



Scientific article

FEATURES OF ONION CULTIVATION TECHNOLOGY WITH DRIP IRRIGATION IN THE ARID ZONE OF SOUTHERN KAZAKHSTAN

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ABSTRACT

The onion growing technology in the arid zone of southern Kazakhstan should consider the specific requirements of this crop for soil moisture throughout the growing season, considering the main phases of its development. The purpose of the research was to establish the features of the onion growing technology under drip irrigation with the determination of the optimal moisture threshold for the phases of plant development and the assessment of its effect on crop yields. Research method field experience in a specially designated experimental area. The authors have established that drip irrigation provides yields up to 103.2 t/ha, with a soil moisture threshold of 85% HB from germination to the start of bulb formation with a further decrease in soil moisture to a level of 75% HB for the formation phase - the beginning of bulb ripening and to a level of 70% HB before bulb ripening. This technology is recommended for use in farms in the south of Kazakhstan to increase productivity and product quality.

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1. INTRODUCTION

Currently, new trends in the world agrarian economy and demography are being formed in the context of global climate change in the direction of strengthening and lengthening the period of heat and drought, which has a sharp negative effect on the yield of many important agricultural crops, including such a valuable crop as onions.

It is noted that an increase in the average annual air temperature is observed in all regions of Kazakhstan. On average, the increase in the average annual air temperature in Kazakhstan is 0.36°C every 10 years [1].

At the same time, its significant increase is observed in European and Asian countries. Under the conditions of climate change, the growing seasons of agricultural crops in regions between the tropical and arctic regions and in the arctic regions can be lengthened in comparison with the basic duration and shortened in areas suffering from prolonged droughts [2].

Under such conditions, in order to withstand negative factors, a significant change in the elements of the cultivation technology of various agricultural crops is required, which should be directed towards reducing the negative impact of critical factors on productivity.

Understanding the future impacts of climate change and successful planning for adaptation measures are of particular importance for Central Asia (CA), given the region's economic vulnerability, dependence on scarce water resources, and observed warming rates above the global average. In general, the temperature conditions in Central Asia, including Kazakhstan, are suitable for growing many different crops, such as wheat, corn, cotton, rice, fruits, vegetables, and others. However, highly efficient agricultural production in this region is constrained by the uneven spatial distribution of water resources, the presence of inefficient irrigation systems, low productivity of agricultural practices, as well as the insufficient level of

modern innovative water-saving technologies to eliminate water losses directly on irrigated lands in the face of growing water shortage.

In the current conditions, in order to increase the productivity of the water and land resource use, the transition to water conservation is of particular importance. The main objectives of water conservation are saving irrigation water; increasing the efficiency of irrigation water use; improving the water and land use productivity [3].

Ensuring the rational use of water resources to reduce water losses on irrigated lands can be achieved through the use of water-saving irrigation technologies. These are drip irrigation and sprinkling of agricultural crops. The large-scale introduction of these technologies on restored and new irrigated lands will make it possible to rationally use irrigation water and increase the productivity of its use by several times.

Intensive onion cultivation in the arid zone of southern Kazakhstan is possible with the use of advanced irrigation systems, in particular drip irrigation systems, which are characterized by high economic and technological efficiency. Drip irrigation is aimed at the rational water use, the prevention of negative phenomena and the preservation of fertility, and at the same time provides a reduction in water consumption per unit of output. With such irrigation, the conditions for agricultural technology of all field work are improved, the possibility of simultaneous irrigation and mechanized tillage is created, significant savings in water and fertilizers are ensured, the contamination of fields with weeds is reduced, soil compaction is reduced, productivity increases and the crop quality improves [4].

The onion cultivation technology under drip irrigation is a complex of interrelated agrotechnical, technological, organizational and economic measures developed based on summarizing the results of modern scientific research and best practices.

The effect of maintaining an optimal level of soil moisture, taking into account the water consumption of plants during the onion development phases and the use of fertilizers when growing onions, is confirmed by research from scientists in Kazakhstan, international research in the regions of the India, Spain and Turkey, and scientists from Russia, the USA, and Australia.

As a result of international studies on the onion irrigation needs based on studies in arid and semi-arid regions of the USA, India, Spain and Turkey, the authors found that the seasonal water requirements of onions vary greatly depending on agro-climatic conditions, location of the object and growing time. Seasonal irrigation needs vary from 225 to 1040 mm to obtain a yield of 10 to 77 t/ha. The phases most sensitive to water stress are emergence, transplanting and bulb formation. Excess water can also affect the final crop quality. Lack of water at certain phases can adversely affect the quality, resulting in reduced size and multi-centered bulbs. It is noted that in recent years, due to the increasing demands on water resources, advanced technologies such as drip irrigation and sprinkling are more efficient for irrigating onions [5]. A study on onion yields under drip irrigation in Las Cruces, North Carolina found that onion yields were 20% higher than in Farmington, New York, with sprinkler irrigation [6].

Drip irrigation in Ethiopia has ensured efficient water use and increased onion yields up to 34.99 t/ha with lateral drippers along each row of onion crops [7].

Drip irrigation of onions in the Volgograd region (Russia) during the research period from 2017 to 2020 ensured an increase in the efficiency of managing the water and mineral nutrition of onions by substantiating the calculated soil moisture layer and agrotechnical methods of cultivation on light chestnut soils to obtain 110 t/ha of marketable products [8].

