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Root traits differentiates osmotic stress tolerant and susceptible wheat genotypes under PEG-treatment

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Abstract: Wheat is an important cereal crop that often suffers from osmotic stress under various growing conditions. The objective of this study was to investigate the effects of PEG-induced osmotic stress at the phytomer level on root growth and root hair morphology of 22 hydroponically grown wheat varieties. Two treatments, 0% and 10% PEG, were imposed for 15 days duration at 20 days old wheat seedlings. PEG stress significantly reduced plant height, number of live leaves per tiller, chlorophyll content, shoot dry weights, number of root bearing phytomers and roots per tiller. By contrast, PEG stress significantly increased leaf injury scores, root dry weight, main axis length and diameter of developed roots, length and diameter and density of both first and second order lateral roots, density and length of root hairs. An increase in root dry weight in PEG stress tolerant wheat genotypes was achieved through increase in length and diameter of main axis and lateral roots.

Keywords: Wheat; PEG; osmotic stress; root traits.

Results and Discussion

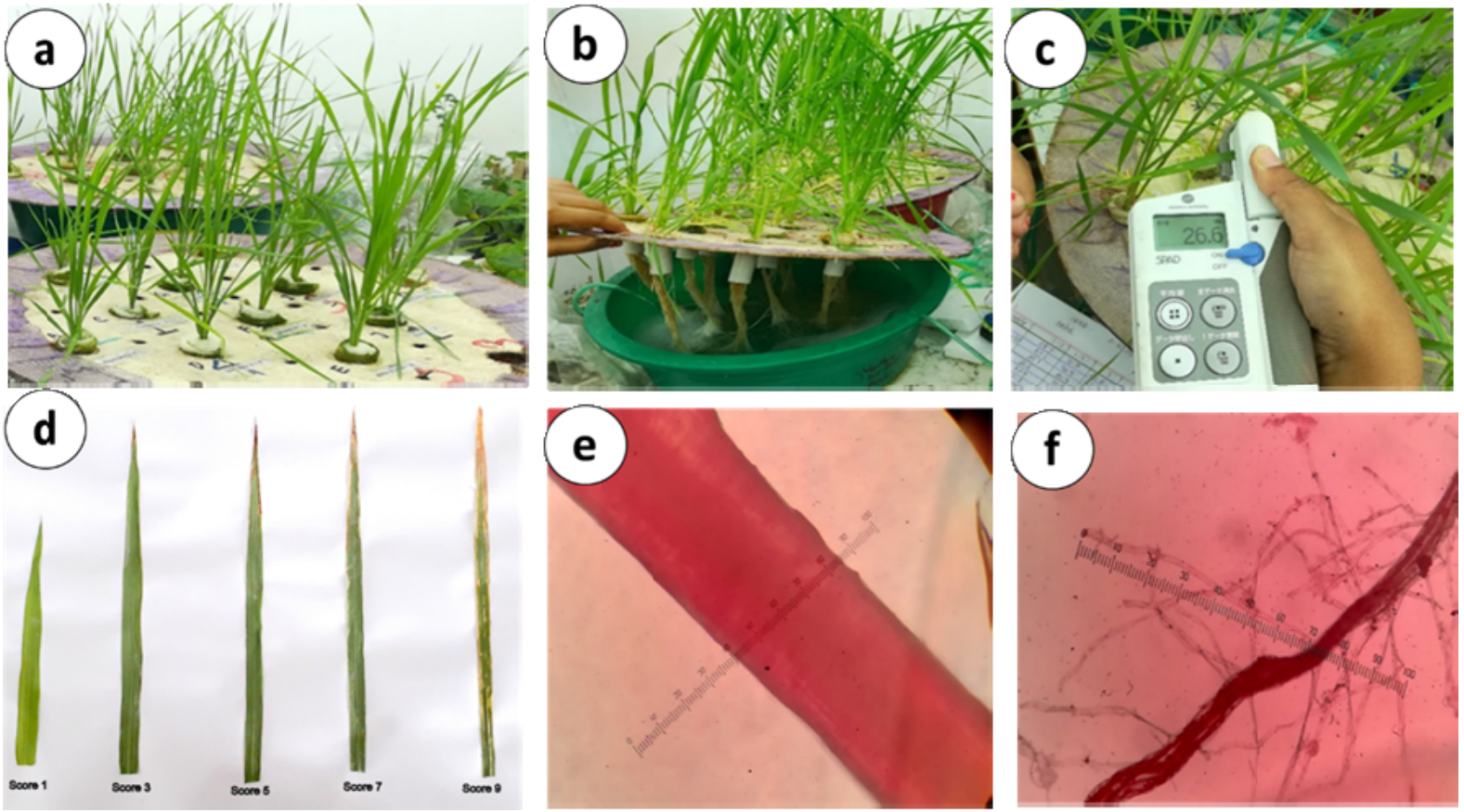

Figure 1. Hydroponic culuture of wheat genotypes and measurements. (**a**) wheat plants at 20 days ready for treatment impostion; (**b**) Root growth of what plants under 10%PEG induced osmotic stress; **(c)** Measurements of chrolophyll content using SPAD meter; **(d)** scoring of damaged leaves under osmotic stress; (e) diameter of a root axis and (f) length of a root hair.

