AgroLife Scientific Journal - Volume 4, Number 2, 2015
ISSN 2285-5718; ISSN CD-ROM 2285-5726; ISSN ONLINE 2286-0126; ISSN-L 2285-5718

GRAIN YIELD AND YIELD COMPONENTS AT MAIZE UNDER DIFFERENT PRECEDING CROPS AND SOIL TILLAGE CONDITIONS

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Abstract

The preceding crop and the soil tillage are among the important crop technology measures with a significant influence upon the yield, respectively upon the yield components which represent those elements participating to the yield formation. The aim of this paper is to present the grain yield and yield components at maize under different technological conditions in the specific growing conditions from South Romania. In this respect, field experiments were performed in the year 2014 in South Romania (44°29' N latitude and 26°15' E longitude), under rainfed conditions. Six maize hybrids were studied under two preceding crops, respectively sunflower and maize, and under two soil tillage, respectively ploughing and harrowing. There were determined the grain yield at 14% moisture content (kg.ha^{-1}) and the following ear yield components: ear length (cm), ear diameter (mm), number of kernels per ear, ear weight (g), kernel weight on ear (g), and weight of thousand seeds (g). The highest values of the grain yield and yield components were registered under maize as preceding crop and ploughing as soil tillage. Among the two preceding crops, maize determined higher values for the grain yield and yield components. Among the two soil tillage conditions, ploughing determined higher values for the grain yield and yield components, except for the weight of thousand seeds.

Key words: *maize, yield, yield components, preceding crop, soil tillage.*

INTRODUCTION

Maize (*Zea mays* L.) has a high grain yield potential, which is determined by the genetics of the cultivated hybrid and is influenced by the environmental factors that are affecting the plant growth (Ion et al., 2014). The yielding capacity of plants is determined by the yield components, which are the components that are participating to the yield formation (Ion et al., 2013).

The preceding crop and the soil tillage are among the important crop technology measures with a significant influence upon the yield, respectively upon the yield components.

Šeremešić et al. (2013) found that the effect of crop rotation on maize yield was inversely proportional to the ratio of the maize in the crop rotation. Ciontu et al. (2012) found that the three and four years of crop rotation play an important role in achieving safe and stable yields.

The benefits of crop rotation for land and water resource protection and productivity have been identified, but many of the rotation factors, processes and mechanisms responsible for increased yield and other benefits need to be better understood (Berzsenyi et al., 2000).

Tillage is one of important activities in the crop production system that optimizes the conditions of soil bed environment for seed germination, seedling establishment and crop growth (Wlaiwan and Jayasuriya, 2013). Different tillage practices may affect the growth and yield of maize due to different soil conditions created (Aikins et al., 2012).

Soil tillage is one of the greatest energy and labour consumer in a crop technology. In this respect, Košutić et al. (2005) found the following: no-till system enabled saving of almost 85% energy, while conservation tillage system enabled saving of 37-39% energy per hectare and per yield unit in comparison to conventional tillage system; labour requirement comparison shows that no-till soil tillage system saved 76-80%, while conservation tillage system saved 43-46% of labour; soil tillage systems differ with respect to achieved yields, but differences aren't statistically significant; however, the greatest maize yield achieved conventional soil tillage system.

Many farmers are converting to reduce tillage systems to diminish soil erosion and field-work time requirements, and to remain eligible for government programs (Lund et al., 1993).

Although different soil tillage managements have been widely investigated on different soil types in the USA and Canada, there are relatively few studies that have been conducted on the soils of South-East Europe (Videnović et al., 2011).

The aim of this paper is to present the grain yield and yield components at maize under different technological conditions (two preceding crops, respectively maize and sunflower, and two soil tillage, respectively ploughing and harrowing) in the specific growing conditions from South Romania.

MATERIALS AND METHODS

Researches were performed in field experiments located in South Romania, respectively at Moara Domneasca Experimental Farm (44^{o}29' N latitude and 26^{o}15' E longitude) belonging to the University of Agronomic Sciences and Veterinary Medicine of Bucharest. The field experiments were performed under rainfed conditions in the year 2014.

In the studied area, the specific soil is reddish preluvosoil, with humus content of 2.2-2.8%, clay loam texture, and pH of 6.2-6.6.

For the period April-August 2014, the average temperature was 18.8^{o}C, while the multiannual average temperature for this period is 18.5^{o}C. For the same period (April-August), in the year 2014 the sum of rainfall was 408.0 mm, while the multiannual average rainfall is 313.2 mm.