The research results of agrotechnological methods influence on obtaining a high-quality onion crop with drip irrigation in the experimental plots of the Caspian Agrarian Federal Scientific Center of the Russian Academy of Sciences (Astrakhan region, Russia) with the treatment with the water-soluble fertilizer "Rastvorin" and the growth regulator "Energy-M" in combination with the use complete mineral fertilizer stimulated the growth and development of plants. The onion yield was 150 t/ha while maintaining soil moisture at the level of 70 - 80 - 75% of the soil moisture capacity [9].

With drip irrigation, the response of the onion to the irrigation intensity and drippers' consumption is interesting. According to a number of researchers, drip irrigation requires very high irrigation frequencies with a small water amount. The results of studies using drippers with a flow rate of 0.25 l/h and 0.5 l/h showed that the number of irrigations from 1 to 8 per day does not make a significant difference in the average soil water potential. The use of 1/16, 1/8-, 1/4- and 1/2-inch drip tapes with 0.25 l/h and 0.5 l/h flow rates showed that 1/2-inch drip tape with drippers is recommended for watering onions flow rate of 0.5 l/h, providing the average water potential of the soil between irrigations. At the same time, the number of irrigations per day is set considering the accepted level of soil moisture and the productivity of drippers [10].

To manage limited water resources and increase yields, the impact of subsurface drip and furrow irrigation on onion yields was evaluated at the AgriLife Research Center in Weslaco, Texas. Drip irrigation with more frequent waterings and a shallower soaking depth compared to furrow irrigation resulted in a 93% higher onion yield than furrow irrigation. Bulb sizes were also 181% larger. The surface irrigation method requires a large amount of water to ensure the irrigation of the onions [11].

Watering is one of the most important agrotechnical procedures in onion cultivation. It is necessary to water the onion from the moment it is planted, but an important condition is irrigation in moderation, otherwise the plant will be attacked by various fungi that develop in conditions of excessive importance. One should perform watering, considering the fact that the plant instantly reacts to any changes in climate and soil. If the bulb is in dry and not moistened soil for a long time, it simply stops growing greens and nourishes the tuber itself. The lack of moisture has one significant disadvantage - the plant can significantly slow down growth or even stop in development. Therefore, the issue of timely and normalized watering is very important. When watering onions, water should not get on the bulb itself and its leaves, the soil should be saturated with water to a depth of 20 cm. The appearance of a soil crust is unacceptable. When irrigating onions, one should consider that oversaturation with water is a rather dangerous factor for onion crops. If the amount of water exceeds the norm, then the risk of developing pathogenic bacteria increases significantly, which affects the duration of maturation after harvest [12].

To fulfill these conditions, it is recommended to water the onions with drip irrigation. The frequency of watering depends on the level of soil moisture and weather conditions. Constant monitoring of soil moisture is necessary, since under the influence of the sun and wind, the open ground dries quickly, which has a direct effect on the yield of onions. After the beginning of the bulbs formation and breaking off their arrows, the watering is mandatory, since when the arrow is formed, the bulb practically stops pouring, and all the moisture goes into this very arrow. At the same time, watering stops a few weeks before harvest [12].

Researchers conducted two-year field experiment with drip irrigation and plastic mulch to study an irrigation management strategy to increase onion yields and water productivity in arid region of Northwest China. As a result of considering four options with different levels of water stress throughout the growing season and four options with the water stress use at the phases of rooting, development and maturation, they defined plant height, aboveground biomass, yield, and water productivity. The researchers established that all these indicators are sensitive to water stress and only a small deficit is acceptable during the growing season [13].

The results of studies on the influence of moisture in the active soil layer depending on the onion interphase periods and the application of mineral fertilizer doses in the soil and climatic conditions of the Lower Volga region revealed the optimal irrigation mode and mineral fertilizer doses in open ground to obtain the planned yield of Sabroso F1 onions using the drip method glaze. The highest onion yield was obtained with 80-90-70% HB irrigation combined with N100P85K95 fertigation. And high yield levels were achieved in the following options: 75...85...75% HB and N100P85K95 - 82.3 t/ha; 80...90...70% HB and N100P85K95 - 86.7 t/ha; 85...85...75% HB and N100P85K95 - 84.4 t/ha. The lowest water consumption coefficient is also in these options: 80...90...70% HB and N100P85K95 - 60.5 m³/t; 85...85...75% HB and

N100P85K95 - 47.4 m³/t; 75...85...75% HB and N100P85K95 - 46.5 m³/t. High levels of output of marketable products (at the level of 96...97%) were achieved in combinations of the first irrigation mode and the third, fourth fertigation modes, the second irrigation mode and the fourth fertigation mode, as well as the third irrigation mode and the fourth fertigation mode. Based on the research performed in the onion cultivation in the climatic conditions of the Lower Volga region, the use of a dose of N100P85K95 fertilizers makes it possible to obtain the planned onion yields. To apply a fertilizer dose in the first ten days of the growing season, N10P17K10 must be applied with irrigation water, in the next twenty days - N15P17K10, in the next twenty days - N20P17 K20, in twenty-five days - N35P17K30 and in another twenty-five days - N20P17 K25. This option was the best [14].

