REPLACEMENT SERIES APPROACH FOR DETERMINING THE RELATIVE INTERFERENCE OF CONYZA BONARIENSIS IN RELATION TO LETTUCE AND TOMATO

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INTRODUCTION

In agriculture and forestry, replacement series have regularly been used in studies of weed-crop associations, and the approach is commonly used for evaluating yield advantages in intercrops. Experiments that use multiple densities make it possible to compare monoculture stands, and allow for the determination of the relative extent of intra- and interspecific competition between the interacting species. The objective of this study was to assess the allelopathy of Conyza bonariensis in relation to that of lettuce and tomato by incrementally increasing C. bonariensis or crop plant density, thus increasing the concentration of putative compounds with allelopathic potential in the growth medium.

MATERIALS AND METHODS

Replacement series experiments were conducted in a greenhouse at the Hatfield experimental farm. The experimental design was completely randomized. C. bonariensis plants were collected at the rosette stage on the experimental farm, and were grown in pots in sterilized field soil (sandy loam) together with either lettuce or tomato seedlings. Treatments consisted of combinations of six proportions of C. bonariensis and either lettuce or tomato. The experiment was laid out in replacement series as outlined by Radosevich et al., 1996. Harvesting of the trial was done four weeks after treatment commenced and dry mass of tops and roots were measured. Relative yield (RY) and relative yield total (RYT) (Radosevich, 1988) were calculated. Data were subjected to ANOVA and separation of means was done with the least significant difference test of Tukey at $p = 0.05$.

RESULTS

Results for dry mass of lettuce and tomato grown at different proportions with C. bonariensis showed that there were no significant effects on the growth of the crop species at all proportions. RYT was > 1 at all the combinations, which implies that both crop species and C. bonariensis were less affected by interspecific interactions than in their respective monocultures.

CONCLUSIONS

Methodology, growth stage of receiver plant and plant organ of donor plant are the factors suspected to have restricted the phytotoxicity of allelochemicals in this experiment. In the preceding bioassay studies we conducted, the acceptor species were in the seed/seedling growth stages when it was concluded that the leaves of C. bonariensis contained allelochemicals of higher potency than the roots. We propose that allelochemicals in the present experiment were either adsorbed on soil colloids and/or were metabolized by soil microorganisms. This theory, however, needs to be substantiated with further investigations.

Keywords: Allelopathy, Conyza bonariensis, replacement series

ORIGIN AND GROWTH STAGE AFFECT THE TOLERANCE OF *CONYZA BONARIENSIS* TOWARDS GLYPHOSATE HERBICIDE

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INTRODUCTION

Glyphosate came on the market as a broad-spectrum, non-selective, systemic herbicide in 1974. After 20 years of glyphosate use, in 1994, there were no reported cases of glyphosate resistance and it was believed that resistance was highly unlikely to develop. In 1996, glyphosate-resistant *Lolium rigidum* was reported in Australia. Since then 23 other weeds the world over have evolved resistance to this herbicide. The same happened in South Africa when the first case of resistance to glyphosate in rigid ryegrass was reported by Eksteen and Cairns (2001) in vineyards. Resistance to glyphosate in *Conyza bonariensis* was reported in 2003 by Cairns and confirmed by De Wet in the Breede Valley, Western Cape in 2005.

MATERIALS AND METHODS

Screening experiment: *Conyza bonariensis* seed was collected next to the road from Pretoria to George at 12 locations. Seed was planted in 12-cm diameter pots in a sand-coir mixture. Seedlings were thinned out to only one per pot. The recommended rate to control C. bonariensis is 2 L/ha Roundup Turbo. At the 4-6 leaf stage, six rates of glyphosate was applied: 0, 0.25, 0.5, 1, 2 and 4 times the recommended rate. Plants were visually assessed on a scale from 1 to 9. At 21 days after treatment (DAT) the plants were clipped at the soil surface and weighed to obtain the fresh mass. Data were subjected to ANOVA.

Growth stage experiment: From the previous experiment two resistant, two tolerant and two susceptible populations were identified. The experiment was conducted in the exact same manner as the screening experiment, with growth stage as an added factor. Plants were treated with glyphosate at two different growth stages. For the second growth stage, glyphosate was applied three weeks later than the first application.

RESULTS

In two populations, plants survived the 1x rate, and therefore, were classified as 'resistant'. These populations plus two 'tolerant' and two 'sensitive' populations were used in the growth stage experiment. GR50 values calculated from dose-response curves showed that plants sprayed at the later growth stage (10-12 leaf stage) were significantly more tolerant to glyphosate.

