N O T F O R P U B L I C A T I O N

PROGRESS REPORT # 7

November 1990

Improvement of Poa annua for Golf Turf

The University of Minnesota

Department of Horticultural Science

Project: Biology and Utilization of Turfgrasses

and

The United States Golf Association

Cooperating

PERSONNEL

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I EXECUTIVE SUMMARY:
IMPROVEMENT OF POA ANNUA FOR GOLF TURF #7, 1990

Approximately 1500 individual accessions / selections have been maintained and propagated for field evaluation. The 8 prime selections under evaluation and consideration for introduction all performed well over the difficult winter of 1990. A total of 101 new accessions from 25 locations were integrated into the germplasm pool of the project. Poa annua selections #117 (10-C) and #184 (16-B) received the highest ratings over winter. Poa annua #117 (10-C), #493 (NY-12), #42 (3-A) and Poa supina #391 (29-F) exhibited excellent flowering habits this spring. Several new selections have been identified for the next cycle of evaluation for introduction. New evaluation plantings under close mowing were established at the University of Minnesota, 9 golf courses around the country and at 3 Universities. Work has been completed on improving and adapting a mist technique to regulate pollen shed and assist in emasculation to facilitate our ability to accomplish specific crosses. Work on improving an excised stem technique was completed and applied to practice. Fructose improved seed production and uniformity compared to sucrose; contrary to other work, no biocide is required and seed matures in 15 days after pollination with the stems maintained in the solution. Approximately 75 crosses were completed with the 8 selections; 40 additional crosses were made to incorporate and combine desireable characteristics. 50 self pollinations were completed in a continuing effort to ascertain heritability of specific characteristics. Several successful interspecific crosses between Poa annua and Poa supina were accomplished using mist and excised stem techniques. Plants resulting from seed of these crosses are currently under evaluation. These are the first interspecific crosses we have been able to accomplish. In the spring, a field seed production trial was established at the University of Minnesota to evaluate seed production potential of the 8 advanced selections. A seed production trial of 4,000 plants, 500 each of the 8 advanced selections, was space planted on November 9 and 10 on Pickseed West land in Tangent Oregon. The primary objectives of this planting are: 1) to assess the seed production capabilities of each selection under supervision of a commercial seed grower; 2) to compare differences in seed production between materials; and 3) to produce a supply of breeders seed that can be used for increase.It is planned that all current studies will continue. Collection of new materials and selective crossing will continue. Strong emphasis will focus on the seed production aspects with the 8 advanced materials.

II INTRODUCTION

The following is a report of the research conducted under the Project: "Improvement of Poa annua for Golf Turf" for 1990. The activities pursued during the year are summarized and are offered in outline form. More detail is available upon request.

III ENVIRONMENTAL IMPACTS 1989-90

The winter of 1990 was hard on many plants in the landscape in Minnesota. It was not only a difficult winter, but it followed 4 years of drought and open winters. Poa annua in general was hard hit over a wide area of the country. Several of the advanced selections in this program exhibited excellent tolerance to the open, harsh winter in Minnesota. The winter included a relatively warm fall and early winter that ended abruptly in mid December with low temperatures of -32 C. The winter was also punctuated with several episodes of very high, drying winds and included thunder storms in late winter. The Poa supina selections exhibited extraordinary tolerance to these conditions.

IV NEW COLLECTIONS

A total of 101 new accessions from 25 different locations were integrated into the germ plasm pool of the project over the year. New collections were received from Minnesota, Georgia, Louisiana, Washington State, Montana, Virginia, New York, Tennessee, California, Indiana, Utah, Kentucky, New Jersey, and Ohio. These materials are currently under evaluation for characteristics that they might contribute to the program.

V COLD TOLERANCE

Of the Poa annua selections, #117 (10-C) and #184 (16-B) received the highest ratings over winter. These selections continue to perform at a very high level in almost all categories including tolerance to high rootzone temperatures as well as over-wintering ability. The two advanced selections of Poa supina, #417 (55-D) and #391 (29-F) also over-wintered extremely well.

