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REACTION OF *SORGHUM VULGARE* VAR. *TECHNICUM* [KÖRN.] IN THE EARLY GROWTH STAGES OF DEVELOPMENT IN DROUGHT AND WATER DEFICIENCY IN LABORATORY CONDITIONS

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Abstract

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The effect of polyethylene glycol PEG – 20000 on the induction of water stress on germination and the initial development of five genotypes (varieties and local populations) *Sorghum vulgare* var. *technicum* [Körn.] was determined under laboratory conditions at the Institute of Forage Crops – Pleven. In order to simulate the water deficit induced by osmotic stress, different concentrations (1.25%; 2.5%; 5.0%; 7.5%; 10.0%; 12.5%; 15.0%; 17.5% and 20.0%) of non-ionic water soluble polymer polyethylene glycol of molecular weight 20000 (PEG – 20000) were used in the study.

It was found that: Osmotic stress induced by the addition of PEG inhibits root growth and shoot IR% from 15.03 to 72.29% at higher applied concentrations (from 10.0 to 20.0%). Lower applied concentrations (1.25 to 7.5%) had a stimulating effect IR% from 11.71 to 135.77%. according to control treatments for all tested genotypes. There was a specific variety reaction with regard to the effect of PEG on seedling growth (cm) and formation of fresh weight on seedlings (g) in the tested genotypes *Sorghum vulgare* var. *technicum* (Körn.). It was found that with relatively good tolerance to osmotic stress it is possible to determine Szegedi 1023 variety and the AS17P local variety (TI average varied from 2.28 to 2.55). With low coefficients of tolerance, i.e. the high sensitivity of drought in the early growth stages of development (BBCH – 09-10) were the G16V and MI16N local varieties (TI average varied from 1.29 to 1.36) while GL15A local variety occupies an intermediate position – TI – 1.62. In the Szegedi 1023 variety and AS17P local variety, unlike the growth of the seedlings, the formed fresh biomass in g for one seedlings increases with the increasing level of PEG 20000 treatments, except for the highest applied concentrations (17.5 and 20.0%), while the GL15A, G16V and MI16N local varieties formed fresh biomass of the roots, shoots and seedlings decreased IR% varied from 22.22 to 100.0% and the differences were statistically significant ($p = 0.05$). which can be explained by their sensitivity to drought in the early growth stages of development (BBCH-09-10). The G16V and MI16N local varieties found superior and might be productive in further breeding programmes for drought tolerance.

Key words: *Sorghum vulgare* var. *technicum* [Körn.], polyethylene glycol (PEG), water stress, seedling.

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Introduction

Drought is one of the major abiotic factors that suppress the growth and development of cultivated plants and considerably reduce their productivity. Water deficit is its basic component that causes a number of morphological and physiological changes in the plants растенията (Arora et al., 2002; Ali et al., 2011a; Zapryanova and Nencheva, 2013; Zapryanova et al., 2016).

The research on the physiological mechanisms of plant resistance in laboratory conditions gives an opportunity to the determine specific response and tolerance to drought in the early growth stages of development in a number of agricultural crops (Alexieva, 2003; Borrell et al., 2014; Tsago et al., 2014; Rauf et al., 2016; Zapryanova et al., 2016)

The drought simulation in laboratory conditions at Sorghum species was accomplished with a nonionic water-soluble polyethylene glycol with high molecular weight (>6000). The use of PEG allows to recreate the necessary osmotic potential and prevents water absorption roots, i.e. the to simulate soil drought (Bibi et al., 2010; O'Donnell et al., 2013; Tsago et al., 2014; Zhang et al., 2015; Donchev et al. 2016; Fadoul et al., 2016).

According to Munns (2002), Bozhanova et al. (2005); Bibi et al. (2012); O'Donnell et al. (2013); Zhou et al., 2013; Basha et al. (2015); Chipilski et al. (2017) degree of inhibition of growth processes in the shoot under the influence of osmotic stress correlated with drought tolerance of a species or genotype.

