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Grain Marketing and Production Research Center

Research Kernels

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Discrimination of soft and hard white wheat kernels using the Single Kernel Characterization System parameters and kernel imaging

Wheat kernel hardness is a measure of the kernel texture and an important indication of baking qualities of flour produced from the wheat. While wheat can have a broad range of hardness values, there are two main categories, or classes, of wheat based on hardness: soft and hard. It is desirable to market and trade wheat of a pure hardness class as it will have more predictable end use qualities. One of the most commonly used methods for measuring wheat hardness and determining purity of hardness classes in loads of wheat is the Single Kernel Characterization System (SKCS). However, for some varieties of wheat, particularly those grown in the Pacific Northwest, the SKCS has trouble distinguishing kernels from hard and soft classes. This leads to errors in determining if a sample is pure hard wheat, pure soft wheat, or a mixture. This research focused on improving the accuracy of the SKCS for wheat grown in the Pacific Northwest by use of more modern digital signal processing of the data that the SKCS already produces and by combining images with the SKCS. It was found that integrating new signal processing techniques into the SKCS software can reduce the errors made by the SKCS in half. By adding data extracted from images of kernels, the errors can be reduce by over 70%. This technology should aid wheat inspectors to determine the proper quality of a load of wheat, especially at export terminals. This will help improve the quality and international competitiveness of wheat produced in the United States.

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Role of symbiotic and non-symbiotic bacteria in carbon dioxide production from hosts infected with *Steinermena riobrave*

Entomopathogenic nematodes in the family Steinernematidae and their mutualistic bacteria (*Xenorhabdus* sp.) are biological control agents of insects, but how they respond to host insects that are already infected is not well understood even though this has an important influence on efficacy. We hypothesized that growth of the nematode's mutualistic bacteria in the insect host may contribute to the production of cues, specifically carbon dioxide (CO2), that could be used by the nematode infective stage (IJ) in evaluating potential hosts for infection. We characterized the population growth characteristics of both the mutualistic bacteria and other species of non-mutualistic bacteria in infected hosts. One insect host (*Galleria mellonella* larvae) infected by nematodes and bacteria together produced two distinct peaks of CO2, whereas hosts injected with bacteria alone showed only one peak of CO2. Another insect host (*Tenebrio molitor* larvae) infected with nematodes and bacteria together exhibited only one peak of CO2 production, with one peak also occurring in hosts infected with bacteria alone. These results indicate a relationship between bacterial growth and the first peak of CO2 in both host species, but not for the second peak exhibited in *G. mellonella*. Understanding these changes in cues and their causes can lead to a better understanding of why IJs select certain hosts over others and lead to more effective use as biological control agents.

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Capillary electrophoresis as a tool for evaluating lactic acid production from sorghum

Sorghum is an underutilized renewable resource that can be used to produce bio-based products such as ethanol. Recently the production of lactic acid from sorghum was also demonstrated, which can be used to produce a wide range of products. In order to facilitate the production of lactic acid from sorghum, capillary electrophoresis was investigated as a tool to monitor the fermentation process and characterize the fermentation products. It was found that sample preparation, namely dilution of the samples prior to analysis and rinsing the capillaries with HCl were critical steps for using capillary electrophoresis to separate the fermentation broth.

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Runoff and erosion in sodic soils treated with dry PAM and phosphogypsum

It is well known that an increase in soil sodicity in arid and semi-arid zones seriously increases soil vulnerability to sealing, runoff, and erosion. Most studies found that surface application of a soil amendment such as polyacrylamide (PAM) and/or gypsum (PG) was effective in stabilizing soil aggregates, and decreasing seal formation, runoff and erosion. PAM can be directly applied through the irrigation water or by spraying a PAM solution. Neither practice is suitable for rain-fed agriculture because water for spraying the PAM solution is not available and because it is difficult to dissolve PAM in water. For instance to apply 20 kg ha−1 of PAM, the volume of PAM solution to be sprayed is 20 m3 ha−1 because solutions of > 1000 g m−3 are too viscous for practical use. Spreading dry PAM at the soil surface has the advantages of low shipping cost, long shelf life, elimination of the difficult dissolution of dry PAM in irrigation water and elimination of the handling of the viscous PAM solution. We investigated the effects of surface application of dry granular PAM and PG combinations on the infiltration rate (IR), runoff, and wash erosion from semi arid soils under simulated rainstorms. We used four semi-arid smectitic soils varying in texture (loamy sand, loam, sandy clay and clay). Each soil had four sodicity levels (non, low, medium and high, e.g exchangeable sodium percentage from 2 to 20). Increasing soil sodicity increases the intensity of clay dispersion and its importance in the processes of seal formation and erosion. Thus in untreated soils increasing sodicity from non sodic to high sodicity, decreased steady state or final IR more than up to 6 times and increased runoff and wash erosion up to 3 times. Spreading PG alone or PAM mixed with PG on the soil surface significantly increased the final IR (up to 6-15 times) and decreased runoff and soil loss (up to 5 times) compared with the control/untreated samples. The trend of the effects was similar yet it depended on soil texture. Spreading the mixture of dry PAM with PG resulted, in all cases, in higher relative final IR values, over the entire sodicity range studied, compared with those obtained for spreading just PG. When PG is added to the soil surface it dissolves during the rainstorm and releases electrolytes to the soil solution and thus prevents clay dispersion. Application of PAM mixed with PG decreased runoff and soil loss by the same mechanisms identified for PG and also by binding particles at the soil surface by the polymer chains. Cementing the soil particles stabilized them against detachment and increased their deposition rate. Spreading of dry granular PAM mixed with PG could potentially be considered as a management tool for reducing soil susceptibility to crust formation in rainfed agriculture, where physical and physico-chemical destabilization of the surface aggregates are the dominant mechanisms in erosion.

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Starch granule size distribution of hard red wheat: their relationship to wheat, flour and breadmaking quality

It is generally accepted that two distinct sizes of wheat starch granules, large A-type granules (generally larger than 10 micron in diameter) and small B-type granules (smaller than 10 micron in diameter) exist, and they have different physical, chemical, and functional properties. However, limited research has been conducted to find the relationship between starch granule size distribution and final product quality. The objectives of this study were to investigate the in-depth starch granule size distribution of hard red winter (HRW) and hard red spring (HRS) wheats, and their relationships to wheat, flour, and breadmaking properties. We found that there were significant differences in the granule size distribution between HRW and HRS wheats. The B-type granules occupied volumes in the range 28.5 - 49.1% (mean 39.9%) for HRW wheat while HRS wheat B-type granules occupied volumes in the range 37.1- 56.2% (mean 47.3%). Numerous wheat and flour quality traits were also shown to be related to starch granule size distributions. The volume and size of B-type granules tended to decrease when protein content increased. Crumb grain of bread seemed to be affected by starch granule size distribution, showing an optimum volume ratio of A- and B-type granules. In addition, the optimum ratio appeared to be variable depending on the protein content of flour to produce bread with better crumb grain.

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