BREEDING SMALL GRAINS: MINIMUM TILLAGE AND ENERGY IMPLICATIONS

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Wheat, oats, and rye along with the clovers and ryegrass are used as the winter annual components of many multiple cropping systems commonly used in the southeastern United States. They can be used as forage or grain crops, green manure, and cover crops, or as a weed suppressing and moisture holding mulch for summer row crops. Small grains require relatively low levels of input in the way of energy requiring fertilizers and pesticides. They are able to utilize much of the nitrogen fixed by leguminous summer annuals, such as soybeans and peanuts, that might be lost by leaching during the winter months. They also are very efficient in the utilization of residual fertilizers which have been applied to row crops. Small grains do require fertilization but not nearly as much as most summer annual grass or vegetable crops.

Small grains do not require nematicides or insecticides because these pests are relatively inactive during the growing season of the small grains. Also, they do not require herbicides because very few winter weeds are able to compete with them.

There are three methods of establishing a small grain crop: 1) prepared seedbed, 2) sod seeding into permanent pasture, and 3) aerial seeding into standing crops. The prepared seedbed method is the best and most widely used, though more costly. The major problem in sod seeding small grains into summer grasses is that the summer grass is vigorously growing at the ideal planting time for small grains. The summer grass must be grazed very closely in order to obtain an acceptable stand of small grains. Sod seeding is usually more successful with ryegrass or clover since their growing season does not overlap that of the perennial grass.

Aerial seeding is growing in popularity because it is cheaper, easier, and faster than conventional methods and can be done into a number of crops but works best in soybeans. The seed are disseminated from the air just as the soybean leaves start to turn yellow, then the leaves fall covering the seed. This works very well with adequate moisture but does not work well during dry falls. It works best with the later-maturing soybeans since their leaf fall comes at the optimum time to seed small grains. This system is used quite extensively in the southeast for seeding rye and ryegrass for winter-grazing.

Diseases are a major limiting factor to small grain production in Florida because the mild winters are extremely favorable for the maximum development of plant diseases. Minimizing the losses to disease requires an integrated approach that includes crop rotation, deep plowing, timely planting, variety selection, and fungicides. Crop rotation is especially important

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in the case of wheat because several serious diseases build up if wheat is grown on the same area year after year. Turning the soil, although rather expensive and requiring high energy, would help reduce the initial inoculum of several wheat diseases if wheat had recently been grown on the same area. This practice reduces weed problems for the following summer crop since many of the weed seed are buried. Also, any potential problem that might be caused from a herbicide used on the previous summer crop would be reduced since the herbicide residue would be diluted into a larger volume of soil.

Fungicide seed treatments are a cheap way to avoid potential germination problems. If the seed are not of top quality, seed treatment will often improve germination and insure a better stand. Seed treatments are especially useful when planting in early fall when temperatures are high and seedling diseases are active. Seed treatments are helpful late in the season when the temperatures are rather low and germination is slow. When the seedlings are below the soil surface over a long time period, they are more susceptible to attack by seedling diseases.

Wheat is the most versatile of the small grains. It can be used as a grazing, silage, hay, greenchop, green manure, or mulch crop. It can also be used as a feed grain and most importantly as a food crop. The type of wheat grown in the southeast is soft red winter wheat. The flour from this type of wheat is not used in bread but is used in cakes, cookies, donuts, crackers, etc. High quality soft red winter wheat should be low in protein and have a high test weight. Excess nitrogen fertilization will cause the protein content to be too high and results in poor quality wheat.

Diseases are one of the major limiting factors in wheat production. Leaf rust, septoria glume blotch, and powdery mildew are all capable of causing substantial yield losses and must be controlled either by the use of resistant cultivars or fungicides. It is important in wheat production to adopt new cultivars as soon as they become available because after a few years new races of disease organisms develop and cause severe damage to the new cultivars.

Increased wheat acreage in the southeastern United States has resulted in sharp yield reductions caused by lack of rotation and seedborne infestation by Septoria nodorum **(13).** Our observations and those of others indicate that infested seeds are a major source of inoculum (10, 13) that might be reduced by foliar fungicide applications (9) and by seed treatments. Other work with fungicides has shown that yield increases may be obtained when fungicides are used properly (3, 4, 8).

Planting late in the season reduces the damage caused by several important pest of wheat, septoria, powdery mildew, and hessian fly. Some of the new early-maturing cultivars of wheat perform well from later planting and they fit into the multiple cropping systems better than the later-maturing cultivars.

All small grains provide excellent winter pasture but there are marked differences among species and cultivars in their forage production. Under a monthly clipping schedule, rye yields considerably more forage than the other small grains (11). When used as a silage or hay crop, oats perform better than the other small grains (2). Rye produces more forage early in the season, whereas oats and wheat produce most of their forage later in the season.

There are also differences between cultivars in their season of forage production. For example, Florida 501 oats produces significantly more forage than Coker 227 in the fall but the reverse is true for spring forage production. Oats can be planted about one month earlier in the fall than rye or wheat because oats have more resistance to seedling diseases, and are more tolerant of heat stress.

