Evaluation of alfalfa varieties for maturity and stem diameter.

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EXECUTIVE SUMMARY

Forages are a primary feed source for many classes of animals in the province, including, but not limited to, dairy, beef, sheep, and equine. Although each of these sectors have different constraints and opportunities, a common theme is a desire to use plant varieties that are best suited to the production system. This is to ensure stability of feed production and reduced costs of their production, harvest, and storage. This research project was designed to provide a systematic evaluation of commercially available forage varieties in Ontario for specific attributes. In this particular study, this was evaluation of herbage yield and stem physical characteristics in a hay management system. Since these characteristics are subject to genotype by environment interaction, assessment under Ontario conditions was necessary to provide relative variety performance within the province.

Herbage yield of 49 varieties of alfalfa managed under a standard, 3-harvest system, were obtained from trials conducted at Elora and Enniskillen. Yield results were incorporated into the Ontario Forage Crops Committee performance database and computations of relative variety performance for Ontario. Maturity and stem diameter measures were also recorded from these trials; for stem diameter measurement, diameters of Stage 4 stems (late bud stage, >2 buds with open flowers) were measured to avoid confounding effects due to maturity differences among stems. For both traits, variety differences were detected, however, there were no significant variety x environment interactions. This indicated that relative maturity and stem diameter were consistent from test to test, harvest to harvest, and that the data could be pooled. Combined over trials, six varieties (Macon, Amerigraze 401+Z, Steak, Oneida VR, Rhino, and Hybri-Force 400) were significantly less mature than the test mean and six varieties (Starbuck, Reliance, Genoa, Stallion, Exp636, and 4.2) were significantly more mature than the test mean. Three varieties (Affinity+Z, 53V52, and Rhino) had Stage 4 stems that were significantly smaller in diameter compared to the test mean. Seven varieties (GH700, Stallion, 134, FSG 300LH, WinterGold, OAC Superior, and Renaissance) had Stage 4 stems that were significantly larger in diameter compared to the test mean.

Herbage yield, maturity, and Stage 4 stem diameter were not correlated with each other. The absence of a strong correlation indicated that if maturity and/or stem diameter was an issue for producers, then both management (ie. harvest timing) and variety selection are factors to incorporate in the design of a system to produce the desired harvested product. For example, harvesting at an earlier stage of development will result in forage that has a greater proportion of finer stemmed, less mature material. However, varieties differ in their maturity as well as their diameter of Stage 4 stems. Thus, one could leave harvest date unchanged but modify the maturity/diameter by changing the variety. Since there was not a high correlation with herbage yield, the latter does not need to be sacrificed to obtain the desired forage characteristics. Bi-plots were constructed to assist in identifying varieties with the desired combination of attributes.

Alfalfa seeded at higher seeding rates will, when harvested on the same date, be less mature than stands seeded at lower seeding rates. This relationship was found for all harvests of the season. For the five varieties tested, there were differences in their reaction to changes in seeding rate. At higher seeding rates, the maturity was less, but the relative change in maturity differed between varieties.

Alfalfa seeded at higher seeding rates had smaller diameter stems at first harvest compared to lower seeding rates. However, seeding rate did not affect stem diameter at the second or third harvest of the season.

MATERIALS AND METHODS

Maturity and stem diameter-Variety effects.

Trials were seeded in 2005 at two sites in Ontario, one at the University of Guelph Elora Research Station, the other on a private farm site located near Enniskillen. Forty-nine varieties of alfalfa were seeded. The test was arranged as a simple lattice repeated with two replications and two repetitions. Plot size was 1 x 6 m, seeding rate of 13 kg/ha. Trial management corresponded to the Ontario Forage Crop Committee (OFCC) Standard Test Protocols. In 2005, trials were clipped and forage removed early August. Fertilizer was applied in early September as per soil test.

In 2006 three yield harvests were taken for each test. A Haldrup self-propelled sickle bar forage harvester was used at Elora and a Carter self-propelled sickle bar forage harvester used at Enniskillen. In 2007, three harvests were taken at Elora, and one at Enniskellin. Severe drought at the latter site prevented further yield harvests to be taken from that test for 2007. Herbage dry matter yields were computed for each plot and yields of each harvest and total seasonal yields were subjected to variance analyses with a lattice model using the Proc Mixed procedure of SAS.

Prior to harvest, a 9 dm^2 hand clipped sample was removed from two replications. The samples were fractionated into maturity classes and the Mean Stage by Weight (MSW) maturity computed as per the method of Kalu and Fick (1981). The stem diameter of the first full internode above the cut end was measured for all Stage 4 stems using electronic calipers. Stage 4 corresponds to the late bud stage (>2 floral buds with no open flowers). MSW and stem diameter measures were subjected to Proc Mixed variance analyses for individual harvests as well as combined analyses over harvests and locations. Correlations and graphical analyses were used to elucidate relationships and genotype interactions. A Type 1 error rate of 0.05 was set for all statistical comparisons.

Maturity and stem diameter – Variety and Seeding rate effects.

Trials were seeded in 2006 at two sites in Ontario, one at the University of Guelph Elora Research Station, the other on a private farm site located near Enniskillen. Five varieties of alfalfa (54V46, 54V54 , Ascend, Magnum IV, and OAC Superior) were seeded at four seeding rates (5.5, 11, 16.6, 22 kg/ha) . The test was arranged as a complete factorial with four replications. Plot size was 1 x 6 m. Trial management corresponded to the Ontario Forage Crop Committee (OFCC) Standard Test Protocols. In 2006, trials were clipped and forage removed early August. Fertilizer was applied in early September as per soil test.

