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Impact of tillage practices on dry soil aggregate distribution in different soil types in Austria

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1. Introduction

Conventional (arable) agriculture is mainly based on tillage operations. Tillage has been considered to increase soil fertility through mineralization of soil nutrients. At first mechanical tillage creates a good soil tilth for root and crop growth (Lal 1991), but continuous misuse of tillage implements is one of the main causes of soil degradation in agricultural lands (Lal 1994). The main benefit of CA is to preserve the soil in more or less semi-natural conditions as soil disturbance by cultivation is minimized and chemical and physical depletion are reduced (Kertesz, 2004). Soil aggregation is one of the main factors controlling the chemical, physical, and biological processes that contribute to soil productivity and agricultural sustainability. Several studies showed that conservation tillage improved soil aggregation even within short-term application (D'haene et al., 2008, Coppens et al., 2006). The interaction of clay colloids with organic compounds and inorganic cementing materials creates soil aggregates by forming organo-mineral complexes (Strestha et al, 2006). This explains that soil aggregate formation is dependent on soil texture. A review of available literature indicates that different soil types and management practices have a strong effect on soil properties, like aggregation. (Strestha et al, 2006). Several methods exist to express soil aggregation, however, dry sieving provides the naturally existing situation of aggregates unlike wet sieving where most information about naturally occurring peds is lost (Yang et al, 1998). Therefore dry aggregate size distribution could be considered to represent the actual state of soil aggregation and soil structure. Hevia et al., (2007) found out that differences in size of these aggregates have been associated with the effect of different tillage practices. Little is known about the effect of different tillage practices on the distribution of dry aggregates in different soil types and their temporal change. The objectives of this study were therefore to investigate the impact of tillage practices on dry mean weight diameter (DMWD) in different soil types and to determine the range of aggregate sizes that are affected by tillage practices in spring and autumn.

2. Materials and Methods

This study is part of the long-term experiment of different soil management practices at 5 sites with different soil type in lower Austria. The experiment was started at different periods in each experimental site. The name of the sites are Kirchberg, Mistelbach, Pixendorf, pyhra

and Tulln. Table 1 shows some of the physicochemical properties of each site and the start of the soil management practices. Composite surface soil (0-10 cm) samples were collected from the experimental sites treated with different tillage practices in spring and autumn 2008. The management practices were conventional tillage (CT), reduced tillage (RT) and No till (NT) that are implemented at different period of time in lower Austria.

Table1. General characteristics of the experimental sites

Study Sites	Av. annual T (°C)	Av. annual Rainfall	Sand (%)	Silt (%)	Clay (%)	Soil texture	EC	pH	Start of CA
Kirchberg	9.1	730	53	27	20	Sandy clay Loam (SCL)	266	6.6	2007
Mistelbach	9.6	645	8	68	24	Silt loam (SL)	179	7.9	1994
Pixendorf	9.4	685	25	58	17	silt loam (SL)	173	8.0	1999
Pyhra	9.4	945	43	37	20	Loam (L)	73	7.0	1994
Tulln	9.4	685	13	37	50	Clay (C)	195	7.9	1999

3. Result and Discussion

The soil textures were loam (L), sandy clay loam (SCL), clay (C) and silt loam (SL). Samples were air dried and passed through a nest of sieves to provide soils with aggregate size groups; namely <1 mm, 1-2 mm, 2-4 mm, 4-8 mm and 8-22.4mm. The overall result shows that NT has significantly higher ($P< 0.0001$) DMWD followed than RT and RT has also significantly higher DMWD than CT. NT in L has significantly higher DMD than in all other soil types and tillage practices. This shows the strong interaction (0.0136) between tillage practices and soil texture. In general, L has the highest DMWD (7.60 mm) than SCL (6.76 mm) and C (6.69 mm) where as SL has the lowest (6.21 mm). The implementation of NT in silt loam for 14 years in Mistelbach resulted in a reduction of DMWD by 2 % compared as CT. Where as in Pixendorf, after 9 years of application, it resulted in 11 % increase as compared to CT. Largest increase in DMWD was observed in Clay soils (26 %) after 9 years of conservation tillage implementation followed by sandy clay loam soil (19 %) just after one year of NT application. In general, implementation of NT resulted in –2 % to 26 % increase in DMWD in all the experimental sites.

The DMWD of all soils in autumn was significantly ($p< 0.0001$) higher than in spring. The smaller dry mean weight diameter during spring could possibly be due to mechanisms deteriorating aggregation like raindrop impact, repeated soil drying and wetting and repeated soil freezing and thawing, while the higher value in autumn could be soil drying and warming and improved biological activity associated with the weather condition. In autumn, there is significantly high percentage of aggregate size in the range 8-22,4 mm and 4-8 mm and significantly low percentage of 2-4 mm, 1-2 mm and <1 mm aggregate ranges.