Six maize hybrids were studied, respectively: ES Method (FAO precocity group 380), ES Antalia (FAO precocity group 450), Korimbos (FAO precocity group 530), Janett (FAO precocity group 540), Mikado (FAO precocity group 550), ES Feria (FAO precocity group 550). Every hybrid was studied under two preceding crops, respectively sunflower and maize, and under two soil tillage, respectively ploughing and harrowing. Each experimental variant consisted in six lines with a length of 10 m.

For the variants with ploughing as soil tillage, one harrowing work was performed on 26th of September 2013, and the ploughing was performed at a depth of 18 cm two days later, on 28th of September 2013. For the variants with harrowing as soil tillage, two harrowing works were performed on 26th of September 2013, at a depth of 12 cm.

In spring, the soil preparation was performed by one harrowing passage on 1st of April 2014 and by one cultivator passage on 30th of April 2014.

The fertilization was performed with 106 kg.ha^{-1} of nitrogen and 60 kg.ha^{-1} of phosphorus. The weed control was performed by herbicides, which were completed by one manual hoeing. The sowing was performed on 30th of April 2014, at 50 cm between rows and a plant density of 80,000 plants.ha^{-1}.

The determinations of grain yield and yield components were performed at the ears from one square meter for each experimental variant. The grain yield was reported at moisture content of 14%, and the following determinations of the ear yield components were performed: ear length (cm), ear diameter (mm), number of kernels per ear, ear weight (g), kernel weight on ear (g), and weight of thousand seeds (g). The data are presented and analyzed within the paper as average values for the six studied maize hybrids.

RESULTS AND DISCUSSIONS

Grain yield at 14% moisture content. In average for all the experimental variants, the grain yield was of 8,466 kg.ha^{-1} (Figure 1).

Compared to soil tillage, the preceding crop determined larger variations of the grain yield, higher values being registered under maize as preceding crop compared to sunflower. Thus, the grain yield was in average of 9,023 kg.ha^{-1} under maize as preceding crop, while under sunflower it was of 7,909 kg.ha^{-1}.

Among the two soil tillage conditions, the ploughing determined higher values for the grain yield (8,592 kg.ha^{-1}) compared to harrowing (8,340 kg.ha^{-1}).

The smallest value of the grain yield was registered under sunflower as preceding crop and harrowing as soil tillage (7,796 kg.ha^{-1}), while the highest value was registered under maize as preceding crop and ploughing as soil tillage (9,163 kg.ha^{-1}).

Compared to harrowing, the ploughing determined a comparable increased of the grain yield according to the preceding crop, respectively from 7,796 to 8,021 kg.ha^{-1} when the preceding crop was sunflower, and from 8,884 to 9,163 kg.ha^{-1} when the preceding crop was maize. This situation conducted to a comparable increased of the grain yield determined by the preceding crop under the same soil tillage. Thus, the grain yield under harrowing conditions increased from 7,796 kg.ha^{-1} when sunflower was the preceding crop to 8,884 kg.ha^{-1} when maize was the preceding crop. Under ploughing conditions, the grain yield increased from 8,021 kg.ha^{-1} when sunflower was the preceding crop to 9,163 kg.ha^{-1} when maize was the preceding crop.

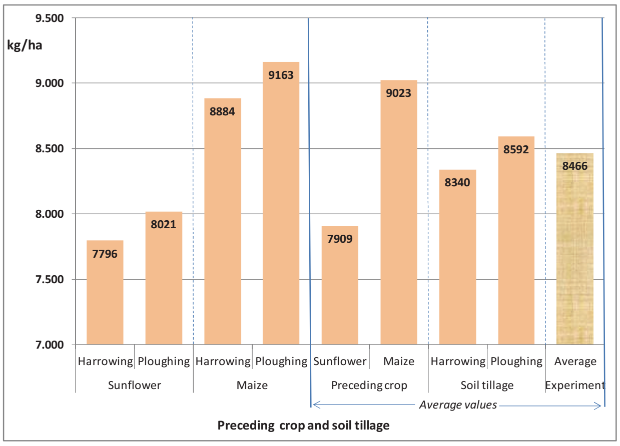

Figure 1. Grain yield at 14% moisture content at different preceding crops and soil tillage conditions

Ear length. In average for all the experimental variants, the ear length was of 15.1 cm (Figure 2).

Compared to preceding crop, the soil tillage determined larger variations of the ear length. Higher values were registered under ploughing conditions compared to harrowing conditions. Thus, the ear length was in average of 15.5 cm under ploughing conditions, while under harrowing conditions it was of 14.6 cm.

Among the two preceding crops, the maize determined higher values of the ear length (15.2 cm) compared to sunflower (14.9 cm).