In 2007 herbage yield harvests were taken for each test. A Haldrup self-propelled sickle bar forage harvester was used at Elora and a Carter self-propelled sickle bar forage harvester used at Enniskillen. In 2007, three harvests were taken at Elora, and one at Enniskellin. Severe drought at the latter site prevented further yield harvests to be taken from that test for 2007. Plot MSW and Stage 4 stem diameter were subjected to variance analyses with a two-factor factorial model combined over locations using the Proc Mixed procedure of SAS. Blocks within locations were treated as random effects, all other terms and interactions were assumed fixed effects. Seeding rate effects and interactions were partitioned into linear regression contrasts.

RESULTS

Variety yield performance

Herbage yield was analyzed and the results for the standard management tests at Elora (2006 and 2007) and Enniskillen (2006) were included in the OFCC variety trial database. Due to the drought for

second and third harvests at Enniskillen, there was insufficient yield data in 2007 to include this test-year in the OFCC database. Yield summaries are presented (Tables 1-3).

Maturity and Stem Diameter- Variety effects

Genotype differences were detected but there were no genotype by location differences detected. Table 4 provides the summary for first harvest (two locations, two years), and the summary for season weighted MSW (three location-years). The season weighted MSW was computed as the average MSW at each harvest weighted by the herbage yield for the harvest. Season weighted MSW is a measure of the average maturity of all material removed from the plot that season. The varieties in Table 4 have been sorted based on the average MSW across trials, the least mature are at the top and most mature are at the bottom of the list.

At first harvest in 2006, the Elora trial was at a later stage of maturity than the Enniskillen test (trial MSW 3.4 vs 2.9, respectively) but the situation was reversed the following year (trial MSW 3.7 vs 4.6, respectively). Relative maturity ratings of varieties were consistent from trial to trial and cut to cut. First harvest MSW was correlated to the season weighted MSW ($r=0.76$, $P=0.0001$).

Combined over trials, the season weighted MSW of the varieties ranged from 3.0 to 3.6. Six varieties (Macon, Amerigraze 401+Z, Steak, Oneida VR, Rhino, and Hybri-Force 400) were significantly less mature than the test mean and six varieties (Starbuck, Reliance, Genoa, Stallion, Exp636, and 4.2) were significantly more mature than the test mean.

There were genotype differences for stem diameter of Stage 4 stems, however, there were no genotype by harvest, or genotype x location differences detected. Thus, the data across trials and harvests could be pooled. Table 5 presents the stem diameter means pooled over harvests and tests. Varieties are sorted in Table 5 from thin stems (top of list) to thicker stems (bottom of list).

Three varieties (Affinity+Z, 53V52, and Rhino) had Stage 4 stems that were significantly smaller in diameter compared to the test mean. Seven varieties (GH700, Stallion, 134, FSG 300LH, WinterGold, OAC Superior, and Renaissance) had Stage 4 stems that were significantly larger in diameter compared to the test mean.

Table 1. Herbage yield of 49 alfalfa varieties seeded 2005 and harvested three times in 2006 under a standard yield test management regime, Elora, Ontario. Design was a simple lattice repeated with two replicates and two repetitions.

		Herbage yield (kg DM / ha)			
code	entry	cut 1	cut 2	cut 3	total
1073	SURPASS	5275	4236	3310	12851
1294	DOMINION	5726	3958	3187	12896
1325	MAGNUM IV	5927	3827	2947	12683
1388	GOLD PLUS MF	5367	3729	2647	11762
1392	AMERIGRAZE 401+Z	5450	4035	3431	12898
1402	GRAZEMASTER	5207	3932	3178	12311
1409	AFFINITY+Z	4953	3510	2696	11192
1410	STALLION	5404	3911	2955	12314
1411	JOLT	5355	3836	2988	12217
1416	RENAISSANCE	5122	3542	2745	11403
1419	54V54	5470	3867	2892	12262
1432	OAC SUPERIOR	5550	3892	2987	12424
1448	PICKSD 8925MF	5618	3618	2709	11953
1462	RHINO	5044	3661	2966	11718
1471	ENHANCER	5920	3810	3000	12751
1474	GENEVA	4984	3835	3109	11943
1479	MARQUIS	5394	3553	2670	11591
1481	APPROVED	4939	3632	2776	11358
1482	WINTERGOLD	4985	3740	3057	11755
1486	AC BRADOR	5455	3583	2690	11714
1498	134	5436	3881	3077	12418
1504	PICKSD 2065MF	5459	3971	2965	12437
1512	WL 327	5641	4161	3110	12948
1521	MAGNUM III-Wet	5458	4162	3282	12895
1524	HYBRI-FORCE 400	5269	3806	2965	12072
1525	FORECAST 1001	5160	3939	2971	12064
1527	MACON	5240	4109	3085	12441
1535	RELIANCE	4989	3825	2912	11772
1537	VALIANT	5020	3963	3063	12057
1541	MULTIPLIER 3	5034	3590	2738	11366
1577	STARBUCK	5166	3696	2907	11731
1579	ASCEND	4913	3924	3130	11967
1580	STEAK	5082	3842	3101	11987
1582	54V46	5090	3856	2971	11891
1584	54H91	5058	3673	2882	11608
1586	Exp586	5179	3660	2990	11842
1599	WL319HQ	5065	3774	3077	11905
1600	4.2	5418	3703	3023	12090
1601	FSG 300LH	4810	4026	3130	11949
1607	GENOA	5275	4099	3071	12391
1609	GH700	5028	3904	3037	11928
1610	Exp610	5202	3942	3148	12289
1613	53V52	5179	3689	2870	11743
1615	STEALTH SF	5240	4102	3038	12377
1624	Exp624	5086	3988	3080	12148
1633	GUARDSMAN II	4921	3559	2716	11151
1635	Exp635	4771	3800	3058	11598
1636	Exp636	5294	4020	2930	12199
9041	ONEIDA VR	5540	4127	3247	12921
se		253.6	187.1	198.9	541.5
mean		5248	3847	2990	12085
CV (%)		7.8	6.9	9.8	6.3

Table 2. Herbage yield of 49 alfalfa varieties seeded 2005 and harvested three times in 2006 under a standard yield test management regime, Enniskillen, Ontario. Design was a simple lattice repeated with two replicates and two repetitions.

