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DEFINITION OF THE CRITERIA INFLUENCING ON CULTIVATION CONDITIONS OF ONIONS

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ABSTRACT
Bulb onion is one of the most profitable crops among the vegetable group; this fact determines the relevance of the choice of the most suitable plots for its growing on light kastanozems. The purpose of the research is the scientific substantiation of methodical positions and the definition of reliable criteria for the assessment of land for the cultivation of bulb onions on intensive technology. The studies were conducted in the household «Khvan V.A.» in 2008-2015 on the following onion hybrids: Banco F_1, Hilton F_1, Exacta F_1, Gladstone F_1, Rossa di Firenze F_1, Manas F_1. During the study of crop rotations, natural soil fertility and fertilizers system the standard for vegetable growing methods of field experiments were used. The influence of growing conditions on yield of bulb onion was analyzed. The criteria of soil estimation, allowing predicting success of the growth and development of onion plants were determined. Correlation analysis showed that the granulometric composition of soils (r=0.79), natural fertility (0.71) and the system of fertilizers (r=0.54) have most significant influence on the formation of the yield. Found that rye and wheat, grown for green manure, are the best precursors on light kastanozems. It is revealed that onion is necessary to place the on medium loamy soils, where the highest productivity of hybrids is observed. The significant influence of the granulometric composition of soil on onion plants was substantiated. The best soil differences for this culture (light loam, medium loam), where productivity of crops is increased to 80-90 t/ha were selected. Criteria that determine the success of the cultivation of bulb onion on light kastanozems were identified, which will help to efficiently plan the crop rotation and predict the crop growth to increase production stability.

KEY WORDS
Bulb onion, crop rotations, predecessors, light kastanozems, fertility, fertilizers system.

Bulb onion is one of the priority crops for the Volgograd region. The demand of it in the market leads to a continuous increase in production and the increase of areas. In connection with the necessity of culture in high level agrotechnics, the provision of nutrients and irrigation norms, comprehensive analysis of the factors affecting yield formation during selecting plots for onion growing is required [1]. However, genetic potential is not always realized in a production environment. This is reflected in the data on average crop yield in the region. It amounts to 40-50 t/ha, which is 20-40 % below potential productivity achieved in the advanced farms [5].

The intensive technology of cultivation allows regulating the water regime, mineral nutrition, protective measures [2, 4]. Set of factors composing the soil fertility is lesser manageable [6, 7]. Agrochemical analysis allows establishing the sufficiency of soils by nutrients, but does not give a full picture of land productivity due to the complex action of factors [8, 9]. However, light kastanozems are very diverse, even on relatively small areas. This leads to the occurrence of inhomogeneity in crops and yield losses. Conducting the detailed evaluation of the plots where onion is cultivated allows obtaining the necessary data for the adjustment of farming practices and for the improving of soil fertility.

It is important to make the right choice of evaluation criteria for complex analysis, especially at plots where onions are grown in the rotation for a long time, and long-term data about the success of its growth and development are available [11]. The distribution of the

fields on the attractiveness for growing this crop is possible on the basis of a certain evaluation rating scale based on several criteria. Its scientific justification allows to conduct deep analysis and to obtain reliable results that are the new actual direction of the work. To detect the influence of strength factors in crop production uses the dispersion analysis.

During the exploration of the results of field observations of growth and development for different hybrids of onion, agrochemical indicators of soils, effect of precursors by the method of dispersion analysis, it is possible to identify the most significant criteria for the compilation of the evaluation scale of the suitability of the plots. In this regard, the aim of this study was the scientific substantiation of methodical positions and the identification of reliable criteria for the assessment of plots for onion cultivation with intensive technologies on light kastanozems.

PROGRAM AND METHODS OF RESEARCH

The research was carried out in 2008-2015 on the basis of the fields of «Khvan V.A.» of the Gorodishchensky district of the Volgograd region. Soils are complex light kastanozems with the average humus content from 1.26 to 1.74 %. Soils characterized by a neutral reaction in upper horizon of the soil (pH 7.2-7.3) and slightly alkaline below. The absorption capacity of the grounds is 13-35 mg-eq per 100 g of soil. In the composition of absorbed bases calcium and magnesium that comprise 85-97 % of the capacity of exchange are dominated. Absorbed sodium may be 3-15 %. Soils have a low content of nitrogen and the average content of mobile forms of phosphorus and potassium.

At the area of the crop rotation of 67.2 hectares, onion culture takes 59.5%. In the experiments we have used the technology of cultivation that common in the region. The irrigation is drip. In the system of protection from diseases, pests and weed plants the next remedies were used: Stomp, Goal 2E, Centurion, Sharp 600, Konfidor, Euphoria, Lanat, Ridomil gold, Corset, Bravo.

