



USE OF MECHANICAL CULTIVATORS FOR MARKET VEGETABLE CROPS

Horticultural Research and Development Centre (HRDC), Saint-Jean-sur-Richelieu, Qc

Marie-Josée Hotte, B.Sc., Research Assistant, Diane Lyse Benoit, Ph.D., Weed Scientist and

Daniel Cloutier¹, Ph.D., Weed Scientist

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In a context of sustainable agriculture, producers endeavour to employ non-chemical control methods to manage weed infestations and protect the environment. Mechanical cultivators are an integral part of the weed management practices available as an alternative to herbicides.

For many fresh market vegetable crops, the range of registered herbicides is limited, and growers must rely on alternative weed management strategies when chemical control is not feasible. Mechanical cultivation is an environmentally friendly option of weed control and can help reduce expenses related to herbicide use.

For vegetable production, the decision to use a particular cultivator depends on a number of factors. Crop tolerance, weed control efficacy of each cultivator, the number of cultivation required, tractor speed and operating costs are all key factors that growers need to consider in choosing cultivators.

TYPES OF CULTIVATORS

In recent years, various types of more efficient cultivators have come onto the market. The new machines vary in their design, mode of operation and intervention window for cultivation (See chart on page 3). The description of the cultivators, their weed control efficacy and control strategies proposed in this factsheet are the results of a research project carried out by the

Horticultural Research and Development Centre and McGill University on behalf of the Fondation québécoise pour la recherche en agro-forêt, under the Canada-Quebec Subsidiary Agreement on Environmental Sustainability in Agriculture.

Spring-tine harrow (Rabewerk™)



The spring-tine harrow is used in muck soil to control weeds between crop rows. This harrow has six rows of 10 narrow flexible tines; they can be raised or lowered individually in order to cultivate specific areas. The raised tines may drop as a result of jolting when the harrow moves over uneven ground. However, they can be adjusted easily and crop damage is small since tines are kept raised above the crop row. This type of cultivator disturbs the soil to a depth of 2 to 5 cm. To ensure effective weed control, four cultivations are required early in the season at intervals of 5 to 7 days.

Rigid-tine harrow (Rabewerk™)

The rigid-tine harrow has rigid non-flexible tines and is used in mineral soil. As with the spring-tine harrow, each of the tines can either be raised or lowered depending on the



surface to be cultivated. The harrowing depth ranges from 2 to 5 cm. For effective weed control, three successive cultivations must be made at intervals of 5 to 7 days.

Torsion weeder & spyders (Bezzeries™)



This cultivator consists of two units: spiked disks (Spyders) and steel rods (torsion weeder). This fairly aggressive weeder is suited to operate in both muck soil and mineral soil. Depending on the angle at which the disks are set, this weeder either pushes the soil away from the crop row or it ridges soil onto the row, uprooting any weeds it encounters. The torsion weeder consist of rigid steel rods, which are positioned on opposite sides of the crop row; they are slightly offset so

¹ Institut de malherbologie, P. O. Box 222, Sainte-Anne-de-Bellevue, QC Canada H9X 3R9

they can work as close to the row as possible without injuring the crop plants. The teeth penetrate into the soil and uproot the weeds. Since the height and angle of each unit can be modified, the machine requires numerous adjustments. Furthermore, on account of the rounded shape of the disk attachments to the tool bar, this weeder exhibited a tendency to lose its adjustment. It works the soil to a depth of 5 to 10 cm. As a result of its aggressiveness, only a few cultivations (2 to 3) need to be made; hence, cultivation operations can be spaced farther apart during the season.

Rotary hoe (Yetter™)



Rotary hoe

The operating principle of the rotary hoe is simple: a series of rolling disks with spoon-shaped tips mounted on a common axle. This type of cultivator is used only in mineral soil. It offers several advantages, including rapid operating speed and preemergence blind harrowing. Although slight crop damage may be observed if cultivation is done right after crop emergence, the plants quickly recover. This type of equipment cannot be used with crops that are susceptible to damage. The rotary hoe breaks the soil crust, thus providing better aeration. It uproots sprouting weeds and works to a depth of 5 cm. Effective weed control is obtained following three cultivations with the rotary hoe.

Danish tines cultivator (Kongsilde™)

This is an aggressive cultivator that has S-shaped tines with triangular bladed tips. The tines dig deeply into



Danish tines cultivator

the soil, mixing and aerating it, as it uproots weeds. Danish tines have a working depth of about 10 cm. Because of its aggressiveness, fewer cultivations are required than with the other cultivators. It may be used as a follow-up to a rotary hoe.

Basket weeder (Buddingh™)



Basket weeder

This cultivator has two sets of baskets that each rotate on an axle; the first set of baskets has larger diameters and rotates slower than the second set. The baskets, which are manufactured in various widths, can be arranged along the axle according to the desired inter-row width to be cultivated. The adjustment is rapid since it merely entails selecting the baskets and positioning them on the axle. This type of weeder can be used in mineral soil or organic soil; its hoeing depth is 3 to 7 cm. Effective weed management requires making three to five cultivations during the season.