Flower production evaluations of materials over-wintered outside in flats showed that Poa annua 10-C, NY-12, 3-A, and Poa supina 29 F exhibited exceptional flowering habits this Spring.

Selections performing best under greenhouse conditions during winter included (listed but not ranked): Poa annua #117 (10-C), #184 (16-B), #187 (16-E), #887 (16-E X-2), #1799 (16-C X-1), #658 (85003), #1841 (85004-3), #1974 (MN 88-9), #1959 (Interlachen Gr. 1 6.2M), #998 (O-14-13); and Poa supina #285 (22), #1814 (35-3), #417 (55-D), #419 (55-F), #319 (56), #1961 (56-X-1), #1979 (56 X-1 X-2), and #353 (89).

VI EVALUATIONS:

This year was spent in continuing to shift emphasis toward evaluation and seed production of the first group selected for advance evaluation in the field. Much of the field work focused on assessing, in a limited way, the seed production potential of materials in the project.

Substantial effort was also placed on vegetatively propagating enough materials of the 8 advanced selections to establish experimental plantings at several new locations. In addition, several previous plantings were replaced to ensure that a good test would result.

Field Space Plantings:

Field plantings were evaluated for over-wintering characteristics. Selections were made of those plants which survived best.

A field planting was established that included 102 selections that have survived several evaluation cycles. The planting includes 5 replications of each selection for continued evaluation.

#1793 (42 * 234 -2), #1976 (MN 88 23), #1959 (Interlachen Gr. 1 6.2M), and #1383 (Olympic), #353 (PS 89), represent selections from this group in the next cycle of improvement that are fine textured, low growing types that produce a very dense dark green turf.

Approximately 1500 individual accessions / selections have been maintained and propagated for initial evaluation in a field space planting that was established this Spring. Roughly half of this planting was comprised of new hybrids, selfs and collections that have had no previous field evaluation.

Seed Production Plantings:

A field seed production trial was established on the University of Minnesota field research area to evaluate seed production in the 8 selections currently under consideration for introduction. This trial included several hundred plants of each selection in a planting that included 3 replications. Of the eight selections, only #234 (PA 21) had any significant seed production this first year.

A larger seed production field trial of 4,000 plants was planted on November 9 & 10 in Tangent, Oregon. The trial includes 500 rooted stolons (clones) of each of the 8 selections under consideration for naming and introduction. The trial is being conducted with cooperation from Dr. Jerry Pepin, Vice President of Pickseed West at Tangent. The planting was accomplished in a randomized block design with 5 replications of 100 plants each. Plants were planted on a 2' by 2' spacing and were planted into activated charcoal treated spots in a field that had been recently treated with atrazine and other herbicides.

The primary objectives of this planting are: 1) to assess the seed production capabilities of each of these selections under the supervision of a commercial seed grower; 2) to compare differences in seed production between selections; 3) to produce a supply of "Breeders" seed for increase and subsequent production of foundation seed for commercial planting.

Golf Course Turf Plantings:

A replicated planting was established on the University research area to evaluate the 8 primary selections under collar height mowing pressure. The replications were established from stolons in plots of approximately 2' X 3' size completely surrounded by a well established Penncross population that has been maintained at 1/2" height of cut. In addition, four replicates of each of the eight selections were established in our putting green to ascertain competitive ability under those conditions. These latter plots have the same size and were established in the same manner as those materials distributed to the following list of USGA cooperators.

Distribution of Experimental Materials:

The eight most promising selections to date were prepared for distribution to golf courses and universities in selected locations around the country. They were propagated in 6 by 9 inch plastics packs, maintained at 1/2" height of cut and distributed in the manner described in last year's report.

