INFLUENCE OF THE CONDITIONS OF SOIL NUTRITION AND MINERAL FERTILIZERS ON THE PRODUCTIVITY AND QUALITY OF CHICKPEA BEANS

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Abstract: The results of the researches carried out in the period from 2003 to 2007 are provided on the dark chestnut easy margalitic soils of Northern Kazakhstan for the study of soil nutrition and mineral fertilizers influence on the productivity and quality of chickpea. According to the results, the lack of moisture, heat and basic nutrients in the soil significantly affect the growth and development of chickpea. Basic nutrients are the main obstacle in the conditions of Northern Kazakhstan. The tests have shown that nitrogen and phosphorus fertilizers affected differently the forming chickpea yield according to the initial state of nitrogen and phosphorus in the soil. The applied fertilizers stimulated the intensive development of the vegetative mass and the root system, which is particularly important in dry years with high moisture scarcity in the soil in Northern Kazakhstan. Depending on the set edaphoclimatic conditions and the applied doses, phosphorus fertilizers increased the productivity of chickpea to 63.9%, but nitrogen ones – to 70%. In various years the best result was provided by various doses of the applied fertilizers. Thus, in 2003 the highest yield gain of chickpea was achieved when 90 kg of a rate of application was applied, in 2004 and 2005 – from 150 kg of a rate of application, in 2006 – from 210 kg, whereas in 2007 – from R120. The same relates to nitrogen fertilizers. The ratio of phosphorus to nitrogen in the soil is a major factor for the efficiency of phosphorus and nitrogen fertilizers. Phosphorus and nitrogen are produced by the applied fertilizers. The applied nitrogen fertilizers have significantly affected protein content by an average of 4%, whereas phosphorus fertilizers reinforced the production of fat and fiber. Nitrogen fertilizers almost did not affect the formation of fats, whereas phosphorus fertilizers – the albumen production.

Keywords: Chickpea, Nitrogen fertilizers, Phosphorus fertilizers, Dark chestnut soils, Productivity, Beans quality.

1 Introduction

Chickpea is one of the most important leguminous crops. This is a valuable food and feed crop rich in proteins and vitamins (A, C, B1, B2, C, RR, D). Chickpea is a relatively cheap source of protein nutrition. (1) Leguminous plants are unique according to their protein content. There is 1.5-3.0 times more protein in their seeds, than in the cereal crops. Leguminous plants are prominent with high accessibility. The proteins of leguminous plants are complete and have high quality. (2, 3) The researches by Behnoush Rasaei (4) have shown that chickpea proteins consist of such key amino acids as tryptophan, lysine, arginine and others, which are contained no less in peas, lentils, and legume.

In chickpea seeds, the protein content ranges from 13 to 30%, the fat content – from 4.1 to 7.2; nitrogen-free extractable substances – from 47 to 60; starch – from 48 to 61; crude fiber – from 2.4 to 12.2; ash – from 2.3 to 5.0; calcium – 0.255; phosphorus – 0.561%. (5-14)

A prevailing share of proteins is made by chickpea due to the atmospheric nitrogen being absorbed. Deeply penetrating the soil, the roots of chickpea improve the nitrogen balance of it and contribute to the increase in productivity of the crop rotation. (15-17) All leguminous crops are good forerunners for winter and spring crops. (18)

Chickpea is a culture which is relatively not strict to the soil compared to other leguminous crops. (19) It grows well, ranging from sand dunes in the Thal of Pakistan to sandy clay (Northern India), up to deep black cotton soils (central India, West Asia, and the Ethiopian highlands), as well as on sandy clays and light loams. (20) The reaction of the soil solution should be neutral or alkalescent. (21, 22) According to Mahler et al. (23), the optimum value of ph environment for chickpea should vary from 5.7 to 7.2.

The advantages of the chickpea should also include its high technology. Seeds do not lay, and grain does not crumble. (24) Zavyalova (25) notes that chickpea can be used as a green manure.

