Influence of stubble burning on weed control in cropping systems

Role of non-chemical methods of weed control
Globally there is an increased emphasis on promoting weed control techniques that are not dependent on agrichemical herbicides. These non-chemical (or cultural) methods may not always provide the same level of control as herbicides, but they may be more sustainable and slow down the development of herbicide resistance. Many non-chemical weed control methods can be employed to combat grass weeds on a cropping farm. Some of these are addressed in FAR Arable Extras 97, 98 and 104 by Dr Charles Merfield from the Lincoln University Biological Husbandry Unit (BHU). Non-chemical weed control methods are divided between those which impact on weeds either pre or post crop establishment.

Pre crop establishment
• Pre harvest crop desiccation.
• Delaying the sowing of the new crop to allow time to germinate weeds in a stale seedbed.
• Removing residue from the paddock by baling or burning (depending on the weed species and its maturity at harvest).
• Cultivation such as rotational ploughing, or periodically burying weed seeds in a particular part of the rotation.
• Fallowing the land for a longer period of time to allow weed seed germination.
• Adopting a greater proportion of spring cropping.

Post crop establishment
• Adopting narrower row spacing and more competitive cultivars.
• Sowing the new crop at a higher seed rate to obtain better weed competition.
• Foraging a crop (e.g. whole crop) to remove weed seeds prior to maturity.

Influence of stubble burning on weed control
Early in 2013 Environment Canterbury (E-Can) invited FAR to provide expert information on the practice of stubble burning for consideration within a review of the Air Chapter of its Natural Resources Regional Plan. FAR assembled an expert panel of scientists, industry representatives and growers to review scientific literature, regulatory requirements and on-farm practices, and to consider alternative crop residue management options. Their report, A review of the role and practices of stubble burning in New Zealand, including alternative options and possible improvements, included a section on the effects of stubble burning on weed control. This Arable Extra discusses information raised in the preparation of the report, alongside FAR and international research results.

Three important weed control issues to consider when deciding whether or not to burn stubble are:
1. The impact of burning on weed seeds.
2. The influence of crop residue on the performance of herbicides.
3. The influence of crop residue ash on herbicide activity.
1. The impact of burning on weed seeds

Stubble burning can help with weed seed control, particularly where reduced tillage is adopted. It can destroy freshly shed viable weed seeds (particularly of annual grasses) and, in some grass species, reduce the dormancy of any freshly shed seeds that survive the straw burning operation.

The Western Australia Department of Agriculture notes the following benefits of stubble (residue) burning (Anon 2013a).

- Burning windrows of wheat, canola or lupin trash has been found to destroy 75% of wild radish seed and a high proportion of annual ryegrass seeds.
- Burning can stimulate weed germination, often by breaking seed dormancy (Moss, 1981), of some weed species which provides for a greater opportunity for subsequent control by either cultivation or with herbicides prior to the next crop being sown.
- Seeds close to the soil surface are more likely to be killed by burning than seeds that have been buried.
- Burning removes crop residues and allows more effective incorporation of pre-emergent herbicides.

In Canterbury, soil quality has improved as reduced tillage practices have replaced ploughing. However higher weed numbers, especially of annual grasses like sterile brome, occur where reduced tillage is practiced. This is because with traditional plough cultivation weed seeds are buried and often decay, provided they are left buried for a period of time.

The benefits of ploughing and burning for control of brome species in cereals has been shown in recent research trials conducted by FAR in Canterbury (Figure 1). Work conducted in autumn sown barley illustrated that both ploughing and burning significantly reduced subsequent ripgut brome head numbers in crop. However, where the previous cereal crop residues received shallow cultivation (minimum tillage) rather than ploughing, stubble burning was an essential prerequisite for the control of brome in the following barley crop.

![Figure 1. Influence of residue management on ripgut brome head number/m² (LSD 390 – all treatments, significant interaction between plus and minus burn and cultivation p=0.05) (Chynoweth 2012, unpublished).](image)

Influence of burning for weed control in grass seed crops

In Canterbury, stubble burning has also been observed to reduce the incidence of volunteer wheat in ryegrass seed crops (Table 1).

Table 1. Impact of stubble burning and cultivation on populations of volunteer wheat plants (plants/m²) in a ryegrass seed crop.

