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Boron Tolerance in Wheat Roots

- Brief Communication -

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Abstract: One of the consequences of high boron concentracions in soil is the suppression of wheat (*Triticum aestivum* L.) roots growth. Variability of boron tolerance in wheat genotypes was analysed by germination on filter paper soaked with different concentrations of boric acid (0, 50, 100, 150 mg/l). Observed genotypes showed significant differences in roots length and number at different boron treatments. Genotypes which had very small differences in roots length between the control and treatments are identified as boron tolerant.

Key words: Boron tolerance, roots, wheat.

Introduction

Boron is an essential micronutrient for wheat and the others higher plants, ***Hu*** and ***Brown***, 1997. Present in excessive amounts, which is commom for arid and semi-arid environments like Vojvodina, ***Kraljević-Balalić et al.***, 2004, boron becomes toxic and causes important disorders in plant growth, which results in reduction of yield and quality, ***Nable et al.***, 1997. A wide range in genetic variation in response to high levels of soil boron occurs among wheat genotypes, ***Paull et al.***, 1991, and can be exploited in order to create tolerant high-yielding cultivars.

Material and Methods

Boron tolerance in 14 wheat cultivars, created in Research Institute of Field and Vegetable Crops, Novi Sad, has been analysed by method of ***Chantachume et al.***, 1995. 1200 grains of each cultivar were surface sterilized and pre-germinated for two days at 4ºC and one day at 18ºC. The grains were placed embryo downwards in plastic boxes which contained filter paper soaked with different concentrations of boric acid solution (0, 50, 100 and 150 mg/l), and covered with aluminium foil. All solutions included 0,5 mM $Ca(NO_3)_2x4H_2O$, 0,0025 mM $ZnSO_4x7H_2O$ and 0,015 mM H_3BO_3. The boxes were stored at 18ºC and moistened every day with solutions. After eleven days the length and the number of roots were measured. The samples included 50 grains for each tretman and control, separated in five replications.

Results and Discussion

The length of the longest root (LRL), the number of roots (RN) and the length of all roots (ARL) showed significant variability among analysed wheat genotypes and boron treatments (Tables 1 and 2). The correlations between ARL at B 0 and B 50, B 100 and B 150 were significant (r = 0.43, 0.46 and 0.43, respectively). The relationships between ARL at different boron treatments were also significant, with correlation coefficients between B 50 and B 100 and B 150, and between B 100 and B 150 being r = 0.50, 0.36 and 0.52, respectively. It indicates the consistent reaction of ARL to boron treatments. However, the correlations between LRL at B 0 and B 150, B 50 and B 150, and B 100 and B 150 were non-significant, which is probably due to changes in RN at different treatments (Tab. 1.) and implies

Table 1. Average Length of the Longest Root (LRL) in cm and the Number of Roots (RN) for Wheat Cultivars Tested by a Filter Paper Method at Control (B 0) and Three (B 50, B 100, B 150) Boron Treatments
Prosečna dužina najdužeg korenčića (LRL) u cm i broj korenčića (RN) za sorte pšenice testirane filter papir metodom na kontroli (B 0) i tri tretmana borne kiseline (B 50, B 100 i B 150)

Cultivar	LRL				RN			
Sorta	B 0	B 50	B 100	B 150	B 0	B 50	B 100	B 150
Renesansa	11.6	10.5	8.2	6.1	4.8	4.7	4.5	4.3
Rusija	11.8	10.6	7.4	5.3	5	4.2	4.1	3.9
Arija	12.7	10.9	10.1	7	4.4	4.3	4.3	4.5
Cipovka	15	12.4	12.1	9.6	3.2	3.5	3.3	3.5
Pobeda	11.8	11.2	9.9	6.7	4.6	4.3	4.6	4.6
Evropa 90	11.6	11.1	8.2	7.9	4.2	4.1	4	4.3
Astra	8.8	9.2	9.1	6.8	5	4.6	4.3	4.3
Vila	14.2	14.5	10.6	10.6	4.9	4.5	4.9	4.9
Oda	11	10.7	10.8	7.6	5.2	5.1	4.6	4.2
Diva	13.8	13.2	12.2	12.2	4.7	4.6	4.6	4.6
Ljiljana	11.2	11.5	11.1	9.9	3.8	3.6	3.7	4.3
Simfonija	13.5	14.2	15.2	10	4.1	3.8	3.8	4.3
Dragana	10.3	12.8	9.4	9.2	4.9	4.9	4.6	4.6
Mina	10.9	12.6	13.6	11.7	4.5	4	3.8	3.8
Average/Prosek	12	11.8	10.6	8.6	4.5	4.3	4.2	4.3