The smallest value of the ear length was registered under sunflower as preceding crop and harrowing as soil tillage (14.4 cm), while the highest value was registered under maize as preceding crop and ploughing as soil tillage (15.6 cm).

Compared to harrowing, the ploughing increased more the ear length when the preceding crop was sunflower (from 14.4 to 15.4 cm) compared to maize as preceding crop (from 14.8 to 15.6 cm).

Under harrowing conditions, the maize as preceding crop increased the ear length compared to sunflower, respectively from 14.4 to 14.8 cm. Under ploughing conditions, the maize as preceding crop also increased the ear length compared to sunflower, but the difference is less important, respectively from 15.4 to 15.6 cm.

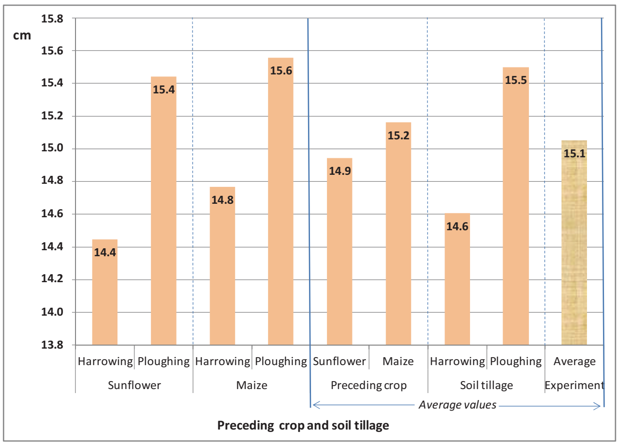

Figure 2. Ear length at different preceding crops and soil tillage conditions

Ear diameter. In average for all the experimental variants, the ear diameter was of 42.71 mm (Figure 3).

Opposite the situation registered for the ear length, compared to preceding crop, the soil tillage determined smaller variations of the ear diameter. Higher values of the ear diameter were registered under maize as preceding crop compared to sunflower. Thus, the ear diameter was in average of 42.93 mm under maize as preceding crop, while under sunflower it was of 42.49 mm.

Among the two soil tillage conditions, the ploughing determined higher values for the ear diameter (42.79 mm) compared to harrowing (42.63 mm).

The smallest value of the ear diameter was registered under sunflower as preceding crop and harrowing as soil tillage (42.33 mm), while the highest value was registered under maize as preceding crop, with values practically equal for the two soil tillage conditions, respectively 42.94 mm for harrowing and 42.93 mm for ploughing.

Compared to harrowing, the ploughing increased the ear diameter only for the sunflower as preceding crop, respectively from 42.33 mm to 42.65 mm.

Under harrowing conditions, the maize as preceding crop increased much more the ear diameter compared to sunflower, respectively from 42.33 to 42.94 mm. Under ploughing conditions, the maize as preceding crop also increased the ear diameter compared to sunflower, but the difference is less important, respectively from 42.65 to 42.93 mm.

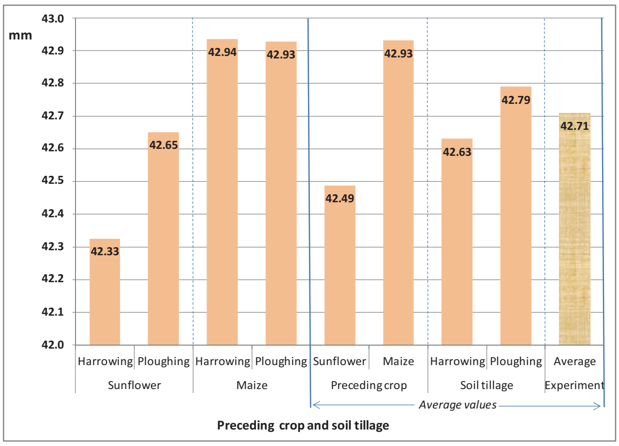

Figure 3. Ear diameter at different preceding crops and soil tillage conditions

Number of kernels per ear. In average for all the experimental variants, the number of kernels per ear was of 457 (Figure 4).

Compared to soil tillage, the preceding crop determined larger variations of the number of kernels per ear, higher values being registered under maize as preceding crop compared to sunflower. Thus, the number of kernels per ear was in average of 475 under maize as preceding crop, while under sunflower it was of 439.

Among the two soil tillage conditions, the ploughing determined higher values for the number of kernels per ear (466) compared to harrowing (447).

