Allelopathy in canola: potential for weed management

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INTRODUCTION

Canola (*Brassica napus* L) is a member of the family *Brassicacea*e, and is one of the leading crops in the world for the production of vegetable oil for human consumption, animal nutrition, and, more recently, biodiesel (Yasumoto *et al.* 2010). It has received great attention in Australian agriculture due to its price, substitution for other vegetable oils, increased demand due to population growth, demographic changes, economic growth, changing consumer preferences, domestic and foreign trade, and food policies. Moreover, as a cover and/or break crop it has played a significant role in agriculture due to its wide variety of benefits to the overall farming system. In Australia, canola is third-largest broad-acre crop (after wheat and barley), and according to the AOF (Australian Oilseeds Federation), production for 2011-12 is estimated at 2.44 million tones from 1.81 million ha (www.australianoilseeds.com).

There are many factors responsible for low yields in canola crops, among them, inevitably, the large number of weed species that occur and the difficulty of economic control. In addition, Australian farmers have moved away from aggressive tillage practice because of the extreme risk of soil erosion, damage to soil structure, and reduction in soil carbon. Consequently, current crop rotations and seeding techniques are highly dependent on herbicides. Repetitious use of herbicides has selected for resistant weed biotypes – herbicide resistance has evolved in 25 weed species in Australia, and a number of weed species have evolved resistance to several herbicide modes of action. Foremost among them is annual ryegrass, and some of its populations have evolved resistance to all the selective-mode-of-action herbicide groups (Storrie *et al.* 2009). In recent years, the increasing cost of herbicides and ecological and human health concerns, have renewed interest in exploiting non-chemical alternatives including allelopathy and crop competitiveness (Holethi *et al.* 2008).

COMPETITIVENESS IN CANOLA AGAINST WEEDS

Canola is a useful break crop in rotations, with a wide range of cultivars available including conventional, forage, and hybrid types. There is significant variation in competitiveness with weeds between cultivars (Lemerle *et al*. 1996; Harker *et al*. 2003). In Australia, data show large variation in competitiveness of local canola genotypes in the field against the most common weed (annual ryegrass), and triazine-tolerant cultivars are generally considered poorly competitive, whilst the vigorous hybrids are thought to offer an improved opportunity to suppress weeds as has been recorded in wheat (Lemerle *et al.* 1996). Recently, Lemerle *et al*. (2010) documented the competitiveness of 15 canola types against annual ryegrass where significant differences in crop yield were recorded in weedy and weed-free plots, with percentage yield reductions from weeds of 60-100%. Competitiveness was correlated with crop dry matter, with more vigorous genotypes being most competitive. Therefore, there is a tremendous opportunity to breed for highly competitive canola cultivars. Target characters may include: rapid germination, robust establishment, early seedling vigor, leaf size, leaf shape, and leaf number.

ALLELOPATHY IN CANOLA

Allelopathy is a process whereby a plant gives itself a competitive advantage by placing phytotoxins into the near adjacent environment (Pratley, 1996). Due to its potential, the science of allelopathy has attracted worldwide attention in the last two decades, and several areas of crop allelopathy have been identified (Liu *et al.* 2011). To date, research has indicated that under both tillage and no-till systems, canola stubbles, residues or extracts have allelopathic effects – influencing both the growth of canola itself, and the growth of a number of weeds (Uremis *et al*. 2009, Moyer and Huang, 1997). Biofumigation is another 'feature' of canola where volatiles from decomposed *Brassica napus* inhibit soil born pest and diseases (Gimsing and Kirkergaard 2009) and may also affect the germination and the root growth of some weed.

Some effort has been placed on the isolation and identification of allelopathic compounds from canola residues and their associated soils but there are no reports of allelochemicals from root exudates or leaf leachates of living plants. Several other crops have shown such allelopathic potential including rice (Seal *et al.* 2004), wheat (Wu *et al.* 2000), sorghum (Chang et al. 1986) and black walnut (Rice, 1984). So, research is required on the isolation, identification and quantification of the allelopathic compounds in root exudates of living canola plants. Root exudates represent the largest source of allelochemical input into the rhizosphere (Jilani *et al*. 2008), and inputs vary with the plant species, cultivar, plant age, and stress levels (Uren, 2007).

PROPOSED RESEARCH

In Australia, crop allelopathy research has mainly focused on rice and wheat, however, the limited work in canola suggests that it may have strong allelopathic potential. A new PhD research study has commenced on allelopathy in canola. It will explore the allelopathic profile of a worldwide collection of 188 canola accessions, in both live tissues and crop residues; identify and quantify the responsible allelochemicals, and study the associated gene expression. It is anticipated that success may lead to reduced costs and impacts of weeds in canola cropping systems with more choice of availability of strongly-competitive cultivars. Also, the opportunity may arise to develop "natural" herbicides with new modes of action which will lead to reduced negative impacts on crop sustainability and biodiversity.

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