		Herbage yield (kg DM / ha)			
code	entry	cut 1	cut 2	cut 3	total
1073	SURPASS	6321	4106	2174	12698
1294	DOMINION	5346	4010	1668	10986
1325	MAGNUM IV	5694	3762	2378	11886
1388	GOLD PLUS MF	6300	4368	2115	12819
1392	AMERIGRAZE 401+Z	5786	3875	2331	11955
1402	GRAZEMASTER	6011	3970	2235	12246
1409	AFFINITY+Z	6572	3616	2131	12309
1410	STALLION	6369	4089	2211	12663
1411	JOLT	6604	4138	2097	12775
1416	RENAISSANCE	6138	4136	1876	12174
1419	54V54	6574	4250	2067	12901
1432	OAC SUPERIOR	7517	3931	2053	13437
1448	PICKSD 8925MF	5779	3654	1843	11279
1462	RHINO	5278	3915	1999	11155
1471	ENHANCER	6120	4094	2096	12383
1474	GENEVA	5990	4350	2263	12617
1479	MARQUIS	6004	4297	2108	12511
1481	APPROVED	7118	4283	2364	13853
1482	WINTERGOLD	5958	4317	2034	12324
1486	AC BRADOR	6350	4016	2189	12636
1498	134	6706	4082	2281	13112
1504	PICKSD 2065MF	6312	4320	2349	12913
1512	WL 327	6118	4055	2272	12393
1521	MAGNUM III-Wet	7153	3778	2208	13177
1524	HYBRI-FORCE 400	7321	4007	2236	13587
1525	FORECAST 1001	5319	4361	2351	11980
1527	MACON	6214	3848	1646	11724
1535	RELIANCE	6943	4899	2242	14060
1537	VALIANT	5852	4631	2391	13055
1541	MULTIPLIER 3	6184	3897	1975	12177
1577	STARBUCK	6776	4022	2009	13017
1579	ASCEND	5973	4439	2894	13501
1580	STEAK	5948	3993	2153	12217
1582	54V46	6428	4146	2143	12905
1584	54H91	5904	3465	1919	11151
1586	Exp586	6916	4091	1980	13135
1599	WL319HQ	6652	4272	2359	13089
1600	4.2	6711	3866	2025	12495
1601	FSG 300LH	6686	3591	1627	11782
1607	GENOA	6163	4511	2581	13060
1609	GH700	7055	3921	1709	12557
1610	Exp610	5498	4141	2410	11882
1613	53V52	6542	4323	2620	13440
1615	STEALTH SF	6345	4578	2288	13106
1624	Exp624	5577	4311	2268	12125
1633	GUARDSMAN II	5209	3898	1964	10967
1635	Exp635	5141	4111	2321	11535
1636	Exp636	6867	4080	1885	12817
9041	ONEIDA VR	5312	3979	2164	11377
Mean		5993	4016	2110	12239
CV		15.7	11.3	18.7	9.3

Table 3. Herbage yield of 49 alfalfa varieties seeded 2005 and harvested three times in 2007 under a standard yield test management regime, Elora, Ontario. Design was a simple lattice repeated with two replicates and two repetitions.

		Herbage yield (kg DM / ha)			
code	entry	cut 1	cut 2	cut 3	total
1073	SURPASS	6779	2269	1468	10387
1294	DOMINION	6467	1851	1063	9371
1325	MAGNUM IV	6719	1844	1109	9655
1388	GOLD PLUS MF	6723	1621	1146	9427
1392	AMERIGRAZE 401+Z	7151	2367	1239	10640
1402	GRAZEMASTER	6535	2014	1281	9766
1409	AFFINITY+Z	6828	1417	985	9177
1410	STALLION	6544	2009	1283	9789
1411	JOLT	6330	1683	1104	9189
1416	RENAISSANCE	6582	1467	921	9035
1419	54V54	6737	1685	1190	9631
1432	OAC SUPERIOR	7120	2124	1171	10380
1448	PICKSD 8925MF	6303	1551	987	8860
1462	RHINO	6664	1679	1059	9432
1471	ENHANCER	6648	1799	1224	9610
1474	GENEVA	6821	2109	1287	10274
1479	MARQUIS	6073	1370	948	8441
1481	APPROVED	6316	1442	1084	8846
1482	WINTERGOLD	6511	2006	1287	9754
1486	AC BRADOR	6755	1379	866	9004
1498	134	6776	2138	1386	10314
1504	PICKSD 2065MF	6733	1979	1270	9954
1512	WL 327	6839	2019	1360	10308
1521	MAGNUM III-Wet	6863	2509	1288	10744
1524	HYBRI-FORCE400	6651	1695	1039	9424
1525	FORECAST 1001	6884	2042	1220	10131
1527	MACON	6982	1827	1093	9940
1535	RELIANCE	6605	1835	1133	9622
1537	VALIANT	6804	1990	1422	10208
1541	MULTIPLIER 3	6221	1510	908	8749
1577	STARBUCK	6988	1806	1152	10049
1579	ASCEND	6683	2177	1331	10248
1580	STEAK	6588	1887	1056	9534
1582	54V46	6966	2138	1366	10527
1584	54H91	6525	1681	1069	9217
1586	Exp586	6873	1798	1072	9812
1599	WL319HQ	6303	1932	1171	9466
1600	4.2	7242	1977	1172	10443
1601	FSG 300LH	6392	1923	1091	9413
1607	GENOA	6809	2128	1524	10415
1609	GH700	6965	2071	1324	10367
1610	Exp610	6497	2211	1216	9941
1613	53V52	6646	1608	1048	9184
1615	STEALTH SF	6679	2445	1590	10715
1624	Exp624	6647	2157	1429	10181
1633	GUARDSMAN II	6512	1756	1158	9322
1635	Exp635	6322	2390	1373	10034
1636	Exp636	5158	2109	1267	8528
9041	ONEIDA VR	6577	2173	1101	9810
Mean		6379	1872	1167	9545
CV		9.6	20.1	13.3	9.4