The *Sorghum* species are a multipurpose crop grown for food, animal feed and industrial purposes. According to studies a number of authors (Ali et al. 2011b) It is considered more tolerant to many stresses, including heat, drought, salinity and flooding as compared to other cereal crops, however, the Sorghum species in the early growth stages and development effected by drought stress – reduction of yield and plant growth (Bibi et al., 2012; Calvino and Messing, 2012; O'Donnell et al., 2013).

In the literaure there is data on evidence of differences between *Sorghum* species in terms of their sensitivity to drought in the their early growth stages of development (Zhou et al., 2013). Identification of *Sorghum vulgare* var. *technicum* (Körn.) (broom corn) genotypes that can withstand drought in the early stages of growth and development BBCH 09-10 is important to increase the production of fodder and seeds QI et al. (2016). Tolerant genotypes of broom corn to drought in the early stages of development may be recommended for cultivation in drought-affected areas.

The purpose of the study is to identify the reaction to water deficit in local varieties of *Sorghum vulgare* var. *technicum* (Körn.) (broom corn) in the early stages of their development under laboratory conditions by using a non-ionic water-soluble polyethylene glycol (PEG) having a molecular weight of 20000.

Materials and Methods

In order to establish the influence of water deficit in laboratory conditions on the genotypes. *Sorghum vulgare* var. *technicum* (Körn.) (broom corn) at the initial growth stages and development were used adapted method Chaniago et al. (2017).

Two factors have been studied: Factor A genotypes of *Sorghum vulgare* var. *technicum* (Körn.) (broom corn), local varieties from the region of Central Northern Bulgaria and a Hungarian variety: a1 – Szegedi 1023 (Hungarian variety); a_2 – AS17P; a_3 – GL15A; a_4 – G16V; and a_5 – MI16N (local varieties) Factor B – polyethylene glycol concentration (PEG 20000): b_1 – 0.0% (control); b_2 – 1.25%; b_3 – 2.5%; b_4 – 5.0% and b_5 – 7.5%; b_6 – 10%; b_7 – 12.5%; b_8 – 15.0%; b_9 – 17.5% and b_{10} – 20.0% (w/v).

Technique of bioassay. Two hundred seeds from tested genotypes broom corn were germinated on two layers of filter paper Filtrak 388 in 140 mm Petri dishes were pipetted distilled water at a ratio of 1:2.5 to the mass of the seeds. The prepared samples were placed in an incubator at 48 h at 23^{o}C ± 2^{o}C. Seeds were considered as germinated if they exhibited radicle extension by more than ≥ 3.0 mm.

Successively, twenty germinated seeds of each genotypes *Sorghum vulgare* var. *technicum* (Körn.) (according factor A) were placed between filter paper Filtrak 388, in the Petri dishes for all tested concentrations polyethylene glycol (PEG 20000). From all concentrations of polyethylene glycol (PEG 20000) (Factor B) in the petri dishes, 5 ml of solution was pipetted. The prepared samples were placed in an incubator at 22 ± 2^{o}C in the dark for five days. Each treatment consisted of six replicates, including the control treatment.

Effect assessment. For assessing experimental results, the following parameters were used:. Biometric parameters: root, shoot and seedling length, cm; fresh biomass weight per seedling, g. Length was measured using graph paper and weight on an analytical balance; Mathematical-statistical evaluation and calculated formulas:

Percent inhibition (IR) was determined by the equation (1) (Ahn et al., 2005):

$$IR\%=[(C-T)/C].100 \quad (1)$$

where C – characteristic in the control treatment; T – characteristics in each treatment. Positive values "+" show inhibition effect, while negative "-" values show stimulation effect.

Tolerance index was determined by the equation (2) (Chaniago et al., 2017):

$$TI = \frac{Y_d}{Y_n} \cdot \frac{Y_d}{H_{yd}} \quad (2)$$

where Y_d and Y_n respectively represent observed variable under drought and normal condition. Hyd is the highest observed variable under drought condition.

All experimental data were statistically processed using the software STATGRAPHICS Plus for Windows Version 2.1.

Results and Discussion

The effect of osmotic stress induced by the Poly Ethylene Glycol (PEG 20000) on the seedling length (cm) on the tested genotypes *Sorghum vulgare* var. *technicum* (Körn.) (broom corn) varieties is presented in Table 1. Seedling development in lab conditions have been recognized as testing procedure in sorghum it was found that with the increase in PEG concentrations, the rate and growth of seedlings decreased IR% from 2.6 to 96.4.

