Impressions from the Fourth International IFOAM Conference (1993) on Non-Chemical Weed Control

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Introduction

There is a growing interest in non-chemical weed control methods worldwide because of a) induced changes in weed species and populations by some herbicides that increase the severity of weed problems, b) increased resistance of weeds to herbicides, c) increased environmental pollution and degradation, and d) increased legal restrictions on the use of chemical pesticides.

Both organic farmers and conventional farmers have a strong interest in non-chemical weed control; the former because there is no other alternative, and the latter because of all the reasons stated, especially legal restrictions on pesticide use. Administrators who manage public institutions and facilities (e.g., roads, water supplies, and parks) also have an interest in non-chemical weed control.

In view of these concerns, the Fourth International IFOAM Conference on Non-Chemical Weed Control was held during July 5-9, 1993, in Dijon, France. More than 250 research workers, engineers, teachers, and farmers representing 37 countries attended the conference which included some 68 technical papers (oral communications and posters) on aspects of non-chemical weed control. Specific topics discussed were:

- Control and management of weeds.
- Mechanical control practices.
- Thermal and physical weed control.
- Biological, allelopathic and cultural methods.
- Applications in field crops and grasslands.
- Applications in vegetable crops and medicinal plants.
- Applications in vineyards and orchards.

This paper expands on the proceedings of the conference and discusses some important strategies and approaches that may be practical and feasible, including:

- Preventing rather than curing.
- Flame weeding to freezing.
- Biological control practices: A European workshop.
- Special practices for each crop.

Authors cited in the following sections presented papers at the IFOAM Conference which are included in the proceedings entitled “Communications of the Fourth International IFOAM Conference,” 1993, 419 pages, J.-M. Thomas, editor. Copies of the proceedings are available through IFOAM or ENESAD.

Preventive Rather Than Remedial Weed Control Strategies

Curative or remedial herbicide usage alone is unlikely to adequately control weed populations. Early growth and establishment of crops provide an important competitive advantage and effective non-chemical control method (H. Albrecht; J. Igrc and M. Macelj ski; D. van Egmont-Florian and J. Keilling).

Long and diverse crop rotations, with proper timing and precision of field operations can suppress adapted weed populations to low levels (D.L. Regehr, L. Marzolo and M. Speranza). The type of tillage performed and the sequence of crops in rotation are major determinants of weed populations (E. Hintzche).

Despite the progress on development of mechanical weed control methods, such technologies have not been widely accepted or adapted in the humid tropics where manual weed control is still the farmer’s choice (S. Anobah). Nevertheless, there are many different types of cultivators, harrows, and hoes that are commercially available for mechanical weed control (P. Jobin and Y. Douville; W. Kress; B. Real et al.; H. Weber and J. Meyer).

Mechanical weed control can accelerate the decomposition of soil organic matter and N mineralization which, in turn, can increase crop yields (A. B6hrnsen; J. Pohlan and R.H. Diaz Lopez). If farmers are to accept mechanical weed control, it must be practiced without a decline in crop yield (J. Ascard; F. Fogelberg and T. Johansson). The efficiency of mechanical weed control methods depends on:

a. The soil type (A. Bohrnsen; B. Real et al.; H. Weber and J. Meyer).
b. The implement's working depth, driving speed and angle of the teeth (W. Kress; H. Weber and J. Meyer).
c. The combination and sequence of tillage implements and number of operations (J. Lambin et al.; J. Pohlan and R.H. Diaz Lopez; B. Real et al.; M. Tessier and G.D. Leroux; J. Topic).
d. The growth stages of weeds and crops (J.R. Bevan et al.; A. Bohrnsen; W. Kress; H.-H. Steinmann and B. Gerowitt).
e. The density of cultivated plants, row-spacing (A. Bohrnsen; J. Lambin et al.; B. Real et al.) and the density of weeds (J. Rasmussen).
f. The weather before and after a mechanical weed control operation (B. Real et al.).

Mechanical weed control studies have been conducted on a wide range of cultivated crops including wheat and other cereals (A. Bohrnsen; J. Lambin et al.; B. Real et al.; H.-H. Steinmann and B. Gerowitt; L. Hammarstr6m et al.), corn (P. Jobin and Y. Douville; M. L. LeBlanc et al.; B. Real et al.; N. Sarpe), sugarbeet (F. Fogelberg and T. Johansson), pea (B. Real et al.) and various other vegetable crops (J. R. Bevan et al.; F. Fogelberg and T. Johansson; E. Juncker et al.; M. Tessier and G. D. Leroux), vineyards (U. Hofmann; J. Topic) and pineapple (J. Pohlan; R. H. Diaz Lopez). J. Ascard reported that in Germany and Sweden, soil cultivation in daylight with a light-proof cover on the harrows actually reduced weed emergence.

From Flame Weeding to Freezing

Today, flame weeding is often used for weed control in pre-planting of some vegetable crops (B. Morelle) and for pre-emergence weed control in slow-germinating vegetable crops (B. Morelle; B. Taupier-Letage et al.; M. Trouilloud), aromatic plants (B. Taupier-Letage et al.), and beet (B. Morelle). Flame weeding is an effective post-emergence control method for row crops such as corn, soybean and sunflower (P. Casini et al.; B. Morelle; M. Trouilloud), and vegetables such as beet (A. Nemming), carrot (R. Holmoy and J. Storeheier), leek and garlic (B. Morelle; M. Trouilloud), pepper (P. Casini et al.; B. Morelle) and onion (P. Casini et al.; R. Holmoy and J. Storeheier; E. Juncker et al.; B. Morelle; A. Nemming; M. Trouilloud). Flame weeding can also be used effectively for perennial crops such as orchards, vineyards and small fruits (A. Ferrero et al.; B. Morelle; M. Trouilloud).

