Chemical and Non-chemical Weed Control Opportunities in CTF – A European Experience

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ABSTRACT

This paper describes some of the weed control methods discussed at the 7th European Weed Research Society (EWRS) Physical and Cultural Weed Control Workshop, Salem, Germany 12-14 March 2007 and following study tour including Denmark. Harrowing after sowing wheat and placing nitrogen below the wheat seed were some of the non-chemical methods used. Lower than label chemical rates are also being used in Denmark as advised by an on-line weed control model that is used by 1000 growers and 200 consultants. Controlled Traffic Farming (CTF) allows all these methods due to access to the paddock but the same lines are not used each year due to ploughing. CTF offers the added advantage for Australia since ploughing is not common.

STUDY TOUR OUTLINE

Organic food is in great demand in Germany and Denmark but supply is a problem. Growers are facing increasing weed numbers and the cost of hand weeding is huge. The main focus of the EWRS working group is therefore targeted at organic growers. Papers included thermal (steam or flame) or cultural control with tillage – harrowing, inter-row and intra-row. The latest work involves detecting plants for controlling a physical or cultural method of control, such as gas flames, hydraulic controlled tools or a new rotary disc target the intra-row weeds, particularly for vegetables. Robotic weeders are currently very slow and expensive but this is an exciting area for future development.

The papers from the workshop are available on the EWRS website (www.ewrs.org/pwc).

Interesting points from the three day workshop were:

1. Thomas Bak (www.aau.dk) works in Intelligent Autonomous Farming Systems and he spoke of the problems of current robots being too slow. He has worked on identifying in-row weeds then spraying with fine nozzles (used a commercial cardboard box printer) and used hair removal lasers to target small weeds but with both systems height control is critical and a 3D camera is needed.

2. Alisha Cirujeda gave an interesting paper on using heavy brown Kraft paper (200g/m^2) as mulch instead of plastic for vegetables since the plastic caused a disposal problem for the growers.

3. Bill Curran found a crimper roller most effective for green mulching flowering cereals (best time Zadok 55-60) but was not effective on canola.

4. Johan Ascard described why some non-chemical weed control methods are adopted in practice while others are not. He said men go for “Steel in the field” whereas women like living mulch to reduce weeds. Organic mulches have problems; perennial weeds, field mice and slugs. Band steaming is slow, expensive and high energy use; freezing is slow and expensive; electrical has a safety problem; flaming is expensive, short term effect but fast and reliable; weed harrowing has low selectivity but fast; brush weeders are expensive to purchase; ground driven rotary finger weeders seem to work as

there are lots of brands on the market and torsion weeders have to be setup correctly or crops can be damaged.

5. Pieter Bleeker released a new book "Practical weed control in arable farming and outdoor vegetable cultivation without chemicals", which I purchased. This book has a wealth of practical tips on crops and machinery but mainly covers wide row crops.

Following this I visited Dirk Rautmann (d.rautmann@bba.de) at the Application Techniques Division of the BBA Federal Biological Research Centre for Agriculture and Forestry, Braunschweig. All application technology equipment (granular and liquid applicators) to be used in Germany has to be approved by the BBA. The purpose of the Application Techniques Division is to check plant protection equipment adheres to the Plant Protection Act. The Division also publishes a list of certified equipment for growers to buy.

Rigorous testing which costs manufacturers around €3,000 includes a static spray pattern distribution, which has to have a coefficient of variation of less than 7%, a dynamic test on a vibrating floor and the coefficient of variation has to be less than 9% and a residual test. Voluntary testing is also done for manufacturers and growers. The potential exists that if a grower's sprayer fails the test, the grower's subsidies could be reduced if not brought up to the standard.

Orchard spray drift is a problem and remote controlled shields for one side of an orchard sprayer when on an edge run can reduce drift dramatically (Photo 1). All sprayers are tested on a tilting floor (fore and aft and sideways) to measure residual spray volume in the sprayer (Photo 2).

Photo 1. Dirk Rautmann with shielded orchard sprayer and vertical collection system (patternator).

Large boom sprayers are tested for spray pattern variability by bolting to a vibrating floor to simulate field dynamics. Dirk said the room size needs to be upgraded as the 36 m booms currently just fit but wider booms are coming on the market.

Andreas Herbst (a.herbst@bba.de) showed their Oxford Laser VisiSizer droplet size analyser. There still seems to be a problem getting the correct information on nozzle spray quality as he showed, as an example, the company catalogue for the Agrotop Airmix 11003KS nozzle shows medium spray quality but his tests show it as Coarse spray quality, and even Very Coarse at 1 bar pressure.

The wind tunnel is used to measure nozzle spray drift and it has a recirculating air system which has the ability to adjust temperature and humidity. Andreas had developed a technique to wash the spray off the fine food grade tube collectors that stretch across the wind tunnel at various heights (Photo 3).

Photo 2. Tilting floor for spray residual measurement.

