POST HARVEST STRAW MANAGEMENT AS DECISIVE PARAMETER FOR FINAL YIELD OF CROPS

Zdenek Kviz, Milan Kroulik, Frantisek Kumhala, Jiri Masek
Czech University of Life Sciences in Prague
kviz@tf.czu.cz

Abstract. Straw management is usually quite neglected point in the overall cropping system. The basic precondition for good tillage and further crop growth is well performed harvest of the preceding crop - short stubble, well chopped straw and evenly distributed plant remains on the field surface. Good plant growth results in good crop yield when other variables such as the weather, sufficient fertilization and others, are favourable. Many authors found out that different tillage and straw treatments had a certain effect on the crop yield. There is also research evaluating different combinations of soil tillage and straw management including straw burning and their influence on the next crop yield. Our experimental measurements were performed in trial plots. The influence of plant remains on the next crop germination and growth was analysed. For the purpose of simulation of straw and chaff distribution quality across the working width of a combine harvester after its passage, two extreme variants with even and uneven plant remain distribution were established. All plots were treated under normal field conditions using conventional machinery. The number of plant individuals germinated and the number of tillers were counted at the experimental plots. The results of the measurements and their further analysis showed that there is a relationship between the amount of plant remains plus their quality of distribution and between the number of next plant individuals germinated and plant growth.

Keywords: plant remains, straw management, yield, conservation tillage.

Introduction

Straw management is a decisive factor when applying conservation tillage technologies in the cropping system. According to many authors, the basic precondition for good tillage and further crop growth is well performed harvest of the preceding crop - short stubble, well chopped straw and evenly distributed plant remains on the field surface [1; 2]. Good plant growth results in good crop yield when other variables such as weather, sufficient fertilization and others, are favourable.

Sow et al., 1997 [3] evaluated the influence of the tillage and residue management practices on grain sorghum (*Sorghum bicolor* L., Moench), namely the rooting depth and also the changes in the soil water content and cone index. Conservation tillage systems increased the sorghum grain yields by around 15 % compared to the conventional tillage system with ploughing. The root length in the 40 to 60 cm depth on reduced tillage plots was by 30 to 85 % greater compared to the conventional tillage.

Malhi at al., 2006 [4] found out that different tillage and straw treatments had generally no significant effect on the crop yield during the first three years observed. But after that time, reduced tillage plots produced 55, 32, and 20 % greater canola seed, straw and chaff respectively than the conventional tillage. There is also research evaluating different combinations of soil tillage and straw management including straw burning and their influence on the next crop yield [5].

Placement of straw remains into the seeding layer, which is very often to happen when using only shallow tillage without ploughing, has an adverse effect and reduces plant germination up to 68 % compared with 80 % germination ratio with straw incorporating by a plough [6].

There is also research evaluating different combinations of soil tillage and straw management including straw burning and their influence on the next crop yield [5]. The best results were achieved exactly for the straw burning technology and the worst for straw chopping and its shallow incorporation into soil.

It is evident from the cited papers that the influence of the tillage technologies and straw management systems used in practice on the next crop in general, depends on specific factors for each region, climatic and soil conditions. The objective of this study is evaluation of different straw management effects on the next plant yield.

Materials and methods

Experimental plots were chosen for the observation of plant remain management and its effect on the next plant yield – it means in details plant germination and growth when using conservation tillage technologies without ploughing. The soil in the field was Luvisol soil, according to the FAO

classification, altitude 410 m a.s.l. and with long term average precipitation and temperature 580 mm per year and 7.6 ºC, respectively. The soil texture was non-homogenous with the texture of sandy loam. The trial plots were observed during four consecutive years. For the purpose of simulation of straw and chaff distribution quality across the working width of a combine harvester after its passage, the following straw management variants were established in the trial field. It has to be stated in advance that all measurements were carried out under normal field conditions under conventional machinery operation which is commonly used in practice.

Firstly, the trial plots with even chopped plant remain distribution of the preceding crop after 6.10 m combine harvester header working width were established. The evenness was improved manually because the combine harvester was not able to perform ideal plant remain distribution itself. These plots were taken as control plots. Secondly, the plots with extremely uneven plant remain distribution were established – the same combine harvester was working with its straw chopper engaged but the distributing mechanism was dismounted. It resulted in straw and chaff strip placed along the combine passage axis which was approximately 3 m wide. So, generally there were two strips on both sides of the combine passage with almost no plant remains on the field surface and one middle strip containing majority of plant remains from the harvested area. The real amount of plant remains per square meter was weighed and recorded for each trial plot. Conservation tillage (shallow tillage with shovels and discs) was carried out on all trial plots.