A number of speakers discussed ways in which to optimize flame weeding (A. Bertram and J. Meyer; B. Morelle; J. Rahkonen and P. Vanhala; M. Trouilloud). The principle of thermal weed control is to apply sufficiently high temperatures that will physically destroy the cells of the target plants. However, effective weed control is possible when weeds are exposed to much lower temperatures of 70 to 80^{o}C (B. Morelle; M. Trouilloud). Thus, more efficient thermal weed control devices are possible (J.-P. Douzals et al.; R. Holmoy and J. Storeheier) which could improve such weed control strategies as a) mechanical weed control between the rows and flame weeding in the rows (A. Nemming) and b) flame weeding in the rows with deflectors to protect the cultivated plants (J.-P. Douzals; B. Morelle).

During flame weeding, the temperature at one-half centimeter below the soil surface increases only about 7^{o}C. Thus, the soil microflora and microfauna are not adversely affected (B. Morelle). Moreover, flame weeding does not significantly affect the population and activity of ground beetles (H. U. Dierauer and L. Pfiffner).

Studies have shown that early flame weeding is essential for effective weed control (P. Casini et al.).

After thermal application, weed re-growth and seed germination are unlikely, but may often occur following mechanical control methods (B. Taupier-Letage et al.). Fire can be a hazard under dry weather conditions. In this case, freezing with liquid nitrogen and carbon dioxide foam have been used as a weed control measure. However, freezing actually consumed more energy than flaming while achieving a comparable level of control for dicotyledonous weeds.
Soil solarization using woven polypropylene and solid sheets of polyethylene was effective in controlling annual weeds (A. Arrufat; M. Horowitz; P. Printz; H. L. Silveira et al.). The efficacy of solarization depends largely on the color of the plastic; white and green were least effective while black and blue were most effective (M. Horowitz; P. Printz).

Biological Control Pracices
A new initiative referred to as COST (European Cooperation in Scientific and Technical Research) is now coordinating the activities on biological control of ten serious weeds including *Amaranthus sp., Chenopodium album, Convolvulus sp. and Senecio vulgaris*. Some 12 European countries have now expressed their keen interest in COST participation (H. Muller-Scharer).
The biological control of weeds is the deliberate use of natural predators and pathogens to reduce the population density of a particular target weed below its economic injury level (J. Igrc and M. Maceljski). Biological control of weeds may employ:

a. Biological herbicides, i.e., pathogens of weeds released with cultivated plants (L. E. Child et al.; I. Lanszi et al.; T. LeBourgeois and Y. Beix).
b. Host-specific insect herbivores (L. E. Child et al.; H. U. Dierauer).
c. Water extracts from buckwheat straw which suppresses the germination of *Sinapis alba* and *Echinochloa crusgalli* (S. W. Gawronski and D. Ciarka). Phenolic compounds derived from the decomposition of pepper leaves actively inhibit the growth of some weeds (L. Gonzalez et al.).
d. Inter-seeded green manure crops that can compete against certain weed species; although there is a risk of increasing the soil seed bank with new weeds (J. Pino et al.).
e. Selective grazing by small ruminants (i.e., goats and sheep) can help to lower weed density in many cases (G. G. Nuoffer; S. Stober).

Special Practices for Specific Crops
Cereal Crops
Studies have focused on the conditions that are necessary to optimize the efficiency of non-chemical weed control methods. Researchers have shown that this depends largely on crop row-spacing. plant population density, and stage of growth (A. B6hrnsen; L. Hammarstrom et al.; J. Lanibin et al., B. Real et al.). Strategies that combine mechanical weed control and inter-seeded crops are promising (P. Jobin and Y. Douville; M. L. LeBlanc et al.) although, it is difficult to find non-competitive species that will sufficiently inhibit light penetration. Other alternatives may be to select wheat cultivars for their morphology and shading capacity (A. Verschwele and P. Niemann). It is important to know the results of new field studies on weed population dynamics (E. Hintzche; I. Landa) and selected species such as *Avena sterilis* (L. Marzolo and M. Speranza) and *Alopecurus myosuroides* (B. Chauvel and J. Gasquez).
Vegetable Crops
Only a few special practices were presented; among them are the following strategies:

a. Combination of hoeing and power brush-weeder with protective disks for carrot (J. Ascard).
b. Combination of flame and mechanical weed control methods for onion (E. Juncker et al.).
c. Combination of hoeing and inter-seeded crops for broccoli (M. Tessier and G. D. Leroux).

Orchards and Vineyards
Many implements can be used for mechanical control of weeds in the interrows. However, in the rows, the most effective method appears to be flame weeding (A. Ferrero et al.) and sometimes mechanical methods (U. Hofmann). Mulching with green materials in the interrow (A.-L.

Domange; U. Hofnrann) or with pine bark (A.-L. Domange) can also be an effective control measure. Mulching can increase the growth and yield of crops such as avocados in Spain (S. Jaime et al.) and apples and apricots in France (A.-L. Domange). It can also increase the incidence of rodents and other pests.

Conclusions

Today, there are no easy solutions for controlling weeds using non-chemical methods and technologies. Recent research has focused increasingly on weed control strategies that involve a combination of mechanical, thermal, biocontrol and physical methods that are applied with proper timing and precision. Obviously, some non-chemical methods are not economically-viable because of costs. Future application of non-chemical weed control methods, or combinations thereof, will depend on the crop, its cultural and management requirements, and its market value.

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