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EFFICIENCY OF FERTILIZERS AND PESTICIDES IN A DROP IRRIGATION SYSTEM OF POTATOES IN THE SOUTH-EAST OF KAZAKHSTAN

There are developed in this scientific article the results of researches on studying of efficiency of mineral fertilizers, chemical affinities of plants protection and the technology of a drop irrigation on culture of potatoes in the conditions of South-East Kazakhstan. Application of fertilizers against the drop irrigation increased productivity of potatoes in comparison with control on 14,6-53,2 %. Fungicides reduced the disease on infected plants 87,4-92,6%, safety tuber yield - 16,4-33,6%. A high percentage of deaths Colorado potato beetle (94,3-98,5%) provided new insecticides. Drip irrigation has reduced the debris fields on 61.5%, the cost of irrigation water - 35.8%, improved water and soil physical properties and product quality.

Keywords: potatoes, drop irrigation, fertilizer, pesticides, productivity, quality of tubers, ecology

Introduction. Potatoes in Kazakhstan are one of the main, widely cultivated crops. They are in big demand from public as the valuable food product. It is demanded also by processing industry as raw materials. The occupied areas - 180-190 thousand ha, gross collecting - 2,7-3,0 million tons [1].

Potato-growing industry of Kazakhstan is developing every year. The state subsidizes up to 40% higher reproductions potato seeds, fertilizers and pesticides. In Kazakhstan State Register includes more than 90 varieties of potatoes with the best economic-useful properties, of which the share of Kazakh breeding varieties account for about 50% [2]. Large potato specialized farms are equipped with high agricultural machinery. Commissioning date of potato. However, despite the availability of high-yielding varieties of potatoes and advanced technologies, the average crop yield is still low - 14-17 t/ha. This is due to several factors, among which is essential mineral nutrition, protection from pests and irrigation. Intensive use in potato and vegetable production has led to sharp low soil fertility southeast of Kazakhstan, which is a big problem agro ecological [3]. Without the use of organic and mineral fertilizers on these soils is difficult to obtain high yields of potatoes [4]. Because great harm to potato diseases and pests, the prevalence and harmfulness of which is growing every year [5]. This is accompanied by their resistance to existing pesticides. Potato crop losses from pests are very high (35-40 % or more). The above necessitates the discovery and application of new products with high biological efficiency and environmental security.

It should be noted that when using agrochemicals necessary to pay special attention, along agronomic and economic efficiency, environmental consequences. Violations of fertilizer application technologies and plant protection chemicals can cause soil and products with toxic residues [6-7].

Potatoes are cultivated mainly on irrigation with furrow irrigation, in which the acute shortage of irrigation water is observed, since it requires large volumes. In addition, highly developed irrigation erosion, especially in mountainous and foothill areas with steep slope (2-90° C) [8]. In this aspect very promising water-saving technologies. Kazakhstan has introduced advanced irrigation technology is very small - less than 1% of the total area. It requires study and adaptation of foreign technologies of irrigation applied to the soil and climatic conditions of Kazakhstan [9].

The above-stated elements of cultivation technology of potatoes (fertilizer, protection of plants, irrigation) were included into the list of the main objectives of our researches. Carried-out researches are actual and are important for potato growing development in South-East Kazakhstan.

Materials and methods. *Fields details:* Researches are carried out on a skilled hospital of the Kazakh Scientific-Research Institute of Potato and Vegetable Farming (KazSRIPVF) in 2009-2012. The region - the South-East of Kazakhstan. Climate is extremely continental. The warm period - 240-275 days, frost-free season - 140-170 days. The sum of active temperatures - 3100-3400°C. Hydrothermal factor - 0,7-1,0. The annual amount of precipitation - 350-600 mm, for the vegetative period drops out 250-320 mm. The soil - dark-chestnut, middle loamy, the maintenance of a humus - 3 %, the general nitrogen - 0,18-0,20 %, gross phosphorus - 0,19-0,20 %, gross potassium - 2,4-2,7 %, P₂O₅ - 33-35 mg/kg, K₂O - 340-360 mg/kg, pH 7,3-7,4, volume weight - 1,1-1,2 g/cm³. Experience options with fertilizers: N₀P₀K₀ (control), N₆₀P₆₀K₆₀, N₁₂₀P₁₂₀K₁₂₀, N₁₈₀P₁₈₀K₁₈₀. Experiences with pesticides: fungicides – the ditan, metaxil, ridomil gold, concento, the acrobat of MTs; insecticides – decis – extra, konfidor, enzhio, koragen, Biysk. Experiences with irrigation: borozdkov watering (control), drop irrigation («Naan Dan Jain», Israel). An agrotechnology of potatoes – standard for this zone. Potato variety - Aksor.