The world areas of chickpea are about 10 million hectares. The major producing countries are India (68 %), Turkey (11 %), and Pakistan (8 %). (26) Chickpea is mostly (90%) grown in rainfed conditions, as well as in semi-arid and arid regions. (27)

The cultivated areas of chickpea in Kazakhstan are 50.9 thousand hectares (0.5%) (according to the statistical agency of the Ministry of Agriculture).

Despite its drought resistance, high food, and feed value, it has not been widely spread in Kazakhstan, mainly due to its low productivity and insufficient knowledge.

In Kazakhstan, a lot of papers is devoted to the culture of chickpea. (25, 28-36) Here the main attention was paid to the issues of biology and technology of chickpea cultivation. However, soil nutrition and chickpea fertilizer, as a crucial method to improve its productivity and quality, have been insufficiently studied.

It is only known that regarding the conditions of mineral nutrition, chickpea is less strict to the soil, compared to other leguminous crops.

The conditions of nitrogenous nutrition largely affect the growth and development of plants. In the case of normal nitrogenous nutrition, plants form strong stems and leaves with bright green color. The plants grow and cluster intensively. Reproductive bodies are better formed and developed. Synthesis of protein substances is increased. A living ability of a body remains longer. The growth is accelerated and leaf senescence is slightly slower.

The yield is greatly increased, and its quality improves with normal phosphorous nutrition. Phosphorus improves winter resistance of plants, as well as accelerates their development and ripening. (37)

The optimal phosphorous nutrition contributes to the development of the plant root system. The latter more intensively branches and deeper penetrates into the soil. Due to that the nutrients and moisture get to the plants. That is particularly important for arid conditions. (38)

Saxena (39), Korbut (40), Bodnar (8), Vanifatiev (41-43), Vinokurov (35), Pereira Stamford (44), Jiang (45), Sarir (46), Schulze (47), and Islam (48) note the positive reaction of chickpea both for the seeding application of phosphorus fertilizers and the main application of nitrogen and phosphorus fertilizers, and complete mineral fertilizer (NPK). We also observed the positive influence of biological fertilizers, seed treatment with nitrogen, zinc sulfate and molybdenum on the productivity of chickpea. (34, 40, 44, 49-53)

However, these studies do not reveal the peculiarities of a crop's mineral nutrition and do not allow to develop a scientifically based fertilizer system of chickpea, according to the level of soil fertility, agronomic and other conditions.

The solution of these issues is relevant at the current stage. Due to that chickpea can take its rightful place in the diversification of a grain production in Kazakhstan.

Given these issues are insufficiently studied in northern Kazakhstan, we aim to study the influence of the conditions of soil nutrition and mineral fertilizer on the productivity and quality of chickpea in the conditions of dark chestnut soils in northern Kazakhstan.

2 Materials and Methods

Study Site: The researches were carried out in 2003-2007 in Akmola region of Tselinograd district at farming enterprise "Aktyk" JSC, which is located in a dry steppe area of Northern Kazakhstan. An amount of precipitation and temperature conditions of the research year are shown in the figures 1-2.

The experiment design: The soil is dark chestnut and carbonated. The mechanical composition is easy margalitic soil. The capacity of a humus horizon (An + B1) is 42-44 cm, the content of humus in an arable layer (0-20 cm) is 2.89 - 3.28%, pH – 7.8-8.0, the amount of absorbed bases is 21.0-22.0 mg-eq/100 g of a soil, a content of nitrogen nitrate – 9.1-12.0 mg/kg of a soil (in the layer 0-40 cm – 5.8-10.6); phosphorus – 7.6-24 mg/kg, potassium – 42.0-52.0 mg/100 g of a soil.

Application of treatment: In order to study the conditions of chickpea mineral nutrition and to control the dynamics of the nutrients before a crop, according to the main options from nonadjacent repetitions, the soil samples from 5 points on a site were selected to a depth 40 cm, each 20 cm to determine the main fertility factors: humus, pH, Ca2 + , Mg 2 +, N-NO3, P2O5, K2O and moisture.

