WINDTHROW RESISTANCE SCREENING BASED UPON NON-DESTRUCTIVE, LOW-ENERGY X-RAY IMAGING OF EARLY ROOT EMERGENCE FROM POPLAR HARDWOOD CUTTINGS

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Windthrow is a term for trees uprooted by excessive wind. Windthrow is due to a complicated interplay of intrinsic and extrinsic factors. Stand topology, soil condition, and airflow are key extrinsic factors while canopy, trunk and wood properties above ground and root architecture below ground are key intrinsic factors. Breeding for improved intrinsic traits is of interest. Field selection of potentially improved varieties of windthrow resistant trees is expensive and typically takes many years. This project investigated the question: Can early screening be used to identify new tree varieties with the potential for better windthrow resistance? The project specifically investigated screening for early root traits.

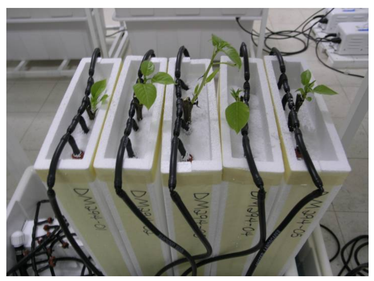
Field Selection for windthrow resistance

Indirect Selection for windthrow resistance using X-Ray Imaging

Nine Clones. Previously Classified as Windthrow Resistant or Windthrow Susceptible, Were Provided for X-ray-Based Wind Firm Screening Technique Development

Identity	Accession	Taxon	PSC ID	Type	# of trees
181-92-3246	6018	TxD	TD246	WF	4
282-93-4361	6198	DxT	DT361	WF	2
618-97-19560	8199	DxT	DT560	WF	3
222-93-4144	6154	DxT	DT144	S	3
545-5362	8360	TxD	TD362	S	5
124-91-1907	5081	TxD	TD907	S	4
284-93-6294	6320	DxM	DM294	WF	5
605-97-19163	8019	DxM	DM163	WF	3
386-95-11567	7388	DxM	DM567	WF	4
					33

Notes: WF = Wind Firm, S = Susceptible. Not available for excavation. Poor field perf.

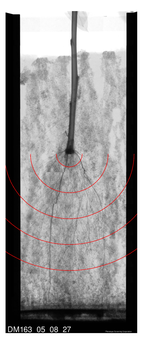


Growth containers were 500mmX200mmX45mm.

Substrate was EPS “T” beads (~1mm diameter)

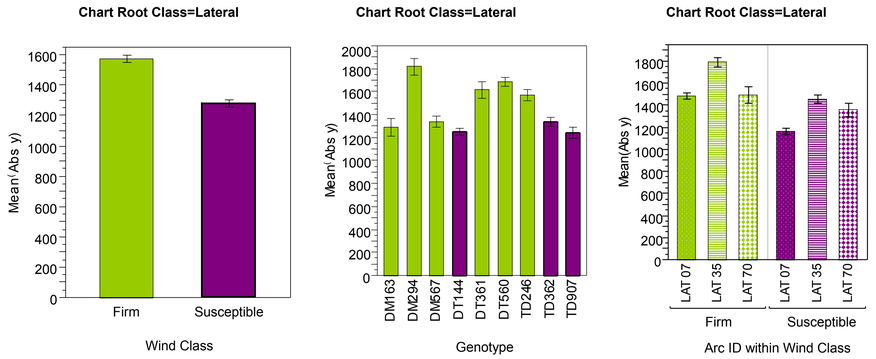
Nutrient Delivery was via drip irrigation.

