Comparison of weed management methods in organic carrot

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Summary: 14 combinations of mechanical and also physical (thermal) weed management techniques are compared for organic growing of carrot. Crop of our weed management research is carrot because of its difficulties in weed management (long growing period, poor weed tolerance) and because carrot needs to be important product of organic farming. Herbicide treatment is used as control – cultivator, brush hoe, hand hoeing and hand weeding are mechanical control tools and flame weeder is used for thermal control. Measured parameters are the weed cover, cover of the crop and dry mass of them. Result of the two appraisable years shows contradictory results, which contradiction can be justifiable with different weather conditions of these two vegetation periods. In 2000 brush hoe was significantly the best in interrows but in the year 2001 cultivator combined with hand weeding in rows seemed to show the best result. We can see in this example that agriculture and weed management depends very much on the weather of the year, so that is why it is so difficult to develop a method, which can be generally used for organic weed control of carrot.

Key words: weed management, mechanical, thermal, carrot, organic

Introduction

Because of environmental aspects and because of the increasing demand for ecologically produced vegetables, more and more farmers convert their conventional farming systems into ecological ones, not at last because they want to boycott herbicides from production. *(Vereijken & Kropff,* 1996)

Vegetable crop rotation has weak competition ability. Plants, like carrot with slow initial development are very sensitive for weediness *(Turner,* 2000). Its thin, feathery leaves do not shade out competing weeds and its long growing season creates an opportunity for successive flushes of weeds *(Bell & Smith,* 2001). If the main tool of weed management is still herbicide, these weed-sensitive plants increase the amount of utilised herbicides of vegetable production in general.

We have chosen carrot as crop plant because of its wide spacing and its slow initial development, so it has high weed management risk *(Bilalis* et al., 2001). Carrot is important basic material of healthy food so we need large amount of it from ecological production.

One of the most important questions of environmentally sound plant production is weed management *(Tu* et al., 2000). The other important thing is to examine not only the successfulness of weed management but also the yield of the crops, because our aim is – for keeping biodiversity *(Kristiansen* et al., 2001) – only to decrease weediness under the level of damage to production and yield and not to destroy them totally.

Moreover with spreading of environmentally sound farming, development of its production technology become more and more important *(Vereijken & Kropff,* 1996).

Farmers growing crops organically often expect to achieve good control by using only one mechanical weeder type. It is important therefore that the correct machine is selected. *(Pullen,* 1999)

Material and method

15 treatments with 4 repetitions were examined in this field experiment. Herbicide utilisation (as control) was preemergent with mixture of DUAL 960 EC (20mL 100 m^{-2}) and Maloran 50 WP (20 g 100 m^{-2}). Used carrot variety was *Nanti* with 75 cm row distance. Sowing depth was 3 cm. Times of sowing were 12. 07. 2000. (second sowing) and 04. 04. 2001.

Ecological circumstances: *Soil* type is restrainedly deep chernozem-like sandy soil. Soil forming rock is calcareous sand. Depth of humic layer is 30–40 cm. Soil is fast warming, with good water permeability and good air capacity. The disadvantage of this soil type that it is inclined to quick cooling down and drying out. Weakly calciferous, faintly alkaline soil. *Climate*: Precipitation of growing season in 2000 was significantly lower (223 mm) than in the

average 1999-year (480 mm) in the same period. During this period the average monthly temperature was higher with about 10% and because of this dual effects a significant depression were detected in case of lack of irrigation. After continuous drought of the year 2000, precipitation of 2001 was enough for emerging and growing of carrot but also increased weediness.

We did not use any irrigation.