Table 2. AverageLength of All Roots (ARL) in cm and a Relative Root Length (RRL) in % for Wheat Cultivars Tested by a Filter Paper Method at Control (B 0) and Three (B 50, B 100, B 150) Boron Treatments
Prosečna dužina svih korenčića (ARL) u cm i relativna dužina korenčića (RRL) u % za sorte pšenice testirane filter papir metodom na kontroli (B 0) i tri tretmana borne kiseline (B 50, B 100 i B 150)

Cultivar	ARL				RRL		
Sorta	B 0	B 50	B 100	B 150	B50/0*	B100/0*	B150/0*
Renesansa	41.3	34.2	25.3	18.2	83	61	44
Rusija	30.7	26.9	18.2	12.9	88	60	42
Arija	38.5	31.3	29.2	19.9	81	76	52
Cipovka	35.7	29.3	28.4	23.4	82	80	66
Pobeda	35.3	32	31.4	19.9	91	89	56
Evropa 90	30.9	30.8	22.7	21.9	100	74	71
Astra	26.5	24.5	22.4	17.7	93	85	67
Vila	44.7	47	33.1	34.5	105	74	77
Oda	31.9	31.3	32.5	19.2	98	102	60
Diva	33.2	32.1	30.7	27.5	97	92	83
Ljiljana	27.7	26.2	26.1	25	95	94	90
Simfonija	37.5	36.8	41.4	28.3	98	110	75
Dragana	31.3	40.5	27.1	29	129	87	93
Mina	31	34.5	37.1	30.5	111	120	99
Average/Prosek	34	32.7	29	23.4	97	86	70

* B50/0 -(length of all roots at B 50/length of all roots at B 0) x 100 - (dužina svih korenčića na B 50/dužina svih korenčića na B 0) x 100
B100/0 - (length of all roots at B 100/length of all roots at B 0) x 100 - (dužina svih korenčića na B 100/dužina svih korenčića na B 0) x 100
B150/0 - (length of all roots at B 150/length of all roots at B 0) x 100 - (dužina svih korenčića na B 150/dužina svih korenčića na B 0) x 100

the certain modification of result interpretation given by ***Chantachume et al***., 1995. Instead LRL, ARL is discussed as selection criterion for boron tolerance in wheat.

Between analysed genotypes occured significant variability of relative root length (RRL). Diva, Ljiljana, Simfonija, Dragana and Mina are cultivars with small differences in root length between control and boron treatments (Table 2), and they are identified as boron tolerant. Mina even showed significant increasing in root length at B 50 and B 100 in relation to B 0, and the same root length at B 0 and B 150.

It is important to remark that the root growth suppression is only one of the aspects of boron tolerance in wheat, ***Jefferies et al***., 2000. Genotypes can surely be marked as tolerant or sensitive only if leaf symptoms and yield are also considered. Therefore, boron tolerance in analysed genotypes will be studied in field trial and by molecular marker methods.

Conclusion

The analysed wheat genotypes demonstrated the significant variability regarding the length of the longest root, the number of roots and the length of all roots at different boron treatments. Cultivars Diva, Ljiljana, Simfonija, Dragana and Mina are marked as boron tolerant, which will be further studied in field trial and by methods of molecular markers.

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Tolerancija korena pšenice na visoke koncentracije bora

- Prethodno saopštenje -

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Rezime

Redukcija rasta korena pšenice (*Triticum aestivum* L.) je jedna od posledica prisustva visokih koncentracija bora u zemljištu. Analizirana je varijabilnost genotipova pšenice u pogledu tolerancije korena na visoke koncentracije bora metodom naklijavanja semena na filter hartiji navlaženoj rastvorom borne kiseline koncentracija 0, 50, 100, 150 mg/l. Ispitivani genotipovi su ispoljili značajne razlike u dužini i broju korenčića na različitim tretmanima. Izdvojeni su genotipovi kod kojih je uočena vrlo mala razlika u dužini korenčića između kontrole i tretmana i koji se smatraju tolerantnim na visoke koncentracije bora.

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