Table 4. Mean stage by weight (MSW) of 49 alfalfa varieties seeded in 2005 at Elora and Enniskillen and harvested three times in 2006 and 2007.
Design was a simple lattice repeated with two replications and two repetitions. Table sorted based on season weighted MSW.

	Harvest 1, MSW						Season weighted MSW					
		Maturity index	2006		2007			Maturity index		2006		2007
Variety	Mean	relative to mean	Elora	Enniskillen	Elora	Enniskillen	Mean	relative to mean		Elora	Enniskillen	Elora
MACON	3.5	-0.1	3.5	2.6	3.3	4.6	3.0	-0.3	*	3.2	2.5	3.2
Amerigraze_401+Z	3.4	-0.3	3.1	2.6	3.4	4.5	3.0	-0.3	*	3.1	2.6	3.3
Steak	3.3	-0.4	3.0	2.6	3.2	4.3	3.1	-0.2	*	3.1	3.1	3.0
Oneida_VR	3.4	-0.2	3.3	2.7	3.6	4.1	3.1	-0.2	*	3.0	2.8	3.4
Rhino	3.4	-0.3	3.4	2.6	3.2	4.2	3.1	-0.2	*	3.3	2.9	3.2
Hybri-Force 400	3.4	-0.2	3.4	2.6	3.6	4.1	3.1	-0.2	*	3.3	2.8	3.2
Exp586	3.5	-0.2	3.0	2.9	3.3	4.8	3.1	-0.2		3.1	3.1	3.2
Marquis	3.6	-0.1	3.0	3.1	3.4	4.8	3.1	-0.2		3.0	3.1	3.2
Approved	3.4	-0.3	3.4	2.6	3.7	3.7	3.1	-0.2		3.2	2.8	3.4
Magnum_IV	3.5	-0.1	2.8	2.8	3.6	4.9	3.1	-0.2		2.9	2.9	3.6
54V54	3.5	-0.2	3.2	2.8	3.5	4.4	3.2	-0.2		3.2	2.9	3.3
WL319HQ	3.7	0.0	3.3	2.7	3.5	5.0	3.2	-0.1		3.2	2.9	3.4
54H91	3.7	0.1	3.4	3.0	3.4	5.1	3.2	-0.1		3.2	3.2	3.3
Affinity+Z	3.7	0.1	2.9	3.1	3.7	5.1	3.2	-0.1		3.0	3.1	3.6
Exp635	3.3	-0.3	3.1	2.6	3.3	4.2	3.2	-0.1		3.2	3.1	3.5
Dominion	3.6	0.0	3.5	3.5	3.3	4.2	3.2	-0.1		3.4	3.1	3.3
53V52	3.7	0.0	3.3	2.9	3.7	4.7	3.3	-0.1		3.3	3.0	3.4
WL327	3.6	-0.1	3.5	2.6	3.7	4.5	3.3	0.0		3.4	2.9	3.5
Grazemaster	3.5	-0.1	3.5	2.6	3.6	4.4	3.3	0.0		3.5	2.9	3.4
Renaissance	3.5	-0.2	2.9	2.9	3.7	4.5	3.3	0.0		3.2	3.1	3.5
Surpass	3.6	0.0	3.4	3.0	3.8	4.2	3.3	0.0		3.4	3.0	3.5
Exp624	3.7	0.0	3.5	2.4	3.9	4.9	3.3	0.0		3.4	2.9	3.6
PICKSEED_8925MF	3.7	0.1	3.6	2.7	3.5	5.2	3.3	0.0		3.5	2.8	3.6
AC_Brador	3.8	0.1	3.3	3.1	3.7	5.1	3.3	0.0		3.3	3.1	3.5
GH700	3.8	0.2	3.5	3.1	3.9	4.9	3.3	0.0		3.2	3.2	3.6
Ascend	3.8	0.1	3.6	3.0	3.6	4.9	3.3	0.0		3.3	3.1	3.5
VALIANT	3.7	0.0	3.4	2.6	3.8	5.0	3.3	0.0		3.4	2.9	3.7
54V46	3.7	0.0	3.4	3.1	3.6	4.6	3.3	0.0		3.5	3.1	3.3
Stealth_SF	3.8	0.1	3.4	3.0	3.7	5.1	3.3	0.0		3.4	3.0	3.6
PICKSEED_2065MF	3.7	0.0	3.1	2.9	4.0	4.8	3.3	0.0		3.2	3.1	3.7
134	3.6	-0.1	3.4	2.7	3.9	4.4	3.4	0.1		3.4	2.9	3.7
OAC_SUPERIOR	3.7	0.0	3.4	2.9	3.3	5.0	3.4	0.1		3.5	3.1	3.5
Multiplier_3	3.6	0.0	3.2	3.3	3.6	4.4	3.4	0.1		3.3	3.2	3.6
Magnum_III-Wet	3.7	0.0	3.3	3.1	4.0	4.3	3.4	0.1		3.4	3.1	3.6
Geneva	3.6	0.0	3.3	2.9	4.0	4.4	3.4	0.1		3.4	3.0	3.8
Gold_Plus_MF	3.7	0.1	3.7	3.2	3.7	4.4	3.4	0.1		3.5	3.1	3.6
JOLT	3.6	0.0	3.5	2.7	3.7	4.5	3.4	0.1		3.5	3.0	3.7
Guardsman_II	3.7	0.1	3.5	3.0	3.7	4.7	3.4	0.1		3.5	3.3	3.5
Enhancer	3.8	0.1	3.8	2.6	3.7	5.0	3.4	0.1		3.7	2.9	3.6
WinterGold	3.8	0.2	3.3	3.0	3.9	5.0	3.4	0.1		3.3	3.3	3.6
Forecast_1001	4.0	0.3	3.6	3.1	4.0	5.1	3.4	0.1		3.6	2.9	3.8
Exp610	3.9	0.3	3.6	3.4	3.8	5.0	3.5	0.1		3.5	3.1	3.7
FSG 300LH	3.8	0.2	3.5	2.9	3.9	5.0	3.5	0.2		3.4	3.2	3.9
Starbuck	3.9	0.3	3.3	3.0	4.4	5.0	3.5	0.2	*	3.3	3.1	4.1
Reliance	3.9	0.2	4.1	3.3	3.9	4.3	3.6	0.2	*	3.7	3.3	3.6
Genoa	3.7	0.1	3.5	3.0	3.8	4.6	3.6	0.3	*	3.4	3.3	4.0
Stallion	3.9	0.3	3.6	3.2	4.2	4.7	3.6	0.3	*	3.6	3.2	4.0
Exp636	3.8	0.1	3.6	3.2	4.1	4.3	3.6	0.3	*	3.6	3.3	3.8
4.2	4.0	0.3	3.8	3.0	4.4	4.5	3.6	0.3	*	3.5	3.0	4.3
mean	3.7		3.4	2.9	3.7	4.6	3.3			3.3	3.0	3.5
se	0.14		0.27	0.27	0.27	0.27	0.10			0.17	0.17	0.17
LSD (0.05)	0.38		0.75	0.75	0.75	0.75	0.27			0.46	0.46	0.46