Treatments

In rows:
- weedy control
- hand weeding
- herbicide
- weed flaming

In interrows:
- weedy control
- hoeing, herbicide
- weed flaming
- cultivator
- brush hoe

Combinations of treatments:

1. Control
2. Herbicide on the whole surface
3. Herbicide in the rows + cultivator in the interrows 1x
4. Herbicide in the rows + brush hoe in the interrows 1x
5. Herbicide in the rows + hoeing in the interrows 1x
6. Weeding in the rows 1x + cultivator in the interrows 1x
7. Weeding in the rows 1x + cultivator in the interrows 2x
8. Weed flaming on whole surface + cultivator in the interrows 1x
9. Weed flaming on whole surface + cultivator in the interrows 2x
10. Weeding in the rows 1x + brush hoe in the interrows 1x
11. Weeding in the rows 1x + brush hoe in the interrows 2x
12. Weed flaming on whole surface + brush hoe in the interrows 1x
13. Weed flaming on whole surface + brush hoe in the interrows 2x
14. Weeding in the rows according to need + brush hoe in the interrows 2x
15. Weeding in the rows according to need + cultivator in the interrows 2x

Sampling

- weed surveys: right before and two weeks after treatments
- dry mass of weeds, of root and leaf of carrot right before and two weeks after treatments, both in the rows and interrows in the case of weeds (weeds have taken from 0.25 m^2 in the rows and from 0.5 m^2 in interrows; carrots have taken from 1 running meter from each plots) SPSS 9.0 program was used to analyse data and Tukey's test to compare means.

Results and discussion

In the year 2000 we did not find any significant differences between the weed cover of treatments at the first survey so we can say that experiment area was homogenous in view of weediness.

We can make homogenous groups from dry mass of weeds in rows in herbicide treatments (treatments 2., 3., 4., 5.). Two weeks after the first treatments the herbicide treatments made statistically homogenous group and significantly decreased dry mass of weeds compared to weed flaming.

In interrows brush hoe (treatments 4., 10., 11., 12., 13., 14.) made significantly lower dry mass of weeds and they made statistically homogenous group two weeks after the utilisation of cultivator and brush hoe. Cultivator in interrows (treatments 3., 6., 7., 8., 9., 15.) seemed to be less effective. Herbicide, utilised on the whole surface (treatment 2.) is still effective one month after spraying out.

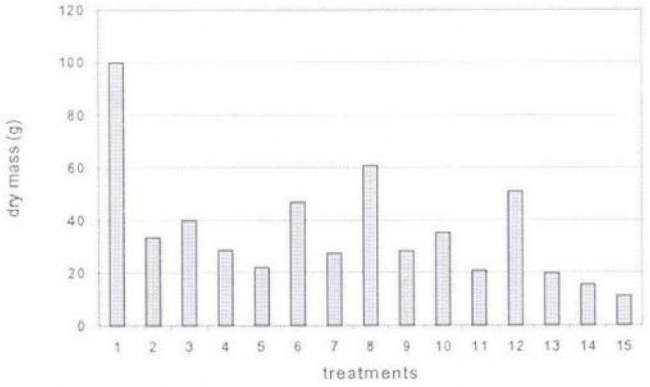
At the end of the growing season every treatments decreased the dry mass of weeds in the rows compared to untreated control *(Figure 1)*. Weeding in the rows according to need was the most effective of all treatments and these ones (treatments 14., 15.) made a homogenous group.

At the end of the growing season herbicide, utilised on the whole surface (treatment 2.) lost all of its effect and we found higher mass of weeds in these interrows than in the interrows of untreated control *(Figure 2)*.

Brush hoe gave better results if we see its effect at the end of the growing season than cultivator did, except treatment 15. Cultivator (treatments 7., 9., 15.) and also brush hoe if we used them twice a growing season (treatments 11., 13., 14.) showed better results in all cases than if we used them once (cultivator: treatments 3., 6., 8.) (brush hoe: treatments 4., 10., 12.).

