SUSTAINABLE WEED MANAGEMENT ON PERMANENT BEDS

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Summary

Weed management systems in cotton are continually evolving, particularly in response to reduced cultivation and chipping and increased use of herbicides. The use of permanent beds and reduced tillage is likely to cause a shift in the problem weed spectrum, towards perennial weeds and those with rhizomatous root systems, which have previously been controlled with cultivation.

A survey of 23 properties found that most weeds were much worse on fully cultivated fields than permanent bed fields. The exceptions were rhyncho, datura, nutgrass and polymeria, which were much worse on permanent bed fields.

These data support the use of permanent beds as a way of reducing over-all weed pressure, but emphasise the need to develop control strategies targeted at perennial and rhizomatous weeds.

Introduction

Weed management in cotton is a constantly changing and evolving science. Management systems vary from field to field, farm to farm and season to season, in response to weed pressure (density and species), environmental conditions, cropping rotations, soil type and moisture content, time, labour, equipment and financial constraints, previous experience and individual preferences. Soil management, insect management (pupae busting), irrigation/rainfall method and timing, and stubble levels and management (stubble burning, stubble incorporation or stubble retention on the surface) also impact on weed management.

With continuing expansion of the cotton industry and in particular the rain-fed area, a wide range of systems for weed management have developed over time, ranging from heavy reliance on cultivation and chipping to heavy reliance on herbicides. These systems developed particularly in response to climatic and cultural differences, and to accommodate reduced tillage, permanent-beds, controlled trafficking and stubble-retention systems.

Over the decade, there has been a general reduction in the use of hand-chipping, with substitution of residual herbicides. Over the industry, diuron and trifluralin use has increased, while fluometuron, prometryn, pendimethalin, dicamba and glyphosate use has substantially increased. Of the remaining herbicides, only MSMA use has declined.

These changes in approach to weed management have both benefits and costs. Benefits should include reduced weed competition with improved yields and efficiency, but this may not actually be the case. Systems reliant on herbicides may well be more expensive than more conventional systems and herbicide damage to seedling cotton is becoming a more common and more serious problem. Greater reliance on herbicides and especially residual herbicides may also lead to a build up of herbicides in the cotton environment and to environmental contamination. Herbicides may select out a new range of weeds which have in the past been controlled by cultivation, and heavy herbicide use may lead to the emergence of herbicide-resistant weeds as a major problem.

The ACRI's role

With the introduction of new herbicides (Staple and Sempra), herbicide-resistant transgenic cotton, and the continuing spread of problem weeds, it is likely that weed management will continue to evolve over the next decade. The primary aim of weeds research at the ACRI is to help the industry to assess the impact of changing management systems and to develop sustainable weed management systems for the future which rely less heavily on herbicides. In order to achieve this, my project includes a regular weeds survey of the 3 CRC farming systems sites, as well as another farming systems site, 5 permanent bed sites, and a fully cultivated site. Also, I have a weed management system experiment at the ACRI and am involved with the development of weed management systems for herbicide-resistant transgenic cotton.

A second weed scientist, Dr. Grant Roberts, has now commenced work at ACRI and will be focusing on developing sustainable, low-input weed management systems for fields which do not have heavy weed pressure, including rain-fed cotton production areas.

Permanent beds

Farming systems generally are moving towards the concept of minimum-tillage, and where possible, controlled trafficking. Implementation of this concept is leading to greater efficiency, with improved production and reduced soil degradation, but is also likely to cause a change in the weed spectrum. Weed spectrums evolve over time, as pressure from environmental conditions, cultivation, herbicides and crop competition select species tolerant of prevailing conditions. Species controlled by a component of one management system, may not be controlled by a new system, and over time numbers may increase until the weed becomes an important pest.

However, these weed problems, though important, may be slow to emerge. In many instances, weed spectrum will relate more closely to field history than to current practices, as many of the more difficult to control weeds of cotton are hard-seeded and seeds persist in the soil for very long periods. High levels of seed production and seed longevity in the seed-bank may mean that a lapse in weed control on just one occasion may ensure a weed problem over many years.

Reduced tillage, with increased reliance on herbicides, in particular glyphosate, will lead to the selection of a new weed spectrum, consisting of those species tolerant to the herbicides. This is likely to include perennial weeds and those with rhizomatous root systems. It is unlikely that these will be new weeds, but will be weeds already present at low frequency and being controlled with cultivation. Weeds which will probably become more important under reduced tillage, permanent bed systems, include: sow thistle, medics, emu-foot, rhyncho, verbine, the takealls (polymeria, haloragis & vigna), bindweeds, tar vine, nutgrass and oxalis.

Field data

To gain information on the impact of permanent beds, Paul Castor and Max McMillan undertook a survey of 23 properties in the Gwydir and Macintyre valleys in the 91/92 season. Fully cultivated and permanent bed fields were surveyed on each property. This survey included information on cropping history, herbicides used, and irrigation practice at planting (pre-irrigation or watering-up). Weeds were assessed using quadrats, with counts of hill and furrow areas.

