WINTER COVER CROPS IMPACT ON PLANT NUTRIENTS IN AN ORGANIC CROP ROTATION

Liina Talgre[1], Viacheslav Eremeev[1], Berit Tein[1], Helena Madsen[1], Anne Luik[2]
[1]Institute of Agricultural and Environmental Sciences, Department of Field Crop and Grassland Husbandry, Estonian University of Life Sciences, Tartu, Estonia, [2]Institute of Agricultural and Environmental Sciences, Department of Plant Protection, Estonian University of Life Sciences, Tartu, Estonia, Tartu, Estonia

Objectives

In crop rotations winter cover crops (WCC) can play a certain role in organic matter and plant nutrient formation. Under Nordic conditions the selection of crops for winter cover crops is quite limited. The aim of the present research was to explain the biomass and nutrients (N, P and K) formation by certain winter cover crops in an organic crop rotation. The effects of WCC on the following main crop yields were monitored.

Method

The field experiment was situated at the experimental station of the Estonian University of Life Sciences in Eerika, Tartu, Estonia (58°22'N, 26°40'E). The soil type of the experiment area was sandy loam *Stagnic Luvisol* according to the World Reference Base classification (FAO 2014). The experiment was set up in four replications with each plot (60 m^2) in a systematic block design. In a five-field crop rotation, barley under sown with red clover, red clover, winter wheat, pea and potato were grown in succession in three organic systems. System Org 0 followed only the rotation. In system Org I, green manures as winter cover crops (WCC) were used: after winter wheat – mixture of winter oilseed rape and winter rye, after pea – winter oilseed rape and after potato – winter rye were grown. In System Org II, green manures as WCC were used with the application of fully composted cattle manure with the amounts of 20 t ha^{-1} for potato and 10 t ha^{-1} for both cereals. Seeding rate for winter oilseed-rape was 6 kg ha^{-1}, for winter rye 220 kg ha^{-1}, for mixture of rye and oilseed-rape 180 and 6 kg ha^{-1}, respectivey. In Org I and II systems all plots had green plant cover in winter. After the previous main crops were harvested the soil was immediately cultivated and WCC were sown with a Kongskilde sowing machine (row line width 12.5 cm). In all systems, the red clover was cut and then ploughed into the soil. The aboveground biomass of WCC were measured before their incorporation into soil by ploughing at end of April (2013, 2014, 2015). Total nitrogen and carbon contents of oven-dried samples were determined by dry combustion method on a varioMAX CNS elemental analyzer (Elementar, Germany).

Results

One way to reduce nitrogen/nutrient leaching and increase the soil organic matter/nutrient content is to use WCC. Our results showed that WCC biomass production depended on a crop species grown and growing year. On average, the winter rye produced the largest amount of biomass 893 kg ha^{-1} compared to rye and oilseed rape mixture 717 kg ha^{-1} and oilseed rape 577 kg ha^{-1}. However there were big differences between the years. The average biomass of WCC was lowest in 2013 and highest in 2015 ($p<0.05$). In autumn of 2012 there were problems with excessive wetness and the following winter was very long which suppressed the development of WCC. Also, the different WCC showed large differences in biomass production and in above-ground plant parts N binding. In system with green manures (Org I) the total biomass of WCC varied from 39 kg dry matter ha^{-1} of winter oilseed rape (in 2013) to 2174 kg dry matter ha^{-1} of winter rye (in 2015). Winter rye had also the best N binding ability: 15 kg ha^{-1} in 2013 and 99 kg ha^{-1} in 2015, whereas the winter oilseed rape fixed only 1 kg ha^{-1} in 2013 and 36 kg ha^{-1} in 2015. The low biomass of winter oilseed rape in 2013 can be explained by the extremely long winter in 2012/2013 which damaged the crop. The co-influence of cattle manure (Org II system) increased the amount of biomasses as well as N, P and K contents in all WCC but differences between Org I and II systems were not significant. Winter rye was also the most effective binder of phosphorus ($p<0.05$). There were no significant ($p<0.05$) differences between WCC in terms of potassium binding.

The winter cover crops within crop rotation supply N for the subsequent crop. After the WCC are incorpo-

rated into the soil the N mineralization process starts, thus part of the mineralized N becomes available for the following main crop. The main crop yields in Org 0 system was lower compared to other two systems where WCC probably helped to increase the yields. WCC and their combination with cattle manure application increased significantly grain yields of barley and, pea, as well as potato tuber yield (in 2013). Our results showed that lower crop yields and nutrient uptake under Org 0 system resulted with somewhat lower surpluses of N but the N use efficiencies were higher.

Conclusions

Winter rye, winter oilseed rape and their mixture as winter cover crops enrich crop rotation with organic matter, N, P and K whereas the winter rye was the most effective. A tendency occurred that the use of cattle manure increased the organic matter and nutrient formation in all WCC. Winter cover crops and their combination with cattle manure increased the yields in all rotation crops compared to a system in which no WCC were grown.

Acknowledgements

This research was supported by the ERA-NET CORE ORGANIC project FertilCrop, by Estonian University of Life Sciences project 8–2/P13001PKTM and by institutional research funding IUT36-2 of the Estonian Ministry of Education and Research.