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G. M. Dunn and R. A. Kilpatrick*

THE New Hampshire Station conducted variety trials with the following forage species during 1955-60: bromegrass (*Bromus inermis* leyss), Alfalfa (*Medicago sativa* L.) and Ladino white clover (*Trifolium repens* L.). The purpose of this report is to briefly summarize performance of varieties and strains of these species for the above period.

BROMEGRASS

Material and Methods

Bromegrass test # 1 was seeded on a Charlton loam soil at Dover, N. H., May 28, 1954. This test, conducted in cooperation with the NE-28 Regional Forage Breeding Project, contained thirteen experimental strains selected in the Northeast and four check varieties. The same test was also seeded in New York and Pennsylvania. Seeding rate was 12 lbs. per acre, and 400 lbs. of 8-16-16 fertilizer, 2½ tons of lime, and 10 tons of manure were applied at seeding. The design was a random block with six replications of 5 x 16 foot plots. Fertilization rate during 1955, 1956, 1957 was 500 lbs. of 10-10-10 in early spring, with an additional 50 lbs. of N per acre after the first and second harvest.

Bromegrass test # 2 was seeded August 27, 1957, on an Agawam fine sandy soil at the Strafford County Farm, Dover, N. H. This included five New Hampshire bromegrass strains with three check varieties. Fertilization at seeding was 800 lbs. per acre of 8-16-16 and one ton of lime. The design was a random block with four replications of 5 x 10 foot plots. Fertilization in 1958 and 1959 was 600 lbs. per acre of 10-10-10 in the spring, followed by 60 lbs. of N per acre after the first and second harvest. Somewhat higher rates were used in 1960 when three applications were made with 15-10-10 at about 450 lbs. per acre per application.

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Results and Discussion

Results for bromegrass test # 1 are given in Table 1. This test was beset by several unfavorable production factors. Three harvests were made as scheduled in 1955, on June 8, August 2, and September 15. However, after the first harvest several plots in two localized areas developed large, bare spots where establishment had apparently been good. Weeds immediately filled in these spots, which comprised up to three-fourths of the area of some plots and contributed to variability of the test. No explanation is available for the disappearance of the bromegrass since no detailed studies were made at the time; it is possible that root rots may have been involved.

Table 1.
Forage Yields for 17 Bromegrass Strains, Dover, New Hampshire, 1955-1957.
(tons per acre at 12 percent moisture)

Strain	Year No. Harvests	Total Season Yield 1955 (3)	 1956 (2)	 1957 (1)	Average
		tons	tons	tons	
USDA No. 2		4.06	2.91	1.16	2.71
USDA No. 3		4.43	3.21	1.17	2.94
USDA No. 4					
USDA No. 5		3.85	3.04	1.12	2.67
USDA No. 6		4.18	2.83	.81	2.61
USDA No. 7		4.07	2.92	.98	2.66
USDA No. 8		4.27	3.01	1.00	2.77
N. Y. Syn B		4.70	2.92	.97	2.86
N. Y. Syn H		4.24	2.76	.92	2.64
N. Y. Syn J		3.24	2.19	.81	2.08
N. Y. Syn K		3.67	2.74	.94	2.45
N. Y. Syn L		4.05	2.89	1.16	2.70
Achenbach		3.07	2.24	.65	1.99
Lincoln		3.82	2.11	.13	2.12
Manchar		4.27	2.87	1.06	2.73
Canadian		3.54	2.55	.72	2.27
Average		3.98	2.75	0.93	2.55
L.S.D. (P = 0.05)		0.75	0.50	0.31	
C.V. %		16.4	16.2	29.0	—

An August drought reduced growth to the extent that only two harvests could be made in 1956. The 1957 season was one of the driest on record at this location. As a result, practically no growth was made on the plots after the first harvest, and yield data were obtained on only one harvest. The drought began in early spring, and yields obtained June 7, 1957, were very low. When the test was terminated in 1957, stands were comparatively good, except for plots lost in 1955.

Two of the experimental strains, USDA No. 3 and New York Synthetic B, appeared promising for total and aftermath yields. The latter has recently been named Saratoga and released by the New York Station. Seed of this variety should be available in 1961. Saratoga also produced early spring growth, and had good seedling vigor. One of the check varieties, Manchar, also performed well in this test, and has repeated this performance in subsequent tests.