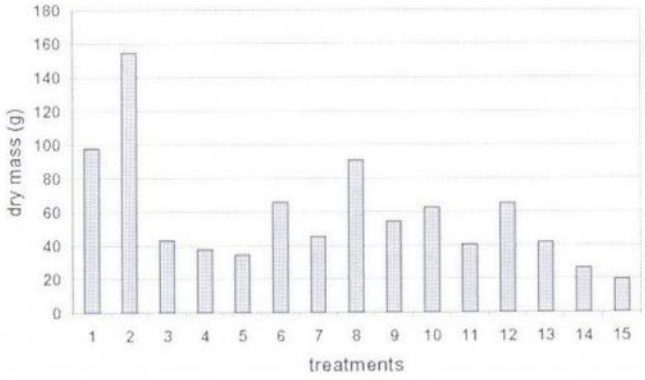
Higher mass of weeds were observable in all cases when utilisation of cultivator or brush hoe was combined with weed flaming in interrows. Relying upon these findings we can say that utilisation of weed flaming is not economic.

Under the influence of mechanical weed control occurred twice in interrows, cover of perennial geophyte weeds increased, which is explainable with cutting up stoles and rhizomes. The same treatment had the opposite effect on annual weeds; it efficiently reduced their cover in all cases.



Legend:
1. *Control*
2. *Herbicide*
3. *Herbicide in rows + cultivator in interrows 1x*
4. *Herbicide in rows + brush hoe in interrows 1x*
5. *Herbicide in rows + hoeing in interrows 1x*
6. *Weeding in rows 1x + cultivator in interrows 1x*
7. *Weeding in rows 1x + cultivator in interrows 2x*
8. *Weed flaming + cultivator in interrows 1x*
9. *Weed flaming + cultivator in interrows 2x*
10. *Weeding in rows 1x + brush hoe in interrows 1x*
11. *Weeding in rows 1x + brush hoe in interrows 2x*
12. *Weed flaming + brush hoe in interrows 1x*
13. *Weed flaming + brush hoe in interrows 2x*
14. *Weeding in rows according to need + brush hoe in interrows 2x*
15. *Weeding in rows according to need + cultivator in interrows 2x*

Figure 1 Dry mass of weeds in rows at the end of the growing season, 2000.



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4. *Herbicide in rows + brush hoe in interrows 1x*
5. *Herbicide in rows + hoeing in interrows 1x*
6. *Weeding in rows 1x + cultivator in interrows 1x*
7. *Weeding in rows 1x + cultivator in interrows 2x*
8. *Weed flaming + cultivator in interrows 1x*
9. *Weed flaming + cultivator in interrows 2x*
10. *Weeding in rows 1x + brush hoe in interrows 1x*
11. *Weeding in rows 1x + brush hoe in interrows 2x*
12. *Weed flaming + brush hoe in interrows 1x*
13. *Weed flaming + weed brush in interrows 2x*
14. *Weeding in rows according to need + brush hoe in interrows 2x*
15. *Weeding in rows according to need + cultivator in interrows 2x*

Figure 2 Dry mass of weeds in interrows at the end of the growing season, 2000.

On perennial weeds there was no significant effect of any row treatments. Repeated hand weeding caused significantly lower weed cover but only in the case of annual weeds.

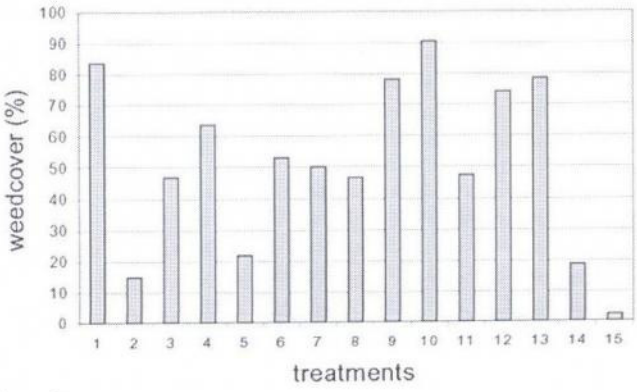
In the year 2001 at the beginning of the growing season every treatments decreased the dry mass of weeds in the rows compared to untreated control.

Cultivator-treated interrows made statistically homogeneous group and are different from brush hoe-treated ones, in which cover of annual weeds were much higher two weeks after the treatment. These differences are observable one month after the treatment, so cultivator can be called effective for a relative long term in interrows against annual weeds, which germinate from seed.

