Stability of Soil Aggregates Affected by soil tillage and organic and inorganic fertilization in long-term field experiments

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Introduction

The aggregate stability of soils, as the extent of the resistance against different types of soil degradation processes, are at the forefront of the soil physical researches. The aggregates themselves can be considered as gathering of primary soil particles; inside of these, the components bond higher forces together than to other soil particles around them.

Higher aggregate stability values are essentially important for the maintenance and increase of soil fertility. From an agronomical aspect, besides the erosion processes, soil tillage and fertilization systems can influence the aggregate stability of soils. The effect of these management methods can be investigated reliably only in long-term field experiments. However, in the literature, only a few results can be found from long-term field trials (e.g. Aoyama et al. 1999, Blanco-Moure et al. 2012).

The aim of our investigations was to study the effects of soil tillage, farmyard manure application and straw+green manure incorporation as well as the increasing doses of inorganic N-fertilization on the macroaggregate stability of soil, in two long-term field experiments.

Material and method

A study was conducted in a 46 years old maize-winter wheat bicultural tillage experiment and in the 35 years old International Mineral and Organic Nitrogen Fertilization Trial (IOSDV) located in Keszthely, Hungary. The soil tillage experiment has two factors; the main factor is tillage, with three different cultivations: deep winter ploughing (conventional tillage system), shallow winter disking (shallow tillage system) and disking just before drilling (minimum tillage system). The second factor is fertilization, the mineral N-rates in case of maize are 0-120-180-240-300 kg ha⁻¹. The trial was arranged in a split-plot design with four replications. The IOSDV trial is a bifactorial experiment which has a strip-plot design with three replications. The two factors are the complementary applications of different forms of organic fertilizers and increasing rates of mineral N fertilization. The organic fertilizers have 3 different variants: no organic fertilizer application (control, straw is removed), farmyard manure (FYM) application (35 t/ha, in every third year, straw is removed), straw/stalk (St) incorporation. After winter barley on the St plots, an extra green manure (GM) is applied (Raphanus sativus var. Oleiformis). The N rates are 0-70-140-210-280 kg ha⁻¹ in case of maize.
During the vegetation period, samples were collected from the selected maize plots three times: firstly two weeks after emerging, secondly after flowering in August, lastly before harvesting in October. During the investigations, a „Wet Sieving Apparatus” distributed by Eijkelkamp Agrisearch Equipment (The Netherlands) was used. For the examinations, 4 grams of soil samples were measured. The samples were treated with 0,1M Sodium pyrophosphate for „sand” correction. The measurements were carried out with three repetitions in all of the sampled plots. For the statistical evaluation, ANOVA with Duncan post-hoc tests were performed.

Results and discussion

As a function of different soil tillage systems, aggregate stability decreased with the increasing intensity of soil tillage. Conventional ploughing resulted in the lowest, while minimum tillage resulted the highest values of stability. The stability values significantly decreased with sampling dates. Considering the IOSDV trial, the additional application of FYM didn’t result in a significant difference compared to the sole NPK treatment, even slightly lower values were measured. Opposing this, St+GM application significantly increased the stability of soil macroaggregates in the average of all sampling dates and N-supplies. When averaged over the variants of nitrogen fertilization and organic matter supply, with the time of sampling the WSA values increased, however, this increase was more considerable in the first half of the vegetation period.

Conclusions

Conventional ploughing resulted in significantly lower stability values as minimum and shallow disking tillage system. Increasing of the N-fertilizer doses significantly decreased the stability of aggregates. Residue incorporation resulted in significant increase in WSA-values, while in contrast FYM application reduced WSA-values in case of higher N-fertilizer rates. As concluded from the results, application of reduced tillage systems could be effective to maintain higher stability values. Besides, residue incorporation is proved to be a very effective tool to sustain and increase the stability of soil macroaggregates on arable land when soil is regularly disturbed.

References


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