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Self-Pollinated Rhizomatous Tall Fescue

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PLSS 391 Honors Project

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Dr. Diesburg

Introduction: Tall fescue (*Festuca arundinacea*) is a wear resistant and low maintenance turf species. It also has good drought tolerance. Tall fescue as a turf has proved to be useful in the transition zone, between the prominent areas of cool and warm season grasses. Some golf courses use this turf in what is called the rough. This would be located between the fairways. Tall fescue is also used in home lawns. One disadvantage of tall fescue is its bunch type growth habit. Tall fescue lacks rhizomes or stolons to spread outward and fill in open areas. This would be useful for the turf to recuperate after damage and make the transport of tall fescue sod easier.

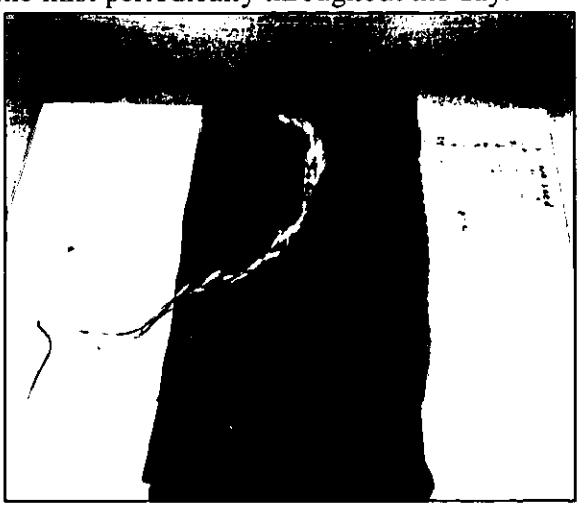
The purpose of this project is to test the germplasm's capability to be self-pollinated in hopes to start the development of rhizomatous tall fescue. This project was performed by practicing S1 selection of superior parents. The germplasm used in this project has rhizomatous activity. The germplasm has been growing in the Southern Illinois climate for years now and is adapted to the environment. Tall fescue is normally a cross-pollinated plant. Cross-pollination leads to heterozygosity in the plant's genes. This leads to more variety in the progeny. Self-pollination reduces this and influences homozygous genes that are more stable and pass on their traits to the progeny. Repeated self-pollination will increase the percentage of homozygous genes each year. The progeny with the desired phenotype can then be selected and entered into a polycross test. A polycross is performed with twenty-five to fifty clones were cross pollination is allowed only between the clones. Self-pollination of a plant that is normally cross-pollinated, which is what was done in this project, reduces the vigor of the progeny. The polycross is used to establish a variety of genotypes to maintain vigor, but still keeping homozygosity for the desired traits.

Materials and methods: This is a list of the materials used.

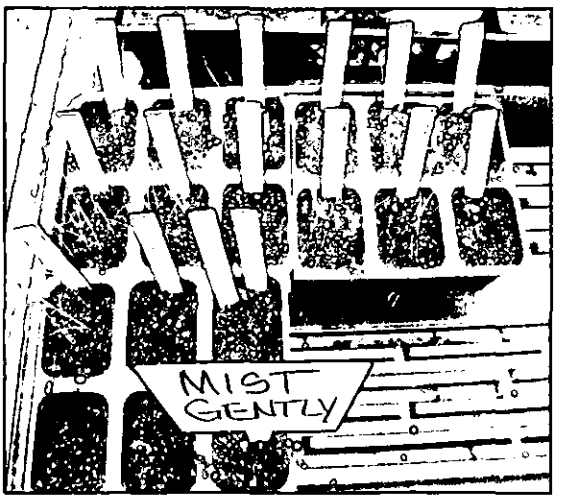
Adapted Portuguese tall fescue germplasm
paper bags
staples
marker flags
permanent marker
thin steel rod
plastic cups
tape
wooden tray
block with rubber grips
greenhouse mix rooting medium
six pack plastic trays
4" plastic pots