CONCLUSION

Significant differences in tolerance to glyphosate existed between the 12 populations from diverse locations. *C. bonariensis* treated later than the label recommendation are more tolerant to glyphosate than if sprayed earlier. Label recommendations must be followed strictly to ensure that weeds can be effectively controlled, and to avoid false claims of glyphosate resistance.

Keywords: *Conyza bonariensis*, glyphosate, weed resistance

GLYPHOSATE RESISTANCE IN *CONYZA BONARIENSIS*

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INTRODUCTION

The introduction of glyphosate-resistant crops caused a significant increase in the use of glyphosate. Basically, the high weed control efficacy and consequent popularity of glyphosate has led to overreliance on this herbicide as a sole weed control method in cropping systems, which promoted the evolution of weed resistance to the herbicide. In South Africa, *Lolium rigidum, Conyza bonariensis* and *Plantago lanceolata* have been reported to have evolved resistance to glyphosate. There have been reports that Conyza bonariensis has become increasingly difficult to control especially in no-tillage or minimum-tillage systems (orchards and vineyards), even with the use of herbicides with more than one mode of action. A study was carried out at the University of Pretoria for screening different Conyza bonariensis populations to assess levels of glyphosate tolerance in different populations from diverse cropping systems in various regions of the country

MATERIALS AND METHODS

Seeds of *Conyza bonariensis* were collected from 24 different geographical sites in the summer and winter rainfall regions. Seed collection locations are distributed in both the summer and winter rainfall regions. Seeds were planted 0.5 cm deep in a sand-coir mixture in 12 cm-diameter pots in a greenhouse under controlled temperature conditions. Plants were watered and fertilized as required and thinned to two plants per pot. At the 4-6 leaf stage, plants were treated with glyphosate (Roundup Turbo) at rates of 0, 0.25, 0.5, 1, 2 and 4 times the label recommended rate (2 L/ha). Seven and fourteen DAT, plants were visually evaluated for herbicide damage. Twenty one days after treatment, all the plants were clipped at the soil surface, and fresh mass recorded before being oven-dried to constant weight at 65 0C and later weighed to obtain dry biomass. Data were subjected to ANOVA using SAS statistical package. GR50 values were used to distinguish resistant, tolerant and susceptible biotypes.

RESULTS

Glyphosate rate by location interaction was highly significant. Using GR50 values, *Conyza bonariensis* populations were categorized into three categories: ‘susceptible’, ‘tolerant’ and ‘resistant’.

CONCLUSION

Conyza bonariensis with differential tolerance to glyphosate occurs in both the winter and summer rainfall regions. The presence of resistant biotypes poses a serious problem in annual and perennial cropping systems. It is therefore important that mitigation measures be put in place, and existing ones be improved, to not only contain resistance to glyphosate but to also prevent its evolution in locations where resistance has thus far not been reported.

ACKNOWLEDGEMENT

Funding by Monsanto and OWSD is highly appreciated.

Keywords: *Conyza bonariensis*, glyphosate, weed resistance

WEED RESISTANCE TO GLYPHOSATE: CASE OF MISTAKEN CLASSIFICATION OF A CHLORIS VIRGATA POPULATION

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INTRODUCTION

More than 400 weed species have developed resistance to herbicides across the spectrum of existing mechanisms of action. Considering the extensive use of glyphosate since commercialization about four decades ago, relatively few weeds have developed resistance to it. Globally, glyphosate resistance has been proven for 24 weed species, of which three also occur in parts of the Western-Cape. It is imperative that cases of mistaken or false weed resistance not confound this highly important issue. A case in point is an investigation conducted at UP to determine if rumors of glyphosate-resistant Chloris virgata, which emanated from certain crop producers in the Springbok Flats region, were true or not.

MATERIALS AND METHODS

Seeds of C. virgata were collected from three different geographical locations: Naboomspruit (Limpopo), Oudtshoorn (Western Cape) and Lichtenburg (North West Province). Seeds were planted in a sand-coir mixture in 12 cm diameter pots in a temperature-controlled greenhouse at the UP phytotron facility. Plants were watered and fertilized to avoid water and nutrient stress. At the 3-5 leaf stage, plants were treated with glyphosate (Roundup Turbo) at rates of 0, 0.25, 0.5, 1, 2 and 4 times the label recommended rate (2 L/ha). Plants were visually evaluated for herbicide damage. The plants were clipped at the soil surface at 21 DAT, and fresh mass recorded before oven-dried at 65 0C for dry biomass measurement. Data were subjected to ANOVA using SAS statistical package, and means were compared using Tukey's test.