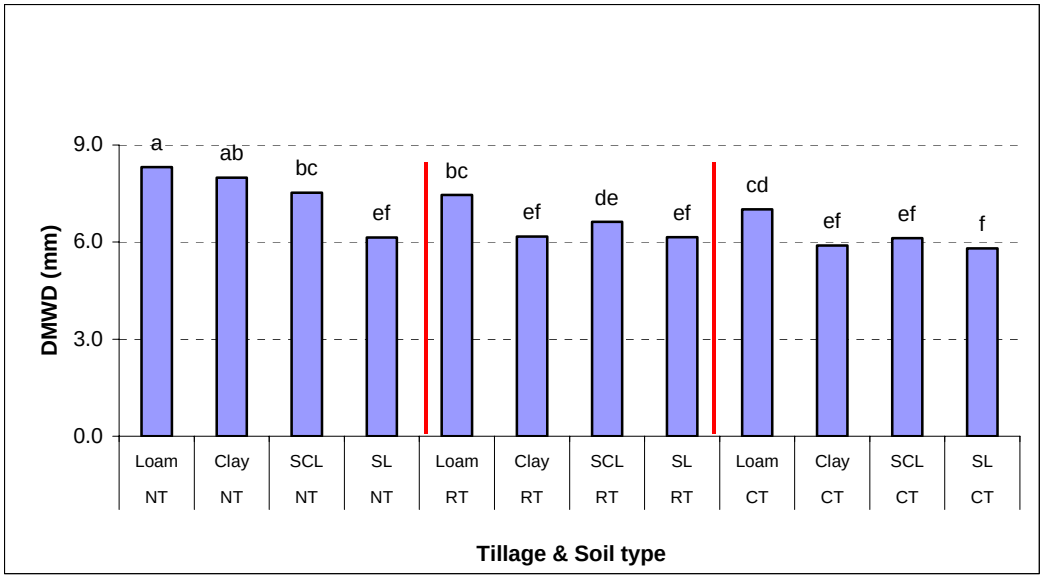
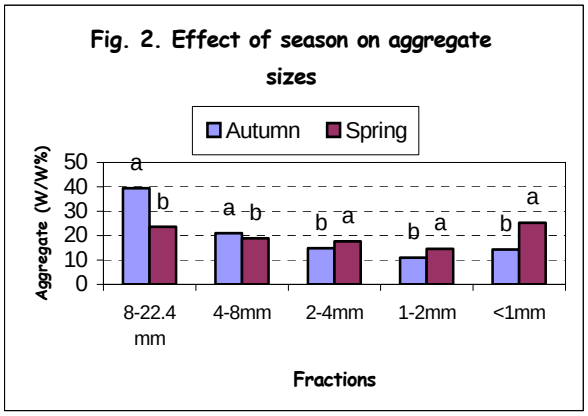
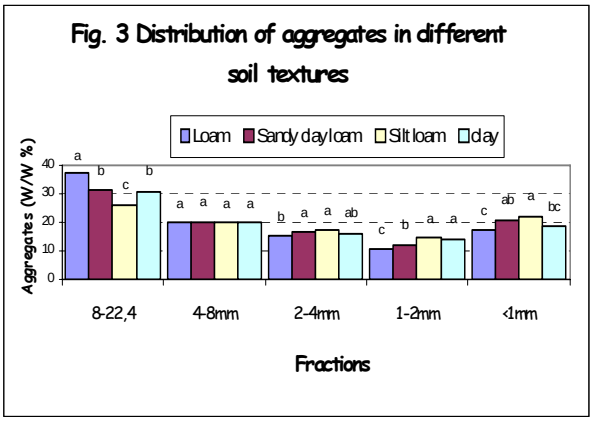


Fig.1, **Effect of tillage and soil type on Dry Mean Weight Diameter (DMWD)** where CT =conventional tillage, RT= reduced tillage, NT= No till, L=loam, SCL= sandy clay loam, C= clay, SL= silt loam.

Loam and silt loam soils have significantly higher and lower amount of 8-22.4 mm sized aggregates respectively where as they have significantly smaller and larger amount of aggregates <1mm respectively.. NT produced significantly higher amount of large aggregates (8-22.4 mm) and lower amount of small aggregates (<1 mm) respectively than RT and CT in autumn in C and L. Tillage has no effect on the amount of 2-4 mm aggregate group.





4. Conclusion

This study showed that implementation of the different tillage practices has different impact on DMWD and distribution of different sized aggregates for different soil types. In loam and clay soils, NT performed very well as compared to CT in relation to DMWD. Long-term application of NT on silt loam soils resulted in negative DMWD. Further research has to be done in order to observe the impact of tillage practices on wet mean weight diameter and aggregate stability and its interaction with soil texture, season and years of application.

5. References

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