In the selected samples the following was determined: soil moisture by weight method (GOST 28168-89), ammonia nitrogen – with a Nessler's reagent (GOST 26489-85), nitrate nitrogen – at the ionomer "EV-74", and by phenoldisulfonic method according to Grandval-Lyazh (GOST 26951-86), labile phosphorus and potassium from one extract – according to Machigin (GOST 26205-91), humus – according to Tyurin-Kononova (GOST 26213-91), absorbed Ca2 +, Mg2 + – by tyrilonometric method (GOST 26487-85), a pH water extract – by ionometric method (GOST 26483-85).

In order to control the dynamics of moisture and nutritional elements before sowing, soil samples were selected at the control every 20 cm to a depth of 1 meter at the stages of branching, blooming and after the cleaning of chickpea. Plant samples (to 20 plants) from 10 points were selected for the main development and cleaning stages to determine the accumulation of a dry substance in plants and to consider the yield structure.

In the phytochemistry laboratory by the project leadership team of Research and development center of grain farming named after A. I. Barayev of Ministry of Agriculture of the Republic of Kazakhstan, a fiber was determined by Kirchner and Ganek method (GOST 13496.2-84), fat – with a nonfat residue (GOST 13496.15-85), and ash content of seeds was determined as well (GOST 13496.16-75).

Ammonium nitrate (34.6% rate of application) was used as nitrogen fertilizers. Ammophos was from phosphorus-containing fertilizers (46% P2O5, 11-12% N). In autumn, amorphous was superficially applied. Then there was a dump processing to a depth of 18-20 cm, with a view to an equal embedding of fertilizers. In spring, nitrogen fertilizers were applied for preplanting cultivation. In spring, the moisture closure (BIG-3) and the preplant treatment of the soil with a cultivator (Op-8) were carried out at the depth of 6-7 cm. The sowings were carried out with seeding-machines SZS-2.1. The breed "Jubilee" was sown calculated as 0.7 million of fertile seeds per hectare.