Investigations were carried out by conventional methods, "Methods of agrochemical research" [10]; "Methods of field experience" [11]; "The methodology of experimental work in the Vegetables and Melons" [12]; "Agrochemical methods of soil investigation" [13]. Norms vegetation irrigation - I.A. Kostyakov formulas: $M = 100 \cdot L \cdot h (V_{nv} - V_f)$, where: M - irrigation rate, m³/ha; L - soil bulk density, g/cm³; h - depth of wetting, m; V_{nv} - field capacity, %; V_f - actual moisture before watering, K_p - correction factor to account for the water to evaporation and transpiration (K_p = 1). Pesticides test conducted in accordance with the "Guidelines for the registration tests, fungicides, seed and biological crop" [14] and the "Guidelines for the registration tests of insecticides, miticides, biologics and pheromones in crop" [15].

Results and discussion. In the South-East Kazakhstan from fungal diseases of a leafy biomass of potatoes, the most harmful is macrosporiosis (*Alternaria* blight). Phytophthora rot in this region is shown poorly, however in separate years the epiphytotoy of illness can be observed. To fight against these and other fungal diseases it is recommended various fungicides.

On experimental fields KazSRIPVF in the years 2010-2012 in the drip irrigation system on potato biological and economic efficiency evaluated 5 fungicides.

Phyosanitary monitoring of landings of potatoes in the phenological phase "flower-bud formation - flowering", showed that without chemical handling the fungal diseases will strongly extend. Under the control they increased from 21,7 to 32,5 %. On experience options with fungicides the general affect of potato plants by diseases before handling constituted 20,4-23,0 %, and after handling - 2,4-4,1 %. Twofold application of fungicides reduced a affect of plants on 81,8-88,8 % in relation to their initial affect on option where a certain preparation was applied. biological efficiency of fungicides equaled 87,4-92,6 %. Chemical handling of landings of potatoes by fungicides against fungal diseases provided preserving of 4,2-8,6 t/ha of a crop of tubers that constitutes 16,4-33,6 % to control. Among tested fungicides in the conditions of drop irrigation more effective were metaxil and ridomil gold. It is necessary to note also new fungicide concento. As a whole, all fungicides were effective against fungal diseases of potatoes.

The Colorado beetle - the most harmful and dangerous wrecker of potatoes. In the conditions of the South-East of Kazakhstan the beetle gives 2-3 generations. Plants of potatoes are harmed by imagos and larvae which can destroy completely leaves and partially stalks. Therefore obligatory agronomic process is carrying out chemical handling of landings of potatoes by insecticides against the wrecker. It should be noted that the acquired resistance to pest insecticides tens. Chemical industry's leading countries near and far abroad synthesized and discount agriculture all newer drugs with insecticidal properties.

In 2010-2012 we tested new insecticides on the experimental field of KazSRIPVF: biysk (thiacloprid, Calypso, 240g/l), a konfidor (imidokloprid, 200g/l), dalate (a.i.-lambda-cyhalothrin, 50g/l), koragen (chlorantraniliprol, 200l/ha), shaman (a.i. - chlorpirifos, 500g/l + cipermetril, 50g/l), enzhio (tiometoxan, 141g/l + lambda-cyhalothrin, 106g/l) and citrin (a.i. - cipermetrin, 500g/l). The assessment of biological efficiency of these chemical remedies of plants was carried out against drop irrigation of potatoes and in case of fertilizer of plants of by N₁₂₀P₁₂₀K₁₂₀.

Chemical handlings of landings of potatoes in case of drop irrigation shall be decreased as in case of frequent passes of equipment the equipment for watering is mechanically damaged (bulk distribution lines, drop tapes). Therefore it is important to find a highly effective insecticide with the long period of action on ovipositioning and larvae of beetle of all age (1-4 phases of development).

