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Original article

Effect of Cultivation Conditions on the Growing Activity of Winter Barley Genotypes

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Abstract

In the period 2018-2020 in the Institute of Agriculture - Karnobat, Bulgaria the influence of growing conditions on the growth activity of winter barley genotypes was studied. The experiments were performed in field and laboratory experiments. In a field multifactorial experiment with 4 fertilization variants (N0: N8: N12: N16) and three sowing rates (250, 350 and 450 germinating seeds) the barley varieties Kuber, Sayra, Zemela and Bozhin were grown. The obtained seeds from the different variants were studied in a laboratory experiment by the method of rolls. From each variant 20 seeds are laid in 3 repetitions on filter paper. The rolls are immersed in water and after 10 days the length of the first leaf, the length of the coleoptile, the number of roots and their length are taken into account. It was found that there are proven differences in the indicators in the studied genotypes. On average for the years of study, the length of the first leaf and the length of the roots is the largest for the seeds obtained in the variant at a sowing rate of 450 germinating seeds and N8. With the largest length of coleoptile and the largest number of roots are the seeds of the variant with a sowing rate of 250 germinating seeds and N8. Analysis of the variant shows that the length of the first leaf, the coleoptile and the number of roots depend on the genotype. The strongest influence on the length of the roots have the conditions of the year. The interaction between the two factors strongly influences all the studied indicators. The interaction between the year, genotype, sowing rate and fertilization also has a great influence on the indicators of the length of the first leaf, coleoptile and roots.

Keywords: Genotype, Barley, Growing Conditions, Growth Activity.

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INTRODUCTION

Depending on the cultivation conditions some varietal deviation could be observed in the seed production process, which is caused by reasons such as poor crop density, fertilization, soil fertility, low or high temperatures in critical plant growth stages and others (Gramatikov et al., 2004). The effect of environmental factors, technological methods for harvesting and processing the crops and storage conditions can affect far more directly the crops and the sowing qualities of seeds (Karpov, 1983). To obtain maximum yield from barley it is of great importance to create suitable conditions for plant growth and development (Gramatikov et al., 2004). Dzhugalov (2011) established that genotype and fertilization have the strongest effect on the formation of a large number of productive tillers, whereas seed size depends on sowing rate and fertilization. It was established that the yield of wheat seeds depends on nitrogen fertilization and crop density (Vasileva et al., 2014). The greatest part in forming the yield of barley seeds is played by sowing date, followed by weather conditions of the year and nitrogen fertilization (Bonchev, B., Valcheva, D., 2013; Bonchev, 2017). A number of research scientists claim that the growth rate of cereal crops can be judged from coleoptile length, first leaf and germinal roots. These traits are affected by genotype, climatic characteristics of the year, applied agrotechnics, as well as the growing conditions and duration of seed storage (Pieta Filho, C., Ellis, R. H.,1991; Box, A. J., Jefferies, S. P., Barr, A. R., 1999; Maleki Farahani et al., 2010; Vulchev et al., 2010; Bodner et al., 2013; Tabatabaei, S. A., 2015).

The aim of this study was to establish the effect of cultivation conditions on the growth activity of winter barley genotypes.

MATERIALS and METHODS

During the period 2018-2020, at the Institute of Agriculture in Karnobat, Bulgaria was studied the effect of cultivation conditions on the growth activity of winter barley genotypes. The experiments were conducted as field and laboratory trials. A field multi-factor trial in 4 fertilization variants (T_0- unfertilized; T_1- fertilization with N_8; T_2- fertilization with N_{12}; T_3- fertilization with N_{16}) and three sowing rates (P_1 - 250, P_2 - 350 and P_3 - 450 germinating seeds) were used to cultivate the winter barley varieties Kuber, Sayra, Zemela and Bozhin. The obtained seed from various variants were studied in a laboratory trial by the coil method (Atanasova et al., 2001). Out of each variant were set 20 seeds in 3 repetitions on filter paper. The coils were immersed in water and 10 days later first leaf length, coleoptile length, number of roots and their length were measured. The results were statistically processed with analysis of variance by means of SPSS 19.0 software.

