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Soybean nodulation and symbiotic nitrogen fixation in response to soil compaction and mulching

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Symbiotic nitrogen fixation by legume crops such as soybean plays a key role in supplying nitrogen for agricultural systems. In symbiotic associations with *Bradyrhizobium japonicum* soybean can fix up to 200 kg N ha^{-1} yr^{-1}. This reduces the need for expensive and often environmentally harmful because of leaching nitrogen fertilization. However both soybean nodulation and nitrogen fixation are sensitive to soil conditions. One of the critical soil constraints is soil compaction. Increasing use of heavy equipment and intensive cropping in modern agriculture leads to excessive soil compaction. Compaction often is found as a result of field operations that have to be performed in a very short period of time and when soils are wet and more susceptible to compaction. This results in unfavourable water content, temperature, aeration, pore size distribution, strength for plant growth and microbial activity. The surface mulching can alleviate the adverse effect of the environmental factors on soil by decreasing fluctuation of soil temperature, increasing moisture by controlling evaporation from the soil surface, decreasing bulk density, preventing soil crusting. The effect of mulch on soil conditions largely depends on soil compaction and weather conditions during growing season. The positive effect of the straw mulch on soil moisture has been seen under seasons with insufficient rainfalls. However thicker layers of mulch can act as diffusion barrier, especially when the mulch is wet. Additionally, low soil temperature prevalent during early spring under mulch can impede development of nodule, nodule size and delay onset of nodulation. The aim of this study was to determine the effect of the straw mulch on nodulation and nitrogen fixation of soybean in variously compacted soil.

The experimental field was 192 $m^2$and was divided into three parts composed of 6 micro-plots with area 7 m^2. Three degrees of soil compaction obtained in each field part through tractor passes were compared: low, medium and heavy (0, 3 or 5 passes, respectively). This resulted in a wide range of soil bulk density (1.2 to 1.65 Mg m^{-3}) that can occur in the arable fields. To obtain uniform conditions for seed germination and initial seedling growth the entire plot area was tilled with a cultivator-harrow to a depth of 5 cm after soil compaction. Soybean “Aldana” seeds inoculated with *B. japonicum* were sown in rows with spacing of 0.3 m. After sowing half of each micro-plot was mulched with wheat straw (0.5 kg m^{-2}) and another one – not. Nodulation was evaluated by using the parameters of nodule number and nodule weight and acetylene reduction assay was used for the measurement of nitrogenase activity. Number of nodules on root system under mulched and not mulched soil was the highest in not compacted and medium compacted soil, respectively and the lowest – in most compacted soil with mulch. Nitrogenase activity (μmol C_2H_4 h^{-1} $plant^{-1}$) decreased as soil compaction increased but the more pronounced tendency and higher values were obtained in mulched plots. The results indicate that mulching in some range of soil compaction can improve soybean nodulation and nitrogen fixation.

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