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SOME EXPERIENCES FROM THE WORLD IN THE USE OF COVER CROPS AND THE POSSIBILITY OF THEIR IMPLEMENTATION IN THE REGION

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Abstract

The paper aims to point out many benefits offered by the use of cover crops, selecting ecologically adequate plant species for this purpose, and the possibilities of their wider implementation within the intensive development of organic agriculture in the Region. Analyzed characteristics and experience with species that have been successfully grown as cover crops in the northern hemisphere indicate that many of them could be very successfully applied in the Region. Some of these species have been already used in the most countries of the Region, but not primarily as cover crops, but because of other beneficial properties. It is very important to pay attention to proper choice and management of cover crops. At the beginning, it is important to determine the desired primary benefits of cover cropping, then to analyze site conditions (climatic, type of soil, water availability, method of irrigation, cropping sequence, cultural practices). After all these analyses, can be accessed to the choice of a species or mix that will provide specific desired benefits and that will be compatible with the farming system.

Key words: *cover crops, benefits, experiences, implementation*

Introduction

The group of cover crops presents a group of plants with a long list of benefits. They are grown for many purposes: for soil erosion control, to add organic matter, stabilize and increase the content of nutrients, improve the number and diversity of microorganisms and on that way to improve physical, chemical and microbiological soil properties. They also suppress appearance and spreading of weeds, and even contribute to the control of diseases and pests. These plants are not primarily planted to be harvested for food. They are usually ploughed or tilled under before the next food crop is planted, in which cases it is used as a soil amendment ("green manure crop"), or its capacity to control weeds ("living mulch"). In addition to listed practical considerations, they also have aesthetic role from the landscape designer’s perspective, since they are taking the place of garden plants in between growing seasons.

Cover crops were frequently used on farms in the first half of 20th century, but when pesticides and fertilizers came into widespread use (after 1950s), they were rarely grown.

In the last decades, researchers and farmers have taken a renewed interest in cover crops because of their potential role in reducing chemical inputs and numerous other benefits. Cover crops are also recognized in Serbia as an important component of “sustainable” agro production (Dolijanovic, Z. et al., 2012., Cupina B., 2014., Ćupina, B. et al., 2011., Ćupina B., et al., 2007., Ivanišević, D. et al., 2012. and many other articles).

Matherials and methods

We analyzed the characteristic and experience with species that have been successfully grown as cover crops in the northern hemisphere, and could be successfully applied in the Region. Some of these species have been already successfully used in the most countries of the Region, but not primarily as cover crops, but because of other beneficial properties.

Generally speaking, the largest number of cover crop species belongs to the three groups of plants: Grasses, Legume and Non-Legume Broadleaves.

Grass species suitable for use as cover crops are fast growing and relatively easy to control, chemically, mechanically or by winter weather. Grasses do not fix any nitrogen out of the atmosphere, but they can accumulate large quantities from the soil. The group of Grasses which are characterized bya fine, fibrous root systems, includes: Rye (*Secale cereale* L.), Winter wheat (*Triticum aestivum*L.), Oats (*Avena sativa* L.), Barley (*Hordeum vulgare* L.), Sudangrass and Sorghum (both in the species *Sorghum bicolor* (L.) Moench), Ryegrass (*Lolium* sp.), and some other (corn, pearl millet, etc.).

Legume includes a group of cover crops that can fix nitrogen from the air, supplying nitrogen to the succeeding crop as well as protecting the soil from erosion and adding organic matter. The amount of nitrogen fixed varies between species. Some legume species have aggressive tap roots which can break up subsoil compaction. Commonly used legume cover crops include: *Red clover* (*Trifolium pratense* L.), Alfalfa (*Medicago sativa* L.), Sweet Clover (*Meliolotus* sp.), Hairy Vetch (*Vicia villosa* Roth.), Field Peas (*Pisum sativum* subsp. arvense (L.) Asch.) and some other (soybeans, white clover, crimson clover, berseem clover, etc.).

Non-legume broadleaf crops are specific. They may have a role as green manure crops and in providing a different plant species and root system for soil building. They cannot fix nitrogen out of the air, but they can absorb large quantities from the soil. Most of these crops are not winter-hardy. We have found that is mostlyin use the following species of non-legume broadleaves: Buckwheat (*Fagopyrum esculentum* Moench), Oilseed Radish (*Raphanus sativus* or *R. sativus* var. oleiferus, Fam. *Brasicaceae*), some other Brassicas (Fam. *Brassicae*) and Marigold (*Tagetes* spp., Fam. Compositae).

