INFLUENCE OF NITROGEN PHOSPHORIC FERTILIZERS ON THE USE OF ELEMENTS OF NUTRITION BY BEANS OF CHICKPEAS FROM THE SOIL AND FERTILIZERS UNDER THE CONDITIONS OF KAZAKHSTAN

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Abstract: The work sets out results of an investigation conducted in 2003-2007 on the dark chestnut light-clay soils of Northern Kazakhstan, on the study of the influence of soil nutrition and mineral fertilizers on chemical composition and removal of elements of nutrition by beans of chickpeas from soil and fertilizer. The results showed that when cultivating chickpeas for non-steam predecessors, the latter incurs a deficit of nitrogen and phosphorus in the soil, which doesn't contribute to the formation of a high yield without application of nitrogen-phosphate fertilizers. Fertilizer stimulates intensive development of vegetative mass and root system, which is especially important for arid years with high moisture deficit in the soil. Drilled fertilizers essentially change the chemical composition of chickpeas. Nitrogen fertilizers increase the nitrogen content in the grain and, accordingly, the protein content by 4-6%. Phosphate fertilizers increase the content of phosphorus and fat in grains of chickpeas, but they can reduce the content of nitrogen and protein, and the higher dose of introduced nitrogen, the greater collection of protein. Applications of nitrogen-phosphate fertilizers increased removal of elements of nutrition from the soil by a factor of 1.5-2.0, which was determined not only by the chemical composition but also by the yield height. There is the largest amount of nitrogen and phosphorus removal and less amount of potassium because of grains of chickpeas. There is a number of nitrogen and potassium, and less amount of phosphorus with large fluctuations from year to year because of straw and roots. The nitrogen content varied in grain by a factor of 1.5, in the straw by a factor of 3.6, in phosphorus, respectively, by a factor of 2.8-7.9. Removal of elements of 1 c of total production varies within wide limits (2.5-4). According to the averaged data, the removal was: nitrogen in a factor of 5.2 (from 3.8 to 8.4); phosphorus in a factor of 1.4 (0.8-1.9); potassium in a factor of 2.41 (1.1-4.6). In general, assessing the quality status of chickpeas, it should be noted that chickpea is an important high protein culture that allows to solve protein problem both in the food industry and feed one successfully. In view of the combination of the factors, chickpeas may be considered a worthy culture for diversification of grain production in the North of Kazakhstan.

Keywords: Chickpeas, nitrogen fertilizers, phosphoric fertilizers, dark chestnut soils, productivity, chemical composition, removal of elements of nutrition.

1 Introduction

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. On the other hand, availability of elements of nutrition, as well as the effectiveness of utilized fertilizers, duration of their action depends on climatic conditions, soil and fertilizer properties in many respects. Chemical composition, productivity, and quality of cultivation are formed under the combined effect of these factors.

Chickpea is one of the perspective grain legume crops for Northern Kazakhstan, a valuable food and feed crop, rich in proteins and vitamins (A, B, B1, B2, C, PP, D). (1) Proteins of pulse plants are high-grade and high-quality. (2-3) Investigations of Behnoush Rasaei (4) found that proteins of chickpeas consist of such essential amino acids as tryptophan, lysine, arginine, and others, which are not less than in peas, lentils, and beans.

Protein content in seeds of chickpeas varies from 13 to 30%, fat content – 4.1-7.2; free-nitrogenous extractive agents – 47-60; starch – 48-61; crude fiber – 2.4-12.2; ash – 2.3-5.0; calcium – 0.255; phosphorus – 0.561%. (5-14)

Chickpeas create a predominant share of proteins as a result of assimilation of atmospheric nitrogen. Roots of chickpeas penetrate deeply into the soil (15), improve nitrogen balance of the soil, increase the productivity of the crop rotation. (16-17) All pulse plants are good precursors for winter and spring crops. (18)

G.V. Bodnar (8) and I.A. Abugaliev (10) note in their investigations that chickpeas play a significant role in increasing the soil fertility due to the remarkable property of synthesizing and accumulating a large amount of protein and other nitrogenous matters using a cheap source of the air nitrogen. Nodule bacteria live on the roots of these crops. They fix the air nitrogen from 50 to 300 kg/ha and enrich the soil by it. (19)

Changing conditions of plant nutrition, it's possible to increase the yield, to enhance plant growth, to accelerate or retard the rate of their development, to change the relation between generative and vegetative organs, chemical composition and quality of the obtained products, to make plants more resistant to unfavorable external conditions. (20)

In order to obtain a high yield of adequate quality, plant growth factors have to be represented in certain harmonious combinations that are most appropriate to the needs of plants in the corresponding periods of their growth and development. Insufficient or untimely inflow into plants of at least one of the nutrient elements leads to disruption of all metabolic processes between plants and the environment and, consequently, to a decrease in the yield and the quality.

