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New Problems in Weed Control in Italy

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Abstract

During the last few years, the use of herbicides has increased enormously in Italy. Herbicides have been a great help in solving varied and difficult problems, but have also raised problems not first appreciated. For example, weeds that were not significant a few years ago are now causing much concern. Specifically, *Galium aparine* is very difficult to control in wheat, and nearly impossible to control in sugar beets. The same can be said for *Heteranthera* spp. in rice, and *Abutilon theophrasti* in soybeans, sugar beets, maize and other crops. *Amaranthus* sp. is not well controlled by herbicides, and in particular, "resistant *Amaranthus*" is a concern in Northern Italy because it is resistant to atrazine. Wild oats (*Avena fatua*) in wheat is spreading considerably, because: (a) weed control is carried out using herbicides effective for dicotyledonous weeds which are ineffective against wild oats; (b) ditches are cleaned with mechanical equipment which does not kill wild oats; and (c) durum wheat is grown in Northern Italy where wild oats are a serious problem. Problems caused by other grasses, such as *Sorghum halepense* and *Panicum* spp. are also very serious. In some areas, to control *S. halepense* and other grasses, some crops, especially maize, are not cultivated. To solve these problems, research is being carried out which is already showing good results. Several effective products have been discovered to control *Galium* in wheat. On weeds resistant to atrazine, post-emergence applications with foliar-active products are being tested. Specific products such as Fluazifop-butyl and Setoxidim are being used on soya bean. Considerable progress has been made against *Heteranthera* with broadleaf herbicides. Another serious problem is the build-up of toxic or harmful herbicide residues in soil and in atrazine-contaminated water in Northern Italy. We must formulate a plan which permits use of herbicides and which takes into consideration environmental safety and human health. The problem with atrazine-contaminated water emphasizes what happens when herbicides are abused, and shows the necessity to take corrective steps. Early research results show that atrazine can be reducing drastically by integrating it with other products, and good control can still be obtained. These findings encourage continuation of this research.

Introduction

Agricultural technology has recently made considerable progress in many ways, especially in chemical weed control. The history of herbicides, in fact, goes back only 25 to 30 yrs, but has provoked one of the most radical changes that agriculture has ever experienced. Today, without weed control, the cultivation of crops such as wheat, maize, sugar beet and rice would be absolutely impossible in the quantities and at the price we can currently produce them. However, even though modern agricultural technology has many advantages, we must not overlook its many negative aspects, one of these being the incorrect use of herbicides.

In the field of plant protection with fungicides, acaricides, insecticides and herbicides, the latter are a chapter apart. Care should be taken with all pesticides, but extra consideration must be given to herbicides, otherwise serious crop damage may occur or poor weed control may be obtained (Marocchi 1983).

Continual progress is being made in this field, not only by the discovery of new herbicides but also by research which goes far beyond the application of herbicides. It involves all aspects of weed control; i.e., the effects of herbicides, their persistence in soil, their effects on weed behaviour, spread of particularly destructive weeds, selection and existence of resistant weed species, the negative consequences of the use of certain herbicides, etc. (Ferrari *et al.* 1984).

It is appropriate to discuss the advantages and results of weed control, and to analyze the negative aspects, such as the new problems which have recently emerged and the possible

means or systems by which maximum weed control can be obtained with minimum damage to crops and the biosphere.

The very important results achieved so far cannot be ignored. It is not possible to list them all because there are too many, but I can mention just a few; i.e., successful wild oat control in wheat, control of *Cirsium* sp. (Compositae) in sugar beet using Clopyralid, the effect of specific herbicides on grasses in industrial and horticultural crops, good control of *Sorghum halepense* (L.) Pers. (Poaceae) in soybeans and sugar beets, and successful weed control in many horticultural crops, rice, orchards, and many other sectors. But there are also negative aspects, and new problems to solve, the most important of which follow.

The Incorrect Application of Herbicides

The technique of herbicidal application has not always coincided with requirements and often even excellent products have given poor results. The most elementary principles of application are often ignored, and serious errors are made in rates of application (resulting in under- or over-treatment in the field), use of unsuitable machinery, or treating the wrong stage of the plant. Moreover, weather conditions should be taken into consideration when treatments are carried out. For example, the dosage rate should be varied according to air and ground temperature and humidity. Attention to such details can give better results and save products.

The first step is to correct such errors. Other improvements, such as reducing the quantity of herbicide used, thus causing less environmental impact, should also be tried. Study of appropriate herbicidal application has improved application technology. There is now machinery for measuring the precise quantity of water required and for the distribution of minute amounts of active ingredient. Progress has been made with low and ultra-low volume (ULV) applications, and weed wipers are now available for localised application of chemicals (Marocchi 1987).

