

The importance of biological control for the reduction of the incidence of major weeds in developing countries

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Abstract. Weeds cause up to 10% of crop losses in agriculturally developed countries, while in the developing world this figure could be two or more times higher. Several weed problems caused by intensive monocropping or repeated use of a particular herbicide are very difficult to resolve using a single control method. Crop losses and other cropping problems caused by weeds make weed management the most important activity within an Integrated Crop Management Scheme. The development of sustainable agriculture requires the judicious use of several practices that are integrated and compatible with pest control. Biological control should play a major role in reducing the incidence of prevailing weed species within an Integrated Pest Management (IPM) system. In tropical and sub-tropical areas all over the world there are several weed species causing serious crop losses. These are: *Striga* spp. in cereals and cowpea crops in Africa south of the Sahara; *Orobanche* spp. are parasitic weeds in vegetables, legumes and sunflowers in northern Africa and the Near East region; *Rottboellia cochinchinensis* in various food and industrial crops in Central and South America, including the Caribbean; and water hyacinth (*Eichhornia crassipes*) in various tropical countries of Latin America, Africa and southeast Asia. The development of technically sound and economically feasible biological control of these and other major species would be of great help to farmers in the developing world. The Food and Agriculture Organization (FAO) of the United Nations, within its Special Action Programme on IPM, gives priority to the development of IPM in crop production, and improved weed management is one of the major components of this effort.

Introduction

Weeds severely affect crop yields. Weed scientists recognize that the importance of weeds is usually neglected by farmers, and even government officials, in several developing countries. A recent FAO survey revealed that, although weeds are important pests causing substantial food losses every year, their control is generally given low priority by national plant protection programmes, particularly in developing countries (Labrada 1994a). On the one hand, in various developing countries, it is assumed that weeds are easily controlled by manual removal, whereas in developed economies there are many who consider that just by using herbicides the problem is already solved. These misunderstandings of the problem do not allow further development of weed science and, subsequently, of weed management. If we accept that weeds may cause between 5-10% of crop losses in developed countries (while this figure could be two or

three times higher in the developing world), then we should also admit that improvement of weed management is a necessity in both economic areas of the world.

In this paper I briefly explain my understanding of improved weed-management, the role of biological control in this context and FAO activities in this field.

The improvement of weed management

To achieve the improvement of weed management we need, as pre-requisites, to promote some ideas and actions among farmers and agricultural and, or, development institutions, such as: (i) the awareness of the problems caused by weeds to agricultural production and to other economic areas (once this is achieved, it will be possible to obtain financial support); (ii) the development of a research programme in the relevant countries that aims at studying weed population dynamics, critical periods of weed

competition and, or, weed economic thresholds, which will improve weed control methods and reduce farmers' labour on hand-weeding and the use of herbicides (where relevant); and (iii) the establishment of stronger links between weed research and agricultural extension services in order to facilitate the training of extension personnel in weed control methods enabling the transfer of this technology to farmers.

It is obvious that weed scientists cannot achieve satisfactory results, at least compatible with those of other agricultural disciplines, if the work is carried out in isolation and not in the context of a multi-disciplinary group.

Weed control methods

Depending on the economic situation on the farm, a single control method normally prevails. As a rule, chemical control is practiced in large wealthy farms and manual weeding in subsistence economies. Weed management consists of various control methods which may be implemented judiciously either on large or small farms. In certain crops some methods may not be of use. For instance, although crop rotation is accepted as a relevant pest control method, in perennial crops it cannot be practiced; flooding is effective for weed control in rice while it is not feasible in several other crops that do not tolerate excessive water.

Among the most useful weed control methods, many of which can be practiced by any farmer, are: (i) cultural methods, including crop rotation, intercropping, inter-row cultivation, mulching and others; (ii) chemical control through the use of herbicides; (iii) non-conventional control methods, e.g. soil solarization; and (iv) biological control, the importance of which is still not widely recognized.