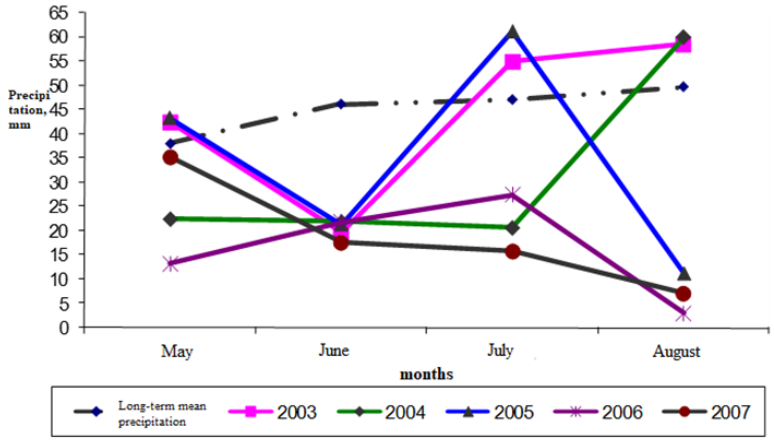

Figure 1. Amount and Distribution of Precipitation during Vegetation Period

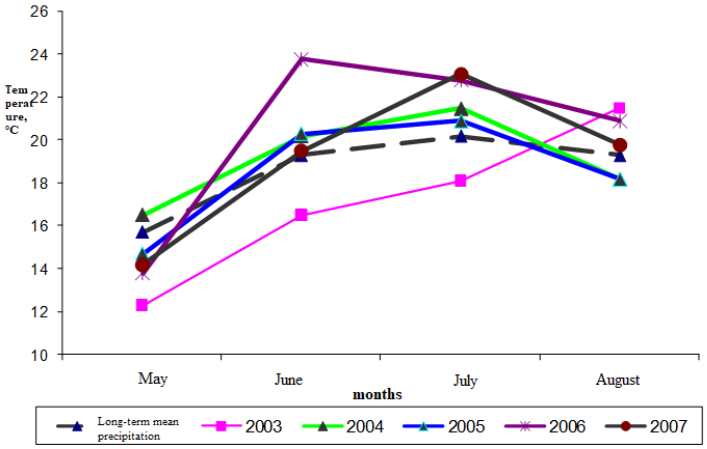

Figure 2. Daily Average Air Temperature during Vegetation Period

6 levels of phosphorus, 4 – nitrogen and pair combinations in total were studied in the tests. The scheme provided creation of different levels of phosphorus and nitrogen content in the soil (from low to excessively high) in order to establish a quantitative relationship between the level of nutrients content in the soil and chickpea productivity, on the one hand, and the efficiency of fertilizers, on the other hand.

The accounting area of a site is 112.5 m^2.

3 Results and Discussion

The research years were different in hydrothermal conditions: 2003, 2005, 2007 are moderately arid, with precipitation for the agricultural year, respectively, 252, 269, 248 mm, and deposits of productive moisture before sowing in the layer 0 100 cm – 111, 105, 141 mm; 2004, 2006 are very dry. Annual precipitations are 191, 203, 213 mm. Productive moisture in the soil is 133.6, 81.4, 129.3 mm.

Meteorological conditions have significantly affected the soil processes as well as the peculiarities of growth and development of plants, and the formation of the chickpea yield.

The conditions of soil nutrition in the research years have varied. Table 1 shows the original content of the nutrients in the soil before the chickpea sowing.

As we see from the table in all years, the chickpea has been grown with a scarcity of nitrogen and phosphorus in the soil. The sufficiency was increased only as for potassium.

Table 1. Nutrients Dynamics in the Soil Before Chickpea Sowing, mg/kg

Layer of the soil, cm	$N\text{-}NO_3$				P_2O_5				K_2O			
	The research years											
	2003	2004	2005	2006	2003	2004	2005	2006	2003	2004	2005	2006
0-20	11.0	9.8	9.1	12.0	**24.0**	**7.6**	**12.2**	**13.0**	**520**	**420**	**420**	**480**
20-40	6.5	7.9	2.5	9.1	7.4	2.8	5.4	7.0	340	280	340	320
0-40	**8.8**	**8.8**	**5.8**	**10.6**	15.7	5.2	8.8	10.0	430	350	380	400
40-60	3.2	6.8	4.1	9.2	3.2	0.0	0.0	7.0	320	180	240	200
60-80	3.5	3.8	3.0	1.1	2.8	0.0	0.0	1.6	220	160	170	160
80-100	-	3.8	2.0	0.0	0.0	0.0	0.0	0.0	220	180	180	160

The application of nitrogen and phosphorus fertilizers contributed to increasing the content of nitrogen nitrates, and labile phosphorus in the soil 2-3 times. It was determined by the number of applied fertilizers (table 2). Due to the high content of exchange potassium in the soil, the application of potassium fertilizers was not expected.

Consequently, according to the options, the supply of chickpea with nitrogen and phosphorus varied in the tests. Both the content and the ratio of nutrients depended on the number of applied fertilizers. Nitrogen nitrates played a major role in nitrogen nutrition. The content of ammonia nitrogen in the research years was largely dependent on climatic conditions. At the initial stage of the plants' development of the ammonia nitrogen was not available in the soil, which is explained on the one hand by its possible absorption by plants, and by active nitrification on the other hand.

Table 2. The Influence of Fertilizers on the Content of Nutrients in the Soil Before the Chickpea Sowing, mg/kg

