Project Title:	Vining peas: the use of mechanical weeding techniques
Project Number:	FV 243
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Key Words:	vining peas, mechanical weeding, crop growth stage, weed control, maturity, weed, peas

CONTENTS

GROWER SUMMARY

Headline

- Mechanical weeding in vining peas can be a useful alternative to pre-emergence herbicides

- Early passes with an Einbock weeder reduce small weeds, do not impair pea crop growth and do not affect maturity.

In trials carried out in 2002, weed control in vining peas was investigated using a mechanical weeding method in the absence of chemical herbicide treatments.

In a vigorous growing variety of vining peas a useful level of weed control with a minimum of crop damage and effect on the maturity of vining peas was achieved using two passes along the direction of the pea rows at GS 102 and GS 105 respectively with an Einbock spring-tine weeder.

Background and expected deliverables

In vining peas, weed control is the most important limiting factor for production. Competition by weeds affects early seedling growth and later competes with the crop for nutrients and light. Work in conventionally grown peas has shown that yield can be reduced by around 30% in the absence of weed control. Contamination by weed flower and seed heads are a major cause of crop rejection by the processors. Such contamination is difficult to remove during the processing operations. As a result of the EU review of pesticides, the commonly used active ingredients for both pre-emergence and post emergence herbicide mixtures will be unavailable after July 2007. The long development period required before replacement chemicals become available to the grower necessitated an strategy for a reliable, practical alternative for weed control. Preliminary studies in both organic and conventional pea production have shown benefits of mechanical weeding with an Einbock weeder at various crop growth stages. In 2001, useful weed control was achieved in organically grown vining peas with two passes of the weeder during the early part of the season. However, the studies were made in observation areas in the field and were carried out during commercial operations with a limited number of treatments. Further work was needed to identify the most suitable stages of both crop and weed development for weeding and also to examine the effects on crop maturity.

The expected deliverables from this work include:
A mechanical weeding alternative to replace the use of chemical herbicides in vining pea production together with an assessment of the physical impact on the pea crop with particular regard to yield and quality.

Summary of the project and main conclusions

The early maturing variety, Avola and the maincrop variety Bikini, were used in the trials. In both varieties of vining peas, weeds were removed using a standard Einbock weeder at specific crop growth stages and in two directions, along or across the rows.

1. Control was most effective against smaller weeds such as small black bindweed and shallow rooted annuals such as fat hen.

2. Control of large established weeds and deep rooted perennials such as perennial thistle was poor. Volunteer potatoes were a particular problem.

3. Control was most effective where two passes were made in the direction of the rows of the crop at the early vegetative stage (GS 102) and again at the fifth leaflet and tendril stage (GS 105).

4. A single late pass at enclosed bud stage (GS 201) was too late to be useful as an effective control method.

5. The crop plant population was not significantly reduced, even following treatments that had been carried out three times.

6. Physical damage such as leaf stripping and tendril loss was most severe at later growth stages when weeded across the rows. Weeding at the enclosed bud stage (GS 201) was most damaging.

7. The maturity of the vined peas appeared to be influenced more by the weed competition than the physical effects of weeding.

Additional notes for growers

It may be possible to compensate for plant loss by increasing seed rates. More robust cultivars may out-compete weeds and be less susceptible to physical damage. Careful rotation planning and aid weed control by eliminating problem volunteers. The use of glyphosate or similar systemic total herbicides in preceding cereal crops may reduce weed problems in the following pea crop.

Another problem when implementing this technique on a wider scale may be the damage it can inflict on ground nesting birds such as the skylark. These are already in decline in many arable areas as a result of rotational changes, such as the move towards winter cereals which grow too tall for them. Pea crops are a popular nesting and feeding site for skylarks, and regular mechanical weeding could disrupt their breeding habits.

If possible hoeing control should be optimised by targeting periods of dry weather, to minimise opportunities for weeds to re-root.

Where soils have the potential to form hard crusts the hoe has been shown to be less effective against weeds. If it is necessary to weed across the rows it is best to do it early in the crop growth stage.

