Historical increase in corn yield -- it's in the roots

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One of the most significant developments in agricultural growth in modern times has been the continuous and substantial increase in corn yield over the past 80 years in the U.S. Corn Belt.

This extraordinary yield advance has been associated with both breeding of improved hybrids and the ability to grow them at increased density. In a new study, published in the January-February issue of *Crop Science,* researchers have investigated the importance of the effects of leaves and roots on this dramatic increase in yield in the U.S. Corn Belt, and have found that the root structure may be the key to understanding how these crops have grown so efficient.

One associated change in the traits of these corn crops has been a more erect leaf angle, which is known to create greater efficiency in converting incident light to biomass. Over the years, detailed studies have shown that the increase in total biomass accumulated through sustained photosynthesis is one of the key factors explaining the yield increase.

However, some studies have also shown that changes in the root system also have an effect, as newer hybrids appear more effective at extracting soil water from deep in the soil profile. There is some evidence suggesting that hybrids with narrower root angle have this capability. It is also plausible that decrease in root angle combined with growing plants at higher density could cause the increase in biomass accumulation. Root systems with improved occupancy of the soil at depth can extract more

water to sustain biomass increase.

A team of scientists from Australia and the U.S.A., led by Professor Graeme Hammer of The University of Queensland (UQ), conducted this study on the leaves and roots of corn as part of an Australian Research Council linkage project with Pioneer Hi-Bred International. The project included scientists from UQ, Queensland Department of Primary Industries, and Pioneer.

Their approach involved the use of virtual plant computer simulation technologies. They modified an advanced crop model to take account of known effects on crop growth associated with varying leaf erectness and/or root system architecture. They then simulated consequences on yield for representative sites in the U.S. Corn Belt for a set of "hypothetical hybrids" varying in leaf and root characteristics.

The study revealed that the historical corn yield trend and its association with higher plant density was more likely related to change in root system architecture than to change in leaf erectness. While more erect leaf types could contribute to the effect in some high-yielding situations, changes in root systems to enhance capture of soil water at depth had the dominating effect. Results for simulations conducted for hypothetical hybrids that varied in root system characteristics were found to be consistent with a set of field experiments that reported yield response to density for hybrids released over the past 20 years.

"The use of dynamic crop models helped us to look beyond the clearly visible differences among hybrids in this time series of yield advance," says Hammer. "It enabled us to focus on the driving processes of crop growth that must be responsible for these effects. It is clear that as we move forward we need to look much harder at root systems and how they capture water."

In the study, the extra amount of water required for the 6t/ha historical yield increase was estimated as about 270mm. Further research is required to determine whether this has now positioned the corn crop near the limit of water resource availability or whether there remains opportunity for yield advance by further improvement in water capture.

More information: View the abstract at crop.scijournals.org/cgi/content/abstract/49/1/299.

Source: Crop Science Society of America (news : web)