Executive Summary

Breeding and Evaluation of Kentucky Bluegrass, Perennial Ryegrass, Tall Fescue, Fine Fescues, and Bentgrass for Turf

New Jersey Agricultural Experiment Station

1. Over 7,000 new turfgrass evaluation plots and over eight acres of spaced-plant nurseries were established during 1995. Turfgrass evaluation tests included 3,305 plots of Kentucky bluegrass, 1,470 plots of perennial ryegrass, 1500 plots of tall fescue, 850 plots of fine fescues, and 305 plots of creeping, colonial, dryland, and velvet bentgrasses. A total of over 50,000 plots of turfgrass cultivars, experimental selections, and germplasm sources are under observation and evaluation in field trials at Adelphia, North Brunswick, and Pittstown, New Jersey.

2. Intraspecific and interspecific hybridization programs are being expanded in *Poa*. Many of the interspecific crosses are directed to the transfer of a useful endophyte into *Poa pratensis* as well as increasing our pool of genetic diversity. Many of our intraspecific crosses are directed to the development of improved mid-Atlantic type bluegrasses with enhanced tolerance of heat and drought, improved resistance to insect pests, and economical seed production. Current mid-Atlantic type Kentucky bluegrasses such as Wabash, Bel 21, Vantage, and Eagleton are not widely used because of low seed yields. Improved resistance to and/or tolerance of billbugs is of vital importance to the summer performance and survival of many non-irrigated, medium-to-low maintenance turfs. Thinning of turf by billbugs creates conditions favorable to additional damage by chinch bugs and grubs. Weed invasion follows restricting recovery of the Kentucky bluegrass turf. We need improved mid-Atlantic types of Kentucky bluegrass with excellent disease and insect resistance, deep roots and rhizomes, increased tolerance of heat and drought, and high seed yields. Useful endophytes might enhance many of these characteristics.

3. Significant differences in damage by, tolerance of, and recovery from white grubs were observed in an older Kentucky bluegrass test growing under conditions of reduced air circulation which resulted in periods of severe heat stress. Kentucky bluegrasses showed striking differences in their ability to maintain an active, deep root system and to regenerate roots severed by grubs under these conditions. Differences in the ability of various Kentucky bluegrasses to maintain an adequate rate of net photosynthesis has been suggested as a partial explanation of these differences. Tolerance of high soil temperatures could also be involved. Mid-Atlantic ecotypes generally showed the best performance.

4. Germplasm developed at the New Jersey Agricultural Experiment Station contributed to a number of new turfgrass cultivars including Calypso II, Citation III, Manhattan III, Windstar and RPBD perennial ryegrasses; Titan II, Coronado, Finelawn Petite, and Coyote tall fescues; Southport Chewings Fescue; Warwick hard fescue; Princeton 105 and Eagleton Kentucky bluegrasses; and L-93 creeping bentgrass.

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5. Improved cultivars of *Koelaria macrantha* show promise as an attractive, fine-leaved, low-growing turfgrass for low-maintenance turfs. The cultivar Barkoel has performed well in turf trials receiving little or no fertilizer. However, it becomes excessively dense and is damaged by *Rhizoctonia* brown patch and other diseases when given too much fertilizer. Hard fescues and blue fescues also perform best in lower maintenance trials receiving limited fertilizer. Hard and blue fescues frequently show serious damage from summer patch and subsequent chinch bug feeding when over fertilized, mowed close, and subjected to soil compaction. Acremonium endophytes frequently enhance performance of all fine fescues in New Jersey turf trials. This includes improved resistance to the dollar spot disease and perhaps summer patch.

6. Most improved turf-type cultivars of perennial ryegrass were developed from a very limited genetic base. Extensive population improvement programs using phenotypic and genotypic recurrent selection and occasional backcrossing has been very effective over thirty years in developing ryegrasses with striking improvements in persistence, attractiveness and overall turf performance. Dramatic progress has been made in developing ryegrasses with a darker color, greater density, finer leaves, a lower growth profile, improved mowing quality, and endophyte-enhanced insect resistance. Significant advances have also been made in seed yield potential as well as in seed production technology. Moderate progress has been made in improving tolerance of heat, cold, drought, shade, and wear. However, only limited progress has been made in developing stable resistance to crown rust, red thread and dollarspot. Turfgrass breeders have a great challenge and opportunity to find new sources of genetic resistance and better selection techniques to make improvements in these characteristics.

