mentioned they should be put on separately and a week or two should elapse before the second substance is applied.

A COMPARISON OF BENT TURF FROM SELF- AND OPEN-POLLINATED SEED AND FROM STOLONS †

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An experiment to compare turf from self-pollinated and open-pollinated seed was begun in 1928 at the Rhode Island Agricultural Experiment Station. Adjacent to this experiment were plots of turf planted with stolons, which afforded an opportunity to make a comparison of the results from the two methods of planting.

Description of Experiment

The following five different strains of bent grasses were used in the test: Piper, Kernwood, and Highland velvet bents, and Washington and Virginia creeping bents.

Special plants of the five strains were selected in the grass nursery for self-pollination purposes. Certain selected heads of the grasses were covered with tight paper bags in order to avoid cross-pollination. The self-fertilized seed was planted in flats in the greenhouse and 10 different plants were selected from a single fertilized head of each of the strains. These were planted in the nursery in order to produce sufficient stolons for later use. The open-pollinated seed was secured from seed-producing areas of the different strains.

The next step was to plant the open-pollinated seed and

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stolons of the self-pollinated material of the same strain in putting green plots. The area covered by each strain was 20 by 20 feet. The east halves were seeded with open-pollinated seed; the west halves were divided into ten 2-foot strips 10 feet long, and each strip was planted with stolons that were developed from a single seed which had resulted from self-fertilization. This arrangement of planting was followed in order to make comparisons of the plants from self-fertilized heads with the original open-pollinated type. The plots were topdressed, fertilized, mowed, and maintained at as near to putting green conditions as possible.

The plots were compared on the basis of factors affecting quality as follows; a rating of 1 being poor and 5 excellent in each case.

Vigor—Rapidity of upright growth.

Color—Darkness of green. A light green does not rate as high as a rich dark green.

Texture—Fineness of the leaf blades.

Density—Amount of crowding together of the leaves.

Uniformity—General appearance with regard to all quality factors but especially color.

Invasion—Percentage of bent grass other than the kind planted. This indicates bent grass invasion, either from the dropping of clippings or from the aggressive turf on an adjacent plot.

Notes on the factor of color were taken monthly from April to October. Vigor, texture and density were noted during April, June, August, and October. In the tables the quality averages based on the scale of 1 to 5, for the season, were multiplied by 20 in order to express the ratings in per-

centage. The ratings are made on a basis of comparison with other putting green plots of Colonial and creeping bents.

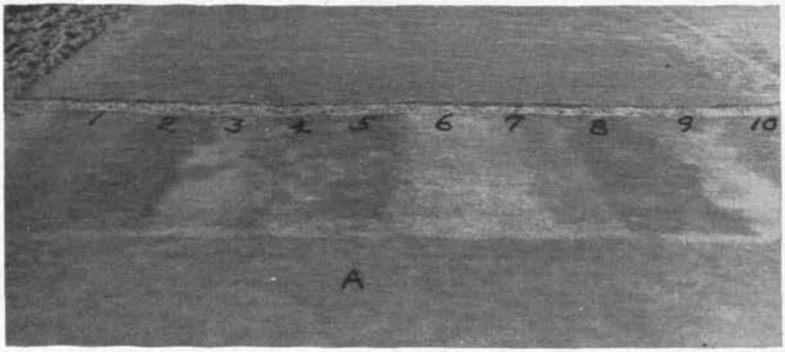
Method of procedure and execution of the experiment was the same with the various velvet and creeping bents and results were much the same. However, instead of giving data for all five grasses used, Piper velvet only will be discussed as it has been rated as producing the best putting green turf at the Rhode Island Experiment Station based on a comparison with other popular bent grasses over a period of several years.

Results and Discussion

The table on page 174 shows the quality relationship of 10 plants developed from seed of one selected self-fertilized head as compared with turf from seed of open-pollinated heads. The latter turf will be designated hereafter as the type. Regarding color, there was quite a wide range of variation. As can be noted in the photograph on page 172, plants numbers 1, 2, 5, and 8 were darker green than the type form; number 10 was on a par with the type form; while numbers 3, 4, 6, 7, and 9 were lighter green.

