Reducing environmental risks in use of plant protection products in Northern Europe

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Plant protection in extreme northern circumstances

Finland is one of the world’s northernmost agricultural countries. Approximately 6% of Finland’s surface area is agricultural land and 9% water bodies. The growing season is short and intensive. In the summer, there is light almost round the clock and plants develop fast. Crop varieties bred for the northern circumstances are in use. The list of pests is relatively short and the sale of plant protection products is smaller than in Central Europe. Since Finland is located between marine and continental climates, this causes great and rapid changes in the weather. In many cases, pests cannot be controlled in optimal conditions, and unexpected changes in the weather have an impact on the effect of the pesticide. Due to the cold winters, chemicals may break down slowly in the environment and their environmental impacts can be unpredictable. The predicted climate change introduces an additional challenge to plant protection in the future. An increasingly warm climate can introduce new and surprising risks such as pests that were unable to survive previously and this, in turn, can increase the need to use plant protection products. In addition, as the rainfall increases, the risk of plant protection products leaching into the water bodies increases.

Figure 1. Water systems in Finland and the locations of demonstration fields
Legislative background of the sustainable use of plant protection products

Political decision-makers at the European Union level have assessed that the use of plant protection products is not sustainable. The objective of the Thematic Strategy on the Sustainable Use of Pesticides drafted in 2006 is to reduce the risk caused by plant protection products to the environment and human health and to decrease dependency on the use of plant protection products. The Framework Directive on the sustainable use of pesticides implements the objectives of the strategy. This Directive requires that all professional farming must apply the general principles of integrated plant protection from 2014 onwards. In addition, the Directive requires that EU Member States draft a National Action Plan (NAP), regarding the use of pesticides. In Finland, the NAP was adopted in November 2012. Reforms of the European Union pesticide policy were introduced into Finnish national pesticide legislation and the new Finnish Plant Protection Products Act. The Act is complemented by decrees regarding the general principles of Integrated Pest Management, IPM, and a training programme.

IPM is a part of sustainable plant production

Plant protection is an important part of successful plant production. IPM combines different methods to restrict the development of pests and control them so that operations are economically justified. Preventive methods such as crop rotation, resistant varieties and soil cultivation methods are prioritized. In the control of pests, biological, physical and mechanical control actions take precedence when such actions can be implemented in an economically sustainable manner. Chemical plant protection is only the last means of control. In such case, pests are controlled according to the need, while utilising observation, prediction methods and threshold values.

In IPM, the safest product for the environment is selected when possible and only that amount is used that is required for the adequate effect. The goal is to take care of the plant’s health and produce a good and high-quality yield while taking the prevention of pesticide resistance into consideration and preventing pesticides from getting elsewhere in the environment such as water bodies.

Goals of the project

The goal of the PesticideLife project was to develop and test IPM methods and threshold values in cereal cultivation in cooperation with the farmers, and to produce and communicate information regarding IPM and its application both on a national level and in the northern cultivation zone that comprises the Nordic and Baltic countries. In addition, the objective was to utilise and develop co-operation networks between plant protection operators and apply NAP principles in cereal production. One work package of the project aimed to develop a new method to measure the environmental risks and impacts caused by the use of pesticides.
Testing and developing the methods of IPM together with farmers

PesticideLife is a demonstration project that tested the methods of integrated pest management in a total of nine farms and 77 cereal fields in 2010-2012. The farms were located in Southern Ostrobothnia, South-West Häme and Western Uusimaa (Figure 1). In addition to spring cereals like barley, oat and spring wheat, winter wheat and rye were cultivated in the selected fields.

A list of key IPM measures was drawn up in co-operation with the farmers, who selected at least three measures to test in their fields. Threshold values, plant disease and aphid prognoses, use of control windows, prevention of pesticide resistance, record-keeping of observations and the identification of pests were the most important of the selected actions. So far, non-chemical plant protection methods are rare in cereal cultivation, so the measures concentrated on preventative control methods and the detection of the need for chemical plant protection based on observations.

In addition, the project tested the functionality and reliability of the WisuEnnuste plant disease forecasting model in 27 barley and spring wheat fields. The plant disease model predicts the incidence probability of tan spot (DTR) and Stagonospora blotch in wheat and net blotch in barley.

The occurrence of insects, plant diseases and weeds was observed in the cereal fields. The quantity and quality of the crop yield were measured. The occurrence of insects was observed with the help of sticky traps. Crop-specific bird cherry-oat aphid and orange wheat blossom midge were counted twice to define threshold values. The occurrence of plant diseases was observed three times during the growing season. The objective was to make sprayings according to the field-specifically noted need. Weeds were calculated three times by species from an area of one square metre: before the herbicide spraying, approximately one month after the spraying and just before harvesting. Chemical weed control was used in each cereal field and the herbicide, dose and time were adjusted according to the weed species, weed amount and spraying conditions. The crop was harvested from both untreated and treated cereal fields. In addition to the yield (kg/ha), the thousand kernel weight and hectolitre weight were defined. Also other information related to the cultivation methods in the field was collected.