On the experimental site of the farm "Pioneer", Gorodishchensky district of the Volgograd region, in 2014-2015, researchers performed studies to improve the efficiency of onion drip by substantiating agro-reclamation modes and agrotechnical methods of cultivation. They have established that the conditions of water nutrition of onion farming plants and elements have a significant impact on water consumption, productivity and efficiency of water resources use in drip irrigation. The implementation of the drip irrigation mode, focused on maintaining a given threshold (80...70% HB) of pre-irrigation soil moisture in a layer of 0.4 m, provides an onion yield of 114.7...115.3 t/ha [15].

Studies in the south of Kazakhstan found that an effective technology for irrigating onions is also subsoil irrigation of onions using porous water-conducting hoses in comparison with the onion growing technology with drip irrigation with ground drip tapes. The water consumption coefficient here was 67.2 m³/ton, while with surface drip irrigation it reached 74.1 m³/ton. The use of subsoil irrigation modes, differentiated by the phases of plants growth and development, ensured the optimal moisture content in the soil, which, along with the use of fertilizers, allowed to obtain a biological yield of onion varieties "Manas" up to 90 t/ha. At the same time, soil moisture in the 0.3...0.4 m layer was 70...85% HB during the first half of the growing season (from germination to the beginning of bulb formation) and 70...75% HB in the second half of the growing season (from bulb formation to industrial ripeness) [16]. This technology is also promising, while during the planting of onions, the upper soil horizon must have sufficient moisture, which is not always possible with a subsoil irrigation system in conditions of a lack of moisture in this horizon.

A field experiment evaluating the effect of drip irrigation deficiency on onion growth, yield and water productivity in semi-arid Maharashtra found that growth and yield-promoting characteristics of onions decrease as water stress increases. Drip irrigation without water stress recorded a higher bulb yield (35.5 t/ha) with a water saving of 42.8% compared to surface irrigation [17].

In China an important factor in agriculture is available water resource management. At the same time, despite the introduction of modern irrigation methods in agriculture, such as drip irrigation, with the development of irrigation methods and the elimination of old traditional irrigation methods, one should consider the fact that water use efficiency is related to the qualifications of farm workers and other users of irrigation water. Farmers are encouraged to provide all information on the use of drip irrigation technology in order to improve the technical level in the irrigation water use and to avoid some common mistakes in the design, use, management and maintenance of drip irrigation systems. Such systems meet the needs of plants in water, reduce the contact of water with the stem, leaves and fruits of plants. Water can only moisten a limited area, which is close and directly to the root zone of plants. This will avoid several serious plant pathologies such as rotting of plant parts. A big problem on drip irrigation systems is drip clogging because the water contains a lot of solids and nutrients that build up inside the drip lines, especially when irrigated with domestic or municipal wastewater. One should pay special attention to this [18].

The onion irrigation needs versus surface furrow and sprinkler irrigation have been extensively studied for 22 years at the Malheur Experimental Station at the University of

Oregon, USA. Researchers have found that onions have high soil moisture requirements compared to other crops. Below optimal soil moisture results in lower yields, and above optimal soil moisture contributes to bulb decomposition. Short-term water stress during the plant growth phase of three to six leaves contributes to the appearance of several centers in the bulb. Onions, which are sensitive to water stress and have a shallow root system, need frequent watering to maintain high soil moisture and produce high yields [19].

A study in Australia on the water supply effect on vegetative growth and yield characteristics of the Giza 6 onion variety in 2004...2005, when water was supplied with an irrigation interval, found that the amount of water supplied has a significant effect on the onion vegetative parameters. Higher water supply resulted in higher vegetative parameters: plant height, number of leaves per plant, bulb and neck diameter. The bulb ratio was reversed as the lowest water supply resulted in a higher bulb ratio. The dry matter content showed a high negative correlation with the amount of water applied, both in the leaves and in the bulbs. The higher water supply has doubled the number of bulbs and small bulbs, while the number of bulbs exported has decreased [20].

The analysis of research materials on onion irrigation indicates the effectiveness of crop drip irrigation, which allows to exclude water from entering the bulb itself and its leaves, to provide the necessary moisture for plants in the bulb formation layer, considering the requirements for soil moisture in their development phases. This will ensure the optimal use of water resources and increase the yield of such a crop.

Despite some study of issues on assessing the drip irrigation impact on onion yields, researchers have established that the onion seasonal needs in water vary greatly depending on agro-climatic conditions, location of the object and growing time [5].

The purpose of research in the work based on field experience was to assess the features of the onion growing technology under drip irrigation in the arid zone of southern Kazakhstan with the establishment of the optimal soil moisture threshold for the plant development phases and its effect on crop yields.

2. MATERIALS AND METHODS

The authors performed the research on the experimental production site of the peasant economy (KH) "AISHA" located on the territory of the Sarybulak rural district, Kordai district, Zhambyl region. The farm has a full range of agricultural machinery for high-quality and timely implementation of the necessary agrotechnical measures, as well as the necessary equipment for the application of drip irrigation technology.

Research was performed in 2020...2022 on onion cultivation lands.

The climate of the region is sharply continental, with hot summers and moderately cold winters. The hottest month is July. The coldest month is January. The annual precipitation in 2020 was 386.2 mm, in 2021 301.2 mm and in 2022 434.6 mm. Relative air humidity varied from 51.2% to 57.4% over the years of research. The prevailing wind direction is east, the average wind speed is 3.1...3.3 m/s. [21].

