ASPECTS OF HERBICIDE RESISTANCE IN THREE NEW ZEALAND WEED SPECIES

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Abstract

Herbicide resistant weeds have become a challenge in agricultural systems globally. In this thesis, aspects have been studied of three weed species which have evolved resistance to herbicides from different chemical families within New Zealand.

Dicamba-resistant fathen (*Chenopodium album*) was recently reported by researchers in Waikato. In this thesis, the level of resistance to dicamba in two of these populations of fathen was investigated using a whole plant dose-response experiments and it ranged from 5- to 20-fold. Also, a seed-test for rapidly and reliably detecting dicamba resistant fathen has been developed. Seed tests have seldom been used for detecting resistance within weeds to auxinic herbicides.

The thesis also investigated aspects of the first reported cases of glyphosate resistance in New Zealand, found in both Italian ryegrass (*Lolium multiflorum*) and perennial ryegrass (*Lolium perenne*) from vineyards. Resistance to glyphosate in two populations of Italian ryegrass (Populations A and P) and two populations of perennial ryegrass (Populations J and N) was found to be almost 10-fold, whereas it was almost 30-fold for one perennial ryegrass population (Population O). Three different quick tests (seed assays, excised tiller bioassays and shikimic acid assays) were developed for detecting glyphosate resistance in Italian ryegrass and perennial ryegrass.

Of the five populations of ryegrass studied, only Population O had a target site modification at Codon 106 of the enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS). Translocation of radiolabelled glyphosate was studied in four of the populations (Populations A, J, O and P), and movement from treated leaves was significantly reduced in them all compared with susceptible populations (non-target site mechanism of resistance). Therefore, Population O had two mechanisms of resistance, possibly explaining the 30-fold resistance.

The studied glyphosate-resistant ryegrass populations were all found to be resistant to glufosinate. Populations A, J and O were also found to be resistant to amitrole. Genetic studies showed that the restricted glyphosate translocation trait is incompletely dominant and can be transmitted via pollen. The restricted herbicide translocation was suppressed under cool conditions in experiments, suggesting that application of

glyphosate during winter might improve control of glyphosate-resistant Italian ryegrass and perennial ryegrass infestations.

KEYWORDs: *Chenopodium album*, dicamba, glyphosate, *Lolium multiflorum*, *Lolium perenne*, amitrole, glufosinate, glyphosate mechanisms of resistance, target site mechanism of resistance, restricted herbicide translocation.

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Dedication

I dedicate this work to my respected mother, with gratitude for her love, encouragement and support.

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Abbreviations

µCi	microcurie
ABC	ATP-binding cassette
ABP	auxin binding-protein
a.e.	acid equivalent
a.i.	active ingredient
Ala	alanine
ALS inhibitors	acetolactate synthesis inhibitors
AMPA	aminomethylphosphonic acid
ANOVA	analysis of variance
Arg	arginine
Asn	asparagine
ATPase	adenylpyrophosphatase
bp	base pair
DMSO	dimethyl sulfoxide
DNA	deoxyribonucleic acid
dpm	disintegrations per minute
drc	dose-response curve
EPSPS	5-enolpyruvylshikimate-3-phosphate synthase
Gly	glycine
GR_{50}	dose that caused growth reduction of 50%
IAA	indole-3-acetic acid
kBq	kilobecquerel
LD_{50}	lethal dose for 50% of population
Leu	leucine
LMP	low melting point
MBq	megabecquerel
Met	methionine
NAA	2-naphthoxyacetic acid
NMR	nuclear magnetic resonance
PCR	polymerase chain reaction
PEP	phosphoenolpyruvate
Pro	proline
rcf	relative centrifugal force

RNA	ribonucleic acid
rpm	revolutions per minute
S3P	shikimate-3-phosphate
Ser	serine
Thr	threonine
Trp	tryptophan
UV	ultraviolet