Sven-Erik Jacobsen: Cultivation of quinoa in Northern Europe
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Establishment

The most critical period in the cultivation of quinoa in Northern Europe, and elsewhere, is the initial establishment, which has to be quick and efficient. Quinoa is sensitive to suboptimal conditions at the time of sowing, such as deep sowing, heterogeneous seed bed, low soil temperature and especially poor seed quality, which all lead to yield reduction.

Seed bed

The seed bed must be optimal, fine textured and with sufficient humidity for a quick germination and establishment of the plants. The seed bed should be free from weeds at sowing time. Weed problems are most severe at a late sowing.

Sowing conditions

Optimal sowing conditions are created by using high quality seeds with a high germination percentage and vitality, sowing in 1-2 cm depths in a uniform, fine structured, humid seed bed, with a soil temperature above 0 °C.

Sowing date

An early sowing just after frost has left the soil after winter has given good results, if the first month of spring (April) is relatively dry. If the period after sowing is humid and cold, seedlings or plants with 2-4 leaves can be attacked by soil-borne diseases and pests, such as Fusarium sp.

Quinoa should be grown as a spring crop, as it cannot overwinter in the field.

Sowing in an optimal seed bed

Emerged quinoa seedlings

Row spacing

Quinoa can be sown on 50, 25 or 12.5 cm. If quinoa is sown with a row spacing of 25-50 cm, hoeing can be applied. If a sowing at cereal distance (12.5 cm) is used, weeds can only be controlled with harrowing.

Sowing rate

There is no correlation between plant density and yield, which shows the compensatory capability of quinoa. If there are few plants, they will be large with high yield per plant. However, a relatively high density is preferred in order to secure uniform plants and maturity, so the recommendation is 100 plants m^{-2}, obtained with a sowing rate of approximately 10 kg ha^{-1}.

Weeds

No herbicides controlling two leaved weed species can be used in quinoa. For this reason and for the main interest in producing quinoa organically, the mechanical methods hoeing, harrowing and flame treatment have been studied.

Flame treatment: As quinoa seems to emerge faster than any weed species, there is no possibility to use flames to combat weeds before quinoa emergence.

Hoeing: For optimal weed control it is important to sow in a clean seed bed, and allowing weeds to germinate in a false seed bed can be very effective. Hoeing should take place as early as possible, but without covering the quinoa plants with soil between rows. In a subsequent control it is possible to drive faster, creating a hilling which will have a positive effect on weed control in the row. Hoeing allows for an accurate treatment between the rows, which makes it easier to control weeds, as it is possible to work deep in the soil and at high speed without damaging the quinoa. Crop soil cover should be avoided, although quinoa is relatively tolerant, and may survive being covered.

Harrowing: This technique is easy to perform irrespective of how the crop was sown. Higher speed is possible. The disadvantage is that the crop needs to be ahead of the weeds in order to avoid damage. It has, however, been demonstrated that quinoa is tolerant to a rather tough harrowing without damaging the crop.

Both weed control strategies result in loss of quinoa plants. Early hoeing may cause crop soil cover and result in loss of plants. Harrowing results in losses of the smallest plants as it is necessary to drive relatively fast for maximum weed control. Seed yield is highest with an efficient weed control strategy, and in general hoeing has given better results than harrowing. Prices for hoes and harrows are similar.

Harrowing

Hoeing

Manure

In an organic production system, nitrogen is normally applied to quinoa in the form of manure containing 80-120 kg N ha^{-1}. Quinoa may respond positively to higher levels.

Diseases and pests

Normally there are relatively few problems with diseases and pests in quinoa, although downy mildew (*Peronospora variabilis*) is seen all years and experienced everywhere quinoa is grown. This is especially the case under humid conditions with temperatures of 15-20 °C. The disease is less important if the summer is dry. A lack of disease control may result in a significant yield decrease.

Harvest

Early harvest is essential in mountain regions and at high latitude, requiring early establishment and growth in the spring. This enables the crop to avoid a cold, humid autumn climate in northern latitudes, which makes harvest more difficult, increases drying costs and reduces seed quality. In high altitudes it is desirable to avoid drought and frost towards the end of the growing season. A late sowing or a cold growing season will delay development and harvest date.

Harvest can be carried out with a combine harvester, putting the bridge close together, and reducing the air current. Yield is up to 2t ha^{-1} with properly adapted cultivars.

Good plant density in a clean crop

Quinoa close to maturity

Sowing dates, early and late

Commercial harvest

Seed yield

Harvested seed

Nutritional value

Quinoa has a high oil content (6% compared to 2% in cereals), and a high content of poly-unsaturated fatty acids (omegas). It has a high protein content (14-18%), including a high lysine- and methione content (double of cereals). Quinoa has a high iron content, 50% higher than in cereals, and higher than any other crop.

Uses

Quinoa is attractive for food as well as animal feed purposes. Main use of the primary product, the seed, is for human consumption, and in South America only the other plant parts are used for animals. Also in North Europe main customer will be the food market. However, quinoa has a high feed value, as a result of the protein quality, starch and high methionine composition, which makes it perfect for pig and chicken feed.