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Abstract

Livestock industry in Western Kazakhstan is one of the most important sectors at the national level. The sustainable livestock production is largely based on the fodder production. The chickpea is one of the most important fodder legume in the world. Preceding culture, seeding timing, seeding rate and seeding depth greatly may influence the chickpea growth and production. In this study, the technology of chickpea growing in dry-steppe area of Western Kazakhstan is presented. The chickpea was planted on the plot where the previous crop was wheat by random spreading method of sowing, which ensures optimum nutrition area for each plant. Phenological phases of the growth and development of chickpea was monitored during the vegetation season. Results showed that the height of attachment of the lower beans corresponded to the requirements of mechanical harvesting and was at 20 cm. The relatively favourable conditions of the first half of the chickpea vegetation contributed to the good ovary of the beans. According to field records, one chickpea plant produced up to 10 beans. However, 60-70% of the beans were productive due to a set of the factors, where the most influential was the biological characteristics of chickpea.

Keywords: chickpea, planting time, planting depth, phenological phases, biological structure

INTRODUCTION

One of the urgent tasks of Agriculture in West-Kazakhstan region is the full development of the livestock industry based on an improved system of fodder production. Significant reserves of fodder production lie in the expansion of cultivated areas under leguminous cultures, particularly chickpeas (*Cicer arietinum* L.).

The Chickpea (*Cicer arietinum* L.) is fifth most important legume in the world, on the basis of total production after soybean, groundnuts, beans and peas (Muzquiz and Wood, 2007). It is an important source of cheap protein with high energy and nutritive value, complex carbohydrates, fibre, vitamins and minerals (Gupta 1988; Williams and Singh, 1988; Hulse, 1991; El-Karamany and Bahr, 1999). Chickpea is grown on a wide range of environments, from the subtropics to arid and semi-arid environments (Dhima et al., 2015).

In the Ural piedmont, where the main limiting factor for agricultural production is moisture, the chickpea is a promising legume due to its biological characteristics. Chickpea is believed to be tolerant to drought condition, but there is little published evidence to support this contention (Saxena, 1984). Moisture deficit affects seed germination and seedling establishment in the field, however, genotypes vary in their capacity to tolerate moisture stress (Rizvi et al., 2017).

Chickpea is resistant to disease, doesn't lodge and allows to harvest both direct and separate way. The beans of chickpeas do not crack when maturing. The protein content in seeds of chickpeas vary from 20.1 to 32.4%, 2.2% fat and 61.2% carbohydrates (Gupta, 1987). Chickpea seeds contain a lot of phosphorus, potassium and magnesium. Chickpea is a good source of lecithin, riboflavin (vitamin B2), thiamine (vitamin B1), nicotinic and pantothenic acids and choline. Content of vitamin C in seeds of chickpea vary from 2.2 to 20 mg per 100 g of biomass. The number of major essential acids-methionine and tryptophan, the chickpeas surpass other leguminous crops. Chickpea is also used widely as fodder and green manure (Naseer and Naseer, 2014).

MATERIALS AND METHODS

The Western-Kazakhstan Agrarian Technical University named after Zhangir Khan within the Project "Services on introduction and implementation of innovative experience" conducted a field experiment on the technology of cultivation of chickpeas on the territory of Janvarcevsky district, in West-Kazakhstan region on area of 50 hectares.

Pedological cover of the studied arable lands is Chestnut soils with dominance of dark-chestnut soils with medium loam texture in combination with meadow-chestnuts soils. These are the best quality soils in the studied region and are classified as 1st class that require regular zonal agrotechnical measures.

Predecessor

The chickpea (*Cicer arietinum* L.) was planted on the plot where the previous crop was wheat. Chickpea is not sensitive for the predecessors, but the main condition in choosing the location for chickpea planting is a weak weed infestation and the absence of perennial rhizome weeds. In its turn, the chickpea is an excellent predecessor for most of agricultural crops. The chickpea early releases the field and therefore creates favourable conditions for soil preparation and accumulation of moisture and other agricultural activities.

Agrotechnical measures

For the improvement of agrophysical, agrochemical and biological characteristics of the soil we applied the measures of minimum mechanical disturbance of soil. In autumn, a deep tillage of the plot was performed. To preserve moisture in the soils the field was spring harrowed with zig-zag harrows. Before sowing a pre-sowing tillage (cultivation) to a depth of 8-10 cm was performed. On day 5 after seeding a pre-germination harrowing of soil was carried out. The aim of pre-germination harrowing is not just removing of the first thread-like weed shoots, but also align the soil surface.

Preparation of seeds for sowing

Attention is paid to the preparation of the seed for sowing. After an assessment of germination ability of chickpea seeds was performed, the seeding was carried out with high-quality seeds that possess high germination and vigour ability. The laboratory germination ability of the seeds was 97%. The seeds directly before sowing were treated with bacterial preparation “Flavobacterin”, at the rate of 3 litre/tonnes of seeds, which allows to increase the grain yield and protect against diseases. The seed inoculation was conducted using knapsack sprayer.