For all tested genotypes had a reduction in seedling length at higher concentrations of PEG (17.0 and 20.0%), while at lower applied concentrations (IR% from 1.25 to 15.0%) was established a stimulating effect, according the control treatments, the differences are significant at the $p = 0.05$ (Table 1).

The maximum value for the seedling length was observed in concentration 1.25% and minimum value was observed in 20.0% PEG for all genotypes. The differences among genotypes were also highly significant for the studied indicator (Table 1).

The growth of seedling indicated that all genotypes in early growth stage (BBCH – 09-10) (Hess, et al, 1997) after treatments in the 17.5 and 20.0% PEG suffered significant physiological stress despite the proven drought resistance of the tested species.

Similar results were reported by O'Donnell et al. (2013) and Damame et al., (2014); Chaniago et al., (2017) according to whom applied of 20.0% PEG in early growth stage of *Sorghum* species provoked significant physiological stress.

There was a specific variety reaction with regard to the effect of PEG on seedling growth in the tested *Sorghum vulgare* var. *technicum* (Körn.) genotypes.

Average seedlings length at broom corn local variety GL15A (8.99 cm) was established that grows intensively when exposed to 15.0% PEG and formed the longest seedling average for the treatment. Relatively long seedling formed local varieties GL15A (14.42 cm) and G16V (13.36 cm). Seedlings length at the Szegedi 1023 varieties and local variety MI16N and AS17P was significantly different to other local varieties and ranges from 8.95 to 8.80 cm. Two local varieties G16V and SMI16N conditionally can be identified as susceptible to drought stress.

The reduction on the seedling length (IR%) according control treatments at the two local varieties G16V and SMI16N and was ranging from 0.95 to 57.7% conditionally can be identified as susceptible to drought stress. It was found that the average length of the root and shoot in the tested genotypes of broom corn, irrigated with distilled water, ranges over a broad range of roots: from 4.44 to 7.94 cm and from 2.33 to 7.97 cm at shoots.

From the biometric measurements, it was found that the GL15A and G16B local varieties form the relatively longest root and shoot, respectively, from 7.94 and 7.84 cm and from 5.69 to 7.97 cm respectively. Smallest root length and shoot were recorded at AS17P and Sz16 local varieties respectively: from 4.44 and 4.80 cm at the root and from 2.33 to 4.13 cm. With regard to the studied indicators the local variety MI16N – has an intermediate position (Table 1). Therefore, the observed differences in the studied genotypes broom corn with regard to the osmotic stress of PEG could be also explained by genetic differences, because the comparisons between them were conducted at the same concentrations of the applied of PEG.

Osmotic stress induced by the addition of PEG inhibits root growth and shoot IR % from 15.03 to 72.29% at higher applied concentrations (from 10.0 to 20.0%). Lower applied concentrations (1.25 to 7.5%) had a stimulating effect IR % from 11.71 to 135.77%, according to control treatments for all tested varieties. PEG indicates a stronger depressant effect on the shoot growth (on average from 24.3 to 72.3%) according to compared to root growth (on average from 15.03 to 35.56%), that indicating the increase in shoot is affects more strongly the osmotic stress, compared to the growth of the root. Similar results were reported by Bozhanova et al. (2005); Bibi et al. (2010); O'Donnell et al. (2013) Donchev et al. (2016). According to the studied on these authors the observed dependence can be explained by a protective reaction of plants to prevent dehydration, given the important role that roots play in supplying the plant with water and nutrients.

A high negative correlation was detected between germination and the root growth (r of -0.755 to -0.931) and shoot growth (r of -0.668 to -0.985), and the seedling length (r of -0.944 to -0.985) for all tested genotypes of broom corn.

With relatively good tolerance to osmotic stress it is possible to determine Szegedi 1023 variety and the local variety AS17P (TI average varied from 2.28 to 2.55). With low coefficients of tolerance, i.e., the high sensitivity of drought in the early growth stages of development (BBCH -09-10) were the G16V and MI16N local varieties (TI average varied from 1.29 to 1.36) while GL15A local variety occupies an intermediate position – TI – 1.62 (Table 1 and 2, Figure 1).