Rototiller

The rototiller is a very aggressive cultivator that is commonly used in organic soil; it cuts and buries weeds deeply. Since this machine is equipped with shields to protect the crop, it can be operated near the row. It cultivates to a considerable depth, up



Rototiller

to a 10 cm. Only one or two cultivations are needed.

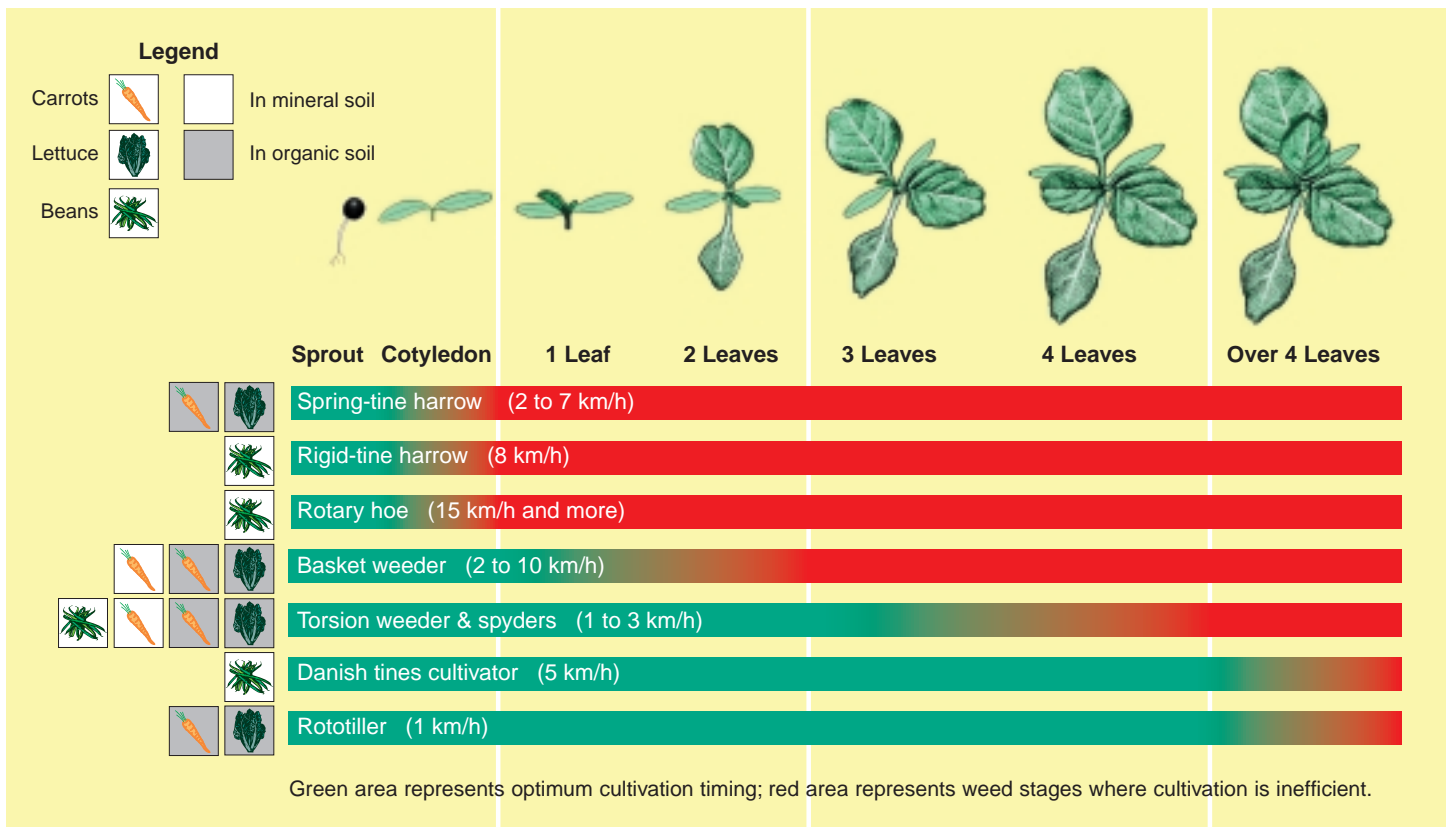
CHOOSING A CULTIVATOR

The goal of the research conducted by the Horticultural Research and Development Centre and McGill University was to test several types of mechanical cultivators in market vegetables to assess their weed control efficacy and their effects on crop plants. Vegetable crops selected for these trials represented market garden crops of economic importance to the fresh market and canning sectors.

Carrots

Carrots represent a crop which cannot tolerate root damage or displacement during its early growth stage. Mechanical cultivators may be used prior to crop emergence and until the crop rows have closed when cultivation is no longer feasible. To minimize damage, however, care must be taken to cultivate far enough from the row prior to carrot emergence and when they are small, up to 20 days after carrot emergence.

