

Productivity of the lines — the parent components of corn hybrids depending on the irrigation methods and plant density in the Southern Steppe

Vozhegova R.¹, Lavrynenko Yu.², Marchenko T.³, Zabara P.⁴

Institute of Irrigated Agriculture of NAAS, Naddniprianske, Kherson, 73483, Ukraine

e-mail: ¹izz.ua@ukr.net, ²lavrin52@ukr.net, ³tmarchenko74@ukr.net, ⁴pavelzabara@gmail.com*

ORCID: ¹0000-0002-3895-5633, ²0000-0001-9442-8793, ³0000-0001-6994-3443, ⁴0000-0002-6149-3393

Goal. To determine the effect of method of irrigation and plant density on growth, development, and yield of seed lines of corn, which are the parental components of the innovative hybrids. **Methods.** Field, laboratory, comparison, generalization. The study had been carried out during 2016 – 2018. **Results.** It is established that the main factor influencing the duration of the period «germination — flowering» of lines of corn was the ripening group. The duration of the period increased from 49 (in early-maturing lines) to 62 days (in late-maturing lines). The plant density was quite an effective factor influencing the timing of the flowering of female inflorescences. The greatest reaction to the thickening was observed in the mid, medium late and late maturing lines from FAO 380 – 500. This reaction of the lines to stand can be used in hybridization areas for the synchronization of the flowering of parental components of hybrids. It is established that drip irrigation promotes the formation of a higher grain yield of corn. Compared with sprinkler irrigation, the yield increase due to drip irrigation was 0.56 t/ha or 12.1%. The highest increase in seed yield was fixed for lines FAO 300 – 500 (from 0.88 to 1.18 t/ha). The parent line DK445 (FAO 420), on average for the period of the research, proved to be the most productive one — the average seed yield made 5.79 t/ha. **Conclusions.** The specific reaction is fixed of lines on the density of cenosis. For each parent form, there is an optimum plant density that should be considered in areas of hybridization to obtain the maximum yield of seeds. The obtained results show that for the planning seed production lines of corn, which are the parental components of hybrids, it is necessary to take into account their genotypic features, the reaction on the density of the growing and irrigation method.

Key words: *drip irrigation, development, synchronization of flowering, yield, seeds.*

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The parent components of maize, as a product of prolonged forced self-pollination, are more demanding to growing conditions, are more sensitive to the effects of adverse factors, have a smaller plant habit compared to hybrids. Genotypic features of the line affect the phenotypic expression of traits, so it is necessary to take into account the biological characteristics of the parent components and technological recommendations for the cultivation of areas of hybridization. In this regard, scientific developments on optimization of technological methods of cultivation of seed of corn lines - the parent components of perspective hybrids - are of great importance.

The modern parent components of corn that have been created for irrigation must be provided to production with certain parameters of technological requirements. This is especially true of irrigation regimes and irrigation methods. The conducted researches on different ways of irrigation made it possible to give the production parameters of adaptation of the parent components of certain to specific agro-ecological and technological features.

Analysis of recent research and publications. In the complex of agrotechnical measures of cultivation of corn, on which the crop and its quality depend, the density of plants occupies an important place. A significant crop can be obtained due to high individual productivity and maximum permissible stem density in a particular growing zone [1–5].

Plant density is one of the main factors that determines the efficiency of fertility, temperature and water conditions of soil, solar energy and other components of agrocenosis life [6–8]. When cultivating self-pollinated corn lines, the stocking density should be adjusted to the chosen artificial moistening strategy.

Drop irrigation is a modern, resource-saving, environmentally friendly way of watering [9]. Increasingly, producers are using drip irrigation when growing crops. But experiments on growing lines - parent components of corn hybrids on drip irrigation have not yet been conducted.

For new lines, the parent components of corn hybrids, there are no recommendations for drip irrigation technology. Therefore, at present, the question of optimization of the technology of cultivation of

line - parent components of corn hybrids different in the growing season in order to increase their yield and accelerate the introduction of new hybrids is still poorly understood and needs further research.

The purpose of the research is to determine the effect of the irrigation method and plant stand density on the growth, development and yield of corn seed, which are the parent components of innovative hybrids.

Materials and methods of research. The studies were conducted during 2016–2018 at the research field of the Institute of Irrigated Agriculture of the NAAS, located in the south of Ukraine in the area of the Ingulets Irrigation Massif.

Growing agrotechnics is generally accepted for irrigation conditions and meets the requirements of grain maize production technologies for the agri-environmental conditions of the steppe zone of Ukraine [10]. The precursor is soy.