RESULTS and DISCUSSION

Each barley variety is characterized by specific limits of variability of the main morphological indicators. Nevertheless, depending on the cultivation conditions, the different genotypes respond to a

different degree, and the main traits related to productivity vary from weak to strong (Dimova, 2015). Table 1 and Figures 1, 2, 3 and 4 present results for the tested indicators mean for period 2018-2020 by varieties and variants. First leaf length varied from 10.617 cm for seed grown in the variant of sowing rate 250 germinated seeds and unfertilized up to 11.477 cm for seeds obtained at sowing rate 450 germinated seeds and fertilization with N 8 kg active substance. The highest values of first leaf from seeds in the variants of sowing rate 250 seeds and all fertilized variants; at sowing rate 350 seeds and fertilization with N 12 kg and 16 kg active substance; at sowing rate 450 seeds and fertilization with N 8 kg and 12 kg active substance. The lowest indicator values were reported for seeds from the variants with sowing rate 250 seeds and unfertilized and of highest density (450 seeds) and fertilization at high rates (N 16 kg active substance) (Table 1, Figure 1). Analyzing the data from Table 1, it is noteworthy that the different cultivation variants show varietal characteristics. For example, the seeds of variety Saira obtained in all the variants formed the highest values of first leaf length. This shows that this variety has the fastest growth rate compared to the other varieties. The deviation from the mean values for Saira was greatest in the variants of 450 seeds sowing rate and fertilization with N 8 kg and 12 kg active substance and there the variety had the greatest first leaf length. Varieties Bozhin and Zemela in most variants had the lowest values of first leaf length compared to the mean values for the studied group. For Bozhin the lowest values were obtained from seeds in the unfertilized variants, whereas for Zemela – from the variants of greater density and higher fertilization rates. It shows that Bozhin has a favorable response at higher fertilization rates, whereas Zemela showed greater first leaf length from seeds formed at low sowing rates and low fertilization rates.

The coleoptile length ranged within small limits from 3.668 cm for seeds from variant P_2T_3 to 3.806 cm (P_1T_1) (Table 1). Figure 2 shows that the highest values of coleoptile length mean for the period were formed by seeds from the variants of low fertilization rates (T_1- fertilization with N_8).

Table 1. Mean data on growth rate by varieties and variants for the period 2018-2020

Seeds obtained from variants:	Varieties	First leaf length	Coleoptile length	Root number	Root length
P_1T_0	Kuber	9.873	3.577	5.88	10.292
	Saira	11.743	3.831	5.53	11.940
	Zemela	10.914	3.857	5.24	11.132
	Bozhin	9.940	3.638	4.97	10.431
	Mean	**10.617**	**3.726**	**5.41**	**10.949**
P_1T_1	Kuber	11.072	3.744	5.85	11.428
	Saira	12.314	3.823	5.54	12.162
	Zemela	11.356	3.988	5.18	11.565
	Bozhin	10.657	3.672	5.08	10.896
	Mean	**11.350**	**3.807**	**5.41**	**11.513**
P_1T_2	Kuber	11.075	3.706	5.88	11.316
	Saira	12.368	3.758	5.50	12.176
	Zemela	11.177	3.898	5.12	11.091
	Bozhin	10.907	3.696	4.94	11.129
	Mean	**11.382**	**3.765**	**5.36**	**11.428**
P_1T_3	Kuber	11.286	3.616	5.69	11.585
	Saira	12.642	3.764	5.49	12.299
	Zemela	11.259	3.979	5.17	11.485
	Bozhin	10.308	3.636	4.83	10.501
	Mean	**11.374**	**3.749**	**5.30**	**11.468**
P_2T_0	Kuber	11.384	3.696	5.82	11.842
	Saira	11.708	3.772	5.55	11.899
	Zemela	10.418	3.801	5.13	10.769
	Bozhin	9.362	3.538	5.09	9.732
	Mean	**10.718**	**3.702**	**5.40**	**11.061**
P_2T_1	Kuber	11.152	3.735	5.71	11.532
	Saira	12.005	3.906	5.52	11.943
	Zemela	10.148	3.752	5.02	10.207
	Bozhin	9.608	3.599	4.95	10.175
	Mean	**10.728**	**3.748**	**5.30**	**10.964**
P_2T_2	Kuber	11.111	3.707	5.88	11.501
	Saira	11.404	3.707	5.51	11.283
	Zemela	10.897	3.797	4.97	11.274
	Bozhin	10.916	3.615	4.99	11.094
	Mean	**11.082**	**3.707**	**5.34**	**11.288**
P_2T_3	Kuber	11.369	3.656	5.83	11.644
	Saira	11.762	3.584	5.25	11.294

