

Practice PF n° 3

ZERO SPOTS METHOD TO OPTIMIZE WHEAT NITROGEN FERTILIZATION

Introduction

Category: Good Practice (GP)

Practice identity card

#Optimize nitrogen fertilization, variable rate application (VRA)

#PF, Food, feed, Winter wheat, industrial, GP, Sweden

Calibrate Zero spots against the field and make a VRA file



Short description

→ The zero spot fertilization method for wheat is based on the following principles: The nitrogen supply to the wheat during the growing season is done in three steps. 1) The first application in early spring at the time of the start of wheat growth (BBCH30 (middle of March) about 25-40% of the estimated total nitrogen intake. 2) The main application, 40-55% of the estimated total nitrogen intake, is applied at BBCH 30 (middle of April) so that it is available when shooting at BBCH32. 3) The final supplementary application is made in the flag leaf stage at BBCH39) (middle of May). The final supplementary amount of Nitrogen is calculated according to the result of the measuring of the Zero spots. The zero spot is defined as a square area of 3x4 meters within the field that has not been subjected to the application of nitrogen fertilizer. The supplementary rate is distributed according to biomass from satellites.



- The total nitrogen requirement is calculated after the zero spots have been evaluated and revealed the soil's nitrogen supply. The nitrogen requirement is calculated according to 3 different formulas depending on the winter wheat variety and on the final use of the wheat. The winter wheat varieties are classified into three categories based on protein content at optimal nitrogen levels: 1) Low protein wheat (<10% protein) at optimum, 2) Medium protein wheat (10-12% protein) at optimum and 3) High protein wheat (>12% protein) at optimum. In addition, the nitrogen calculation is adapted according to the use of the wheat. A) Own feed and bread wheat 22 kg N/tons harvest, B) Feed for industrial and starch wheat medium or high protein varieties 20 kg N/tons harvest. C) feed for industry and starch wheat Low protein wheat 15 kg N/tons harvest.
- In practice, non-fertilized zero spots for nitrogen are laid out in the fields in the spring in connection with nitrogen fertilization of the winter wheat. At each nitrogen fertilization, it is ensured that the zero spots do not get any nitrogen. When wheat approaches BBCH39, measurements of nitrogen uptake are made in the zero spots. Nitrogen uptake is measured indirectly with Yara's N-tester and via image analysis in Yara's Atfarm app. The values from the measurement are then entered into a formula developed by Yara, where the characteristics of the variety and the use of the wheat is also taken into account as described above. In the formula, the farmer also specifies the estimated harvest and previous fertilization. In this way, the supplemental nitrogen requirement is determined. The supplemental requirement is then used as a basis for determining the optimal distribution of the nitrogen application based on Satellite data via Atfarm or Cropsat.
- In these programs, the value from the zero box is calibrated against the satellite images so that the zero box represents the correct part of the field. Then a VRA file is created and the farmers spread their supplementary application based on the VRA (Variable Rate Application) file.
- By laying two zero spots when spreading organic fertilizer (one that only gets organic fertilizer and one that gets no nitrogen at all), we also have the opportunity to calculate the contribution of the organic fertilizer and remove it from the need for supplementation. This is done by measuring the nitrogen uptake in both zero spots.

Implementation process

Which practice is considered as the standard in this region? Most farmers use 3 nitrogen applications in much the same way as in the zero-spot method. But the nitrogen level is determined based on experience from previous years and the fertilization that was carried out last winter.

What was the on-farm issue/challenge/opportunity that led to the implementation of the practice? The background to the method was that traditional field experiments with nitrogen fertilization only gave the answer about the optimal strategy after harvest. There were no tools available to evaluate the nitrogen requirement during the wheat growing season and be able to adjust the nitrogen application during the growing season based on the crop needs and variation in the field. Nitrogen fertilization experiments were analyzed to look for correlations that could explain the difference in nitrogen requirements at different sites with the same harvest. These analyses showed that these differences could be explained by the soil's nitrogen delivery capacity which could be measured using nitrogen Zero spots. At the same time, a new series of experiments was started that looked at nitrogen fertilization for specific varieties. These experiments showed that the Swedish wheat varieties can be divided into 3 groups depending on the protein content in the kernel at optimal nitrogen application. These studies also led us new calculation tools based on the characteristics of the variety, the final use of the wheat, and the expected yield and soil nitrogen delivery capacity. We have then also linked these methods with the possibility of using satellite-based biomass maps to account for variations in the field and apply the final nitrogen application as a variable rate application based on crop needs rather than a uniform average dose.

How long did it take to implement the practice and which are the measures needed to monitor: Zero spot method is the result of knowledge built up over several years. It took about 10 years from the time the evaluating nitrogen fertilization experiments started until a method useful for farmers was developed. Once the method was developed, it was relatively quick to put it into practice and to get farmers and advisors interested in the method. In the beginning, they measured with a handheld N sensor in 2015. But this was very time-consuming, and one single sensor had to travel around with one person to take measurements at several farms. Since 2015, other indirect methods have been tested to measure nitrogen delivery. For example, measuring straw length using image analysis to see if we could find an easier method to measure the nitrogen uptake. The aim was to come to a method farmers could manage themselves. 2024 was the first year we were able to offer a method where the farmers themselves can measure nitrogen uptake in their own zero spots without being dependent on anyone having to come out and measure with him. So that development has taken 9 years. The knowledge of nitrogen need per variety type has been evaluated in trials since 2013. But it only took 2 years before we could see correlations which we were able to implement in the method in 2015. Since then, the trial series has remained until 2022. So that we could evaluate and be sure that the results were right. During these years we have fine-tuned the system to be better. From 2025 all the steps in deciding the Nitrogen uptake can be managed in Atfarm (at. Farm, Yara).