Measuring the environmental risks of pesticides

One aim of the project was to develop a method to measure the environmental risks caused by the use of pesticides. Finnish cereal farmers’ pesticide usage data from the year 2007 was used as the material for this. This information was gathered as pilot material by the Information Centre of the Ministry of Agriculture and Forestry, Tike, when it, as a Finnish authority, prepared for the monitoring of pesticide use required by the EU statistics regulation. The procedure includes two models (Figure 2). Regional environmental risks caused by the use of pesticides were measured with HAIR risk indicators (HArmonised environmental Indicators for pesticide Risk). The HAIR model was developed in the EU to examine the risks caused by pesticides on the environment and humans. Another model is the ecotoxic environmental impact class of life cycle assessment, LCA.

Networking and information sharing

The farmers were assisted in the implementation of IPM methods by discussing matters with them. By arranging field days, the aim was to achieve interaction and learn together. In addition to the electronic and printed publications, information regarding the application of IPM was gathered and communicated in several agricultural events.
Demonstrations in the use of IPM methods in cereal cultivation
During the three-year research period, the annual weather conditions varied greatly and there were differences in temperature and moisture conditions between the areas. In 2010 and 2011, the growing seasons were warm and dry and the autumns favourable for harvesting. The 2012 growing season was average with regard to the temperature conditions, but the autumn was exceptionally rainy. Very dry or wet conditions reduced the share of merchantable crop. However, all cereal fields except one were able to be harvested.

Insect pest control
The amount of insect pests during the research years was small. In Finland, the pest populations vary notably both with regard to the region and year. Although orange wheat blossom midge was not found over the threshold value in any of the wheat fields, the farmers still used insecticides against them in four wheat fields during the first research year. The threshold value for aphid control was exceeded in only a few spring cereal fields in Uusimaa and some of these fields were also sprayed. The annual bird cherry-oat aphid prognosis drafted by the MTT Agrifood Research Finland reports the extent of the domestic population, but the migration to the cereal fields is finally determined by the weather conditions. In addition, aphids arrive annually as transboundary pollution. Field-specific observation plays an important role in the detection of pests. The demonstration farms stopped routine sprayings against wheat midges.

Plant disease control
There was significant variation in the incidence of plant diseases between the different fields. Both weather conditions and cultivation methods had an impact on the amount of plant diseases. Plant diseases were most frequent in monoculture production and on fields where direct drilling was used. The most common diseases were net blotch in barley and tan spot and Stagonospora blotch in wheat. Plant variety played a significant role. Yields from disease-susceptible barley varieties were up to 1,500 kg/ha lower than those of resistant varieties. Threshold values for the control of plant diseases were exceeded in 40% of the cereal fields. Approximately 85% of the sprayings were cost-effective. The plant disease forecast model tested and further developed in the project was noted to be a practical tool for the assessment of leaf blotch disease risk in cereals.

Weed control
Chemical weed control was used in all cereal fields. The prevention of herbicide resistance was taken into consideration efficiently as the study progressed. The farmers learnt to use alternative products for spraying. While in the first year common chickweed, which tolerates a specific herbicide group, would have been controlled in only a few fields, in the third project year, more than 60% of the sprayings would have eradicated it. Based on the project’s results, it was found that the financial threshold value for weed control is strongly depended on cereal price (Figure 3). Different weed species increased in ploughed and direct seeded fields, which was an important fact to consider when the herbicide was selected.

Amount and quality of the yield
In nearly all fields, the chemical control of both plant diseases and weeds increased the amount of the yield, from 9 to 12%. Plant disease control improved the yield quality more than the use of herbicides. In many cases, plant disease control increased the grain yield notably, even though the threshold value was not achieved. In the hot summer of 2011, the hectolitre weight of cereals was low in many cases and the quality specifications did not fulfilled. As a consequence of plant disease control, the grain yield could often be sold in a higher quality class. Plant growth regulators were used as a tank mixture with fungicides or herbicides to a surprising extent: in Southern Ostrobothnia in approximately 70% of all sprayings, in Uusimaa in approximately 60% of herbicide sprayings and in Häme in approximately a third of all sprayings. The impact of growth regulators was not measured separately in the demonstrations but some of the yield impacts can surely be explained with the use of the growth regulators.