Results and discussion

Based on a detailed analysis of available data about successful use of numerous plant species as cover crops in northern hemisphere, we decided to point out a few specially interesting species that could be successfully grown as cover crops in the region. By groups of plant species, these are:

Grasses

Rye(*Secale cereale*), verry common in use from numerous reasons: it tolerates a wide range of soil conditions, but themost appropriate are well drained light soils – sands, loamy sands, sandy loams and gravelly soils. Well tolerate cold temperatures and can withstand temperatures of – 35° C. Rye is more drought tolerant than wheat or oats. It is also shade tolerant and can be seeded in corn fields before leaf drop. In addition to the other benefits, it is good for suppressing weeds and have allelopathic effect – prevents weed germination and growth. It is of significance that the large volume of plant biomass is returned to soil.

Winter wheat(*Triticum aestivum*) tolerates a moderately wide range of site conditions, but does not thrive well in saturated or droughty soils. Grown as a cover crop and food crop. Can be overseeded in growing crop (e.g. beans, tomatoes).

Oats (*Avena sativa*) is growing as an annual grass with fibrous root system that reaches 1-2 m. Preferred soil in pH range from 5.0 to 6.5, but can tolerate as low as 4.5 Require moist soils for optimum growth and do not tolerate hot and dry conditions. Oats produce high quantity of biomass.

Barley (*Hordeum vulgare* L.), belongs to the fast growing annual grasses, with fibrous root system reaches 1.5 to 2 m in depth. Grows best in cool dry conditions, requires less soil moisture for optimum growth. Preferred soil pH is greater than 6.0. It is very significant that barley has a very high salt tolerance. The amount of biomass is sufficient to increase soil organic levels.

Sudangrass and *Sorghum* (both in the species *Sorghum bicolor* (L.) Moench), are warm season annual grass cover crops that can provide good weed suppression, grazing and forage supply, in addition to the soil structure improvements. It prefers neutral pH, but can tolerate 5.0 to 9.0 and it is characterized by extreme drought tolerance and tolerance to salinity. Besides Sorghum and Sudan grass can be used as forage, they also can produce massive amounts of dry matter (Björkman, T. and J.W. Shail., 2010). These crops provide abundant root biomass, which is useful for increasing soil organic matter. They suppress root knot nematodes and inhibit weed germination if densely sown.

Ryegrass (Lolium sp.) can be grown as annuals (60-120cm) or perennials (30-90cm annually for 3-4 years).Shade tolerant, often used in orchards and vineyards for ground cover. Grows best on medium to heavy soils and have high requirements for moisture and nutrients. Annual ryegrass tolerates more standing water than perennial ryegrass.

Corn (*Zea mays*). Annual grass which can make an inexpensive and effective cover crop if seeded early. Tolerant of most soil types, but very sensitive to frost. Corn is best used as a green manure crop and very often used in erosion control projects to stabilize banks.

Pearl millet [*Pennisetum glaucum* (L.) R.Br.] is a warm season annual grass crop that is best known in the U.S.A. as a forage crop. Pearl millet grown for grain has a growth habit similar to sorghum. Like any grain crop, pearl millet will yield best on fertile, well drained soils. However, it also performs relatively well on sandy soils, under acidic soil conditions, and when available soil moisture and soil fertility are low.

Legume

Red clover (*Trifolium pratense* L.). Short lived perennial, grow on a wide variety of soil conditions - including slightly acidic pH, but best growth with soil pH 6.0 to 7.0. Shade tolerant species, efficient nitrogen-fixer - 45 kg/ha, adds considerable biomass, improves conditions for soil microbial life, improves water holding capacity, infiltration and permeability rates.

Alfalfa (*Medicago sativa* L.). Excellent cover once established. Performs best on a deep permeable soil with adequate soil moisture, but no prolonged periods of standing water. Not tolerant of severely compacted soils, intolerant of acidic soils (pH < 6.2). Large biomass producer. *Alfalfa* can breaks-up some compacted layers, improves soil infiltration and permeability.

Sweet Clover (*Meliolotus* sp.). Grows in the areas with average annual temperature range between 5° and 22°, on a wide range of soil textures, pH tolerance 6.5 to 7.5C. Strong taproot system can penetrate up to 2 m compacted silty and clayey soils. White sweet clover tolerates calcareous conditions, perform well in moderately well drained conditions. Fixes nitrogen and believed to move P and K to the root zone through the root system.

Hairy Vetch (*Vicia villosa* Roth.).Winter annual legume with many cultivars. Does well on most soils if well drained, but the best on sandy soils, prefers soil pH of 6.0 to 7.0, drought tolerant. Fixes nitrogen and can make K more accessible to subsequent crops. Once established it provides enough cover to suppress weeds and protect soil.