Four types of cultivators can be used in carrot production, depending on the stage of crop development and weed growth. In mineral and organic soils, a basket weeder or a torsion weeder & spidders can be employed. A spring-tine harrow or a rototiller can likewise be used in organic soil. The basket weeder (especially in organic soil) and the torsion weeder & spidders performed well in the field and produced good yields.



Cultivation timing and cultivator optimum operating speed for successful weed control in carrots, beans and lettuce.

Lettuce

Lettuce represent a crop whose leaves are susceptible to damage from mechanical cultivation.

Cultivators may be used for weed control before the lettuce plants begin to form heads. However, to prevent damage, the cultivators must not be operated too close to the crop rows.

Four different types of cultivator are suited for weed control in lettuce: the spring-tine harrow, the torsion weeder & spyderys, the basket weeder and the rototiller. The basket weeder and the torsion weeder & spyderys offer good field performance and produce good yields.

Beans

Beans represent a crop whose flowers and pods are susceptible to mechanical damage. Special care must be taken if cultivation is done prior to the first trifoliolate leaf stage, since beans are highly

susceptible to damage at that time. Cultivators can be operated until the rows close up and flowering has begun.

Four types of cultivators can be used in beans. The torsion weeder & spyderys gave the most consistent performance in terms of weeding efficacy. The rotary hoe is effective provided the weeds are sprouting but are not beyond the cotyledon stage. Rotary hoeing can be complemented by using the Danish tines cultivator between the crop rows later in the season. The Danish tines cultivator will destroy any weeds that have survived the cultivation with the rotary hoe, improving weed control considerably.

EFFECTS ON DISEASE INCIDENCE AND CROP YIELDS

Cultivators have virtually no effect on disease incidence (Trembley, 1997). It has been shown, however,

that when disease incidence is high, there is a close correlation between the infection level and the amount of time required during the season to ensure full weed control.

Consequently, the shorter the weed cultivation period and the greater the number of early-season cultivation, the lower the disease incidence can be expected. Disturbance of crop foliage associated with late-season cultivation can spread diseases or cause foliage damage, thereby promoting infection.

In general, mechanical cultivation provides yields and product quality equivalent to those obtained by conventional weed control methods and in some cases, may result in yield and quality similar to those obtained with manual weeding (Trembley, 1997). In beans, cultivators with a greater working depth appear to provide better results during dry growing seasons, whereas those working near the soil surface perform

better when the growing season is wet. For carrots in organic soil, the research showed that the basket weeder produced the largest number of Canada No. 1 carrots. This weeder offers the advantage of shallow cultivation, preventing disturbances to root development. In lettuce crops, deeper cultivation with the torsion weeder & spyders appears to provide the best yields. Despite these differences, all the cultivators tested provide good yields, with no losses or deterioration in product quality.

ENSURING EFFECTIVE CULTIVATION

Regardless of the type of cultivator selected and the crop in which it is to be used, good cultivation does not only depend on the cultivator chosen but rather on the conditions in which it will be used. It is crucial to operate cultivators under optimal conditions in order to derive maximum benefit from them. The greater the weeder efficacy, the fewer the number of cultivations that will be needed during the season. Early and effective cultivations will make it possible to control weed infestations at the beginning of the season and possibly avoid the need for later cultivations, which may promote the spread of disease. This approach represents savings in time and money for growers.

Cultivators need to be adjusted so they will suppress weeds over the desired area without damaging the crop. The weed species present and their development stage will dictate the choice of the cultivator. Regardless of the intervention window for using a particular type of cultivator, the smaller the weeds are, the more effective the cultivation will be.

It is also important that the soil be dry both during and after cultivation. If the soil is too wet while

cultivating, the weed control will not be adequate. The uprooted weeds are less likely to dry out and die. And if it rains following cultivation, the weeds may even re-root and start to grow again.

CONTROL STRATEGIES

The spring-tine harrow and the rigid-tine harrow can be used in market vegetable crops provided the weeds have not developed beyond the cotyledon stage. In contrast, a rotary hoe can be used only on large seeded crops such as beans; however, the intervention window is fairly narrow, from weed sprouting to cotyledon stage. Although the rototiller offers the greatest weed control efficacy, its very slow operating speed is a serious drawback. The basket weeder and the torsion weeder & spyders proved to be both practical and economical alternatives for the crops in which they were tested.

In carrots, herbicide use can be reduced by half by making band application of preemergence and postemergence herbicides on the row and by cultivating between the rows using a basket weeder in organic soil or a torsion weeder & spyders in mineral soil.

In lettuce, where the rototiller is used conventionally, any cultivator that does not work the soil as deeply and that has a faster operating speed such as the basket weeder or the torsion weeder & spyders, can replace the rototiller.

Beans can be produced without herbicides by using a rotary hoe early in the season (2 cultivations), followed by a later cultivation with the Danish tines cultivator. To offset the plant losses when cultivating beans up to the first trifoliolate leaf stage, it is recommended that the sowing rate be increased by 5 to 10%.

Mechanical cultivators represent a promising and cost-effective option for reducing or eliminating herbicide use in some market vegetable crops while maintaining yields and product quality.

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