The irrigation array is located on a foothill slightly hilly plain.

In the surveyed area, the authors identified light northern gray soil with medium loams in terms of mechanical composition. Groundwater is deeper than 6 m.

At the pilot production site, we studied features of the onion growing technology under drip irrigation in the arid zone of southern Kazakhstan to objectively justify the introduction of scientific achievements in agricultural production. This provided for the use of a whole range of interrelated agrotechnical, technological, organizational and economic measures developed on the basis of summarizing the results of modern scientific research and best practices. The experiment was laid in 4-fold repetition. The experiment considered the specifics of experiments with open ground vegetable crops. The authors took the size of the accounting plots as 30 m². Side protective strips are taken in 2 rows. The physical and water-physical properties of soils were determined at the beginning of the growing season. The authors daily considered readings of the GGI 3000 evaporimeter, which considers evaporation from the water surface and

atmospheric precipitation, as well as meteorological observations. They daily monitored volume of water supplied to the plots by water meters. Soil moisture indicators were set daily using moisture sensors. They monitored soil moisture content by thermostatic-weight method every ten days. The terms for accounting for crop yields were set according to the degree of onion ripening. Onion harvesting from experimental plots was performed manually. They considered the harvest by the continuous method, weighing vegetables from all accounting plots after drying the onions in windrows. The principle of experiment repetition was based on the presence of four plots within four repetitions to exclude the influence of a random factor on the results of the experiment. The authors performed the statistical analysis of the experiments using dispersion analysis of data according to B.A. Dospekhov's method [22]. The technique provided for the processing of data analyzes according to the experiment options, considering repetitions using the Excel computer program.

Development of onion cultivation technological methods using drip irrigation technology in the conditions of the Zhambyl region provided the binding of all agrotechnical measures performed when growing a crop, considering the characteristics of its cultivation.

On the experimental production site, the authors determined the features of the technology for growing onions under drip irrigation, with defining the optimal soil moisture threshold in the 10–30 cm layer by the phases of plant development and the assessment of its effect on crop yields.

During the research, they studied influence evaluation of the soil moisture optimal level on the yield of onions (experimental options):

Option 1 - drip irrigation with a soil moisture threshold from germination to the beginning of bulb formation at the level of 85% HB with a further decrease in soil moisture to a level of 75% HB in the formation phases - the beginning of bulb ripening and to a level of 70% HB until the bulbs are fully ripe.

Option 2 - drip irrigation with a soil moisture threshold from germination to full ripeness of bulbs 80% HB.

Option 3 - drip irrigation with a soil moisture threshold from germination to full ripeness of the bulbs 70% HB.

Control - drip irrigation with a threshold of soil moisture from emergence to full ripeness of the bulbs at the level of 70...100% HB.

The authors adjusted the water supply mode according to the experiment options depending on the moisture content of the root-inhabited soil layer in the soil moistening zone at half the radius of the moistening contour with drippers.

3. RESULTS

The results of the field experiment allowed to establish the features of the onion growing technology under drip irrigation, to determine the optimal soil moisture threshold for the phases of plant development, and to assess its impact on crop yields.

Research has established the main technological operations performed at the pilot production site, shown in table 1.

Based on the condition that the onion has a high responsiveness to soil moisture, in the experimental options immediately after sowing and installation of the drip irrigation system in late April and early May, the researchers performed two irrigations until the moisture contour in the seeding zone was completely wet. Further, they performed watering on the experimental options considering the accepted threshold of soil moisture. Drip irrigation with a threshold of soil moisture from germination to the beginning of bulb formation was performed at the level of 85% HB with a further decrease in soil moisture to a level of 75% HB before the formation phase - the beginning of bulb ripening and to a level of 70% HB before bulb ripening in the option 1. In options 2 and 3, they performed irrigation during the entire onion growing season under the condition of maintaining soil moisture at the level of 80% HC and 70% HC, respectively. The control option was the site where drip irrigation was performed considering

the maintenance of soil moisture at the level of 70-100% HB. Watering was stopped 3 weeks before harvest.

