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University of Banja Luka

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AGRORES 2024

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# XIII INTERNATIONAL SYMPOSIUM ON AGRICULTURAL SCIENCES

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# EDITORIAL

Agricultural production worldwide faces numerous challenges, including climate change, technology, social, and economic barriers. These obstacles must be overcome to meet the food demands of the growing population. The key to overcoming these challenges is knowledge. Scientific research can offer new insights into how we can adapt to the changing conditions that affect food production for both humans and animals.

The strategy of the European Union for Southeast Europe (SEE 2020) emphasizes that a knowledge-based economy should be the foundation for improving agriculture in the region and that in this sense, significant investments in research and innovation are necessary. The research and innovations should primarily be tailored to family farms, which are the main subjects of agricultural production in the Republic of Srpska, Bosnia and Herzegovina, and the surrounding area. In other words, the results obtained from scientific research must be accessible to agricultural producers, and this can be most effectively achieved through agricultural advisory services operating in the field. The previous statement applies to large agricultural combines, which are the backbone of agricultural production in some regions.

The results of significant scientific research in the field of food production are presented in these Proceedings.

The Proceedings contains 39 papers presented at XIII International Symposium on Agricultural Sciences "AgroReS 2024" in Trebinje, Bosnia and Herzegovina, from 27 to 30 May, 2024.

In the Proceedings are published only papers for which their authors choose that way of publishing. The Proceedings are published only in electronic form and are available free of charge on the AgroReS website (https://agrores.agro.unibl.org/).

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*President of the Organizing Committee*

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# Effect of mulching and fertilizing on yield and quality of kohlrabi (*Brassica oleracea* var. *gongylodes* L.)

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## Abstract

Kohlrabi is a short vegetation vegetable species from Brassicaceae family. In 2010 was examined influence of soil mulching with black polyethylene film and fertilizing on the yield and quality of kohlrabi. The trial was carried out during May and June on the experimental field of Agricultural Extension Service Sombor at the Toplana location. The two-factor experiment was set up in split-plot method in four replications. The main plots ~~(factor A)~~ include an experiment without mulching ~~(control)~~ and an experiment with mulching with a black polyethylene film. The sub plots ~~(factor B)~~ were fertilization treatments: 1. control - without fertilization (K); 2. mature cattle manure (CM), 3. composted pig manure (PM), 4. NPK fertilizer. Soil mulching with black polyethylene film significantly increased the kohlrabi total yield (20.8%) compared to the unmalched control. On average, all fertilization treatments achieved higher swollen stem weight compared to the control without fertilization. The average thickened stem weight on mulched plots was 310.8 g and 18.4% higher than control without mulch. All fertilization treatments achieved higher dry matter content compared to the control without fertilization. Based on the obtained results black polyethylene mulch should be used in mid-early kohlrabi production.

***Key words:*** kohlrabi, black polyethylene film, total yield, stem weight, dry matter content

## INTRODUCTION

As a part of Brassicaceae family, kohlrabi is a fast and short-growing moderate cool season vegetable crop (Zutić et al., 2016). Kohlrabi is grown largely for its spherical, thickened stem (Khan et al, 2023), and can be eaten fresh, cooked or pickled, while young leaves can be prepared as fresh salad or stew (Lešić et al., 2004). It is grown in the open field for spring and autumn consumption, but during the early spring, greenhouses should be the prevailing area for cultivation (Zutić et al., 2016). Open field kohlrabi production in second half of April and first half of May is influenced by unstable temperatures and moisture, so the application of polyethylene mulch has multiple benefits. Kosterna (2014) reported that mulching improves the chemical, physical, and biological properties of the soil and reduces weed population. Under artificial mulch soil temperature increases, soil moisture is conserved and harvested products are cleaner (Farjana et al., 2019). According to Dadheech et al. (2018) black plastic mulch can give a harvest earlier by some 7-14 days, and provides better quality and higher yields (Spizewski et al., 2010). Mulching reduces fertilizer leaching (Guo et al., 2019) and stimulates of soil microflora (Bandopadhyay et al., 2018), and enhances the production of above and belowground biomass (Zhang et al., 2006). The effects of mulching with black polyethilene film depend on the climate and weather conditions during the growing period and should be used in early vegetable production during cool conditions of early spring (Adamović et al., 2023). Organic fertilizers play a direct role in plant growth as a source of all necessary macro and micronutrients in forms accessible to plants during mineralization and improve physical and chemical soil properties (Abou El-Magd et al., 2006). According to same authors, organic fertilizers take longer to

transform nutrients into accessible forms (Bogdanović et al., 2014), while mineral fertilizers have a faster nutritive effect and are beneficial to plant growth and yield (Abou El-Magd et al., 2006).