* = significantly different from the test mean according to a t-test (P=0.05).

Table 5. Stem diameter (mm) of Stage 4 maturity stems of 49 alfalfa varieties seeded in 2005 at Elora and Enniskillen and harvested three times in 2006 and 2007. Design was a simple lattice repeated with two replications and two repetitions. Table sorted based on mean diameter over tests.

	Harvest 1, Diameter (mm)					Mean over harvests	
		2006		2007		2006 & 2007	
	Mean	Elora	Enniskillen	Elora	Enniskillen	combined	
Affinity+Z	2.8	2.6	2.6	3.3	2.9	2.50	*
53V52	3.1	2.9	2.6	3.6	3.4	2.55	*
Rhino	3.1	3.1	2.8	3.3	3.1	2.57	*
54V54	3.1	3.1	3.1	3.1	3.0	2.62	
Magnum_IV	3.2	3.2	3.5	3.3	3.1	2.65	
Genoa	3.3	3.3	3.5	3.2	3.2	2.65	
Exp624	3.1	3.1	3.2	3.1	3.1	2.66	
Enhancer	3.0	3.1	3.1	3.1	2.7	2.66	
Multiplier_3	3.3	3.4	3.0	3.3	3.3	2.67	
Forecast_1001	3.1	3.1	3.1	3.4	2.8	2.67	
Amerigraze_401+Z	3.1	3.1	3.1	3.4	2.9	2.67	
54V46	3.2	3.2	3.1	3.1	3.3	2.67	
Geneva	3.2	3.2	3.0	3.4	3.1	2.67	
Reliance	3.2	3.1	3.2	3.3	2.9	2.67	
Steak	3.3	3.5	3.0	3.3	3.4	2.67	
WL327	3.1	3.2	3.1	3.2	3.1	2.68	
JOLT	3.2	3.2	2.7	3.9	2.9	2.68	
Oneida_VR	3.4	3.3	4.0	3.2	2.9	2.69	
PICKSEED_2065MF	3.2	3.0	3.3	3.3	3.0	2.69	
Approved	3.2	3.1	3.6	3.2	3.0	2.69	
Dominion	3.2	3.3	3.3	3.0	3.3	2.70	
WL319HQ	3.2	2.9	3.4	3.5	2.9	2.72	
Exp586	3.3	2.9	3.4	3.6	3.4	2.73	
AC_Brador	3.1	3.2	3.3	3.0	2.9	2.74	
VALIANT	3.3	3.4	3.8	3.4	2.7	2.74	
Stealth_SF	3.2	3.2	3.4	3.4	2.8	2.75	
Gold_Plus_MF	3.3	3.4	3.3	3.7	2.9	2.77	
Exp635	3.5	3.5	3.6	3.7	3.3	2.77	
Magnum_III-Wet	3.2	3.4	3.0	3.3	3.2	2.77	
Exp610	3.3	3.6	3.2	3.3	3.1	2.79	
Starbuck	3.4	3.6	3.4	3.0	3.5	2.80	
Guardsman_II	3.3	4.1	3.1	3.2	2.9	2.81	
PICKSEED_8925MF	3.3	3.2	3.6	3.6	3.0	2.81	
Marquis	3.4	3.4	3.9	3.4	3.1	2.81	
54H91	3.2	3.4	3.3	3.3	3.0	2.82	
Hybri-Force 400	3.5	3.5	3.6	3.3	3.5	2.82	
MACON	3.3	3.7	3.4	3.2	2.9	2.83	
Ascend	3.2	3.4	3.2	3.5	2.8	2.84	
Exp636	3.4	3.2	3.6	3.5	3.2	2.85	
Surpass	3.3	3.4	3.4	3.3	3.0	2.86	
4.2	3.4	3.5	3.9	3.4	3.0	2.89	
Grazemaster	3.2	2.8	4.5	3.0	2.6	2.90	
GH700	3.4	3.3	3.5	3.6	3.1	2.91	*
Stallion	3.4	3.4	3.6	3.6	3.1	2.91	*
134	3.6	3.9	3.5	3.8	3.1	2.92	*
FSG 300LH	3.3	3.5	3.4	3.6	2.9	2.94	*
WinterGold	3.6	4.0	3.9	3.4	3.1	2.97	*
OAC_SUPERIOR	3.9	3.2	5.8	3.5	3.3	3.08	*
Renaissance	3.7	3.5	5.1	3.4	2.8	3.10	*
mean	3.2	3.3	3.4	3.3	3.0	2.76	
se	0.14	0.28	0.28	0.28	0.28	0.072	
LSD (0.05)	0.38	0.77	0.77	0.77	0.77	0.198	