Different plants react to the lack of individual nutrient elements not equally. Some plants are very sensitive to it, they have characteristic external changes during the initial period of the growth.

The chemical composition of plants is determined by the content of nutrient elements in the soil, depends on the amount, the form of fertilizers and the methods of their application, moisture and temperature of the soil. (21) Change in the absolute content of individual chemical elements in individual organs is determined by their specific function and processes of biosynthesis, physiological state, and age of individual tissues, organs, and plants as a whole. (22)

J.B. Bussengo (23), one of the first French scientists in the scientific history, put forward a position of the relevance of needs of the plant for nutrients. He pointed out that in order to check the opinion of the scientists, it's necessary to ask the opinion of the plant.

As of from 1868 to 1900, the questions of determining the need for fertilizers on the chemical composition of mature plants, grains and roots of cereal crops (barley, oats, wheat) were covered in the works of Gelrigel (1868), Heinrich (1882), Gassner (1887), Dikova (1887) and other researchers. (24) They showed that plants grown in field and vegetation experiments contain different amounts of nitrogen, phosphorus, and potassium depending on type and doses of fertilizers. These and other researchers came to the conclusion that soil analysis is less suitable for elucidating the need for fertilizers than plant analysis.

V.V. Tserling (25) considers that the chemical composition of agricultural crops is a fairly stable quantity, and deviations from it are primarily associated with a change of the conditions of mineral nutrition. According to the conclusion of Sh.I. Litvak (26), the optimal levels of content of elements of mineral nutrition in plants vary only slightly depending on the variety, culture, and region of its cultivation, and they are their physiological characteristics, and established variation of definitive exponents of nutrient content in plants indicates a number of unaccounted factors that affect on reliability and reproducibility of the analytical data.

In the process of their growth and development, plants consume a different amount of nutrient elements, depending on the specific chemical composition of the crop and variety, relation of biomasses of the main and secondary production, soil and climatic conditions, content of mineral substances in the soil, agricultural technology, harvesting phase, etc. (27)

Z.I. Zhurbitskiy and B.M. Lavrichenko (28) noted that plants of the same species expend the same amount of each element on the formation of the yield unit in the same soil-climatic conditions. But at the same time, R.T. Wildflush and A.N. Minich (29) note that removal of nutrients by cultivation during the cool vegetation period is much less than during the warm period. S.N. Yurkin (30) reports that removal of nitrogen and potassium per yield unit rises sharply under the arid conditions, and removal of phosphorus decreases.

According to the data of N.S. Korogodov (31), annual pulse plants remove 140-160 kg of nitrogen, 15-28 kg of phosphorus and 80-100 kg of potassium from a hectare. The nature of nutrient enrichment during the vegetation period varies considerably. Thus, according to the data of M.P. Petukhov (32), to the beginning of flowering, when 30% of the crop mass accumulates, 40% of the total amount of nitrogen removed by the crop, 30% of phosphorus and 60% of potassium enter the plant.

V.V. Tserling (1963), N.K. Boldyrev (1970), Yu.I. Yermohin (1983) and others note that fertilizers are the main factor affecting absolute and relative removal of nutrients. Plants acquire only a part of the active forms of nutrients from both the soil and mineral fertilizers. According to the data of L.M. Derzhavin (35), in the field conditions, plants use 30-40% nitrogen from mineral fertilizers, 20-30% is fixed in the soil, 15-20% is lost in gaseous form as a result of the processes of denitrification, ammonification, and nitrification, 5-15% is eluted from the root layer. It is known that the use of nitrogen by agricultural crops depends on the regime of their nutrition by phosphorus and potassium. (36) When solution interacts with the soil, a chemical equilibrium is created. Plants shift this equilibrium by absorbing ions from solution by the root system, stimulating the appearance of new quantities in solution.

As changes in the ratio of nutrient elements of plants are caused by the development of plants and the growth of individual organs during the vegetation period, these processes may be controlled in a great measure, regulating absorption of nutrients by fertilizer application, and establishment of fertilizer doses to a large extent depends on the amount and composition of nutrients removed from the soil by the agricultural crops.

The presented data of investigation of Kazakhstan investigators (37-46), don't disclose an attitude to conditions of mineral nutrition and fertilizers fully, as well as methods of diagnostics of needs of chickpeas in nutrient elements under the conditions of Northern Kazakhstan haven't been studied practically, exactly this thing was the aim of our investigations.

