O.29 - Oilseed rape weed integrated management: concern of mechanical weed control

Lieven, J., Quere, L., Lucas, J.L.

CETIOM, Avenue Lucien Brétignières, Campus de Grignon, 78850 Thiverval Grignon, France

Contact: lieven@cetiom.fr

Abstract

Oilseed rape prevalent weed control is based on pre-planting herbicide (trifluraline) whose efficacy is well known for control of weed grasses and for increased performances of many pre-emergence herbicides to destroy broad leaf weeds (*Papaver rhoeas, Galium aparine, Fumaria officinalis, Geranium sp., Veronica sp, etc.*). Only a few post-emergence molecules are available for broad leaf weed control and engage high costs and short and restricting periods.

The integrated weed management approach refers to a combination of direct and indirect methods in order to limit chemical applications, especially systematic pre-emergence herbicides. In oilseed rape, mechanical weed control can be an alternative or a complement to herbicides and should take progressively a larger place in the direct weed control options, taking account to the restrictive policy on the use of chemicals.

Two main motivations could lead farmers to adopt mechanical control: reducing herbicides costs and complementing or partly replacing chemical weed control. Several farmers interviewed also expressed fears about crop damages, the high sensitivity to the climate and the workforce these techniques require.

CETIOM launched a research programme to assess, in different backgrounds, the selectivity and the efficacy of three tools, alone or combined with herbicides: the rotary hoe, the tine weeder and the in-row hoe. Decision grids have been built to guide farmers in the use of these tools, according to their adjustments, the stage of the crop and the weeds, the soil texture and moisture, etc.

Materials and methods

From 2003 to 2006, three tools have been tested in a network of 15 farmers' fields, alone or combined with herbicides, in different soil types and on different weeds:

The rotary hoe is composed of wheels laid out on two lines, each wheel features curved and spoon-tipped teeth that hit the soil vertically at a high speed and tear off the weeds on the whole soil surface. The width of this tool can vary from 4.70m to 9 m.

The tine weeder is composed of many long metallic flexible tines whose vibrations uproot the weeds, when scratching the whole soil surface. The width goes from 9m to 24 m.

The in-row hoe cuts the roots of the weeds between the rows of the crop. It can work on 6 to 12 inter-rows. A combined technique has been tested which consists in spraying herbicides only on the row when sowing (with a specific material), and then using the in-row hoe to destroy weeds between the rows. The quantity of herbicide is thus reduced by 60%.

Different combinations of these tools and herbicides have been tested, in comparison with a chemical reference (pre-sowing and pre-emergence herbicides):

- Pre-sowing herbicide (trifluraline) followed by one to four mechanical weeding with the tine weeder or the rotary hoe;

- Pre-sowing herbicide followed by one to two interventions with the in-row hoe;

- Pre-sowing herbicide on the whole soil surface followed by pre-emergence herbicide only on the row and then in-row hoeing between the rows;

- Combinations of the tine weeder or rotary hoe and the in-row hoe.

Two main measurements have been made: efficacy and selectivity, by counting the plants (oilseed rape and weeds) before and after the tools have been used.

Results and discussion

Selectivity. The rotary hoe is systematically less damaging for the crop than the tine weeder. If the soil is not too crumbly and the rapeseeds not too deeply drilled, the rotary hoe is selective, at high speed (minimum 10-12km/h) from pre-emergence crop stage to 4-leaf crop stage. At that time, the plant losses are inferior to 10% and may not affect yield. In comparison, because of the forceful penetration of the tines and the forward speed required by the tine weeder, damage caused from cotyledon stage to 2- leaf stage can lead to yield losses. This tool is suitable at pre-emergence - but it tends to displace the seeds out of the row and may sometimes delay the crop emergence - and then from 3-leaf crop stage. The throwing action of tines varies with soil type, smoothness and moisture content. That's why rapeseed rates should be increased 10-15% to compensate for any losses, especially if the crop is poorly established in dry conditions and if repetitive harrowing is planned at juvenile stages of the crop.

Both rotary hoe and tine weeder have better selectivity by cultivating on a larger row-spacing rape, at equal plant density per square metre. A higher crop linear density on the row leads thus to a better plant resistance than in the case of narrow row spacing where density on the row is inferior.

In crumbly ground, when rotary hoeing or harrowing, the tractor wheels tend to increase the compaction and don't permit any plant growth. Farmers who use frequently rotary hoe or tine weeder consider their tramlines as fertiliser or sprayer tramlines. Increasing working width increases understandably the distance between tramlines and improves the level of selectivity for the crop.