The paper objective was to analyze the effects of mulching with black polyethylene film on thickened stem yield, the weight of thickened stem and dry matter content.

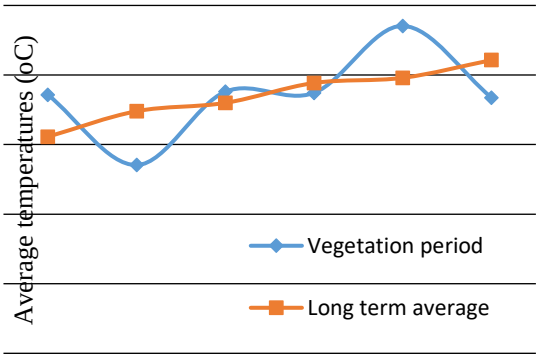
## MATERIALS AND METHODS

The field experiment was conducted in 2010 at the experimental field (45◦ 75′ 13″ N and 19◦ 13′ 52″ E) of the Agricultural Extension Service, Sombor, Serbia. The basic soil properties are shown in Table 1.

Table 1. Soil properties (soil depth 0-30 cm)

| pH $H_2O$ | pH KCL | Humus (%) | Total N (%) | AL-$P_2O_5$ (mg100g$^{-1}$) | AL-$K_2O$ (mg100g$^{-1}$) | $CaCO_3$ (%) | Mineral N | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | $NH_4$-N (kg ha$^{-1}$) | $NO_3$-N (kg ha$^{-1}$) |
| 7.6 | 7 | 3.12 | 0.2 | 21.9 | 22.1 | 4.59 | 28.00 | 36.05 |

The experiment was conducted in the conditions of drip irrigation, without any additional fertilization during the growing season. The mean air temperature and monthly precipitation during the experiment are given in Figure 1 and Figure 2.



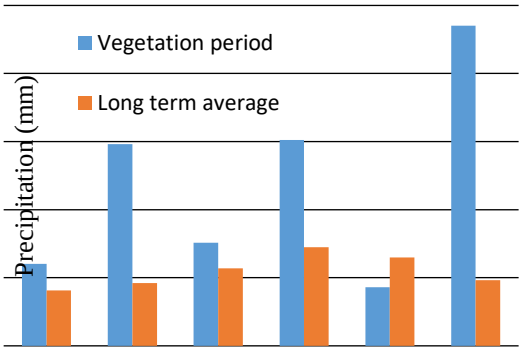




Figure 1. (Left) Mean air temperature (°C) and Figure 2. (Right) precipitation (mm) during the kohlrabi vegetation period in Sombor

The optimum temperature for kohlrabi growth is 15-18°C (Lazić et al, 2001). During May, temperatures were optimal for vegetative growth, while during June, temperatures were several degrees above optimal. During the kohlrabi growing season, 154 mm of precipitation was recorded, more than the long-term average.

The experiment was conducted using a two-factorial split-plot completely randomized design, with ground cover management (mulch) as a whole-plot factor and fertilization treatments in split-plots. The experiment was conducted with four replications.

The main plots (factor A) include an experiment without mulching (control) and an experiment with mulching with a black polyethylene film. The sub-plots (factor B) were fertilization treatments: control - without fertilization (K); mature cattle manure (CM), composted pig manure (PM), and NPK fertilizer. Organic fertilizers were applied in amounts of 20 t/ha. The chemical compositions of the applied organic fertilizers are presented in Table 2. Mineral complex NPK fertilizer (formulation 11:11:21) was applied in an amount of 300 kg/ha which contained 33 kg of N, 33 kg of $P_2O_5$ and 63 kg of $K_2O$. The whole amount of organic and mineral fertilizers was applied before transplanting kohlrabi.

Table 2. Chemical analysis of manure

| Type of manure | pH $H_2O$ | pH KCL | N (%) | $P_2O_5$ (%) | $K_2O$ (%) | Ash (%) | Organic matter (%) |
|---|---|---|---|---|---|---|---|
| CM | 6.9 | 6.6 | 1.2 | 1.82 | 0.33 | 24.84 | 75.16 |
| PM | 7.9 | 7.7 | 1.3 | 3.58 | 1.68 | 16.48 | 83.52 |