Reducing fresh biomass of root, shoot and seedling is common the response of crop plants when subjected to moisture deficiency (Sharp and Davies, 1979, Santamaria et al., 1990; Ambika et al., 2011 Song et al., 2013).

Formation of fresh biomass (g per seedling) was genotype dependent.

Szegedi 1023 variety and AS17P local variety, unlike the growth of the seedlings, the formed fresh biomass (g for seedlings) increases with the increasing level of PEG 20000 treatments, except for the highest applied concentrations (17.5 and 20.0%), and the differences were statistically significant (p = 0.05) (Table 2).

The water stress induced by the application of PEG 20000 also decreases IR% from 22.22 to 100.0% the formed fresh biomass of the primary root, leaf and and seedligs at the GL15A, G16V and MI16N local variety, and the differences were statistically significant (p = 0.05), which can be explained by their sensitivity to drought in the early growth stages of development (BBCH – 09-10).

Dhanda et al. (2004), Hajime (1999) Bibi et al. (2010), Sabadin et al. (2012) also observed significant differences for various seedling traits contributing to drought in Sorghum species, respectively.

Data from dispersion analysis (Table 3) showing hierarchical allocation of variations among factors determing the osmotic stress induced by the addition of different PEG 20000 concentrations (% w/v) on the tested species howed that factors A (η^2 varied from 9.5 to 13.2) interaction AxB (η^2 from 3.8 to 5.9) had statistically significant action but factor B (concentration of PEG 20000 % w/v) (η^2 from 19.1 to 21.5) had the strongest effect for the root, shoot and seedlings lenght. Regarding weight parameters root, shoot and seedlings weight, factor B also to had a statistical significance (η2 from 19.6 to 40.2). followed by factor A genotipes (η2 from 4.10 to 25.9). Interaction of the genotypes factor A applied concentration – factor B had a relatively high proportion of total variation of η2 from 25.5 to 47.5 had statistical significance regarding formed fresh biomass of root, shoot and seedlings.

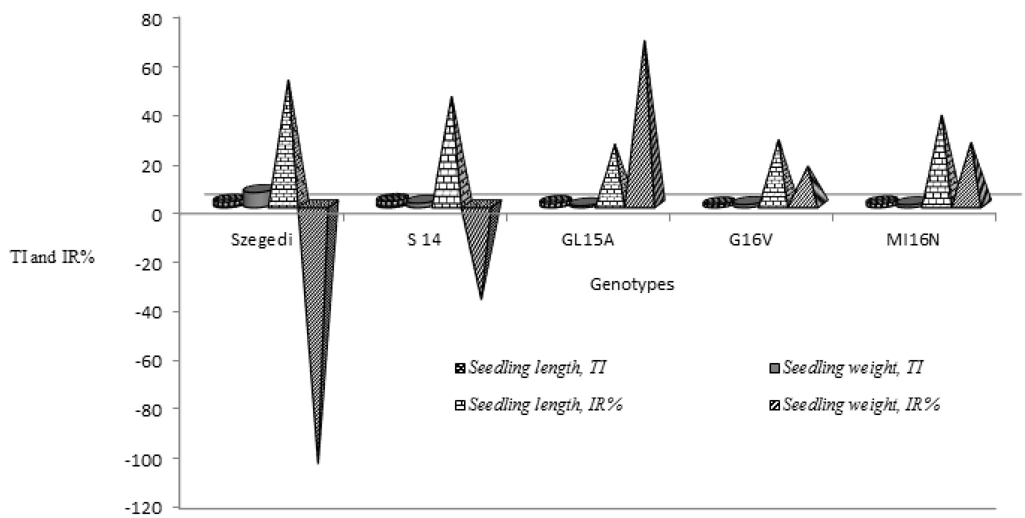

Fig. 1. Sensitivity to drought in *Sorghum vulgare* var. *technicum* (Körn.) genotypes
Legend: IR% - Percent inhibition. Positive values "+" show inhibition effect, while negative "-" values show stimulation effect; TI – Tolerance index, coefficient average for all tested concentrations of PEG 20000