* = significantly different from the test mean according to a t-test (P=0.05).

Maturity and Stem Diameter- Variety effects Cont'd.

There were variety differences for herbage yield, for maturity, as well as stem diameter (Stage 4 stems). These attributes are, in general, not related. Herbage yield was not correlated with season weighted MSW (r=0.17 P=0.2383) and not correlated with Stage 4 diameter (r=0.05 P=0.7538). Furthermore, maturity was not correlated to Stage 4 stem diameter (r=0.26 P=0.0650).

The absence of strong correlation revels that if either maturity or stem diameter is an issue for producers, then both management (harvest timing) and variety selection are factors that should be considered in designing a system to produce the desired harvested product. For example, harvesting at an earlier stage of development will result in a forage that has a greater proportion of finer stemmed, less mature material. In the present study, the varieties were all harvested on the same date with the finding that varieties differed not only in their maturity but also in their diameter of Stage 4 stems. Thus, one could leave harvest date unchanged but modify the maturity/diameter profile by changing the variety.

The absence of correlation among the three attributes (yield, maturity, and diameter) provides the opportunity to mix and match desirable traits but increases the complexity of selecting a variety that has an optimal combination. Of these three traits, herbage yield is probably the attribute of greatest importance. So, a method of selecting varieties would be to choose from among varieties with greater than average yield and, from among those varieties, select the ones with the desired performance for maturity, diameter, or both.

Figure 1 illustrates a scatterplot of average yield and average maturity of the 49 varieties. These values combine all first year and second year data. The graph has been bisected with lines marking the average yield and the average maturity of the trial. Varieties on the right side are varieties that had greater than average yield. Those in the upper right quadrant are varieties that were more mature on average, those in the lower right quadrant are varieties that were less mature on average.

A similar bi-plot could also be constructed for yield by diameter and for maturity by diameter, however, it was desired to present all three variables in a single graph. The stem diameter results have been incorporated into Figure 1 by using different symbols to plot the variety means. Varieties that had Stage 4 stems that were smaller in diameter than average are indicated using an asterisk (*), those that were larger in diameter are plotted with a plus (+) sign.

Figure 2 is the same plot as Figure 1 but only presents the varieties that had an average Stage 4 stem diameters that were less than the test mean. Varieties in the lower right quadrant are varieties that had a mean yield higher than the test mean, a maturity index lower than the test mean, and had Stage 4 stems that were smaller in diameter than the test mean.