The results of testing of insecticides on potatoes against the Colorado beetle showed their different biological efficiency. The death of imago and larvae of the wrecker constituted: citrin (0,05-0,08 l/ha) - 82,14 - 86,20 %; dalate (0,1 l/ha) - 79,44 %; shaman (0,3-0,5 l/ha) – 82,98-92,55 %; Biysk (0,2-0,3 l/ha) – 93,10-98,46 %; koragen (0,04-0,05) – 85,42-90,75 %; konfidor (0,05-0,07 l/ha) – 87,32-95,61 %; enzhio (0,1 l/ha) – 94,29 %.

As it seen from the data, new insecticides render various-biological efficiency. Preparations dalate and citrin were less effective. These preparations are created on the basis of chemicals (a.i.) lambda-cyhalothrin and alpha-cipermetrin to which the Colorado beetle has resistance; it explains their rather weak action on the wrecker. A preparation shaman consisting from phosphorus - organic connection and synthetic piretroid, showed high effect in the norm of 0,5 l/ha (92,6%). However in ecological aspect big regulations of pesticides are undesirable. The great interest is represented by insecticides with absolutely new a.i.- Biysk and koragen. The Bisky provided fast death (15-30 minutes) larvae of the Colorado beetle almost completely (to 98,5%). Impact of koragen was slow, gradual. Thus the death of the wrecker was noted within 1-3 days and more. From all studied insecticides koragen has the lowest regulation of application (0,05 l/ha) in case of its outstanding biological performance (~91 %). As distinct from citrin, the preparation enzhio, a.i of which, except lambda-cyhalothrin, it is added tiametoxam, showed very high effect against imago and larvae of beetle (94,3 %). The most effective among the studied insecticides against the Colorado beetle on potatoes is the konfidor. This conclusion is based on such benefits of a konfidor, as very outstanding biological performance (95,6 %), very low rate of application (0,07 l/ha), big duration of protective action (30 days and more). In case of application of other insecticides it was necessary to carry out 2-3 handlings in connection with emergence of new larvae of beetle, in experience with konfidor it was enough to carry out one handling against the wrecker. It is very important in system of drop irrigation.

Results of our testing of a new chemical preparation prestige (29% s.c.) are very valuable, it possesses insectofungicide properties. On the experimental field where the prestige was used, the mechanized handling by pesticides was excluded. The prestige was applied by handling of seed tubers of potatoes in regulation of 1 l/ha. This preparation, along with suppression of development of potatoes diseases as the result of a.i. of pencikuron (150g/l), prevented settling of landings by the Colorado beetle and development of larvae, as the result of a.i. of imidoklopid (140g/l). Application of prestige is, in our opinion, important and obligatory process in case of potatoes cultivation on drop technology of irrigation. It is prevention of mechanical damage of the irrigation equipment, an environmental pressure on the soil and plants.

Determination of residual amounts of pesticides in the soil and products (tubers) showed that the tested chemical agents of plants (insecticides, fungicides) are ecologically safe. In analytical tests the trace and admissible minimum quantities of toxic residue are found.

In 2009-2011 comparative efficiency of **borozdkov** watering (a traditional method - control) and drop irrigation (new technology) was studied. On the average for 3 years there are received the following results for benefit of a new method of irrigation in comparison with control.

The economy of irrigating water constituted 35,8 % (2780 and 1785 m³ waters are spent for 1 ha). The contamination of landings of potatoes decreased with 78 to 30 pieces on 1 m² or on 61,5%. The positive tendency of improvement of water-physical properties of the soil is noted. Water stability of soil aggregates raised from 38,7 to 39,9 % that is rather good indicator during 3 years of researches. It is result of a sparing mode of watering on droppers. In case of a borozdkov method there is a destroying impact on the soil of a big and strong flow of irrigation water. As the result of drop irrigation the structure of the soil became steadier to washout by water. The volume mass of the soil decreased from 1,21 to 1,15 g/cm³, that is it is less condensed. It promotes more powerful

development of root system of plants. The soil in case of drop watering remained friable during the whole vegetative period. The soil porosity on experimental fields depending on technology of irrigation constituted 52,4 and 56,6 %. Also water penetration of the soil by experience options respectively differed. Penetration of irrigation water deep into in the first hour of watering constituted 76,3 and 87,8 %.

It is necessary to particularly note here the following positive ecological aspects of drop irrigation: economy of irrigating water which is in very short supply, prevention of irrigational erosion, improvement of water physical properties of the soil, decrease in a contamination of a field (reduction of herbicidal loading).