Timing, seeding rates and seeding depth

In the dry steppes of Western Kazakhstan region, with high probability of drought in June the sowing of the chickpea the timing, seeding rates and seeding depth are established the way that the plants can most optimally use the moisture accumulated in spring and that the critical phases of plant growth coincide with the periods of precipitation (end of June-beginning of July).

Timing of seeding

In the given climatic conditions, the sowing of chickpea is better to perform simultaneously with early crops (barley and spring wheat). Therefore, depending on the length of the growing season the chickpea should be sown between the end of April-the first five days of May, preferring the earlier sowing. We performed the sowing of chickpea on 2-3 May 2015 with planter AUP-18-05, that is multifunctional versatile unit designed for a random spreading method of grain sowing with simultaneous application of granulated mineral fertilizers. The random spreading method of sowing ensures optimum nutrition area for each plant.

Seeding depth

The seeding depth is essential to receive high harvests. Because the topsoil after the pre-processing is quickly losses moisture, the abundance of moisture is ensured only with relatively deep placing the seeds that chickpea well withstands, since by the germination characteristics it belongs to the group of crops, who's cotyledons remain in the soil. However, both at deep and shallow placing of the seed, the field germination rate decreases and the root system worse develops. In our research, we performed the sowing of chickpea seeds on the depth 6-7 cm. According to the action plan, we conducted the field and laboratory researches: the surveys of field germination, estimation of the growth dynamics, weed and disease and pest infestation, and the phenological observations. Before sowing the samples of soil were taken to determine the field moisture and soil agrochemical characteristics. The contents of the field moisture in a meter layer ranged from 11.67 to 16.48 % and in the 0-10 cm layer from 11.91 to 17.10 %. This amount of available moisture provided good simultaneous germination of chickpeas.

Managing the plantings

To destroy weed seedlings in the chickpea plantings pre-growing harrowing was performed. In the experiment herbicides were not applied, because the herbicides recommended for peas and other legumes, even in minimal doses markedly inhibit development of chickpea. The most harmful diseases for chickpea is *ascochyta*. For its growth, the a*scochyta* require high humidity and high temperature conditions, what very rarely happens in the dry steppe climate of West Kazakhstan region. In the dry 2015 year, the disease was not manifested. To increase the yield and resistance of the chickpea to diseases during the vegetation, the plantings on 1 hectare area were again treated with bacterial preparation «Flavobacterin», as well as with liquid bio-organic fertilizer NAGRO in the dose of 0.5 l/ha.

In 2015, some individual locusts were observed on the plantings of chickpea. The plantings were treated with insecticide twice. The recordings and observations conducted during the second half of the summer did not reveal any damage of the chickpea planting with other pests and diseases. When the bulk of the beans matured, the chickpea was harvested by direct combining with the "Vector-410" machine.

RESULTS AND DISCUSSION

Growth and development characteristics of the chickpea

The vegetation conditions of the current year significantly influenced the chickpea growth and development. The spring and early summer were characterized by relatively favourable agro-meteorological conditions, while the middle and second half of the summer were extremely dry, with abnormally high temperatures, up to 35-40° c, and long hot dry winds. This climatic anomaly occurred during the critical period (the phase of formation of beans and grain filling) for growth and development of the chickpea. As a result, the plants didn't reach their full development, rapidly passing the phases of development.

Duration of vegetation period

The duration of the vegetation period influenced primarily, by the temperature for seed germination and by the amount of available moisture in soil. We have carried out the phenological monitoring of the growth and development of plants during the growing season.

An even emergence of shoots of the chickpea plants was observed on the 10-11 day. The field germination of chickpea seeds was at the level of 70-92%; flowering of 75% of plants was observed on the 38-39 days after sowing. The phase of bean formation was observed on the 10^{th} day after the flowering, and grain filling after 7 days. The ripening of grains was observed on July 16, after 19 days after the grain filling. In general, the duration of the vegetation period of chickpea plantings decreased to 84 days, instead of 90 days characteristic for the local chickpea variety Jubileini (Table 1).

Table 1. Growth and development characteristics of the chickpea

Indicator	Germination	Brunching	Budding	Flowering	Bean formation	Grain filling	Ripening	Harvest
1	2	3	4	5	6	7	8	9
Date of phenophases	12.05	21.05	04.06	11.06	21.06	28.06	16.07	30.07
Interphase periods, days	9	9	13	7	10	7	19	84
Plant height, cm	7	11	34	41	41	40	37	-

As the data show, the interphase periods of the generative cycle of the chickpea development have basically decreased: the formation of beans, the filling and ripening of grain. This is because in the phylogenesis, the plants are under unfavourable conditions for self-preservation, tend to complete the development faster, which is always accompanied by a

decrease in their biological productivity. The high aridity of the climate during this period also caused an acute shortage of soil moisture.

