THE ROLE OF GREEN MANURE IN HUNGARIAN CROP PRODUCTION

Fekete Ágnes*, Pepó Péter*

*University of Debrecen, Institute of Crop Science, Faculty of Agricultural and Food Sciences and Environmental Management, 138 Böszörményi St., 4032, Debrecen, Hungary, e-mail: fekete.agnes.91@gmail.com; pepopeter@agr.unideb.hu

Abstract

According to the data of KSH (Hungarian Central Statistical Office) sowing area of cereals in the crop year 2016 was over 2.56 million ha, on which winter wheat and maize were produced in a rate of around 50-50%. Regarding these data it is obvious that the domestic sowing structure has been simplified and become unilateral. This unfavourable crop rotation system causes several problems. Due to the unilateral plant production soil conditions may deteriorate, several nutrient supply, plant protection and water supply problems may occur. It has to be added that the number of Hungarian livestock decreased in the past decades. Amount of manure was 24 million tons in 1960, but only hardly 4.5 million tons of organic manure was applied in 2016. According to the data of the Research Institute of Agricultural Economics it can be stated that the production area of green manure crops was less than 40 000 hectares before 2015, but after the introduction of the new subsidiary system their sowing area was doubled in Hungary. The targeted sowing area of green manure crops in 2017 was over 86 000, 26 000 ha of which was planned to be sown in the Southern Great Plain region (AKI 2013, 2017). There are several methods for the recovery of organic matter. One is if plant organic substances and by-products are tilled into the soil, the other is if different green manure crop species and/or their mixture are sown directly.

Key words: biculture, grean manure, organic matter, maize, winter wheat

INTRODUCTION

The application of green manure is a millennial method in crop production. Its importance is increasing nowadays, even if the modernization of manure treatment and its adequate application in the 19th century, just as the propagation of mineral fertilization in the 20th century have mostly eliminated it (Füleky, 1999).

Green manure means that living, green, succulent, only slightly senescent plants that contain high amount of sugar, starch and proteins, just as nitrogen are tilled into the soil and parallel to that the living roots of the plants are destroyed as well (Kahnt, 1986). Or according to the definition of Szabo (2003) green manure is fresh and green biomass that is suitable for nutrient supply and the improvement of soil structure.

Birkás (2017) has defined the target of green manure production as follows ‘Green manure plants serve the maintenance of soil fertility and the enhancement of its agricultural state’.

According to Antal (1993) advanced green manure crops can be sown after cereals or other plants, after that the main pre-crop – harvested during

the summer before – during autumn or in the springtime and they develop after the harvest of the main crop in the second half of summer.

Kahnt (1986), Antal (1993), Birkás (2017) classified green manure crops into two main groups. Traditional green manure crops are legumes. Their determining role in crop rotation systems was defined by Antal (2005) as follows: 'bacteria (Rhizobium) colonize on their root and form nodules that are able to fix atmospheric nitrogen; this relationship develop into symbiosis between bacteria and plant, while plant is provided with high amount of nitrogen thus'. According to Birkás (2006), Antal (1993), Szabó (2003), and Kahnt (1986) the most important legumes sown on weak, acidic, light sandy Hungarian soils are lupin (*Lupinus*), white sweet clover *(Melilotus albus L.*), hairy vetch (*Vicia Villosa*) and Crimson clover (*Trifolium incarnatum L.*).

The other main group of green manure crops cover cruciferous and other beneficial plants. Their common attribute is that they maintain loose soil structure and produce high amounts of biomass (Birkás, 2017). Fodder radish (*Raphanus sativus L. convar. oleiferus* (Mill)) that has short vegetation period and nematocide effect, white mustard (*Raphanus sativus L. convar. oleiferus* (Mill)) that has a deep root system and rape (*Brassica napus var.annus*) are commonly used on Hungarian fields (Antal, 1993). However, in their experiment between 2004 and 2009 Talgre et al. (2012) stated that birdsfoot trefoil (*Lotus corniculatus*) is less suitable as green manure plant, furthermore red clover (*Trifolium pratense*) and hybrid alfalfa (*Medicago sativa*) produce significantly higher biomass than birdsfoot trefoil. Plants that protect against wind and water erosion, just like California bluebell (*Phacelia tanacetifolia*) and green rye (*Secale cereale L.*) are classified as plants applicable as green manure (Antal, 2005).

Many researchers have defined the most important criteria and characters of green manure plants in their works. The main properties of crops utilized as green manure can be characterized with the following features according to Szabó (2003), Füleky (1999) and Nagy (2002):

- short vegetation period, herbaceous plants with large leaf area and high soil coverage,
- low demand on water,
- good nutrient mobilizing and uptake ability,
- deep and dense root system,
- tolerance and resistance against pathogens and pests,
- favourable effect as pre-crop,
- simple and cost-effective sowing material, production,
- well-adapted to extreme climatic conditions.

In order to achieve positive results with green manure crops thorough and considered planning is essential. Many researchers carried out studies in

which the positive effect of green manure crops is manifested. Cherr et al. (2006) emphasize that the production of green manure crops is a complex project, the success of which is depending on the relationships between the green manure plant, environment and technology.

Kahnt (1985) has stated that green manure crops accumulate nitrogen and humus in the soil, decrease the leaching of mineral substances, deflation and erosion, result crumbly soil conditions and help the protection against pests (nematodes) and diseases, distract light from other weeds and have antagonistic effect. Talgre et al. (2012) concluded in their study that the products of legume plants increase soil nitrogen and carbon stock and thus they improve the physical state of soils.