Financial benefits

The use of mechanical weeding of peas at an early stage in their growth will reduce the need to use a pre-emergence herbicide in some situations, particularly in dry conditions when residual herbicides are not active. Cost savings of around £25 per hectare for the herbicide will however be offset by the increased number of passes made with the weeder.

Action points for growers

- On the strength of one years results the author is not confident to make recommendations for changes in current grower practice. However, results so far give some early indications that mechanical weeding may be worthwhile.

- Weeding either in the same direction or across the rows at early growth stage (GS 102 - 105) appears to be the most useful.

- If cross weeding is used it should be done before enclosed bud (GS 201) to minimise crop damage.

- Crop damage can be reduced by selecting vigorous varieties that are more tolerant to physical damage.

Cultivation Equipment For Weed Control

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Finger weeders can be attached to other types of harrow and hoe to give better weed control of small weeds. The Steketee Finger Weeder is another example of the type.

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The brush hoe uses power driven rotating nylon brushes to aggressively rip weeds out of the soil. The crop must be protected by shields hung above the crop surface. It must be precisely driven, requiring a second operator on a rear seat. This is an expensive piece of equipment. The additional labour cost of a second skilled operator is essential. It cannot be adjusted to different row spacing which must be standardised to accommodate the machine.

SCIENCE SECTION

Introduction

Effective weed control is essential to minimise competition and reduce the risk of product contamination. After 2007 the pre-emergence herbicides, terbutryn plus terbuthylazine, fomesafen plus terbutryn and the post emergence herbicide, cyanazine will be withdrawn from use in Europe, thereby severely~~severley~~ limiting the opportunities for chemical weed control.

Mechanical weeding appears to be an option in some crop situations but detailed trial work in peas has been limited.

In the past, manual methods of control, such as hoe gangs, were quite effective but modern labour costs render this method prohibitively expensive. The use of mechanical weeding machines was a standard part of weed control until the 1960s. Machines such as the Ferguson finger weeder were commonly used in pea and bean crops, but crops were grown in wider rows than at the current time. Today steerable inter-row hoes and cultivators are used successfully in row vegetable crops and sugar beet. Vining peas, however,~~howevr~~ are grown~~growm~~ in narrow rows and this limits the efficiency of row crop weeders. Earlier work carried out by PGRO in organic combining peas, indicated that a satisfactory level of weed control without a measurable level of yield and quality loss, could be achieved using an Einbock tined weeder.

In addition it is good Integrated Crop Management practice to investigate other control methods to ensure that optimal financial return is obtained at minimum impact to the environment.

Drawing upon this earlier experience, the practicality of mechanical weed control as part of the agronomic package in conventional vining pea production was assessed in a trial at Thornhaugh in 2002.

Materials and Methods

The PGRO headquarters trial~~trila~~ ground was chosen for the work. The soil type was ~~a~~classified as a sandy loam overlying limestone but contained a high level of stones and subject to drying rapidly in the spring and summer. Two areas of the PGRO trial ground were drilled on separate dates with the early maturing vining pea variety Avola drilled on 8th March and the early maincrop variety Bikini sown on 3rd April. Pre-drilling cultivation was made with a spring tine cultivator and the peas were drilled with a Nordsten cereal~~cerael~~ drill with row width of 15 cm. The target population was 90 plants per square metre. The three-section 8 m Einbock Weeder was driven through the plots at three different pea growth stages as shown in table 1.

<u>Table 1. Crop growth stages</u>

GS 102	Vegetative Stage: Second node, stipule and second node unfolded with one pair of leaflets, simple tendril.
GS 105	Fifth leaf fully unfolded with more than one pair of leaflets with complex tendril.
GS 201	Enclosed bud. Small flower buds enclosed in terminal shoot.

At each timing, the direction of weeding was varied to give 12 combinations (i.e. parallel to or across the rows) with an untreated~~d~~ area that was unweeded. The combinations and directions are summarised in table 2 below.

