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Articles in this issue

Inter-row subsoiling increases marketable yield in potatoes

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It is well known that potatoes prefer a loose soil and several experiments have shown that potatoes may respond positively to subsoiling. In a Danish study by N. K. Jensen (1971) subsoiling in autumn increased yield in 7 out of 9 years.

In an older English study by E.W. Russell (1956) subsoiling in autumn significantly increased yield on clays and loams, if a high level of fertilizer was used. In a more recent German study, subsoiling in autumn increased potato yield by up to 14 pct (Häge 1996).

Inter-row subsoiling in potatoes during the growing season has previously been found to slightly decrease yield (Friessleben 1981), but positive results, and a dependence on water supply, has been demonstrated in corn (Reeves and Touchton 1986, Beck and DeBoer 1992, Gameda et al. 1994).

To investigate if inter-row subsoiling during the growing season could improve the yield and quality of organic potatoes under different irrigation levels a three-year field experiment was conducted at St. Jyndevad (in the south of Denmark) from 2001-2003.

Field experiment at St. Jyndevad

The field experiment consisted of 8 individual treatments grouped by three factors: primary soil tillage, subsoiling and irrigation. The primary soil tillage treatments were

low input food

Catch crops may improve plant sulphur nutrition

Simulating root growth

Nature conceptions, management and cross-compliance in organic farming

Wind dispersal of genetically modified pollen from oilseed rape and rye fields

Brief news

Front

mouldboard ploughing and autumn ridging, the subsoiling treatments were inter-row subsoiling and no subsoiling and the irrigation treatments were full irrigation and reduced irrigation (approximately 50%) according to PC-Markvand.

Autumn ridging was performed immediately after harvesting the previous rye crop and ploughing was performed in spring when the soil was sufficiently dry. In the treatments with autumn ridging the ridges were gently opened before planting. After planting, all plots received 120 kg N/ha in the form of liquid animal manure, which was injected into the side of the ridges. Inter-row subsoiling was performed with a big winged subsoiler to 40 cm soil depth shortly after the potato plants were breaking through the soil (see video).

Subsoiling increases marketable yield

Inter-row subsoiling increased average yield of 40-65 mm potatoes by 14 pct ($P<0.001$), but there were significant differences between the years. In 2001, subsoiling increased yield of 40-65 mm potatoes by 49 pct ($P<0.001$) and total yield by 5 pct ($P<0.01$). In 2002 there was no effect of subsoiling on total yield and yield of 40-65 mm potatoes, but in 2003 subsoiling reduced total yield by 7 pct ($P<0.01$).

On average subsoiling significantly reduced the percentage of malformed potatoes. In 2001 there was no effect whereas subsoiling reduced the percentage of malformed potatoes in 2002 and in 2003. Subsoiling also reduced the incidence of common scab under reduced irrigation whereas there was no effect under full irrigation. There was no effect of subsoiling on late blight, growth cracks, green potatoes, dark potatoes and disintegration after cooking, but in 2002 subsoiling reduced taste quality.

Effects on black scurf

The average percentage of tubers infected with black scurf was generally very low, but autumn ridging managed to reduce the incidence of black scurf. There was no main effect of subsoiling and reduced irrigation on black scurf, but reduced irrigation reduced the incidence of black scurf in 2002 and increased the incidence of black scurf in 2003. There was no correlation between the incidence of black scurf and yield.

Optimal conditions in 2001

Since the highly positive effect of subsoiling in 2001 was much more pronounced for marketable yield than for total

yield, it can be concluded that subsoiling resulted in a much better size distribution in 2001. There are several potential reasons for this.

1) Precipitation levels immediately before and after subsoiling were much higher in 2002 and 2003 compared with 2001. Thus, subsoiling was not performed under optimal conditions in 2002 and 2003, since subsoiling will compact the soil instead of loosen it, if the soil is too wet (Spoor and Goodwin 1978, Spoor 1982), and loosened soil will collapse if rain is falling immediately after subsoiling.

2) Crop growth stages at the time of subsoiling may have been different between the years and the ability of subsoiling to break off sprouts/stems, resulting in fewer, but larger tubers is dependent of crop growth stage.

3) Subsoiling may also have a positive effect on crop growth by increasing nitrogen availability. Tillage during the growing season has previously been found to increase nitrogen mineralization in onion (Bohrnsen et al, 1993), however such an effect depends on numerous factors and recent studies in wheat have failed to demonstrate an effect (Thomsen and Sørensen 2004).

Further studies

The positive effects of subsoiling found in the first experiment year are most likely determined by a combination of these factors. However, it is not possible to determine which factor is most important and the question remains on how to reproduce a higher yield. As long as we do not fully understand the mechanisms involved we will experience higher yields in some years and lower yields in other years. Further studies are warranted to investigate if it is possible to control the effect of subsoiling by timing the subsoiling operation according to crop growth stage and precipitation levels.

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