Awareness campaigns on the alternatives available should be carried out to motivate government officials and the donor community, and to obtain the necessary financial support for projects or related activities. I am aware that opinions differ greatly regarding the usefulness of chemical control and biological control. Those dealing with agronomic problems often recognize chemical control as the only economic and quick way to control weeds, while those working on classical biocontrol sometimes claim that biological control will solve all weed problems in any crop. The fact is that both methods are overrated and other control methods are normally overlooked.

Those who feel that chemical control is the solution normally belittle the importance of crop rotation. They assume that the use of herbicides eliminates the need for rotation. In fact monocropping causes the prevalence of several difficult-to-control weeds, e.g. *Rottboellia cochinchinensis* (Lour.) Clayton in maize, sorghum and sugar cane, and *Striga* spp. and *Orobanche* spp. in cereals and vegetables, respectively.

The only sound approach is to regard all methods as having value and, depending on the prevailing weed species present, to act accordingly.

The importance of biological control

Auld (1994) stated that one of the most desirable weed control strategies from a low-input farmer's point of view is classical biological control which, from a community or national viewpoint, may also be the most suitable method of controlling widespread or rapidly-spreading exotic weeds. He also added that, financially speaking, the control agent's ability to search for, or to come independently into contact with, the pest can be regarded as an advantage, compared with chemical and mechanical pest control where human effort and additional expense and energy are required to link the agent with the pest.

Based on this valid statement, it is evident that classical biological control should be intensively promoted in the developing world, an approach requiring the provision of technical assistance to these countries. One step in this direction has been made recently by FAO through the approval of the International Code for the Introduction of Exotic Biological Control Agents by Member States during the last FAO Conference (November 1995). On the basis of such a Code and related guidelines, technical assistance will be given regarding the procedures for effective introduction of biological control agents in developing countries.

There are several possible alternatives for effective biological control of weeds and these need to be exploited. Waterhouse (1994) provided a list of bioagents for 27 weeds prevalent in southeast Asia, including six grass species. Such useful material gives a good indication to the officials of plant protection services regarding the organisms which can be introduced to solve particular weed problems. It would be impossible to develop biocontrol methods for every weed problem. Sometimes other control practices, in

particular cultural methods, are cost effective and do not represent a problem to the environment. Mixed populations of weeds may require more inputs on cultural methods than on other methods.

However, under certain circumstances a particular weed species will be well adapted to a crop or group of crops or (even worse) to particular cropping practices within the established rotation system. At this point biological control seems to be the most feasible alternative. Biological control might be a solution to the problems of species with acquired herbicide resistance.

The main weed problems in the developing world

Striga species

In Africa south of the Sahara, the major weed problems at present are *Striga* spp., including: *Striga hermonthica* (Del.) Benth. and *Striga asiatica* (L.) O. Ktze. on sorghum, millet and maize; and *Striga gesnerioides* (Willd.) Vatke (and *Alectra vogelii* Benth.) on cowpea. All these weeds are a consequence of deforestation and subsequent reduction of rainfall and soil fertility. It is recognized that the application of nitrogen fertilizer, crop rotation and inter-cropping of affected cereals with legumes provide consistent reduction of *Striga* spp. (Sauerborn 1991). Nevertheless, the application of some bioagents such as *Fusarium* spp. and, or, weevils of the genus *Smicronyx*, would help to reduce the weed stand and seeds in the soil-bank. There is ongoing work on the use of *Fusarium* spp. fungus as a control agent of *S. hermonthica* at ICRISAT, Mali.

Orobanche species

In north Africa and the Near East, the major weed problems are various *Orobanche* spp. in vegetables, potatoes, tobacco and sunflower. Again these parasitic weeds prevail under low soil-fertility. *Fusarium oxysporum* var. *orthocera* is promising for the control of these weeds (Bozoukov and Kouzmanova 1994; Labrada 1994b), and in central Asian countries of the former USSR the fly *Phytomyza orobanchia* has been released. The method of rearing and release of the latter, which is not very well known in the western hemisphere, has been published by Bronstein (1985).