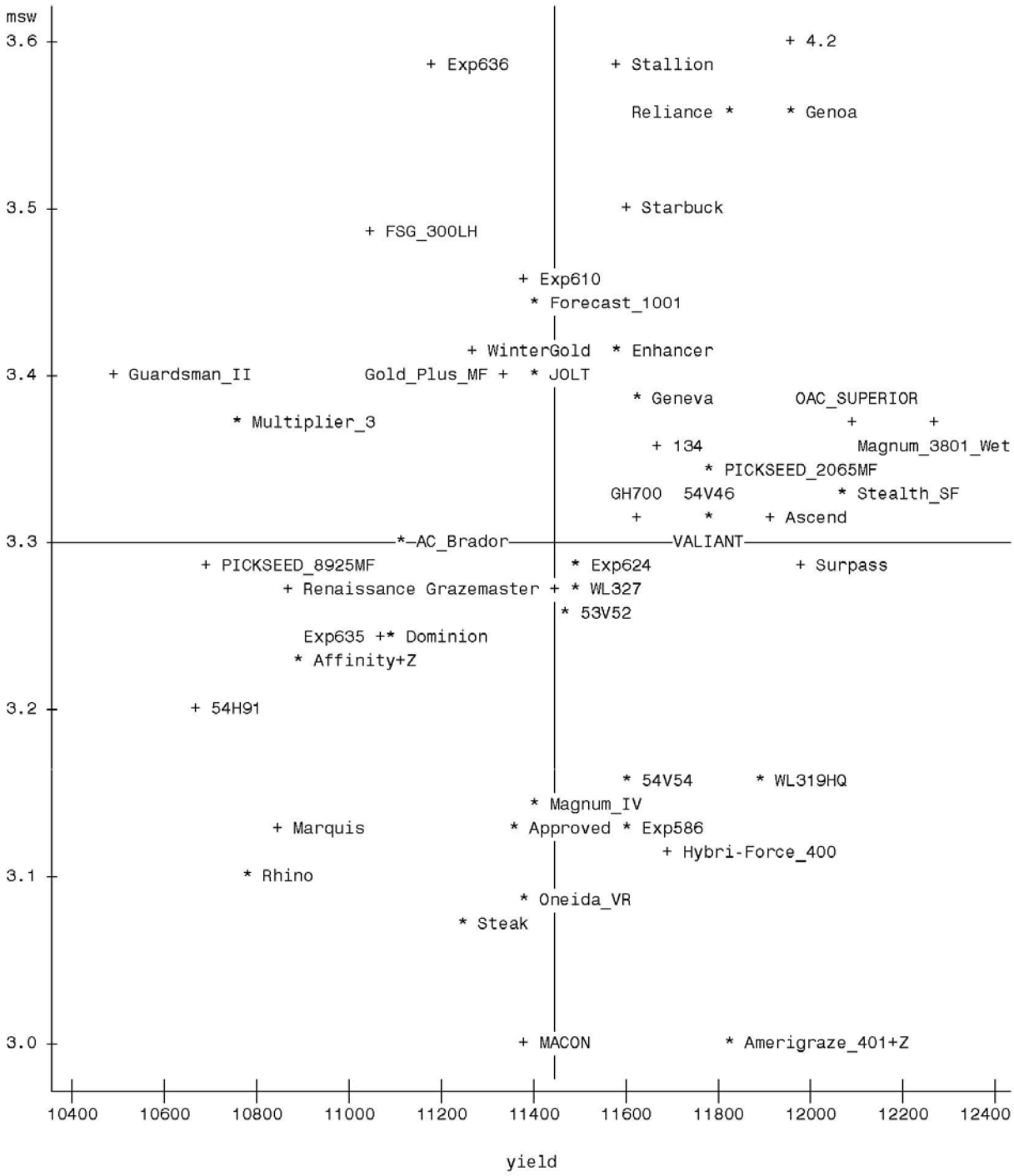

Figure 1. Scatterplot of mean seasonal herbage yield (kg DM / ha) and season weighted mean stage by weight (MSW) of 49 varieties of alfalfa seeded in 2005 and evaluated over a three harvest management in 2006 and 2007, Elora and Enniskillen, Ontario. Design was a simple lattice repeated with two replications and two repetitions. The graph has been bisected with plots showing the test mean for mean yield and mean MSW. Varieties that had Stage 4 stems that were smaller in diameter than the test mean were plotted with the symbol * and those with stems larger in diameter than the test mean were plotted with the symbol +.

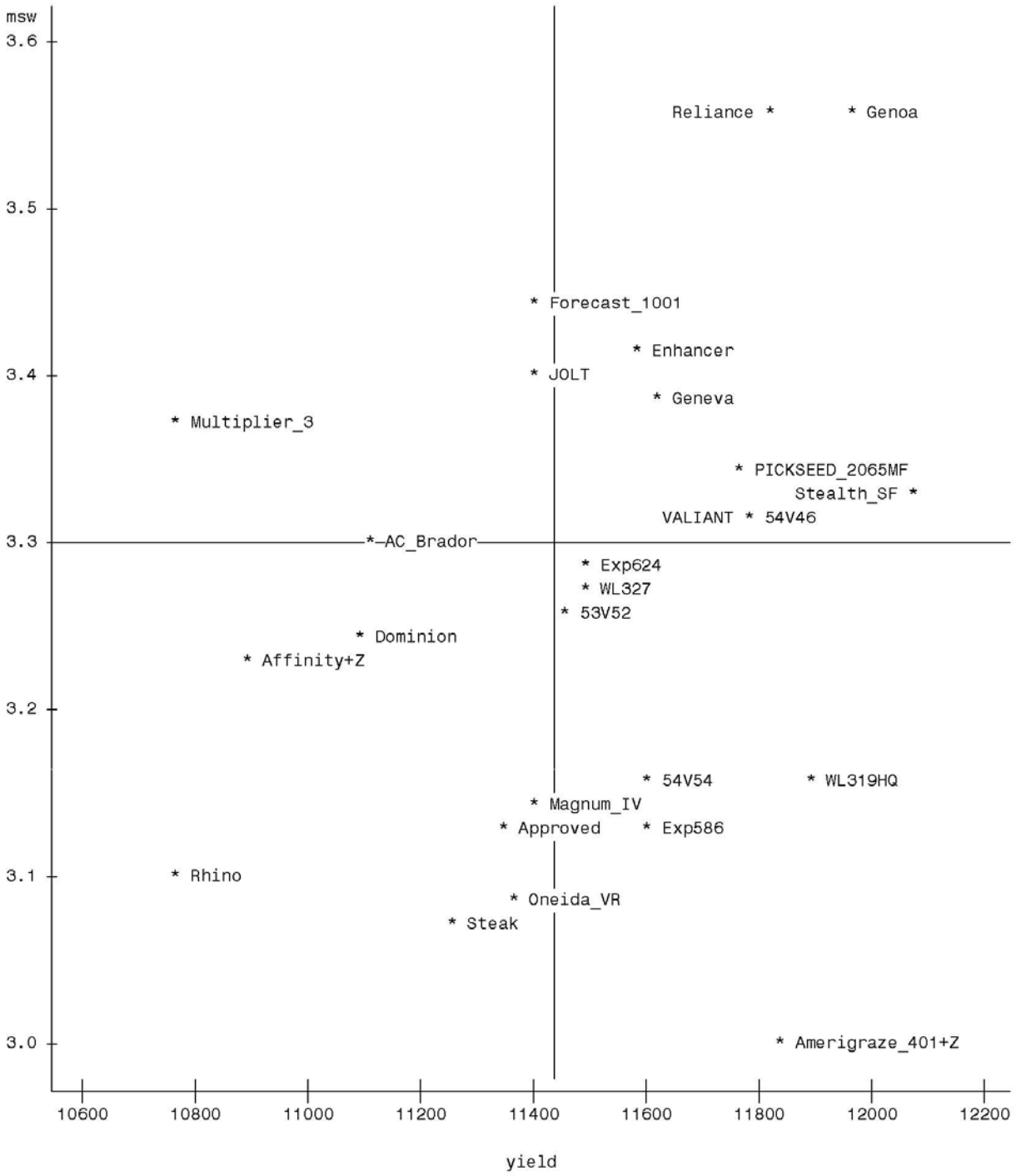

Figure 2. Scatterplot of mean seasonal herbage yield (kg DM / ha) and season weighted mean stage by weight (MSW) of 49 varieties of alfalfa seeded in 2005 and evaluated over a three harvest management in 2006 and 2007, Elora and Enniskillen, Ontario. Design was a simple lattice repeated with two replications and two repetitions. The graph has been bisected with plots showing the test mean for mean yield and mean MSW. Varieties plotted were only those that had Stage 4 stems that were smaller in diameter than the test mean.