The smallest value of the number of kernels per ear was registered under sunflower as preceding crop and harrowing as soil tillage (421), while the highest value was registered under maize as preceding crop and ploughing as soil tillage (476).

Compared to harrowing, the ploughing increased much more the number of kernels per ear when the preceding crop was sunflower (from 421 to 456) compared to maize as preceding crop (from 473 to 476).

Under harrowing conditions, the maize as preceding crop increased much more the number of kernels per ear compared to sunflower, respectively from 421 to 473. Under ploughing conditions, the maize as preceding crop also increased the number of kernels per ear compared to sunflower as preceding crop, but the difference is less important, respectively from 456 to 476.

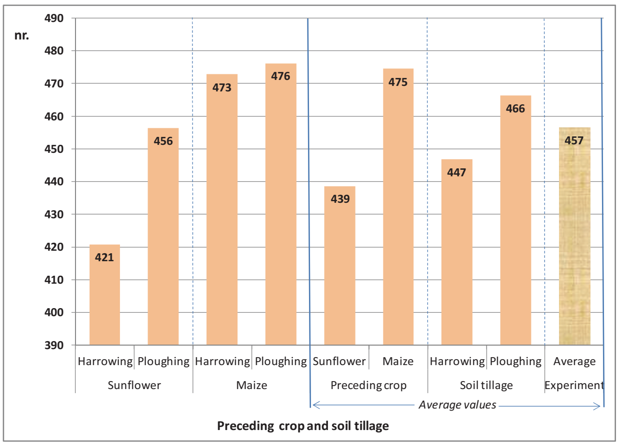

Figure 4. Number of kernels per ear at different preceding crops and soil tillage conditions

Ear weight. In average for all the experimental variants, the ear weight was of 125.43 g (Figure 5).

Compared to soil tillage, the preceding crop determined larger variations of the ear weight, higher values being registered under maize as preceding crop compared to sunflower. Thus, the ear weight was in average of 132.61 g under maize as preceding crop, while under sunflower it was of 118.25 g.

Among the two soil tillage conditions, the ploughing conditions determined higher values for the ear weight (128.55 g) compared to harrowing conditions (122.32 g).

The smallest value of the ear weight was registered under sunflower as preceding crop and harrowing as soil tillage (116.42 g), while the highest value was registered under maize as preceding crop and ploughing as soil tillage (137.00 g).

Compared to harrowing, the ploughing increased much more the ear weight when the preceding crop was maize (from 128.23 to 137.00 g) compared to sunflower (from 116.42 to 120.09 g).

Under ploughing conditions, the maize as preceding crop increased much more the ear weight compared to sunflower as preceding crop, respectively from 120.09 to 137.00 g. Under harrowing conditions, the maize as preceding crop also increased the ear weight compared to sunflower, but the difference is less important, respectively from 116.42 to 128.23 g.

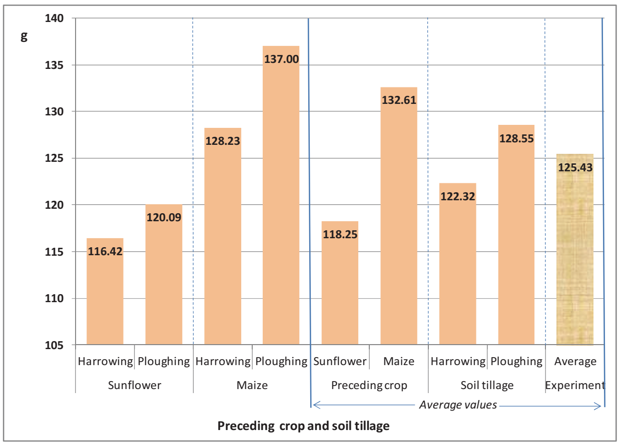

Figure 5. Ear weight at different preceding crops and soil tillage conditions

Kernel weight on ear. In average for all the experimental variants, the kernel weight on ear was of 107.89 g (Figure 6).

Compared to soil tillage, the preceding crop determined larger variations of the kernel weight on ear, higher values being registered under maize as preceding crop compared to sunflower. Thus, the kernel weight on ear was in average of 114.16 g under maize as preceding crop, while under sunflower it was of 101.63 g.

Among the two soil tillage conditions, the ploughing determined higher values for the kernel weight on ear (109.18 g) compared to harrowing (106.60 g).

The smallest value of the kernel weight on ear was registered under sunflower as preceding crop and harrowing as soil tillage (100.56 g), while the highest value was registered under maize as preceding crop and ploughing as soil tillage (115.66 g).

