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Effect of Polyethylene Glycol on the Growth of Two Populations of *Anthxanthum odoratum*

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ABSTRACT

The effect of Polyethylene Glycol (6000) was studied on morphological characters of two populations of *Anthoranthum odoratum* (T606 x T15 and C8) in nutrient solution. Shoot and root length was significantly reduced with an increase in PEG concentration. Population difference and interaction between concentration x population were significant. When compared, T606 x T15 revealed significantly better growth than C8.

Key Words: *Anthoxanthu odoratum;* Shoot length; Root length; PEG; Osmotic stress

INTRODUCTION

Grass is grown throughout the world for grazing purpose. Carrying capacity of grassland is determined by its biomass productivity. Grime *et al*. (1988) reported that *Anthoxanthu odoratum* is found throughout the British Isles, Europe, Temperate Asia, Australia and New Zealand. It frequently occurs on heath, moors hill grasslands, old pastures woodlands and meadows on a wide range of soil types from sand to clay in dry and damp habitats. It is also frequently found lead zinc mine spoil and scree slopes in the limestone dales, river banks verges and other waste places. *A. odoratum* is polymorphic and morphologically variable (Wu & Jain, 1980) and have population differentiation due to soil metal concentration (Antonovics & Bradshaw, 1970; Davies & Snaydon, 1973).

Breeders are still looking for traits that are suitable for germplasm for characters affecting plant water relations under drought conditions (Bittman & Simpson, 1989; Al–Hakimi *et al*., 1995; Begg & Turner, 1996; Teulat *et al*., 1997; Merah, 2001). The lack of reliable method for identifying drought tolerant genotypes and the multitude of factors involved in tolerance to water stress makes it difficult to choose traits conferring an advantage under such conditions.

The kinetic parameters of mineral and water absorption and growth are neither constant nor homogenous within the root system (Habib *et al*., 1991). Moreover, the roll of root system in absorption also varies widely depending on the physiological status of the plant. Under conditions of limited water, water uptake from the soil by plant is directly related to root growth (Richard & Passioura, 1981), however, root characteristics vary with edaphic and climatic conditions (Souty, 1987).

Polyethylene Glycol induces water stress in plants. The aim of the study was to investigate the effect of various concentrations of PEG in order to estimate water stress status of *A. odoratun*.

MATERIALS AND METHODS

Seeds of two populations of *A. odoratum* T606 x T15 and C8 collected from Trelogan Mine Spoil, England and New Zealand, respectively were tested. The test solutions were prepared in 0.1 strength Rorison water culture nutrient solution (Hewitt, 1966). Three concentrations of PEG (6000) were chosen i.e., 80 g L^{-1} (-0.84Mpa), 120 g L^{-1} (-1.25Mpa) and 160 g L^{-1} (-1.67Mpa) including control (without PEG only nutrient solution).

Twenty four rubber glasses of 12 cm length were filled with test solutions for two populations, four treatments and three replicates. The black plastic beads were added in each glass. Six seeds of each population were sown on the beads in the glasses. The experiment was carried out in growth room of Life Science Department, University of Liverpool, England (UK) at temperature 24 ± 2^0C with constant relative humidity of 65% and under constant illumination at 50µ moles m^{-2} s^{-1} by cold white fluorescent lights. The experiment was arranged in a CRBD. After one month of sowing of seeds, the shoot and root length of the seedlings were measured in mm.

Statistical analysis. The data were analysed using the two way ANOVA from Proc ANOVA with interaction components using the SAS package on the PC (SAS Institute Inc., 1989). For separation of means the LSD at 0.05 level was also computed (Steel & Torrie, 1980).

