Performance and agronomic potential of Composite Cross winter wheat populations and other genotypes in a mixed cropping system

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Unpredictable climatic conditions and increasing pressure on non-renewable resources mean that alternative agricultural systems able to cope with increasing biotic and abiotic stresses, as well as resource costs, are needed. Sustainable agricultural systems should be self-regulating, characterized by a high degree of inter- and intra-specific diversity (Moreau, 2010). Evolutionary breeding through the introduction of Composite Cross Populations (CCPs) increases intra-specific diversity, enabling CCPs to adapt to changing environmental conditions. Increasing inter-specific diversity, through mixed cropping, also plays an important role in sustainable systems. A focus of sustainable agricultural systems is self-regulation, which helps to reduce external inputs, while maintaining or increasing system output and providing ecosystem services (Altieri, 1999). Mixed cropping systems contribute to self-regulation by increasing inter-specific diversity, as well as ensuring increased soil cover and reducing mechanical soil disturbance. Breeding particularly for mixed cropping systems has only recently gained attention as an important aspect imperative to improving dynamic and resilient agricultural systems, which are better able to buffer biotic and abiotic stresses through increased intra- and inter-specific diversity. Suitable crops are needed that are able to cope with the increasing inter-specific competition found diversified systems.

An important aim of INSUSFAR(INnovative approaches to optimize genetic diversity for SUStainable FARming systems of the future) is the breeding and selection of crops better suited for sustainable agricultural systems with an emphasis on increased inter- and intra-specific diversity. Therefore, 8 CCPs (with differing cultivation histories), 10 commercial varieties and 10 selected lines from CCPs (CCP lines) were tested with and without white clover (*Trifolium repens*) as an undersowing in order to test competitive ability and performance. A split-plot design with the undersowing treatment as the main plot factor was managed under organic conditions with plot sizes of 18m^2 (12 x 1.5m). Triticale (*Triticosecale x*) was the pre-crop and the white clover was sown at the end of August 2015. The wheat was sown directly into the clover at the end of October 2015. The replicates without the undersown clover were harrowed in April 2016. Soil Nmin samples of each replicate block were taken at sowing, after winter and at flowering at two depths (0-30cm, 30-60cm). Assessments included ground coverage of wheat and weeds at the end of winter (BBCH 30-31), final stand height, number of ear bearing tillers per m^2, harvest index, grain and straw yields, as well as TGW. In addition to these, leaf disease assessments were done three times during the season (May to end of June), as well as a foot disease assessment at the beginning of July.

The early clover sowing date and the inability to harrow the undersown replicates in the spring, led to significantly higher weed pressure in the undersown treatment. As such, the wheat suffered significantly under the high weed and clover pressure, which meant that the harvest of wheat with clover as an undersowing could only be done by hand. The main foliar pathogen of the 2015/16 experimental year was yellow rust (*Puccinia striiformis*), which has been the dominant foliar pathogen since new virulent races initially appeared in 2011. Generally, the commercial varieties and CCPs had low to moderate values for AUDPC (Area Under the Disease Progress Curve). The mean values for AUDPC of all entries were not significantly different between the two treatments. The control treatment had a mean AUDPC of 607 and the mean AUDPC of all entries in the undersown treatment was 596. Mean AUDPC values for the grouping of commercial varieties, CCPs and CCP lines indicate significantly higher AUDPC values in both treatments for the CCP lines. Ground cover assessment was done on the 12 April 2016, and the mean weed cover (%) of all entries was significantly higher in the clover undersown treatment (28%) in comparison to the control treatment (3%). The mean wheat cover (%) for all entries was significantly greater in the control treatment (29%), in comparison to the clover undersown treatment (8%) and significant differences between the entries were found in both the control and clover treatment. In the control treatment, the grouped CCPs had a mean wheat cover of 32%, in comparison to the mean of the grouped commercial varieties with a wheat cover of 30%. There were also significant differences between the entries for wheat cover in the clover undersown treatments. The greatest differences within groups were found among the CCPs. Thus, the two significantly highest wheat cover values in the presence of clover (13%), but also the significantly lowest value (5%) were present in this group. Nevertheless, the mean cover for the CCPS was 9.75% compared to 8,0% for the references and 6,9% for the CCP lines. Ground cover in the presence of clover, however, did not necessarily correlate with number of ears produced nor final yield.

The aim of this task was to identify potential genotypes or populations, which may be better suited to mixed systems with greater inter-specific competition. The results of the first experimental year showed some significant differences between genotypes for a number of agronomic and morphological characteristics in the clover treatment. The early sowing date of the clover in August gave the weeds and clover an unfair growth advantage, which meant that the wheat genotypes were not able to compete and agronomic performance was therefore poor. For this reason, it was decided that the clover would be sown on the same day as the wheat, and could be resown in early spring in order to ensure full clover establishment should the winter be too cold. In this way, better wheat establishment with less weeds is expected and identification of genotypes and populations better suited to these mixed agricultural systems should be more clear.

Literature

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