Resistance to brown leafspot caused by *Pyrenophora bromi* (Died.) Drechsl. is one of the objectives of bromegrass breeding at this Station. The strains in this test appeared to be uniformly susceptible to this organism. Natural infection is normally heavy at this location, with a primary infection in the spring, followed by heavy secondary infections in July and again in the fall. Incidence of disease was highly influenced by weather. Severe infection occurred in periods of high rainfall and humidity, but relatively light infection occurred during the late summer drought in 1956 and 1957.

MacKay (3) conducted a detailed study of these strains, the parental clones, and their progenies. In general, it appeared that selection for resistance to brown leafspot and better aftermath yields should be quite feasible in bromegrass.

Regional results for this test were published elsewhere (4).

Data from bromegrass test # 2 are given in Table 2. The germination of Fischer and Manchar was relatively low in the August 27 seeding, and unsatisfactory stands were obtained for these varieties. Another seeding was made with good seed of these varieties on September 17, and yields were consequently low in 1958, probably because the plants were not yet well established. However, these varieties produced comparatively good yields in 1959 and 1960. Best total and aftermath yields were obtained from Saratoga bromegrass, although two of the synthetics, Syn B and F, also produced relatively high total and aftermath yields.

Table 2.
Forage Yields and Reaction to Brown Leafspot for 8 Bromegrass Strains, (tons per acre at 12 percent moisture)

Strain	Year No. Harvests	Total Season Yield 1958 (3)	 1959 (3)	 1960 (3)	 Average	Disease Rating*
		tons	tons	tons	tons	
N. H. Syn A		7.25	4.72	5.12	5.70	2.1
N. H. Syn B		6.40	5.89	4.92	5.74	5.0
N. H. Syn D		6.91	5.12	4.60	5.54	2.5
N. H. Syn E		6.63	5.00	4.59	5.41	2.2
N. H. Syn F		6.87	5.18	5.41	5.82	2.0
Saratoga		7.42	6.12	5.47	6.34	3.8
Fischer		2.83	5.92	5.11	4.62	3.4
Manchar		2.62	5.55	5.46	4.54	3.8
Average		5.87	5.44	5.09	5.46	3.1
L.S.D. (P = 0.05)		1.07	N.S.	0.46	—	—
C.V. %		12.4	13.6	6.14	—	—

* Based on a scoring system of 1 = no leafspot to 5 = highly susceptible. Number of ratings per strain for 1958-1960 varied from eight to sixteen.

Synthetic B was selected for susceptibility to brown leafspot, and was extremely susceptible in this experiment. It is being used primarily as a source of inoculum for other strains. These results indicate that the disease is very abundant at this location. Some of the synthetics such as A and F, appear to have relatively good resistance to this disease, and seem

significantly more resistant than the check varieties. Some of them also appear to resist lodging better than the check varieties.

These plots were harvested approximately the first week of June, the first week of August, and the middle of September for the three-year period. The average percent stand during 1960 was 63 percent, as determined by three visual estimates during the season. The strains ranged from 50 (Syn A) to 80 percent stand (Saratoga) in the third harvest season. Generally, the checks had somewhat better stands than the synthetics. Clipping height was approximately two inches in this test. It is known that height, frequency, and date of cutting, as well as fertility practices, are often critical in maintenance of bromegrass. There was an indication in this and other similar tests at this location that the management system was not very satisfactory for maintenance of good stands of bromegrass. Studies are in progress to evaluate the effect of the above factors on stand maintenance.

Part of the results from a test of 65 polycross seed progenies of bromegrass selections, not described under methods, is given in Table 3. This test was seeded in the spring of 1958 in the same field as bromegrass test # 2, and fertilized and harvested similarly.

The 65 progenies ranged from 4.17 to 5.82 tons per acre. The data show that individual bromegrass selections can be found which will equal or exceed present varieties in yield, and apparently possess significantly higher resistance to brown leafspot.

Table 3. Forage Yields and Reaction to Brown Leafspot of Bromegrass Progenies and Check Varieties, Dover, 1959-60.*
(tons per acre at 12 percent moisture)

Strain	1959	1960	Average	Average Leafspot†
	tons	tons	tons	
1575	5.35	5.91	5.65	2.3
2410	5.23	5.26	5.25	2.4
4024	5.26	5.27	5.26	2.0
4181	5.12	5.63	5.53	2.3
Lincoln	3.82	5.01	4.42	3.6
Saratoga	5.24	4.51	4.88	4.1
Manchar	5.15	5.70	5.43	4.2
Average	5.07	5.33	5.20	3.0

* Two to three replications of 5 x 10 foot plots.

† Based on four to six visual ratings per strain during 1959-60, on a scale of 1 = no leafspot to 5 = very susceptible.