Turf from plant number 1 was practically as dense as the type, was of very fine texture, very uniform, and not subject to invasion. Turf from plant number 3 was comparatively low in density, coarse in texture, and very subject to invasion although a rapid grower. Number 3, being low in density, was thus subject to invasion in spite of high vigor. On the other hand, numbers 1, 2, 8, and 10 had lower vigor than number 3 but their density was greater and therefore they were not so subject to invasion. Number 9, with low density, low vigor, and comparatively coarse texture, had the highest amount of invasion.

With reference to vigor, in general, the turf from the individual plants was quite similar to the type, with the exception of plant 8 which was the slowest upright grower. A rapidly growing vigorous turf alone without good density will not hold off invasion. A good putting green turf cannot be judged by vigor alone, but density, texture, and color must



Comparison of turf from open- and self-pollinated seed of Piper velvet bent. Plot A, turf from open-pollinated seed. Plots 1-10, strips of turf produced from 10 selected plants grown from self-pollinated seed of a single head of Piper velvet bent and planted vegetatively here.

also be considered. The fastest growing grass may not necessarily produce the best turf for putting greens.

The lateral growth of number 6 is very rapid, as is evident in the photograph by its encroachment on the adjacent turf of plant number 7 to such an extent that only one-half of 7 remains evident. Invasion in the case of number 7 was due to its close proximity to number 6, which was very aggressive with regard to creeping qualities but was not a vigorous turf as measured by rate of upright growth. This adjacent invasion is different from the interior invasion that is due to the dropping of clippings of different plants and their subsequent

rooting and intermingling with the local turf. In general, the plants that produced the most open or least dense turf were quite subject to invasion of other grasses, as can be noted in numbers 3 and 9 in the table and also in the photograph. Plants 1, 2, 6, and 8 were rated as slightly more uniform in appearance than the type.

Based on average quality ratings, plants 1, 2, and 8 were slightly superior to the type form. Number 1 was more uniform than the type and the color was dark green; number 2 was darker in color but the texture and density were not so good as the type; and number 8 possessed a slightly darker green color and was more uniform in appearance. Since these plants showed some improvement over the type, they have been propagated vegetatively and planted in larger plots to be further observed and compared.

Further study of the average quality ratings showed plant number 10 to be slightly inferior to the type and numbers 3 and 9 to be decidedly inferior. It should be noted in the table on page 174 that the factors which pulled the ratings of these two poor strains down were uniformity, texture, and density. Vigor is not necessarily an index of the best turf since often it is the slow-growing grass that has fine texture and other high quality factors. Also, a grass which is slow in producing upright growth does not require so much cutting as a more vigorously growing grass.

The six best plants had an average rating of 92, which is identical with the average quality rating of the type form. The two poorest plants had an average rating of 80 percent, which, in the light of the method by which these average ratings were determined, is considered a large and significant difference. In seeding turf with open-pollinated material of

improved velvet bent, therefore, it would seem that the number of desirable plants will far exceed the number of undesirable individuals.

COMPARISON OF TURF FROM SELF- AND OPEN-POLLINATED SEED OF PIPER VELVET BENT. FIGURES ARE GIVEN IN PERCENTAGE AND ARE BASED ON OBSERVATIONS MADE IN 1940 OF PLANTINGS MADE IN 1931. THE SELF-POLLINATED PLOTS ARE ARRANGED IN ORDER OF THEIR FREEDOM FROM INVASION BY OTHER STRAINS.

	Rating Expressed in Percentage					
Plot	Density	Texture	Vigor	Uniformity	Average quality *	Invasion of other velvet bents
Open-pollinated						
22E	100	98	79	90	92	0
Self-pollinated						
22W-1	99	97	80	98	94	0
22W-2	98	97	80	92	93	trace
22W-8	98	98	76	94	93	5
22W-6	96	80	78	92	86	5
22W-10	96	96	80	86	91	8
22W-5	97	98	80	80	90	14
22W-4	93	95	82	76	88	50
22W-7	98	97	80	85	91	52
22W-3	88	80	84	62	81	60
22W-9	88	90	78	50	79	70

* This average includes color, density, texture, vigor, and uniformity.

Another experiment, consisting of over 100 selected plants of velvet and Colonial bents developed from selfed and open-pollinated material, shows considerable variation in quality factors between the turfs from the different selections. Several promising and improved plants are under observation for disease resistance, color, texture, density, and other quality factors.