According to the results of the infestation records, the late spring weeds prevailed in the chickpea plantings: *Amaranthus retroflexus* (L.), *Setaria viridis* (L.) and Panicum crus galli (L.). The bulk of them emerged in late May - early June. Of the perennials, the *Euphordia virgate* (L.) and *Lactuca tataric*a (L.) were mostly presented, which grew up in separate microtensions in the micro depressions of the field relief. The number of weeds was 5-11 pcs/m^2, the dry weight of weed plants was 26.4 g/m^2.

Yield

The extreme climatic conditions in summer and locust invasion affected the chickpea biomass development in the first half of summer. As noted above, in the flowering phase, the height of the chickpea plants was 41 cm and they were characterized by high turgor, good leafiness and density of plantings.

However, the long-term atmospheric and soil drought that occurred in the second half of the vegetation led to the drying of the plants, yellowing and fall of the lower leaves, as well as to the accelerating the passage of the next phases of the chickpea development. Thus, the intensity of the processes of grain formation and grain filling decreased sharply, what resulted in insufficient grain filling of beans and in a low mass of grain.

At the same time, a significant part of the plants, that was in the relief depressions, was still green and was in the phase of milky wax and wax ripeness of grain. Moreover, the maturing of chickpeas in the current year was uneven, the lower beans were already yellow and hardened, and the upper ones were still green. Before harvesting, a complex of field surveys and observations was conducted, the results of which determined the biological productivity of the chickpea (Table 2).

The number of plants before harvesting was calculated on three trial plots by random sampling. According to the average results, before the harvest, there were 42 chickpea plants per 1 m^2. Despite the extreme conditions of the second half of the vegetation period, the high conservation of chickpea was noted in the plantings, which amounted to 95%. This was due to the deep rooting of plants and the high adaptability of the chickpea plants to dry conditions, which resulted in that plants reduced the intensity of biological processes, dumped lower leaves, but continued their vegetation.

Table 2. The structure of biological yield of chickpea plantings, 2015 year.

No.	Elements of the yield structure	Average
1.	Number of plants before harvest, pcs/m^2	42
2.	Plant height, cm	39.3
4.	Number of branches, pcs/plant	2.2
5.	Number of leaves, pcs/plant	69.9
a	The height of attachment of the lower bean, cm	20.5
b	Number of beans per 1 plant total, pieces	10.2
c	Including beans with grains, pieces	8.2
d	The number of seeds per bean, pieces	1.2
6.	Number of grains per 1 plant, pieces	9.8
7.	Weight of seeds from 1 plants, g.	2.17
8.	Weight of seeds from 1 m^2, g.	91.28
9.	Biological productivity, t/ha	0.91

Plant height

The height of plants, the number of branches and leaves in many respects characterizes the state and potential productivity of the plantings of chickpea. Of great importance is the height of the plants and especially the height of the attachment of the lower beans, on which the quality of harvesting depends, since if the height of the lower beans is below 14-16 cm, during harvest a large yield losses occurs.

Intensive growth of chickpea plants occurs in the branching, budding and flowering phases, gradually slowing down to the phases of grain filling and ripening. In the current year, intensive growth processes were observed before the beginning of the flowering phase. Then, in the conditions of the long drought of the second half of vegetation, the growth processes of chickpea practically stopped. The height of the chickpea plants averaged 39 cm, the height of the attachment of the lower beans was 19-21 cm. In the conditions of high temperatures of the current year, and the accompanying moisture deficiency, the branching of the plants was minimal and on average one plant had a little more than two branches.

The leafiness of the chickpea plants was quite high and amounted to about 70 leaves per plant. The largest area of the leaves is in the budding phase - the beginning of flowering. However, about half of them to the phase of grain filling have already dried up and the presence of them could only be judged by the remained central axis of the pinnate leaf of the chickpea.

The main elements of the structure of the chickpea yield are the number of beans per plant, the number of grains per bean in their mass. In our research, the conducted accounting showed that the height of attachment of the lower beans corresponded to the requirements of mechanical harvesting and was at 20 cm. The relatively favourable conditions of the first half

of the chickpea vegetation contributed to the good ovary of the beans. According to field records, one chickpea plant produced up to 10 beans. However, 60-70% of the beans were productive due to a number of factors. The first factor was the biological characteristics of chickpea. As in most plants growing by apical point of growth, the formation and maturation of the generative organs of the chickpea occurs from the bottom up, therefore, often the lower beans are already ripening, and the apical ones are only being formed. In the current year, the time difference in the formation of chickpea beans was exacerbated by the aridity of the second half of the vegetation, what resulted in that the apical beans lagged and did not form seeds.

A characteristic biological feature of chickpea is the poor graininess of beans, which in the sowings of the studied year was an average of 1.2 grains per 1 bean. Most of the beans were one-seeded, although occasionally there were two- and even three-seeded beans.

The laboratory calculations and measurements of the sheaf material showed that the weight of seeds from 1 chickpea plant averaged 2.17 grams, and in 1 m^2, considering the number of plants averaged 91.28 grams. The actual yield of chickpeas after threshing was 0.72 t/ha.

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