Table 1. Growth of seedlings in *Sorghum vulgare* var. *technicum* (Körn.) genotypes under different concentrations of PEG 20000

Geno-types	Indica-tors	PEG concentrations,%									
		0.0	1.25	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0
Szegedi 1023	Shoot, cm	4.80c	7.07e	5.60cd	5.56cd	7.20e	6.73cd	5.78cd	5.24cd	2.36b	0.30a
	IR%	0.00	-47.29	-16.67	-15.83	-50.00	-40.21	-20.42	-9.17	50.83	93.75
	TI	1.00	4.41	2.77	2.73	4.58	4.00	2.95	2.42	0.49	0.06
	Root, cm	4.13cd	5.12de	6.20e	5.86e	3.64c	3.73c	3.55c	3.47c	1.88b	0.00a
	IR%	0.00	-23.97	-50.12	-41.89	11.86	9.69	14.04	15.98	54.48	92.74
	TI	1.00	3.38	4.95	4.42	1.71	1.79	1.62	1.55	0.46	0.07
	Seedling, cm	8.93cd	12.1e	11.80de	11.42cde	10.84cde	10.46cde	9.33cde	8.70c	4.24b	0.30a
	IR%	0.00	-35.50	-32.14	-27.88	-21.39	-17.13	-4.48	2.58	52.52	96.64
	TI	1.00	3.87	3.68	3.44	3.10	2.89	2.30	2.00	0.47	0.03
AS17P	Shoot, cm	4.44bc	8.24e	7.53de	6.78de	5.58cd	5.88cd	4.16bc	3.34b	3.49b	0.30a
	IR%	0.00	-85.59	-69.59	-52.70	-25.68	-32.43	6.31	24.77	21.40	93.24
	TI	1.00	4.38	3.66	2.97	2.01	2.23	1.12	0.72	0.79	0.07
	Root, cm	2.33b	7.68d	5.63c	5.34c	5.21c	4.47c	4.63c	2.13b	2.16b	0.30a
	IR%	0.00	-229.61	-141.63	-129.18	-123.61	-91.85	-98.71	8.58	7.30	87.12
	TI	1.00	11.72	6.30	5.67	5.39	3.97	4.26	0.90	0.93	0.13
	Seedling, cm	6.78b	15.92f	13.16ef	12.13cd	10.79cd	10.35cd	8.79bc	5.47b	5.65b	0.60a
	IR%	0.00	-134.81	-94.10	-78.91	-59.14	-52.65	-29.65	19.32	16.67	91.15
	TI	1.00	6.62	4.52	3.84	3.04	2.80	2.02	0.78	0.83	0.09
GL15A	Shoot, cm	7.94cd	10.07e	9.25e	8.09cd	8.07cd	6.79bc	7.73cd	6.58abc	4.78ab	4.19a
	IR%	0.00	-26.83	-16.50	-1.89	-1.64	14.48	2.64	17.13	39.80	47.23
	TI	1.00	2.67	2.25	1.72	1.72	1.21	1.57	1.14	0.60	0.53
	Root, cm	5.69abc	8.83e	9.31e	7.50bcde	7.59cde	6.66bcd	6.10abc	8.55de	4.22a	5.45a
	IR%	0.00	-55.18	-63.62	-31.81	-33.39	-17.05	-7.21	-50.26	25.83	4.22
	TI	1.00	3.25	3.61	2.34	2.40	1.85	1.55	3.04	0.74	0.96
	Seedling, cm	13.62bc	18.91d	18.57d	15.59cd	15.67cd	13.45cd	13.84bc	15.12bc	8.99a	9.64ab
	IR%	0.00	-38.84	-36.34	-14.46	-15.05	1.25	-1.62	-11.01	33.99	29.22
	TI	1.00	2.92	2.82	1.98	2.01	1.48	1.56	1.87	0.66	0.71
G16V	Shoot, cm	7.84bcd	10.28ef	10.68f	8.46de	8.03cd	6.27abc	6.04ab	5.58a	5.85a	4.71a
	IR%	0.00	-31.12	-36.22	-7.91	-2.42	20.03	22.96	28.83	25.38	39.92
	TI	1.00	2.30	2.49	1.56	1.41	0.86	0.80	0.68	0.75	0.60