Table 1*Technological operations for growing onions with drip irrigation*

№	Types of agricultural work	Date	Name of equipment
1	Removal of crop residues from the predecessor field	October	MTZ-82.1 tractor + hitch with harrows and manually
2	Plowing to a depth of 27...30cm	November	
3	Plowing	October	Tractor MTZ-82.1 + mounted plow PN-3-35
4	Disk in 2 tracks	November	
5	Malovanie	March	Tractor MTZ-82.1 + mounted plow PN-3-35
6	Chiselling	April	Tractor MTZ-82.1 + disc/cultivator
7	Cutting furrows with the formation of a ridge	April	Tractor MTZ-82.1 + rail small
8	Application of mineral fertilizers (N-15 kg/ha, P-15 kg/ha, K-15 kg/ha a.i.) - 200 kg/ha)	April	Tractor MTZ-82.1 + cultivator - bed former KGF-2.8
9	Sowing of onion seeds with simultaneous rolling with a seeding rate of 5 kg/ha	April	Tractor MTZ 82.1 + bed former with a row spacing of 0.75 m
10	Pre-emergence treatment with herbicides (Stomp 33% a.e., norm - 6 l/ha)	April	Tractor T-25 + mineral fertilizer spreader RUM-0.35
11	Installation of a drip irrigation system	April	Tractor T-25 + mounted vegetable seeder SON-1.5
12	Weeding manually, first	May	Tractor T-25 + sprayer PO-1
13	Chemical weeding of weeds by seedlings with herbicides ("Galacsi.", Norm - 0.9 l / ha)	May	manually
14	Chemical treatment against pests ("Engio 247 s.k.", norm - 0.3 l / ha)	May	manually
15	Treatment with herbicides ("Stomp 33% a.e.", norm - 5 l / ha)	May	Tractor T-25+ trailed sprayer OP 18
16	Chemical treatment against pests ("Engio 247 s.k.", norm - 0.2 l / ha)	May	Tractor T-25+ trailed sprayer OP 18
17	Chemical treatment against diseases ("Ridomil Gold MTs 68 v.d.g.", norm - 2 l / ha)	May	Tractor T-25+ trailed sprayer OP 18
18	Treatment with microfertilizers (Kristalon - 2 kg/ha)	May	Tractor T-25+ trailed sprayer OP 18
19	Fertilizing with mineral fertilizers (ammonium nitrate 150 kg/ha)	May	Tractor T-25+ trailed sprayer OP 18
20	Treatment with herbicides ("Stomp 33% a.e.", norm - 5 l / ha) with irrigation water	June	Tractor T-25+ mineral fertilizer spreader RUM-0.35
21	Weeding manually, second	June	manually
22	Fertilizing with mineral fertilizers (ammonium nitrate N- 100 kg/ha)	June	Tractor T-25+ mineral fertilizer spreader RUM-0.35
23	Fertilizing with mineral fertilizers (ammonium nitrate N- 100 kg/ha)	June	Tractor T-25+ mineral fertilizer spreader RUM-0.35
24	Application of microfertilizers (Kristalon - 2 kg/ha) with irrigation water	June	drip irrigation system
25	Chemical treatment against diseases ("Ridomil Gold MTs 68 v.d.g.", norm - 2.5 l / ha)	June	Tractor T-25+ trailed sprayer OP 18
26	Chemical treatment against pests ("Engio 247 s.k.", norm - 0.3 l / ha)	June	Tractor T-25+ trailed sprayer OP 18
27	The introduction of biostimulants (Sodium humate - 0.25 kg/ha) with irrigation water	June	Tractor T-25+ mineral fertilizer spreader RUM-0.35
28	Chemical treatment against diseases ("Bravo 500 s.k.", norm - 3 l / ha)	June	Tractor T-25+ trailed sprayer OP 18
29	Treatment with microfertilizers and biostimulants (Sodium humate - 0.25 kg / ha; Crystal - 2.5 kg / ha)	June	Tractor T-25+ trailed sprayer OP 18
30	Application of mineral fertilizers (ammonium nitrate 250 kg/ha) with irrigation water	July	drip irrigation system
31	Chemical weeding with herbicides ("Marbidol.", Norm - 1.0 l / ha)	July	Tractor T-25+ trailed sprayer OP 18
32	Chemical treatment against pests ("Aktellik 500 k.e.", norm - 2.5 l / ha)	July	Tractor T-25+ trailed sprayer OP 18
33	Application of biostimulants (Sodium humate - 0.25 kg/ha)	July	Tractor T-25+ trailed sprayer OP 18
34	Application of fertilizers ("Suprephos" - 50 kg/ha) with irrigation water	July	drip irrigation system
35	Chemical weeding with herbicides "Fusilade Forte 150 k.e.", norm - 1.5 l / ha)	July	Tractor T-25+ trailed sprayer OP 18
36	Fertilizing with mineral fertilizers (ammonium nitrate 300 kg/ha)	July	Tractor T-25+ mineral fertilizer spreader RUM-0.35
37	Treatment with microfertilizers and biostimulants (Sodium humate - 0.25 kg / ha; Crystal - 3.0 kg / ha)	July	Tractor T-25+ trailed sprayer OP 18
38	Chemical weeding with herbicides ("Marbidol.", Norm - 1.0 l / ha)	July	Tractor T-25+ trailed sprayer OP 18
39	Application of ammonium sulfate 200 kg/ha with irrigation water	August	drip irrigation system
40	Chemical treatment against diseases ("Strobe", norm - 0.25 l / ha)	August	Tractor T-25+ trailed sprayer OP 18
41	Treatment with microfertilizers and biostimulants (Sodium humate - 0.25 kg / ha; Crystal - 2.5 kg / ha)	August	Tractor T-25+ OP 18
42	Fertilizing with mineral fertilizers (ammonium nitrate 300 kg/ha)	August	Tractor T-25+ mineral fertilizer spreader RUM-0.35
43	Application of potash fertilizers 150 kg/ha	August	Tractor T-25+ trailed sprayer OP 18
44	Dismantling the drip irrigation system	September	manually
45	Harvesting with laying in rows	September	manually
46	haulm cutting	September	manually
47	Packing onions into nets with sorting	September	manually

The plot of onion cultivation under drip irrigation is shown in Figure 1.