At the beginning of the last summer, the parent plants were selected and paper bags were placed over the seed head and stapled. The bag was then stapled to a thin steel rod that was used for support. A flag was also placed at the site of the plant and a number was assigned to the plant. The number was written on the flag and bag with a permanent marker. The parent plants were selected because of their dark green color and appearance to have rhizomes. Next, the bags were checked periodically to make sure they were not punctured. The seed heads were allowed to pollinate and mature. The seed heads were then harvested at the end of June when half of the stem turned yellow. Harvesting included collecting seed heads and placing them in the paper bags. Checks were collected at this point. These seed heads were from a numbered plant, but the seed heads were allowed to be cross-pollinated. Then, all the bags were stored in an air-conditioned room, spread out, and allowed to dry until the fall semester began. Later, the seeds were cleaned by rubbing against a block with rubber grooves in the wooden tray. This separated the florets from the stem. In addition the palea, lemma, and as much of the pericarp as possible were removed by more rubbing or peeling away. Then, the seeds

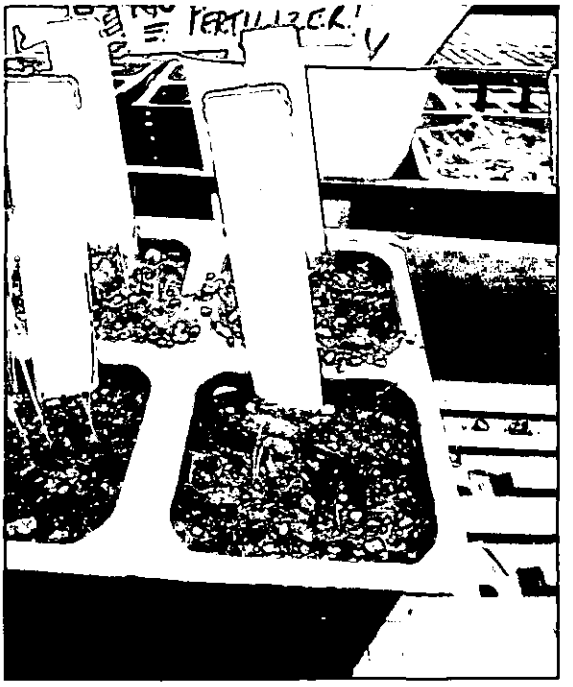
were planted in a plastic six-pack with greenhouse mix medium. The packs were placed in the greenhouse where they received a gentle mist periodically throughout the day.

The seedlings were allowed to grow up to about six inches then they were transplanted into pots. All of the self-pollinated plants and some checks were transplanted. At this point three pots were seeded with a commercial seed to use as a check. The plants were observed periodically and progress was noted. When the commercial seeds reached a sufficient size, all the plants were moved to a different location in the greenhouse where they were only watered when needed. The plants were observed periodically. Later, once the plants grew to the point the roots were circling the bottom of the pot, the leaves were clipped to prevent the plants from drying out. A list of my day-by-day actions and observations is attached to this report.