Applied, kg, the rate of application.	The soil's layer, cm	The research years				
		2003	2004	2005	2006	2007
		Content of $N\text{-}NO_3$				
O	0-20	10.8	10.0	9.1	13.4	9.1
	0-40	**9.7**	**8.7**	**5.8**	**12.8**	**8.5**
N30	0-20	15.8	15.0	10.2	21.2	13.5
	0-40	**15.3**	**13.1**	**7.6**	**18.1**	**12.9**
N60	0-20	19.6	19.1	15.5	27.7	17.8
	0-40	**17.2**	**16.7**	**11.8**	**21.2**	**17.6**
N90	0-20	24.6	22.4	24.0	28.8	22.0
	0-40	**19.2**	**20.5**	**15.5**	**23.3**	**19.6**
		Content of P_2O_5				
O	0-20	24.0	9.6	13.0	14.4	17.8
P60	0-20	32.8	14.2	16.6	19.1	23.7
R90	0-20	35.6	17.2	19.6	21.2	27.5
P120	0-20	38.0	21.6	22.0	27.2	29.3
R150	0-20	41.6	26.0	29.6	30.6	34.7
R210	0-20	46.0	30.8	36.6	37.4	39.2

According to the options, the content of nitrogen nitrates ranged from 5.8 to 23.3 mg/kg of the soil. The content of labile phosphorus was from 9.6 to 24.0, at the control – 30.0-46.0 mg/kg, on fertilized options.

The conditions of moistening and soil nutrition also affected the chickpea productivity. Table 3.

As we see from the table, during the research years the chickpea's productivity, especially on the natural non-fertilized ground, was low. There are a few causes: the low level of moisture supply and mineral nutrition. The significant influence on the chickpea's plants by ascochytosis was also provided. The efficiency of fertilizers varied and depended on a number of factors. The most important factors were the moisture supply of the soil, the original content of the nutrients in the soil before the sowing, and their ratio. They also varied in the research years. That is the reason for a mixed reaction of chickpea for the application of the same types, doses, and combinations of a fertilizer.

The lowest productivity of chickpea and its sensitivity to fertilizers was observed in 2004, despite the scarcity of nitrogen and phosphorus in the soil. This year the determining factor was

the distribution of precipitations rather the number of them in the period of vegetation (125 mm). 50% of the precipitations occurred in August (59.9 mm). In May and June, the monthly precipitation amounted to no more than 22 mm. The plants survived mainly from spring moisture reserves – 133.0 mm in meters. This is the best figure of all years.

Table 3. Influence of Nitrogen-phosphorus Fertilizers on the Productivity of Chickpea, C/GA

Applied, kg, the rate of application.	The harvest of beans chickpea on control and a raise									
	2003.		2004.		2005.		2006.		The 2007	
	C	%	C	%	C	%	C	%	C	%
0	7.0	-	6.5	-	9.6	-	8.3	-	20.3	-
P60	0.3	4.3	0.2	3.1	1.3	13.5	1.7	20.5	3.8	18.7
P90	2.6	37.1	1.1	16.9	3.6	37.5	3.3	39.8	4.8	23.6
R120	1.8	25.7	1.3	20.0	2.6	27.1	3.9	47.0	6.1	30.0
P150	2.0	28.6	2.1	32.3	4.8	50.0	4.1	49.4	4.0	19.7
P210	1.5	21.4	0.5	7.7	3.8	39.6	5.3	63.9	2.5	12.3
N30	1.2	17.1	0.4	6.2	3.7	38.5	1.6	19.3	4.8	23.6
N60	0.5	7.1	1.5	23.1	5.3	55.2	2.6	31.3	5.9	29.1
N90	0.3	4.3	0.5	7.7	6.8	70.8	1.3	15.7	3.0	14.8
P60 N60	1.0	14.3	0.7	10.8	5.5	57.3	5.7	68.7	3.0	14.8
P90 N30	3.0	42.8	0.8	12.3	0.7	7.3	3.8	45.8	1.9	9.4
P90 N60	2.5	35.7	1.1	16.9	1.8	18.8	3.7	45.6	2.7	13.3
P90 N90	1.6	22.8	0.9	13.8	4.0	41.7	3.0	36.1	0.5	2.5
R120N60	3.3	47.1	1.5	23.1	3.6	37.5	3.8	45.8	3.1	15.3
P120N90	2.5	35.7	1.0	15.4	0.8	8.3	4.7	56.6	2.1	10.3
P150N60	3.8	54.3	1.1	16.9	4.1	42.7	5.7	68.7	3.3	16.3
P150N90	0.4	5.71	1.4	21.5	3.9	40.6	4.5	54.2	2.0	9.8
P210N90	3.0	42.8	0.1	1.5	0.7	7.3	4.7	56.6	2.5	12.3
NSR_{05}	0.48		0.64		1.21		0.79		1.68	
m%	1.94		3.02		3.34		2.35		2.51	