Using low volume applications, it is possible to spray only 100 to 200 l/ha, and with ULV, as little as 20 to 40 l/ha. These techniques reduce water and herbicide used, and save labour. Herbicide application with weed wipers saves up to 50 to 70% of the herbicide. With weed wipers it is possible to operate under leaves and between crop rows or above the crop to control taller weeds. Treatments may be carried out in windy weather or even when susceptible crops such as grape vines and fruit trees are nearby. Research in this field is still very active and better techniques will result.

Other application advantages can be obtained by using activators or wetting agents, which give better results and reduce herbicide used. Much has been learned by the use of glyphosate (*N*-[phosphonomethyl] glycine), the performance of which can be greatly improved by various additives. Also, control with products that integrate atrazine (2-Chloro-4-ethylamino-6-isopropylamino-*s*-triazine), and treatments at post-emergence have proved effective. Excellent results are already being obtained with pyridate- and bentazon- (3-[1-Methylethyl]-1H-2,1,3-benzothiadiazin-4[3H]-one-2,2-dioxide)-based mixtures.

Occurrence of Weeds and Deterioration of the Situation

Progress has been made even against the more difficult-to-control weeds. However, there have been some negative aspects, such as spread of weeds that were originally only sporadically present, or appearance of resistant strains of weeds. There are many examples of these factors, which have created much concern and are a major focus for research activity.

Wild oats (*Avena fatua* L.; Poaceae) are now present in wheat in areas where they were once absent. Among the reasons for this is the use of herbicides which are ineffective against wild oats, mechanical weeding of ditches (which spreads the weed by keeping a seed reservoir), and the widespread cultivation of durum wheat in Northern and Southern Italy, which increased the area susceptible to infestation by wild oats. There are some excellent avenicides available, but their high cost calls for other management techniques such as

rotation of wheat with other crops, mechanical soil intervention, stimulating germination with fertilizers, improvement in weeding techniques of ditches, use of clean seed, etc.

The rotation of wheat with other crops is one of the most ideal methods since it has a beneficial effect on the soil. For example, if maize, alfalfa, soya beans or various horticultural crops are grown, specific herbicides which are both economic and effective may be applied to control grasses.

Galium aparine L. (Rubiaceae) has become widespread in wheat, and is found more frequently in areas where previously it was absent. The reasons for this are its remarkable seed dissemination ability and the use of ineffective herbicides, irrigation, etc. Good results can be achieved by agronomic methods, such as crop rotation with alfalfa, which has a beneficial effect on the land (Marocchi 1987).

Research has already discovered some extremely effective products such as ioxynil (3,5-Diiodo-4-hydroxybenzonitrile) and bromoxynil (3,5-Dibromo-4-hydroxybenzonitrile). Starane and other candidate materials are still at the experimental stage.

Because of the loss of effectiveness of hormone-based compounds, other weeds which are becoming widespread in wheat are *Viola tricolor campestris* L. (Violaceae), *Scandix pecten veneris* L. (Apiaceae), *Bifora radians* Bieb. (Apiaceae), *Chrysanthemum segetum* L. (Asteraceae), *Matricaria camomilla* L. (Asteraceae), *Picris hieracioides* L. (Asteraceae), *Myagrum perfoliatum* L. (Brassicaceae), *Equisetum arvense* L. (Equisetaceae), *Convolvulus arvense* L. (Convolvulaceae), and others. For control of these weeds, the new herbicides specific to broad-leaf plants should give good results and replace the more commonly-used hormone-based compounds.

Weeds are also becoming more widespread in many horticultural and industrial crops, and are causing more serious concern there than in wheat. *Ammi majus* L. (Apiaceae), *Abutilon theophrasti* Medic. (Malvaceae), and *Datura stramonium* L. (Solanaceae) are difficult or impossible to control in many leguminous crops, but can be controlled in sugar beet with clorpyralid. The biology of these weeds and their spread are of extreme interest and will be studied further in the immediate future. *Xanthium italicum* Moretti (Asteraceae) is also becoming more common in areas other than the Riviera, to which it was limited in the past (Mahn 1984, Ellemberg 1987).

These cases are those which give most cause for alarm because they present something new in weed control. There are also numerous cases of very common weeds such as *Polygonum aviculare* L. (Polygonaceae), *P. persicaria* L., *Equisetum* sp. (Equisetaceae), *Chenopodium album* L. (Chenopodiaceae), *Amaranthus* sp. (Amaranthaceae), *Medicago lupulina* L. (Papilionaceae), and many others which recently have become more widespread and therefore more important. Crop rotation permits the variation and alternation of herbicides and interrupts the subsequent reproductive cycle of the weeds (Marocchi 1987).

