CP 180

Control of Sorghum Root and Stalk Rots

Summary and Synthesis II

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This commentary is based on the three breeders' papers presented by Drs Rosenow, Maunder, and Henzell.

The summary comments and generalizations we have read in these three papers represent extensive field experience spanning the past two decades in Australia, North America, and South America. In spite of the sharply contrasting environments in which these scientists have worked, there is a remarkable similarity in their breeding strategies, field screening, and selection criteria.

Major Points

All three breeders have had to wrestle with the following problems:

1. identification of what resistance is desired—charcoal rot, fusarium root rot, lodging, drought, or all at once;
2. lack of reliable field screening techniques for identifying sources and derivatives of heritable resistance;
3. identification of plant characters that either impart or indicate resistance.

The three authors are interested in breeding out yield limiters (stalk rots, lodging, or drought susceptibility) at the postfloral stage. Henzell reiterated several times that lodging ("stem collapse") is the ultimate effect of stalk rots and drought in Australia. Therefore he breeds directly for lodging resistance and thus indirectly for stalk rot resistance. Rosenow (personal communication, 1983) has come to the same conclusion. He no longer cuts stems to verify the presence of charcoal rot sclerotia. He takes lodging scores. Although Maunder places due importance on standability, he identifies separate sources of charcoal rot, fusarium root rot, and drought resistance. He takes charcoal rot measurements even on standing plants.

These authors agreed that reliable field screening is difficult. Consequently, all three breeders make multilocational plantings with large numbers of entries under a range of growing conditions. They are all interested in locations with disease or drought occurrence. In at least some of their nurseries they try to create a boom and bust situation with high plant populations, high fertility, and optimum irrigation, followed by postfloral heat and moisture stress. In Australia, an off-season location (at the Kimberley Research Station) has been found that, under irrigation manipulation, can accurately predict the lodging performance of main-season location nurseries. Excellent fusarium root rot "hot spots" have been identified in Argentina. Rosenow has made considerable progress by making lodging scores in nurseries left standing over winter.

Plant maturity differences can confound lodging and stalk rot response. If stress occurs too soon before or after flowering then stalk rots or stem collapse may not occur even in susceptible sorghums. To overcome the problem of plant maturity, these authors try to group their materials according to maturity and base their decisions on large numbers of multilocational observations.

Maunder and Rosenow make use of the tooth-

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pick method of charcoal rot inoculation in at least some replications of some nurseries. However, Henzell has found little success with that practice in Australia.

Nonsenescence was identified by all three authors to be the single most important plant character indicative of stalk rot, lodging, and postfloral drought resistance. Maunder and Rosenow relate nonsenescence closely with drought resistance. Henzell and Rosenow point out the significant association between nonsenescence and disease resistance. In the case of SC-599-6 nonsenescence is also linked with fusarium root rot resistance. Nonsenescence is used as a selection criterion per se by all three breeders.

The stiff stalk character is emphasized by Maunder and Henzell for both charcoal rot and lodging resistance. The lodging-resistant lines SC-56-6 and NSA 663 have been described by Rosenow as having an elastic stalk.

Short stature was related to lodging and stalk rot resistance. Maunder proposes that the shortened internodes slow down stalk rot development in the stem.

Late maturity was also related to stalk rot and lodging resistance by Henzell and Rosenow. Henzell insists that the reason for late maturity resistance is due to a happy source-sink balance.

Henzell and his colleagues place considerable importance on the role of the source-sink equilibrium during grain fill. They propose that stem collapse during grain fill is due primarily to source limitations and that the problem of stalk rots and lodging can be best understood through source-sink dynamics.

Additional Information

Some recent observations of Malian local sorghums may shed additional light on the foregoing summary:

During the past 5 years we have made extensive multilocational observations of local varieties, introduced varieties and hybrids, and local x introduced hybrids. White-seeded exotic hybrids (U.S. and Indian) are generally susceptible to charcoal rot. Durra x exotic hybrids are highly susceptible and Guineense x exotic hybrids are highly resistant.

We have never seen a local Guineense or Guineense x exotic hybrid succumb to charcoal rot. The Guineenses are 3-5 m tall, relatively nonsenescent, and have elastic, dry stems. Under the microscope the cortex cells appear completely empty. In contrast, juicy- and intermediate-juicy-stem sorghums have cortex cells filled with sap.

It is clear that the Guineense stalk rot and lodging resistance is related neither to short stature nor to stiff stalk. Since their grain straw ratio is only about 20%, their resistance may be related to the favorable source-sink balance. However, their resistance may also be related to empty cortex cells. Without a readily available substrate, how can a stalk rot pathogen grow in the pith?

In juicy-stem sorghums, sudden changes of osmotic pressures in the sap during grain fill may cause cortex cell hemorrhage and stem collapse. That eventuality may be prevented by the absence of sap in the cortex cells.

Gaps in Knowledge and Research

1. Very little anatomical work has been done to clearly describe the stems and leaves of resistant vs susceptible varieties or senescent vs nonsenescent varieties. Schertz and Rosenow's article (1977) was a beginning, but only a beginning. These studies should be done with known separate sources of resistance to charcoal rot, fusarium root rot, and lodging. Parallel studies could trace the growth of stalk rot pathogens in stem tissues to accurately identify which tissues are affected.

2. The physiologists need to distinguish between cortex, vascular tissue, and sclerenchyma tissue in describing stem carbohydrate dynamics, so that pathogenic, physiological and botanical descriptions of the stem can be coherently understood.

3. Nonsenescence needs to be more clearly defined and assessed. Many local Malian durras can show severe leaf firing and be rated highly senescent, yet they make immediate regrowth after late rains. On the other hand CSH-5 (and 2077A hybrids in general) is nonsenescent when it does not succumb to charcoal rot.

4. A systematic screening of representative groups of the sorghum world collection is needed to identify separate and multiple sources of resistance to charcoal rot, fusarium root rot, lodging, and postfloral drought.