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Research Application Summary

Impact of crop management practices and soil type of Hwedza communal area of Mashonaland East Province in Zimbabwe

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Abstract

The impact of crop management practices and soil type on weeds is only partially understood in Zimbabwe. A weed survey was carried out in Hwedza communal area of Mashonaland East Province in Zimbabwe during the 2014/2015 agricultural season to assess the impact of these factors on weeds. A questionnaire was administered to the farmers and soil samples were randomly collected from a 0.5m by 0.5m quadrat. We established that *Richardia scabra, Bidens pilosa, Acanthospermum hispidum, Leucas martinsensis, Xanthium strumarium, Cyperus esculentus, Cynodon dactylon, Eleusine indica, Bulbostylis contexta* and *Commelina benghalensis* were the most important weeds in that order. Soil type, current crop planted, fertilizer application, cattle manure application, tillage method and number of weeding events significantly impacted ($p < 0.05$) on weed emergence. New weed species that threatened crop and livestock production were *Xanthium strumarium, Argemony mexicana, Tithonia rotundiflolia* and *Tribulis terrestris*. It was therefore concluded that soil type and crop management practices such as current crop planted, fertilizer application, and number of weedings have an impact on the total weed density while cattle manure application had a significant effect on weed diversity.

Key words: Crop management practices, smallholder farmers, weed communities, weed surveys, Zimbabwe

Résumé

L'impact des pratiques de gestion des cultures et du type de sol sur les mauvaises herbes n'est que partiellement compris au Zimbabwe. Une enquête sur les mauvaises herbes a été réalisée dans la zone communale de Hwedza de la province du Mashonaland Est au Zimbabwe pendant la saison agricole 2014/2015 pour évaluer l'impact de ces facteurs sur les mauvaises herbes. Un questionnaire a été administré aux agriculteurs et des échantillons de sol ont été prélevés au hasard dans un quadrat de 0,5 m sur 0,5 m. Nous avons établi que *Richardia scabra, Bidens pilosa, Acanthospermum hispidum, Leucas martinsensis, Xanthium strumarium, Cyperus esculentus, Cynodon dactylon, Eleusine indica, Bulbostylis contexta* et *Commelina benghalensis* étaient les mauvaises herbes les plus importantes dans cet ordre. Le type de sol, la culture actuelle ensemencée, l'application d'engrais, l'application de fumier de bétail, la méthode de travail du sol et le nombre d'épisodes de désherbage ont eu un impact significatif ($p < 0,05$) sur la levée des mauvaises herbes. Les nouvelles espèces de mauvaises herbes qui menaçaient la production agricole et animale étaient *Xanthium strumarium, Argemony mexicana,*

Tithonia rotundiflolia et *Tribulis terrestris*. Il a donc été conclu que le type de sol et les pratiques de gestion des cultures telles que les cultures actuelles plantées, l'application d'engrais, et le nombre de mauvaises herbes ont un impact sur la densité totale des mauvaises herbes tandis que l'épandage de fumier de bétail a eu un effet significatif sur la diversité des mauvaises herbes.

Mots clés : Pratiques de gestion des cultures, petits exploitants agricoles, communautés de mauvaises herbes, enquêtes sur les mauvaises herbes, Zimbabwe

Introduction

Weeds are universal crop pests that have continuously built tolerance to control measures and adapted to the changing environmental conditions (Zimdahl, 2007). Weed populations could be impacted by agronomic practices such as crop rotation, tillage method, manure, weed control method, time and frequency of weeding, soil type and prevailing environmental conditions (Koocheki *et al*., 2009). Conventional tillage systems discourage the establishment of perennial weeds such as *Cynodon dactylon* but reduced tillage may promote perenniality (Mhlanga *et al*., 2015). The use of cattle manure especially that which is not well cured may act as an agent for weed seed dispersal especially annual weeds such as *Amaranthus* species (Pleasant and Schlather, 1994). In Zimbabwe, the effect of agronomic practices and soil type on weed populations in farm lands is only partially understood (Nyamangara *et al*., 2014).

Despite research efforts, weeds cause the greatest yield losses compared to other crop pests. In maize, 40-60% yield loss is attributed to weeds (Yeganehpoor *et al*., 2007). Weeds compete with crops for nutrients, sunlight and water. Some weeds have allelopathy effects adversely affect the growth of other plant species (Drost and Doll, 1980).

