Potential of some forage brassicas for green manure use

Branko Ćupina[1], Đorđe Krstić[1], Aleksandar Mikić[2a], Ana Marjanović-Jeromela[2b], Svetlana Antanasović[1], Pero Erić[1], Vojislav Mihailović[2a]
[1]University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia
[2a]Institute of Field and Vegetable Crops, Forage Crops Department, Novi Sad, Serbia
[2b]Institute of Field and Vegetable Crops, Oil Crops Department, Novi Sad, Serbia

Abstract

The contemporary agriculture in Europe is faced with numerous challenges related to environmental issues. According to the widely accepted and environment-friendly approaches such as organic farming and sustainable agriculture, it is desirable that as many field crops as possible find their alternative purposes that may contribute to the general conservation of soil fertility, improvement of agro-ecosystems and enhancement of the health of the whole society. In these schemes, it is brassicas that are one of the most appropriate crops for a rapid application and fast return, resulting in a long-lasting benefit to both farmers and other parts of the society. Due to the shortness of their growing season and a rare ability to develop and produce abundant below- and aboveground biomass, brassicas have a special role in the production of green manure, apart from their numerous uses in food and feed industry. A recently started research on the potential of several brassicas for green manure production, carried out as a concerted action between the Faculty of Agriculture in Novi Sad and the Institute of Field and Vegetable Crops, brought forth useful and abundant results. Although all brassicas have a much lower proportion of aboveground dry matter in comparison to other annual crops such as legumes, ranging between 0.09 in fodder kale and 0.12 in white mustard, these crops are rich in aboveground nitrogen that by incorporating may significantly increase the soil fertility and directly enhance the yields of subsequent crops. Some of the fodder kale genotypes, tested within the trial set at Rimski Šančevi from 2005 onwards, have shown an ability to produce about and even more than 150 kg ha-1 of aboveground biomass nitrogen. At the same time, despite lower forage yields, certain white mustard genotypes had average aboveground biomass nitrogen yields higher than 100 kg ha-1. These results encourage similar research on other brassicas such as oilseed rape and open a possibility for developing special green manure brassica cultivars, with high aboveground biomass nitrogen yield and increased speed of the incorporated biomass biodegradation in the soil.

Key words: aboveground biomass, forage brassicas, green manure, nitrogen yield

Introduction

However advanced in many of its aspects, the contemporary agriculture in Europe has been faced with growing challenges related to environmental issues. The profit-based cropping systems led to a serious exhaustion of the soil resources and a long-term lack of balance of the basic agro-ecological factors. One of the strategic goals of modern agronomy is to remediate the numerous bad consequences of such practice. According to the widely accepted and environment-friendly approaches such as those that underlay organic farming and sustainable agriculture, it is desirable that as many field crops as possible find their alternative purposes that may contribute to the general conservation of soil fertility, improvement of agro-ecosystems and enhancement of the health of the whole society (Ćupina *et al.*, 2004a). In these designs, brassicas represent one of the most appropriate crops for a momentary application and fast return, resulting in a lasting benefit to farmers and other segments of one society (Ćupina *et al.*, 2004b). Due to the prominent shortness of their growing season and a remarkable ability to develop abundant below- and aboveground biomass, forage brassicas have a specific role in the production of green manure, apart from being used in food and feed industry (Mihailović *et al.*, 2008).

Forage brassicas and green manure

Autumn-sown fodder kale (*Brassica oleracea* L. var. *viridis* L.) is the most important forage brassica in Serbia and many other temperate European regions (Mihailović *et al.*, 2007). Fodder kale produces high and stable forage yields, has high crude protein content in forage dry matter surpassing 170 g kg^{-1} (Bradshaw & Borzucki, 1981) and is characterised by a prominent earliness. All this makes fodder kale a good crop for various farming systems. Along with its primary purpose as a forage crop,

autumn-sown fodder kale is considered a valuable cover crop and an essential segment in forage crop rotations (Ćupina *et al.*, 2004a).
White mustard (*Sinapis alba* L. subsp. *alba*) is cultivated primarily as aromatic and oil crop. However, this species has a great potential to be forage crop as well (Erić *et al.*, 2007). When grown for forage, white mustard produces high and quality yields, with crude protein content in forage dry matter of between 150 g kg and 175 g kg (Schuchert, 2006). It also has a very brief growing season, providing the cattle growers with a clear possibility of sowing silage maize, Sudan grass or sorghum as succeeding crop. In a similar way as the other forage brassicas (Ćupina *et al.*, 2004b), white mustard could be cultivated as a green manure crop, producing high above ground biomass yields with high proportion of nitrogen.

