Increased nitrogen fertilization in autumn can reduce need for nitrogen fertilisation in spring

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Abstract

Autumn application of nitrogen fertilizer can be discussed in connection with the eutrophication of lakes and seas. When growing winter oilseed rape in the short autumn and under cold climate conditions it's very important to get a heavy crop before winter. To get that crop in northern Europe autumn application of nitrogen is essential. A good crop with sufficient amount of nitrogen will stand the winter better. When the crop takes up more nitrogen during autumn the total need of nitrogen, autumn+spring, will be reduced.

Under 15 field trials in Sweden during 2008-2010 we have studied the ability of winter oilseed rape to collect nitrogen, to survive hard winter without growth regulators and to decrease the ratio of spring application by adding more nitrogen in autumn. Nitrogen has been applied from 0 to 80 kg per hectare in steps of 20 kg in autumn followed by 140 kg and 180 kg per hectare in spring. Two different hybrid cultivars have been used. In 2008 SW Calypso was used and in 2009 Excalibur was used.

The trials have showed that farmers should apply more nitrogen in autumn to save nitrogen in spring. 20 kg more nitrogen in autumn can reduce need by 40 kg of nitrogen or more in spring and deliver the same or better yield. At the same time the crop will have better winter hardiness.

Introduction

After several years of trials we know the importance in using low seeding rates and early sowing for the crop to pass winter. Sometimes we get a good leaf mass but sometimes poor. A poor leaf mass often means that the crop will have difficulties to survive winter. To get the perfect crop of oilseed rape before winter sets in there are three things to consider: early sowing, low seed rate and enough available nitrogen in the top soil. When prices are good winter wheat, winter barley and rye will be the pre crop for winter oilseed rape instead of set a side. A good yield of grain and straw left in the field will consume and immobilise nitrogen that would be necessary for the rape crop. These conditions are unfavourable when time is short between planting and first frost. In Sweden first frost occurs in October-November. Frost and low mean temperatures, below +5º C, in combination with short days winter oilseed rape will stop growing. During this short period between planting and first frost winter oilseed rape needs to grow fast and set at least 8 leaves and develop a long pole root. Former work has shown that it's very important to have a good crop in the spring. It's however not possible to compensate a poor stand with higher nitrogen levels in the spring. This is the idea behind creating different crop stand by differentiating the autumn levels of nitrogen.

Material and Methods

Every year six field trials where conducted, four in Southern Sweden in the county of Skåne and two more further north in the county of Västergötland (2008) and Östergötland (2009 and 2010). Totally15 field trials were harvested in year 2008, 2009 and 2010. The soil in Skåne is a sandy clay (15-25% clay) and in Östergötland soils have >25 % clay. All places have got approximately 2-6 % soil organic matter in the A-horizon. All sites for the field experiments have a long term average precipitation of 700 mm per year.

The field trials have 11 treatments, 2*5 as split-plot design with spring applications as big plots and autumn application as small plots. Spring application of 0 kg nitrogen is combined only with 0 kg nitrogen in autumn. Seed and nitrogen are combidrilled.

Table 1. Trial plan and application levels of nitrogen in kg/ha.

Autumn		Spring
NS 27-4		NS 27-4
A.	0+12 Sulphur	1. 140
B.	20	2. 180
C.	40	3. 0+27 Sulphur
D.	60	
E.	80	

All other treatments such as phosphorus and potassium and pesticide applications were carried out according to soil, weather conditions as well as severity of weeds, pests and insects. Pre crop was always grain, mainly wheat and no manure was applied the last five years.

Late in autumn and early in spring dry matter and plant nutrition content were analysed by collecting green parts from plants of 0.5 m^2 in autumn treatments of 0, 40 and 80 kg nitrogen per hectare.

Winter hardiness was scored by counting plants late in autumn and in spring. In some trials plants were examined according to placement of the meristem, root length and top root diameter. Yield were measured by harvesting the plots. Yield were analysed in every plot according to moisture, waste and oil content.

Results

The plant analyses of biomass from the plants before first frost showed that winter oilseed rape can collect as much as 100 kg more nitrogen than applied, roots excluded. As an average of six trials harvested 2009 and 2010 the uptake is shown in fig 1.

One question has been if it's possible to compensate late sowing with higher rates of nitrogen. The trials show that you can never compensate late sowing with more nitrogen. It's rather like that the plant can use less nitrogen when planted late. There is simply no time to take up more nitrogen. In trials where planting were late or growth conditions bad nitrogen uptake and also nitrogen efficiency was low.

The trials show that the diameter of stem base increased with the amount of nitrogen applied, fig 2. The same happened to the placement of the meristem, fig 2. The height of the meristem increased by higher rates of nitrogen but never exceeded 20 mm over soil surface which otherwise could result in bad impact to winter hardiness. Especially as increased diameter of the stem base could improve winter survival.

All three years showed similar results. Mean yield for the fertilized treatments was 4340 kg/ha. The lowest yield was 3050 kg/ha in one trial 2009 in Östergötland. The highest yield was 5120 kg/ha in Skåne, also in 2009. Moisture content and waste by harvest shows lower values with higher nitrogen rates which indicates a more even ripening. As expected treatments without nitrogen showed the highest oil content, 51.9 %. Treatments with 140 kg nitrogen as spring application had 1.3 % higher oil content than treatments with 180 kg nitrogen as spring application.

The highest net profit and also yield in kg oil/ha were obtained by 60 kg nitrogen in autumn combined with 140 kg nitrogen in spring as showed in fig 3. By moving 40 kg N/ha from spring to autumn the net profit will increase from €36 to €101. The biggest profit differences appear when the lowest total nitrogen rates are used. Highest difference is when 0 or 20 kg/ha is increased by 40 kg nitrogen in autumn.