A solution of these issues at this stage is topical, it will allow chickpeas to take a worthy place in the diversification of grain production in Kazakhstan.

In this regard, we studied not only the issues of responsiveness of chickpeas for fertilizers within 6 years but also the features of their use depending on the conditions of cultivation.

2 Materials and Methods

Study Site: The investigations on dark chestnut carbonate light-clay soils of the Akmola region located in the dry steppe zone of Northern Kazakhstan were conducted from 2003 to 2008. The amount of precipitations and the temperature regime of the year of investigations is given in Table 1.

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

Application of treatment: In order to study the conditions of mineral nutrition of chickpeas and control of dynamics of nutrient elements before sowing, according to the basic variants with non-contiguous repetitions, soil samples were taken of 5 points at a plot to a depth of 40 cm, every 20 cm to determine the main factors of fertility: humus, pH, $Ca2 +$, $Mg2 +$, N-NO3, P2O5, K2O and moisture.

The moisture content of the soil was determined by the weight method (GOST 28168-89), ammonia nitrogen – with Nessler's reagent (GOST 26489-85),nitrate nitrogen – on the ionomer "EV-74" and by the disulphophenol method according to Grandval-Liazhu (GOST 26951-86), labile phosphorus and potassium from one extract according to Machigin (GOST 26205-91),humus according to Tyurin-Kononovoy (GOST 26213-91), absorbed by Ca2+, Mg2+ – by trilonometric method (GOST 26487-85), pH of aqueous extract ionometrically (GOST 26483- 85). All of them were determined in the selected samples.

Soil samples were selected every 20 cm to a depth of 1 min order to control dynamics of moisture and nutrient elements–before sowing, during the branching phase, the flowering phase and after harvesting of chickpeas. During the main phases of development and harvesting time, plant samples (20 plants for each) were selected from 10 points to determine the accumulation of dry matter in plants, taking into account the yield formula.

The fiber according to the method of Kurshner and Ganek (GOST 13496.2-84), fat – on defatted residue (GOST 13496.15-85) and ash content of seeds (GOST 13496.16-75) were determined in the laboratory of the RSE "SPC of grain farming named after Baraev" of the Ministry of Agriculture of the Republic of Kazakhstan.

Chickpeas were seeded by the second cultivation in rotation of crops, therefore it moved in the fields annually. The investigations that were conducted in previous years found that the main factors determining the formation of crop capacity are moisture availability, the content of mineral nitrogen, phosphorus and their ratio, under the conditions of Northern Kazakhstan. Potassium doesn't limit the yield. (47-48)

Ammonium nitrate (rate of application is 34.6%) was used as nitrogen fertilizers, ammophos (46% P2O5, 11-12% N) – of phosphorus fertilizers. Ammophos was drilled in autumn superficially with the subsequent dumping labouring to a depth of 18-20 cm for the purpose of equal placement of fertilizers. Nitrogen fertilizers were drilled in spring under pre-sowing cultivation. The end of the moisture (BIG-3) and the secondary tillage were carried out by a cultivator (OP-8) to a depth of 6-7 cm in spring. The sowing was carried out by seeding-machinesSZS-2.1. The "Jubilee" variety was sown at the rate of 0.7 million of fertile seeds per hectare. Experiments were laid in fourfold repetition. The total area of the plot is 112.5 m2. Agrotechnics are generally accepted for the zone.

3 Results and Discussion

Meteorological conditions during the years of the investigations were developing in different ways, but they were quite typical for Northern Kazakhstan. All the years were dry, especially 2004, 2006 and 2008 with precipitation of 191, 203 and 213 mm for the agricultural year.2003, 2005 and 2007 were characterized by somewhat better moisture (252, 269, 248 mm, respectively), Table 1.

Table 1. Characteristics of Meteorological Conditions During the Vegetation Period (According to the Data of the Weather Point "Phoenix").

Months	Precipitation, mm						
	Long-time average annual	2003	2004	2005	2006	2007	2008
V	38.1	42.4	22.5	43.4	13.2	35.2	24.0

VI	46.2	19.6	21.9	21.4	21.7	17.5	10.0
VII	47.1	54.8	20.7	61.2	27.4	15.7	19.7
VIII	49.7	58.5	59.9	11.3	3.0	7.1	22.0
V-VIII	181.1	175.3	125.0	137.3	65.3	75.5	75.7
Agricultural year	302.0	252.1	191.6	269.5	203.1	248.5	212.9
	Average daily air temperature, ^0C						
V	15.7	12.3	16.5	14.7	13.8	14.2	16.0
VI	19.3	16.5	20.2	20.3	23.8	19.5	21.0
VII	20.2	18.1	21.5	20.9	22.8	23.1	25.3
VIII	19.3	21.5	18.2	18.2	20.9	19.8	19.0
V-VIII	18.6	17.1	19.1	18.5	20.3	19.2	20.3

They also differed on the temperature regime of the vegetation period: 2003 was the coldest 17,10C with the long-time average annual temperature of 18.60C. Especially May was cold – 12.30C. 2004, 2005 were within normal limits.