Colorado: Denver Country Club; Fritz Law Superintendent

Georgia: Sea Island Club; Tom Burton, Superintendent

Massachusetts: The Country Club; Bill Spence, Superintendent

University of Mass.; Richard Cooper, Professor

Minnesota:	Oak Ridge Country Club, Keith Scott, Superintendent
	Edina Country Club, Bill Johnson, Superintendent
Montana:	Green Meadow Country Club; Steve Johnson, Superintendent
New Jersey:	Rutgers University; David C. Thompson, Professor
Ohio:	Sylvania Country Club; Michael Barton, Superintendent
Oregon:	Oswego Lake Country Club; Dick Fluter, Superintendent
Texas:	Texas A&M Res. & Exp. Sta.; Bridget Ruemmele, Research Associate
Utah:	Willow Creek Country Club; Chip Arbarno, Superintendent

VII BREEDING AND GENETICS

Advanced generation material from some of the earliest material accessioned into the project was maintained under study for progeny testing and heritability of select characteristics. Materials into the 7th generation are included in these studies as well as 1st generation materials from newly collected or acquired materials.

Mist Chamber:

Work on the adaptation and application of a fog (mist) technique (after G. Burton) which enables control of pollen-shed and easy emasculation of Poa flowers was essentially completed during the year and the technique applied toward making crosses in our program. The technique allows exsertion of the anthers while inhibiting pollen shed. The exsertion of the anthers makes them very accessible for easy removal (emasculation). This improves the efficiency of our crossing operations and solves many of the problems associated with accomplishing controlled pollinations with and between both Poa annua and Poa supina.

A plexiglass box was constructed and interfaced with an ultra-sonic humidifier with mist control and a timer. It was determined that 15 days is the optimum length of time to leave excised stems in the nutrient solution after pollination for the best seed numbers and quality. Tight control over the mist is especially essential with Poa annua. A lapse of as little as 15 minutes when the anthers are being exserted can result in pollen shed and loss of control of the pollination. Under the

constraints, continuous control of the misting operation is essential. At the same time, constant (24 hour) mist inhibited flower opening and substantially reduced seed-set. It was determined that the mist had to be constant only during the normal time when pollen was shed (1 AM to 9AM) to control the pollination process. Allowing the flowers to dry out in between times proved to be beneficial resulting in improved seed set.

Refinement of Excised Stem Technique:

In addition research into improving the excised stem technique for controlled crossing was continued. Earlier work by Ruemmele showed the potential usefulness of this technique in conducting a controlled crossing-selfing program. Research this year has shown that, contrary to previous data, fructose sugar(s) improved seed set over that achieved with sucrose. Fructose also reduced variation in seed weight. The optimum range for fructose concentration was found to be between 4% and 6% by weight. It was also shown that excised flowering culms given supplimental light exposure produced heavier seed, up to a point. This indicates that the stems and leaves can contribute photosynthate to developing seeds. Timing of excising the stems was also observed to be important. Stems excised just prior to anthesis were found to be the most productive. Early experiments included a biocide (8-hydroxyquinoline citrate) to protect against organisms that could affect seed production. However, our research showed that the use of this material was of little value to this project.

The real value of these techniques is realized by combining them for controlled pollination and seed ripening. Approximately 165 individual crosses and selfs were made possible by the application of these techniques.

Approximately 75 crosses were completed with the 8 advanced selections currently under evaluation for introduction. Combinations were aimed at improving seed production, flower stem length, flowering period and turf characteristics. Progeny from these crosses were compared with an additional 50 selfs of each of the materials involved. Another goal for the selfs is to evaluate the possibility of stabilizing inbred lines. Uniform lines selected for special adaptations would allow the development of crossing systems for the production of new, improved varieties. The selfing work also included Poa supina, which prior to this time appeared to be self-incompatible.

An additional 40 crosses were conducted between the most desireable plant types in the program.

Field evaluation of the progeny from these pollinations indicated that there was substantial uniformity between progeny of the same cross. This may indicate that many of the parents

selected for use in this study were genetically homozygous. Segregation of various characteristics may then be expected in the F_2 generation.

The application of these techniques has resulted in several successful inter-specific crosses between Poa supina and Poa annua which we were unable to accomplish previously. Some characteristics that appear to be the result of these crosses are improved plant color, vigorous growth habits, and consistency in plant type.