Table 1. Continued

	Root, cm	7.97d	9.55e	7.89d	6.96cd	6.11bc	5.19ab	5.20ab	4.72ab	4.45a	4.46a
	IR%	0.00	-19.82	1.00	12.67	23.34	34.88	34.76	40.78	44.17	44.04
	TI	1.00	2.57	1.76	1.37	1.05	0.76	0.76	0.63	0.56	0.56
	Seedling, cm	15.81cd	19.83e	18.58de	15.43cd	14.14bc	11.46ab	11.24ab	10.30a	10.30a	8.93a
	IR%	0.00	-25.43	-17.52	2.40	10.56	27.51	28.91	34.85	34.85	43.52
	TI	1.00	2.41	2.12	1.46	1.23	0.81	0.78	0.65	0.65	0.56
MI16N	Shoot, cm	6.32ef	8.34f	5.46de	5.25cde	4.94bcde	3.21abc	2.41a	3.52abcd	2.82ab	3.09ab
	IR%	0.00	-31.96	13.61	16.93	21.84	49.21	61.87	44.30	55.38	51.11
	TI	1.00	3.90	1.67	1.55	1.37	0.58	0.33	0.70	0.45	0.49
	Root, cm	5.31cdef	7.34ef	7.36e	6.28def	4.84bcd	5.26cde	3.24abc	2.24a	2.10a	2.85ab
	IR%	0.00	-38.23	-38.61	-18.27	8.85	0.94	38.98	57.82	60.45	46.33
	TI	1.00	4.83	4.86	3.54	2.10	2.48	0.94	0.45	0.40	0.54
	Seedling, cm	11.63cde	15.67e	12.83de	11.52cd	9.77bcde	8.47abc	5.66a	5.76ab	4.92a	5.94ab
	IR%	0.00	-34.74	-10.32	0.95	15.99	27.17	51.33	50.47	57.70	48.93
	TI	1.00	4.29	2.88	2.32	1.67	1.25	0.56	0.58	0.42	0.51

Legend: IR% - Percent inhibition. Positive values "+" show inhibition effect, while negative "-" values show stimulation effect; TI – Tolerance index; Different letters in columns indicate significant differences by the LSD test at p=0.05 probability

Table 2. Accumulation of fresh biomass g for one seedlings in *Sorghum vulgare* var. *technicum* (Körn.) genotypes under different concentrations of PEG 20000

Genotypes	Indicators	PEG concentrations,%									
		0.0	1.25	2.5	5.0	7.5	10.0	12.5	15.0	17.5	20.0
Szegedi 1023	Shoot, g	0.005a	0.018c	0.019c	0.010b	0.014b	0.013b	0.012b	0.014b	0.006b	0.005a
	IR%	0.00	-260.0	-280.0	-100.0	-180.0	-160.00	-140.0	-180.0	-20.0	0.00
	TI	1.00	12.96	14.44	4.00	6.53	6.76	5.76	6.53	1.20	1.00
	Root, g	0.02b	0.06e	0.05d	0.05d	0.05d	0.05d	0.04c	0.04c	0.01a	0.02b
	IR%	0.00	-47.29	-16.67	-15.83	-50.00	-40.21	-20.42	-9.17	50.83	93.75
	TI	1.00	4.41	2.77	2.73	4.58	4.00	2.95	2.42	0.49	0.06
	Seedling, g	0.03b	0.08f	0.07e	0.06d	0.06d	0.06d	0.06d	0.05d	0.02c	0.03a
	IR%	0.00	-35.50	-32.14	-27.88	-21.39	-17.13	-4.48	2.58	52.52	96.64
	TI	1.00	3.87	3.68	3.44	3.10	2.89	2.30	2.00	0.47	0.03
AS17P	Shoot, g	0.01a	0.02b	0.01a	0.02b	0.01a	0.01a	0.01a	0.02b	0.01a	0.01a
	IR%	0.00	-100.0	0.00	-100.0	0.00	0.00	0.00	-100.0	0.0	0.0
	TI	1.00	4.00	1.00	4.00	1.00	1.00	1.00	4.00	1.00	1.00

