

The influence of irrigation regimes and fertilizer rates on growth and yield of corn varieties

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Abstract

The article presents the results of studying the influence of irrigation regimes and fertilizer rates on the growth, development of plants and the yield of varieties of sugar and dent corn. In the field experiments carried out under irrigated meadow-sierozem soils, it was revealed that maintaining the pre-irrigation soil moisture regime at the level of 70-80% PISM and applying fertilizers at a rate of 30 t/ha manure + N₂₀₀P₁₆₀K₁₀₀ kg/ha has a positive effect on the growth and development of plants, lengthens the growing season by 2-7 days, the formation of tall, leafy plants with an optimal leaf area (0.81-0.89 m²), as a result of which bushes with high productivity are formed (2.4-2.9 pieces of ears).

The grain yield for sweet corn varieties ranged from 5.6-10.0 t/ha, and for indentata corn varieties - 6.1-12.8 t/ha. The highest grain yield (8.6-12.8 t/ha) in the studied maize varieties was obtained with an irrigation regime of 70-80% PISM on an organic-mineral nutritional background (30 t/ha of manure + N₂₀₀P₁₆₀K₁₀₀ kg/ha). At the same time, the yield increase was 3.0-4.6 t/ha.

Key words: varieties of corn sacharata and indentata; fertilizer rates; irrigation regime; the preirrigation soil moisture (PISM); irrigation rate; increment of yield

INTRODUCTION

The introduction and acclimatization of plants occupies an important place in ensuring food security of the peoples of the world (Ostonakulov, 2002; Ostonakulov et al., 2020). Sugar (vegetable) and dent-like corn in the world is a valuable food product of the population and is widely cultivated in the USA, China, Brazil, Argentina, Ukraine and other countries on an area of 192 million hectares and produces 1.1 billion tons of grain (Ostonakulov et al., 2009; 2019). In recent years, farmers and peasants in the republic have shown great interest in this culture as a profitable culture. It is used for food during the period of milky-wax ripeness of grain in fresh, canned and frozen form.

As a result of breeding work, we have bred and included in the State Register of the Republic varieties and hybrids of sweet corn - Sherzod, Zamin, Zamon, and of indentata corn – Samarkandskaya zubovidnaya, Okpatri and others.

Currently, the technology of cultivation for food and seeds, improvement of primary and elite seed production is being developed.

Considering the above, in 2017-2020 we carried out field experiments on irrigated meadow-sierozem soils of the Samarkand Scientific Experimental Station of the Scientific Research Institute of Vegetable and Melon Crops. The mechanical composition of the soil is medium loamy with groundwater deposition at a depth of 4-5 m. Agrochemical indicators of the arable layer are characterized by a low content

of humus (0.98-1.11%), nitrate nitrogen (8.41-10.67 mg/kg), mobile phosphorus (25.43-27.61 mg/kg), exchangeable potassium (186-203 mg/kg) soil.

MATERIALS AND METHODS

The purpose of the research is to study the growth, development and productivity of sweet corn varieties Sherzod, Zamon and dent corn Sarik donli L-113, Kizil yaltirok donli L-205 (Samarkandskaya zubovidnaya), Ok donli L-27 (Okpari) under various irrigation regimes and fertilizer rates and as a result, to establish the optimal parameters of the irrigation regime and fertilizer rates, ensuring a stable high yield of at least 8.5-9.0 tons per hectare.

In the experiments, 2 irrigation regimes were studied according to pre-irrigation soil moisture not lower than 65-70 and 70-80% PISM. In each irrigation mode, the following fertilizer rates were studied: 1. $N_{150}P_{120}K_{75}$; 2. $N_{200}P_{160}K_{100}$; 3. 30 t/ha manure + $N_{150}P_{120}K_{75}$; 4. 30 t/ha manure + $N_{200}P_{160}K_{100}$.

On the experimental plot of the maximum field moisture capacity of the soil (PISM) in the first period "shoots - panicle formation" 0-50 cm in the soil layer was 22.17%, the bulk density of the soil was 1.34 g/cm³, and in the second period "formation panicles - full ripeness" 0-100 cm³ in the soil layer - 21.64%, and the bulk density - 1.36 g/cm³.