In 2004 phosphorus fertilizers were the most efficient. The best result was obtained from a dose R150, where the content of R2O5 in the soil was 26.0 mg/kg. A gain of the control is 32.3%. Other doses are less efficient.

Among nitrogen fertilizers, there was a little yield gain (23.1%) due to the application of 60 kg of nitrogen's rate of application where the content of N-NO3 in the soil in the 0-40 cm layer has increased from 8.7 to 16 mg/kg (table 2).

Lower and higher doses which provided the content of N-NO3 13.0 and 20.0 mg/kg in the soil, did not significantly gain the yield. In the first case, the yield gain was insufficient, whereas in the second one – excessive.

In 2003, for the same reasons, the better result was also due to the phosphorus being applied. The yield gain was 37% in a dose 90 kg of a rate of application. It was 17.1% from 30 kg of nitrogen (the content of N-NO3 in the soil is 15.3 mg/kg).

The largest gains due to fertilizers are obtained in the 2005 year which is more favorable for moistening. When the initial content of N-NO 3 in the soil layer 0-40 cm is 5.8 mg/kg of the soil, the highest yield gain 6.8 centners or 70.8% to the control is obtained from N90 being applied, where the content of N-NO 3 has reached 15.5 mg/kg of the soil. According to the phosphorous options, the best gain is obtained from R150, which provided the increase of phosphorus in the soil to 29.6 mg/kg of this soil. The increase in P 2 O 5 in the soil to 36.6 mg (with 210 kg of a rate of application) reduced the yield gain of chickpea from 4.8 to 3.8 centners or from 50 to 39.6 % to the control.

The efficiency of pair combinations varied in years and was determined by the same factors, i.e. the initial content and the ratio of elements.

According to researches, as any other crops, chickpea needs a certain level of soil's saturation with nutrients. We can achieve that by applying fertilizers, with a certain account of the initial content of nutrients in the soil.

There is a quantitative correlation between the content of nutrients in the soil and chickpea yield. This correlation allows determining the optimal parameters of the basic agrochemical properties of the soil.

Moisture level in the soil, mineral nitrogen, and labile phosphorus which more likely to determine the development of yields are mostly affected by weather and agronomic factors. Other factors (pH, Ca, Mg, and even humus) have had less influence on the yield due to a slight variation in tests. However, they are also important, as confirmed by the high correlation coefficient between them and their yield. So, in the test the highest yield of chickpea was developed at the pH 7.8 (R =0.71), the content of Ca and Mg at 21.6-21.9 mg-eq/100 g of the soil – at R=0.79. The correlation coefficient did not exceed 0.61 with the productive moisture before chickpea sowing in the 0-100 cm layer. In some years, the relation was insignificant, despite the great importance of the factor. This is because not only spring deposit of moisture, however very significant, but also the degree of a growing season's moistening, the number, and manner of precipitations' distribution play a major role in order to develop a yield. The precipitations in July are particularly important.

The potential opportunities for plant growth and development can be realized only in the optimal conditions of mineral nutrition. After the influence of fertilizers on chemical composition of the soil and plants was studied, the yield's quality can be purposefully changed.

The chemical composition of leguminous plants is rather completely studied, including chickpea, according to the conditions of growth. The influence of the properties of the soil and fertilizers on chickpea quality is less studied.

Such environmental conditions as soil and air moisture, nutrients, temperature, and light most strongly affect the content and quality of both protein and albumen. (54) The protein content in the chickpea seeds is pretty high. However, according to protein content, chickpea is inferior to other leguminous crops. This is because there are a lot of fat, fiber, and other substances in the chickpea seeds. (54)

Table 4 shows the results of researches regarding the quality of chickpea grain.