ALFALFA

Material and Methods

An alfalfa test of four varieties was seeded May 29, 1956 on a Worthington soil at Colebrook, N. H. Seeding rate was 10 lbs. per acre. Approximately one bushel of oats per acre was seeded as a companion crop. The

land was limed at four tons per acre and fertilized with 600 lbs. of 8-16-16 WB at seeding. The design was a random block with five replications of 6 x 20 foot plots. Fertilization rate during 1957, 1958 and 1959 was approximately 400 lbs. per acre of 0-15-30 in early spring, with a similar application after the first harvest.

Results and Discussion

Dupuits alfalfa has excellent seedling vigor, and best stands were obtained with this variety, as shown by 1957 yields in Table 4. Weeds (largely daisies) were common in the first season, and contributed to the excessive variability in 1957 as shown by the large coefficient of variation. Reasonably good yields were obtained in 1958 and 1959. The 1958-59 average is probably more reliable than the three-year average because of the excessive variability in 1957. Only two harvests were made per year because of the distance of this test from Durham. Undoubtedly, Dupuits alfalfa, which has outstanding ability to recover after cutting, would have shown greater superiority with three harvests per year. However, it is not known whether three harvests per year can be made at this location. Narragansett alfalfa, as indicated in earlier trials (1), also appears to be an excellent variety for New Hampshire. Vernal alfalfa, although lowest in this test, is also an excellent variety, with superior resistance to bacterial wilt. However, as far as is known, bacterial wilt does not seem to be a major problem in New Hampshire at this time.

Table 4. Forage Yields of Four Alfalfa Varieties, Colebrook, New Hampshire, 1957-1959. (tons/D.M./acre)

Variety	Total Seasonal Yields (2 Harvests)				
	1957	1958	1959	1957–59 Average	1958–59 Average
	tons	tons	tons	tons	tons
Narragansett	1.20	2.65	3.11	2.32	2.88
Dupuits	2.15	3.04	3.12	2.77	3.08
Vernal	1.02	2.41	2.64	2.02	2.33
Ranger	0.82	2.20	2.90	1.97	2.55
Average	1.30	2.57	2.94	2.27	2.71
L.S.D. (P = 0.05)	0.75	0.36	N.S.	—	—
C.V. %	41.9	10.3	10.0	—	—

Although the 1958-59 winter was considered one of the most severe on record, no differential survival was noted in 1959. In fact, yields were higher and the stand good when the test was terminated in 1959 because experimental work by the Agronomy Department was transferred to Groveton. Good survival was obtained in other legume tests in northern New Hampshire, probably because of the excellent snow cover in this region. Many clover and alfalfa fields in southern New Hampshire were completely killed during the winter of 1958-59.

LADINO WHITE CLOVER

Material and Methods

Ladino white clover test # 1, which includes eleven seed lots, was seeded June 4, 1955, on a Charlton soil at Dover, New Hampshire. The land had previously been fertilized in 1954 with 600 lbs. per acre of 5-10-10, ten tons of manure, and three tons of lime. In 1955, two additional tons of lime were applied and 600 lbs. per acre of 8-16-16 at seeding. The design was a split plot with three sub-plots seeded to Ladino alone and three to a Ladino-bromegrass mixture. The clover was seeded at three pounds per acre except for Vermont polyploid, which was seeded at six pounds because of the larger seed size of this strain. Fifteen pounds of bromegrass per acre were seeded in the mixture.

Two topdressings were made in 1956 and 1957, one in early spring and one after the first harvest. Approximately 500 lbs. per acre of 8-16-16 were applied each time on the mixture and 500 lbs. per acre of 0-15-30 on Ladino alone.

Ladino white clover test # 2 was seeded May 29, 1956, on a Worthington soil at Colebrook, New Hampshire. Seven strains were seeded at three pounds per acre except for Vermont polyploid which was seeded at five pounds per acre. Three tons of lime were applied per acre at seeding and 600 lbs. of 8-16-16. The design was a split plot, with four sub-plots seeded to Ladino alone and four to a Ladino-Fischer bromegrass mixture. The bromegrass was seeded at about 12 pounds per acre. Approximately one bushel of oats per acre was seeded as a companion crop. Fertilization rate during 1957, 1958, and 1959 was approximately 400 pounds per acre of 0-15-30 in the spring and again after the first harvest.