After the next interrow treatments hoeing and cultivator caused the lowest dry mass of weeds. Hoeing decreased better the mass of weeds, maybe because of greater preciseness of this method, but we have to take notice of the lack of manpower and its costs.

At the end of the growing season significantly lower weed cover was observable *(Figure 3)* in rows in treatments 2., 5., 14. and 15. Among them the last one (treatment 15.) showed the best results in weed cover and in dry mass of weeds too.

In weed cover of interrows there is bigger difference between treatment 14. and 15., so in this year cultivator was more effective than brush hoe and it had better effect also on the crop.



Legend:
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9. *Weed flaming + cultivator in interrows 2x*
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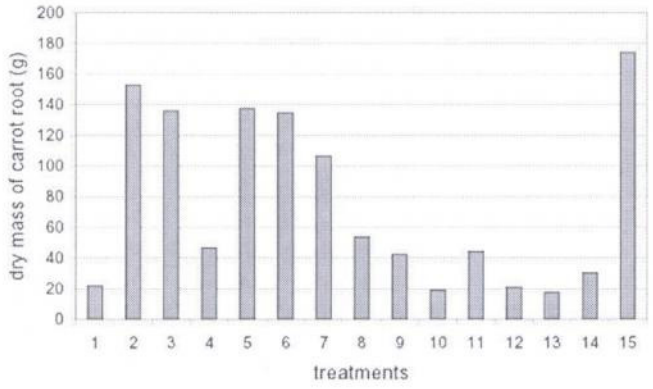
11. *Weeding in rows 1x + brush hoe in interrows 2x*
12. *Weed flaming + brush hoe in interrows 1x*
13. *Weed flaming + brush hoe in interrows 2x*
14. *Weeding in rows according to need + brush hoe in interrows 2x*
15. *Weeding in rows according to need + cultivator in interrows 2x*

Figure 3 Total cover of weeds in rows at the end of the growing season, 2001.

In ineffectiveness of brush hoe would have big role the dry weather at the time of occurrence, which reduced effectiveness of brush with higher rate than in the case of cultivator. Because of dry and hard soil surface brush hoe only rubbed off the leaves of weeds and was not able to penetrate into the topsoil where it could better destroy annual weeds, which germinate from seed.

Cultivator, and hoeing had better effect on the growing of carrot than brush hoe had *(Figure 4)* so moving the soil in interrows serves not just for weed control but it is good also for the crop plant. Apart from the fact that weeds in interrows meant concurrence for carrot, moving of soil in a larger extent can also help growing of carrot – surely cultivator and hoeing cause larger soil moving than brush hoe.



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14. Weeding in rows according to need + brush hoe in interrows 2x
15. Weeding in rows according to need + cultivator in interrows 2x

Figure 4 Dry mass of carrot roots at the end of the growing season, 2001.

It is noticeable that we reached the lowest weed cover and dry weed mass and the highest yield of carrot in treatment with cultivator occurred twice in interrows and weeding in rows according to need (treatment 15.).

Conclusion

In 2000. under extremely dry and warm circumstances we took the following conclusions:

- herbicide treatment was the most effective treatment
- brush hoe was more effective in weed management than cultivator
- both equipment gave satisfactory results if we occurred them twice
- mechanical weed control reduced cover of therophyte weeds but increase the cover of geophyte weeds

In 2001. under less dry circumstances:

- the most effective treatment was weeding in rows according to need and cultivator in interrows occurred twice
- we can say that herbicide utilisation can be eliminated from ecological carrot production because the above mentioned treatment combination was more effective, than herbicide utilisation and it had higher yield increasing effect too
- cultivator occurred twice and many times row weeding cause higher expenses, which is common in ecological farming. But in the same time it give higher yield and also product with higher value
- brush hoe showed very bad effectiveness even if we occurred it twice. To choose the time of its utilisation needs more attention than in the case of cultivator *(Pullen D.* 1999)
- higher carrot cover was in the treatment with lower weed cover

Acknowledgements

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