With the irrigation mode for pre-irrigation soil moisture not lower than 65-70% PISM, 6 irrigations were carried out according to the scheme 2-4 with an interval of 18-16-14-12-10-10 days. The irrigation rate is 5696-5734 m³/ha, and the irrigation rate is 827-1185 m³/ha.

Under the irrigation mode, according to the pre-irrigation soil moisture not lower than 70-80% PISM, they were watered 8 times according to the 3-5 scheme, that is, in the first period "shoots - panicle formation" 3 times, and in the second period "panicle formation - full ripeness" - 5 once every 15-13-10-9-8-7-7-9 days with an irrigation rate of 5451-5500 m³/ha, and an irrigation rate of 536-918 m³/ha.

The irrigation rate was determined by the moisture deficit, and the deviations of the actual pre-irrigation soil moisture did not exceed \pm 1-2%, which is within the recommended rates. Irrigation water accounting was carried out using a Chipoletti spillway.

The full rate (100%) of manure, potash fertilizers, 75% of the annual rates of phosphate fertilizers was applied for fall plowing. The rest (25%) norms of phosphorus during sowing, and nitrogen fertilizers in top dressing (the first - during the formation of 5-6, and the second - 10-12 plant leaves).

Sowing was carried out on April 28-30 according to the scheme 70x20 cm. The plot area was 560 m² for irrigation, 112 m² for fertilizer, and 56 m² for varieties. Repetition three times.

In the experiment, all records, observations, analyzes and calculations were carried out according to the generally accepted methodology and recommendations (Dospekhov, 1985; Ostonakulov & Beknazarova, 2010; Ostonakulov et al., 2019).

RESULTS AND DISCUSSION

Research results have shown that irrigation and fertilization rates have a significant impact on plant growth and development and corn yield.

As can be seen from Table 1, the growing season for both varieties of sweet corn (*Zea mays* L. Sacharata) was 81-93 days according to the variants of the experiment. With the irrigation mode for pre-irrigation soil moisture 65-70% PISM, according to the fertilizer norms, the growing season of plants in both varieties was extended by 3-7 days, and with the irrigation mode for pre-irrigation soil moisture 70-80% PISM - 2-6 days. With an increase in the pre-irrigation soil moisture regime from 65-70 to 70-80%, the PISM of the vegetation of plants is lengthened by 2-4 days and is 83-93 days for varieties. When maintaining the regime of pre-irrigation soil moisture not lower than 70-80% PISM on an organic-mineral background, at a rate of 30 t/ha manure + $N_{200}P_{160}K_{100}$ kg/ha turned out to be favorable for the formation of tall (172-184 cm), leafy (14.6-15.7 pcs.) and with a thick leaf surface (0.81-0.89 m²) of plants with high productivity (2.4-2.9 pieces of ears from a bush).

The yield of sweet corn grain in the Sherzod variety, according to the experimental options, ranged from 5.6 to 8.6 t/ha, and in the Zamon variety from 6.4 to 10.0 t/ha. The highest grain yield in both varieties (8.6-10.0 t/ha) was obtained with an irrigation regime of 70-80% PISM on an organic-mineral nutritional background (30 t/ha of manure + $N_{200}P_{160}K_{100}$ kg/ha). A relatively high grain yield

Table 1. Growth, development and productivity of sweet corn varieties (Zea mays L. sacharata) under different irrigation regimes and fertilization rates