Table 2. Continued

	Root, g	0.05a	0.08d	0.09e	0.08d	0.08d	0.07c	0.06b	0.06b	0.06b	0.05a
	IR%	0.00	-60.00	-80.00	-60.00	-60.00	-40.00	-20.00	-20.00	-20.00	0.00
	TI	1.00	2.56	3.24	2.56	2.13	1.96	1.44	1.20	1.20	1.00
	Seedling, g	0.06a	0.10e	0.10e	0.09d	0.09d	0.08c	0.08c	0.08c	0.07b	0.06a
	IR%	0.00	-66.67	-66.67	-50.00	-50.00	-33.33	-33.33	-33.33	-16.67	0.00
	TI	1.00	2.78	2.78	2.25	1.93	1.78	1.78	1.52	1.17	1.00
GL15A	Shoot, g	0.04d	0.01b	0.02c	0.01b	0.01b	0.01b	0.01b	0.01b	0.01b	0.00b
	IR%	0.00	75.00	50.00	75.00	75.00	75.00	75.00	75.00	75.00	100.00
	TI	1.00	0.25	1.00	0.25	0.25	0.25	0.25	0.25	0.25	-
	Root, g	0.12g	0.07f	0.06e	0.05d	0.05d	0.05d	0.04c	0.04c	0.03b	0.00a
	IR%	0.00	41.67	50.00	58.33	58.33	58.33	66.67	66.67	75.00	100.00
	TI	1.00	1.36	1.00	0.69	0.69	0.69	0.44	0.44	0.25	-
	Seedling, g	0.16g	0.08f	0.08f	0.07e	0.06d	0.06d	0.05c	0.05c	0.03b	0.00a
	IR%	0.00	50.00	50.00	56.25	62.50	62.50	68.75	68.75	81.25	100.00
	TI	1.00	1.33	1.33	1.02	0.75	0.75	0.52	0.52	0.19	-
G16V	Shoot, g	0.01a	0.02b	0.01a	0.02b	0.02b	0.01a	0.01a	0.01a	0.01a	0.01a
	IR%	0.00	-100.00	0.00	-100.00	-100.00	0.00	0.00	0.00	0.00	0.00
	TI	1.00	4.00	1.00	4.00	4.00	1.00	1.00	1.00	1.00	1.00
	Root, g	0.09d	0.12e	0.09d	0.07c	0.07c	0.06b	0.06b	0.06b	0.05a	0.05a
	IR%	0.00	-33.33	0.00	22.22	22.22	33.33	33.33	33.33	44.44	44.44
	TI	1.00	3.20	1.80	1.09	1.09	0.80	0.80	0.80	1.00	0.56
	Seedling, g	0.10d	0.14f	0.11e	0.09c	0.09c	0.07b	0.07b	0.07b	0.06a	0.06a
	IR%	0.00	-40.00	-10.00	10.00	10.00	30.00	30.00	30.00	40.00	40.00
	TI	1.00	3.27	2.02	1.35	1.35	0.82	0.82	0.82	1.00	0.60
MI16N	Shoot, g	0.01a	0.01a	0.01a	0.01a	0.01a	0.01a	0.01a	0.01a	0.01a	0.01a
	IR%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TI	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	Root, g	0.07f	0.06d	0.08e	0.06d	0.06d	0.05c	0.04b	0.04b	0.03a	0.04b
	IR%	0.00	14.29	-14.29	14.29	14.29	28.57	42.86	42.86	57.14	42.86
	TI	1.00	1.29	2.29	1.29	1.71	0.89	0.57	0.76	0.75	0.57
	Seedling, g	0.08d	0.07c	0.09e	0.08d	0.07c	0.05b	0.05b	0.05b	0.04a	0.04a
	IR%	0.00	12.50	-12.50	0.00	12.50	37.50	37.50	37.50	50.00	37.50
	TI	1.00	1.23	2.03	1.60	1.53	0.63	0.63	0.78	0.80	0.63