The biometric researches which have been carried out in the period of intensive tuberization, showed that the technology of drop irrigation promotes formation of more developed biomass of potatoes in comparison with **borozdkov** (table 1). So, on ways of irrigation the following indicators are received: height of plants of potatoes - 58,8 and 62,2 cm, quantity of stalks of 1 plant - 5,3 and 5,9 pieces, quantity of leafstalks- 13,9 and 15,3 pieces, the area of leaves of 1 plant - 773 and 854 cm², quantity of tubers on a bush - 8,0 and 10,0 pieces, mass of tubers of 1 bush - 429 and 550 g accordingly.

Intensive development of plants of potatoes at drop irrigation, finally, ensured more higher crop of tubers, than at **borozdkov** watering.

Table 1

Biomass formation by potato plants at system of drop irrigation (2009-2012)

Irrigation method	Height of plant, cm	Quantity of stalks, pieces	Quantity of leafstalks pieces	Length of leaves, cm	The area of leaves of 1 plant, cm ²	Quantity of tubers on a bush, pieces	Mass of tubers of 1 bush, g
1. Borozdkov watering by blousing	58,8	5,3	13,9	26,1	773	8,0	429
2. Drop irrigation	62,2	5,9	15,3	29,0	854	10,0	550

Productivity of potatoes at a drop irrigation increased by 36,6 %, having made 30,6 t/ha at 22,4 t/ha on option with **borozdkov** watering. Biochemical analyses of crop showed improvement of separate quality indicators of the tubers which have been grown up on drop watering. There is established the increase of the content of solids from 25,8 % (control) to 27,3 %, starch - from 17,8 % (control) to 18,2 %. On technologies of irrigation in tubers contained 12,46 and 11,98 mg % of vitamin C, 2,02 and 1,95 % of the general sugar.

Along with it, against **borozdkov** and drop ways of irrigation, various norms of mineral fertilizers were studied: 1) N₀P₀K₀ (control), 2) N₆₀P₆₀K₆₀ (the minimum norm), 3) N₁₂₀P₁₂₀K₁₂₀ (a moderate form), 4) N₁₈₀P₁₈₀K₁₈₀ (the increased norm).

There are established considerable distinctions on efficiency of potatoes between technologies of watering and norms of NPK fertilizers (table 2).

The lowest productivity of potatoes is received on control by **borozdkov** watering - 17,1 t/ha. Application of the minimum norms of nitrogen, phosphorus and potassium (N₆₀P₆₀K₆₀) increased productivity of tubers on 2,5 t/ha (14,62 %), moderate norms (N₁₂₀P₁₂₀K₁₂₀) - 5,5 t/ha (32,16 %), the increased norms (N₁₈₀P₁₈₀K₁₈₀) - 9,1 t/ha (53,22 %).

Table 2

Productivity of potatoes at various ways of irrigation with application of different norms of mineral fertilizers (a grade - Aksor)

Variants	Pro-duc-tivity, t/ha	Crop increase		Dry weight, %	General sugar, %	Vitamin C, mg/%	Starch, %	Nitrate, mg/kg
		t/ha	%					
Borozdkov								
Control	17,1	-	-	26,60	2,02	13,16	21,36	30
N ₆₀ P ₆₀ K ₆₀	19,6	2,5	14,62	27,72	1,84	12,18	19,58	30
N ₁₂₀ P ₁₂₀ K ₁₂₀	22,6	5,5	32,16	25,62	2,02	11,48	20,29	20
N ₁₈₀ P ₁₈₀ K ₁₈₀	26,2	9,1	53,22	25,60	1,28	9,52	21,00	87
Drop								
Control	20,7	-	-	27,92	2,02	13,86	20,11	26
N ₆₀ P ₆₀ K ₆₀	23,9	3,2	15,46	27,22	2,02	12,6	20,11	25
N ₁₂₀ P ₁₂₀ K ₁₂₀	27,5	6,8	32,85	27,04	1,85	12,04	21,00	24
N ₁₈₀ P ₁₈₀ K ₁₈₀	31,6	10,9	52,66	30,92	1,84	10,36	21,36	58
m, %	2,3 - 2,9							
s _x , t/ha	2,0 - 3,0							

At potatoes irrigation on drop technology productivity of culture considerably raised. On unfertilized control there are received 20,7 t/ha of crop of tubers, that on 3,6 t/ha or 21,05 % is more than control option of **borozdkov** watering. Entering into the soil of N₆₀P₆₀K₆₀ ensured getting of 23,9 t/ha of crop, N₁₂₀P₁₂₀K₁₂₀ - 27,5 t/ha, N₁₈₀P₁₈₀K₁₈₀ - 31,6 t/ha. The size of an additional crop of potatoes on the fertilized options of experience with drop irrigation in comparison with similar options of experience with **borozdkov** watering made 4,3; 4,9 and 5,4 t/ha or 21,94; 21,68 and 20,62 %.

