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Long-term selection for length of weevil and its influence on morphological indexes of primary root system of corn (Zea mays L.)

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The purpose. To determine link of long-term selection on length of weevils with changes in morphological characters of primary root system of lines of corn. **Methods**. Field: disruptive takeoff. Laboratory: sprouting seeds in Petri dishes within 6 days. Methods of analysis of variance. **Results.** After 10-years directed selection they created lines of corn with length of weevils on 40 – 60% more than at lines-analogues, which were not exposed to such takeoff. It is proved that essential increase of length of a weevil results in substantial growth of morphological characters of primary root system of corn. Deep differentiation of lines on rates of change of their morphological indexes in reply to increase of length of a weevil is determined. A supposition is made about influence of increase of length of a weevil and morphological characters of primary root system on adaptive ability and drought resistance of corn in after-germination period. **Conclusions.** It is proved that increase of length of a weevil of corn by selection results in essential raise of values of morphological characters of primary root system. It is supposed that it can call significant improvement of autoadaptivity and drought resistance of corn in after-germination period.

Key words: *lines of corn, length of a weevil, primary little roots, morphological characters, drought resistance.*

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The maize kernel length was always considered by one of the important morphological traits. In works of home and foreign authors the significant attention was taken to different aspects of its role in formation of the economically important the maize lines and hybrids traits. The link of this trait

with the main morpho-biological characters was studied: the kernel rows number, cob's diameter, grain yield, harvest grain moisture [1 – 3]. But among the professional sources analyzed we didn't meet scientific data as regards to the connection of the kernel length with the maize genotype adaptability. In separate publications the conclusion about impossibility the forecast of maize adaptability by morphological traits was substantiated [4]. However, the ecological adaptation problem is one of the most actual in the modern agroproduction. Therefore different scientific ways for its solution are applied: methods of classic selection [4 – 5], biochemical approaches [6 – 7], molecule marker technologies for computer assessment of the maize kernel and ear morphological traits and drought resistance [8 - 11].

The significance of a embryo root system, especially on the first morphogenesis stages in definite ecological conditions, is difficult to overestimate yet: it provides concerted shoots, high initial grow rates and, ultimately, the cultivar adaptation for drought ecological conditions of the Ukraine southern Steppe on stage of initial plant growth: shoots – 10-th leaf [12 – 13]. But in accessible for us

home and foreign literature sources we didn't find any publications concerning linkage of the directional selection for the kernel length with the morphological traits variability of the primary rootage system and its impact on the ecological adaptation. These aspect in the modern home and foreign maize breeding has left actually not to be studied. Our work, in a way, fills in these blank. The results of 10-years maize hybrid population selection for kernel length variability and its influents on the morphological traits of the primary rootage system and connection with the ecological adaptation were presented in it.

Materials and methods. As the starting material for selection 5 hybrid populations (F_3) of different original were used: NS 377/2-122 (Serbia), Monika – 111 – 3 (Ukraine), Georgia 224/38C (USA), KWS 2744/321 (Germany), O20/5 – 264 (USA). The kernel length segregation was revealed in them, that's why they were chose as a subject for the subsequent selection on the trait. In each population we were selfing on 40 plants, selecting on 30 – 35 well seedy ears, on the meddle of each of them measuring the length of 10 kernels. In each population there were obtained on 2 genotypes gropes: with the maximum and middle significance of the trait. In the future selection in the subpopulation “maximum” was carried out only on the maximum length of a kernel, in subpopulation “middle” only on the middle one. Such modified disruption selection was carried out during 10 years (2005 – 2014).

In order to determine the morphometric parameters of the primary roots from each subline on 25 germinated kernels in Petri caps by 4-times replication at t 24^0 C in dark were germinating. Measurements were carried out after 6 days . The main rootlet length, number, total length and rootage air dry mass, coleoptil length and mass, relation of rootlets mass and shoots mass were estimated. Statistics applied by Lakin [11]] with computer application program Microsoft Excel.

Results of researchers. Statistical parameters of starting and final populations, witch were obtained after 10 years selfing and selecting, presented in the table 1.

Table 1. Statistical parameters of the starting and final inbred sublines populations, obtained by directional selection for the maximum kernel length (2005 – 2014)

Subline	2005			2014		
	lim	ẍ	V, %	lim	ẍ	V, %
NS 377/2-122	0,72-1,19	0,86	58,8	1,26-1,35	1,3	2,3
Monika – 111 – 3	0,68-1,11	0,90	43,4	1,16-1,29	1,19	2,2
Georgia 224/38C	0,61-1,13	0,84	45,4	1,23-1,47	1,34	4,1
KWS 2744/321	0,69-1,09	0,82	55,9	1,03-1,15	1,09	3,7
O20/5 – 264	0,37-1,11	0,75	59,3	0,97-1,2	1,02	3,3

In result of 10-years selection for target trait “maximum kernel length” final inbred sublines populations were produced , which included constant inbred sublines with much more (by 40 – 60 %) kernel length (tabl. 1).