Legend: IR% - Percent inhibition. Positive values “+” show inhibition effect. while negative “-” values show stimulation effect; TI – Tolerance index; Different letters in columns indicate significant differences by the LSD test at p=0.05 probability

Table 3. Main effects of the factors tested

Indicators	Causes of variation	Intercept	Factor A - genotypes	Factor B – concentracion	Interaction AxB	Error	Total
Root length	Degrees of freedom	1	4	9	36	5920	5969
	Sum of squares	156937.4	9755.8	15258.9	4342	44692.6	73994.5
	Mean square	156937.4	2439	1695.4	120.6	7.5	
	Influence of factors, η2		13.2	20.6	5.9		
Shoot lenght	Degrees of freedom	1	4	9	36	5914	5963
	Sum of squares	204287.8	9227.5	18480.8	4580.5	64366	96753.5
	Mean square	204287.8	2306.9	2053.4	127.2	10.9	
	Influence of factors, η2		9.5	19.1	4.7		
Seedling length	Degrees of freedom	1	4	9	36	5914	5963
	Sum of squares	718366	36079.2	66809.1	11712.7	197274.3	311403.2
	Mean square	718366	9019.8	7423.2	325.4	33.4	
	Influence of factors, η2		11.6	21.5	3.8		
Root weight	Degrees of freedom	1	4	9	36	250	299
	Sum of squares	0.044068	0.000425	0.002031	0.004932	0.002998	0.010388
	Mean square	0.044068	0.000106	0.000226	0.00022	0.000013	
	Influence of factors, η2		4.1	19.6	47.5		
Shoot weight	Degrees of freedom	1	4	9	36	250	299
	Sum of squares	0.961068	0.041272	0.063292	0.040568	0.01405	0.159132
	Mean square	0.961068	0.010818	0.007255	0.001405	0.000012	
	Influence of factors, η2		25.9	39.8	25.5		
Seedling weight	Degrees of freedom	1	4	9	36	250	299
	Sum of squares	1.4283	0.03676	0.09026	0.08058	0.01705	0.2247
	Mean square	1.4283	0.01194	0.01067	0.00225	0.00014	
	Influence of factors, η2		16.4	40.2	35.9		

LSD at the 0.05 probability level

Conclusion

The genetic potential of five sorghum genotypes (one variety and four local variety) was evaluated through artificially created water stress by PEG of molecular weight 20000 in laboratory conditions to drought tolerance in the early growth stages and development BBCH 09-10.

Osmotic stress induced by the addition of PEG inhibits root growth and shoot IR% from 15.03 to 72.29% at higher applied concentrations (from 10.0 to 20.0%). Lower applied concentrations (1.25 to 7.5%) had a stimulating effect IR% from 11.71 to 135.77%, according to control treatments for all tested genotypes.

There was a specific variety reaction with regard to the effect of PEG on seedling growth (cm) and formation of fresh weight on seedlings (g) in the tested genotypes *Sorghum vulgare* var. *technicum* (Körn.).

It was found that with relatively good tolerance to osmotic stress it is possible to determine Szegedi 1023 variety and the AS17P local variety (TI average varied from 2.28 to 2.55). With low coefficients of tolerance, i.e. the high sensitivity of drought in the early growth stages of development (BBCH – 09-10) were the G16V and MI16N local varieties (TI average varied from 1.29 to 1.36) while GL15A local variety occupies an intermediate position – TI – 1.62.

In the Szegedi 1023 variety and AS17P local variety, unlike the growth of the seedlings, the formed fresh biomass in g for one seedlings increases with the increasing level of PEG 20000 treatments, except for the highest applied concentrations (17.5 and 20.0%), while the GL15A, G16V and MI16N local varieties formed fresh biomass of the roots, shoots and seedlings decreased IR% varied from 22:22 to 100.0% and the differences were statistically significant (p = 0.05). which can be explained by their sensitivity to drought in the early growth stages of development (BBCH-09-10).

The G16V and MI16N local varieties found superior and might be productive in further breeding programmes for drought tolerance. Selection can be made on the basis of these characters at early growth stage to screen a broom corn genotypes for drought stress or water deficit.

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