Table 1. Average values of fresh above ground biomass yield, dry above ground biomass yield and above ground biomass nitrogen yield in winter fodder kale genotypes for 2005/06 and 2006/07 at Rimski Šančevi (Ćupina *et al.*, 2010)

Genotype	Fresh aboveground biomass yield (t ha^{-1})	Dry aboveground biomass yield (t ha^{-1})	Aboveground biomass nitrogen yield (kg ha^{-1})
NS-Bikovo	66.2	5.3	148
Perast	73.0	6.6	183
K-021	56.0	5.0	140
Maksimirski Visoki	51.9	4.1	116
SK-01	50.5	4.5	127
SK-02	52.1	4.7	130
SK-03	33.2	2.7	74
SK-04	47.7	4.3	119
SK-05	45.6	4.1	114
SK-06	36.3	3.3	91
Average	51.2	4.1	114
$LSD_{0.05}$	6.7	1.4	44
$LSD_{0.01}$	9.3	1.7	62

A recently started concerted action between the Faculty of Agriculture in Novi Sad and the Institute of Field and Vegetable Crops is aimed at assessing the potential of several brassicas for green manure production. In average, brassicas have a much lower proportion of aboveground dry matter in comparison to other annual forage crops such as pea, vetches and other annual legumes, varying from 0.09 in fodder kale and 0.12 in white mustard. However, these crops are rich in aboveground nitrogen that by incorporating may significantly increase the soil fertility and directly enhance the yields of subsequent crops.
Some winter-sown fodder kale genotypes, tested within the trial carried out at Rimski Šančevi from 2005 onwards, have shown an ability to produce about and even more than 150 kg ha^{-1} of aboveground biomass nitrogen (Table 1). At the same time, despite lower average aboveground biomass yields, certain white mustard genotypes had average aboveground biomass nitrogen yields higher than 100 kg ha^{-1} (Table 2).

Table 2. Average values of fresh above ground biomass yield, dry above ground biomass yield and above ground biomass nitrogen yield in white mustard lines for 2005/06 and 2006/07 at Rimski Šančevi (Krstić *et al.*, 2010)

Genotype	Fresh aboveground biomass yield (t ha^{-1})	Dry aboveground biomass yield (t ha^{-1})	Aboveground biomass nitrogen yield (kg ha^{-1})
BS-01	13.9	2.1	56
BS-02	14.7	2.1	55
BS-03	23.1	3.7	99
BS-04	12.3	2.0	53
BS-05	26.4	4.2	113
BS-06	19.2	2.9	77
BS-07	25.9	3.6	97
BS-08	32.3	5.2	138
BS-09	31.5	4.4	118
BS-10	26.4	3.7	99
Average	22.6	3.4	90
$LSD_{0.05}$	4.5	0.9	24
$LSD_{0.01}$	5.8	1.2	32

Conclusions

Although still preliminary, the obtained results encourage further research on both fodder kale and white mustard and other brassicas such as oilseed rape as green manure crops. They also open a possibility for developing specific green manure brassica cultivars, with high aboveground biomass nitrogen yield and increased speed of the incorporated biomass biodegradation in the soil.

Acknowledgements

This research is a part of the projects TR31016 and TR31024 of the Ministry of Science and Technological Development of the Republic of Serbia.

References

Bradshaw J. E., Borzucki R. (1981): The effect of cultivar and harvest date on the chemical composition and digestibility of fodder kale. Journal of the Science of Food and Agriculture, 32, 965-972.
Ćupina B., Erić P., Krstić Đ., Vučković S. (2004): Forage catch crops in sustainable agriculture and organing farming. Acta Agriculturae Serbica, IX, 17, 451-459.
Ćupina B., Erić P., Mihailović V., Mikić A. (2004): The importance and role of cover crops in sustainable agriculture. Field and Vegetable Crops Research, 40, 419-430.
Ćupina B., Krstić Đ., Antanasović S., Erić P., Manojlović M., Čabilovski R., Mikić A. (2010): Potential of fodder kale (*Brassica oleracea* L. var. *viridis* L.) as a green manure crop. Cruciferae Newsletter, 29, 10-11.
Erić P., Mihailović V., Marinković R., Ćupina B., Marjanović-Jeromela A., Krstić Đ., Mikić A. (2007): Preliminary results of forage yields evaluation in some brassicas. Field and Vegetable Crops Research, 44, I, 455-459.
Krstić Đ., Ćupina B., Antanasović S., Erić P., Čabilovski R., Manojlović M., Mikić A. (2010): Potential of white mustard (*Sinapis alba* L. subsp. *alba*) as a green manure crop. Cruciferae Newsletter, 29, 12-13.
Mihailović V., Erić P., Marjanović-Jeromela A., Marinković R., Ćupina B., Krstić Đ., Mikić A. 2007. Preliminary results on growing oilseed rape and other brassicas for forage. Proceedings of the 12th International Rapeseed Congress *Sustainable Development in Cruciferous Oilseed Crops Production*, Wuhan, China, 26-30 March 2007, 287.
Mihailović V., Mikić A., Katić S., Vasiljević S., Marjanović-Jeromela A., Marinković R., Ćupina B., Erić P. (2008): Directions and achievements in breeding forage brassicas in Serbia. Proceedings of the International Conference *Conventional and Molecular Breeding of Field and Vegetable Crops*, Novi Sad, Serbia, 24-27 November 2008, 582-585.
Schuchert, W. (2006). Weisser Senf. Max Planck Institute for Plant Breeding Research, Cologne, Germany, http://www.mpiz-koeln.mpg.de/oeffentlichkeitsarbeit/kulturpflanzen/ Nutzpflanzen/Weisser_Senf/index.html