№	Irrigation mode, % PISM	Experience options fertilizer rate, kg (t)/ha	Vegetation period, in days				Main stem height, cm	Number of leaves, of the main stem, pcs.	Leaf area from 1 plant, m ²	Yield by years			Productivity, t/ha		Deviation from control		Irrigation water consumption per 1 center of grain, m ³
			2017	2018	2019	t/ha				%	t/ha	%	t/ha	%			
															by irrigation regime	by fertilizer rates	
At the variety Sherzod (standard)																	
1	65-70 (control)	N ₁₅₀ P ₁₂₀ K ₇₅ (control)	81	146	10,4	0,51	5,5	5,4	5,9	5,6	-	-	-	100	102,1		
2		N ₂₀₀ P ₁₆₀ K ₁₀₀	84	155	11,9	0,57	5,9	6,0	6,4	6,1	-	-	0,5	109	93,7		
3		30 t/ha manure +N ₁₅₀ P ₁₂₀ K ₇₅	86	161	12,2	0,62	6,6	7,3	7,1	7,0	-	-	1,4	125	81,6		
4		30 t/ha manure +N ₂₀₀ P ₁₆₀ K ₁₀₀	88	167	12,6	0,66	7,2	7,7	7,9	7,6	-	-	2,0	136	75,2		
5	70-80	N ₁₅₀ P ₁₂₀ K ₇₅	83	152	10,8	0,54	6,1	6,6	6,2	6,3	0,7	113	-	100	86,9		
6		N ₂₀₀ P ₁₆₀ K ₁₀₀	87	167	12,4	0,61	6,5	7,3	7,1	7,0	0,9	115	0,7	111	78,2		
7		30 t/ha manure +N ₁₅₀ P ₁₂₀ K ₇₅	90	170	13,3	0,74	7,7	8,1	8,2	8,0	1,0	114	1,7	127	68,4		
8		30 t/ha manure +N ₂₀₀ P ₁₆₀ K ₁₀₀	92	172	14,6	0,81	8,4	8,5	8,9	8,6	1,0	113	2,3	137	63,7		
										Sx-(%)=							
										LSD₀₅(t/ha)=							
At the variety Zamon																	
9	65-70 (control)	N ₁₅₀ P ₁₂₀ K ₇₅ (control)	84	151	12,2	0,60	6,1	6,5	6,6	6,4	-	-	-	100	89,3		
10		N ₂₀₀ P ₁₆₀ K ₁₀₀	88	164	13,0	0,66	6,8	7,2	7,3	7,1	-	-	0,7	111	80,5		
11		30 t/ha manure +N ₁₅₀ P ₁₂₀ K ₇₅	89	170	13,3	0,69	7,7	8,2	8,1	8,0	-	-	1,6	125	71,4		
12		30 t/ha manure +N ₂₀₀ P ₁₆₀ K ₁₀₀	90	172	13,8	0,73	8,2	8,7	8,6	8,5	-	-	2,1	132	67,2		
13	70-80	N ₁₅₀ P ₁₂₀ K ₇₅	88	159	14,4	0,71	6,9	7,4	7,6	7,3	0,9	114	-	100	75,0		
14		N ₂₀₀ P ₁₆₀ K ₁₀₀	90	176	15,0	0,82	8,1	8,5	8,6	8,4	1,3	118	1,1	115	65,2		
15		30 t/ha manure +N ₁₅₀ P ₁₂₀ K ₇₅	91	179	15,2	0,85	9,0	9,5	9,4	9,3	1,3	116	2,0	127	58,9		
16		30 t/ha manure +N ₂₀₀ P ₁₆₀ K ₁₀₀	93	184	15,7	0,89	10,3	9,5	10,2	10,0	1,5	118	2,7	137	54,8		
										Sx-(%)=							
										LSD₀₅(t/ha)=							

Table 2. Growth, development and productivity of indentata corn varieties (*Zea mays L. indentata*) under different irrigation regimes and fertilization rates