Good crop husbandry has become a determining factor, and in many cases is the only possibility for weed control. For example, thorough preparation of the land to avoid water stagnation is an excellent way of eliminating *Equisetum*. Another serious cause for concern is *Cuscuta* sp. (Cuscutaceae), which infect alfalfa and many other crops (onion, sugar beet, potatoes, etc.). The solution to this problem is difficult and at present the only effective method is cultivation of plants not attacked by *Cuscuta*.

In rice crops, apart from the usual weeds, *Heteranthera limosa* (Sw.) Willd. and *H. reniformis* R. & P. (Pontederiaceae) have already invaded vast areas of Northern Italy. Good control may be obtained by using herbicides developed for dicotyledonous weeds.

In many maize-growing areas *S. halepense* is common, and not always sufficiently controlled by the compounds available. In many areas where control is impossible, cultivation of maize has been abandoned. Introduction of soya beans with the use of the herbicide fluazifopbutyl is an extremely effective example of weed control by crop substitution.

Appearance and Spread of Herbicide-Resistant Species or Strains

Contrary to what has occurred with fungicides, acaricides and insecticides, the appearance of resistant weed species is a new phenomenon. It was thought impossible because of the slow reproductive rate of weeds (generally one generation/yr).

The cases of resistant weeds observed are a significant alarm signal. In Italy, a few cases have been reported, the most important being that of the atrazine-resistant weeds in maize. In this crop, resistant forms of *Amaranthus* hybrids and of *A. cruentus* have been found in Northern Italy (Brescia, Cremona and Mantova) where the cultivation of maize is widespread. Cases of resistance of *Solanum nigrum* L. (Solanaceae) have also been observed in the Treviso and Pordenone provinces, and of *C. album* in the provinces of Asti and Cuneo.

This resistance must not be considered a "selection" of the more aggressive, therefore more intrusive, species. Chemical weed control always eliminates the more susceptible species, leaving the remaining more tolerant species, which have no competition, to flourish. True resistance to atrazine (or any other type of tolerance) is a phenomenon occurring within the species, by selection of individual weeds able to resist a certain product because their chloroplasts either become or have the quality of being unsusceptible to that compound.

Therefore from these resistant individuals a strain emerges with the possibility of hereditary transmission of the tolerance or resistance to this compound. In a short time the new "progeny" become widespread.

If this supposition is true, it is possible for the "resistance" to shift from the typical maize-growing areas to other areas. Weed seeds are easily transported accidentally by birds, wind, water and machinery. This phenomenon should neither be undervalued nor be cause for excessive alarm. All future cases should be examined carefully to determine whether they are actual cases of resistance or only impressions of resistance caused by faulty or mis-timed herbicide application.

Herbicide Residues in Soil and Water

Residues of herbicides in the soil are of prime importance because of damage they can cause to successive crops and their environmental impact in cases of water runoff. Since there have already been cases of such damage, maximum attention to the problem of herbicide load in the soil is required. Herbicides are all equally hazardous but some may prove dangerous when applied on certain crops. Horticultural crops grown in soil previously treated with very persistent herbicides are a primary concern. Crops which are most at risk include cucurbits, peas, beans, alfalfa, sugar beet and various horticultural crops.

Of all the various products used some, such as atrazine, give more cause for worry because of the problems that have actually arisen from residues in the soil and the contamination of the water table. This serious occurrence has resulted in severe limitations of the use of atrazine and even its prohibition in some instances. Atrazine for weed control in maize is extremely useful because of its low cost, high selectivity and efficacy. However, its misuse has resulted in water contamination. If use of atrazine was completely prohibited, cultivation of maize in the present quantities and at the present price would often be impossible. However, prime importance should be given to human health.

Conclusions

If a solution is to be found, improvement in application techniques are required, such as a reduction in the dosage rate with an addition of one or more integrative compounds such as alachor (2-Chloro-2,6'diethyl-*N*-[methoxzymethyl] acetanilide), metolachlor (2-Chloro-N-[2-ethyl-6-methylphenyl]-N-[2-methoxy-1-methylethyl]acetamide), pendimenthalin (N-[1-ethylpropyl]-3,4-dimethyl-2,6-dinitrobenzenamine), Linuron® (3-[3,4-Dichlorophenyl]-1-methoxy-1-methylurea), terbutilazine (2-[*tert*-butylamino]-4-chloro-6-[ethylamino]-*s*-triazine), and others. The use of localized treatments permit a notable reduction in the

amount of product used/ha, post-emergence applications with low levels of atrazine in mixture with broadleaf weed killers, more rational irrigation, and short-term cultivation of maize on the same land (not 15 to 20 yrs successively, which is the current practice in many areas).

These precautions must be taken until another compound able to replace atrazine comes on the market. It will be difficult to compete with the low cost, selectivity and efficacy of the old and well-known atrazine.

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