<u>Table 2. Treatment summary.</u>

Treatment Number	GS 102	GS 105	GS 201
1	Untreated	Untreated	Untreated
2	Along	Untreated	Untreated
3	Across	Untreated	Untreated
4	Untreated	Parallel	Untreated
5	Untreated	Across	Untreated
6	Parallel	Parallel	Untreated
7	Parallel	Across	Untreated
8	Across	Parallel	Untreated
9	Parallel	Parallel	Parallel
10	Across	Untreated	Parallel
11	Untreated	Across	Parallel
12	Across	Across	Parallel
13	Across	Across	Untreated

Across = At right angles to the rows
Parallel = In the same direction as the rows.

Each plot measured 12m long and 10m wide. All other maintenance was conducted according to standard agricultural practice. It was not possible to fully randomise the treatments but the same layout was used for each variety.

Results

Effect on plant numbers.

Plant numbers per square meter were recorded for each treatment before and after hoeing. Counts were made using a circular quadrat at several positions within each plot. The results of the plant counts for each variety are shown in figures 1 and 2.

Figure 1. Avola population scores after each weeding.

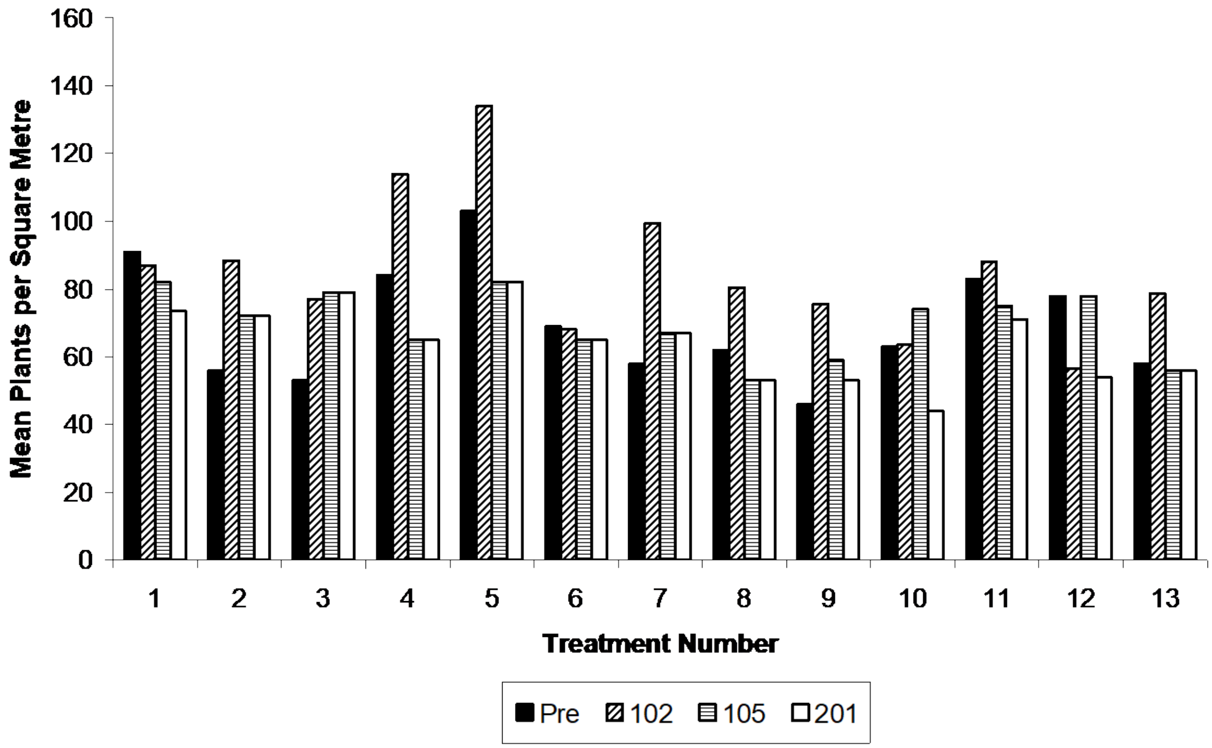
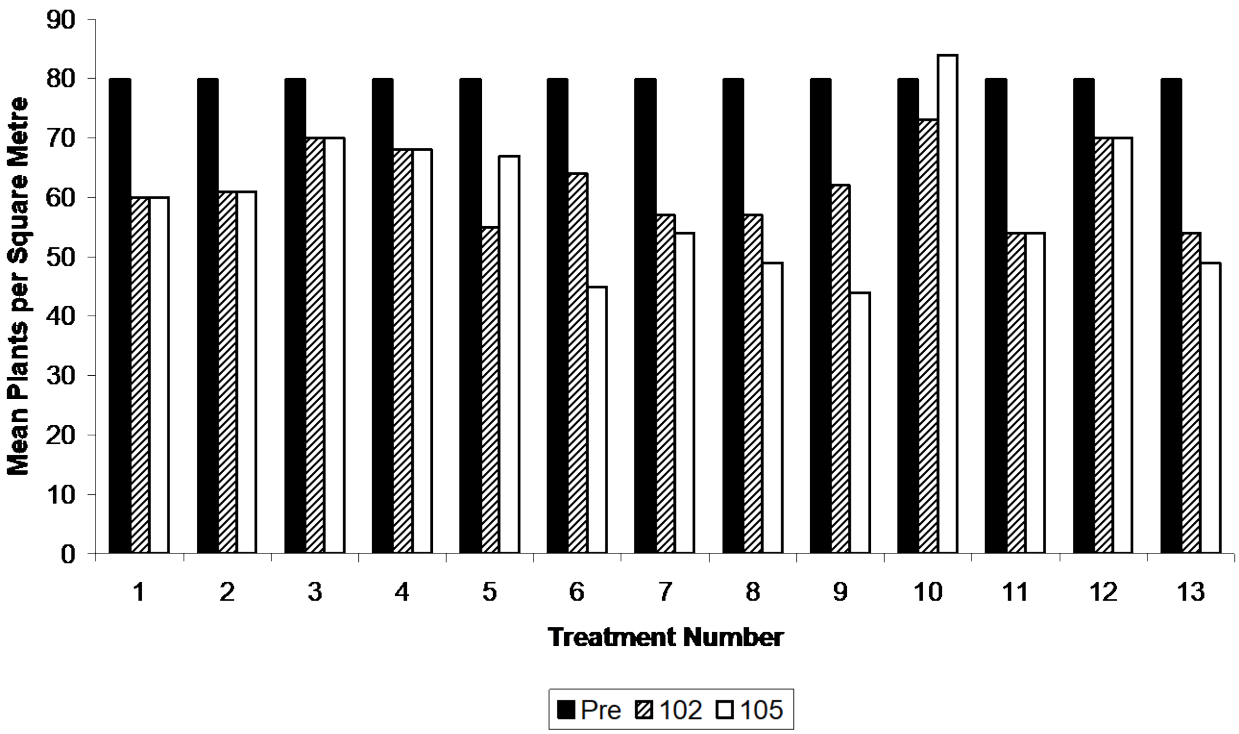


