Biological control of weeds in small grain

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Invading weeds can reduce a wheat crop’s yield to 33%. South Africa’s producers face many problematic weeds and to add injury, weeds developed resistance to many herbicides. Other control measures are therefore desperately needed.

SMALL GRAIN PRODUCTION is hampered by many factors and these have a negative effect on crop production and the yields that can be obtained. Literature reminds us that yield reduction solely due to invading weeds can be estimated at around 33% for wheat and 40% for maize (Derke, 2006). This can have a tremendous impact on the producers’ ability to farm.

During a study by Drennan and Alshallah (1996), it was found that a species of ryegrass, *Lolium multiflorum*, at densities of up to 200 plants/m² can decrease wheat yields by between 12% and 15%, while similar trials by Liebl and Worsham (1987) reported that a density range of 0 to 100 plant/m² can reduce grain yields by 4.2% for every 10 plants/m². *L. multiflorum* densities of 10 plants/m² reduced wheat yield by between 1.3% and 1.6%. Every additional 10 plants/m² of *L. multiflorum* reduced the wheat yield by 140 to 2 000 kg/ha (Pederos, 2001).

South Africa
South Africa has many problematic grass weeds and broad-leaved weeds that occur throughout the small grain production areas. The most problematic grass weed is still ryegrass (*Lolium* spp.), occurring mainly in the Western Cape and some of the irrigation areas of South Africa. Ryegrass has the ability to develop resistance to various herbicides in a relatively small timespan.

Although it is very difficult to quantify the ryegrass problem in South Africa, survey data, gathered from 2008 to 2011, showed that only 4 out of 162 samples were still sensitive to herbicides from Group A, Group B, Group D and Group G (according to the HRAC table of CropLife South Africa). This means that 97.5% of the samples screened, showed resistance to either one or more of the herbicides tested.

The sheer level of ryegrass resistance in South Africa indicates that other control measures are desperately needed. The continuing success of herbicides is threatened by the development of herbicide resistant weed biotypes as a result of the extensive and repetitive use of a particular class of herbicide.

In the past, research has focused on the management of ryegrass and identification of herbicide resistance in various populations (Ferreira, 2011). Since cross-resistance to various herbicides has been identified in most South African
populations, the options of chemical control are very limited.

Another factor that needs to be considered is the potential pollen-mediated gene flow from current resistant farms to herbicide-sensitive farms. Pollen of herbicide resistant mutant ryegrass has been documented to travel up to 3 km in a single season, depending on wind flow. It is therefore clear that the control of resistant ryegrass is problematic and that new ways need to be found to be able to control the further spread of this weed.

**Biological control**

Limited research has been conducted on the biological control of ryegrass, as it is difficult to control a grass weed in a grass crop. Biocontrol agents need to be found that are host specific on the ryegrass and would not affect the wheat crop.

Allopathy is a biological phenomenon by which an organism produces one or more biochemicals that influence the germination, growth, survival and reproduction of other organisms. The potential of an allelopathic extract of *Evolulus alsinoïdes* (slender dwarf morning-glory) has been studied against the most dominant weeds in tropical regions of Southeast Asia. Ryegrass was one of six test plants that was included in the study (Kato-Noguchi, 2000).

During the study (laboratory) it was found that *E. alsinoïdes* contains potent allelochemicals that might make it more efficient as a weed. Residues or aqueous extracts of this plant may be useful in weed management, since it has been shown that some plant residues and extracts can work as weed inhibiting agents (Bhowmik & Doll, 1982; Putnam & Tang, 1986; Einhellig, 1996). Significant reductions were observed in the germination and growth of the roots and hypocotyls as the concentration increased.

The effect of *E. alsinoïdes* on wheat must however be studied. Although this plant is not endemic to South Africa, it occurs in Gauteng, KwaZulu-Natal, Limpopo, Mpumalanga, Northern Cape and the North West.

In a study, also by Kato-Noguchi (2001), it was reported that the extracts of lemon balm (*Melissa officinalis L.*) inhibit the germination and growth of roots and shoots of ryegrass (*L. multiflorum*). Lemon balm is widely used as aromatic, culinary and medicinal herb. The inhibitory activity of the water-soluble fraction was the greatest. The effectiveness of the water-soluble fractions was however greater on the roots than on the shoots. A significant reduction in the germination and growth of the roots and shoots were observed with an increase in extract concentration. Again, wheat was not included in this study and the effect of this extract on the growth of wheat must be investigated.

Another method that has received world-wide attention for its potential in integrated weed management, is crop allelopathy. The phenomenon refers to the addition of phytotoxic allelochemicals, exuded by crop plants into the growth environment, so that the growth of weeds in the close vicinity is affected (Wu et al., 2000).

The application of crop allelopathy in weed suppression involves two stages, i.e. a vegetative stage and a post-harvest stage. At the vegetative growth stage, crop seeding allelopa-

thy could be exploited to suppress weeds. At the post-harvest stage, crop residue allelopathy could be used for weed suppression, especially during the establishment period of the following crop.

In a study by Wu et al. (2000), 453 wheat accessions from 50 countries were used to evaluate seedling allelopathy against ryegrass. They found significant differences in the allelopathic potential, with some wheat accessions inhibiting the root growth of ryegrass by up to 90.9%. The researchers found considerable genetic variation conferring allelopathic activity in wheat germplasm, thus supporting the notion of breeding cultivars with enhanced allelopathic activity for weed suppression.

**Summary**

Biocontrol is an environmentally safe way to control weeds. There are various suggestions as to possible biocontrol agents, but all of these agents need intense study. Exploitation of crop allelopathy, a trait already present in the wheat genome, seems a viable approach in addressing herbicide resistance in not only ryegrass, but also other weed species.

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**References**