Table 4. The Influence of Mineral Fertilizers on the Quality of Seeds of Chickpea Beans (Average Indicators by Years), %

Applied, kg, the rate of application.	Albumen	Protein	Ash	Fat	Fiber
O	19.2	21.0	3.07	5.7	5.08
R60	19.5	21.4	3.04	5.9	5.17
R90	19.5	21.4	3.19	6.1	5.26
R120	19.4	21.3	2.99	6.4	5.36
N30	21.6	23.7	3.04	5.9	5.02
N60	22.3	24.6	2.90	5.8	4.44
N90	22.1	24.3	2.84	5.6	4.40
R60N30	20.6	22.5	2.96	5.7	4.85
R60N60	21.2	23.2	3.00	5.9	4.80
R90N60	21.8	23.8	3.13	5.5	4.81
R120N60	21.5	23.6	3.03	5.6	5.02
R120N90	21.2	23.2	3.01	6.0	4.86
Average	20.8	22.8	3.02	5.8	4.92

The table shows that the chickpea' grain is described by albumen and protein content. It varied by years and test's options. The largest number of albumen and protein was accumulated in the 2005 year, which is more favorable by weather conditions (22% in the control). By the fertilized backgrounds, albumen and protein reached 26%. In 2006-2007 the albumen and protein content was by 3% lower and slightly varied according to the fertilized options. But the positive role of nitrogen fertilizers still remained. In moist, but cold 2003 year, chickpea was the least contained in grain. In very dry 2004 year, it was 17.9% in the control. The main reason is the low content of mineral nitrogen in the soil. The options with nitrogen fertilizers being applied confirmed this fact. Albumen and protein content increased to 24.4 and 26.8%, respectively, which is 4.6-7.2% more than on natural background.

An influence of any dose was determined by the initial nitrogen content in the soil and hydrothermal conditions of years. It depended both on the quantity and the manner of precipitations' distribution.

In the dry growing season in 2004, 2006 (this was also the case in 2007), when only ½ long-time average annual norm has fallen in May-July, even against the background of 60 kg/ha of nitrogen fertilizers (the best option), the albumen content was 20-21%, which is 4-5% lower than in 2003-2005.

This suggests that the drought of a growing season has had an adverse impact both on growth processes and on the consuming capacity of the root system.

Moreover, as we can see from the data of 2003-2004, and the later years, the excess of nitrogen (N90) did not affect or even reduced the albumen and protein content. The latter can be explained by the fact that against this background when chickpea is more intensively developing at the beginning of vegetation in the following drought, the plants suffered more from it.

The common thing was the great positive role of nitrogen in forming and accumulating albumen in chickpea products.

Admitting the positive influence of nitrogen fertilizers on albumen and protein accumulation, it should be noted that phosphorus fertilizers almost did not affect the albumen accumulation (+/-0.5 %). Moreover, there was an obvious trend to reduce it along with the doses of phosphorus fertilizers and level of phosphorus supply to the soils being increased. This is also observed in pair options with nitrogen.

Phosphorus fertilizers positively affected the content of fat raising its content as much as possible during the years by 0.5 (2003) – 0.8% (2004). The influence of nitrogen fertilizers was much weaker. Rather, there is a trend to reduce the fat content when nitrogen is excessively contained (by N90). Moderate doses (N30) increased fat by 0.5-0.3%.

The weather conditions – hydrothermal mode of a growing season affected the content of fat much largely than fertilizers. So, the least amount of fats was accumulated in moderately dry, but cold 2003 year (3.9-4.5%). Most fats were observed in the dry 2004 year – 6.2-7.5%. There are 6.1-6.8% in a wet 2005 year, which is favorable by temperature and mode. The difference in years is 2.3-3.0%, which is much more significant than the influence of fertilizers.

Thus, we can conclude that the temperature factor plays a key role to accumulate fats.