In 2006, May was cold (-1.90 C), June and July were hot with a temperature rise up to 4.5-2.60 C and dry – precipitation was 2 times less than long-time average annual ones (49 instead of 93 mm).

In 2007 and 2008, July was very hot and dry – 3-50C higher at 30-40% of precipitation. In addition, in 2008, May and June were dry (24 and 10 mm, respectively).

Apparently, the years of investigations differed significantly on the hydrothermal regime, which reflected on the state of the soil, growth, and development of plants.

The moisture supply of chickpeas depended not only on the conditions of the vegetation period but also on the spring reserves of productive moisture accumulated due to autumn and winter precipitation.

As for reserves of productive moisture before sowing of chickpeas, the most favorable conditions were formed in 2007 –

172 mm in a metrical profile of the soil. 2006 was the most unfavorable – 81 mm.

As Table 2 shows, a deficit of both nitrogen and phosphorus was noted in the soil in all the years. Fertilizers increased the content of nitrogen and phosphorus by a factor of 2.0-2.5. It provided a great variety of conditions of nutrition of chickpeas, which made it possible to identify features and patterns of the effect of fertilizers on its productivity, chemical composition and utilization of nutrient elements better.

Table 2. Effect of Fertilizers on the Content of Nutrient Elements in the Soil, mg/kg

Applied	Years of investigations					
	2003	2004	2005	2006	2007	2008
	The content of nitrogen of nitrates (N-NO3) in the layer of 0-40 cm					
O	9.7	8.8	5.8	12.8	8.5	7.2
N30	15.3	13.1	7.6	18.1	12.9	9.7
N60	17.2	16.7	11.8	21.2	17.6	11.4
N90	19.2	20.5	15.5	23.3	19.6	14.7
	The content of labile phosphorus (P_2O_5) in the layer of 0-20 cm					
O	24.0	9.6	13.0	14.4	17.8	18.4
P60	32.8	14.2	16.6	19.1	23.7	23.9
P90	35.6	17.2	19.6	21.2	27.5	28.1
P120	38.0	21.6	22.0	27.2	29.3	29.5
P150	41.6	26.0	29.6	30.6	34.7	36.2
P210	46.0	30.8	36.6	37.4	39.2	40.2

In the first phases of development, chickpeas consumed more nitrogen than phosphorus at a low air temperature. Its content fluctuated from 4.0 to 2.8% over the years on the non-fertilized ground, and it fluctuated up to 5.47% on the fertilized ground.

Application of nitrogen-phosphorus fertilizers has also significantly affected on the accumulation of dry matter and chemical composition of plants. So, phosphate fertilizers provided a growth of dry basis in 1.4-1.7 times before the flowering phase, and nitrogen fertilizers provided it in 1.2-1.7 times.

Growth processes outstripped the flow of nitrogen from the soil, in light of this, there was nitrogen concentration dilution in plants, Table 3(there are data on relatively contrasting years in the table due to the limitation of the volume). Nitrogen fertilizers have contributed to the accumulation of nitrogen in plants, which is very important, as the quality of the product – protein content – depends on its content.

Table 3. Influence of Conditions of Cultivation and Fertilizers on Chemical Composition of the Vegetative Mass of Chickpeas (% on Dry Basis)

Applied	2003				2005				2008			
	Branching phase		Flowering phase		Branching phase		Flowering phase		Branching phase		Flowering phase	
	N	P_2O_5	N	P_2O_5	N	P_2O_5	N	P_2O_5	N	P_2O_5	N	P_2O_5
O	4.04	0.07	3.31	0.10	3.40	0.77	2.67	0.26	2.82	0.48	2.44	0.53
P60	4.20	0.12	3.69	0.14	3.47	0.91	2.72	0.29	3.00	0.52	2.62	0.56
P90	4.30	0.17	3.90	0.19	3.58	0.95	2.94	0.34	3.10	0.55	2.70	0.59
P120	4.13	0.15	3.95	0.15	3.70	0.97	2.97	0.40	3.08	0.56	2.72	0.61
P150	4.10	0.15	3.79	0.14	3.57	0.85	2.89	0.34	3.06	0.59	2.70	0.63
P210	4.10	0.15	3.79	0.14	3.51	0.84	2.86	0.33	3.08	0.65	2.66	0.68
N30	4.18	0.16	3.53	0.16	3.60	0.82	2.97	0.26	3.14	0.44	2.70	0.44
N60	4.45	0.16	4.13	0.18	3.88	0.82	3.03	0.27	3.42	0.40	3.06	0.44