Rye is well suited to many multiple-cropping systems involving corn, peanuts, and vegetables and especially those that require the small grain be removed early as forage. Rye is better adapted than the other small grains to infertile, sandy, acid soils and will produce a good crop with less fertilizer. Rye grows at lower winter temperatures than the other small grains. It makes an excellent mulch for no-till corn and is easily killed by herbicides.

The breeding program on rye is centered on leaf rust resistance and forage production. Attempts to select types that have resistance to seedling disease are being made. Hopefully these types can be planted earlier in the fall. Tetraploid ryes that should do the same for rye production as tetraploid ryegrass has the ryegrass production are being developed. The tetraploids have larger seed and normally grow more vigorously than the diploid cultivars. The tetraploids develop early and remain vegetative longer in the spring than the diploid, and therefore, increase the length of the forage production season.

A screening program for rye is in progress to develop types that can be planted earlier for forage production. This has been done by planting the rye one month before the earliest recommended date, mowing the plots regularly during the winter, and then bulk harvesting the surviving plants. A number of single plant selections were made in 1979 after 5 cycles had been made. These will be increased and tested to determine if progress has been made in the development rye that can be planted earlier.

Triticale, a synthetic crop derived from wheat x rye hybrids shows promise for forage and feed grain production. Most of the research done with this crop has been done during the last ten years. In clipping trials, triticale produced less forage than rye but more than wheat in Florida (1). It is equal to rye and wheat as a spring silage crop but is inferior to oats (2). and is equal to or better than rye and wheat as a grazing crop (6). In Georgia, triticale has been found lacking in winter-hardiness and forage production (7). Progress has been made in improving grain quality and in developing shorter, earlier maturing, higher yielding types. New cultivars recently tested in Georgia (12), Alabama (14), and Florida (5) had higher grain yields than the best cultivars of the other small grains. The first cultivar developed in the southeast was released during 1979 by Alabama A & M University (15). A number of cultivars have been released in Texas. Only a limited amount of triticale has been grown in the southeast.

Triticale produces vigorous, robust plants that are impressive in appearance and yield better than the other small grains under stress conditions of limited moisture or high temperatures. It has large seed which are less dense than wheat. Slightly higher seeding rates may be required for triticale. Triticale seems to have fewer disease problems than wheat and is somewhat difficult to thresh. It appears to have some potential in minimum tillage, low energy applications but has a marketing problem since there are no regular marketing channels for triticale. Initial use will probably be restricted to the farms where it is produced.

REFERENCES CITED

1. Barnett, R. D., R. L. Stanley, Jr., W. H. Chapman, and R. L. Smith. 1971. Triticale: New feed grain and forage crop for Florida? Sunshine State Agric. Res. Report. July-September. pp. 12-14.

2. Barnett, R. D., and R. L. Stanley, Jr. 1976. Yield, protein content, and digestibility of several species and cultivars of small grains harvested for hay or silage. Soil Crop Sci. Soc. Fla. Proc. 35: 87-89.

3. Barnett, R. D., and H. H. Luke. 1976. The effects of fungicides on disease development, seed contamination, and grain yield of wheat. Plant Dis. Reptr. 60: 117-119.

4. Barnett, R. D., and C. E. Sanden. 1978. Evaluation of various foliar fungicides for the control of leaf rust on wheat, 1977. Fungicides and Nematicide Tests 33: 113-114.

5. Barnett, R. D., and K. H. Duke. 1979. Grain yield and agronomic characteristics of triticale in comparison with other small grains in Florida. Soil Crop Sci. Soc. Fla. Proc. 38: 48-51.

6. Bertrand, J. E., and L. S. Dunavin. 1974. Triticale, alone and in a mixture, for grazing by growingj beef calves. Soil Crop Sci. Soc. Fla. Proc. 33: 48-50.

7. Brown, A. R., and A. Almodares. 1976. Quantity and quality of triticale forage compared to other small grains. Ayron. J. 68: 264-266.

8. Kucharek, T. A. 1977. Profitable control of foliar diseases of wheat by aerial application of zinc ion-maneb complex fungicide. Plant Dis. Reptr. 61: 71-75.

9. Luke, H. H., R. D. Barnett, and S. A. Morey. 1977. Effects of foliar fungicides on the mycoflora of wheat seed using a new technique to assess seed infestations. Plant Dis. Reptr. 61: 773-776.

10. Machacek, J. E. 1945. The prevalence of Septoria on cereal seed in Canada. Phytopathology 35: 51-53.

11. Morey, D. D. 1973. Rye improvement and production in Georgia. Georgia Agri. Exp. Sta. Res. Bull. 129.

12. Morey, D. D. 1979. Performance of triticale in comparison with wheat, oats, barley, and rye. Agron. J. 70: 98-100.

13. Nelson, L. R., M. R. Holmes, and B. M. Cunfer. 1976. Multiple reqression accounting for wheat yield reduction by Septoria nodorum and other pathogens. Phytopathology 66: 1375-1379.

14. Sapra, V. T., and U. R Bishnoi. 1979. Triticale improvement and production in Alabama. Alabama A & M University, Research Bulletin No. 1.

15. Sapra, V. T., J. L. Highes, G. C. Sharma, and U. R. Bishnoi. 1979. Registration of Council! triticaie. Crop Science 19: 930.