7. Most improved turf-type tall fescues were developed from a very narrow genetic base. Recurrent phenotypic assortive mating frequently combined with clonal and/or progeny trials conducted under frequent close mowing has been used over a 34 year period. A few dozen plants surviving in old turfs of the United States were the primary parental germplasm. Substantial improvements have been made in developing tall fescues with darker color, finer leaves, greater density, a lower growth profile, greater persistence under close mowing, and high seed yields. Kentucky 31 and most improved turf-type tall fescues show much better resistance to the Rhizoctonia brown patch disease compared to unadapted tall fescue accessions from the cool-moist summer or hot-dry summer climates of Europe. However genetic improvements in resistance to Rhizoctonia brown patch have not been sufficient to adequately overcome the more favorable conditions for this disease created by the dense, lush turfs, that are frequently developed using high fertility, frequent close mowing and the new turf-type varieties in warm humid environments. Pythium blight can also be severe in dense, lush, highly fertilized turfs in hot, humid environments.

8. Most of our major cool-season turfgrasses evolved in the cool-moist, or hot-dry regions of Europe and are not really well-adapted to warm-humid environments of much of the United States. This helps explain the reason why most of the germplasm used in the improved turf-type perennial ryegrassses and tall fescues originated from a few plants which had survived in old naturalized turfs in warm humid areas of the United States. Much of the germplasm used in the development of the best performing Chewings fescues, strong creeping red fescues, blue fescues, Kentucky bluegrass, creeping bentgrasses, and rough bluegrasses was also collected from old turfs surviving in stressful environments of the United States. There is an urgent need for additional collection efforts in the United States as well as in the regions of origin of all these species.

9. We have much greater genetic diversity in our germplasm collections of Kentucky bluegrass than any other turfgrass species. We have most characteristics desired in a cool-season, lawn-type turfgrass within this pool of germplasm. Unfortunately, we currently lack the population improvement techniques that have been so successful in breeding the turf-type perennial ryegrasses and tall fescues. Because of the apomictic reproductive behavior of Kentucky bluegrass, we have been unable to use recurrent selection and backcross breeding techniques to concentrate all of these useful characteristics into a single cultivar or interbreeding population. The development of successful efficient methods of population improvement in Kentucky bluegrass could lead to great progress in developing better turfgrasses. It might also contribute to more effective breeding methods in other apomictic species.

10. Kentucky bluegrass (*Poa pratensis* L.) is a facultative apomictic with complex cytological and embryological characteristics. The basic chromosome number of the genus is $x = 7$ with chromosome numbers of Kentucky bluegrass ranging from $2n = 28$ to $2n = 153$. Most Kentucky bluegrass cultivars range from $2n = 39$ to $2n = 93$ with many successful bluegrass cultivars being aneuploids. Apomictic reproduction overcomes much of the sterility that would normally occur with the irregular meious and imbalanced gametes associated with aneuploids. Highly sexual Kentucky bluegrass plants that have been studied in greatest detail include Warren's A20, A25, and A26. All three have poor floret fertility and very low seed yields. Hybrids of Kentucky bluegrass with apomictic strains of *P. compressa* L. give vigorous but sterile hybrids whereas hybrids with highly apomictic Kentucky bluegrass were frequently moderately to highly apomictic with moderate to good floret fertility.

Interestingly, aneuploid Kentucky bluegrasses produce adequate amounts of viable pollen. It appears that most pollen contains nuclei with approximately one-half the chromosome numbers of the parent plant as a result of meiotic division. Is this a result of a genetic mechanism for fertility? Alternatively, could this be a result of a high level of polyploidy where there is sufficient buffering to allow unbalanced gametes to function effectively. A third possibility might be that many chromosomes are not really vital to important physiological processes and are somewhat redundant. It is often observed that different chromosome numbers can be observed in different tissues of the same Kentucky bluegrass plant.

The observation that many aneuploid Kentucky bluegrasses produce ample amounts of viable reduced pollen suggests that we should be able to find Kentucky bluegrasses with the ability to produce a high number of reduced eggs even though the mother plants are aneuploid with irregular meious.

Turfgrass breeders at Rutgers have observed some highly sexual Kentucky bluegrass plants with good seed yields and high floret fertility. A more intensive search might identify highly sexual plants with excellent floret fertility and excellent seed yield. We would also like these plants to have excellent turf quality, stress tolerance, and pest resistance and to also show excellent general combining ability for these characteristics.

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