Potential climate change impacts on agricultural weeds in the Northern Agricultural Region of Western Australia

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Summary Weeds cost Australian agriculture over $4 billion annually through factors such as yield loss and management costs (Sinden *et al.* 2004). Although not quantified, the impact of weeds on natural ecosystems has also been recognised as a serious threat to biodiversity. Consequently there is a need to understand the factors that influence the distribution, spread and abundance of these invasive species, both under current and future environmental and management conditions.

The aim of this Australian Weed Research Centre-funded project was to determine the potential effect of climate change on agricultural weeds of the Northern Agricultural Region (NAR) in the southwest of Western Australia (Figure 1). With this area of Western Australia, particularly the NAR, predicted to experience significant environmental impact due to climate change, the development of predictive models to determine future weed threats to the agricultural industry is essential.

Using survey data on weed species distribution in the NAR and surrounding agricultural and rangeland buffer zones (Figure 1), we developed a short-list of 85 species that pose the highest risk to agricultural systems, from an initial list of 5536 unique species using criteria from Groves (2003), Randall (2007) or weed experts. This list was further refined during a workshop involving 11 weed scientists to produce a list of the 20 most threatening weeds for the NAR in 2070 (Table 1) based on the OZclim Echam5 moderate CO_2 scenario. This model predicts a temperature increase of 2.5°C in summer and 1.7°C in winter, and rainfall decrease of 5 mm (16%) in summer and 40 mm (23%) in winter (CSIRO 2009).

Using the South Australian Weed Risk Assessment (WRA) system developed by Virtue (2008), each of the 20 selected weed species posing the greatest risk were subjected to a detailed evaluation using standardised technical criteria to determine the invasiveness and potential impact in the NAR under the climate change scenario. The five most threatening weed species to agriculture in the NAR were selected from the WRA process. These were *Chloris truncata* R.Br. (Poaceae), *Citrullus lanatus* (Thunb.) Matsum. & Nakai (Cucurbitaceae), *Conyza bonariensis* (L.) Cronquist (Asteraceae), *Rapistrum rugosum* (L.) All. (Brassicaceae) and *Solanum hoplopetalum* Bitter & Summerh. (Solanaceae).

Growth chamber experiments are being conducted to measure the growth of the five species at constant temperatures every 5°C between 5 and 40°C in order to estimate the basal, maximal and optimal temperatures for the growth of each species. Plants are also being grown in the glasshouse under semi-natural conditions. For each species, the experiments will run until flowering occurs for the plants in the glasshouse. This will allow us to estimate the total day degrees that the species requires to reach maturity. These growth measurements, in conjunction with data from the literature, geographical distribution and seasonal phenology, will be used to derive the values of parameters used in CLIMEX, a program for modelling potential distribution (Sutherst and Maywald 1985, Sutherst *et al.* 2007). The CLIMEX models will then be used to predict the species distribution in NAR and elsewhere and to make projections on distribution changes following climate change. We will also include a risk assessment for each

Figure 1. Northern Agricultural Region of Western Australia.

Table 1. Top 20 most threatening weeds of the Northern Agricultural Region of Western Australia.

Species	Family	Common name
Acetosa vesicaria (L.) A.Love	Polygonaceae	rosy dock
Asphodelus fistulosus L.	Asphodelaceae	onion weed
Carrichtera annua (L.) DC.	Brassicaceae	Ward's weed
Carthamus lanatus L.	Asteraceae	saffron thistle
Cenchrus ciliaris L.	Poaceae	buffel grass
Chloris truncata R.Br.	Chenopodiaceae	windmill grass
Chondrilla juncea L.	Asteraceae	skeleton weed
Citrullus lanatus (Thunb.) Matsum. & Nakai	Cucurbitaceae	Afghan melon
Conyza bonariensis (L.) Cronquist	Asteraceae	flaxleaf fleabane
Cucumis myriocarpus E. Mey. ex Naud.	Cucurbitaceae	prickly paddy melon
Echium plantagineum L.	Boraginaceae	Paterson's curse
Heliotropium europaeum L.	Boraginaceae	common heliotrope
Hordeum marinum Huds.	Poaceae	sea barley
Mesembryanthemum crystallinum L.	Aizoaceae	iceplant
Oncosiphon piluliferum (L.f.) Kallersjo	Asteraceae	matricaria
Oncosiphon suffruticosum (L.f.) Kallersjo	Asteraceae	calomba daisy
Polygonum aviculare L.	Polygonaceae	wireweed
Rapistrum rugosum (L.) All.	Brassicaceae	turnipweed
Solanum hoplopetalum Bitter & Summerh.	Solanaceae	Afghan thistle
Tribulus terrestris L.	Zygophyllaceae	caltrop

model under the projected climate change parameters and a recommendation for adaptation response to manage the change in weed threat.

Keywords Agricultural weeds, CLIMEX, climate change, Northern Agricultural Region, Western Australia.

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