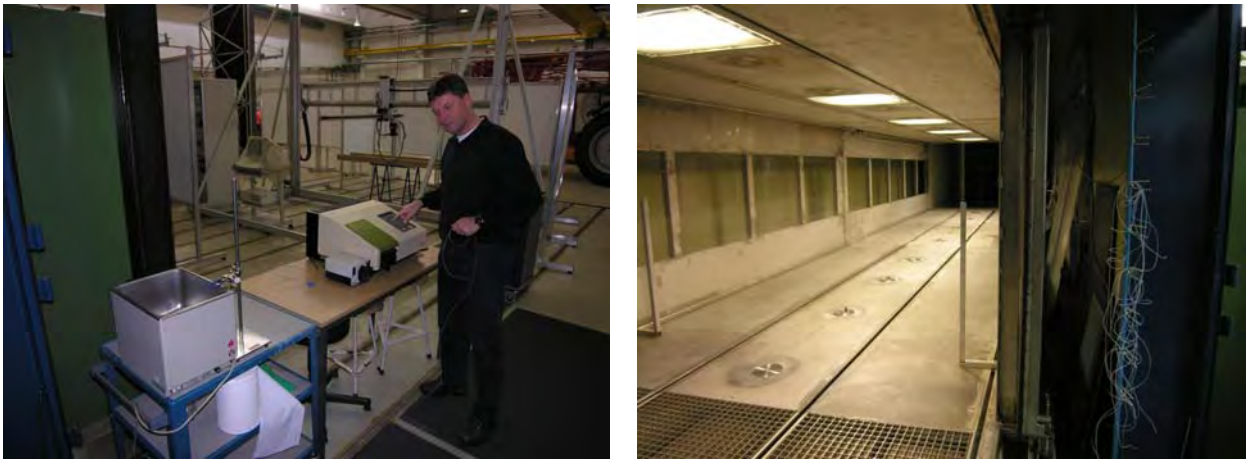

Photo 3. Andreas Herbst measuring drift using an ultra-sonic bath (left) and wind tunnel (right)

Arnd Verschwele (a.verschwele@bba.de) works in the weeds section and he showed some outside plots where he is investigating row spacing of wheat for organic farms. He said organic growers are tending to use wider rows to be able to inter-row cultivate. He also showed their glasshouse herbicide resistance testing centre and spray cabinet. Weed seed is germinated on a petri dish then transplanted into small pots, sprayed and placed in a growth cabinet with daily temperature varying from 10 to 20°C. They also have outside pot work where crop competition is tested.

I visited the Research Station farm with Dirk and the Manager, Hermann Scheb-Wetzel, showed us the equipment they use. He has a new Hatzenbichler inter-row cultivator that has components that may be suitable for use in Australia. The five row unit at 75 cm spacing will be used for maize and it had tines close to the row that are followed by two light duty rotary harrows (Photo 4).

They have 15 ha of organic area where no herbicides are used and Arnd Verschwele is testing weed competition with different row spacings.


Photo 4. Hermann Scheb-Wetzel and Hatzenbichler front mounted inter-row cultivator

All the field is ploughed with a mouldboard before experiments are sown. The organic experiment has a rotation of eight different crops; rape, potatoes, field peas (semi-leafless), set-aside (sown with grass, mown several times and ploughed), rye, winter wheat for two years and spring barley. Potassium fertiliser is allowed on organic potatoes and 90 kg/ha of rock phosphate is applied over 3 years. Organic yields tend to be only 60% of conventional potato yields. Farms use non-permanent tramlines for spraying and spreading fertiliser on 20 to 36m tramlines. There was a housing development nearby and Hermann, being a bit of a character, said the most economical rotation in his experience is wheat followed by barley followed by houses.

Denmark

Visited the University of Aarhus, Faculty of Agricultural Sciences, Flakkebjerg. This centre was called the Danish Institute of Agricultural Sciences up until Jan 2007 but has changed due to a number of factors including government funding cuts. The main purpose of the visit was to see the work of Bo Melander who organised the EWRS workshop in Germany but also to see the work of others at the centre.

The reason Denmark wants to reduce pesticide consumption can be seen from the following timelines:

- 1981-85: Increase in use of pesticides, start of public debate
- 1986: First Danish Pesticide action plan – 1986-1997, reduce pesticide use by half, reduce treatment frequency by half, re-evaluation of all old pesticides, reduction should be stimulated by recommendations from advisers and scientists
- Since 1993: Findings of pesticides in drinking water
- 1994: Introduction of prohibition list
- 1996: Pesticide tax increased from 3% to 13% for herbicides and fungicides, 27% on insecticides
- 1997: Status on 1. Pesticide action plan
- 1997-1999: Bichel committee, to investigate the consequences of a partly and total phasing out of pesticides
- 1998: Tax is doubled, 33% on fungicides, herbicides, growth regulators; 54% on insecticides
- 2000: 2.Pesticide action plan

A Treatment Frequency Index (TFI) was developed to have a measure of reducing pesticide use. A FTI of one means one pass of a full dose or two passes of a half dose etc. The 2000: "2. Pesticide action plan" aimed to have the TFI of 2.0 but achieving this may be difficult.