№	Experience options		Yield by years			Productivity, t/ha	Deviation from control		Irrigation water consumption per 1 center of grain, m ³	
	Irrigation mode, % PISM	fertilizer rate, kg (t)/ha	2017	2018	2019		irrigation mode, % PISM	fertilizer rate, kg (t)/ha		
										t/ha
			Leaf area from 1 plant, m ²	Number of leaves of the main stem, pcs.	Main stem height, cm	Vegetation period, in days				
At the variety Uzbekskaya zubovidnaya (standard)										
1	65-70 (control)	N ₁₅₀ P ₁₂₀ K ₇₅ (control)	6,1	6,4	5,8	6,1	-	-	100,0	93,7
2		N ₂₀₀ P ₁₆₀ K ₁₀₀	6,9	7,0	6,5	6,8	-	-	111,5	84,0
3		30 t/ha manure +N ₁₅₀ P ₁₂₀ K ₇₅	7,4	7,8	7,0	7,4	-	-	121,3	77,2
4		30 t/ha manure +N ₂₀₀ P ₁₆₀ K ₁₀₀	8,1	8,4	8,2	8,2	-	-	134,4	69,7
5	70-80	N ₁₅₀ P ₁₂₀ K ₇₅	7,4	7,1	6,7	7,0	0,9	114,8	-	100,0
6		N ₂₀₀ P ₁₆₀ K ₁₀₀	8,1	7,8	7,5	7,8	1,0	114,7	0,8	111,4
7		30 t/ha manure +N ₁₅₀ P ₁₂₀ K ₇₅	8,3	8,6	9,1	8,7	1,3	112,2	1,7	124,3
8		30 t/ha manure +N ₂₀₀ P ₁₆₀ K ₁₀₀	9,3	10,0	9,8	9,7	1,5	118,3	2,7	138,6
		Sx-(%)=	1,8	2,4	1,1					
		LSD₀₅(t/ha)=	0,4	0,8	0,6					
At the variety Sarik donli-L-113										
9	65-70 (control)	N ₁₅₀ P ₁₂₀ K ₇₅ (control)	8,1	7,8	7,5	7,8	-	-	100,0	73,3
10		N ₂₀₀ P ₁₆₀ K ₁₀₀	8,6	8,4	7,8	8,2	-	-	105,1	69,7
11		30 t/ha manure +N ₁₅₀ P ₁₂₀ K ₇₅	9,2	8,8	8,4	8,8	-	-	112,8	64,9
12		30 t/ha manure +N ₂₀₀ P ₁₆₀ K ₁₀₀	9,5	9,3	9,9	9,6	-	-	123,1	59,5
13	70-80	N ₁₅₀ P ₁₂₀ K ₇₅	8,7	8,9	8,4	8,7	0,9	111,5	-	100,0
14		N ₂₀₀ P ₁₆₀ K ₁₀₀	9,4	10,3	9,2	9,6	1,4	117,1	0,9	110,3
15		30 t/ha manure +N ₁₅₀ P ₁₂₀ K ₇₅	11,1	10,6	9,1	10,3	1,3	117,1	1,6	118,4
16		30 t/ha manure +N ₂₀₀ P ₁₆₀ K ₁₀₀	11,4	12,1	11,0	11,5	1,9	119,8	1,8	132,2
		Sx-(%)=	1,1	1,5	1,9					
		LSD₀₅(t/ha)=	0,4	0,6	0,9					

At the variety Kizil yaltirok donli-L-205

9	65-70 (control)	N ₁₅₀ P ₁₂₀ K ₇₅ (control)	117	273	14,3	0,77	8,2	8,5	8,0	8,2	-	-	100,0	69,7
10		N ₂₀₀ P ₁₆₀ K ₁₀₀	120	288	15,2	0,82	9,0	9,1	8,6	8,9	-	-	108,5	64,2
11		30 t/ha manure +N ₁₅₀ P ₁₂₀ K ₇₅	122	296	15,5	0,84	10,5	10,9	9,7	10,4	-	-	126,8	55,0
12		30 t/ha manure +N ₂₀₀ P ₁₆₀ K ₁₀₀	123	302	15,7	0,88	11,2	12,0	10,5	11,2	-	-	136,6	51,0
13	70-80	N ₁₅₀ P ₁₂₀ K ₇₅	121	284	15,0	0,85	9,0	10,2	8,7	9,3	1,1	113,4	100,0	58,9
14		N ₂₀₀ P ₁₆₀ K ₁₀₀	124	297	15,5	0,89	9,4	10,0	10,6	10,0	1,8	112,4	107,0	54,8
15		30 t/ha manure +N ₁₅₀ P ₁₂₀ K ₇₅	124	306	16,0	0,94	11,2	12,9	11,0	11,7	1,3	112,5	114,0	46,8
16		30 t/ha manure +N ₂₀₀ P ₁₆₀ K ₁₀₀	126	313	16,2	0,98	12,7	13,4	12,3	12,8	1,6	114,3	137,6	42,8
						Sx-(%)=								
						1,3			1,0			1,1		
						LSD₀₅(t/ha)=			0,8			1,0		

(8.0-9.3 t/ha) provided with the same irrigation regime against an organic-mineral background - 30 t/ha of manure + N₁₅₀P₁₂₀K₇₅ kg/ha.