N90	5.14	0.18	4.86	0.19	3.95	0.84	3.24	0.26	3.60	0.38	3.46	0.41
P90 N30	5.00	0.19	4.43	0.17	3.60	0.84	3.44	0.33	3.22	0.52	2.76	0.54

The lowest concentration of phosphorus in plants was noted under the conditions of cold 2005. Phosphate fertilizers increased not only the content of phosphorus in plants, but they also intensified the flow of nitrogen when applying moderately dosed. Increased doses (P150-210) inhibited the absorbing capacity of the root, which is more likely due to the concentration of the soil solution.

Application of nitrogen fertilizers significantly increased nitrogen concentration, both in vegetative mass and grain, reducing the negative effect of increased doses of phosphorus, Table 4.

The fairly high content of nitrogen is in the straw of the harvest from 1% to 1.8% is characteristic for chickpeas. Variation of nitrogen in grain was within 25%, and in straw, it was by a factor of 1.5-3. The content of potassium was marked by greater stability.

Table 4. The Content of N, P2O5, K2O in Grain and Straws of Chickpeas, %

Applied	2003			2004			2005			2006			2007			2008		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	The content of N, P_2O_5, K_2O in grain, %																	
O	3.14	1.32	0.90	3.14	1.02	0.85	3.86	0.72	0.80	3.34	0.58	0.60	3.34	0.87	0.85	3.46	0.52	0.60
P60	3.28	1.38	0.90	3.23	1.10	0.90	3.90	0.84	0.80	3.47	0.65	0.60	3.42	0.93	0.85	3.50	0.61	0.65
P90	3.15	1.38	0.90	3.16	1.15	0.85	4.00	0.98	0.80	3.47	0.68	0.60	3.43	0.98	0.85	3.54	0.63	0.65
P120	3.15	1.48	0.90	3.15	1.18	0.85	3.96	0.91	0.80	3.47	0.73	0.60	3.45	1.02	0.85	3.56	0.69	0.65
P150	wasn't determined			3.15	1.19	0.85	3.93	0.90	0.80	3.46	0.73	0.60	3.47	1.06	0.86	3.54	0,71	0.65
P210	wasn't determined			3.14	1.20	0.85	3.90	0.89	0.80	3.45	0.70	0.60	3.47	1.10	0.85	3.44	0.81	0.65
N30	3.95	1.32	0.90	3.87	1.04	0.80	4.12	0.78	0.80	3.51	0.62	0.60	3.48	1.02	0.85	3.70	0.49	0.62
N60	4.09	1.31	0.90	3.96	1.03	0.80	4.38	0.82	0.80	3.58	0.64	0.60	3.54	0.98	0.80	3.78	0.46	0.62
N90	4.11	1.31	0.90	4.04	1.03	0.80	4.57	0.86	0.80	3.62	0.65	0.60	3.61	0.92	0.80	4.00	0.46	0.62
P60 N60	3.64	1.34	0.90	3.60	1.06	0.80	4.42	0.98	0.80	3.58	0.68	0.60	3.49	0.97	0.80	4.34	0.58	0.65
P90 N60	4.01	1.42	0.85	3.87	1.02	0.80	4.15	0.96	0.80	3.58	0.67	0.60	3.52	0.95	0.80	4.20	0.82	0.65
P120N60	3.80	1.38	0.90	3.68	1.09	0.80	4.18	0.99	0.80	3.62	0.67	0.60	3.49	1.00	0.82	4.48	0.61	0.65
The content of N, P_2O_5, K_2O in straw, %																		
O	0.3	0.12	1.5	1.28	0.50	1.2	1.15	0.16	1.0	0.77	0.08	0.60	0.85	0.42	0.24	1.02	0.15	0.72
P60	0.6	0.13	1.5	1.57	0.56	1.1	1.24	0.26	1.0	0.80	0.10	0.60	0.87	0.45	0.26	1.08	0.16	0.72
P90	0.8	0.24	1.8	1.44	0.59	1.2	1.38	0.28	1.0	0.80	0.10	0.60	0.88	0.49	0.34	1.10	0.16	0.72
P120	0.6	0.21	1.5	1.40	0.63	1.1	1.26	0.33	1.0	0.83	0.14	0.60	0.88	0.52	0.24	1.11	0.18	0.72
P150	0.6	0.22	1.6	1.39	0.64	1.1	1.25	0.32	1.0	0.82	0.13	0.60	0.87	0.56	0.30	1.14	0.22	0.75
P210	0.5	0.24	1.6	1.37	0.65	1.2	1.20	0.30	1.0	0.82	0.13	0.60	0.87	0.59	0.28	1.17	0.24	0.75
N30	0.4	0.15	1.6	1.64	0.50	1.2	1.36	0.22	1.0	0.83	0.09	0.60	0.90	0.45	0.24	1.17	0.16	0.75
N60	0.7	0.16	1.6	1.74	0.44	1.2	1.46	0.23	1.0	0.94	0.10	0.60	1.09	0.45	0.26	1.24	0.16	0.72
N90	1.1	0.13	1.5	1.92	0.44	1.1	1.68	0.26	1.0	1.00	0.10	0.60	1.10	0.44	0.27	1.28	0.16	0.75
P60 N60	0.9	0.12	1.6	1.80	0.54	1.2	1.34	0.27	1.0	1.00	0.12	0.60	1.00	0.45	0.26	1.27	0.16	0.72
P90 N60	0.8	0.15	1.8	1.60	0.52	1.2	1.48	0.26	1.0	0.95	0.14	0.60	0.97	0.43	0.30	1.22	0.19	0.72
P120N60	0.9	0.12	1.6	1.70	0.52	1.2	1.37	0.32	1.0	1.00	0.11	0.60	1.00	0.46	0.26	1.27	0.19	0.72