Ladino white clover test # 3 was seeded June 4, 1957, on an Agawam fine sandy loam at the Strafford County Farm, Dover, New Hampshire. Seven strains were seeded in a split plot arrangement, with three sub-plots to Ladino and three of a Ladino-Saratoga bromegrass mixture. This was a cooperative NE-28 regional study and was also seeded at four other states in the Northeast. The Ladino was seeded at three pounds per acre alone and two pounds in the mixture. The bromegrass was seeded at 10 pounds per acre. Plot size was 5 x 20 feet.

Fertilization at seeding was one ton of lime per acre (to pH of about 6.7) and 600 lbs. of 5-10-10. In 1957, two applications of 0-15-30 were made, 250 lbs. per acre in the spring and again in the fall.

Results and Discussion

Results for Ladino test # 1 are given below in Table 5. Excellent stands were obtained on these plots when seeded in 1955. Three harvests were made in 1956, but because of extensive drought, only one harvest was possible in 1957, and clover stands were then lost.

Several lots of Pilgrim white clover (large type) were included, as well as an intermediate type from New Zealand, and Vermont polyploid, a very large type developed by Dr. A. Gershoy at the University of Vermont. Pilgrim white clover was developed for the Northeast, and generally has produced relatively good yields at this Station. Vermont polyploid produces relatively few stolons, compared to the normal Ladino strains, and stand and yields have been somewhat lower. Strains of common white clover,

Table 5. Forage Yields of Eleven Lots of White Clover, Dover, New Hampshire, 1956-1957, Seeded Alone and with Bromegrass* (tons per acre at 12 percent moisture)

Seed Lot	Type	1956 (3 Harvests) Alone	1956 (3 Harvests) Mixture	1957 (1 Harvest) Alone	1957 (1 Harvest) Mixture	Clover in Mixture†
		tons	tons	tons	tons	Percent
1. Commercial Ladino	Large	1.93	3.12	0.46	1.16	58
2. FC24998 (Registered Pilgrim)	Large	2.27	3.36	0.41	1.48	52
3. FC24126 (N. California)	Large	1.97	—	0.34	—	—
4. FC32620 (Certified Pilgrim)	Large	2.24	3.35	0.49	1.41	51
5. FC23851 (Pilgrim)	Large	2.13	—	0.37	—	—
6. FC24657 (Italian)	Large	1.82	—	0.36	—	—
7. Vermont Polyploid	Large	1.85	2.71	0.21	1.19	41
8. FC24669 (Pilgrim)	Large	2.28	2.93	0.46	1.04	65
9. FC24818 (Comp. of Western Seed)	Large	2.17	3.36	0.43	1.39	50
10. FC24128 (S. California)	Large	2.11	—	0.37	—	—
11. FC31985 (N. Zealand White)	Inter-mediate	1.20	3.18	0.15	1.31	4
Average		2.00	3.14	0.37	1.28	46
L.S.D. (P = 0.05)		0.44	N.S.	N.S.	N.S.	
C.V. %		12.8	13.4	35.6	29.0	

* Yields based on three plots of clover alone, and three plots for each lot with bromegrass. Four of the lots were not seeded in the mixture.

† Percent clover based on dry wts. of botanical separations of the clover-bromegrass mixture, made on three harvests in 1956.

such as FC 31985, generally have produced poor yields in comparison to the larger types. New Zealand white clover also appeared to be unable to compete successfully with bromegrass as indicated by the low percent of clover in the mixture.

Results from Ladino test # 2 are given in Table 6. Good stands were obtained on these plots, and were maintained during the three-year period. Common Wisconsin white clover, obtained from the L. L. Olds Seed Co., flowered profusely and persisted poorly under this management system. Stands of this lot were essentially gone by the spring of 1958, and the subsequent stand appeared to result chiefly from reseeding. It was observed that bromegrass grown in association with this lot of clover was noticeably more yellow than in other plots, and yields in the mixture were greatly reduced. These results indicated that the nitrogen supplied by this strain of clover was inadequate for bromegrass in this test.