A number of weed control methods such as the use of herbicides, mechanical methods like use of ox drawn cultivators, hand hoeing and farm level preventive weed control methods like composting manure are economically feasible weed control methods that can be adopted by smallholder farmers. Although hand weeding is labour intensive, it remains the most common weed control method in Zimbabwe (Nyamangara *et al*., 2014). Smallholder farmers have hardly improved weed management technologies due to resource limitations and lack of knowledge on the general effects of weeds on crops (Mashingaidze, 2004).

Effective weed control measures require sufficient knowledge of weed species diversity (Chivinge, 1988). Weed surveys are used to gather information that will form a historical data base on weeds of an area upon which future weed researches or weed extension activities may be based (Chivinge, 1988). In light of the highlighted knowledge gaps, a survey was conducted to determine weed species diversity as influenced by crop management practices such as crop rotation, fertilizer application, time and frequency of weeding, tillage, use of cattle manure and soil type in Wedza District of Zimbabwe.

Materials and methods

Study site. The study was carried out in Hwedza communal area of Mashonaland East Province in Zimbabwe. The communal area is located about 150 km South West of Harare, the capital city of Zimbabwe. The site is 180 371 S, 310 341 E and 1427 m elevation. Average annual rainfall is 450-850 mm with a mean temperature of 18 ^{0}C. The area falls in agro-ecological zone IIb and the

soils are predominantly sandy, sandy loams and clayey. Hwedza communal area is divided into six wards according to the local government demarcations. This study was carried out in the central part of the district in Chigondo ward 9 and Ruzane ward 12. Per capita land holding ranges from 0.4-2.5 hectares. Mixed farming is the only source of livelihood in Hwedza communal area. Maize (*Zea mays*), tobacco (*Nicotiana tabacum*), sorghum (*Sorghum bicola*), finger millet (*Eleusine coracana*), groundnuts (*Arachis hypogaea*), bambara nuts (*Vigna subterranea*), sweet potatoes (*Ipomoea batata*s) and cow peas (*Vigna unguiculata*) are the major crops grown in the area.

Data collection. For administrative convenience during this survey, two wards were randomly selected from the six wards of Hwedza communal area. Further, five villages were randomly selected from each of the two wards. Four farmers were randomly interviewed from each of the ten selected villages. Information on most difficult weeds, any new weeds invading the area, the types of crop grown and weeding events were recorded from farmer interviews. The fields of the 40 randomly selected farmers were also physically sampled for weeds. The diagonal method was used during sampling and four positions were sampled in each field using a quadrat measuring 0.5 m by 0.5 m. Weeds in each of the quadrats were identified and counted. Weed sampling was done in different crop fields for example fields with maize only, groundnuts only, intercrop or fallow. The data obtained were analyzed using GenStat Version 13.

Results

Weed densities recorded in the farmers' field. Table 1 shows the top 10 important weeds based on field sampling. The most important dicotyledonous and monocotyledonous weed species were *Richardia. Scabra* and *E. indica*, respectively.

Effect of soil type and cropping practices on the emergence of *A. hispidum* and *R. scabra*. A further analysis to see the response of the two most dominant and widely distributed weeds in the area that is *A. hispidum* and *R .scabra* was done. It was observed that soil type had a significant ($p<0.05$) impact on the emergence of *A. hispidum*. While tillage, number of weeding events and the existing crop species impacted ($p < 0.05$) the emergence of *R. scabra. Richardia scabra* densities were higher in Bambara nuts (*Vigna subterranea*), tobacco (*Nicotiana tabacum*) and rapoko (*Eleusine coracana*) fields compared with fields grown with other crops. In fallow systems, *R. scabra* populations were the lowest.

Tillage promoted the emergence of *R. scabra* but not *A. hispidum*. *Acanthospermum hispidum* population remained relatively stable in both fields under reduced and conventional tillage while *R. scabra* was significantly reduced under reduced tillage (Fig. 2).

New weeds invading Hwedza communal area. Four weeds were reported to have invaded Hwedza communal area in the past few years. These are *Xanthium strumarium, Argemony mexicana, Tithonia rotundiflolia* and *Tribulis terrestris*. Table 2 provides a list of the new weeds of Hwedza communal area, and their ranked based on the number of times each weed was reported to be new by the farmers.