The following table shows a comparison between turf of

Piper velvet bent planted with stolons and that planted with seed. The 1940 ratings for different quality factors are given

COMPARISON OF RATINGS OF PIPER VELVET BENT TURF RESULTING FROM STOLON AND SEED PLANTINGS. UNDER EACH QUALITY THE PERCENTAGE RATING FOR 1940 IS GIVEN FIRST AND FOLLOWED BY THE AVERAGE RATINGS FOR THE PLOTS SINCE THEY WERE ESTABLISHED. THE AVERAGE RATINGS FOR PLOTS 16 AND 22E ARE FOR THE YEARS 1931 THROUGH 1940. THOSE FOR PLOT 34N FOR 1932 THROUGH 1940, AND THOSE FOR PLOTS 18NW FOR 1936 THROUGH 1940.

Quality	Rating Expressed in Percentage			
	Stolon-planted plots		Seeded plots	
	Plot 16	Plot 34N	Plot 22E	Plot 18NW
Color				
1940	99	98	95	95
Average	87	88	88	85
Density				
1940	98	98	100	98
Average	94	93	92	86
Texture				
1940	97	98	98	98
Average	98	94	97	92
Vigor				
1940	79	80	79	78
Average	75	74	76	76
Uniformity				
1940	98	97	90	96
Average	89	92	91	92
Average quality *				
1940	94	94	92	93
Average	89	88	89	86

* This average includes the five preceding qualities.

together with the total averages based on observations of 10 years for plots 16 (planted with stolons) and 22E (seeded); 9 years for plot 34N (planted with stolons); and 5 years for

plot 18NW (seeded), depending on the dates of establishment. In considering the average figures it should be remembered that plot 18NW is a much younger turf than the others and consequently did not rate as high in some quality factors on a comparative basis as the older turfs, as can be noted in color, density and texture. In uniformity it rated higher than the older plot of seeded turf.

The turf in 1940 on plot 22E compared very favorably with that on the stolon-planted plot 16 with regard to density, texture, and vigor. However, in 1940 the stolon-planted plot was considerably superior in uniformity of color to the seeded plot which appeared somewhat mottled. This mottled appearance was not so noticeable in 1940 on the more recently seeded plot, 18NW, nor was it so conspicuous on plot 22E in years prior to 1939. The mottled color on 22E is slight and not considered objectionable at present. It is not nearly as conspicuous as on turf of German mixed bent, in which of course there are not only plants representing different strains of a single species but of several different species. However, the mottling may be expected to become more conspicuous on the seeded plots during the years to come as the plants which are off color become increasingly prominent; whereas the stolon-planted plots may be expected to remain uniform in color unless contaminated by clippings of other strains or by seeds.

Summary and Conclusions

These experiments demonstrated that from 10 selected seeds of a single self-fertilized head, the 10 resulting plants produced plots of turf which varied in quality factors such as color, density, texture, vigor and resistance to invasion by other grasses.

The turf resulting from the sowing of seed of either self- or open-pollinated heads, therefore, contained a mixture of plants with different characteristics. The indications were that in using open-pollinated seed of improved strains of velvet bent, the number of desirable plants similar to the strain type predominated, particularly during the first few years following the establishment of the plots.

The present work confirms general observations which have been made frequently that there is considerable variation in strains developed from individual seeds whether they are the result of self- or open-pollination. This fact makes possible the further improvement of velvet bent by the selection and vegetative propagation of plants which show promise of developing particularly desirable turf.

Turf developed from seed harvested from any selected plant or strain is not pure genetically as is that which results from the planting of stolons developed by vegetative propagation of single plants. As has been pointed out, however, at the Rhode Island Agricultural Experiment Station there has been very little difference in the ultimate development of total quality factors of seeded and stolon-planted velvet bent turf except in the uniformity of color. In general, seeded plots of Piper velvet bent were similar to stolon-planted plots after 10 seasons when compared with regard to density, texture, and vigor. When individual plants were studied in detail, differences were evident, but when seeded *en masse* very little difference could be observed until the turf was 7 or 8 years old, after which time the seeded areas became mottled in appearance.