Figure 2. Bikini population scores after each weeding



There was no significant difference between the pea plant populations following each treatment. Despite some plants being buried temporarily, there was no noticeable reduction in plant population per square metre.

Physical crop damage

Hoeing in either direction caused some damage to the plants but generally this was superficial. The physical damage visible immediately after hoeing was mainly to the leaves. In the worst case, stems were almost stripped of side shoots. The main damage resulted from cross hoeing and parallel hoeing at the later growth stage. Early hoeing along the rows affected plants the least.
The damaged peas re-established within a few days and showed more resilience than the shallow-rooted weeds.

Weed Control

Weed numbers
The development of the weeds was delayed by damage from the weeder. In some cases, potential contaminants such as flower heads or seed pods did not have time to develop. Although weed numbers per square metre were not always reduced, the surviving weeds

from earlier passes provided some competition with the crop and pea plant survival was affected and the maturity of the peas was delayed.

The weeder killed weeds by chopping them up or turning over the soil then partially, or completely, burying them. Weeding was more successful in dry conditions when weeds could not re-grow.

Control was seen to be most effective where two passes were made parallel to the crop at the vegetative stage (GS 102) and repeated at the leaflet and tendril stage (GS 105). The final pass at enclosed bud stage (GS 201) did not give effective control.

The main weeds present in the trials, were black bindweed (*Bilderdykia convolvulus*), fat hen (*Chenopodium album*) and chickweed (*Stellaria media*). In addition, there was a high population of volunteer potatoes. Summaries of the weed population counts following each weeding operation are shown in figures 3 - 7).

Figure 3. Avola - black bindweed populations (plants/m^2) present after each hoeing date.

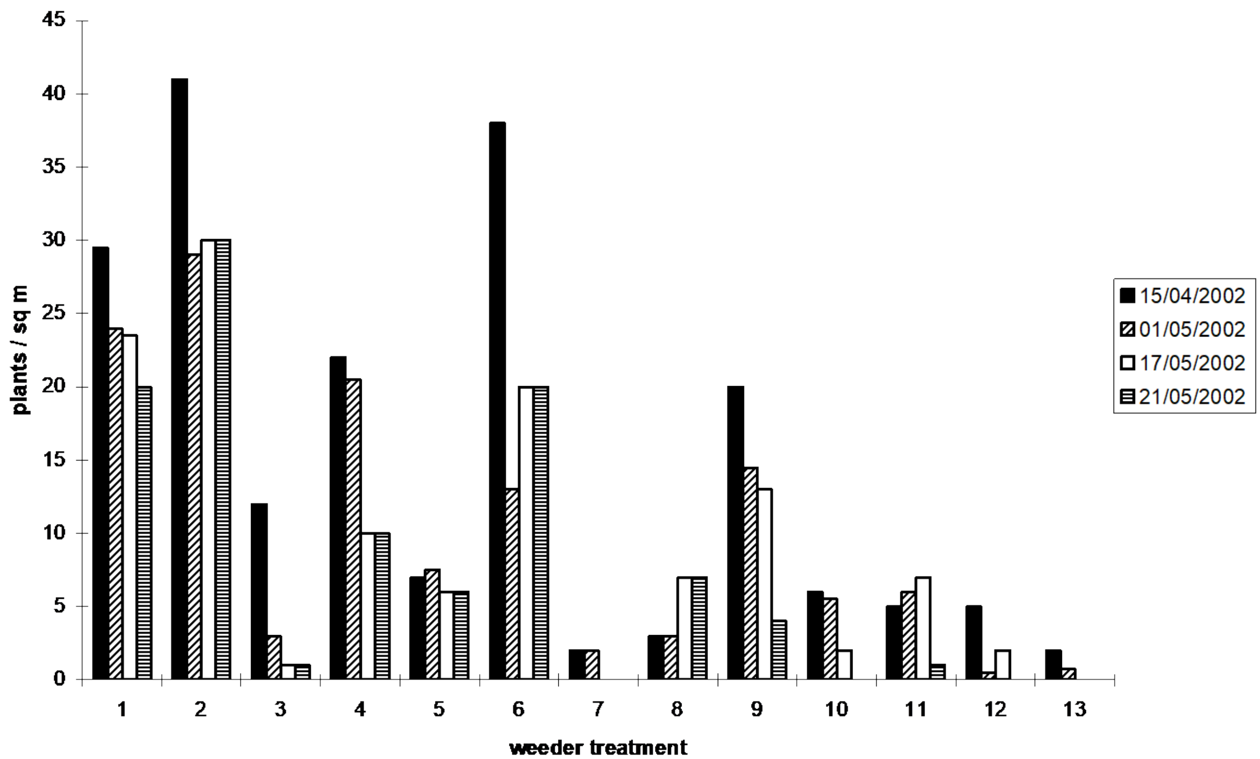


Figure 4 - Avola - fat hen populations (plants/m ^{2}) present after each hoeing date.

