# FORAGE YIELD COMPONENTS IN SOME BRASSICAS

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## Abstract

Modern forage brassicas breeding programmes are aimed at the development of cultivars with high, quality and stable green forage yields, improved tolerance to low temperatures, drought and pests and early maturity. The goal of this study was to examine the variability and the correlation of green forage yield components and green forage yield in four forage brassicas, namely fodder kale, winter oilseed rape, spring oilseed rape and white mustard. A small-plot trial has been carried out in 2007 and 2008 at the Experimental Field of the Institute of Field and Vegetable Crops at Rimski Šancevi, including ten cultivars of each of these four species. In fodder kale, green forage yield was in positively correlated with leaf mass ($r$ = 0.839), stem mass ($r$ = 0.801) and plant height ($r$ = 0.661). The highest among the correlations among forage yield components was between number of lateral branches and number of internodes ($r$ = 0.873). In winter oilseed rape, all yield components were significantly positively correlated. Green forage yield was in positively correlated with leaf mass and stem mass (both $r$ = 0.976), plant height ($r$ = 0.860), number of internodes ($r$ = 0.834) and number of lateral branches ($r$ = 0.724). Among the forage yield components, plant height and stem mass were in the highest positive correlation ($r$ = 0.925). The lowest positive correlation was between number of lateral branches and leaf mass ($r$ = 0.651). In spring oilseed rape, green forage yield was in positively correlated with all forage yield components, such as stem mass ($r$ = 0.990). A high positive correlation was also between stem mass and leaf mass ($r$ = 0.972). Plant height and number of lateral branches and plant height and number of internodes were not correlated. In white mustard, green forage yield was in positively correlated with stem mass ($r$ = 0.990), number of lateral branches ($r$ = 0.891) and leaf mass ($r$ = 0.857). Number of lateral branches was positively correlated with stem mass ($r$ = 0.878) and leaf mass ($r$ = 0.780), while stem and leaf masses were also positively correlated ($r$ = 0.777).

**Key words:** fodder kale, forage yield, forage yield components, oilseed rape, white mustard

## Introduction

The strategic goal of modern forage brassicas breeding programmes is the development of cultivars with high, quality and stable forage yields, enhanced tolerance to low temperatures in autumn-sown genotypes, drought in spring-sown genotypes and pests, as well as early maturity in order to fit better into diverse cropping systems (Mihailović *et al.*, 2008b).

Fodder kale (*Brassica oleracea* L. var. *viridis* L.) is one of the most important forage brassica crops in many temperate regions of Europe (Erić *et al.*, 2006), highly appreciated for its high forage yields and regarded as one of the best preceding crops. Contemporary fodder kale breeding programmes are aimed at the development of cultivars with high, quality and stable forage yields, winter-hardy and with early maturity.

Winter-sown oilseed rape is grown mostly as an oil crop throughout Europe and is considered one of the most significant industrial crops. It may be used as an excellent forage crop as well, with a potential for forage yields of about 40 t ha$^{-1}$ of green forage and about 4 t ha$^{-1}$ of forage dry matter (Mihailović *et al.*, 2008b).

In comparison to winter-sown, spring-sown oilseed rape is less widely cultivated in numerous European countries. Although its primary purpose is oil production, spring oilseed rape may be cultivated for forage, with yields of more than 30 t ha$^{-1}$ of green forage and about 3.5 t ha$^{-1}$ of forage dry matter. It may produce two cuts, especially in rainy seasons (Erić *et al.*, 2007).

White mustard (*Sinapis alba* L. subsp. *alba*) is dominantly used for diverse industrial purposes, it can be cultivated for forage production as well. Most of white mustard cultivars grown for green forage are sown in early spring and have a rather brief period from sowing to cutting of about 60 days (Vučković, 1999). Breeding white mustard for forage production is aimed at high and stable forage yields, early maturity and increased resistance to drought and late spring frosts.

Breeding brassica species for forage production requires a detailed study on their forage yield components and their mutual relationship, with a final result in the form of the development of cultivars with high and stable green forage yields.

## Materials and methods

A series of small-plot trials has been carried out in the seasons 2007/2008 and 2008/2009 at the Experimental Field of the Institute of Field and Vegetable Crops at Rimski Šančevi. It included four brassica species, namely autumn-sown fodder kale, autumn-sown oilseed rape, spring-sown oilseed rape and spring-sown white mustard, and ten cultivars of each species.

All winter genotypes were sown in early October, while spring genotypes were sown in early March, at a seeding rate of 50 viable seeds m$^{-2}$, with a plot size of 5 m$^{2}$ and three replicates. All of them were cut in the stages of full budding and beginning of flowering (Mihailović *et al.*, 2007).