The early hybrid Volturno F1 Rijk Zwaan was used in the experiment. Seedlings were produced in the greenhouse in compressed square blocks (3 × 3 × 3 cm) using peat moss as a growing medium. The kohlrabi was transplanted in open field in the stage 5 to 6 completely developed leaves. Seedlings were transplanted with a 25 cm distance within rows and 30 cm between rows, thus reaching a density of 13.3 plants/$m^2$. The size of the plot was 3 $m^2$ and there were 40 plants on a single plot per repetition. Soil mulching was performed by applying non-degradable black polyethylene film (density 920 kg $m^3$, thickness 20 μm, width 80 cm), with two rows of kohlrabi being planted on one mulch strip. The drip irrigation method was applied with one dripper liner being installed along every row of planted kohlrabi, which had a capacity of 4 l/h/m. Kohlrabi was transplanted on May 8, and harvested on June 26. All plants were used to determine the examined parameters. Kohlrabi harvest was in technological maturity (stage 49 BBCH). The content of dry matter was determined by drying the samples to a constant mass at 105°C in an oven (POL EKO SLW 240 ECO INOX). Total yield consists of stem yield + leaves yield (Zutić et al., 2016). The achieved results were processed using statistical methods of analysis of variance using the program Statistica 13. The significance of the differences was verified using the Fisher test at the level of significance $\alpha = 0.05$.

## RESULTS AND DISCUSSION

Thickened stem weight

The average amount of stem weight in this study is 286.6 g (Table 3). On average for mulching, soil mulching with black polyethylene film significantly increased kohlrabi thickened stem weight (18.4%) compared to unmulched control.

Table 3. Stem weight (g)

| Variants | Mulching (A) | | Mean (B) |
|---|---|---|---|
| | WM | M | |
| K | $170.4^{g}$ | $227.0^{f}$ | $198.7^{C}$ |
| CM | $243.2^{e}$ | $236.5^{ef}$ | $239.6^{B}$ |
| PM | $350.6^{c}$ | $365.1^{b}$ | $345.2^{A}$ |
| $N_{33}P_{33}K_{63}$ | $285.4^{d}$ | $414.6^{a}$ | $368.8^{A}$ |
| Mean (A) | $262.4^{B}$ | $310.8^{A}$ | 286.6 |

*Values followed by different uppercase (mulching, fertilization) and lowercase (mulching x fertilization) letters are statistically significantly different at p<0.05*

This is in agreement with Khan et al., (2023) who presented average stem weight ranging between 281.8–332.6 g when treated with plastic mulch, compared to 257–305.76 grams without mulch. In researching on the other crop, Dadheech et al., (2018) and Adamovic et al., (2023) reported an increase in the mass of watermelon fruit and head mass of cabbage when the plants were grown with mulching. Available water and nutrients were better utilized in the early spring growing period than on unmulched soil Zutić et al., (2016). In average for fertilizing variants, the highest kohlrabi stem weight was obtained on $N_{33}P_{33}K_{63}$ (368.8 g) (Tab. 3) while the lowest was recorded in the control plot (198.7 g) without fertilizing. According to Abou El-Magd et al., (2006) mineral fertilizers have a faster nutritive effect and are beneficial to plant growth and yield. In comparison to the control, both organic manures variants achieved significantly higher stem weight. This is consistent with the results obtained by Uddin et al., (2009). Between PM and $N_{33}P_{33}K_{63}$ variants recorded 23.6 g of distinction, but there was no significant

difference. At all investigated variants higher stem weight was recorded on mulched plots, except CM. The distinction was from 14.5 g (PM) to 129.2 g ($N_{33}P_{33}K_{63}$).

On unmulched plots, the highest stem weight was obtained in the PM variant (350.6 g), whereas the lowest one was recorded in the K (170.4 g). In comparison to the PM, all variants achieved significantly lower stem weight. On mulched treatment, the highest stem weight was measured in $N_{33}P_{33}K_{63}$ (414.6 g), while the lowest was obtained in K (227.0 g). In comparison to the $N_{33}P_{33}K_{63}$ all investigated variants were recorded significantly lower stem weight.

Dry matter content

The average dry matter content in this study is 10.0%, as presented in Table 4. The same values were obtained by Gawęda and Nizioł-Łukaszewska (2011) for variety Delikates (9.59%), while Kovačević et al., (2022) measured higher content (14.47%). On mulched treatments average dry matter was 10.4% and significantly higher than unmulched treatments (9.6%). The same results quoted Wierzbicka (2019) in lettuce, while the opposite results were reported by Spizewski et al., (2010) in cucumber fruits and Adamczewska-Sowińska and Turczuk (2018) in tomato fruit hybrid Bristol F1, which lead to conclusion that dry matter content depends on the crop and agroecological conditions.