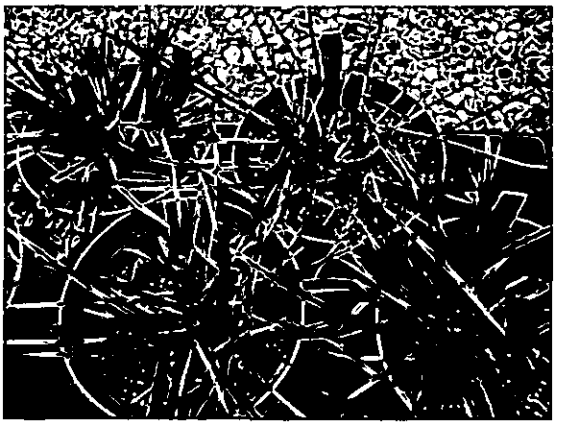


Results: A total of thirty-five parent plants were selected and bagged for self-pollination and nine were collected later for checks. Three of the bags were knocked off during the time the seed heads were pollinated. These included numbers 1, 3, and 35. Thirty-two self-pollinated seed heads were harvested, and five of these produced seed. Numbers 4, 6, 20, 25, and 32 produced seed that was harvested. A few of the seed heads were covered in a fungus. Numbers 25 and 20 contained very small seeds, while 4 and 6 were larger but still smaller than the checks. Number 32 produced normal sized seeds. The number of seeds produced in the self-pollinated seed heads was less compared to the cross-pollinated seed heads. One of the nine checks collected did not produce seed. Out of the five plants that produced seed only 2 plants produced seed that germinated, which included numbers 6 and 32. Number 6 produced one plant and 32 produced three plants. Although an exact value was not found for the germination rate, it was observed to be lower. The self-pollinated progeny germinated at a slower rate than the cross-pollinated checks. These pictures below were taken nineteen days after being planted and the self-pollinated numbers 6 and 32 are considerably smaller in size.



After three and a half months, the self-pollinated plants appear to be growing at the same rate as the checks. The following measurements were made before the leaves were clipped a second time. Number 32b has a tall and loose appearance, while 32c has a dark green color and a compact appearance. The commercial seeds are still smaller in size because they were planted at a later date. The picture below on the left shows from left to right, number 6 and the commercial seed "b" in the back row; commercial seed "a" and "c" are in the front row. The picture below on the right shows from left to right 32c and 32 check "b" in the back row; 32 check "a" and "b" are in the front row.

plant ID	height (inches)	Tillers
32a	8	22
32b	16	18
32c	9	38
32check a	9	35
32check b	8	35
32check c	9	23
6	10	26
com. seed a	6.5	26
com. seed b	8	12
com. seed c	6	24



The picture below on the left shows from left to right, 32b in the back row; 32a and 32c in the front row. The picture below on the right shows the variance in growth habit of two self-pollinated plants from the same parent, 32b is on the left and 32c is on the right.

Discussion: When a plant that is normally cross-pollinated, like tall fescue, is self-pollinated, vigor is reduced. This was observed and expected in the progeny of this project. The small size of seeds was expected, but not too such an extent, as was the case in numbers 20 and 25. However, number 32 did have normal size seeds, but germinated at a slower than normal rate. The vigor is reduced because the endosperm is reduced. The seeds from plants 4, 20, and 25 may not have been viable due to incompatibility of

the gametes. The gametes may have fused to form a seed but they were not viable. The incompatibility of the gametes may have prevented them from fusing in the other twenty-seven seed heads that did not contain seeds. The fungus found on a few of the seed heads could have been detrimental to the production of seeds. The occurrence of fungus was expected due to the enclosed high humidity inside the bag. There was also one cross-pollinated plant (34check) that did not produce seeds. It is possible that a small percentage of the germplasm is not capable of producing seeds even under cross-pollinating conditions. Numbers 6 and 32 germinated slower due to the reduced endosperm. It is possible that a few more seeds from additional plants could have been harvested if I knew exactly what to expect. The viability of these seeds would then have to be tested. If this project was to continue, then more self-pollination would be performed on the progeny and then they could be grouped together for a polycross.

Tall fescue has long been a forage crop for grazing animals. A.J. Turgeon in his book *Turfgrass Management* says, "Tall fescue is a hexaploid species with 42 chromosomes ($2n = 6x = 42$)" (68). John Poehlman in his book *Breeding Field Crops* says, "Another consequence of naturally occurring polyploidy in the forage species is that it increases the complexity of genetic ratios. However, the polyploid species will tolerate to a greater extent deficiencies in chromosomal material than will diploid species" (377). Hexaploidy is an example of polyploidy, which in this case has six sets of chromosomes. A large scale breeding experiment would be needed to achieve the desired traits due to the increased complexity of the genetic ratios. Since tall fescue is a hexaploid, it can tolerate greater deficiencies in the chromosomal material. Deficiencies may occur in the self-pollination since it is normally cross-pollinated. This project served as a good test to see if self-pollination of this germplasm is possible, which it is. To achieve a new variety with a breeding program, more selections must be made.