Discussion

From the results of this study, the top ten important weeds were recorded as *Richardia scabra, Bidens pilosa, Acanthospermum hispidum, Leucas martinsensis, Xanthium strumarium, Cyperus esculentus, Cynodon dactylon, Eleusine indica, Bulbostylis contexta* and *Commelina benghalensis. Richarida scabra*

and *E. indica* were previously reported to be the most important weeds of divergent morphology in Zimbabwe (Chivinge, 1988). The proliferation of perennial weeds *C. esculentus* and *C. dactylon* observed in this study could be attributed to changes in tillage systems from conventional tillage to conservation agriculture (CA). Minimum soil disturbance practiced in conservation agriculture systems creates a stable soil environment that favours the proliferation of perennial weeds (Derpsch, 2008).

Table 1. Weed densities (number/ 0.25m^2) recorded in the farmers' fields in Hwedza communal area during the 2014/15 cropping season

Weed species	Mean	SE
Richadia scabra	43.43	3.35
Bidens pilosa	23.95	4.86
Acanthospermum hispidum	15.45	1.17
Leucas martinsensis	8.49	1.84
Xanthium strumarium	6.33	0.91
Cyperus esculentus	5.92	1.13
Cynodon dactylon	5.76	1.18
Eleusine indica	3.78	0.67
Bulbostylis contexta	3.18	0.82
Commelina benghalensis	2.17	0.37

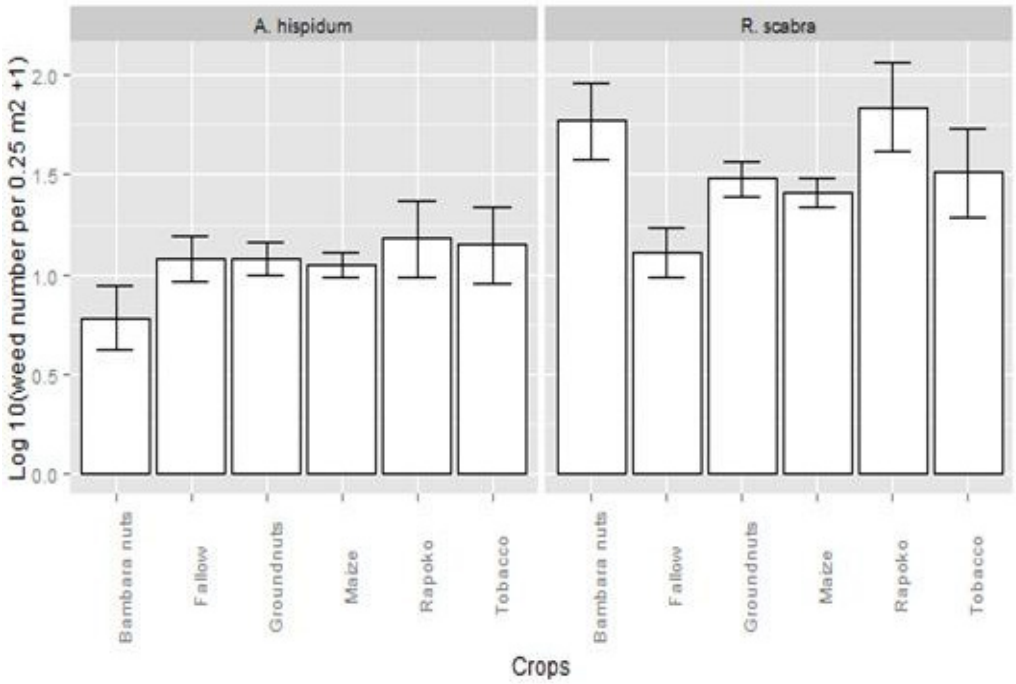

Figure 1. Effect of current crops on the emergence of *A. hispidum* and *R. scabra* in cropping fields of Hwedza communal area in the 2014/15 rainfall season. Bars are standard error bars.

An analysis of the impact of agronomic factors on the two major weeds namely *Richardia scabra* and *Acanthospermum hispidum* showed that tillage and the existing crop were the most important factors

that influenced the density of the two weed species. This difference in the population of weeds supported by different crops may be because of the differences in the micro climates created by different crops. Such differences may arise from factors such as light quality, whether red light or far red light getting to the soil surface passing through the crop canopy which alter soil thermal and light environments thereby impacting on the germination and growth of photoblastic seeds (Mhlanga *et al*., 2015). Some crops like sorghum may suppress the germination and growth of weeds through the release of allelochemicals. Tillage significantly influenced the germination and emergence of *R. scabra*. Fields under conventional tillage supported the emergence of more *R. scabra* compared to *A. hispidum*. The population of *R. scabra* dropped significantly under reduced tillage. This could mean that *R. scabra* cannot easily overcome the mechanical resistance to weed seedling emergence offered by soils in reduced tillage systems (Peachey *et al*., 2004).

