FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: SOIL PHYSICO-CHEMICAL QUALITY

Reference 30

Alvarez, Roberto; Steinbach, Haydee S.; De Paepe, Josefina L. 2017 Cover crop effects on soils and subsequent crops in the pampas: A meta-analysis Soil and Tillage Research 170, 53-65 10.1016/j.still.2017.03.005

Background and objective

Cover crops are a valuable management option for reducing soil erosion and nitrogen losses from agroecosystems. They improve soil quality but the impacts on crop yield depend on the type of cover crop, the commercial crop considered and the climate. In the Argentine Pampas the introduction of cover crops in rotations is being extensively studied by official institutions. Our aim was to perform a meta-analysis of available information on winter cover crop effects on physical and chemical soil properties, soil available water content and soybean and corn yield in order to generate possible management recommendations based on an overall evaluation of the impact of this type of crops on local agroecosystems.

Search strategy and selection criteria

We searched for published results of field experiments in which cover crop effects were evaluated on soils and crops in the Pampas. All possible information sources were taken into account. Information used came from peer reviewed journals, experimental station technical bulletins and scientific congress proceedings in which full length papers were available. Search in peer review journals was performed using Scopus and Google Scholar. Combinations of the words cover crops or catch crops or green manure and Argentina or Pampas or Pampean Region were used as search terms. A local scientific journal devoted to soil science available on line (Ciencia del Suelo) was entirely reviewed. An on line search was performed of technical bulletins from the experimental stations of the Instituto Nacional de Tecnología Agropecuaria, an official institution devoted to field experimentation and agricultural extension. Proceedings of the National Soil Science Congress for the last 26 years (9 proceedings) were also revised. An experiment had to meet the following criteria: 1) it had to be performed by an official institution under field conditions, 2) management practices had to be similar to those applied under production scenarios, 3) a control treatment under bare fallow had to be compared against at least one cover crop treatment, 4) the cover crop species had to be identified, 5) treatments could differ only in fallow-cover crop management and all other factors (grain crop, varieties, fertilization, etc.) had to be similar, 6) the experimental design had to be clearly described (in three cases we contacted the authors of the experiments for some additional missing information), 7) average and number of replications of the control and the cover crop treatments had to be reported for at least one of the following variables: soil bulk density, soil penetration resistance, structural stability, infiltration, organic carbon content, nitrate-N level, available water content, or yield of soybean or corn, 8) experiment duration and time of measurement had to be indicated, 9) sampling depth of soil properties had to be specified. Report of treatment variances was not considered as a requisite in this selection because these were not included in many sources and this would have made the meta-analysis impossible. In around 12% of cases (across all variables and experiments) standard deviation or standard errors were available for the control and cover crop treatments, in which case they were extracted. Usually, variability of the reported means was included in one or two studies for each addressed variable.

Data and analysis

The statistical significance of the cover crop effect was determined using ln(RR). A bias-corrected for skew 95% confidence interval was estimated by bootstrapping resampling methods (Adams et al., 1997) performing 1000 iterations. The ln(RR) was considered to be significant ($P < 0.05$) if its confidence interval did not overlap with one (Rosenberg et al., 2000). When the confidence interval of two different ln(RR) did not overlap they were also considered significantly different ($P < 0.05$).

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
62	In all the experiments the commercial crops were soybean or corn and always sowed after the cover crop.	Cover crops	No cover crops	Metric: 1) Soil penetration resistance; 2) Soil structural stability; 3) Soil water infiltration; Effect size: Logarithm of ratio of considered metrics in system with fertilization with legume cover crops as green manure to the considered metrics in systems with bare soil and N fertilization.	81.25

Results

- Soil penetration resistance was greatly impacted by the adoption of cover crops. Soil resistance decreased in all experiments and depths, in some cases as much as ca. 0.5-0.6 kPa. On average, it was around 15–20% lower under a cover crop than under fallow both in the 0–10 and the 10–20 cm layers.
- Structural stability was generally greater under cover crops but it decreased in 24% of cases. The increases ranged from 1 to 18%. The overall evaluation showed a 12% average positive and significant effect of cover crops on stability
- Infiltration was also enhanced by cover crop use. In 82% of cases infiltration increased under cover crops with half of them exceeding 25 mm h–1. The average infiltration increase was around 36%
- NULL
- NULL

Factors influencing effect sizes

- Soil depth : The impact of cover crops on available water stored in the soils depended on the soil depth considered. In the upper soil layers changes produced by the introduction of cover crops in the rotations had both positive and negative effects but in deep soil layers this trend was clearly negative.

Conclusion

Soil penetration resistance was greatly reduced (15-20%) by the adoption of cover crops. There was a 12% average positive and significant effect of cover crops on soil structural stability. Infiltration was enhanced by cover crop use.