According to Birkás (2006) green manure crops decrease soil compaction and thus soil preparation measurements for the follow-on crop can be executed with lower energy input and less harmful effects. Furthermore, frozen plant residues protect soil surface from siltation and the following cracking after drying in the wintertime. Birkás (2004 and 2017) estimates as positive effects in her works that green manure stimulates soil edaphon, has positive effects on earthworm populations (biological indicators), and may compensate the organic substance decreasing effect of intensive soil tillage.

Furthermore, the production of green manure crops results in increasing soil water capacity (Antal, 2005).

It also has to be added that the utilization of mineral fertilizers is better on soils where green manure was sown before (Szabó, 2003). Based on his experiments Mikó (2009) concluded that the application of low amount – 50 kg ha^{-1} – of nitrogen had favourable effect on the amount of available phosphorous and potassium content as well.

There is intensive plant production when targeted soil tillage, crop rotation and nutrient supply is combined with integrated crop protection and the selection of plant species adapted to the production site. Therefore green manure application has to be planned because its effect is versatile and unwanted secondary effects may occur as well (Kahnt, 1986).

Basic criterion of green manure production according to Kahnt (1986) is to know the target, effects and secondary effects of their application. Sowing material, just as time and soil conditions of sowing have to be chosen with caution.

Birkás (2006) mentioned first the amount of fallen precipitation during the middle of the summer as the most important limiting factor. In her work she emphasizes that green manure crops can be produced in a safe way only using sowing and production methods that hinder soil water stock loss. Nagy (2002) and Kahnt (1986) made more exact definitions: for the

successful production the lower limit of yearly precipitation amount is 600-700 mm.

Kahnt (1986) draws the attention of producers to the fact that in case the wrong green manure crop has been chosen on a drought production site or too high level of nitrogen has been applied, the production will not be successful due to the high water uptake. Furthermore, green manure seeds with hard husks may mean further risk, because they may tilt and overwinter and then they may cause damages in the main crop population as weeds. Furthermore in case too high amount of biomass is ploughed or tilled into the soil, the follow-on crop may be affected as well. This fact is confirmed by Birkás (2006): in case the green manure is tilled and mixed into the soil in larger bunches, local N-deficiency may occur.

The producer has to face financial losses also when the green manure crop develops too low amount of biomass, without reaching the set target. Sowing time of green manure crops has to be chosen properly and carefully because in case it emerges wrong, the coverage of the population will be insufficient and if the root system is inadequate, soil structure will not be improved either (Birkás, 2006).

According to Szabó (2003) the effect of green manure crop production is rather short-term, 1-2 years. It is a consequence of that humus produced from it is no stable, but nutrient humus. Furthermore green manure increases the nutrient content of the upper soil level only, because the mineralized nutrients come from the deeper soil layers of the same site. Legumes are exception of this statement.

Safety of green manure crop production changes: depending on the given crop year the amount of the produced biomass is different, thus its yield increasing effect is changing or may even be absent as well (Antal, 2005).

MATERIAL AND METHOD

Small plot field experiment has been set up at the Látókép Experimental Station of Plant Production of the Farm and Regional Research Institute of the University of Debrecen during the summer 2017. The Station is located on the loess ridge of the region Hajdúság approximately 15 km far from the city of Debrecen, along the main road Nr. 33. The experimental soil can be soil genetically classified as a calcareous chernozem soil.

Soil analysis was executed before the experiment was set up, according to the results of which it can be stated that physically the soil is loamy and its pH is almost neutral. Its phosphorous supply can be regarded as medium, while its potassium supply is rather medium-good. Soil humus

content is about 2.6-2.8%, the depth of the humous soil layer is around 80 cm.

Regarding the characteristic water management result data and the data published by Várallyai the soil can be classified into the 4th water management group, which means a medium water holding capacity.

Fodder pea was sown on 21st July 2017, while the rapeseed hybrid Arkazo as green manure crop on the 8th August. Green manure plants were tilled into the soil on the 4th October. After that the main crop, the winter wheat variety MV Csillag was sown. The other studied main crop of our study, maize will be sown during the spring of 2018 as well.

In the present experimental crop year plant development dynamics of both studied species, just as the time of the main phenological stages, agronomical parameters of populations and plant health conditions will be also monitored. In the vegetation period photosynthetic capacity, just as its dynamic change, leaf area duration and after the harvest yield of the two main crops, just as their most important quality parameters will be evaluated as well. The present study will cover the monitoring of changes in soil conditions too. These soil analyses include mainly the determination of soil organic substance stock and the quantity and quality of humus, just as further soil parameters.

DISCUSSION

After the thorough evaluation of possibilities and risks the production of green manure crop species is especially recommended on soils with low organic substance content, where the depth of soil melioration is limited, or on sites affected by wind or water erosion (Birkás, 2006). The production of green manure crops is especially recommended where crop rotation systems have been simplified and cereals are dominant, or in case of heavy soils, just as wetlands (Kahnt, 1986). It is confirmed by studies that already after the application of low nitrogen amounts the green biomass amount can be even the double (Mikó et al., 2016).

Due to the lack of fossil resources, the expensive measurements and the decreasing amount of manure the production of green manure crops will increase in the future and spread to further production sites and soils. The production of green manure crops can be successful and profitable, if adequate nutrient supply, weed control and plant cultivation measurements are applied parallel. This means in case the demands of green manure crops are covered as well (Cherr et al., 2006).

CONCLUSIONS

Parallel to the growth of humankind population, more and more food will be needed. However, soil physical structure and agricultural state can

decline fast due to the intensive soil utilization. An alternative solution is essential that exclude or minimize the souring effect of mineral fertilizers and that is a far more cost-effective method for both producers and the future. Due to the decreasing number of livestock in Hungary insufficient amount of manure can be produced. Objective of the set experiment is to find new technological solutions that are suitable for the execution of sustainable plant production by inadequate crop rotation, organic substance recovery conditions or under more unfavourable climatic conditions.

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