Figure 3. The influence of the number of weeds on the yield increase caused by the herbicide applications. *Barley price in June 2010, **Barley price in December 2012.
Success of the demonstrations
The farmers implemented the plant protection plans they had prepared annually in their three fields. Not all the sprayings were based on results of the observations or optimal schedules. In addition, necessary disease or aphid control was not performed in some fields. With the help of monitoring the extent of pests and measuring the efficacy of performed plant protection measures, the benefit and profitability of these measures could be defined afterwards and used as basis on a continuous IPM learning.

In many cases, making observations in the implemented ways was laborious and took too much of the farmers’ time. Over the course of the demonstration years, the threshold values for plant diseases and insect pests were modified to be better suited for practice. These should still be modified and instructions clarified. During the project years, the amount of pest insects in the research areas was small, so no research data regarding the functionality of the threshold values could be collected. Professional demonstration farmers felt that the tested methods were familiar to them and that most of the methods had already been in use for years. However, the concept and ideology of IPM is now understood better. During the project, farmers who had committed to the principles of IPM changed their plant protection measures towards IPM. Routine spraying was reduced and the prevention of pesticide resistance was taken into consideration in selecting products.

Communication
During the three growing seasons, the project arranged field days that covered all three research areas. These field visits collected a very good audience and were important for the communication between the research and farmers. The project was presented in several domestic exhibitions and in Finnish and international seminars. In addition, PesticideLife took part in the annual Green Week conference arranged for EU’s LIFE projects in Brussels in 2012 and 2013. The project’s webpages have had a good deal of visitors, and the pages are also available in English and Swedish. Topical issues have also been updated on the project’s Facebook page and a blog has acted as an alternative online communication channel that can be used to discuss current IPM issues wider than on Facebook. In addition to dozens of posters and several other publications, the project has produced six reports that have been published in the MTT Report publication series. These can be found in electronic format on the project’s homepages. The project has also produced three teaching videos that address the general principles of IPM and pest-specific control instructions for cereal farmers.

New products and applications
The new plant disease forecasting model developed in Finland has been validated during all three growing seasons at the project’s cereal fields. This has introduced valuable information regarding the operation and reliability of the model. Information regarding the use of pesticides in cereal production from the 2007 pilot survey was used as a basis for the modelling of the ecotoxic impacts of pesticides on the environment. HAIR risk indicators, developed in the EU, were in research use for the first time in Finland and more extensively in Europe. The new procedure has been described in the project report and it can be further developed for authority use to measure the change in the risk caused by pesticides once IPM is introduced.

PesticideLife has taken part in the development work of the IPM portal in co-operation with the garden sector IPM project. The goal is to develop a data platform tool that would support decision-making and planning related to the plant protection of all key crops.
It is of key importance to have all farmers in all EU Member States incorporate the general principles of integrated pest management. The concrete benefits of the operating method must be pointed out to the farmers. The required measures must be easy to use and economically justified. The maintenance and increase of financial profitability of plant production is one of the main goals of the development work. The entity of financial and environmental sustainability can only be tested on the farm level by utilising the competence of the farmers. Methods used in this research are not necessarily directly applicable to all farms. However, for the objectives of the project, it was important to gather sufficient amount of information so that the functionality of the methods could be tested. The need for information was considerable because the functionality of IPM methods in cereal farms had not been researched in Finland previously.

Crop rotation forms a basis for sustainable plant production and protection. The essential issue is to concentrate on the prevention of risks. In changing and unpredictable circumstances, the significance of sustainable farming practices will become emphasised. Weather plays a notable role in the success of plant protection measures. Due to the risks caused by the climate change on the one hand, and the implementation of the national NAP programme on the other, all stakeholders should invest in the development of IPM methods. When the farmers act correctly, they can avoid unnecessary costs, ensure the amount of yield and quality of products and secure the continuity of their cultivation operations when plant protection risks increase.

All operators in the area need each others to face the forthcoming challenges. The PesticideLife project and other IPM projects have proven the power of co-operation and benefits of learning together. In addition to regional co-operation between different operators, changing of roles is needed so that everyone can learn and teach others. Demonstrations on a farm level will also be an important part of IPM development that aims for comprehensive management of risks, testing and comparison of new methods and reduction of chemical dependency. Farmers, further processors and the whole production chain will benefit from this development when they have to prove the origin of products and the ecological and ethical sustainability of production methods to the consumers. IPM provides tools for consumer communication and confidence for the control of food quality and farming systems.
Reducing environmental risks in use of plant protection products in Northern Europe
PesticideLife (2010-2013)

Coordinating Beneficiary:
MTT Agrifood Research Finland

Associated Beneficiaries:
Finnish Safety and Chemicals Agency (Tukes)
Nylands Svenska Lantbruksförening (NSL)

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The EU’s share of the funding is €510,965 (50%)