Figure 1. Onion cultivation on drip irrigation in the farm "AISHA"

The drip irrigation mode with the accepted soil moisture threshold for the phases of bulb development in the experiment options is shown in Table 2.

Table 2

Drip irrigation mode on loamy soils on experimental options

Phases of onion development	Experiment option	Soil moisture, % HB	Humidification depth, m	Irrigation rate, m ³ /ha
Seedlings - Bulb formation	1	85	0.1...0.2	30...35
	2	80	0.1...0.2	30...35
	3	70	0.1...0.2	30...35
	4 (control)	70...100	0.1...0.2	30...35
Formation - the beginning of the ripening of onion bulbs	1	75	0.2...0.25	45...50
	2	80	0.2...0.25	45...50
	3	70	0.2...0.25	45...50
	4 (control)	70...100	0.2...0.25	45...50
Bulb ripening	1	70	0.25...0.30	75...100
	2	80	0.25...0.30	75...100
	3	70	0.25...0.30	75...100
	4 (control)	70...100	0.25...0.30	75...100

Based on the results of the research, they determined irrigation norms for the experiment options, onion yields and water productivity (Table 3).

The authors have established that the most effective is the observance of the soil moisture level differentiated by the phases of onion development in option 1. Here, the onion yield for the studied years is provided from 98.9 t/ha to 103.2 t/ha with a water use productivity of 45.54 ...53.48 m³/ha. In option 2, with maintaining soil moisture at the level of 80% HB, an increase in yield from 99.2 t/ha to 100.6 t/ha is observed in comparison with option 1, but at the same time, considering water productivity, in comparison with option 1, there are high costs of water to create a unit of production. In option 3, with soil moisture at the level of 70% HB throughout the growing season, the onion yield decreased to 89.3...96.5 t/ha with an increase in water consumption to 47.77... 59.57 m³/t. In the control option with maintaining soil moisture at the level of 70...100% HB, the onion yield varied from 86.2 t/ha to 93.2 t/ha with an increase in water consumption from 51.61 m³/t to 63.22 m³/t.

Table 3*Drip irrigation mode on loamy soils on experimental options*

Year of research	Experiment option	Soil moisture, % HB	Irrigation rate, m ³ /ha	Actual yield, t/ha	Water productivity, m ³ /t
2020	1	85...75...70	5150	98.9	52.07
	2	80	5210	99.2	52.52
	3	70	5090	93.1	54.67
	4 (control)	70...100	5250	90.1	58.26
2021	1	85...75...70	5380	100.6	53.48
	2	80	5430	101.2	53.66
	3	70	5320	89.3	59.57
	4 (control)	70...100	5450	86.2	63.22
2022	1	85...75...70	4700	103.2	45.54
	2	80	4750	103.8	45.76
	3	70	4610	96.5	47.77
	4 (control)	70...100	4810	93.2	51.61

Upon completion of the harvest, an assessment of the vegetative parameters of the onion was performed according to the experimental options to establish the effect of soil moisture on the appearance, size of the bulbs, degree of maturity, the presence of double bulbs, and more. It was established that the bulbs in all experiment options were mature, intact, without damage by agricultural pests, with dry outer scales without excessive external moisture. The bulbs are hard and dense. Regarding the size of the bulbs, it should be noted that the size of the bulbs in the largest transverse diameter of more than 4...5 cm is noted in options 1 and 2. At the same time, in option 2, higher vegetative parameters were observed, such as plant height, bulb and neck diameter. In option 3, the size of the bulbs is from 3 to 5 cm, while up to 20% of the bulbs are up to 4 cm in size. In options 2 and 4 (control), a higher water supply led to the presence of double bulbs up to 6%, associated with waterlogging of the bulbs in the formation phase and bulbs begin to mature.

According to the research results, for irrigated lands of the arid zone of Kazakhstan, the optimal soil moisture threshold for onion drip irrigation is recommended for the following phases of onion development. In the phase from the emergence of seedlings to the beginning of the formation of bulbs, one should maintain the optimal moisture threshold at the level of 85% HB. In the phase of formation - the beginning of the ripening of the bulbs, - a decrease in soil moisture to a level of 75% HB is required, with a further decrease in soil moisture to 70% HB for the ripening phase of the bulbs. Under such conditions, we noted the lowest water consumption per production unit and an improvement in the vegetative parameters of onions

4. DISCUSSION

The results of the field experiment allow to establish the features of the onion growing technology under drip irrigation, to determine the optimal moisture level in the phases of plant development and to assess its effect on the yield and vegetative parameters of an agricultural crop.

For the arid zone of Kazakhstan, the main technological operations for growing onions with drip irrigation have been established, including measures for preparing and cultivating the soil, treating plants to protect them from damage by pests and diseases, improving their nutrient medium, eliminating weeds, and others.

The optimal threshold of soil moisture is determined, taking into account the peculiarities of onion water consumption in the phases of plant development. The onion yield is estimated in experimental variants with different supported thresholds of soil moisture. Providing water in the first 3-4 weeks after germination until the onion began to form with soil moisture at 85% HB, maintaining the soil moisture level at 75% HB in the formation phase - the beginning of

the ripening of the bulbs and 70% HB before the ripening phase of the bulbs ensured optimal conditions for the development of onions and their high yield.