	Zemela	10.623	3.809	5.02	10.968
	Bozhin	11.478	3.628	5.02	11.839
	Mean	**11.308**	**3.669**	**5.28**	**11.436**
P_3T_0	Kuber	11.261	3.716	5.74	11.694
	Saira	11.791	3.713	5.39	11.828
	Zemela	10.362	3.893	4.98	10.850
	Bozhin	10.052	3.585	5.07	11.102
	Mean	**10.867**	**3.727**	**5.30**	**11.369**
P_3T_1	Kuber	11.918	3.701	5.73	12.154
	Saira	13.021	3.747	5.37	12.770
	Zemela	10.707	3.947	5.08	11.074
	Bozhin	10.265	3.641	5.01	10.913
	Mean	**11.478**	**3.759**	**5.30**	**11.728**
P_3T_2	Kuber	11.336	3.591	5.72	11.605
	Saira	12.514	3.735	5.43	11.791
	Zemela	9.734	3.864	4.93	10.309
	Bozhin	11.315	3.736	4.90	11.694
	Mean	**11.225**	**3.732**	**5.25**	**11.350**
P_3T_3	Kuber	10.580	3.606	5.59	10.937
	Saira	10.972	3.639	5.40	11.203
	Zemela	10.471	3.937	4.95	10.900
	Bozhin	10.569	3.651	4.98	10.979
	Mean	**10.648**	**3.708**	**5.23**	**11.005**

The number of roots by variants mean for the period varied weakly within the range from 5.22 pcs. to 5.41 pcs. (Table 1). Figure 3 shows that seeds from low fertilization rates formed higher number of roots. The highest number of roots was formed by Kuber - 5.59 pcs. from variant seeds P3T3 up to 5.88 seeds in variants P_1T_0, P_1T_2 and P_2T_2. Variety Bozhin had the lowest number of roots with 4.83 seeds from variant P_1T_3 up to 5.09 seeds (P_2T_0).

The root length mean for the period also varied within narrow limits from 10.948 cm to 11.727 cm. Figure 4 shows that the longest roots were formed from seeds obtained from the variant with sowing rate of 450 seeds and fertilization with N 8 kg active substance. Varietal response was also observed where variety Saira had the longest roots, and variety Bozhin had the shortest ones.