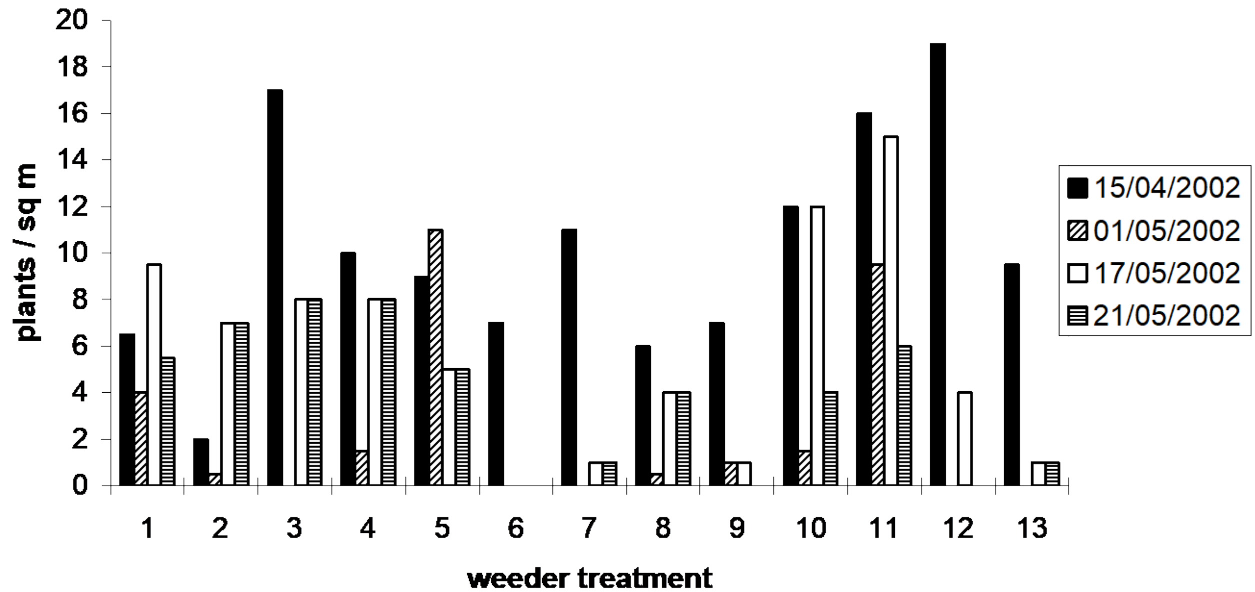


Figure 5. Bikini - fat hen populations (plants/m ^{2}) present after each hoeing date.

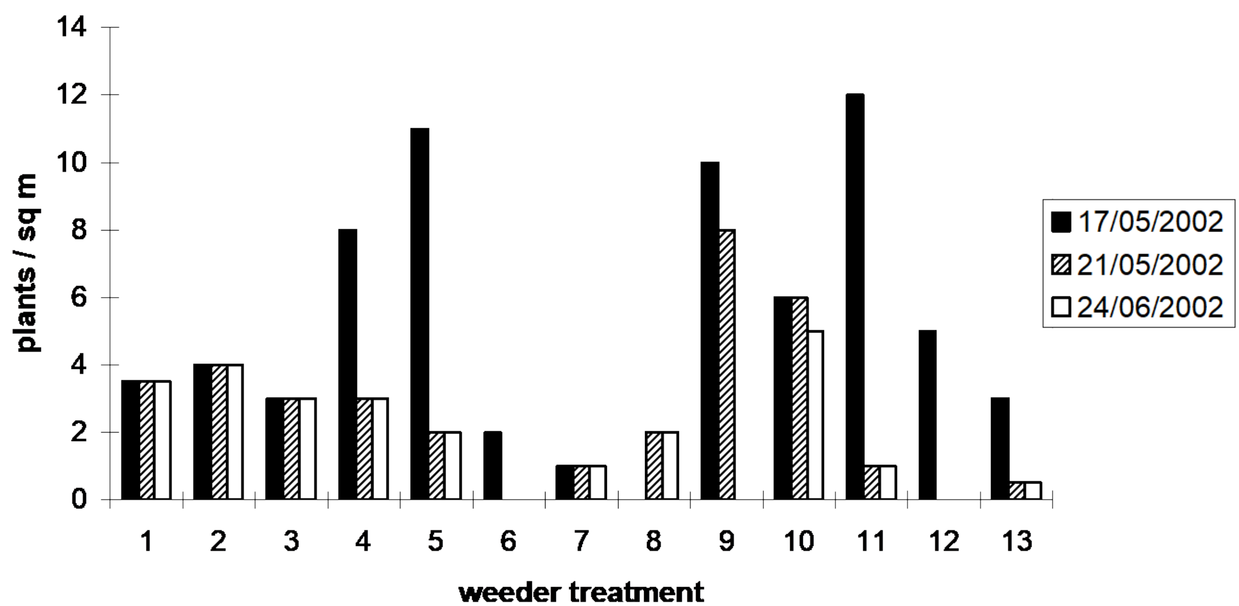


Figure 6. Avola - chickweed populations (plants/m ^{2}) present after each hoeing date.