The three-factor experience. Factor A - different self-pollinated lines in FAO groups: DK281 (FAO 190), X466 (FAO 290), X417 (FAO 320), X5030 (FAO 380), DK445 (FAO 420), X5040 (FAO 500). Corn lines are the parent components of the new innovative hybrids of Stepovy, Skadovsky, Askaniya, Tronka, Gileya, Chongar, Arabat, which are listed in the Register of plant varieties of Ukraine recommended for cultivation. Factor B is the irrigation method (drip irrigation and regular sprinkling). Factor C is the plant stocking density (70; 80; 90 thousand plants per ha). Repeat four times with placement of variants by the method of randomized split plots. The area of crops is 70 m², accounting area - 50 m².

The main criterion for planning the irrigation regime was the level of pre-irrigation soil moisture (RPVG). Used biologically optimal mode of corn irrigation at all stages of organogenesis with RPVG at 80% HB.

The experiments used a stationary-seasonal type of drip irrigation design with the laying of irrigation film pipelines on the soil surface. When irrigation irrigation used double console sprinkler installation DDA-100MA.

The results of phenological, biometric yield data were processed by statistical analysis methods according to generally accepted methodological recommendations [11, 12].

Results of the studies and their discussion. In the seeds of hybrids, indicators of the duration of the period from germination to flowering of the parent components become important. These indicators should be taken into account to synchronize the flowering of maternal and male forms in the hybridization sites. Technological means can adjust the duration and duration of flowering at the expense of plant density, moisture supply. For new hybrids, an important element of their accelerated introduction into production is the production of the required amount of seeds in the hybridization areas, which is provided by the simultaneous flowering of the parental forms and the quality of pollination. Agrotechnical elements can influence the timing and duration of flowering parental forms. The main factor influencing the duration of this interphase period was the maturity group (Table 1). The duration of the period increased from 49 (in the early lines) to 62 days (in the late lines). In our studies, the irrigation method had little or no impact on the duration of the parent-flowering period. However, the density of the plants was a very effective factor in influencing the flowering period of the female inflorescence. Thickening of plants resulted in a delay of flowering from 1 to 2 days. The greatest response to the thickening was observed in the mid-, mid-late and late-mature lines from FAO 380-500. This response of the lines to the density of standing can be used in the areas of hybridization to synchronize the flowering of the parent components of the hybrids.

1. The duration of the period of "seedling - flowering cob" of the parent components of corn hybrids depending on the factors of experience, days (average for 2016-2018)

Factor A, parent line	Factor B, kind of irrigation	Factor C, plant density, thousand plants per ha				On average, by factor	
		60	70	80	90	A	B
DK281 (FAO 190)	drip irrigation	49,3	49,5	50,2	50,3	49,7	56,2
	sprinkling	49,3	49,5	50,0	50,1		56,0
X466 (FAO 290)	drip irrigation	52,7	52,8	53,8	53,2	53,1	
	sprinkling	52,6	52,7	53,5	53,1		
X417 (FAO 320)	drip irrigation	54,7	54,8	55,5	55,7	55,0	
	sprinkling	54,7	54,8	55,0	55,0		
X5030 (FAO 380)	drip irrigation	57,5	57,6	58,8	58,9	58,1	
	sprinkling	57,1	57,2	58,7	58,8		
DK445	drip irrigation	58,1	58,2	60,5	60,9	59,3	

(ΦАО 420)	sprinkling	58,0	58,1	60,2	60,6		
X5040 (ΦАО 500)	drip irrigation	60,4	60,8	62,1	62,3	61,3	
	sprinkling	60,2	60,6	62,0	62,2		
On average, by factor C		55,4	55,6	56,7	56,8		
Assessment of the significance of the partial differences of the NIR ₀₅ : A=0,34; B=0,25; C=0,22							
Significance of average (main) effects of NIR ₀₅ : A=0,25; B=0,21; C=0,19							
Impact share of factors: A=85,2 %; B=4,5 %; C=5,0 %							

Thus, the duration of the individual phases of the development of maize plants is most affected by the maturity group of the parent components, which indicates a clear genotypic certainty of the trait, which has high environmental stability. However, the density of plant lines can be accelerated, or the duration of individual phases of parental components may be prolonged, which may be useful in areas of hybridization if necessary to adjust the flowering synchronization of the female and male components.

The formation of seed productivity of corn lines depends on many factors. The results of the calculation of yield showed that under the influence of agricultural elements in the conditions of irrigation, the productivity of the studied parent components of corn, ranged from 2.42 to 6.17 t/ha (Table 2).