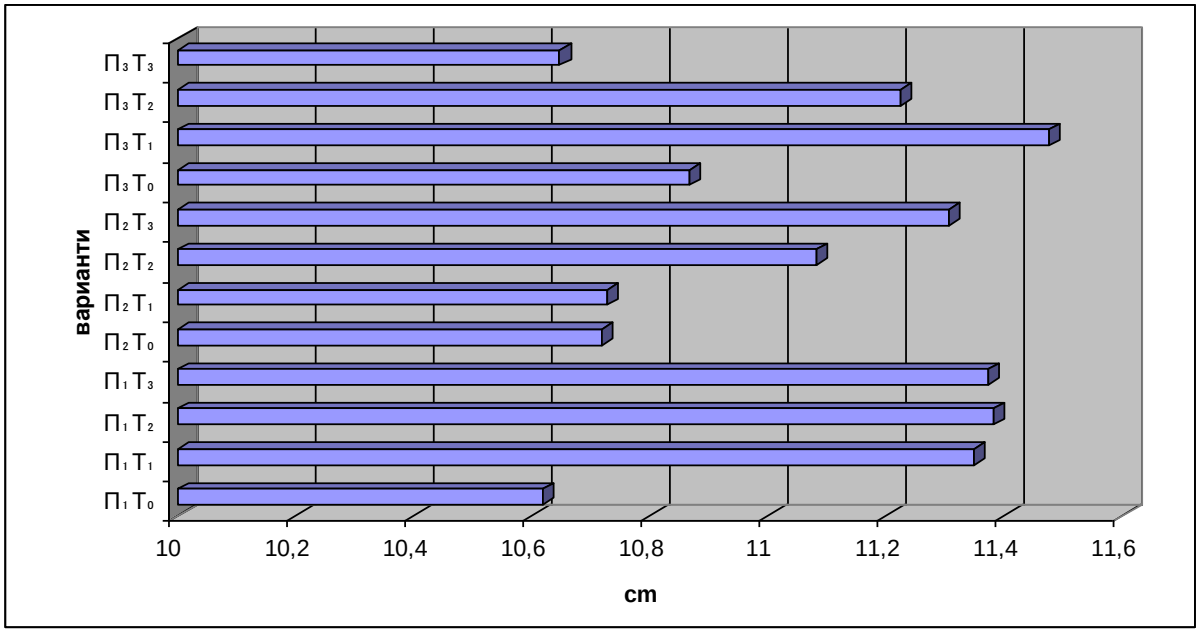

Figure 1. First leaf length of winter barley genotypes by variants mean for period 2018-2020

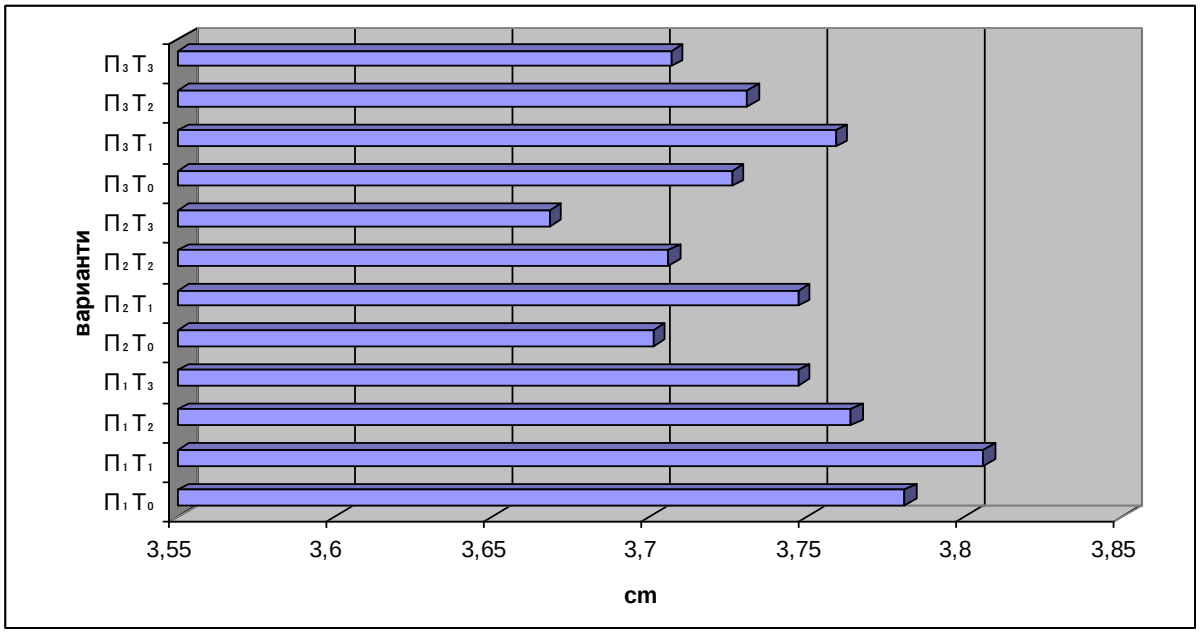

Figure 2. Coleoptile length of winter barley genotypes by variants mean for period 2018-2020