RESULTS

The Naboomspruit population was significantly more tolerant towards glyphosate than both the Lichtenburg and Oudtshoorn populations. At 7 DAT, at the 1x glyphosate rate, the Naboomspruit population were showing clear glyphosate injury symptoms, whereas the other two populations were close to death or dead at the same herbicide rate. Death of the Naboomspruit plants occurred after 14 DAT.

CONCLUSION

Chloris virgata from the Naboomspruit district was not resistant to glyphosate but clearly can be considered 'hard to control'. It would require that farmers adhere strictly to label recommendations for Roundup Turbo, or any other glyphosate-containing product. The investigation reconfirms the need for proper scientific investigation of glyphosate resistance that must be performed by researchers who follow scientifically sound protocol.

Keywords: Chloris virgata, glyphosate, herbicide resistance

WEED RESISTANCE TO GLYPHOSATE: OVERVIEW OF THE MONSANTO/BEATUP COLLABORATIVE RESEARCH PROGRAMME

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INTRODUCTION

Glyphosate is the most popular and arguably the most effective herbicide the world has ever seen, and Roundup Ready crops have been lauded as the most significant technological development in agriculture in 100 years. Compared to other important herbicides, weed resistance to glyphosate is limited (24 weeds globally), given the total number of resistant weeds to all herbicides combined exceeds 400, with more than 180 of these resistant to ALS inhibitors alone. The Monsanto/BEatUP Collaborative Research Programme (3-year duration) was launched in Sept 2012, with core research focus the gaining of more knowledge about glyphosate-resistant weeds in the whole of South Africa, including the elucidation of plant mechanisms contributing to glyphosate resistance, as well as mechanisms causing tolerance towards the herbicide.

MATERIALS AND METHODS

Research approach is to firstly screen selected weed species for tolerance/resistance towards glyphosate. Weed seeds of selected species are collected from diverse geographical locations in both the summer and winter rainfall regions for testing in the greenhouse. Based on growth responses to a range of glyphosate rates the different populations of a particular species are grouped into three categories: sensitive, tolerant, and resistant. Further investigation seeks to identify plant mechanisms involved in conferring sensitivity/tolerance/resistance on a particular population. Research covers the key steps in glyphosate mode-of-action, i.e. from absorption by leaves, translocation in the plant system, to the site-of-action.

RESULTS

Research findings will amend current and perhaps even inform the development of new strategies aimed at the curtailment and avoidance of evolvement of glyphosate-resistant weeds. An outcome with direct bearing on weed management at farm-level is the ‘Best Management Practices’ that are bound to flow from the research findings.

CONCLUSION

Generation of new knowledge is likely to boost understanding of weed resistance towards glyphosate, which would make possible the fine-tuning of existing resistance management strategies, and even the development of new approaches to contend with this daunting challenge.

Keywords: glyphosate, weed resistance, herbicide resistance, weed control

SOUTH AFRICAN HERBICIDE RESISTANCE INITIATIVE (SAHRI): WEBSITE FOR COMMUNICATION ON WEED RESISTANCE ISSUES AND PROMOTION OF 'BEST AGRICULTURAL PRACTICES'

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INTRODUCTION

Because particular weed species tend to be associated with certain crop species, the global distribution of weeds is closely linked to that of the crop 'partner'. Furthermore, because of the extensive global distribution network for pesticides, there is significant similarity in the chemicals used for pest management in a particular crop or cropping system. Therefore, it is not unexpected that the evolution of resistance to pesticides (including herbicides) mirrors their pattern of distribution and use. As a result, South Africa has to cope with its share of herbicide-resistant weeds. We recognise a need for improved interaction between companies and crop producers on this issue in South Africa, and foresee the website contributing to the awareness effort and strategies for resistance management.

APPROACH

Bridging the communication gaps between researchers/farmers/company representatives is key to meeting the challenges presented by herbicide-resistant weeds. The website will convey information and knowledge on topical issues related to weed resistance. Knowledge that has been generated both locally and internationally through scientific research will be disseminated in ways that make science relevant for the farming environment. Interactive communication will be stimulated in order that the knowledge and expertise of farmers and company representatives, i.e. those that deal first-hand with weed resistance, can be drawn into discussions.

One of the website projects seeks to get farmer and company participation in a survey for identifying 'hard to control' weeds on a countrywide basis. Participants will be invited to contribute information and photographs on weeds which they consider particularly problematic. In this way the 'bigger picture' on important weeds in different crop and geographical settings will emerge. Experts can collate and interpret the gathered information with the view to come up with 'best management practices' for dealing with the issues at hand – it may emerge that the issues are broader than weed control per se, and can be addressed as such.

ACKNOWLEDGEMENT

Support by the Monsanto/BEatUP Collaborative Research Programme is gratefully acknowledged.

Keywords: Communication, knowledge transfer, herbicide resistance, weed control