Lateral Root Radii Were Measured at Their Intersection With Linear Transects

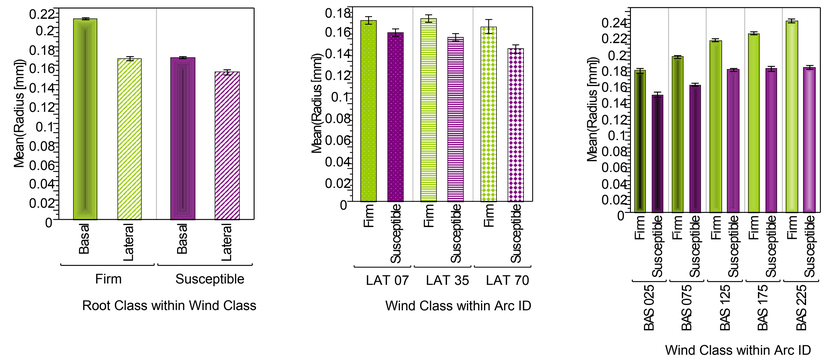


Basal Root Radii Were Measured at Their Intersection With Radial Transects

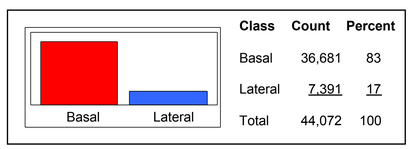
Five replications of each clone were grown under greenhouse conditions for four weeks. The trees were on a 12 hour photoperiod provided by metal halide lights. A modified Hoagland's solution was provided by computer controlled drip irrigation. The nutrient solution was maintained at a pH of ~ 6.0 throughout the experiment.



The distance up from the base of the cutting that a lateral root emerged was greater for windthrow resistant varieties than for windthrow susceptible varieties at this early stage of root emergence (28 days).

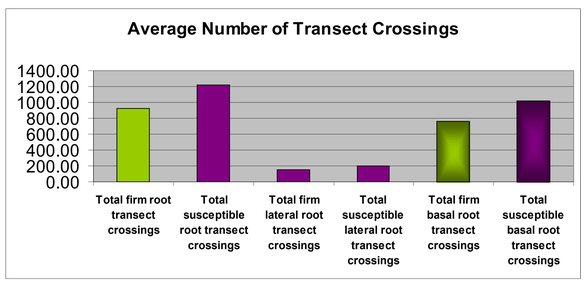


The mean root radius of both lateral and basal roots was greater for windthrow resistant varieties than for windthrow susceptible varieties at this early stage of root emergence (28 days).



Class	Count	Percent
Basal	36,681	83
Lateral	7,391	17
Total	44,072	100

Over forty thousand individual root/transect crossings were measured.



Conclusions: The investigation suggests that varieties which generate fewer but larger early roots from the hardwood cuttings tend to belong to the class of trees thought to be windthrow resistant. This was true for both basal and lateral roots. Trees which generated a larger number of early lateral roots closer to the surface-line also tended to belong to the class of windthrow resistant varieties. Other root traits examined did not show statistically significant differences among resistant and susceptible classes.

References

M. Burylo & F. Rey & C. Roumet & E. Buisson & T. Dutoit. 2009. “Linking plant morphological traits to uprooting resistance in eroded marly lands (Southern Alps, France).” Plant Soil.

Danjon et al 2005. “*Root Architecture and Wind-Firmness of Mature Pinus Pinaster.*” New Phytol. 168:387-400.

Danjon et al. 2008. “Assessing and analyzing 3D architecture of woody root systems, a review of methods and applications in tree and soil stability, resource acquisition and allocation.” Plant Soil. 303:1-34.

Dupuy L, Fourcaud T, Stokes A. 2005. “A numerical investigation into factors affecting the anchorage of roots in tension,”. European Journal of Soil Science 56: 319–327.

Fourcaud et al 2008. “*Understanding the Impact of Root Morphology on Overturning Mechanisms: A Modelling Approach,*”. Ann Bot 101:1267-1280.

Harrington, C.A., and S.D. DeBell. 1996. “Above- and below-ground characteristics associated with wind toppling in a young Populus plantation,”. Trees 11: 109-118.

Khuder et al. 2007. “Is it possible to manipulate root anchorage in young trees?,” Plant Soil 294: 87-102.

Ogris et al. 2004. “Windthrow factors – a case study on pokljuka,” GDK: 421.2–01(497.12*02 Pokljuka)(045)=20

Telewski, F. W. 1995 “Wind-induced physiological and developmental responses in trees,” Wind and Trees, Coutts M.P. and Grace J. eds., Cambridge Press