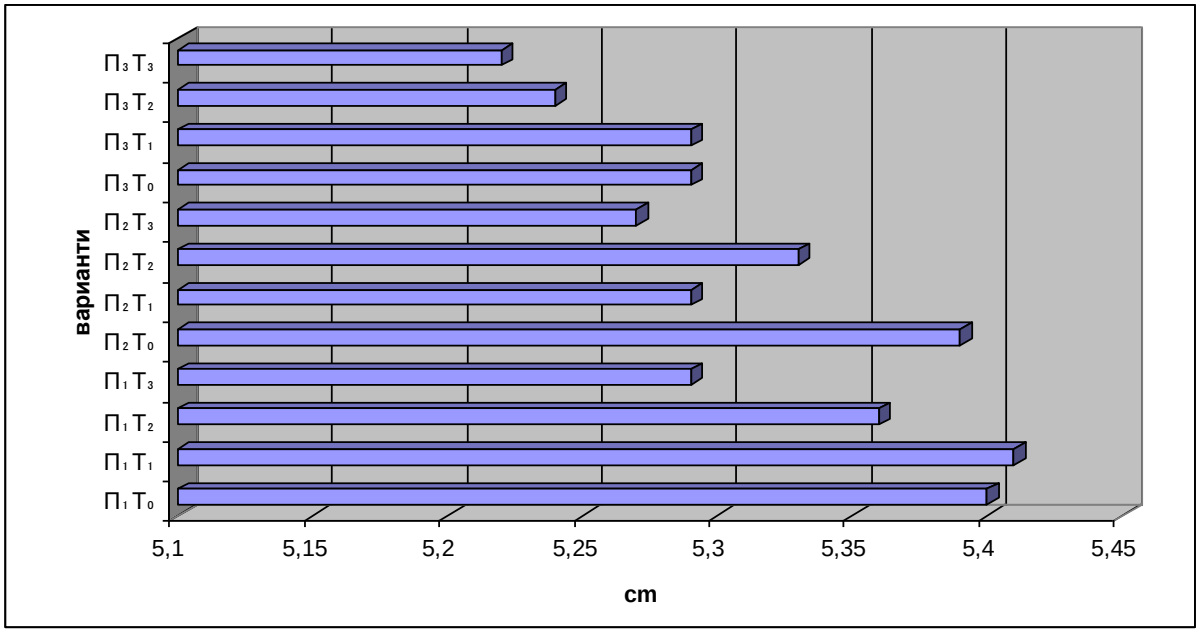

Figure 3. Root number of winter barley genotypes by variants mean for period 2018-2020

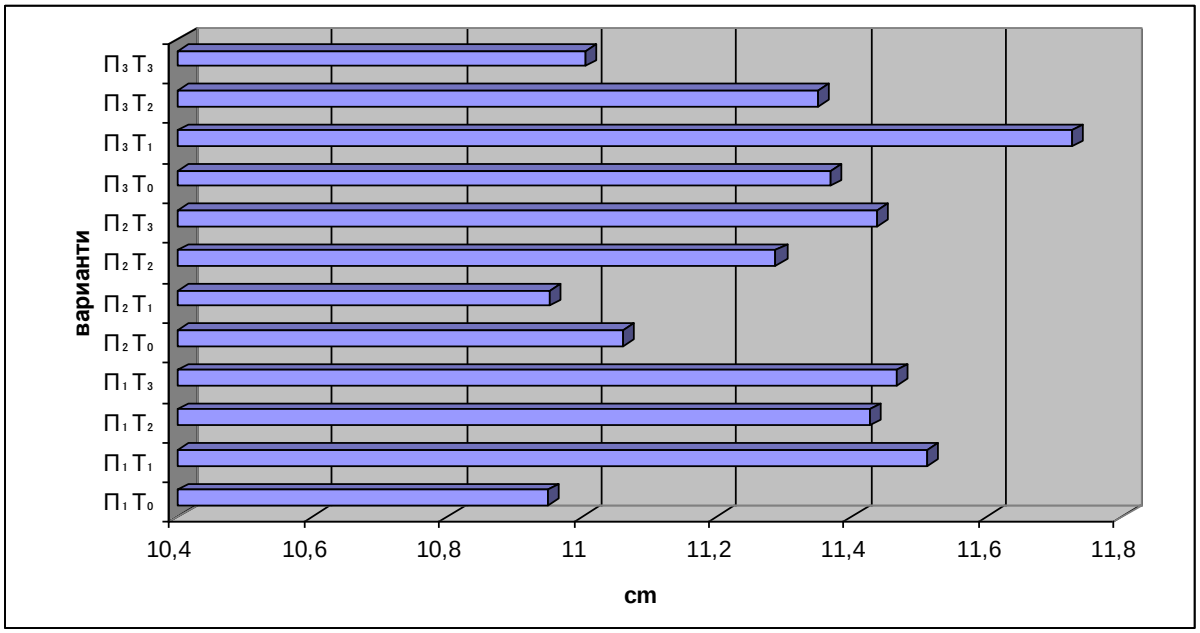

Figure 4. Root length of winter barley genotypes by variants mean for period 2018-2020