There were monitored plant height (cm), number of lateral branches (plant$^{-1}$), number of internodes (plant$^{-1}$), stem mass (g plant$^{-1}$), leaf mass (g plant$^{-1}$) and green forage yield (g plant$^{-1}$). The study results were processed by analysis of variance (ANOVA) with the Least Significant Difference (LSD) test applied. There were calculated simple correlation coefficients (*r*) between each of the monitored characteristics.

## Results and discussion

In fodder kale (Table 1), green forage yield was in positively correlated with leaf mass ($r$ = 0.839), stem mass ($r$ = 0.801) and plant height ($r$ = 0.661). The highest among the correlations among forage yield components was between number of lateral branches and number of internodes ($r$ = 0.873).

Table 1. Simple correlation coefficients (*r*) between green forage yield components and forage yield in fodder kale genotypes (Mihailović *et al.*, 2009)

| | Number of lateral branches | Number of internodes | Stem mass | Leaf mass | Green forage yield |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Plant height | 0.458 | 0.594 | 0.769** | 0.549 | 0.661* |
| Number of lateral branches | | 0.873** | 0.350 | 0.470 | 0.305 |
| Number of internodes | | | 0.616 | 0.731* | 0.493 |
| Stem mass | | | | 0.744* | 0.801** |
| Leaf mass | | | | | 0.839** |

* - significant at 0.05; ** - significant at 0.01

In winter oilseed rape (Table 2), all yield components were significantly positively correlated. Green forage yield was in positively correlated with leaf mass and stem mass (both *r* = 0.976), plant height (*r* = 0.860), number of internodes (*r* = 0.834) and number of lateral branches (*r* = 0.724). Among the forage yield components, plant height and stem mass were in the highest positive correlation (*r* = 0.925). The lowest positive correlation was between number of lateral branches and leaf mass (*r* = 0.651).

Table 2. Simple correlation coefficients (*r*) between green forage yield components and forage yield in winter oilseed rape genotypes (Marjanović-Jeromela *et al.*, 2010)

| | Number of lateral branches | Number of internodes | Stem mass | Leaf mass | Green forage yield |
|---|---|---|---|---|---|
| Plant height | 0.701* | 0.685* | 0.925** | 0.754* | 0.860** |
| Number of lateral branches | | 0.843** | 0.764* | 0.651* | 0.724* |
| Number of internodes | | | 0.843** | 0.786** | 0.834** |
| Stem mass | | | | 0.906** | 0.976** |
| Leaf mass | | | | | 0.976** |

* - significant at 0.05; ** - significant at 0.01

In spring oilseed rape (Table 3), green forage yield was in positively correlated with all forage yield components, such as stem mass (*r* = 0.990). A high positive correlation was also between stem mass and leaf mass (*r* = 0.972). Plant height and number of lateral branches and plant height and number of internodes were not correlated.

Table 3. Simple correlation coefficients (*r*) between green forage yield components and forage yield in spring oilseed rape genotypes (Mikić *et al.*, 2010)

| | Number of lateral branches | Number of internodes | Stem mass | Leaf mass | Green forage yield |
|---|---|---|---|---|---|
| Plant height | 0.393 | 0.578 | 0.784** | 0.756* | 0.780** |
| Number of lateral branches | | 0.753* | 0.771** | 0.735* | 0.765** |
| Number of internodes | | | 0.823** | 0.777** | 0.814** |
| Stem mass | | | | 0.972** | 0.997** |
| Leaf mass | | | | | 0.987** |

* - significant at 0.05; ** - significant at 0.01

In white mustard (Table 4), green forage yield was in positively correlated with stem mass (*r* = 0.990), number of lateral branches (*r* = 0.891) and leaf mass (*r* = 0.857). Number of lateral branches was positively correlated with stem mass (*r* = 0.878) and leaf mass (*r* = 0.780), while stem and leaf masses were also positively correlated (*r* = 0.777).

Table 2. Simple correlation coefficients (*r*) between green forage yield components and forage yield in white mustard lines (Mikić *et al.*, 2009)

| | Number of lateral branches | Number of internodes | Stem mass | Leaf mass | Green forage yield |
|---|---|---|---|---|---|
| Plant height | 0.517 | -0.337 | 0.473 | 0.047 | 0.398 |
| Number of lateral branches | | 0.122 | 0.878** | 0.780** | 0.891** |
| Number of internodes | | | 0.352 | 0.549 | 0.410 |
| Stem mass | | | | 0.777** | 0.990** |
| Leaf mass | | | | | 0.857** |

* - significant at 0.05; ** - significant at 0.01

**Conclusions**

The obtained results provide detailed information on the correlations between forage yield components in four forage brassica species and thus may provide breeders with useful data. The next generation of forage brassica cultivars, regardless of species, should be characterised by an optimal relationship between single green forage yield components and thus have enhanced potential for high and stable green forage yield.

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