Field Assessment of Drought-Tolerant Canola Mediated by Conditional Down-regulation of Protein Farnesylation

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Introduction

Drought is the leading cause of canola yield loss on the Canadian Prairies, and increasing productivity under water deficit stress is an important goal of canola development in this region. Genetic engineering offers promise for increasing canola yield under multiple stress conditions, including drought. Our previous 3-yr (2002-2004) controlled-irrigation field trial results indicated that conditional down-regulation of protein farnesylation using a drought-inducible promoter (RD29A) driving anti-sense *Brassica napus* ß-subunit of farnesyltransferase (BnFTB) confers drought tolerance and yield protection. Results of field experiments conducted at geographically different locations in 2006 are presented.

Objectives

- To evaluate the growth and yield of transgenic canola lines grown under various drought conditions.
- To determine the relationship between rainfall during the flowering period and yield protection.

Materials and Methods

- Three events: one promising transgenic line (mediated by conditional down-regulation of protein farnesylation and designated as YPT™), the segregated null and the parent DH12075, were included.
- Field trials were conducted at seven locations across three Prairie Provinces (Alberta, Saskatchewan and Manitoba) in Canada.
- Experiments were arranged as RCBDs with 6 replications per location.
- Traits evaluated included: seed yield, seedling vigour, plant stand establishment, days to flowering, plant height, lodging and days to maturity.

Results and Discussion

Weather Conditions

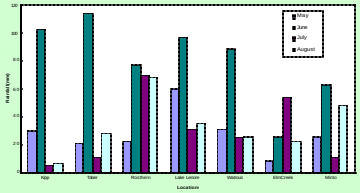

Fig. 1 Rainfall during canola growing season at seven locations in Western Canadian 2006.

Seed Yield and Agronomic Traits

Table 1 Seed yield and growth of different entries grown at seven locations

Location	Entries	Yield	Days to flowering	Plant height	Lodging	Days to maturity
		Kg ha-1	d	cm		d
Elm Creek	YPT™	1034	49	111	2.7	76
	NULL	1004	49	105	2.3	77
	DH12075	1043	49	107	1.8	76
Kipp	YPT™	624	58	107	1	99
	NULL	590	57	105	1	99
	DH12075	701	57	106	1	99
Lake Lenore	YPT™	4834*	50	-	2	91
	NULL	4546	49	-	2	90
	DH12075	4538	50	-	2	90
Minto	YPT™	1039*	53	115*	2	95
	NULL	944	53	111	2	95
	DH12075	837	53	113	2	95
Rosthern	YPT™	1958	47	118	3	98
	NULL	1958	47	114	2.7	98
	DH12075	1880	47	114	3	98
Taber	YPT™	2990	51	158*	1.8	94
	NULL	2589	50	156	2	94
	DH12075	3003	50	152	2.2	94
Watrous	YPT™	4240	49	124	2.2	88
	NULL	4081	48	121	2.2	88
	DH12075	4112	48	124	2.3	88
ANOVA						
Location		*	*	*	*	*
Line		*	NS	NS	NS	NS
Location x line		NS	NS	NS	*	*

Results and Discussion

Seed Yield Increase

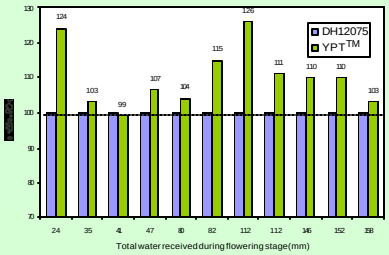

Fig. 2 YPT™ yield increase across wide ranges of water received during the flowering period, 2002 to 2004 and 2006.

Yield Protection and Rainfall at Flowering Stage

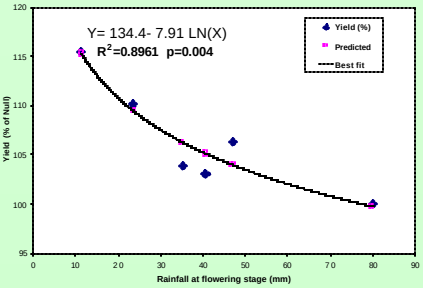

Fig. 3 Regression of YPT™ yield increase with the intensity of drought stress during the flowering period, across six locations.

- Rainfall during the critical growing stage (flowering) varied greatly among different locations.
- YPT™ canola produced higher seed yield than the null and parent at six and five of the seven locations, respectively.
- Pooled data showed the yield of the YPT™ was significantly higher than that of the null and parent ($p<0.05$).
- In each location, there were no significant differences among YPT™, null and parent for seedling vigour, plant stand establishment, days to flowering, lodging and days to maturity.
- Regression analyses of the multiple location data showed a negative correlation between YPT™ seed yield (as % of its null) and rainfall during the flowering period, with an $R^2 = 0.90$ ($p<0.01$). The correlation between canola yield and rainfall received at other times during the growing season was not significant.

Conclusion

These results confirm previous our findings that canola is most susceptible to drought stress at the flowering stage, and conditional down-regulation of protein farnesylation provides effective yield protection against drought stress during this critical period of growth.