Relatively small differences in yield were obtained among the various strains and lots of the large types of white clover. Similar results have generally been obtained in other tests which would indicate that at present no outstanding strains are available of the large type. Pilgrim white clover, however, maintained a somewhat better stand than the others during the three year period as shown in the last column of Table 6. Stands of common Wisconsin white, Vermont polyploid, and Minnesota synthetic were

Table 6. Forage Yields of Seven Strains of White Clover, Seeded Alone and with Bromegrass at Colebrook, New Hampshire, 1957-1959. (tons D.M./acre, 2 harvests/year)

Strain	Type	1957		1958		1959		1957-59 Average		Percent Clover in Mixture*
		Alone	Mixture	Alone	Mixture	Alone	Mixture	Alone	Mixture	
Western Comp. FC32583	Large	1.51	2.28	1.22	2.12	0.80	1.73	1.18	2.14	45
Oregon FC24060	Large	1.61	2.17	1.26	2.36	0.78	1.67	1.22	2.07	48
Vermont Polyploid	Large	1.44	2.27	1.14	2.82	0.95	1.86	1.18	2.32	35
Wisconsin White Clover	Small	1.24	2.00	0.40	1.26	0.50	0.97	0.71	1.41	26
Pilgrim FC33121	Large	1.58	2.25	1.26	2.18	0.75	1.63	1.20	2.02	54
Iowa Synthetic FC32585	Large	1.71	1.94	1.22	2.20	0.76	1.82	1.23	1.99	43
Minn. Syn. FC33223	Intermediate	1.15	2.37	1.11	2.58	0.78	1.82	1.12	2.26	39
Average		1.50	2.18	1.09	2.26	0.76	1.64	1.12	2.03	41
L.S.D. (P = 0.05)		0.24	N.S.	0.25	0.17	0.15	0.12	—	—	—
C.V. %		10.7	13.8	15.4	14.0	12.9	17.4	—	—	—

* Based on visual estimates for both harvests for three years.

noticeably poorer than the rest. Somewhat higher yields were obtained in grass mixtures with Minnesota synthetic and Vermont polyploid as shown by their yield in the bromegrass mixture. Presumably, this is because of the fact that grasses generally produce more dry weight than Ladino clover, and plots with sparse clover stands contained more bromegrass.

There was no differential kill of the white clover strains in this test during the severe 1958-59 winter, probably because of the excellent snow cover at this location.

Results for white clover test # 3 are shown below in Table 7.

Table 7. Forage Yields of Seven Strains of White Clover, Seeded Alone and with Bromegrass at Dover, New Hampshire, 1958. (tons per acre at 12 percent moisture)

Strain	Type	1958 (3 Harvests) Alone	Mixture	Clover in Mixture*
		tons	tons	Percent
Pilgrim (FC32620)	Large	3.28	4.12	52
Past. Lab. Syn No. 1	Large	2.74	3.63	55
Past. Lab. Syn No. 2	Intermediate	2.51	3.28	37
California Ladino (FC33734)	Large	2.99	4.33	55
Oregon Ladino (FC33144)	Large	3.31	3.94	64
Iowa Syn (FC32585)	Large	3.05	4.14	57
Bohnert Ladino (FC33594)	Large	3.16	4.16	54
Average		3.10	3.95	53
L.S.P. (P = 0.05)		0.34	0.53	
C.V. %		6.3	7.5	

* Based on three visual estimates of clover in mixture during 1958.

Good stands were obtained on all strains except Synthetic # 2, developed at the U. S. Regional Pasture Laboratory at State College, Pennsylvania. This strain was intermediate in size, flowered profusely, and was somewhat earlier in maturity than the other strains. It began flowering approximately May 29, and all other strains began about June 10. In general, strains of white clover which flower heavily usually produce less forage, and selections in the breeding program at this Station have generally been in the direction of lower flower production. There is also some evidence that the most floriferous strains are less persistent than the least floriferous.

Oregon Ladino and Pilgrim produced somewhat higher yields in pure stands in this test, while in mixtures the former had the highest percent of clover.

The clover was completely winter-killed during the severe winter of 1958-59 at this location as well as many others in southern New Hampshire. The winter was abnormally cold and extensive ice-sheeting occurred. No data were obtained on differential survival of the strains in this test.

Studies at Michigan (5) and New Hampshire (2) have shown that the primary taproots of white clover rarely live more than about two years. Numerous soil-borne fungi and insects may be associated with the rapid death of the root system. Yields are usually drastically reduced in the second and third production year, as shown in Table 6 in the column for Ladino alone. Basic physiological and chemical studies are needed before substantial improvement can be made in the persistence of this important legume.

CONCLUSIONS

1. Saratoga bromegrass appears to be superior to other available bromegrass varieties which have been tested in New Hampshire.

2. Narragansett and Dupuits alfalfa have performed well in limited alfalfa tests in New Hampshire. Vernal alfalfa is suggested for trial in New Hampshire, particularly in areas where bacterial wilt may be a problem.

3. Pilgrim white clover (large type), although not outstanding, has consistently performed somewhat better than other strains and lots of white clover which have been tested in the state.

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