The high content of nitrogen in straw increases feed value of the secondary production.

Economical removal and expenses of elements per 1 cent of aggregate productions are a mirror reflection of the influence of the climatic factor and fertilizers on the utilization of nutrient elements, Table 5. Chickpeas apply the most nitrogen and phosphorus, less potassium by grain. And it applies more nitrogen and potassium and significantly less phosphorus by straw.

Fertilizers increased the removal of nutrient elements from the soil by a factor of 1.5-2.0, which was determined by the height of the harvest to a greater extent.

The economic removal of nutrient elements by the chickpea grain fluctuated on average depending on the degree of fertilization: from 26.4 kg/ha of nitrogen on the non-fertilized background to 126.7 kg/ha (N60 in 2007) on fertilized options, respectively 6.7-11.4 kg of phosphorus on the control to 44.1 kg on the fertilized backgrounds. Removal of potassium accordingly amounted 12.2-44.9 kg/ha. During the relatively good years on moisturization, nitrogen fertilizers intensified the absorption and removal of phosphorus by the harvest.

Comparing the economic removal with the amount of the drilled fertilizers, it should be noted that the balance of nitrogen and potassium is negative without the application of fertilizers. But, if potassium in the soil is sufficient and it does not limit the harvest, the negative balance on nitrogen leads to a steady decline in soil fertility, as humus is the main source of nitrogen in the soil. When applying nitrogen fertilizers, the zero balance is added at doses N60-90.

When applying 90 kg of active material, the balance on phosphorus is positive with an intensity of 80%.

The removal of nutrient elements of 1% of the aggregate production is also an important indicator. The removal of nitrogen per 1 cent fluctuated from 3.7 kg on the control to 7.4 kg on the fertilized backgrounds or more than by a factor of 2. The removal of nitrogen of 1 cent of chickpeas was 5.22 kg on average.

The removal of phosphorus is3.0-4.0 times less that the removal of nitrogen, and it fluctuated from 0.81 to 1.92 kg, on average by 1.4%, the removal of potassium is 2.1-4.6 kg, on average by 3.36%.

If you know the removal of the elements of 1 cent of the harvest, you can focus only on alienation of the elements by the harvest and the level of decline in soil fertility. Indicators of the removal of 1 cent don't reflect the degree of availability and assimilation of these elements from the soil and fertilizers, and therefore they can't be regarded as the norm of fertilizers per 1 cent of the harvest.

The coefficients of utilization of nutrient elements from the soil fluctuated from year to year on the natural background of nitrogen from 56 to 144% (2008), and they fluctuated up to 162% with the application of phosphorus fertilizers due to the high yield, Table 5.