References

Poehlman, John. Breeding Field Crops. New York: Holt, Rinehart and Winston, Inc., 1959.

Turgeon, A.J. Turfgrass Management. 7th ed. New Jersey: Pearson Education Inc., 2005

Tall Fescue Project-actions PLSS 391

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Date-action-time spent

May 5th– looked at germplasm at HRC. 1 hour

May 11th—discuss actions for rest of the month; begin putting bags on the seedheads ½ hour

May 12th – put bags on some seedheads 1 hour; numbers 1 through 6

May 17th – put bags on seedheads 1 hour; numbers 7 through 18

May 18th – put bags on seedheads ½ hour; numbers 19 – 20

May 23rd—checked bags, put bag numbers 21-24 out, the white envelops are not holding up 1 ¼ hour

May 25th – replaced white bags, put bag numbers 25-30 out, 1 ½ hour

May 26th – put out bags 31-35 ½ hour

June 2nd – checked the bags ½ hour

June 8th – checked the bags ½ hour

June 15th – checked the bags ½ hour

June 17th – rewrote numbers on bags, harvested 10,11,21,28; collected a check from 21, 28; 2 ¼ hour

June 21st – harvested 2,5,7,9,14, 17,18,22,29,30,32,33; collected a check from 14,22,32; 1 ¼ hour

June 23rd – harvested 4,8,9,12,25,27,34; collected a check from 25, 34; 1 ¼ hour

June 29th – harvested 13,15,20,31; collected a check from 13; 1 hour

July 5th – harvested 16, 19, 23, 24, 26; collected a check from 19; ½ hour

Note: a few of the seedheads harvested were covered in a disease (fungus)…The seedheads were stored in paper bags and then spread out in an air conditioned room till Aug. 18 then placed in a box.

Aug. 28 – 2 ½ hours, getting supplies, setting up to thresh and clean seeds. No seeds found in 2,5,9,10,14,15,16,17,18,19,24, 26,30,31,33 took some pictures – Seedheads were rubbed against a block with rubber grooves to separate the florets from the stem. The palea and lemma, and as much of the pericarp as possible were removed by more rubbing or peeling away.

Aug. 29 – thresh and clean seeds in 28check; seeds in 20 & 25 were very tiny, 7 had no seeds 1 ½ hours

Aug. 30 – 34check had no seeds; (13,14,19,21,22,25,32 –all check), 32 all had normal sized seeds; 4,6 had small seeds; 8,11,12,13,21,22,23,27,28,29,34 all had no seed; 4 ½ hour

Aug. 31 – planted seeds from 4, 6, 13 check, 14 check, 19 check, 20, 21 check, 22 check, 25, 25 check, 32, 32 check; seeds are planted in separate packs in greenhouse mix media; the seeds have about ¼ inch of medium on top of the seed. The medium was wetted down. The medium should get frequent gentle misting every day. 1 ½ hour

Sept. 2 – checked packs.

Sept. 7 – checked packs. Seedlings emerging in 13 check, 19 check, 21 check, 22 check, 25 check, 28 check, 32 check.