2. Seed yields of line – parent components of maize hybrids depending on experiment factors, t/ha (2016-2018)

Factor A, parent line	Factor B, kind of irrigation	Factor C, plant density, thousand plants per ha				On average, by factor	
		60	70	80	90	A	B
ДК281 (ΦАО 190)	drip irrigation	3,03	3,19	3,47	3,79	3,03	4,61
	sprinkling	2,42	2,58	2,74	3,03		4,05
X466 (ΦАО 290)	drip irrigation	3,66	3,96	4,12	3,99	3,83	
	sprinkling	3,55	3,64	4,09	3,63		
X417 (ΦАО 320)	drip irrigation	3,62	4,12	4,63	4,17	3,81	
	sprinkling	3,18	3,66	3,75	3,37		
X5030 (ΦАО 380)	drip irrigation	5,21	5,78	5,31	4,92	4,93	
	sprinkling	4,71	4,82	4,44	4,32		
ДК445 (ΦАО 420)	drip irrigation	5,39	6,58	6,17	5,78	5,79	
	sprinkling	5,24	5,64	6,09	5,47		
X5040 (ΦАО 500)	drip irrigation	5,89	5,31	4,24	4,17	4,61	
	sprinkling	4,71	4,25	4,18	4,11		
On average, by factor C		4,22	4,46	4,44	4,23		
Assessment of the significance of the partial differences of the NIR ₀₅ : A=0,28; B=0,16; C=0,23							
Significance of average (main) effects of NIR ₀₅ : A=0,22; B=0,15; C=0,18							
Impact share of factors: A=83,2 %; B=4,5 %; C=5,5 %							

It was found that drip irrigation contributes to the formation of the highest corn grain yield, which averaged 4.61 t/ha. According to irrigation, the seed yield of the lines was slightly lower – 4.05 t/ha. Compared with rainfall, the yield increase from drip irrigation was 0.56 t/ha or 12.1%. All parent component lines responded positively to drip irrigation. The greatest increase in seed yields was recorded in FAO 300-500 lines at certain plant densities (yield increases from 0.88 to 1.18 t/ha). This reaction of mid-to-mid-late hybrids is explained by the fact that the moisture consumption of hybrids with a longer vegetation period of 70-80% is provided by irrigation water. During the period of maximum water consumption (July-August), the daily evapotranspiration of maize sowing in the Southern Steppe exceeds 100 m³/ha, and such amount of water daily can provide drip irrigation. Regular irrigation with frontal action units can be carried out with a minimum period of 4-5 days, which may not always provide the optimum level of moisture.

The DK445 (FAO 420) parent line, on average, during the study period proved to be the most productive, with an average seed yield of 5.79 t/ha. The maximum yield line DK445 showed a plant density of 70 thousand ros./ha on drip irrigation - 6.58 t/ha. Slightly lower yields were obtained in variants with the parent component X5030 (FAO 380) for plant densities of 70 thousand ros./ha on drip irrigation - 5.78 t/ha, and the lowest values of this indicator were set for the parent component DK281 for plant densities. 60 thsd/ha - 2.42 t/ha, which is explained by the biological characteristics of the maturity group of the parent component.

The genotype of the parent component had a specific response to plant density. Early ripening line - the parent component of DK281 showed the highest yield at plant densities of 90 thousand ros./ha - 3.79 t/ha. The mid-morning line X466 formed a maximum yield at a plant density of 80 thousand ros./ha - 4.12 t/ha. Medium-matured parental components X417 and X5030 - at plant densities of 70 thousand ros./ha (5.78 and 6.58 t/ha, respectively). In the late-maturing X5040 line, the maximum yield of 5.89 t/ha was fixed at plant densities of 60 thsd/ha. Thus, it was found that for each line there is its optimum thickening for both irrigation by irrigation and drip irrigation.

According to the results of the analysis of variance, it was found that factor A (line) had the greatest influence on the formation of seed productivity with a share of influence 82.3%. The effect of factors B and C was significantly smaller, respectively - 4.5% and 5.5%.

Conclusions

It has been established that drip irrigation contributes to the formation of higher seed yields of the parent components of maize hybrids, which averaged 4.61 t/ha. According to irrigation, the seed yield of the lines was slightly lower - 4.05 t/ha. Compared with rainfall, the yield increase from drip irrigation was 0.56 t/ha or 12.1%. All parent component lines responded positively to drip irrigation. The greatest increase in seed yields was recorded in FAO 300-500 lines at certain plant densities (yield increases from 0.88 to 1.18 t/ha).

The DK445 paternal line (FAO 420, the parent component of the Chongar, Arabat, Gilea hybrids), on average, during the study period proved to be the most productive - the average seed yield was 5.79 t/ha. The maximum yield line DK445 showed a plant density of 60 thousand ros./ha on drip irrigation - 6.58 t/ha.

The specific response of the lines to the density of the coenosis is established. For each parental form, there is an optimum plant density that must be taken into account in the hybridization areas for maximum seed yield.

In the seeds of hybrids, indicators of the duration of the period of "seedlings - flowering" of the parent components become important. It is established that the density of plants of the lines can be adjusted (accelerate, or extend) the duration of individual phases of development of the parent components, which can be useful in areas of hybridization if necessary to adjust the optimization of flowering of female and male components.

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