Monopotassium phosphate, calcium and potassium nitrates, ammonium nitrate, magnesium and potassium sulfates, Isabion, Grogreen Drip were used for additional fertilizing. The application rate of pesticides was applied according to recommended procedures. The assortment is comprised by the following hybrids of onion: Banco F_1, Hilton F_1, Exacta F_1, Gladstone F_1, Rossa di Firenze F_1, Manas F_1 [10, 11]. Field experiments and processing of results of studies carried out in accordance with the recommendations adopted in vegetable production [3]. Methodological basis of research was «Guidelines on the selection of onion crops» (1997), «The methodology of the tests for distinctness, uniformity and stability» (2001), «The methodology of state variety testing of agricultural crops» (edited by A. M. Fedina, 1985), «Methodology of scientific experience in the vegetables and melons» (edited by V. F. Belik, 1992).

In field experiments over the years of studies, phonological observations of the growth and development of plants, the seasonal dynamics of productivity and the yield of hybrids were conducted. The factors causing the stress of onion plants were revealed according to plants condition and physiological indicators. The obtained data were processed using variance and correlation analyses (Dospekhov B.A., 1985) with the program Statistica.

RESULTS AND DISCUSSION

In the field experiment the influence of precursor (factor A) on yield of onion hybrids (factor B) was studied. Crop rotation included clean fallow, green manure fallow, carrots, pumpkins and bulb onions. Positive impact on the yield of bulb onion was observed in clean fallow and green manure fallow, which is expressed in increasing productivity of crops by 2.7-11.4% and 4.8-17.0%, respectively. Winter rye showed the best results in the experiment as a green manure. After this crop, yield of onions in the plots was increased by 9.1-17.0% (table 1).

Carrot was used as a good precursor for onions. Its impact on yield was minimal and amounted to less than 6%. Pumpkin has a most negative impact on the onion crops. Its

crops have a high degree of infestation by weeds, which worsen the sanitary condition of the onion crops in the coming year and reduce productivity down to 12%. Dispersion analysis showed the significance of the influence of the granulometric composition of soils on the yield of onion hybrids (table 2).

Table 1 – Yield of onion hybrids in the dependence of precursor in 2013-2015, t/ha

Precursor (factor A)	Hybrids (factor B)					
	Banco F_1	Hilton F_1	Manas F_1	Gladstone F_1	Exacta F_1	Rossa di Firenze F_1
2013						
Fallow	86,2	64,1	75,5	82,4	78,2	80,3
Pumpkin	76,4	58,3	69,8	77,6	72,3	75,7
Winter rye *	89,4	65,7	79,5	84,7	83,6	84,2
Winter wheat*	88,7	64,9	78,9	83,1	82,4	83,7
Carrot	84,6	60,4	71,6	79,3	75,8	78,1
The average value	85,06	62,68	75,06	81,42	78,46	80,4
2014						
Fallow	87,5	68,4	70,2	80,7	79,4	76,8
Pumpkin	75,3	60,7	63,4	75,3	74,9	71,5
Winter rye *	89,8	72,2	73,2	83,8	82,1	79,2
Winter wheat*	88,5	71,6	72,6	82,4	80,9	78,4
Carrot	85,7	64,6	65,6	78,2	76,3	74,8
The average value	85,36	67,5	69,0	80,08	78,72	76,14
2015						
Fallow	86,8	69,1	72,6	81,4	82,6	78,1
Pumpkin	76,7	63,7	64,3	76,7	78,1	71,8
Winter rye *	91,3	74,2	76,6	83,6	85,2	83,3
Winter wheat*	90,5	72,8	75,2	82,1	83,8	81,7
Carrot	84,2	65,3	69,3	78,5	80,3	75,7
The average value	85,9	69,02	71,6	80,46	82,0	78,12

The least significant difference: factor A 1.48; factor B 1.62; factor AB 1.15
*Note: * winter rye and winter wheat was grown as a green manure*

Table 2 – Influence of soil granulometric composition on the yield of onion hybrids

Granulometric composition of soils (factor A)	Hybrids (factor B)					
	Banco F_1	Hilton F_1	Manas F_1	Gladstone F_1	Exacta F_1	Rossa di Firenze F_1
2013						
Heavy loamy soils	81,2	59,4	70,8	76,2	73,4	73,8
Medium loamy soils	89,2	65,3	79,2	83,9	83,1	83,9
Light loamy soils	85,7	63,5	75,1	81,7	77,6	79,4
The average value	85,37	62,73	75,03	80,6	78,03	79,03
2014						
Heavy loamy soils	81,5	62,6	63,1	75,8	73,2	72,2
Medium loamy soils	89,2	71,9	73,1	82,9	81,6	78,9
Light loamy soils	86,9	67,7	67,2	80,1	78,7	76,1
The average value	85,87	67,4	67,8	79,6	77,83	75,73
2015						
Heavy loamy soils	80,7	64,2	66,6	75,3	74,7	73,1
Medium loamy soils	90,7	73,6	75,9	82,7	84,4	82,6
Light loamy soils	86,1	68,4	71,9	80,7	81,2	77,4
The average value	85,83	68,73	71,47	79,57	80,1	77,7

The least significant difference: factor A 1.47; B 2.08; AB 1.47

In conditions of light kastanozems medium loamy differences are the most favorable for the cultivation of this culture. The increase in the fraction of physical clay in the soil up to 50-60% leads to a decrease in onion yield by 9-10%. On light loamy soils this connection is less pronounced (4-5 %). It was observed that hybrids with high potential productivity (Banco F1, Exacta F1 and Gladstone F1) is sensitive to growing conditions, which limiting their intensive growth.