Sept. 9 – checked packs. 21 check, 22 check are 1 inch tall, 13 check,19 check,25 check,28 check, 32 check, are ½ inch
Sept. 12—checked packs. 14check is 1 inch, the rest are 1 – 1 ½ inch
Sept. 14 – checked packs. 6 emergence (one plant), the rest are 1 – 2 inch
Sept. 16 – checked packs. 32 emergence (one plant), some checks have 2 leaves per plant
Sept. 19 – checked packs. 32 has 3 plants, checks are 2 –4 inches, 6 is 1 inch tall
Sept. 21 – checked packs. Progressing some checks have 3 leaves per plant.
Sept. 23 – checked packs. Progressing 2-5 inches tall
Sept. 26 – checked packs. Same
Sept. 28 – checked packs. Same, 6 and 32 growing slowly
Sept. 30 – checked packs. Same, checks growing up to 6 and 7 inches tall
Oct. 3 – checked packs. Same
Oct. 5 – transplanted 3 plants of #32, 3 plants of #32check, and 1 plant #6 into separate 4 inch pots. 3 pots were seeded (six seeds) of commercial seed. The rest of the packs were thrown out. 1 hour
Oct. 7 – checked pots. Plants looked more stable and upright.
Oct. 10 – checked pots. 32checks were 6 inches tall and 2 plants have 3 tillers; 32 is 3-4inches tall with 1 plant with a tiller; 6 is 3 inches tall
Oct. 12 – checked pots. Same
Oct. 14 – checked pots. Same
Oct. 17 – checked pots. Emergence in all pots
Oct. 19 – checked pots. Slowly growing, took picture
Oct. 21 – checked pots. Seedlings progressing. Other plants are slowly growing.
Oct. 24 – checked pots. Seedlings are 2 inches tall. Other plants have 2-4 tillers.
Oct. 26 – checked pots. Same
Oct. 28 – checked pots. Slowly progressing
Oct. 31 – checked pots. Seedlings are 2-3 inches tall some with two leaves. Other plants slowly growing.
Nov. 2 – checked pots. Slowly progressing
Nov. 4 – checked pots. Slowly progressing
Nov. 7 – checked pots. Seedlings are 3-4 inches tall with 2 tillers. The largest three seedlings in each pot were saved and the rest were discarded. The other plants have up to 6 tillers and leaves are not upright, spreading out.
Nov. 9 – checked pots. Moved pots to North side of greenhouse with other grasses. The pots will get more sunlight and not kept so wet. Thinned out seedlings. One plant left.
Nov. 14 – checked pots. Growing good with warm weather.
Nov. 16 – checked pots. Plants doing great. Commercial seeds have 4-6 tillers. Other plants have 12-18 tillers
Nov. 18 – checked pots. Commercial seeds 4-6 inches. Note- name change other plants = field seeds. Field seeds have leaves that are 12 – 18 inches.
Nov. 21- checked pots. Same, discussed actions for rest of semester with Dr. Diesburg.
Nov. 28—checked pots. Commercial seed plants are 6-8 inches. Field seed plants have long leaves. 12-18 inches. The field seed pots have roots circling in the bottom. The leaves were cut in half, down to about 6-8 inches.

Nov. 30 – checked pots. Commercial seed plants are the same. Field seed plants have more upright growth, 8-10 inches.

Dec. 2—checked pots. Commercial seed plants are the same. Field seed plants are growing 8-12 inches. #32b is the largest.

Dec. 5 – checked pots. Commercial seed plants are the same. Field seed plants are growing. 8-12 inches. #32b is 14 inches

Dec. 7 – checked pots. Commercial seed plants are slowly growing. Field seed plants have some aphids on the leaves. 10-14 inches tall. #32 is 16 inches tall.

Dec. 8. -- checked pots. I made measurements of height and number of tillers. #32c has a dark green and compact appearance, although two small leaves are wrinkled and twisted. All the plants were cut back to 4 1/2inches except #6 was cut to 6 ½ inches. 20 minutes

Dec. 12 – Checked pots. Pictures were taken

plant ID	height (inches)	tillers
32a	8	22
32b	16	18
32c	9	38
32check a	9	35
32check b	8	35
32check c	9	23
6	10	26
com. seed a	6.5	26
com. seed b	8	12
com. seed c	6	24