The driving force to reduce pesticides comes from:
- Pesticides in ground water. The policy is to close wells not to purify water.
- 5% of public wells have higher concentrations than 0.1 ug/L.
- 13% of filters from ground water (517) have shown higher values than 0.1 ug/L
- Out of 40 analysed a.i and metabolites 29 have been found in concentrations above 0.1 ug/L

Products prohibited by law include:
- Atrazin, cyanazin, trifluralin, hexazinon, dichlorbenil, MCPA, mechlorprop, diclhorprop, 2-4D, propachlor, isoprotoron
- vinclozolin, iprodion, captan, fenarimol, thiabendazole, thiaphanat-methyl, thiram, guazatine, ziram, dazomet, propineb
- diquat, paraquat,
- dichlorvos, deltamethrin, diazinon, lindane, chlorfenvinphos, esfenvalerat

Met Eric Gallandt (Eric.Gallandt@agrsci.dk) from Main, USA and was on sabbatical working on weeds. He has a student going to do some work on row spacing with weeds and may include row orientation after Shahab Pathan's work in Western Australia.

Peter Jensen (PeterK.Jensen@agrsci.dk) presented his work on spray technology. He is focusing on biological efficacy testing, tests in field and semi-field conditions, spray drift, field testing and operator exposure – cleaning of equipment. They use 100 to 200 L/ha of water and there are a lot of banned chemicals. Some of his work on controlling ryegrass with a foliar acting herbicide at the 2-3 leaf stage found a significant increased efficacy angling the nozzles compared to the standard vertical mounting and the best result was obtained using the largest angling and especially forward angling. Questions remain on: should angling be adjusted to wind direction, can efficacy be improved by increasing the angling more, should boom height be reduced correspondingly, what if a crop was present and what about dicotyledon weed control.

He also mentioned the new Syngenta Hawk nozzle developed for control of small black grass, which is a 03 flat fan nozzle with a built in 40° forward angling (the nozzle cap is still vertical). A problem for Australia could be stubble and Syngenta suggest reducing the straw burden.

Ilse Rasmussen (IlseA.Rasmussen@agrsci.dk) who attended the workshop in Germany showed me the glasshouses, machinery they use and some organic field experiments she was working on with Bo Melander. Weed control in organic agriculture is her main focus and one experiment she showed me involved rotations with different levels of tillage before and after sowing. Permanent buried tubes were used to sample ground water for leachate nutrients. Some work appeared to show where animal manure (slurry) was used the crop tended to compete better against weeds. Denmark has a large dairy and pig industry and all waste has to be stored in tanks over winter for spreading in spring.

Per Rydahl (Per.Rydahl@agrsci.dk), a weed scientist, showed me his on-line spray decision system that includes three steps – assesses the level of control needed, selects single herbicides and calculates dose needed and then calculates tank mixtures and optimises cost. There is a demonstration site at www.pvo.planteinfo.dk in Danish, English and German and he has 1000 growers and 200 consultants subscribing to the site. He said sometimes 10% of the label rate is all that is needed and had not had a failure yet and is very confident with his model. He did not mention the possible increase in herbicide resistance with lower rates. He did say the biggest problem has been weed identification since most

chemicals should be applied to small weeds and small weeds can be hard to identify. To help overcome this problem his on-line service includes pictures of at least 75 weed species at various stages of growth and a sorting function based on characteristics such as shape and size of the first leaf.

Bo Melander (Bo.Melander@agrsci.dk) spoke to me about ways to improve weed control by cultural methods such as harrowing before and after wheat emergence (Photo 5).

Photo 5. Harrowing wheat to control weeds (courtesy Bo Melander)

He found injecting animal waste slurry below the wheat seed gave better competitive wheat crops against weeds than slurry applied on top. The hypothesis for the result is the weed seeds that germinate tend to be shallow rooted and by placing the N fertiliser deeper than the wheat, the wheat roots may access the N before the weeds and so grow faster than the weeds. In spring barley he found 20% of the weed control was due to selecting a competitive variety, 30% due to placement of slurry and 80% due to harrowing. He also used inter-row hoeing in spring barley with an ECO-DAN automatic steering system (www.eco-dan.dk) and did inter-row hoeing in winter wheat using a ROBOCROP (www.garford.com) automatic steering system. He found weed biomass was reduced by half in spring barley with 24 cm rows compared to 12 cm rows.

He said vegetable crops have particular problems as weeds can be critical in the early growth of the crop. Intra-row systems include flaming, hydraulic tines, brushing and expensive hand weeding.

CONCLUSIONS

Tramlining or controlled traffic opens up many non-chemical options for weed control that is not possible with conventional farming systems. Operations such as harrowing in wheat and better spray timing are possible with controlled traffic since crop is not damaged by wheels. More work needs to be done in Western Australia on harrowing wheat in stubble to complete some of the work Mike Collins (okuraplantation@gmail.com) started in 2000 (GRDC project DAW617). He found stubble to be a problem and any positive effect was negated by high weed numbers so lower weed densities need to be investigated. Relative weed size to crop was also very important as was the need for dry top soil.

Herbicide resistance is an increasing problem worldwide so some of these current “organic” farming systems may play an important part of an integrated weed control program in the future.

ACKNOWLEDGEMENTS

GRDC and the Department of Agriculture and Food are gratefully acknowledged for the funding of this trip.