Comparing treatments beside each other as in fig 4. it was shown that 20 kg more nitrogen in autumn can save 40 kg nitrogen in spring. The field experiments have also showed the importance of autumn applied nitrogen fertilizer.

Discussion

It's very important to establish a good winter oilseed rape at autumn in Sweden and other places with hard winters with or without snow. When a good crop is established in autumn with high biomass the crop will need less nitrogen in spring. This is showed both in France and in Germany. In Sweden as well in the rest of Scandinavia a good established winter oilseed crop with high biomass gets better yield and has a less demand for nitrogen. The Swedish trials have showed the importance to use autumn applicated nitrogen when growing winter oilseed rape under cold conditions. From the beginning we expected that the application of 80 kg of nitrogen should lead to winter damage. Until this point we have passed the winter with all our trials without winter damage in the heaviest fertilized treatments. Winter 2009-2010 was very cold and with a lot of snow in the two trials in Östergötland. After that winter we saw how the treatments with 80 kg nitrogen had survived winter best. This shows how important it is to pass the winter with good, healthy plants without even small deficiency of nitrogen.

The field experiments have also showed a very important task for oilseed rape production in Northern Europe. A large and well supplied plant of oilseed rape has a smaller need for nitrogen in the spring. By fertilizing winter oilseed rape in autumn with a higher amount of nitrogen than used before, it was shown that twice as much nitrogen can be saved in spring. This ends up in total reduction of the amounts used to winter oilseed rape which under the best situations can reduce nitrogen leakage to groundwater and lakes.

The trials do not show if it's possible to decrease the rate of 140 kg/ha even more. Probably there are possibilities to do so. The trials will continue 2011-2013 by using YARA N-sensor to decide the right amount of spring fertilization in relation to biomass and applied nitrogen in autumn.

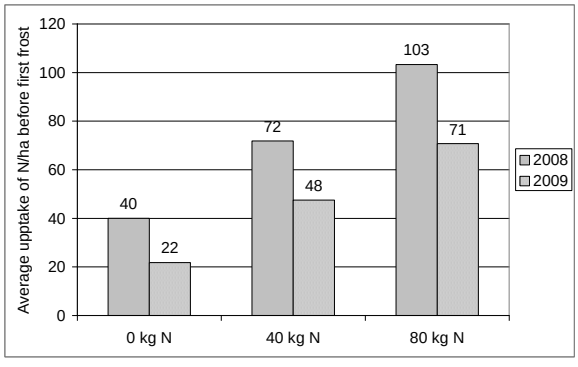

Fig 1. Nitrogen uptake in autumn analysed in biomass before first frost shows that winter oilseed rape take up a lot of applied nitrogen. When adjusted for the 0 kg nitrogen treatment, around 80 % of applied nitrogen was translocated to the green parts of the plants in 2008 and in 2009 around 65 % was translocated.

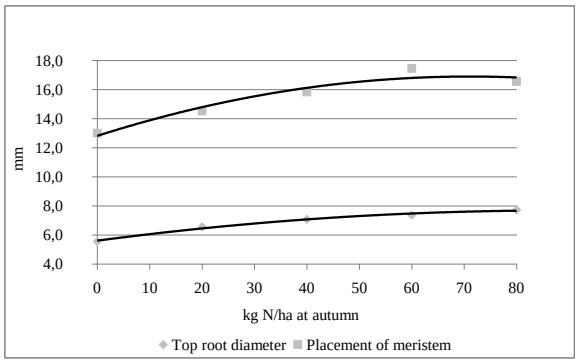

Fig 2. Higher rates of nitrogen in autumn increased top root diameter and the placement of the meristem.

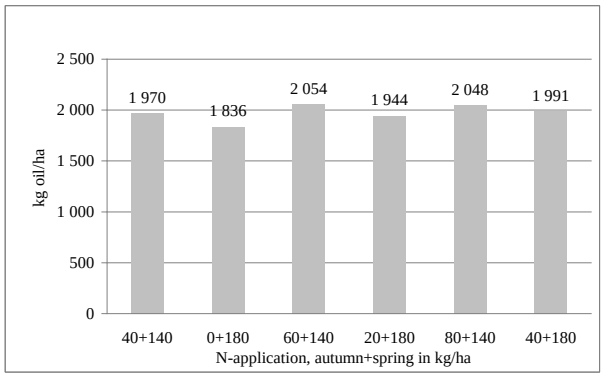

Fig 3. With the same total amount of nitrogen the highest yield was harvested 60+140 kg N/ha. When calculating the net profit a farmer will save (winter 2010) approximately €35 to €100 moving 40 kg nitrogen from spring to autumn.

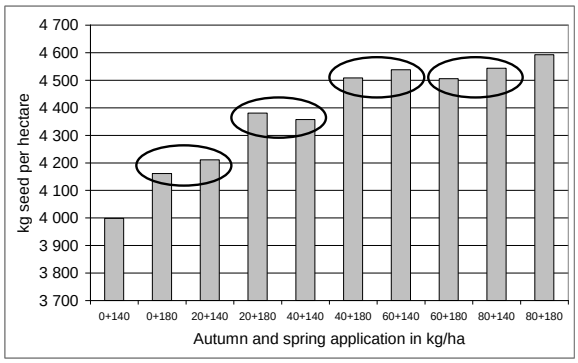

Fig 4. The same or higher seed yield was obtained by increasing autumn application by 20 kg and reducing spring application by 40 kg N/ha.