So long as the character of selection was disruption, then on each starting population simultaneously with selection for the maximum trait level significance the subline group with middle level trait was selected. In future in the first subpopulation only directed selection – for the maximum trait level was conducted, in another one - only for the middle trait significance, that is stabilization selection. It is possibly to maintain substantiatly, that the constant maize sublines developed with high probability ($P_{\leq 0,001}$) exceeded the subline-analogues (by 34 – 60 %) for the kernel length. It was revealed as well the significant kernel length influence on morphological parameters of the primer maize rootage (tabl. 2).

Table 2. Primary rootage morphometric parameters ($\ddot{x} \pm S_{\ddot{x}}$) of the maize sublines with the increased and unchanged kernel length

Subline	Kernel length, sm.	Rootlets number, it.	Total rootlets length. sm.	The main rootlet length, sm.	Total rootlets mass, gr.
NS 377/2-122	1,29 ± 0,01***	4,30 ± 0,27**	5,96 ± 0,18*	7,60±0,45*	3,95±0,09*
	0,89 ± 0,01	1,96 ± 0,28	5,12 ± 0,26	6,11±0,46	2,79 ± 0,34
Monika – 111 – 3	1,22 ± 0,02***	4,17 ± 0,14**	6,59 ± 0,35**	10,11±0,30**	4,37±0,28**
	0,88 ± 0,02	2,45 ± 0,10	4,44 ± 0,32	5,56 ± 0,26	1,91 ± 0,2
Georgia 224/38C	1,33 ± 0,02***	3,96 ± 0,03**	11,17 ± 0,28**	15,20±0,44**	22,56±0,40***
	0,99 ± 0,02	3,55 ± 0,05	6,33 ± 0,14	9,52 ± 0,28	6,77 ± 0,68
	1,09 ± 0,01***	3,35 ± 0,30**	10,79 ± 0,83**	13,52±0,36**	5,96 ±0,11***
KWS 2744/321	0,80 ± 0,01	1,95 ± 0,03	7,01 ± 0,12	8,77 ± 0,35	3,04 ± 0,02
O20/5 – 264	1,20 ± 0,01***	4,09 ± 0,23**	11,06 ± 0,20**	14,27±0,37**	4,05±0,06*
	0,76 ± 0,01	3,05 ± 0,17	9,27 ± 0,20	12,53 ± 0,34	3,13 ± 0,26

*Difference between subline-analogs is reliable on P< 0,05.

** Difference between subline-analogs is reliable on P< 0,01.

*** Difference between subline-analogs is reliable on P< 0,001.

The experimental data obtain clearly show high reliable enhancing all morphological rootage traits studied for sublines with substantially kernel length enhanced. The same data was obtained for such traits like the coleoptiles length and mass, the rootlets mass part in the total plantlet mass (tabl. 3).

Table 3. Coleoptiles and plantlets morphometric parameters ($\bar{x} \pm S_{\bar{x}}$) of the maize sublines with the increased and unchanged kernel length

Subline	Kernel length, sm.	Coleoptiles length, sm.	Coleoptiles mass, g.	Plantlet mass, g.	Rootl. mass part in the plantlet mass, %
NS 377/2-122	1,29 ± 0,01***	5,36 ± 0,24**	4,67 ±0,42*	8,62	45,8
	0,89 ± 0,01	4,27± 0,21	3,34 ± 0,30	6,13	45,5
Monika – 111 – 3	1,22 ± 0,02***	4,76 ± 0,09	3,71 ±0,24*	8,08	54,1
	0,88 ± 0,02	4,81 ± 0,13	2,58 ± 0,23	4,49	42,5
Georgia 224/38C	1,33 ± 0,02***	7,16 ± 0,17**	5,89±0,37**	28,45	79,3
	0,99 ± 0,02	6,30 ± 0,03	4,39 ± 0,11	11,16	60,7
KWS 2744/321	1,09 ± 0,01***	8,79 ±0,78*	6,42±0,54**	12,38	48,1
	0,80 ± 0,01	5,96 ± 0,12	4,09 ± 0,40	7,13	42,6
O20/5 – 264	1,20 ± 0,01***	7,16 ±0,08*	5,23 ±0,10*	9,28	43,6
	0,76 ± 0,01	6,05 ± 0,33	4,14 ± 0,35	9,19	34,1

*Difference between subline-analogs is reliable on $P < 0,05$.

** Difference between subline-analogs is reliable on $P < 0,01$.

*** Difference between subline-analogs is reliable on $P < 0,001$.

The length and mass coleoptiles reaction on the significant kernel length increase proved to be nearly the same like of above the characterized traits: in all lines with the kernel length increased the shoot morphometric indicators were enhanced significantly with the exception of Monika 111-3 sublines, in which we did not observe the coleoptiles length increase.