RESULTS

The results (Tables I & II) showed that PEG (6000) caused a significant ($P<0.001$) reduction on the shoot and root growth of both the populations of *A. odoratum.* The difference among the population was also significant (P<

Table I. Analysis of variance of shoot length (populations sown in various PEG concentrations

Source	*DF*	*S.S*	*M.S*	*F value*	*Pr>F*
Populations	1	1013.361	1013.361	4.92	0.0282
Concs.	3	73313.638	24437.879	118.63	0.0001
Replicates	2	2231.763	1115.881	5.42	0.0055
Popu xConcs	3	7049.638	2349.879	11.41	0.0001

Table II. Analysis of variance of root length (populations sown in various PEG concentrations

Source	*DF*	*S.S*	*M.S*	*F value*	*Pr>F*
Populations	1	10117.006	10117.006	68.80	0.0001
Concs.	3	144874.798	48291.599	328.42	0.0001
Replicates	2	1391.541	695.670	4.73	0.01003
Popu xConcs	3	5437.687	1812.562	12.33	0.0001

Fig. 1. Root and shoot length of *A. odoratum* in various concentrations of PEG 6000

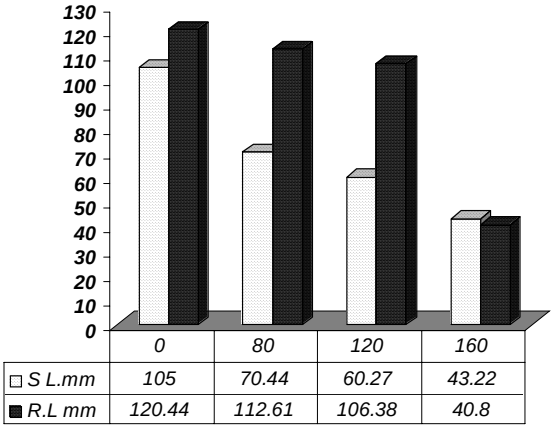
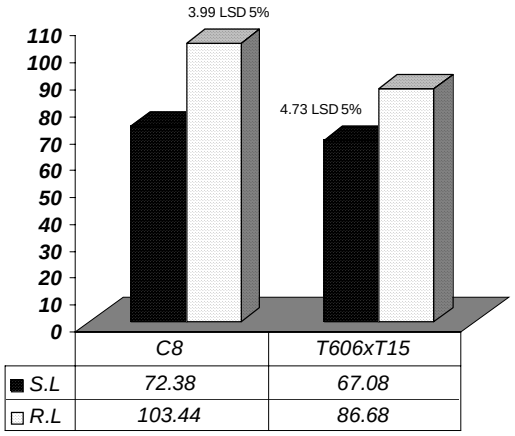


Fig. 2. Over all growth of shoot length and root length of two populations of *A. odoratum*



0.05). The significant interaction (populations x concentrations) also indicates that different populations responded differently to the increasing PEG 6000 concentrations.

The results (Fig. 1 & 2) revealed that shoot and root length of the two populations significantly (LSD at 0.05%) decreased with the increasing concentrations of PEG 6000 when compared with control. The detailed observations of means clearly indicated that the shoot and root growth of New Zealand population C8 was significantly (LSD at 0.05%) higher than that of England T606 x T15.

DISCUSSION

The results showed that PEG 6000 induces osmotic stress which had marked effects on both shoot and root parameters. These results were in accordance with the results of El Midoui (1993). The root growth decreased with the increase of PEG concentrations. Similar results were also found by Huck *et al.* (1970), who reported that reduction of root volume under osmotic stress originates not only from growth inhibition but also from a loss of turgidity, as reported in cotton (Huck *et al*., 1970), sugar beet (Ali Dib & Monneux, 1992). Root and shoot growth was high in the absence of PEG 6000 and decreased after adding the PEG. Similar results were found by El Midaoui *et al.* (2003) who reported the decline of root and shoot growth of sunflower by the addition of PEG 6000 in growth medium. Matsuura *et al.* (1990) also reported the growth reduction of maize. The varied response of these two populations for root and shoot growth was significant. The results can be compared with results on other species such as soybeans (Maertens *et al*., 1987), rice (Ahmadi, 1983) corn sorghum and millet (Matsuuura *et al*., 1996). This experiment strengthens the opinion that PEG induces the water stress in *A. Odoratum*. The response of population variation was also due to the environmental conditions of availability of natural water of England and New Zealand.