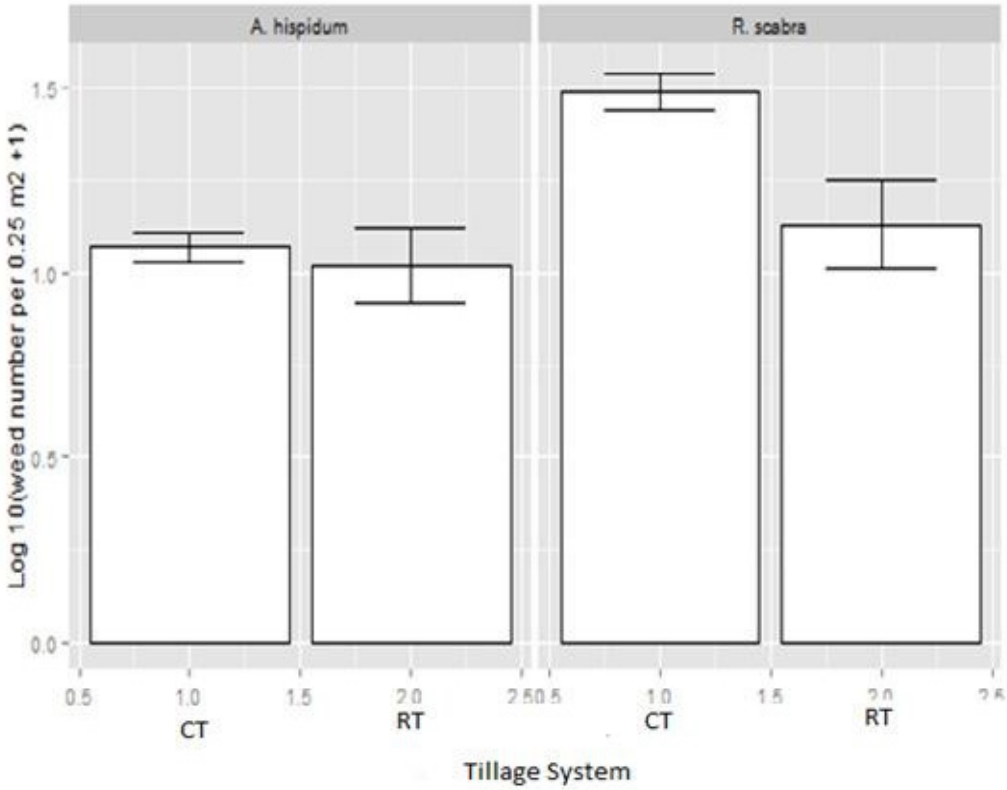

Figure 2. Effect of the tillage systems on the emergence of *A. hispidum* and *R. scabra* in cropping fields of Hwedza communal area in the 2014/15 rainfall season. Bars are standard error bars. CT is conventional tillage and RT is reduced tillage.

Table 2. New weeds invading Hwedza communal area

Name of weed	Number of times reported	Rank
Xanthium strumarium	37	1
Tribulis terrestris	22	2
Tithonia rotundiflolia	9	3
Argemony mexicana	8	4

Xanthium strumarium, Argemony mexicana, Tithonia rotundiflolia and *Tribulis terrestris* are the four new weeds invading the study area. *Tribulis terrestris* has caused havoc in Hwedza communal area. The seed capsule of this weed has three sharp appendages. The appendages are the ones that are causing problems to the farmers as they do not easily break compared to those of other weeds like *A. hispidum*. The population of *Argemone mexicana* is still very low. This weed used to grow only in winter conditions but is evolving and is beginning to grow even in summer. The growth habit of this weed may be due to polymorphism. The only challenge that was reported for this weed is that it is difficult to control through hand pulling as both the stem and the leaves are thorny. *Tithonia rotundiflolia* mainly grows at the edges of the fields but few plants were sampled in the cropped areas. Nonetheless, this weed is of low economic importance.

Conclusion

The present study concludes that *Richardia scabra, Bidens pilosa, Acanthospermum hispidum, Leucas martinsensis, Xanthium strumarium, Cyperus esculentus, Cynodon dactylon, Elusine indica, Bulbostylis contexta* and *Commelina benghalensis* are the most important weeds in Hwedza District. Weed diversity was strongly impacted by the existing crop species and tillage method. New weed species have invaded Hwedza district and further studies are recommended for their control.

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