Thirty five different weed categories were identified; categories consisted of a single weed species or a collection of similar and closely related weeds which were not readily distinguished. Densities of these weeds averaged over all properties and fields are shown on the following page.

The most common weeds were grasses, medics, peach vine, bladder ketmia and sesbania, each occurring at greater than 1 weed per m^2. Many of the other weeds occurred at very low densities (< 0.1 per m^2).

Table 1. The average density of 35 weed categories recorded in the 1991/92 survey of weeds on 23 properties in the Gwydir and Macintyre valleys.

Weed Category	Weeds per m²	Weed Category	Weeds per m²
Grasses (*Poaceae*)		Small broad-leaf weeds	
Barnyard grass	0.06	Amaranthus sp.	0.62
Black oats	0.03	Geranium	0.01
Other grasses	2.00	Goose foot	0.03
		Pig weed	0.02
Legumes (*Fabaceae*)			
Emu foot	0.81	Polymeria	0.14
Medic	2.96	Sensitive plant	0.02
Rhyncho	0.36	Sida	0.02
Vigna takeall	0.06	Spurge	0.09
Vine weeds		Medium broad-leaf weeds	
Aust. bindweed	0.07	Bathurst burr	0.06
Bindweed	0.03	Bladder ketmia	1.74
Devil's claw	0.29	Chinese lantern	0.84
Melon	0.03	Mallow	0.03
Peach vine	3.08	Mint weed	0.77
Wire weed	0.02	Prickly lettuce	0.04
Yellow vine	0.73	Sow thistle	0.04
Perennial weeds		Large broad-leaf weeds	
Nut grass	0.28	Anoda	0.02
Polymeria takeall	0.09	Datura sp.	0.35
		Noogoora burr	0.73
		Sesbania	1.62

Data collected by Paul Castor and Max McMillan.

Further analysis was undertaken of those weeds which were present at greater than 0.1 per m^2. Where cultivation, pre-irrigation method, or position in the row had a significant ($P<0.05$) effect on weed density, these data are presented on the following page. There were no significant effects on sesbania density.

Table 2. The effect of culture, irrigation technique at planting and position in the row, on the average density (number per m^2) of weeds occurring at densities greater than 0.1 per m^2. Data are only presented where the effects are significant ($P<0.05$).

Weed category	Culture		Irrigation		Position	
	Fully Cultivated	Permanent beds	Pre-irrigated	Watered-up	Hill	Furrow
Grasses						
Total grasses	4.2	0.0			1.9	2.3
Legumes						
Emu foot	1.0	0.6	0.5	1.2	0.1	1.5
Medic	4.6	1.3	3.9	2.0	0.5	5.4
Rhyncho	0.1	0.6	0.5	0.2	0.1	0.6
Vine weeds						
Devil's claw	0.6	0.0	0.0	0.6		
Peach vine	5.6	0.5	2.8	3.3	1.1	5.1
Yellow vine			0.2	1.2	0.3	1.2
Small broad-leaf						
Amaranthus sp.	1.2	0.0			0.0	1.2
Medium broad-leaf						
Bladder ketmia			2.0	1.5	0.4	3.1
Chinese lantern	1.7	0.0	1.7	0.0	0.8	0.8
Mint weed	1.5	0.0				
Large broad-leaf						
Datura sp.	0.0	0.7	0.7	0.0	0.2	0.5
Noogoora burr	1.5	0.0	1.5	0.0	0.4	1.1
Perennial weeds						
Nut grass	0.0	0.6			0.1	0.4
Polymeria	0.1	0.4			0.1	0.4

These analyses indicate that weeds are generally worse on fully cultivated fields than permanent bed fields. The exceptions to this were rhyncho, datura, nutgrass and polymeria, which were much worse on permanent bed fields, and sesbania, which was not affected by cultural technique. Planting irrigation had little effect on weed density, as might be expected, although Chinese lantern, datura and noogoora burrs were much worse on pre-irrigated fields, and devil's claw and yellow vine were much worse on watered-up fields. Weeds were consistently worse in the furrow than on the hill, probably indicating that banded herbicides were working effectively.

To achieve an overall analysis, a weed index was developed as follows:

weed index = (grasses + legume + small broad-leaf weeds) +
2 * (vines + perennials + medium broad-leaf weeds) +
4 * (large broad-leaf weeds)

Analysis of the survey results using this index showed that overall, irrigation had no effect on weed pressure, but that there were significant ($P<0.001$) differences associated with cultural technique and position in the row, as shown below.

Table 3. The effect of culture and position on the weed index, which includes all observed weeds. The effect of pre-planting irrigation was not significant ($P>0.05$).

	Culture		**Position**	
	Fully Cultivated	Permanent Beds	Hill	Furrow
Weed Index	52.5	16.5	21.0	48.0

This finding, that weed problems are far worse on fully cultivated fields supports the concept that permanent beds and minimum cultivation are helpful approaches in developing a sustainable, profitable cotton industry which relies less heavily on chemicals. Sustainability will, however, depend on developing strategies targeted at controlling problem weeds such as sesbania, datura, rhyncho, nutgrass and polymeria.