The in-row hoe is less damaging to the crop because it only works within the inter-rows: it can be used, carefully, from 3-leaf stage until the moment when the crop covers the entire surface. In narrow row spacing (minimum 30cm), precise drilling and self-steering mechanism are prerequisites for successful in-row hoeing. The results about selectivity allowed us to build a decision grid which shows at what stages of the crop the different tools can be used. (Table 1)

Table 1: Selectivity of the tools according to oilseed rape stage

	Pre-emergence	Cotyledon	2 leaves	3 leaves	4 leaves	5 leaves
Tine weeder	+ + +	- - -	- - -	+ + +	+ + +	+ + +
Rotary hoe	+ + +	+ + +	+ + +	+ + +	-	- -
In-row hoe	- - -	- - -	- -	+ + +	+ + +	+ + +

(+++) = Possible use, good selectivity; (-) = Possible use, the selectivity is reduced; (--) = Possible use but the selectivity starts to decrease; (---) = Not recommended for use, the selectivity is insufficient

Efficacy of the tine weeder and the rotary hoe. Both implements are suitable for weeds that emerge shortly after drilling. Because of its greater aggressiveness, the tine weeder was more efficient than the rotary hoe for the same conditions of intervention. The efficacy strongly decreased after 2- or 3-leaf weed stages for the rotary hoe (Table 2), and after 4-leaf weed stage for the tine weeder. The rotary hoe did a good job at white root hair stage but it is difficult to join optimum weed stages with optimum soil and weather conditions. In addition, most of weeds usually appear at irregular time intervals and it is not easy for the operator to target the most important flush of weed seedlings. The global efficacy of one passage is thus never 100%. The root system or weed morphology can also explain the big variability of implement efficacy. In general, broadleaf weeds are best controlled by rotary hoeing or harrowing rather than grass weeds. Some early weeds which develop rapidly a

competitive taproot or biomass have to be destroyed very early (*Sinapis arvensis, Raphanus raphanistrum, Geranium sp., Sonchus sp, etc.*). Later emerging weeds are however still a concern because of the interferences with harvest operations and soil seed bank. Mechanical weed control can be efficient against weeds that are hard to destroy with herbicides and when the weed density is at a low level (Table 3).

Table 2: Efficacy of the rotary hoe according to the timing of passage

	15/09/2004	25/09/2004	3/10/2004
Stage of rape	2-leaf	3-leaf	4-leaf
Stage of *Veronica sp*	Cotyledon	3-leaf	4-leaf
Efficacy level	78%	31%	23%

Table 3: Number of weeds.m^{-2} (at 6-leaf rape stage) after different combinations of weed control

	Sonchus sp	Alopecurus myosuroides	Anthemis sp	Geranium sp	Viola sp	Sinapis arvensis	Lamium sp
Control plot	10.8	7	6.5	2.2	1	0.3	0.25
RH x 3	3.5	1.5	0	0.9	0	0	0
TW x 2	2.7	1.5	0	0.4	0	0	0
TW x 1	3	2.1	0.7	0.5	0	0.1	0
TW/RH/TW	3	1	0	0	0	0	0
Herbicide	1.7	0	1.5	0	0	0.6	0

RH = Rotary Hoe, TW = Tine Weeder, Herbicides = trifluraline / metazachlore + quinmerac

Efficacy of the in-row hoe. Table 4 compares the most frequent herbicides, with two alternative methods including the in-row hoe. Spraying herbicides only on the row when drilling, and then using the in-row hoe is as efficient as the chemical reference after the in-row hoe has been used. In-row hoeing alone is not sufficient: the weed coverage level decreases after the intervention of the tool, but increases again after (grass weeds in particular are concerned).

Table 4: Efficacy of different combinations of weed control including in-row hoeing (dynamic of weed coverage levels)

	13/10/2003	22/10/2003	04/02/2004	03/03/2004
Control plot	75%	75%	80%	85%
Trifluraline / Metazachlore	5%	5%	5%	7%
Trifluraline / Metazachlore on the row / In-row hoeing	50%	5%	15%	15%
In-row hoeing	75%	45%	80%	45%
Trifluraline	45%	45%	70%	70%

In-row hoe interventions : 14/10/2003 then 05/02/2004

Weeds: *Geranium sp., Raphanus sp., Anagallis sp., Papaver sp., Lolium sp.*)

Importance of soil type and structure. These features influence both the effectiveness of the weeding operation and the crop selectivity. The tine weeder was more successful on lighter soils and less suitable for heavy land. The rotative hoe achieved best results on calcareous clay soils or soils with crushed-stones and failed on hydromorphic silty clay soils. It required a soil not too wet and not too dry. In-row hoeing worked well for a larger range of soil types but desiccation on the soil surface strongly prevented weed regeneration.

Economic assessment. An economic overview shows that if these techniques involve big cultivated areas, mechanical operating costs and labour requirements can be offset by herbicide cost savings. This assessment is very dependant on the hypothesis made about the operating and labour costs, which vary a lot according to the implement models (working width, type of tines, system of guidance, etc.), the work force availability and the number of hectares on which they are used.

Conclusions

As an alternative or a complement to herbicides, mechanical weed control strategies were selective enough for oilseed rape if they were used in appropriate conditions (crop stage, soil surface moisture, adjustments of the tools). They could be as efficient as herbicides but with an irregularity and strongly dependent on weed development stage. These techniques have to be linked with long term preventive measures to maintain weed population at a low level. For this reason, weed management involves a whole cropping system consideration: crop rotation, tillage system, stale seedbed are known to deal with the weed problem upstream. Non-chemical or combination chemical/non-chemical strategies could be economically competitive but will always require more working time.

These techniques can thus be an answer to some of the new requirements of the agricultural context but operator skill, experience and knowledge are critical to success. Introducing these techniques in a farm requires a deep-change of state of mind that many farmers are not yet ready to make.