Compared to harrowing, the ploughing determined a comparable increase of the kernel weight on ear according to the preceding crop, respectively from 100.56 to 102.70 g when the preceding crop was sunflower, and from 112.65 to 115.66 g when the preceding crop was maize. This situation conducted to a comparable increase of the kernel weight on ear determined by the preceding crop under the same soil tillage. Thus, the kernel weight on ear under ploughing conditions increased from 102.70 g when sunflower was the preceding crop to 115.66 g when maize was the preceding crop. Under harrowing conditions, the kernel weight on ear increased from 100.56 g when sunflower was the preceding crop to 112.65 g when maize was the preceding crop.

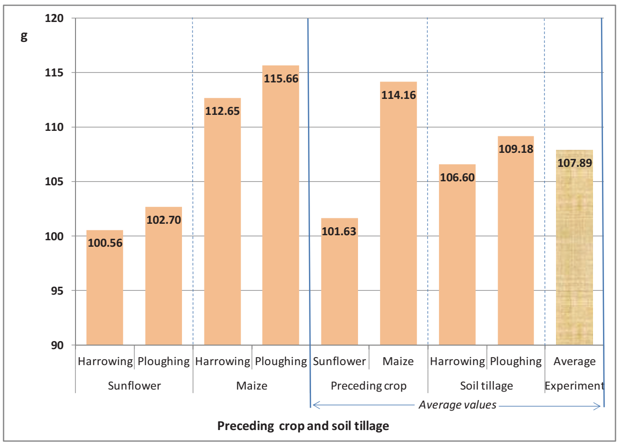

Figure 6. Kernel weight on ear at different preceding crops and soil tillage conditions

Weight of thousand seeds. In average for all the experimental variants, the weight of thousand seeds was of 238.59 g (Figure 7).

Among the two soil tillage conditions, the harrowing conditions determined higher values for the weight of thousand seeds (240.03 g) compared to ploughing conditions (237.16 g).

Among the two preceding crops, maize determined higher values for the weight of thousand seeds (240.60 g) compared to sunflower (236.59 g).

The smallest value of the weight of thousand seeds was registered under sunflower as preceding crop and ploughing as soil tillage (231.16 g), while the highest value was registered under maize as preceding crop and ploughing as soil tillage (243.16 g).

The soil tillage influenced differently the weight of thousand seeds according to preceding crop. Thus, compared to harrowing, the ploughing decreased the weight of thousand seeds when the preceding crop was sunflower (from 242.02 to 231.16 g), and increased the weight of thousand seeds when the preceding crop was maize (from 238.03 to 243.16 g).

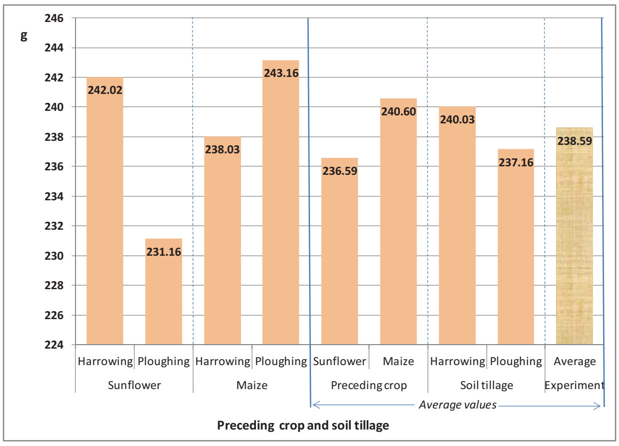

Figure 7. Weight of thousand seeds at different preceding crops and soil tillage conditions

CONCLUSIONS

The highest values of the grain yield and yield components were registered under maize as preceding crop and ploughing as soil tillage.

The smallest values of the grain yield and yield components were registered under sunflower as preceding crop and harrowing as soil tillage, except for the weight of thousand seeds where the smallest value was registered again under sunflower as preceding crop but under ploughing as soil tillage.

Among the two preceding crops, maize determined higher values for the grain yield and yield components.

Among the two soil tillage conditions, ploughing determined higher values for the grain yield and yield components, except for the weight of thousand seeds where the higher value was registered at harrowing conditions.

Compared to soil tillage, the preceding crop determined larger variations of the grain yield and yield components, except for the ear length where the larger variations were determined by the soil tillage.

ACKNOWLEDGEMENTS

The researches carried out for the elaboration of the present paper were financed by Romanian Program “Partnerships for Priority Domains”, project PN-II-PT-PCCA-2011-3.2-1778 “OPTImization of BIOMass and Approach to Water conservation” (OPTIBIOMA-W), Contract no. 45/2012.

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