Particular attention should also be paid to the fact that with the optimal use of water for drip irrigation of onions, an important factor is also providing plants with the necessary fertilizers, including macro and microelements, which have a significant impact on the productivity of this agricultural crop.

Based on the research results, for the arid zone of Kazakhstan, it is recommended to maintain soil moisture in the 0.1...0.3 m layer at a level of 85% HB from the emergence of seedlings until the beginning of onion formation, at a level of 75% HB in the formation phase - the beginning of bulb ripening and 70% HB until the bulb ripening phase. At the same time, the assessment of the vegetative parameters of onions according to the experimental variants shows that the optimal soil moisture, taking into account the onion's requirements for water, taking into account the characteristics of the onion development phases, eliminates the appearance of negative factors that worsen the onion's parameters when the soil is over-moistened.

5. CONCLUSION

For the arid zone of Kazakhstan, the researchers have established the main technological operations for the onion cultivation under drip irrigation, including measures for preparing and tilling the soil, treating plants to protect them from damage by pests and diseases, improve their nutrient medium, eliminate weeds, and others.

The authors determined optimal soil moisture threshold, considering the peculiarities of onion water consumption by plant development phases. Providing water in the first 3...4 weeks after germination before the onion formation begins with a soil moisture content of 85% HB, maintaining the soil moisture level at 75% HB in the formation phase - the beginning of bulb ripening and 70% HB before the bulb ripening phase provided optimal onion development conditions. An increase in the onion yields up to 103.2 t/ha was achieved with the water use productivity at the level of 45.54...53.48 m³/ha. The paper gives an assessment of the vegetative onion parameters. The size of the bulbs according to the largest transverse diameter is more than 4...5 cm. The bulbs are hard and dense. There are no double bulbs, which indicates that the soil moisture level corresponds to the physiological needs of the onion in the phases of its water consumption. The authors recommend the established soil moisture threshold for onion development phases and the list of technological operations for growing onions with drip irrigation for use in the arid zone of southern Kazakhstan.

DATA AVAILABILITY

The data used in this study were obtained by the authors from the following sources: research conducted at the Aisha Farm Production Unit (FPU), located in the Sorbulak rural district of the Kordai District, Zhambyl Region.

AUTHORS' CONTRIBUTION

Conceptualization – VZh; resources - AB; formal analysis – AB; methodology - NB; supervision - PK; visualization – PK; writing—original draft preparation – EZh; writing—review and editing -EZh.

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REFERENCES

1. Annual Bulletin of Monitoring the State and Change of Climate in Kazakhstan: 2023. Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan. Republican State Enterprise "Kazhydromet", Research Center, Astana, 2024, p.: 90.
2. FAO. 2021. The State of the World's Land and Water Resources for Food and Agriculture (SOLAW 2021). The systems are on the limit. Summary report 2021, Rome: p. 77. Date views 02.07.2022 www.doi.org/10.4060/cb7654r.
3. Annual Report 2020-21 ICID. 2021. New Delhi (INDIA): International Commission on Irrigation and Drainage, pp: 82-86.
4. Kvan, Yu.R., Zharkov, V.A., Angold, E.V. 2014. Methods and technologies of watering in irrigated agriculture. Scientific researches in land reclamation and water economy: Collection of scientific works of LLP "KazSRIWE", Taraz, Vol. 51, Iss. 1, pp: 126-134.