The content of ash elements in plants depends on biological features and growing conditions. According to Vladimir Balashov (57), the ash content in chickpea seeds ranges from 2.3 to 4.9 %. In chickpea ash, there are many elements, including (average, mg/%): potassium – 968, calcium – 192, magnesium – 126, sulphur – 198, phosphorus – 446, aluminium – 708, boron – 750, iron – 967, selenium – 28, zinc – 2100, etc.

The quantity of chickpea ash in our tests ranged from 2.58 to 3.33%. The fertilizers slightly affected on the ash content. There is no certain pattern in the influence of phosphorus fertilizers. We can give more definite information about nitrogen. Nitrogen fertilizers reduced the ash content in the chickpea seeds.

Attention must be paid that chickpea seeds have little fiber. That is important when feed rations are compiled. (56, 57)

A fiber or cellulose is the main part of the cell walls of the plants. The seeds of cereal crops with no film contain 2-3% of fiber, whereas the seeds of filmy grains (oats, rice, millet, etc.) contain much more fiber – 10-15%. The seeds of leguminous crops contain 3 -5%.

In tests, the fiber content in chickpea grain ranged from 3 to 7.9%. The most part of fiber was formed in the very dry 2004 year. That is 2 to 2.5 times less than in 2003, 2005, 2007 years which are more favorable for moistening.

According to the analysis of the obtained data, the fertilizers did not significantly affect the content of fiber. The determining factor was a moisture mode.

Thus, due to the accomplished researches we have: studied the relation of chickpea to the conditions of soil nutrition, its sensitivity to fertilizers, defined the main factors which determine their efficiency; established the main agrochemical properties of the soil that generate yield and quality of chickpea.

4 Conclusion

According to the researches carried out in 2003-2007 on the dark chestnut soils of a dry steppe area of Northern Kazakhstan, regarding the influence of soil conditions and fertilizer on the productivity and quality of chickpea, the cultivation of the latter in a dry steppe area presents some difficulties and is due to

climate continentality, insufficient and unstable moistening, rapid change of temperature even within 24 hours, to what chickpea is pretty sensitive.

Different cultures, due to their biological characteristics, present unequal requirements to the conditions of mineral nutrition, have different abilities to absorb elements from soil and fertilizers. Chemical composition, productivity, and quality of cultivation are formed under the combined effect of these factors. (58)

Due to the lack of moisture and heat in a waiting and post-seeding period, upswelling of chickpea seeds slows, and sproutings are delayed. If there are moisture and lack of heat, and the delay in seed sprouting due to that, the conditions to affect the seeds by bacteriosis are created.

Nitrogen and phosphorus fertilizers stimulate the intensive development of the vegetative mass and the root system, which is particularly important for arid years with high moisture scarcity in the soil. Depending on the prevailing conditions and doses, phosphorus fertilizers have increased the productivity of chickpea to 63.9%, whereas nitrogen fertilizers – to 70%.

According to the initial content of labile phosphorus and nitrate nitrogen in the soil, different doses of the applied fertilizers provided the best result in different years. So, in 2003, the highest yield gain of chickpea was achieved when 90 kg of a rate of application was applied, in 2004 and 2005 – from 150 kg of a rate of application, in 2006 – from 210 kg, and in 2007 – from R120. The same regarding nitrogen fertilizers. The efficiency of phosphorus and nitrogen fertilizers is significantly affected by the ratio of phosphorus to nitrogen in the soil created by the applied fertilizers.

The applied fertilizers had largely influenced the quality indicators of chickpea beans. Thus, the almumen content is sustainably and significantly increased only by the nitrogen fertilizers – an average of 4%, which is very important. Phosphorus fertilizers improved the formation of fat and fiber. Nitrogen fertilizers almost did not affect the formation of fats, whereas phosphorus fertilizers – the albumen production.

Generally, assessing the chickpea quality, it should be noted that chickpea is an important high-protein crop that helps to efficiently address the protein issue in both food and fodder industries. Significant content improves the advantages of this crop.

Given the combination of factors, chickpea is a proper culture to diversify grain production in Northern Kazakhstan.

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