Similar results were obtained for varieties of dent corn (*Zea mays* L. *indentata*).

The data in Table 2 show that the growing season for the standard variety *Uzbekskaya zubovidnaya* with an irrigation regime of 65-70% of the PISM was 115-120 days according to the fertilizer rates, and with an irrigation regime of 70-80% of the PISM - 119-125 days or due to the organic-mineral background of the vegetation plants lengthen by 3-6 days, and due to the irrigation regime for 4-5 days.

In promising varieties of dent corn, the growing season was 117-128 days. When cultivating maize varieties on an organic-mineral background (30 t/ha + N₂₀₀P₁₆₀K₁₀₀ kg/ha) with an irrigation regime of 65-70% PISM, the vegetation of plants is lengthened by 4-6 days, and with an irrigation regime of 70-80% PISM - 5 days compared to control (N₁₅₀P₁₂₀K₇₅ kg/ha).

When maintaining the irrigation regime for pre-irrigation soil moisture not lower than 70-80% PISM on a high organic-mineral background (30 t/ha + N₂₀₀P₁₆₀K₁₀₀ kg/ha), it has a positive effect on the height (20-40 cm higher), foliage (by 1.0-1, 9 pcs. more) and the formation of the optimal leaf surface area (0.16-0.21 m² more) of plants.

The grain yield of the standard variety *Uzbekskaya zubovidnaya* with an irrigation regime of 65-70% PISM and application of N₁₅₀P₁₂₀K₇₅ kg/ha was 6.1 tons per hectare, with N₂₀₀P₁₆₀K₁₀₀ kg/ha - 6.8, and with an organic mineral background (30 t/ha manure + N₂₀₀P₁₆₀K₁₀₀ kg/ha) - 8.2 tons. With an irrigation regime of 70-80% PISM, respectively, 7.0; 7.8 and 9.7 t/ha, while the yield increase was 0.9-1.5 t/ha. New promising varieties of *indentata* corn with an irrigation regime of 70-80% PISM on an organic-mineral background (30 t/ha manure + N₂₀₀P₁₆₀K₁₀₀ kg/ha) also had the highest grain yield (12.5-12.8 t/ha) or by 3, 7-4.6 t/ha is more compared to the irrigation regime of 65-70% PISM and fertilization at the rate of N₁₅₀P₁₂₀K₇₅ kg/ha. In conditions of irrigation, an important indicator is the consumption of irrigation water for each unit of production. Irrigation water consumption per 1 centner of grain by varieties and variants of the experiment varied from 42.8 to 102.1 m³. The highest consumption of irrigation water (69.7-102.1 m³) per 1 centner of grain was noted with the irrigation mode for pre-

irrigation soil moisture 65-70% PISM and fertilization at the rate of $N_{150}P_{120}K_{75}$ kg/ha. And the smallest irrigation water consumption per 1 centner of grain (42.8-63.7 m³) was observed under irrigation mode for pre-irrigation soil moisture 70-80% PISM on an organic-mineral nutritional background (30 t/ha manure + $N_{200}P_{160}K_{100}$ kg/ha).

CONCLUSIONS

A high and guaranteed yield of sweet corn varieties Sherzod and Zamon (8.6-10 t/ha), and in the varieties of dent corn Uzbekskaya zubovidnaya, Sarik donli L-113 and Kizil yaltirok donli L-205 (9.7-12.8 tons/ha) can be obtained by growing them with an irrigation mode for pre-irrigation soil moisture not lower than 70-80% PISM or with 8 irrigations according to the 3-5 scheme, that is, in the first period of "shoots-panicle formation" - 3 irrigations, and in the second the period of "panicle formation - full ripeness" - 5 irrigations with an irrigation rate of 536-918 m³/ha and combined application of organic fertilizers at a rate of 30 t/ha of manure and $N_{200}P_{160}K_{100}$ kg/ha.

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