5. Ortola, M.P., Knox, J.W. 2015. Water relations and irrigation requirements of onion (*Allium cepa* L.): a review of yield and quality impacts. *Experimental Agriculture*, Vol. 51, Iss. 2, pp: 210 – 231.
6. Al-Jamal, M.S., Sammis, T.W., Ball, S.T., Smeal, D. 2000. Computing the crop water production function for onion. *Agricultural Water Management*, Vol. 46, Iss. 1, pp: 29-41.
7. Firissa, O., Seyoum, T., Abegaz, F. 2013. Effect of drip lateral spacing and mulching on yield, irrigation water use efficiency and net return of onion (*Allium cepa* L.) at Ambo, Western Shoa, Ethiopia. *Journal of Horticulture* pp: 63-69.
8. Vybornov, V.V., Zaitsev, V.A. 2021. onion drip irrigation. *IOP Conf. Ser.: Earth Environ. Date Views* 02.07.2022. URL: www.iopscience.iop.org/article/10.1088/1755-1315/843/1/012064/
9. Kalmykova, E.V., Petrov, N.Yu., Fomin, S.D., Kalmykova, O.V., Vorontsova, E.S., Koshkarova, T.S., Ileneva, S.V. 2020. Perspective agriculture cultivation of the bulb onion with drip irrigation. *Bulgarian Journal of Agricultural Science*, 26 (4): pp: 877–884.
10. Shock, C.C., Feibert, E.B.G., Saunders, L. 2005. Onion Response to Drip Irrigation Intensity and Emitter Flow Rate. *HortTechnology*, 15(3).
11. Enciso, J., Jifon, J., Anciso, J., Ribera, L. (2015). Productivity of Onions Using Subsurface Drip Irrigation versus Furrow Irrigation Systems with an Internet Based Irrigation Scheduling Program. *International Journal of Agronomy*, Vol. 2015, pp. 6.
12. How to water onions properly? *Date Views* 02.07.2022 (2022) www.ferma.expert/rasteniya/ovoshchi/luk/polivat/.
13. Zheng, J., Huang, G., Wang, J., Huang, Q., Pereira, L.S., Xu, X., Liu, H. (2012). Effects of water deficits on growth, yield and water productivity of drip-irrigated onion (*Allium cepa* L.) in an arid region of Northwest China. *Irrigation Science*, Vol. 31(5), pp. 995–1008.
14. Solovyeva, O.A. (2022). Onion cultivation technology under drip irrigation. *News of the Nizhnevolszhsk Agricultural University Complex: Science and Higher Professional Education*, 1(65), pp. 171-179.
15. Grigorov S.M., Vinnikov D.S. (2016). Bulb onion water consumption and ways of efficiency improvement of water resources utilization in drip irrigation. *Scientific journal of the Russian Scientific Research Institute for Land Reclamation Problems*, 3(23), pp. 19-35.
16. Balgabayev, N.N., Kalashnikov, A.A., Baizakova, A.E. (2016). Elaboration of Subsurface Irrigation Technique of Onions. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 7(2), pp. 738-751.
17. Dingre, S.K., Pawar, D.D. (2020). Response of drip irrigated onion (*Allium cepa* L.) growth, yield and water productivity under deficit irrigation schedules. *Journal of Natural Resource Conservation and Management*, Vol. 1(1), pp. 69-75.
18. Shareef, T.M.El., Ma, Zh., Zhao, B. (2019). Essentials of Drip Irrigation System for Saving Water and Nutrients to Plant Roots: As a Guide for Growers. *Journal of Water Resource and Protection*, Vol.11(9), pp. 1129-1145.
19. Shock, C.C.; Feibert, E.B.G.; Pinto, J.M. (2013). Review of two decades of progress in the development of successful drip irrigation for onions. *Irrigation Show & Education Conference*.
20. Metwally, A.K. 2011. Effect of water supply on vegetative growth and yield of onion (*Allium Cepa* L.). *Australian Journal of Basic and Applied Science*, 5(12), pp: 3016-3023.
21. Meteorological database –URL: http://ecodata.kz:3838/dm_climat_ru/
22. Dospekhov, B.A. (1985). *Methodology of field experience (with basics of statistical processing of research results)*. Moscow: Kolos, pp. 416.

ОҢТҮСТІК ҚАЗАҚСТАННЫҢ ҚҰРҒАҚ АЙМАҒЫНДА ТАМШЫЛАТЫП СУАРУ КЕЗІНДЕ ПИЯЗ ӨСІРУ ТЕХНОЛОГИЯСЫНЫҢ ЕРЕКШЕЛІКТЕРІ

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ТҮЙІН СӨЗДЕР

тамшылатып суару,
пияз өсіру,
өнімділік,
су өнімділігі

АБСТРАКТ

Оңтүстік Қазақстанның құрғақ аймағында пияз өсіру технологиясы оның дамуының негізгі кезеңдерін ескере отырып, вегетациялық кезеңде топырақтың ылғалдылығына осы дақылдың нақты талаптарын ескеруі керек. Зерттеудің мақсаты өсімдіктердің даму фазалары үшін ылғалдың оңтайлы шегін анықтай отырып және оның дақылдардың өнімділігіне әсерін бағалай отырып, тамшылатып суару әдісімен пияз өсіру технологиясының ерекшеліктерін анықтау болды. Зерттеу әдісі арнайы бөлінген эксперименттік аймақтағы далалық тәжірибе. Авторлар тамшылатып суару 103.2 т/га - ға дейін өнімділікті қамтамасыз ететінін анықтады, өнгеннен бастап баданалар пайда болғанға дейін топырақ ылғалдылығының шегі 85% НВ, топырақ ылғалдылығының одан әрі төмендеуімен 75% НВ деңгейіне дейін қалыптасу кезеңі-баданалардың пісуінің басталуы және баданалардың пісуіне дейін 70% НВ деңгейіне дейін.

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ОСОБЕННОСТИ ТЕХНОЛОГИИ ВЫРАЩИВАНИЯ ЛУКА ПРИ КАПЕЛЬНОМ ОРОШЕНИИ В АРИДНОЙ ЗОНЕ ЮГА КАЗАХСТАНА

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КЛЮЧЕВЫЕ СЛОВА

капельное орошение,
выращивание лука,
урожайность,
водоотдача

АБСТРАКТ

Технология выращивания лука в засушливой зоне Южного Казахстана должна учитывать специфические требования этой культуры к влажности почвы в течение всего вегетационного периода, учитывая основные фазы ее развития. Целью исследований было установление особенностей технологии выращивания лука репчатого в условиях капельного орошения с определением оптимального порога влажности для фаз развития растений и оценка его влияния на урожайность. Метод исследования - полевой опыт на специально отведенном опытном участке. Авторами установлено, что капельное орошение обеспечивает урожайность до 103.2 т/га при пороговом значении влажности почвы 85% НВ от всходов до начала формирования луковиц с дальнейшим снижением влажности почвы до уровня 75% НВ в фазу формирования - начало созревания луковиц и до минимального уровня влажности почвы в период вегетации. уровень НВ до созревания луковиц должен составлять 70%. Данная технология рекомендована к применению в фермерских хозяйствах юга Казахстана для повышения продуктивности и качества продукции.

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