<table>
<thead>
<tr>
<th>Crop residue treatment</th>
<th>Cultivation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct drilling</td>
</tr>
<tr>
<td>Wheat</td>
<td></td>
</tr>
<tr>
<td>Burn</td>
<td>1.0</td>
</tr>
<tr>
<td>Chopped</td>
<td>21.7</td>
</tr>
</tbody>
</table>

Anon 2009
Population models in the UK suggest that the annual level of control of wild-oat (Avena fatua) seeds required from herbicides to contain populations in continuous winter wheat with ploughing but no straw burning is 81%. This falls to 72% where the straw is burnt. With shallow tillage and no straw burning, 82% herbicide control is required, but this falls to 73% where the straw is burnt (Cousens et al. 1986). The small difference between the chemical control required under the different cultivation systems is because, unlike other annual grass weeds, wild-oats can emerge when buried to plough depth. The impact of cultivation system and straw burning on the annual control required from herbicides to contain populations is higher for the small seeded black-grass (Alopecurus myosuroides).

In Canterbury, Vulpia hairgrass (an annual grass) is an emerging problem in grass seed crops that follow cereals in the rotation. In Western Australia burning residues provides 50% control (range 30-80% control) of Vulpia when a hot fire back-burning into the wind is used (Anon 2013b). In New Zealand the herbicide Firebird (flufenacet + diflufenican) is providing good control of Vulpia in cereal crops, provided the seed bed is moist, of good tilth and free of clods and trash (Young 2012). Stubble burning is one option to ensure the trash free environment and maximise herbicide efficacy.

2. The influence of straw residue on the performance of herbicides

In the absence of straw burning before reduced tillage, the presence of significant levels of crop residues on, or close to, the soil surface can reduce the control achieved by commonly used soil and soil/foliage acting herbicides.

Herbicides can be classified as soil- and/or foliage-acting, depending on their mode of action. Chopped straw on, or close to, the soil surface is generally expected to reduce the efficacy of soil acting herbicides. Research in Denmark (Kudsk & Mathiessen 2006) and the USA (Banks & Robinson 1986) clearly shows that increasing amounts of straw on, or close to, the soil surface can impede herbicide efficacy. For instance, Danish pot trials indicated that chopped straw residues equivalent to just one tonne/hectare, lying on the soil surface or incorporated in the top few centimetres of the soil, increased the dose of soil-acting herbicides required to control the grass weed loose silky bent (Apera spica-venti) by between 40-70% (Kudsk & Mathiessen 2006). The required dose increased to an extra 90% where the equivalent of three tonnes of straw per hectare was on the soil surface.

However, there are occasional exceptions to surface straw inhibiting the control achieved by soil-acting herbicides. The soil-acting herbicide propyzamide e.g. Kerb® (used to control grasses in white clover seed crops) is very effective in controlling annual grasses when applied post-emergence to a crop where there is a mat of straw lying over a soil surface that has not been disturbed by cultivation. The likely explanation is that in this situation the weed roots are very close to the soil surface and this herbicide is particularly effective in controlling shallow rooting weeds. Similarly, a study at Rothamsted Research (UK) indicated that up to 20% of coverage of the soil surface with straw did not inhibit the activity of the soil-acting herbicide isoproturon on black-grass.

Foliage acting herbicides which are not affected by surface straw may be available, however, with continuous use there is a high risk of resistance developing to the key group of foliage acting herbicides used to control most annual grass weeds, (the ‘tops’, ‘dims’, and ‘dens’). Hence, it is good practice to adopt a range of modes of action to control annual grass weeds. This realistically requires the straw to be burnt where ground cover of straw is high and reduced tillage has been adopted.

3. The influence of crop residue ash on the performance of herbicides

It has been noted that straw ash, when left near or on the soil surface can adsorb soil-acting herbicides thereby reducing their efficacy. However, significant reductions in herbicide efficacy are only likely to occur where crop residues are burnt every year for four of five years and very shallow tillage is adopted (Cussans & Moss 1982).

Adverse effects and improving management of stubble burning

While research has shown the importance of stubble burning within the cropping system, the potential adverse effects cannot be discounted. The key downsides of the practice are smoke nuisance and the risk of fire escape. Both of these issues can be managed through a combination of legislation and regulation, and good management practice.

References


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