Positive influence of drop irrigation and mineral fertilizers on quality indicators of potatoes is noted. In tubers the content of solids (27,0-30,9 %) and starch (21,0-21,4 %) raised. The tubers which have been grown up with application of drop irrigation, contained more vitamin C and the general sugar, than the tubers which have been grown up on **borozdkov** watering. In crop of potatoes it is revealed nitrates in quantity 20-87mg on 1kg of crude weight on a **borozdkov** way of irrigation and 24-58 mg/kg – on drop technology. If to consider that maximum-permissible concentration of nitrates for potatoes makes 250 mg/kg, these levels of nitrates in tubers are minimum, it is less than norm at 3-12 times. Therefore the production is non-polluting.

To control option of drop irrigation of fertilizer increased productivity of potatoes on 3,2 - 10,9 t/ha (15,46-52,66 %).

Increase of efficiency of potatoes from fertilizers is connected with improvement of conditions of a mineral food. Increase of efficiency of fertilizers at drop irrigation is explained by creation of constant optimum moisture content and a favorable air mode of the soil, formation of more developed root system of plants.

Conclusions. For potato farms of a foothill zone of the South-East of Kazakhstan the technology of drop irrigation of potatoes with application of mineral fertilizers in norm of N₁₈₀P₁₈₀K₁₈₀ is recommended. In fight against the Colorado beetle insecticides the most effective are: konfidor (20 % of w.c.) in norm of 0,07 l/ha, enzhio (24,7 % of s.c.) - 0,1 l/ha and Biysk (24 % of o.d.) - 0,2 l/ha. Against fungal diseases of potatoes it is recommended to spray plants in vegetation period by new highly effective fungicide ridomil gold (68 % of w.d.g.) in norm of 2,5 kg/ha and concento (45 % e.c.) - 2,0 l/ha. In system of drop irrigation it is perspective to use of complex insectofungicide prestige (29 % e.c.) in norm of 1 l/ha providing high biological and ecologically efficiency against wreckers and potatoes diseases.

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Анотація

Айтбаєва А.Т., Избасаров Е.Ж., Шаріпова Д.С.

Ефективність добрив і пестицидів у системі крапельного зрошення картоплі в умовах південного сходу Казахстану

Вивчено ефективність добрив, пестицидів і технології зрошення на картоплі в умовах південного сходу Казахстану. Добрива на фоні крапельного зрошення збільшили врожайність картоплі відносно до контролю на 14,6-53,2 %. Фунгіциди знижували ураженість рослин захворюваннями на 87,4-92,6 %, збереженість врожаю бульб – 16,4-33,6 %. Високий відсоток загибелі колорадського жука (94,3-98,5 %) забезпечили нові

інсектициди. Крапельне зрошення знизило забур'яненість полів на 61,5%, витрати поливної води – на 35,8 %, поліпшило водно - фізичні властивості ґрунту і якість продукції.

Ключові слова: картопля, крапельне зрошення, добриво, пестицид, продуктивність, якість, фітосанітарія, екологія

Аннотація

Айтбаева А.Т., Избасаров Е.Ж., Шарипова Д.С.

Эффективность удобрений и пестицидов в системе капельного орошения картофеля в условиях юго-востока Казахстана

Изучена эффективность удобрений, пестицидов и технологии орошения на картофеле в условиях юго-востока Казахстана. Удобрения на фоне капельного орошения увеличили урожайность картофеля к контролю на 14,6-53,2%. Фунгициды снижали пораженность растений заболеваниями на 87,4-92,6%, сохранность урожая клубней – 16,4-33,6%. Высокий процент гибели колорадского жука (94,3-98,5%) обеспечили новые инсектициды. Капельное орошение снизило засоренность полей на 61,5%, расходы поливной воды – на 35,8%, улучшило водно-физические свойства почвы и качество продукции.

Ключевые слова: картофель, капельное орошение, удобрение, пестицид, продуктивность, качество, фитосанитария, экология