Guideline for the implementation of inter-row cultivation in small grain cereals

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WHY INTER-ROW HOEING?

Inter-row hoeing for weed control in small-grain cereals and other crops grown with narrow inter-row spacing has been the subject of renewed interest in recent years thanks to camera-based automatic steering systems. Vision technology eases the steering task and enables inter-row hoeing with a higher operational capacity as implement width and driving speed can be increased (Figure 1).

Weed harrowing has otherwise been the principal implement for mechanical weed control in organic cereals but its popularity is now declining in favour of camera steered inter-row hoeing. Hoe shares simply control weeds with greater aggressiveness than the tines of weed harrows. A hoe share provides a cutting action that can kill weeds that have developed several true leaves. In contrast, tines are far more sensitive to the growth stage of weeds at the time of treatment; weed control effectiveness declines rapidly as weeds develop beyond the cotyledon stage. Elongating and tall growing weed species developing taproots, such as scentless mayweed and common poppy, are better controlled with hoe shares. For effective control of such weeds, timing of weed harrowing needs to be very precise whereas the employment of inter-row hoeing can be more flexible. Inter-row hoeing usually provides a complete weed control in the inter-row zone unless rainy weather prevail for long periods. The operation of inter-row hoes is less requiring than weed harrows where the operator needs to learn the timing and settings that provide effective weed control while preserving the crop. A weed harrow treats both weeds and crop while hoe shares work the inter-row zone only and thus avoid impacting the crop plants.

Fig. 1. Inter-row hoeing in spring barley at 25 cm inter-row spacing using vision technology for automatic steering.

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How?

The equipment

An inter-row hoe for small grain cereals consists of a frame upon which parallelograms with shanks are mounted (Figure 2).

Fig. 2. Parallelograms mounted on a main frame. Each parallelogram is equipped with three hoe shares

There is one vibrating S-tine or shank with one hoe share treating each inter-row space. The steering system can be manual or automatic based on either vision technology (cameras) and/or GPS technology. The hoe shares can have different configurations among which shares shaped as a goosefoot or ducks foot are most widely used. These shares control weeds through uprooting and burial with soil, both mechanisms acting simultaneously while operating. Sideward soil movement is always associated with operating goosefoot shares and the extend is governed by cultivation depth and driving speed. It can be desirable to have some sideward soil movement that buries weeds growing in the crop line (intra-row weeds) but it may also be exaggerate resulting in crop injuries (Figure 3). In the IWMPRAISE project (https://iwmpraise.eu/), a new share design has been developed by AgroIntelli (www.agrointelli.com) and tested for its effectiveness and application (Figure 4). The share is flat and designed for use at early crop growth stages where the crop is particularly sensitive to soil covering. The flatness reduces sideward soil movement while the undercutting action is maintained for effective weed control (Figure 5).

Fig. 3. Exaggerated covering of the crop with soil.

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Fig. 4. Ducksfoot-shaped hoe share (left) and flat-shaped share (right). The flat share is developed by AgroIntelli (www.agrointelli.com). Photo credits Liubava Znova.

Fig. 5. Operation of the flat hoe share developed by AgroIntelli.

The cropping system

Inter-row hoeing in small grain cereals requires enough space in the inter-row space to allow a hoe share to be operated accurately and reliably. Small grain cereals encompass winter rye, winter wheat, winter barley, spring barley, spring oat and spring wheat in this context. These cereals are grown at different inter-row spacings throughout Europe where the narrow spacing of 12.5 cm is particular common. Automatically steered inter-row hoeing is currently not advisable for spacings

smaller than 20 cm, although advancement in software and camera technologies may make smaller spacings possible. It is important that the crop plant density m^{-2} is maintained when increasing inter-row spacing. For example doubling the spacing from 12.5 cm to 25 cm will double the crop plant density in the crop line. A denser crop stand in the crop line enhances the suppression of surviving intra-row weeds and helps minimising the yield penalty associated with widening inter-row spacing. For conventional cropping systems inter-row spacings of 20 – 25 cm are recommended while spacings in the range 20 – 30 cm can be desirable for organic spring barley and spring wheat (Figure 6). A wide spacing of 30 cm means that a larger proportion of the surface area is cultivated than with smaller spacings. Thereby more weeds can be impacted directly by the hoe shares without compromising crop yield. A spacing of 30 cm would result in an unacceptable yield penalty under conventional cropping conditions. Seed rates greater than normal can be further increased to strengthen the suppression of intra-row weeds in case of particular weedy fields.

Fig. 6. Inter-row hoeing at 30 cm inter-row spacing in organic spring barley

WHEN?

Inter-row hoeing is performed when the soil is even, workable and not too wet. Stony soils will hinder a smooth conduction of inter-row hoeing, and stones thus need to be removed beforehand, especially those larger than the size of a fist. The majority of weeds should not have developed more than 3-4 true leaves at the time of treatment (Figure 7). In most cases, the first pass can be made during crop tillering and until tillering has ceased (BBCH growth stage 22-30). The hoe shares should work the soil down to 2-3 cm soil depth and forward driving speed should not exceed what could result in excessive coverage of the crop with soil (Figure 3). The distance between the centre of the crop row and the outer edge of the share should not be less than 3 cm in order to avoid crop injuries from inaccurate steering. Many weeds in this 3 cm untreated zone are still controlled thanks to soil burial and the fracturing arising from moving the share through the soil. An additional pass may be needed, if considerable re-emergence of weeds takes place after the first

pass. Ridging the crop row to control small-sized weeds can be achieved in cases where the crop is clearly taller than the majority of weeds (Figure 8).

Fig. 7. Left: weeds with 2-4 true leaves, time for inter-row hoeing. Right: well conducted inter-row hoeing; weeds are clearly uprooted.

Fig. 8. Moderate ridging of the crop row can reduce intra-row weed growth without compromising crop yield provided that there is a clear size difference between crop and weeds.

DRAWBACKS

Increasing the inter-row spacing beyond 20 cm in conventional crops and 30 cm in organic crops to make room for inter-row hoeing may result in a yield penalty (ca 10 %) because the resources (water, nutrient and light) are not optimally utilized. Long periods of cold and wet weather can hinder the employment of inter-row hoeing and re-growth of weeds can easily take place after treatment. Dry and sunny weather following hoeing usually help improving weeding effectiveness. In contrast, long periods of dry weather prior to hoeing may create soil crusts on clayey soils hard to penetrate with a hoe share.

Inter-row hoeing only partly controls intra-row weeds and particularly erect and tall growing weed species will survive and compete with the crop (Figure 9). Crop yield can be substantially reduced in cases with vigorous intra-row weed growth. In a non-chemical weed control program, pre-emergence weed harrowing possibly followed by weed harrowing after inter-row hoeing can reduce problems with detrimental intra-row weed growth.

Fig. 9. Tall growing cruciferous weed species in the crop line can reduce crop yields substantially and in such cases inter-row hoeing needs to be assisted by other weed control tactics to minimise the impact.

The main points about implementing inter-row hoeing in small grain cereals are summarised in an inspiration sheet that soon will be available on: www.iwmpraise.eu.

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