Further, the influence of non-even distribution of plant residues and their excessive amount placed on the field surface after harvest on next plant germination and growth was observed. The number of plant individuals of the next crop germinated and the number of tillers was counted in the established trial plots. The germinated plant individuals were counted on the 40^{th} day after seeding and the number of tillers was observed at the end of tillering period according to the weather in the particular year.

Results and discussion

Firstly, 12 trial plots were established during the harvest time in the consecutive four years always in the same way. The plots with uneven plant remain distribution (6 plots) were 6 m wide (corresponding with the combine harvester header working width) and 90 m long. These plots were further divided by 30 m lengthwise, so finally 18 trial plots were observed for the variant. The middle strip, approx. 3 m wide (2/4 of the combine harvester header working width) with concentrated chopped plant remains on the field surface left after combine harvester passage, contained 92-96 % of all plant remains from harvest – places with high amount of plant remains per square meter (PHA). The range of the plant remain amount was between 669 $g \cdot m^{-2}$ and 1279 $g \cdot m^{-2}$ during the observed years. The remaining 4-8 % of plant remains were placed at outer parts (outer quarters) of the combine harvester header working width which corresponded with 35-77 $g \cdot m^{-2}$ of plant remains on the field surface – places with low amount of plant remains per square meter (PLA). These places PHA and PLA were compared concerning the number of plant individuals germinated and the number of tillers grown there.

Trial plots with very even plant remains distribution on the field surface across the whole combine harvester header working width after its passage were also established. They were of the same size as the plots with uneven distribution and were used as an etalon - control plots.

The overall overview of the amounts of plant remains left in the field per square meter at PHA and PLA and the corresponding reductions in the number of plant individuals germinated and tillers grown during the observed years is in Table 1.

Generally, it follows from the measured values and their further analysis and also from Fig. 1 and Fig. 2, that there is a relationship between the amount of plant remains and their quality of distribution and between the number of plant individuals germinated and the number of tillers of the next crop.

Statistically significant difference was found for the values of the above mentioned parameters between places with excessive amount of plant remains and places with low amount of plant remains in each year observed. It could be generalized with small exceptions that the higher amount of plant residues placed on the field surface after harvest and the more uneven placement of residues the less plant individuals germinated and the less plant individuals after tillering phase was counted. This fact can significantly influence the final yield and income from a hectare of a field.

Table 1

Reduction in number of plant individuals germinated and number of tillers in dependence on amount of plant remains placed on field surface after harvest

Year	Plant remains per square meter		Reduction in plant individuals number at PHA when compared with PLA	
	plant remains at PHA, g·m^{-2}	plant remains at PLA, g·m^{-2}	reduction in plants germinated, %	reduction in tillers grown, %
1	669	36	5.2	11.0
2	806	46	8.3	14.5
3	1279	62	11.7	18.0
4	720	43	7.7	14.7

The trial was carried out under real field conditions and under conventional machinery operation which is commonly used in practice and also with a real amount of plant remains. Except of the germination rate, the number of plant individuals germinated and number of tillers also the weight of thousand gains (WTG), number of ears, weight of grain per ear and final yield were evaluated during this experiment on these trial plots. However, the processing and evaluation of these data are not included in this article.

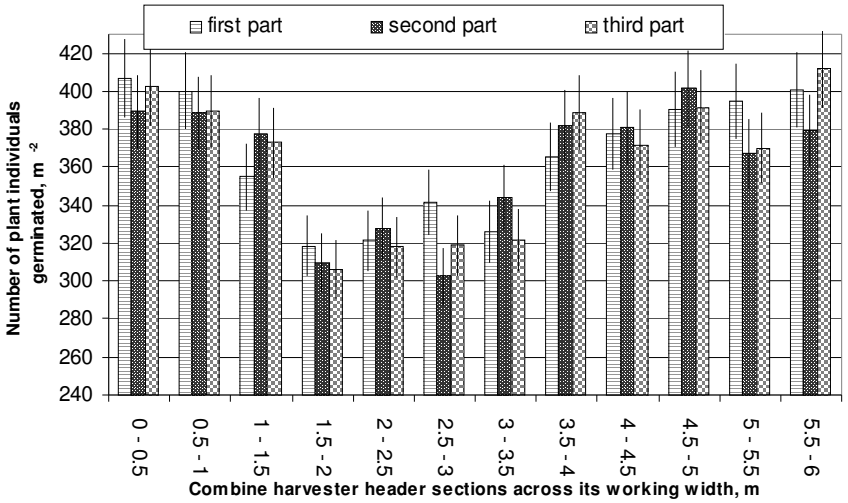

Fig. 1. **Number of plant individuals germinated at different sections across the combine harvester working width (counted 40th day after seeding, uneven placement variant, 1st trial plot divided into 3 sections)**