Table 5. The Economic Removal of Nutrient Elements and the Costs of N, P2O5, K2O per 1 Cent of the Aggregate Production

Applied	2003			2004			2005			2006			2007			2008		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
	The economic removal, kg/ha																	
O	26.4	11.0	28.3	29.6	10.2	14.4	48.1	8.4	17.3	42.0	6.7	12.2	87.9	28.2	22.6	49.7	7.5	14.7
P60	36.1	12.1	29.6	33.2	11.5	14.9	56.0	12.0	20.2	52.9	9.3	14.8	107.3	35.9	27.4	60.5	10.2	18.1
P90	41.1	18.0	44.9	35.2	13.6	16.8	71.0	16.6	23.8	61.0	11.1	17.2	110.6	39.3	30.2	72.4	12.3	21.3
P120	41.6	16.9	35.7	35.8	14.6	16.4	63.7	15.1	22.0	64.6	13.0	18.0	119.2	44.1	29.5	73.7	13.7	21.7
N30	39.3	13.4	35.0	39.1	11.0	14.6	72.9	13.2	23.9	52.9	8.7	14.6	114.9	40.2	28.0	59.9	8.00	16.8
N60	43.2	12.3	31.2	39.7	10.6	14.8	87.0	15.6	26.8	61.0	10.0	16.2	126.7	40.7	28.5	61.2	7.60	16.4
N90	49.3	12.3	30.1	46.0	11.7	15.3	102.5	16.8	29.5	71.1	11.5	18.4	114.2	34.1	25.5	64.4	7.60	16.8
P60 N60	44.2	12.7	34.1	40.1	11.9	15.3	86.9	18.9	27.2	73.0	12.8	19.2	108.5	35.7	25.4	78.0	10.3	19.0
P90 N60	54.1	16.5	43.5	42.8	12.0	16.1	64.2	13.8	20.5	67.2	12.0	17.8	108.9	34.7	26.2	89,4	16.6	22.6
P120 N60	58.6	16.8	43.9	44.4	12.5	17.0	57.5	14.1	18.7	68.9	11.7	17.8	110.2	37.6	26.2	83.9	11.7	20.0
The costs of N, P_2O_5, K_2O per 1 cent of the aggregate production																		
O	3.77	1.57	4.04	4.55	1.57	2.12	5.01	0.88	1.80	5.06	0.81	1.47	4.19	1.29	1.09	4.48	0.68	1.32
P60	4.94	1.66	4.05	4.76	1.72	2.15	5.14	1.10	1.85	5.29	0.93	1.48	4.29	1.38	1.11	4.58	0.77	1.37
P90	4.32	1.88	4.68	4.74	1.79	2.21	5.38	1.26	1.80	5.26	0.96	1.48	4.22	1.44	1.17	4.64	0.79	1.37
P120	4.72	1.92	4.06	4.59	1.87	2.10	5.22	1.24	1.80	5.30	1.06	1.48	4.33	1.54	1.09	4.66	0.87	1.37
N30	4.79	1.63	4.27	5.67	1.59	2.12	5.48	0.99	1.80	5.34	0.88	1.47	4.38	1.47	1.09	4.87	0.65	1.37
N60	5.76	1.64	4.16	5.67	1.51	2.01	5.84	1.05	1.80	5.60	0.92	1.49	4.62	1.43	1.06	5.02	0.62	1.34
N90	6.32	1,58	3.86	5.75	1.46	2.00	6.25	1.05	1.80	7.40	1.20	1.42	4.71	1.36	1.07	5.28	0.62	1.38

P60 N60	5.54	1.59	4.26	5.57	1.65	2.12	5.75	1.80	1.80	5.21	0.91	1.37	4.49	1.42	1.06	5.61	0.74	1.37
P90 N60	5.69	1.74	4.58	5.63	1.58	2.12	5.63	1.80	1.80	5.74	0.98	1.48	4.49	1.38	1.10	5.42	1.01	1.37
P120N60	5.77	1.63	4.26	5.55	1.56	2.12	4.36	1.42	1.80	5.75	1.00	1.48	4.49	1.46	1.08	5.76	0.77	1.43
P120N90	6.29	1.67	4.26	5.09	1.69	2.12	4.26	1.40	1.80	5.54	0.85	1.35	4.53	1.47	1.07	5.75	0.80	1.37
Average	5.28	1.67	4.23	5.23	1.64	2.11	5.41	1.26	1.80	5.89	0.99	1.45	4.43	1,45	1.10	5.10	0.76	1.37

The high coefficient of utilization of nitrogen in 2008is stipulated by the spring application of nitrogen fertilizers and peculiarity if spring of this year. Under the conditions of long cold spring, the nitrification process was delayed in the soil, and a significant amount of non-nitrified ammonium nitrogen was detected. Subsequently, ammonium nitrified and thereby contributed to the accumulation of nitrogen of nitrates and formation of the higher yield.

The coefficient of utilization of nutrient elementsP2O5varied from 17.0 to 66.0%, with an average value of 41.3%, or by a factor of 3.8.