REFERENCES

Ahmadi, N., 1983. Variabilite genetique et herdite de mecanismes de tolerance a la secheresse chez *Oryza sativa* L. I. Developpement racinaire. *Argon. Trop*., 38: 118–22

Al–Hakimi, A., P. Monneveux and C. Galiba, 1995. Soluble sugars, proline and relative water content as trait for involving drought tolerance and divergent selection for RWC from T. polonicum into T. durum. *J. Gene.Breed*., 49: 237–43

Ali Dib, T., and P. Monneveux, 1992. Adaptation a la secheresse et notion d'ideotype chez le ble durI. Characters morphologiquesd' enraccinement *Agronomie*, 12: 371–79

Antonovics, J. and A.D. Bradshaw, 1970. Evolution in closely adjacent plants population. VIII. Clinal pattern at amine boundry. *Heredity*, 25: 349–62

Begg, J.E. and N.C. Turner, 1976. Crop water deficits. *Advances in Agronomy*, 28: 161–217

Bittmann, S. and M. Simpson, 1989. Drought effect on leaf conductance and leaf rolling in forage grasses. *Crop Sci*., 29: 338–44

Davies, M.S., and R.W. Snaydon, 1973. Physiological differences among populations of *A. odoratum*. *J. Appl. Ecol*., 10: 33–45

El Midaoui, M., H. Serieys, A. Berville and F. Kann, 2003. Effect of osmotic and water stress on root and shoot Morphology and seed yield in *Helianthus annus* L., *Hellia*, 26: 1–16

Grime, J.P., J.G. Hogdson and H. Hunt, 1988. *Comparative Plant Ecology* (1st ed). Unwin Hyman Ltd, Oxford University Press

Habib, R., L. Pages, M.O. Jordan, T. Simmonneau and M. Sebillotte, 1991. Apprache a l'echelle du systeme recinaire de l'absorption hydro–minerale. Consequences en matiere de modelisation. *Agronomie*, 11: 623–43

Hewitt, E.J., 1966. Sand and water culture methods used in the study of plants nutrition. *Technical Communication No. 22*. Common Wealth Agriculture Bureau.

Huck, M.G., B. Kleper and M.M. Taylor, 1970. Diurnal variation in diameter. *Pl. Physiol*., 45: 529–30

Maertens, C., J. Masse, D. Picard and F. Tardieu, 1987. Mise en place et fonctionnement du systeme racinaire des principales especes cultivees: recherches en cours a ' l INRA et a I'ITCF. *Perspect. Agric*., 119: 6–12

Matsuura, A., S. Inanaga and Y. Sugimoto, 1996. Mechanism of interspecific difference among four graminaceous crops n growth response to soil drying. *Japanese J. Crop Sci.*, 65: 352–60

Merah, O., 2001. Potential importance of water stress traits for durum wheat improvement under Mediterranean conditions. *J. Agric. Sci*., 137: 139–45

Richard, R.A. and J.B. Passioura, 1981. Seminal root morphology and water use of wheat. II. Genetic variation. *Crop Sci*., 21: 253–5

SAS Institute Inc., 1989. *SAS/Stat User's Guide, Version 6, 4th Ed.*, Vol. 1, Cary, N.C: SAS Institute Inc.

Souty, N., 1987. Aspect mecanique de la croissance des raciness. I. Mesure de la force de penetration. *Agron.*, 7: 623–30

Steel, R.G.D. and J.H. Torrie, 1980. *Principles and Procedure of Statistics. A Biometrical Appproach*. 2nd Ed. McGraw Hill Book Co., Tokyo Japan

Teulat, B., D. Rekika, M. Nachit and P. Monneveux, 1997. Comparative osmotic adjustment in barley and tetraploid wheat. *Plant Breed.*, 116: 519–23

Wu, L. and S. Jain, 1980. Self fertility and seed set in natural populations of *A. odoratum* L. *Botanical Gazette*, 141: 300–4

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