Logistics

- **Logistic aspects to consider:** The method is applicable for farmers or advisors having access to N-tests and Yara's Atfarm in order to be able to measure and evaluate the Zero spots. Previously, a hand-held N-sensor was used, with the challenge that it had to be moved around to measure different fields in a large area in a very short time, which was a major logistical problem. For the farmer to take part in the information of the nitrogen requirements, all that is required is that the zero spots must be measured to find out the nitrogen needs of the field. Either by the farmer with the Zero spots method or by an advisory organization. To utilize the method optimally, the farmer needs a fertilizer spreader that can spread VRA task maps and access to computer programs that can create VRA task maps based on biomass. In Sweden, common examples are Yara's Atfarm and Cropsat.
- **Other specific tools involved/included:** The VRA task map is generated in ATFARM based on satellite images and implemented in the spreader computer or GPS equipment in the tractor. The ease of implementation and the quality depends on the equipment in the tractor. But mostly issues can be easily fixed the first time they want to apply a variable rate application.
- **Additional requirements for application:** No
- **Skill/education level required:** rather low

Agronomical traits

- **Can the practice be applied to a multitude of cultivation techniques?** The method is viable in other cereals. The important thing is to understand the correlation between optimal nitrogen levels and soil nitrogen delivery. The method is tested in Malt barley where there are more factors than the soil's nitrogen delivery capacity that must be taken into account to get a reliable value Unfortunately, there is no model that works in Malt barley, yet There are some small tests

in Hybrid rye and Autumn barley. There are currently tests at farm level in Lay. The zero spots are good at showing the soil's nitrogen delivery capacity in the crop.

- **Targeted crop categories:** food, feed, industrial
- **Influence on soil quality:** No
- **Suitable soil types:** peaty, sandy, clay, loamy, chalky, silty
- **Expected effect on crop yield:** increase
- **Expected effect on crop yield variation:** decrease
- **Expected effect on crop quality:** increase
- **Expected effect on crop quality variation:** decrease
- **Which costs may increase due to the practice?** skilled labour, equipment, internet / data subscription costs
- **Which costs may decrease due to the practice?** fertilizers, fuel, energy
- **Expected long-term/indirect economic benefits of the practice:** improved water quality, higher yield, better quality, optimized and reduced fertilizer use.
- **Expected effect on the leaching of nutrients:** Nitrogen leaching decreases.
- **Specific materials applied through the practice:** digestate, animal manure, agricultural residues, municipal sludge, compost

Administrative context

- **Does the practice qualify for subsidies?** No not in Sweden
- **Status of the legal framework that regulates the practice:** there is hardly any
- **Are there any policy barriers complicating the practice's application?** Not what we can see.
- **Does the practice involve the use of hazardous substances?** No
- **Is the practice supported by Eco-schemes?** No not in Sweden
- **Are there any gaseous emissions to be considered upon application of the practice?** No
- **Greenhouse gas (GHG) reduction potential of the practice:** substantial
- **Expected effects from the practice on the time occupation of the farmer?** moderate increase
- **May the practice contribute to a better public image of agriculture?** Yes. The environmental benefits from this practice should contribute to a better public image and at the same time it contributes to a better quality and quantity of the yield. Because the method optimizes the use of Nitrogen to get the optimal yield and quality with the right amount of Nitrogen. This will minimize Nitrogen leaching to the Baltic Sea which is a major concern in Sweden.
- **May the practice improve the farmer's self-image?** Yes. The environmental benefit from this practice gives the farmer a sense of accomplishment of doing something good at the same time they will improve their own economics.

Contact

Name of the FIN (Fertilization Innovation Network) partner submitting the information:
Hushållningssällskapet

Contact information of the FIN partner: mattias.hammarstedt@hushallningssallskapet.se

Eu member state: Sweden

Find out more

Source of information The method has been developed by Yara and Hushållningssällskapet in a collaborative project which started in 2015. The Zero spots method has been in use since 2016, with yearly updates and improvements and the practical use of the method is increasing (about 30% of the Hushållningssällskapet clients are using this method).

Additional info/links:

Professional magazine.

Arvensis 2015-08-01, Sortanpassa kvävegödslingen, Mattias Hammarstedt HIR Skåne

Arvensis 2018-01-01, Vetegödslingen ska styras efter sort och avsättning, Mattias Hammarstedt HIR Skåne.

Arvensis 2021-02-01, Nollrutor ett måste för rätt kvävegiva, Patrik Svanström HIR Skåne

Arvensis 2024-04-29, Verktyg inför kompletteringsgivan i höstvete, Frida Lindell HIR Skåne

Växtpressen nr1, 2018. Ny indelning i Sortyper avgör sortval och N-gödsling, Mattias Hammarstedt HIR Skåne och Anpassade kvävegivor fungerar, Katarina Elfström och Carl Magnus Olsson YARA.

https://issuu.com/yarasverige/docs/v_xtpressen_yara_20181

Växtpressen nr1, 2016. Nya N-rekommendationer i vete, Ingemar Gruveaus, Yara

https://issuu.com/yarasverige/docs/va_xtpressen1601_low

Växtpressen nr1, 2020, Handfasta råd inför 2020, Magnus Jeppsson, Yara

Pod

Växtpressenpodden: Tid för kompletteringsgödsling, <https://vaxtpressenpod.libsyn.com/tid-fr-kompletteringsgdsling>