The coefficient of utilization of fertilizers averaged 57% depending on doses and conditions of years, and it averaged

from 1.8% on P60 in 2003 to 19.4% on P120 in 2008 or by a factor of 10.8. The coefficient of utilization of phosphorous fertilizers was determined mainly by the efficiency (addition) of phosphorus fertilizers.

Table 6. The Coefficients of Utilization of Nutrient Elements and Fertilizers from the Soil by Chickpeas

Options	Years of investigations					
	2003	2004	2005	2006	2007	2008
The coefficient of utilization of nutrient elements N						
O	56.6	70.1	102	68.4	95.0	143.8
P60	66.0	66.5	117	86.2	112.9	146.6
P90	85.6	70.5	140	87.6	111.0	162.2
P120	76.1	69.1	132	85.2	112.0	153.5
The coefficient of utilization of nutrient elements P_2O_5						
O	19.1	56.0	28.7	21.5	66.0	17.0
N30	23.7	48.7	49.1	23.4	62.7	17.8
N60	20.7	42.1	58.0	27.4	56.9	15.7
N90	18.3	41.3	58.3	33.2	47.8	15.4
The coefficient of utilization of fertilizers N						
N30	43.0	31.7	82.7	36.3	90.0	128.6
N60	28.0	16.8	64.8	31.7	64.7	111.8
N90	25.4	18.2	60.4	32.3	29.2	91.3
The coefficient of utilization of fertilizers P_2O_5						
P60	1.8	2.2	6.0	4.3	12.8	17.6
P90	7.8	3.8	9.1	4.9	12.3	18.2
P120	4.9	3.7	5.6	5.2	13.2	19.4

The coefficient of utilization of nitrogen fertilizers fluctuated from 31.7 to 128.6%, or by a factor of 4.1 with an average value of 82.7; on N60 from 16.8 to 111.8%, or by a factor of 6.6; on N90 from 18.2 to 91.3, or by a factor of 5.0. The total variation of the coefficient of utilization of nitrogen fertilizers was about 8 volumes.

According to the maximum parameters, calculation of doses by the balance method for chickpea crop of 20 centners showed–a deficit P2O5 of 20.9 kg of the active material; a deficit P2O5 of 322 kg of the active material was obtained at the average rate of 116 kg/ha when using the minimum values. While the harvest of 20 centners was obtained on the control (without application of fertilizers), in experiments with a content of 17.8 mg of P2O5 kg in the soil (2007).

With such variation of the indicators, application of the balance method for determination of fertilizer doses for the conditions of Northern Kazakhstan is considered to be impossible, Table 7.

Table 7. Doses of Phosphoric Fertilizers Using Different Criteria in the Balance Calculation (at 20 Centners of the Chickpea Crop, with the Content of P2O5of 17.8 mg/kg in the Soil).

Indicators	Criteria		
	minimum	maximum	average
Removal of 1 centner of the harvest, kg			
nitrogen	3.8	8.4	5.2
phosphorus	0.8	1.9	1.4
The coefficient of utilization of nutrient elements, %			
N	56.6	102	78.4
P	19.1	66	38.3
The coefficient of utilization of fertilizers, %			
N	18.2	96.3	45.4

P	1.8	13.2	6.5
The dose of P_2O_5, kg / ha	20.9	322	116
On the removal of P_2O_5, kg /ha	16	38	28

All these things point to the need to search for more sophisticated methods of diagnostics of the conditions of mineral nutrition and the need for fertilizers that exclude the need for using such dynamic and uncontrolled indicators as the removal of elements of 1 centner of production, coefficients of utilization of nutrient elements and fertilizers used in balanced calculations.

4 Conclusion

The investigations on the dark chestnut soils in the dry steppe zone of Northern Kazakhstan on the effect of soil conditions and fertilizers on chemical composition and removal of nutrient elements of chickpeas were conducted from 2003 to 2007. They showed that chemical composition of chickpeas, intake, and accumulation of nutrient elements, removal of nutrient elements and fertilizers are varied within a broad range, and are determined by the joint effect of such factors as soil fertility – the content and ratio of nutrient elements in the soil, the hydrothermal conditions of the year, a type, a form and an amount of drilled fertilizers. The uncertainty of these indicators excludes the possibility of using them to determine the requirements (doses) of cultivations in fertilizers.

Assessing the quality status of chickpeas totally, it should be noted that chickpea is an important high protein culture that allows to successfully solve the protein problem both in food and feed industry. Significant content raises the dignity of this culture.

Taking into account the combination of factors, it may be considered that chickpea is a worthy culture for diversification of grain production in Northern Kazakhstan.

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