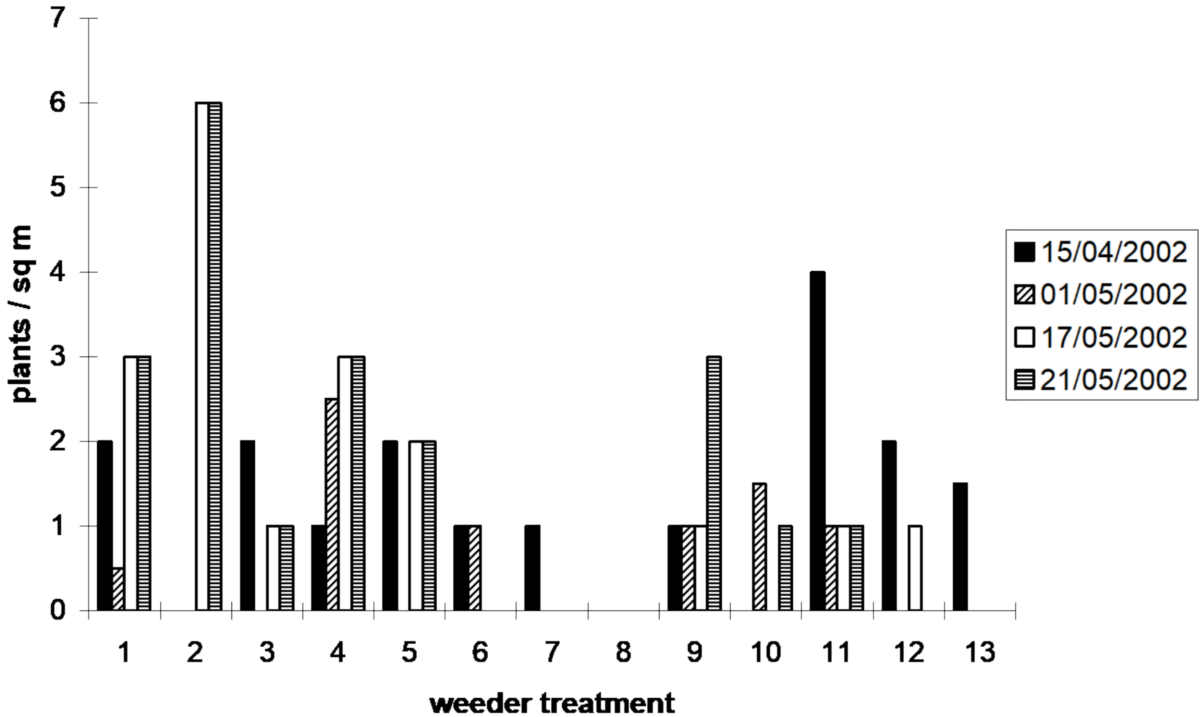
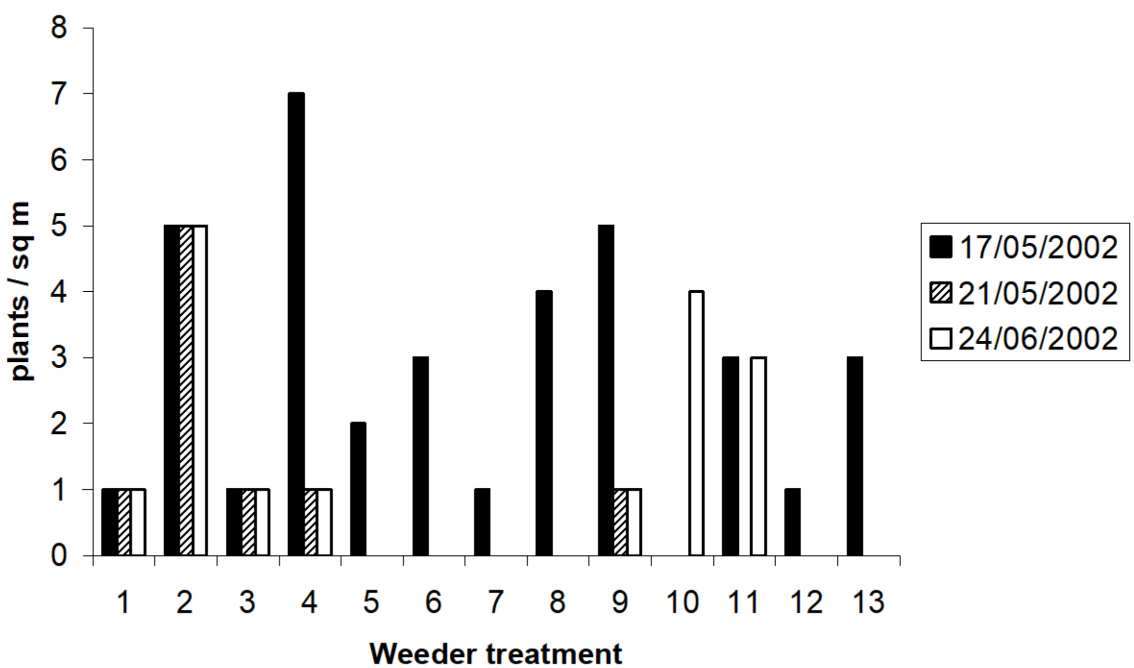