Table 2 presents an analysis of variance on the growing rate of winter barley varieties from seeds obtained under different cultivation conditions. As the analysis mostly takes into account the possibility for seeds obtained under different cultivation conditions to have quick growing rate and their cultivation

factors have indirect effect. Therefore, their impact is considerably weaker compared to the genotype which plays major part for indicator first leaf length (η=36.78%). Out of the independent action of the factors for the formation of seeds, fertilization it is of greater importance (η=3.96%), whereas the strength of factors year and sowing rate was weak. Out of the factor interaction for the formation of well-fed seeds growing into plants of greater first leaf length, year x genotype (η=9.80%) had an impact.

Table 2. Analysis of variance on the growth rate of winter barley varieties from seeds obtained through various cultivation conditions

Factors	**First leaf length**		**Coleoptile length**		**Root number**		**Root length**	
	MS	**ŋ**	**MS**	**ŋ**	**MS**	**ŋ**	**MS**	**ŋ**
Year	3.895***	1.03	1.413***	14.79	38.197***	43.77	77.749***	23.07
Genotype	46.178***	36.78	1.072***	33.66	12.876***	44.27	20.500***	18.25
Sowing rate	1.670***	0.89	0.102**	2.13	0.332***	0.77	1.035***	0.61
Fertilization	4.965***	3.96	0.075**	2.34	0.164***	0.56	1.200***	1.07
Year x Genotype	12.305***	9.80	0.415***	13.03	1.546***	5.31	8.977***	7.99
Year x Sowing rate	4.316***	2.29	0.012ns	0.24	0.078**	0.18	6.231***	3.70
Year x Fertilization	3.818***	3.04	0.030**	0.94	0.123**	0.42	0.075*	0.07
Genotype x Sowing rate	3.204***	5.11	0.073**	4.56	0.091**	0.63	2.762***	4.92
Genotype x Fertilization	2.373***	5.67	0.048**	4.48	0.031*	0.32	1.961***	5.24
Sowing rate x Fertilization	3.252***	5.18	0.006ns	0.36	0.024ns	0.17	2.546***	4.53
Year x Genotype x Sowing rate	1.859***	2.96	0.098***	6.12	0.061**	0.42	2.171***	3.87
Year x Genotype x Fertilization	1.909***	4.56	0.038**	3.58	0.093***	0.96	2.292***	6.12
Year x Sowing rate x Fertilization	2.090***	3.33	0.030**	1.91	0.075**	0.51	1.010***	1.80
Genotype x Sowing rate x Fertilization	1.625***	7.77	0.023*	4.31	0.042**	0.87	1.538***	8.22
Year x Genotype x Sowing rate x Fertilization	1.597***	7.63	0.040**	7.55	0.041**	0.84	1.974***	10.54

Similar results were also obtained for the coleoptile length indicator. The strength of factor genotype was 33.66%, year – 14.79%, and fertilization – 2.34%. The year x genotype interaction played a significant role for coleoptile length (η=13.03%).

In the formation of number of roots from seeds obtained under different cultivation condition the roles of genotype (η=44.27%) and year (η=43.77%), as well as their interaction (η=5.31%) were almost equal. For their length, year prevails over genotype and the strength of factor year was 23.07%, and

genotype – 18.25%. The interaction of all factors had the greatest strength – 10.54%, followed by genotype x sowing rate x fertilization interaction (η=8.22%).

Conclusions

1. The seeds of winter barley varieties cultivated in different conditions entail different growing rates. Varietal features have been established based on the studied indicators. Variety Saira formed plants with the longest first leaf, whereas variety Zemela in most variants formed the longest coleoptile. The Kuber variety had the highest number of roots and the Bozhin variety had the longest roots.

2. The role of genotype for first leaf length and coleoptile length was significant, whereas year conditions prevailed for number of roots and their length. Since the effect of the other factors (sowing rate and fertilization) was indirect on the studied indicators, their role is insignificant, too. The year and genotype interactions for first leaf length and the interactions of all the factors for coleoptile length and root length was more significant and the strength of factors ranged from 7.55% to 10.54%.

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