Itchgrass

Rottboellia cochinchinensis, itchgrass, is an annual grass weed that is considered a serious problem in

various cereal and legume grain crops and sugar cane, particularly in Central America and the Caribbean, where around 3.5 million ha are infested by this weed (FAO 1992). Itchgrass is able to detoxify several chlortriazine herbicides and, where monocropping has been practiced with the repeated use of such herbicides, the weed has invaded almost the whole crop. In this context, IIBC is making major efforts to identify pathogens as bioagents of this weed which can be used safely in various grass crops. A joint applied-research programme with CATIE, Costa Rica, is expected to begin shortly.

Water hyacinth

Water hyacinth, *Eichhornia crassipes* (Mart.) Solms, is probably the most important weed problem in several tropical and sub-tropical countries of Latin America, Africa and south and southeast Asia (Labrada 1995). This plant affects fisheries, irrigation schemes and the work of hydroelectric stations, and harbours vectors of human diseases such as bilharzia, malaria and filariasis. It is generally accepted that classical biological control through the release of the weevils *Neochetina eichhorniae* and *N. bruchi* is the cheapest and most environmentally friendly way to control water hyacinth. Another useful agent is the moth *Sameodes albiguttalis*, but in fact in certain locations, such as the Ugandan side of Lake Victoria, other short-term control measures should be combined with biological control to enable the latter to exert its effect.

The Plant Protection Service of FAO recently organized an expert consultation on water hyacinth management in Fort Lauderdale, United States of America, in September 1995, where it was reported that there are other potential agents which could be introduced, such as the insects *Eccritotarsus catarinensis*, *Thrypticus* spp., *Cornops aquaticum* and others (Cordo 1995). Charudattan (1995) also reported on various fungi as bioagents of water hyacinth, such as *Alternaria eichhorniae*, *Cercospora rodmanii* and others. To make the application of such fungi economically feasible, propagation needs to be carried out in the affected countries, using the correct procedures, and for this training is required.

The control of water hyacinth through the use of biological control is not as quick and spectacular as that achieved with the use of *Cyrtobagous salviniae* against the aquatic weed *Salvinia molesta* D.S. Mitchell. For this reason information on the effect of bioagents against water hyacinth and the time

necessary to achieve consistent control should be given to all those interested, in order to avoid misunderstandings and false expectations.

Echinochloa species

Echinochloa species are common weeds in rice and cause severe crop losses. The use of biological control agents against these species may help to reduce infestations and to increase rice yields.

FAO work on biological control of weeds

The work on weeds in FAO is conducted within the IPM Special Programme. Weeds are an important part of the pest complex and any action in this regard should be compatible with other IPM activities. If IPM is to be accepted in general, biological control is one of the options that should be intensively promoted and during the last four years, the FAO has promoted biological control of particular weed species, such as: (i) FAO support of seven projects on water hyacinth and, or, water-weed control conducted in Latin America and Africa, where the major component has always been the introduction and development of biological control; (ii) FAO involvement in discussions on the biological control of itchgrass at the regional workshop held in Managua, during May 1992, within a work plan for a project on itchgrass control in Central America and the Caribbean; (iii) FAO involvement in the project on *Orobanche* and *Cuscuta* species at a workshop held in Amman, during September 1993, on the future promotion of biological control of these weeds; and (iv) in FAO promotion of an ongoing project aiming at formulation of long-term plans for the control of *Chromolaena odorata* (L.) King and Robinson, using biological control as the major component.

In addition to this, FAO as administrator of the new International IPM Facility, will promote various

studies aimed at the development of biological control of several important pests, including those mentioned above, that are priority problems in developing regions or sub-regions of the world.

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