To our opinion, a peculiar integrate indicator of plant primary rootage power is its total mass and, without a doubt, such criteria as the relation of the total primary root mass and the hole plantlet one (tabl. 3). This index can be considered as a criteria of the primary rootage ability for supplying a plant with moisture and nutrients the in the start growing period. Therefore it can be considered also in a certain extent as a indicator of the drought resistance on the initial developing stages. On the level of defined relation the significant differentiation was observed: this indicator gets much higher for all sublines with the exception of NS 377/2 – 122. Especially high level of the relation was in sublines Georgia 224/38C (+30.6 %) and Monika 111 – 3 (+27.3 %). This may give evidence that the sublines have more heightened drought resistance at the period shoots – tassel appearance. It takes notice to itself the unique ability of Georgia 224/38C sublines to generate so powerful primary rootage the share of each to the whole plantlet mass constitutes near 80 %, which is almost in two times much than the same indicators of another lines (tabl. 3).

Thus, genotypes of the significant heightened kernel length form much bigger primary rootage per the plantlet mass unique in connection with the unchanged kernel length. Such peculiarity can contribute to the stress tolerance improvement of the plants just such type, increasing their possibilities for surviving and developing in dry condition of the post-shooting period in the south steppe of Ukraine. It is necessary to emphasize also peculiarities the subline Georgia 224/38C with long kernel, that substantially exceeded its ordinary analog and genotypes of others lines. This may suggest that such sublines like Monika 111-3, KWS 2744/321, NS 377/2 – 122 and especially Georgia 224/38C may show much bigger stress tolerance to dry conditions of the initial development period at the expense of better plants providing with the bigger root mass and higher development rates.

Conclusions

As a result of the lasting many years directed selection for increasing of the maize kernel length the series of maize inbred lines was developed. They were superior to the unchangeable analogs, created with the stabilization breeding, by 40-60% on the kernel length.

It was also proved that substantial increasing of the kernel length by the directed selection was leading to the significant increase of the maize primary rootage morphological traits.

The supposition of the connected significant influence of the enhanced target trait (kernel length) and indirect ones (morphological parameters of the primary maize rootage) on increasing of the maize ecological adaptation ability and drought tolerance was formulated.

Increase of the kernel length by the directed selection was leading to the significant increase of the maize primary rootage morphological traits. It may bring about substantional increase the maize plant adaptability and drought resistance in the post- shoot period.

Bibliografiia

1. *Domashnev P. P., Dzyubeczkij B. V., Moroz V. V.* Zavisimost mezzhdu vlazhnostyu zerna kukuruzy I eyo priznakami [The relation between the maize grain humidity and its traits]. Tez. dokl. 5 – go sezda genet. i selekz. Ukrainy, Kiev: 1986. pp. 126 – 128.

2. *Bielikov Ye. I., Klimoova o. Y.* Koreliatsiini zviazky produktyvnosti z morfobiologichnymy oznakamy u inbrednych linii zukrovoi kukurudzy [The correlation of the productivity with morpho-biological traits of sugar maize inbred lines]. Biul. Instytutu zernovogo gospodarstva. 2003. # 21 – 22. pp. 104 – 112. [in Ukrainian]

3. *Walters S. P., Russell W. A., Lamkey K., R*. Comparisons of phenotypic correlations among S1 lines and their testcrosses from four Iowa Stiff Stalk populations of maize. *Madica*. 1991. V. 39. pp. 39 - 44.

4. *Fedko M. M.* Adaptyvnyi potentsial ta ekologichna stabilnist prostych hibrydiv kukurudzy (Zea mays) [An adaptive potential and ecological stability of maize single crosses]. Biul. Inst. zern. gospodarstva. 2010. # 39. pp. 161 – 166.

5. *Dzyubeczkij B. V., Cherchel V. Yu.* Selektsiia hibrydiv kukurudzy stiikykh do ekstremalnykh umov vyroshchuvannia [Maize hybrids breeding with the resistance to extreme environment conditions]. Biul. Inst. zern. gospodarstva. 2007. # 31 – 32. pp. 3 – 11.

6. *Belousov A. O., Sokolov V. M., Molodchenkova O. O., Adamovskaia V. G.* Napriamy ta resultaty selektsii kukurudzy u SGI – NTSNS na posukhostiikist [Directions and results of maize breeding in PBG-NCSCI for drought tolerance]. Zbirnyk naukovykh prats SGI – NTSNS. 2016. Vyp. 28 (68). pp. 33 – 43.

7. *Filipov G. L., Cherchel V. Yu., Vyshnevskii M. V.* Agrofisiologichne obgruntuvannia doboru strMarestolerantnykh selektsiinykh form kukurudzy [Agrophysiological substation for selection of stress tolerant maize breeding forms] . Biul. Inst. s. g. stepovoi zony. 2012. # 2. pp. 16 – 20.

8. *Badicean D., Scholfen S., Jacota A.* Transcriptional profiling of *Zea mays* genotypes with different drought tolerances – new perspectives for gene expression markers selection. *Maydica*. 2011. 56 - 1724. pp. 61 - 69.

9. *Marchenko L. O.* Metody doslidzhennia zarodkovoi korenevoi systemy [Methods of maize germ root system investigations]. Visnyk s. – g. nauky. 1968. # 10. pp. 65 - 70.

10. *Zhunko V. S.* Rol epikotelnykh kornej u kukuruzy [The role of maize epicotyls roots]. Selekcziya i semenovodstvo. 1975. # 3. pp. 75.