Figure 7. Bikini - chickweed populations (plants/m ^{2}) present after each hoeing date.



Pea maturity

Bird damage in the earlier maturing Avola trial was very severe and it was not possible to obtain any samples for vining.
In the Bikini, plant samples from each plot were manually harvested and vined to provide sufficient peas to test for maturity using the PGRO Tenderometer which was sampled on 11th July 2002. Peas with a tenderometer reading of 100 are considered to be at the practical freezing stage. No result was obtained from treatment six. The results are shown in table 3.

Table 3 Tenderometer readings (Bikini Only)

Treatment	Tenderometer Reading
1 Untreated	92
2	87
3	106
4	100
5	107
6	N/A (bird damaged)
7	104
8	104
9	82
10	100
11	121
12	111
13	112

The delay in maturity appeared to be associated with weed competition in the untreated plots and the early parallel pass treatment compared with the later passes where weed control was improved.

Conclusion

This trial was unreplicated and therefore conclusions were difficult to draw. It was established that mechanical weed control can provide satisfactory control if used at GS 102 and repeated at GS 105. Weeding at GS 207 did not appear to give good weed control.
The constraints imposed on this trial with its lack of replication of treatments made it difficult to correlate weed numbers directly to weed control efficiency. In addition

control continued to be considered to be sufficient even when the weed persisted through to harvest but was too small to compete with the crop.

It may be possible to compensate for plant loss by increasing seed rates. More robust cultivars may out-compete weeds and be less susceptible to physical damage. Careful rotation planning and aid weed control by eliminating problem volunteers. The use of glyphosate or similar systemic total herbicides in preceding cereal crops may reduce weed problems in the following pea crop.

Another problem when implementing this technique on a wider scale may be the damage it can inflict on ground nesting birds such as the skylark. These are already in decline in many arable areas as a result of rotational changes, such as the move towards winter cereals which grow too tall for them. Pea crops are a popular nesting and feeding site for skylarks, and regular mechanical weeding could disrupt their breeding habits.

In conclusion there is potential in the use of mechanical weeding as a sustainable technology to supplement existing techniques. It can only be fully optimised if further development work is conducted to precisely define the susceptible weed spectra and the yield consequences.

If possible hoeing control should be optimised by targeting periods of dry weather, to minimise opportunities for weeds to re-root.
Where soils have the potential to form hard crusts the hoe has been shown to be less effective against weeds. If it is necessary to weed across the rows it is best to do it early in the crop growth stage.

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