VIII ECOLOGY OF POA - BENTGRASS GREENS

Effort focused on the growth characterstics of Poa annua on golf greens at two golf courses. Findings this year supported previous observations. Poa annua tillers develop primarily from buds at nodes of existing tillers just below the living leaves. Crown development was not discernable, however internode elogation was observed. On some plants, internode elongation was limited while several tillers developed. On other plants, extended, prostrate, non-rooting, tillers developed with 2 or 3 leaves active at the terminal end. These tillers tended to be free of axilary tiller development. All growth appeared to occur in the thatch with roots penetrating below the mat. Tissue necrossis was often observed at the thatch/soil interface. Tillers appear to die when extended to the point that the green tip tissue was removed by mowing. Again, bentgrass tended to dominate during midsummer while the poa tended to dominate during the cool weather of Spring and Fall. This work was supported by the effort of Howard Kaerwer.

IX PLANS FOR 1990 - 91

- The work on developing an understanding of the incongruity phenomena and self-incompatibility in Poa annua will be continued.

- Work on the cytology of Poa annua and Poa supina will receive increased attention, especially with the 8 advanced selections.

- Work on pollen viability and the "hanging drop technique" will continue as part of the compatibility - incompatibility investigations with these materials

- We hope to be able to construct a deep heat controlled rootzone structure in the green house this winter to try to get better information on root relationships with the advanced materials.

- In addition we also hope to construct a small sand based putting green in the field for evaluation of performance and competitiveness of these materials under those conditions.

- We plan to continue to evaluate the advanced selections for cold tolerance hardiness utilizing the controlled heated block and -50 C freezer techniques that we have developed.

- Evaluation of superior selections from the program will continue. This will include the materials currently out to golf courses as well as other less advanced generation materials exhibiting characteristics that deserve attention.

- Efforts into investigating and solving seed production problems associated with the materials under advanced evaluation will be increased.

- We hope to be able to examine some techniques that may assist in harvesting seed of these short stemmed grasses.

- Data on performance of the eight selections will be collected and evaluated. Data will include performance of each selection, cultural regimes, flowering habit, color, texture, and any other information that may become available.

- Progeny testing - heritability studies will continue with the seed that has already been generated from specific selfs, sibs, and crosses as well as from crosses that will be accomplished this year.

- o Selective breeding that is focussed on seeding habit(s) that are related directly to harvesting seed will be continued. The crosses generally will be between materials selected for golf turf quality and materials that have been selected for seeding habit characteristics.

- o The collection of materials from golf courses will continue. Ways of increasing this effort and the identification of materials on golf courses will be investigated. Hopefully, more Poa supina germplasm can be acquired from European sources and integrated into efforts with that grass.

- o Efforts in 90 - 91 will continue to focus on seed production problems and field evaluations of selected materials.

1990 SUMMER MEETING

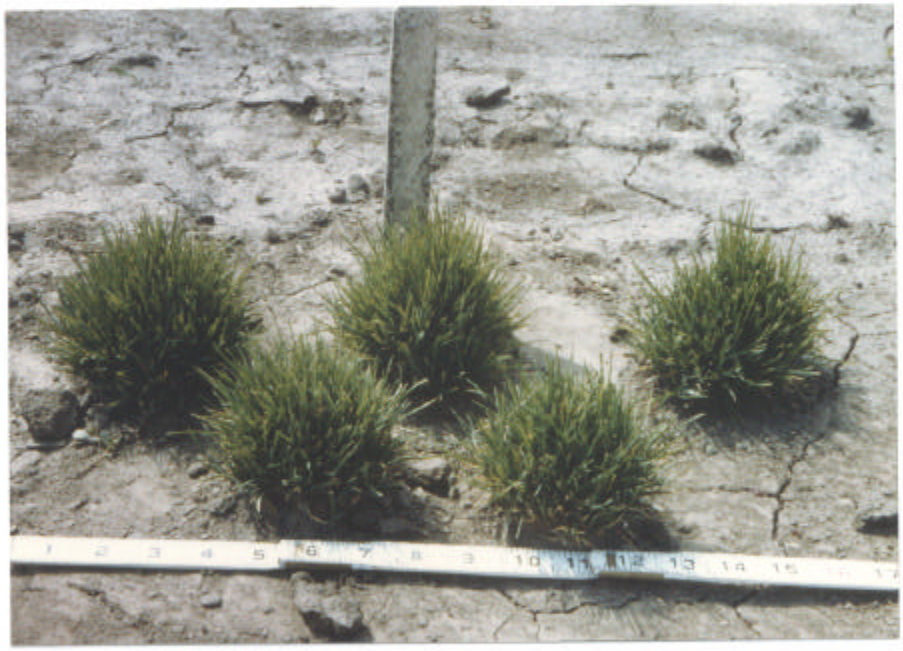
We appreciated the opportunity to review our work with the Research Committee and other researchers last July. It offers the opportunity for first hand viewing and discussion of the details of the program. In addition we hope that the techniques we have developed may be useful for other researchers. Thank you.