Table 4. Stem dry matter content (%)

| Variants | Mulching (A) | | Mean (B) |
|---|---|---|---|
| | WM | M | |
| K | $7.8^{e}$ | $9.4^{cd}$ | 8.6 $^{B}$ |
| CM | $10.6^{abc}$ | $10.8^{ab}$ | 10.7 $^{A}$ |
| PM | $8.9^{de}$ | $9.8^{bcd}$ | 9.4 $^{B}$ |
| $N_{33}P_{33}K_{63}$ | $11.2^{a}$ | $11.4^{a}$ | 11.3 $^{A}$ |
| Mean (A) | 9.6 $^{B}$ | 10.4 $^{A}$ | 10.0 |

*Values followed by different uppercase (mulching, fertilization) and lowercase (mulching x fertilization) letters are statistically significantly different at p<0.05*

In average for fertilizing variants, the highest dry matter content was measured in $N_{33}P_{33}K_{63}$ (11.3%), while the lowest in the K (8.6%) (Tab. 4). Same results recorded Yeshivas (2015) in cabbage production. In comparison to the K, variants $N_{33}P_{33}K_{63}$ and CM recorded significantly higher dry matter content. At all investigated fertilizing variants higher stem dry matter content was recorded on mulched plots.

On both mulched treatments, the highest dry matter content was obtained in $N_{33}P_{33}K_{63}$ variant (WM-11.2%; M-11,4%), whereas the lowest one was measured in the K (WM-7.8%; M-9.4%). Dumičić et al. (2011) stated the highest dry matter of cabbage in variant with mineral fertilizer. On both treatments, in comparison to the $N_{33}P_{33}K_{63}$, K and PM variants achieved significantly lower dry matter.

Total yield

In this study, the average total yield was 51.4 t/ha (Tab. 5). On average for mulching, soil mulching with black polyethylene film significantly increased total yield (20.8%) compared to control.

Table 5. Total yield (t/ha)

| Variants | Mulching (A) | | Mean (B) |
|---|---|---|---|
| | WM | M | |
| K | $31.9^{g}$ | $41.0^{f}$ | 36.5 $^{C}$ |
| CM | $44.8^{e}$ | $45.9^{e}$ | 45.4 $^{B}$ |
| PM | $59.6^{c}$ | $65.6^{b}$ | 62.6 $^{A}$ |
| $N_{33}P_{33}K_{63}$ | $49.6^{d}$ | $72.4^{a}$ | 61.0 $^{A}$ |
| Mean (A) | 46.5 $^{B}$ | 56.2 $^{A}$ | 51.4 |

*Values followed by different uppercase (mulching, fertilization) and lowercase (mulching x fertilization) letters are statistically significantly different at p<0.05*

Mulching treatment achieved 56.2 t/ha, while unmulched plots measured for 9.7 t/ha lower total yield. Higher marketable yield on mulching treatment is recorded by Zutić et al., (2016) on kohlrabi and Dadheech et al., (2018) on watermelon. Under artificial mulch soil temperature increases, soil moisture is conserved (Farjana et al., 2019) providing higher yields (Spizewski et al., 2010). Considering fertilizing variants, the highest total yield was obtained on PM (62.6 t/ha) while the lowest was recorded in the control plot (36.5 t/ha) without fertilizing. There was no significant difference between PM and $N_{33}P_{33}K_{63}$ variants, although a higher total yield was measured in PM. This is in agreement with Reza et al., (2016) who achieved a higher yield on the organic manure variant compared to the mineral fertilizers. Compared to the K, all fertilizing variants measured significantly higher total yield. At all investigated variants higher total yield was measured on mulched plots. The difference in favor mulching was from 1.1 t/ha (CM) to 22.8 t/ha ($N_{33}P_{33}K_{63}$). On unmulched treatments, the highest total yield was obtained in the PM variant (59.6 t/ha), whereas the lowest one was measured in the K (31.9 t/ha). In comparison to the PM, all variants recorded significantly lower total yield. On mulched treatment, the highest total yield was obtained in $N_{33}P_{33}K_{63}$ (72.4 t/ha), while the lowest was measured in K (41.0 t/ha). In comparison to the $N_{33}P_{33}K_{63}$ all investigated variants were recorded significantly lower total yield. This is in agreement with Ahmed et al. (2003) who quoted that combined application of plastic mulch and mineral fertilizer increased plant yield in kohlrabi.

## CONCLUSIONS

Application of mulching significantly increased the kohlrabi total yield, stem dry matter content and average stem weight. The applied organic and mineral fertilizers significantly increased total yield, average stem weight and dry matter, except in the case PM where increased dry matter wasn't significant. Based on the obtained results black polyethylene mulch should be used in mid-early kohlrabi production, especially in cold and wet spring conditions.

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