Studies have shown that on light kastanozems, during the formation of the onion harvest, primarily nitrogen and phosphorus is in deficit. Removal of potassium, magnesium and calcium occur in a much lesser extent. The sufficiency of soils by these elements in vegetable crop rotation is at the level of the annual consumption of onions.

During onions cultivation, by the expense of natural soil fertility only 12% of nitrogen, 23.1% of phosphorus, 41.4% of potassium, 27.9% of magnesium, 60% of calcium is provided. Therefore, despite the relatively high contents of specific nutrients, their uptake by plants is hindered, which can cause abnormalities in the development.

Crop rotation contributes to a more rational use of nutrients between cultures, however this cannot fully satisfy quickly developing plants, causing stress. Necessity for the main food elements of onion hybrids is higher from 1.7 to 8.3 times (especially nitrogen).

The natural fertility of light kastanozems ensures the yield of onion at the level of 24.4-28.9 t/ha, which does not allow to fully realize the genetic potential of the hybrids. This happens primarily because of the lack of nitrogen, which is required in the greatest quantity for the growth of onion bulb (table 3).

Table 3 – Estimation of the influence of natural soil fertility on the yield of onion hybrids (grown without fertilizer application)

Soils (factor A)	Hybrids (factor B)					
	Banco F_1	Hilton F_1	Manas F_1	Gladstone F_1	Exacta F_1	Rossa di Firenze F_1
Heavy loamy weakly gummed	22,6	19,0	20,2	21,4	20,2	19,0
Medium loamy medium gummed	33,1	27,8	29,6	31,3	29,6	27,8
Medium loamy weakly gummed	29,6	25,0	28,1	28,1	26,5	25,0
Light loamy weakly gummed	30,4	25,6	27,2	28,8	27,2	25,6
The average value	28,9	24,4	26,3	27,4	25,9	24,4

The least significant difference: factor A 0.70; B 0.49; AB 0.41

Studying the results of experiments by the method of principal components allowed determining the share of the influence of each factor on the yield of bulb onion. Relationship between precursor and other factors was insignificant (table 4). The correlation coefficient was 0.19 and 0.27 and distributed almost equally between the factors. Close relationship between the granulometric composition of the soil and natural fertility (correlation coefficient of 0.79), which is also connected with the fertilizers system (correlation coefficient of 0.71), is revealed.

Table 4 – Correlation coefficients in the system of factors influencing the yield of onion hybrids

Factors	Precursor	Granulometric composition of the soil	Natural soil fertility	Fertilizers system
Precursor	0,267019	0,111684	0,169203	0,452094
Granulometric composition of the soil	0,271665	0,079997	0,103606	0,544732
Natural soil fertility	0,192228	0,790288	0,016832	0,000652
Fertilizers system	0,269089	0,018030	0,710359	0,002522

The relationship of precursor and granulometric composition of the soil with fertilizers system is expressed by medium level (correlation coefficient of 0.45 and 0.54). This analysis allows us to conclude that during the formation of bulb onion yield it is important to provide the plants with nutrients in a time when it is needed. This gives the opportunity to receive yields at the level of 75-80% of the potential productivity of hybrids. The system of mineral nutrition of bulb onion is based on the distribution of feeding time and allows differentially provide plants with the necessary elements. Studies have shown that using the set of specially selected fertilizers, applied through the drip irrigation system, is possible to optimize the mineral nutrition of onion (table 5).

Table 5 – Distribution of additional fertilizing by onion growth phases

Fertilizer	Norms (kg/ha) by the phases of development			Total, kg/ha
	1st (25 days)	2nd (35 days)	3rd (60 days)	
Terraflex start	25	0	0	25
Monopotassium phosphate	50	0	75	125
Magnesium nitrate	25	75	50	150
Calcium nitrate	30	100	75	205
Potassium nitrate	25	100	120	245
Ammonium nitrate	80	160	400	640
Phosphoric acid 57%	18	90	70	178

Assessment of the degree of influence of fertilizers system on crops of onion hybrids showed that providing plants with necessary food elements allows obtaining a high yield.

CONCLUSION

Criteria that determine the success of the cultivation of onion on light kastanozems are identified. Studies have shown that factors that increase the yield of crops are using green manure in the system of soil preparation, using carrots as a precursor or clean fallow plots, placing onions on medium loamy soils and application of balanced fertilizers system. Natural fertility of the soil, its granulometric composition and the applied fertilizers system have the most significant effect on the yield of onion. In the combination of factors these positions have a share of 88.3% and determine the size of the yield of onion hybrids. The obtained results allow carrying out an objective assessment of the suitability of the plots allocated for onion growing.

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