Respectfully Submitted,

Donald B. White,
Professor, Turfgrass Science

X FIGURES

1).

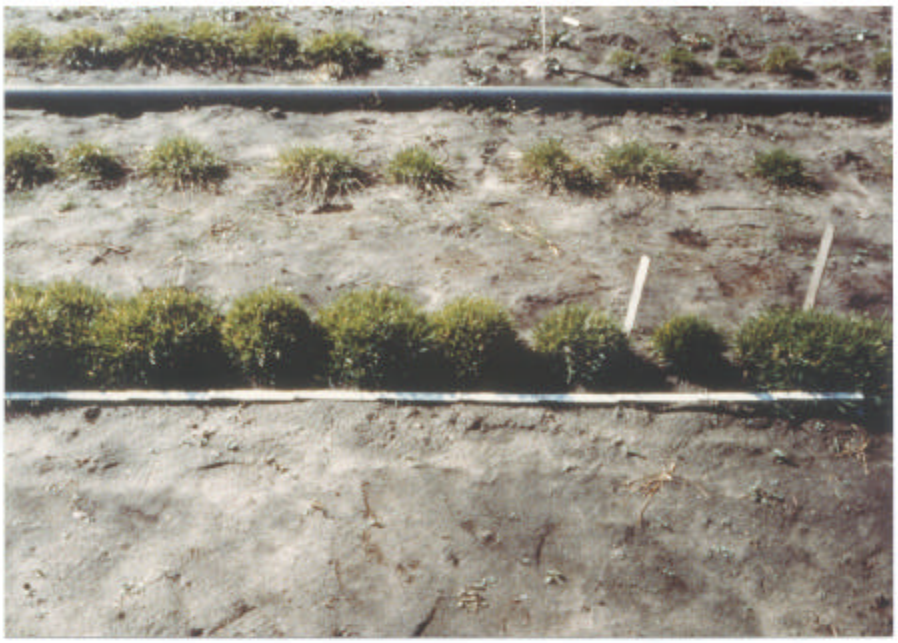


2).

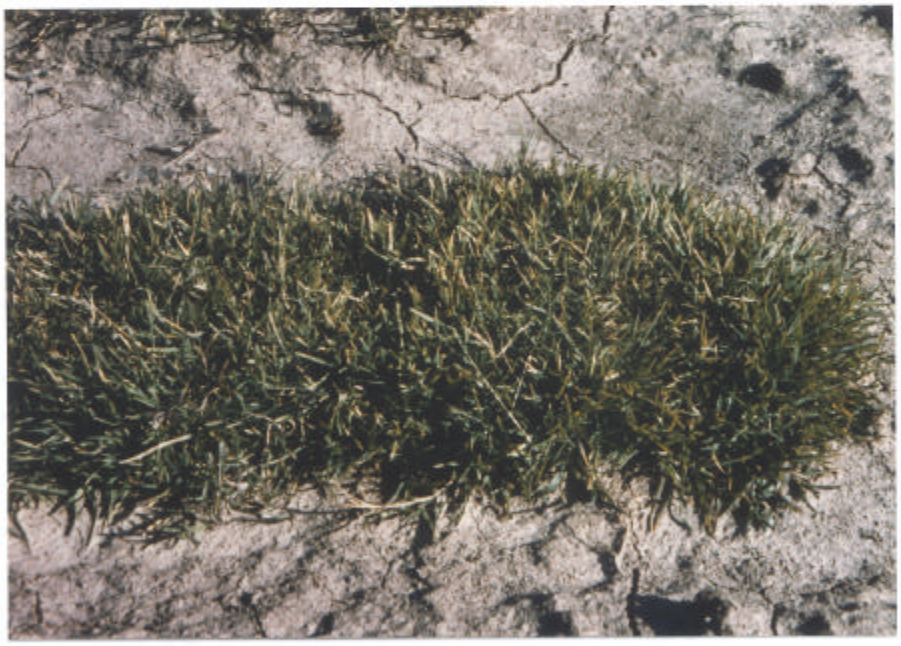
Examples of #117 (PA 10-C) progenies:

1). Selection #117. Upright cone ("Christmas tree") is typical of #117.

2). #117 (family 19) selfs have various forms.



3).

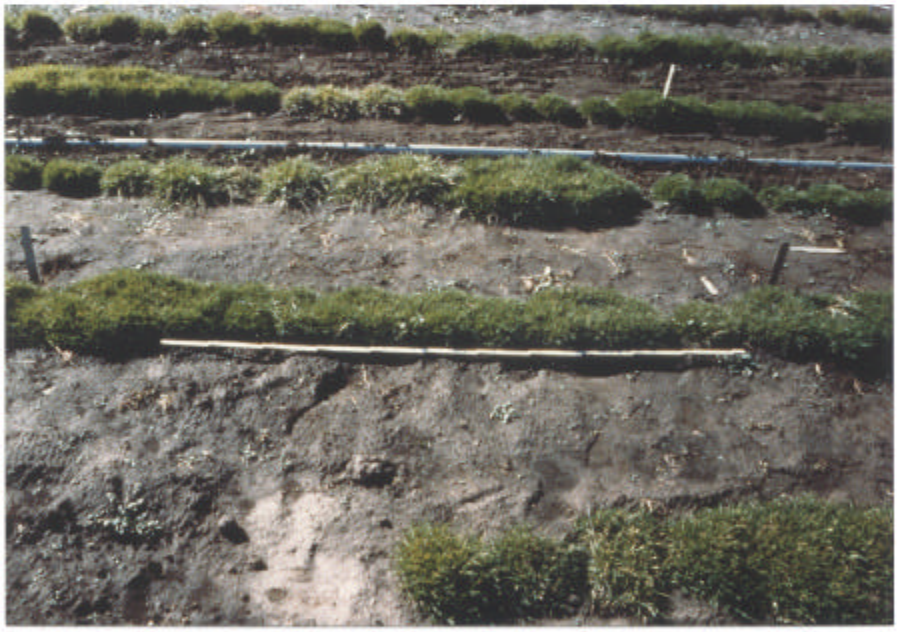


4).

3). Progenies of #117 crossed #42 (family 13) tend to look much like #117 selfs.

4). Selection #42. Note spreading habit which did not carry through to progeny in fig. 3).

5).



6).

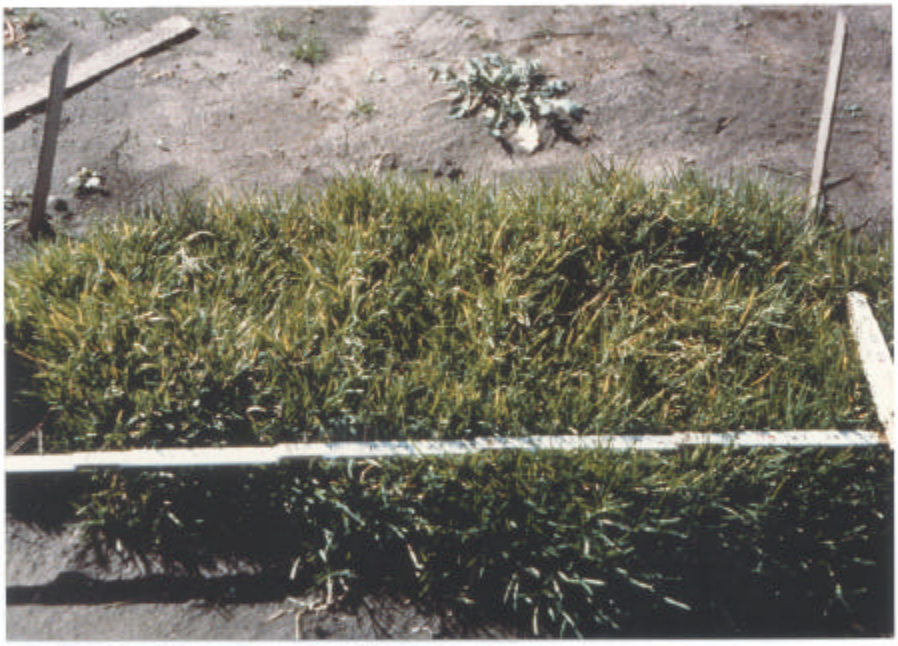
Examples of #42 (PA 3-A) progenies:

5). #42 selfs show consistent type characteristics; dark, fine textured, low, spreading stolons with good vigor.

6). #42 crosses tend to maintain these desirable turf characteristics.

7) .

8) .



9) .

Examples of Family line 20 progenies:

7). #1832, an inbred of #134 (PA 11-H) is a typical family #20 plant with coarse, spreading stolons. When used as a male parent, it donates the spreading vigor but not the coarseness.

8). #117 (PA 10-C) * #1832. Note the upright verdure characteristic of 117 combined with family 20 spreading vigor.

9). #42 (PA 3-A) * #1832. Note the dark, fine texture verdure characteristic of #42 with enhanced stolon density.

10).

11).

12).

PS/PA Interspecifics:

10). Poa supina selection #343 flowers later than typical for species. (Used as female parent in fig. 12)

11). Poa annua selection #223 has a long flowering culm habit. (Used as male parent in 12)

12). #2154 PS/PA Interspecific.

13).

14).

13). Poa annua selection #184 is typically fine textured, dark and not spreading.

14). Reciprocal interspecific crosses of #184 and Poa supina selection #302. #2156 (302 * 184) on left and #2157 (184 * 302) on right. Note similarity regardless of pollen parent and that flowering habit is typical of Poa annua.

15).

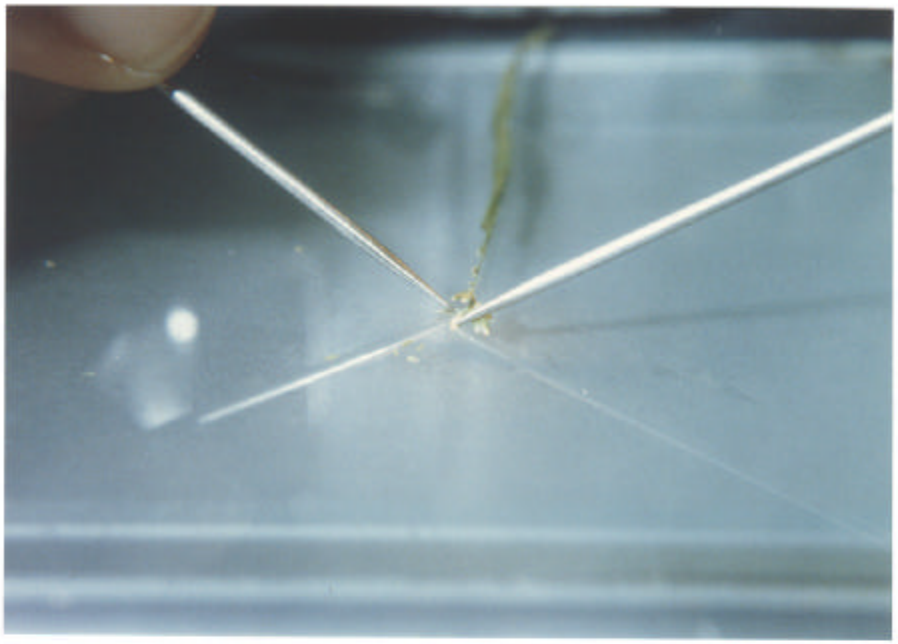
16).