Field Peas (*Pisum sativum* (subsp. arvense (L.) Asch.).Winter annual legume which grows best on well-drained loamy and clayey soils, but does not do well on poorly drained soils and droughty, sandy and gravelly soils. Prefers fertile soils and pH range of 6.0 to 7.5.Fixes nitrogen and adds considerable amounts of biomass to soil. Can be used as feed - either as forage or as dried seed supplement.
There is also in use some other Legumes: soybeans, white clover, crimson clover and berseem clover:
Soybeans (Glycine max (L.) Merr.) well tolerate wide range of soil conditions, but is less tolerant of low pH, droughty and saturated soils. Release N and cause leaching in winter and spring. Residue readily breaks down.
White clover, Crimson clover, Berseem clover (*Trifolium* spp.) also tolerates a wide variety of soil conditions, except poor drainage and calcareous conditions. Does best on well drained, humified, loamy soils with a pH in range of 5.0 to 7.0.

Non-Legume Broadleaves

Buckwheat (*Fagopyrum esculentum* Moench) is fast ground cover which tolerates a wide range of soil types, even on infertile soils. Prefers well drained soils with a pH range of 5.0 to 7.0, but intolerant of droughty, saturated or compacted soils. Buckwheat is effective at extracting phosphorus from the soil. Residue is easily decomposable.
Oilseed Radish (*Raphanus sativus*, Fam. Brasicaceae) primarily used for oil production, now is widely used as a cover crop. Prefer swell drained loam to clay loam soils, cool, moist growing conditions. Intolerant of shade or traffic. May have an allelochemical effect following decomposition that can help control soil-borne pests, including insects, weeds and nematodes. Oil seed radish has a deep root system that can break up compacted soil layers. It is also very good forage and can be used for organic matter production. Because of fast growth it is quick ground cover which also protect against soil erosion.
Other Brassicas (Fam. *Brassicae)*includes canola (*Brassica rapa* subsp. *oleifera*, syn. *Brassica campestris* L.), rapeseed (*Brassica napus* L.) and mustard, black and white.
It should be mentioned one more interesting species for ground cover. It is Marigold (*Tagetes*spp., Fam.Compositae), annual decorative plant (Dover K. E. et al., 2003). Because its allelopathic effect, Marigold can be grown as a cover crop to suppress nematodes before planting a susceptible crop such as a vegetable crop and also in ornamental planting beds where nematodes are a problem (Krueger, R. et al., 2010). Marigold should be planted at least two months before the desired vegetable crop. The allelopathic effect is reflected in the ability to produce chemicals that are toxic to other organisms. Marigold roots release the chemical alpha-terthienyl, one of the most toxic naturally occurring compounds found to date (Gommers and Bakker, 1988). This compound is nematicidal, insecticidal, antiviral, and cytotoxic (Arnason et al., 1989; Marles et al., 1992).

Conclusion

Based on the experience from the similar climatic, soil and other environmental conditions, it can be concluded that there is a significant number of plant species used in the northern hemisphere suitable for use as cover crops in the Region.

Undoubtedly there are the numerous potential benefits of cover crops which are primarily reflected in protection of soil from water and wind erosion, addition of organic matter to soils, improvement of soil structure and water penetration, addition or conservation of nitrogen, suppression of weed growth, attraction and sustenance of beneficial insects and also many others. These benefits considerably exceed the eventual potential disadvantages of cover crops such as depletion of soil moisture, temporary decrease in availability of plant nutrients,

increased weed problems, increased danger of frost damage, attraction of arthropod and rodent pests or increased associated costs.

It is very important to pay attention to proper choice and management of cover crops (Ingels, C.A. et al., 2007). At the beginning, it is important to determine the desired primary benefits of cover cropping, then to analyze site conditions (climatic, type of soil, water availability, method of irrigation, cropping sequence, cultural practices). After all these analyses, can be accessed to the choice of a species or mix that will provide specific desired benefits and that will be compatible with the farming system. All the mentioned phases of planning are necessary in order to maximize the benefits and reduce potential problems.

Research and practical experiences indicate that a successful cover crop stand and the greatest benefits can be obtained by using mixtures of species, such as grasses and legumes and that cover crops should be rotated periodically (Clark, A., 2007).

In this paper, we have tried to identify and listed some of the most important species of grasses, legumes and broadleaf non legumes which are for decades very successfully usedascovercropsin the northern hemisphere. Many of them could find the implementation in the countries of the Region, but to cover cropping should be approached very carefully and systematically.

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