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Table 1. Difference between control and 10% PEG induced osmotic stress among wheat genotypes. Pr, phytomer; MA, main axis; FLR, first order lateral roots; SLR, second order lateral roots; RH, root hairs; d, diameter; Dn, density; L, length.

Traits	Control	10% PEG	P value
Root dry weight (RDW)	0.05 ±0.00	0.07 ±0.00	<0.001
Total no. of phytomer (TPr)	7.18 ±0.16	5.70 ±0.16	<0.001
Total no. of roots per tillers (TRt)	9.34 ±0.36	7.32 ±0.34	<0.001
No. of seminal roots (SR)	5.59 ±0.16	4.48 ±0.17	0.008
Length of seminal roots (LSR)	2.55 ±0.13	3.23 ±0.17	<0.001
Main axis length at Pr 4 (MALPr4)	47.6 ±1.17	53.2 ±1.3	<0.001
Diameter of main axis (dMA)	0.36 ±0.01	0.50 ±0.01	<0.001
Length of FLR (LFLR, cm)	1.48 ±0.08	3.00 ±0.14	<0.001
Diameter of FLR (dFLR, mm)	0.19 ±0.00	0.27 ±0.01	<0.001
Density of FLR (DnFLR)	4.95 ±0.07	6.60 ±0.08	<0.001
Length of SLR (LSLR, cm)	0.39 ±0.09	0.57 ±0.03	<0.001
Diameter of SLR (dSLR, mm)	3.35 ±0.09	5.13 ±0.09	<0.001
Density of SLR (DnSLR)	6.58 ±0.22	8.18 ±0.23	<0.001
Density of root hairs of MA ($DnRH_{MA}$)	6.70 ±0.22	8.41 ±0.20	<0.001
Density of root hairs of SLR ($DnRH_{SLR}$)	7.06 ±0.20	9.15 ±0.20	<0.001
Length of root hairs of FLR (LRH_{FLR})	420.5 ±16.5	503.6 ±12.71	<0.001

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Table 2. Correlation among root dry weight (RDW), total number of root bearing phytomers (TPr) and total number of roots (TR) per tiller and with other root morphological traits of wheat genotypes under PEG induced osmotic stress.

Traits	RDW	TPr	TR
Total no. of phytomer (TPr)	0.379^{NS}		
Total no. of roots per tillers (TRt)	0.492^{NS}	0.92***	
No. of seminal roots (NSR)	0.405^{NS}	0.754**	0.867***
Main axis length at Pr 4 (MALPr4)	0.664*	-0.101 ^{NS}	0.091 ^{NS}
Diameter of main axis (dMA)	0.34^{NS}	-0.383 ^{NS}	-0.358 ^{NS}
Length of FLR (LFLR, cm)	0.481^{NS}	-0.381 ^{NS}	-0.149 ^{NS}
Diameter of FLR (dFLR, mm)	0.073^{NS}	-0.612*	-0.528 ^{NS}
Density of FLR (DnFLR)	-0.145^{NS}	-0.759**	-0.634*
Length of SLR (LSLR, cm)	0.162^{NS}	-0.067 ^{NS}	-0.068 ^{NS}
Diameter of SLR (dSLR, mm)	0.257^{NS}	0.309 ^{NS}	0.266 ^{NS}
Density of SLR (DnSLR)	0.448^{NS}	-0.337 ^{NS}	-0.262 ^{NS}
Density of root hairs of MA ($DnRH_{MA}$)	0.392^{NS}	-0.032 ^{NS}	-0.113 ^{NS}
Density of root hairs of SLR ($DnRH_{SLR}$)	0.205^{NS}	-0.186 ^{NS}	-0.125 ^{NS}
Length of root hairs of FLR (LRH_{FLR})	0.334^{NS}	-0.374 ^{NS}	-0.447 ^{NS}

Conclusions

- This study explored the effects of PEG-induced osmotic stress on root development at the phytomer level. A strong positive association between root dry weight and main axis length was observed. The results indicated that tolerant wheat genotypes increases length and density of main axis and lateral branches as an adaptive mechanism to cope the osmotic stress.

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