Golf Course Turf & Seed Block Evaluations:

15). Newly established collar height plots planted in 'Penncross' creeping bent turf. During the growing season, #42 (3-A), #184 (16-B), #117 (10-C), #208 (18-D), #493 (NY-12) develop good color and texture relative to bentgrass.

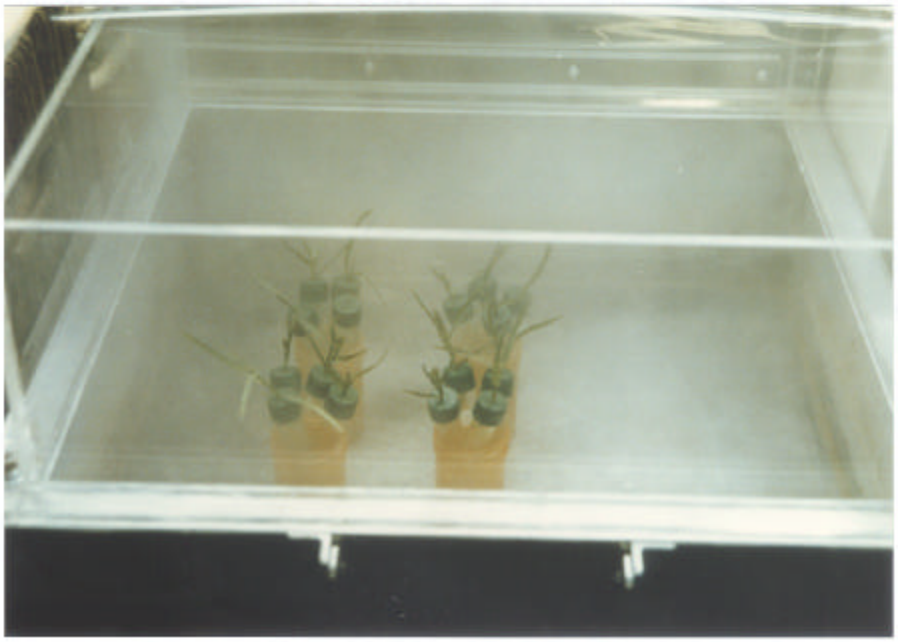
16). K-10 seed block plantings.

17).



18).

19).



Excised Stem Technique:

17). Previous method of manual emasculation was very difficult and tedious.

18). Mist emasculation set-up

19). Inflorescences in the mist box.

20). Inflorescences showing exserted anthers, but no pollen shed.

21). Inflorescences after emasculation with the mist technique.

XI ABSTRACTS:

Abstract from ASA paper:

Application of mist controlled pollen shed with an excised stem technique in Poa annua breeding. P.G. Johnson and D.B White, University of Minnesota.

A mist emasculation technique, described by Burton, was adapted for breeding Poa annua. Mist applied during anthesis allowed anthers to be exserted, yet prevented pollen dehiscence. Anthers were easily removed without self pollinating the flower. use of the technique dramatically improved the ability to make controlled pollinations. Emasculated flowers gave sufficient seed set for breeding work. Timing of the mist period was also investigated. Mist from 12am to 8-10am appears to be optimum. Continued misting for extended periods (24-72h) slowed flower opening and reduced seed set. An excised stem technique improved handling of inflorescences while in the mist. Sources of seed set variation with excised stems included concentration and type of carbon source, and their interaction with light intensity, length of time for seed maturation on the stem, flower morphology and stage of inflorescence development when excised.

In Vitro Pollen Germination of Two Ornamental Grasses. D.B. White and M. Hockenberry Meyer, University of Minnesota.

Determining pollen viability can be imperative in breeding programs. Grass pollen is not always viable in vitro, however, fresh pollen of Pennisetum alopecuroides (L.) Spreng. and Pennisetum setaceum (Forsk.) Chiov. germinated in an aqueous solution containing 250 g kg^{-1} sucrose and 100 mg kg^{-1} boric acid and were counted within 24 hours. Germination of 59% and 20% for P.alopecuroides and P.setaceum respectively, resulted when pollen was collected at anthesis and hydrated. Germination declined rapidly (within one hour) when pollen was held at room temperature for P.alopecuroides, however, P.setaceum retained viability for up to 5 days.