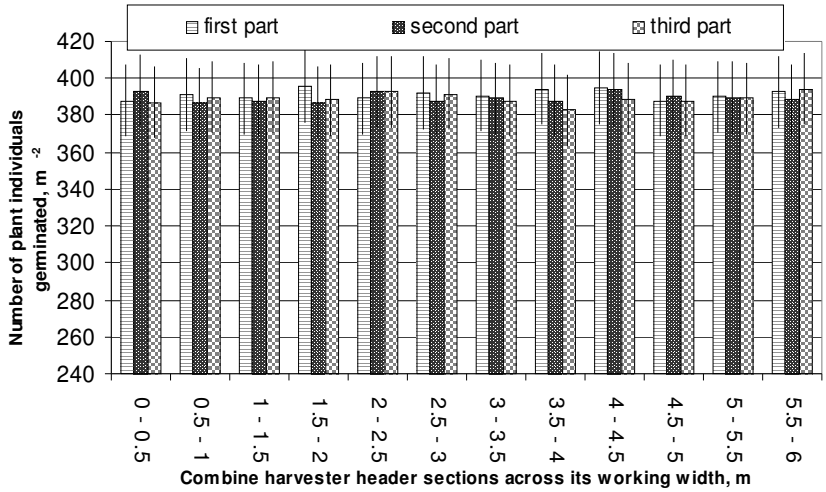

Fig. 2. **Number of plant individuals germinated at different sections across the combine harvester working width (counted 40th day after seeding, even placement variant, 1st trial plot divided into 3 sections)**

Conclusion

The number of plant individuals of the next crop germinated and the number of tillers was counted in the established trial plots with evenly and unevenly distributed preceding crop plant remains on the field surface. The conservation tillage system was used, namely, all the trial plots were tilled once with a shovel tiller and once with a disc tiller before seeding and thus plant remains were only shallowly incorporated into the soil or left on the field surface.

It was found out and statistically proved that the excessive amount of plant residues left on the field surface – places with uneven distribution of plant remains in practice, had a significant influence on the next crop seed germination and further plant growth.

Germination was reduced by 5.2 % to 11.7 % and reduction of tillers was in the range between 11.0 % and 18.0 %.

This finding could be a potential cause for lower yields from places with the excessive amount of plant remains left on the field surface after harvest – usually places with poor quality of plant remain distribution after a combine harvester passage. This parameter will be observed during currently running field trials.

References

1. Raoufat M. H., Mahmoodieh R. A. Stand Establishment Responses of Maize to Seedbed Residue, Seed Drill Coulters and Primary Tillage Systems. Soil and Tillage Research. 2005. Vol. 90, Issue 3, pp.261-269.
2. Bahrani M. J., Raufat M. H., Ghadiri H. Influence of wheat residue management on irrigated corn grain production in a reduced tillage system. Soil and Tillage Research. 2007. Vol. 94, Issue 2, pp. 305-309.
3. Sow A. A., Hossner L. R., Unger P. W., Stewart B. A. Tillage and residue effects on root growth and yields of grain sorghum following wheat. Soil and Tillage Research. 1997. Vol. 44, Issue 1-2, pp. 121-129.
4. Malhi S.S., Lemke R., Wang Z.H., Chhabra B.S. Tillage, nitrogen and crop residue effects on crop yield, nutrient uptake, soil quality, and greenhouse gas emissions. Soil and Tillage Research. 2006. Vol. 90, Issue 1-2, pp. 171-183.
5. Heege H. J., Voßhenrich H. H. Interactions between Soil Cultivation and Climate. ISTRO 2000, 15th Conference of the International Soil Tillage Research Organization, 2000, Fort Worth, Texas, Book of Proceedings, pp.125-133
6. Prochazkova B., Dovrtel J. The effect of different soil tillage on the yields of winter wheat. Rostlinna vyroba. 2000. Vol. 46, Issue 10, pp. 437-442.