Seeding Rate Effects

MSW

As seeding rate increased, the maturity of the forage decreased when all plots were harvested on the same date (Table 6). The pattern of decrease in MSW as seeding rate increased was linear. Across all varieties, for every kg increase in seeding rate, the MSW declined by a value of 0.04 units. There were no significant interactions between locations and seeding rate, and between locations and variety. All varieties significantly declined in MSW as seeding rate increased. Variety 54V46 had the greatest change in MSW and OAC Superior the least change in MSW as seeding rate was altered (Table 6).

In second and third harvest at Elora, the same pattern was found: MSW decreased by 0.06 units/kg and 0.05 units/kg at harvests two and three (Table 6). Unfortunately, the drought conditions at Enniskillen resulted in the absence of second and third cut data for that site. Due to the lower number of data points, comparisons of individual varieties are less robust for harvests two and three.

Stage 4 stem diameter

As seeding rate increased, the stem diameter of Stage 4 stems at the first harvest declined (Table 7). Although all five varieties showed a numerical decline in stem diameter, this change was only statistically significant for two varieties (Ascend and Magnum IV).

In the second and third harvests at Elora, there were no differences among seeding rates Stage 4 stem diameters. The diameter of stems at this stage of development were unaffected by seeding rate. The effect of seeding rate appears to only impact first harvest of the first full production year. Stem diameter of subsequent harvests are not affected by seeding rate.

Alfalfa seeded at higher seeding rates will, when harvested on the same date, be less mature than stands seeded at lower seeding rates. This relationship was found for all harvests of the season. For the five varieties tested, there were differences in their reaction to changes in seeding rate. At higher seeding rates, the maturity was less, but the relative change in maturity differed between varieties.

Alfalfa seeded at higher seeding rates had smaller diameter stems at first harvest compared to lower seeding rates. However, seeding rate did not affect stem diameter at the second or third harvest of the season.

Table 6. Mean stage by weight in 2007 of five alfalfa varieties seeded in 2006 at four different seeding rates at Elora and Enniskillen. Design was a factorial with four replications.

MSW First Harvest 2007-Pooled over Locations

Seeding rate kg/ha	Varieties pooled	54V46	54V54	Ascend	Magnum IV	OAC Superior
5.5	3.8	4.5	3.4	4.2	3.9	3.6
11	3.3	3.7	3.6	3.9	3.4	3.6
16.6	3.7	3.8	3.3	3.5	3.2	3.5
22	3.5	3.3	2.9	3.5	3.3	3.1
se	0.15	0.24	0.24	0.24	0.24	0.24
b	-0.04	-0.06	-0.04	-0.05	-0.04	-0.03
	*	*	*	*	*	*

MSW Second Harvest 2007-Elora

Seeding rate kg/ha	Varieties pooled	54V46	54V54	Ascend	Magnum IV	OAC Superior
5.5	3.3	3.0	3.5	3.2	2.7	3.9
11	2.9	2.9	2.3	3.2	3.1	3.0
16.6	2.6	2.7	2.0	2.8	2.5	2.9
22	2.3	2.2	1.6	3.1	2.4	2.1
se	0.20	0.40	0.40	0.40	0.40	0.40
b	-0.06	-0.05	-0.11	-0.01	-0.03	-0.10
	*	NS	*	NS	NS	*

MSW Third Harvest 2007-Elora

Seeding rate kg/ha	Varieties pooled	54V46	54V54	Ascend	Magnum IV	OAC Superior
5.5	2.6	2.0	2.6	3.5	2.7	2.1
11	2.2	2.3	2.2	2.1	1.9	2.3
16.6	1.8	2.2	1.6	1.9	1.8	1.5
22	1.9	1.7	1.6	2.1	1.9	2.1
se	0.13	0.25	0.25	0.25	0.25	0.25
b	-0.05	-0.01	-0.07	-0.08	-0.05	-0.01
	*	NS	*	*	*	NS

Table 7. Mean diameter (mm) of Stage 4 stems in 2007 of five alfalfa varieties seeded in 2006 at four different seeding rates at Elora and Enniskillen. Design was a factorial with four replications.

Diameter First Harvest 2007-Pooled over Locations

Seeding rate kg/ha	Varieties pooled	54V46	54V54	Ascend	Magnum IV	OAC Superior
5.5	3.25	3.12	3.19	3.32	3.30	3.31
11	3.17	3.21	3.17	3.04	3.16	3.25
16.6	3.07	3.21	3.08	2.82	3.01	3.21
22	2.97	2.89	3.14	2.90	2.71	3.21
se	0.080	0.144	0.144	0.144	0.144	0.144
b	-0.018	-0.012	-0.004	-0.027	-0.035	-0.009
	*	NS	NS	*	*	NS

Diameter Second Harvest 2007-Elora

Seeding rate kg/ha	Varieties pooled	54V46	54V54	Ascend	Magnum IV	OAC Superior
5.5	1.68	1.78	1.84	1.54	1.49	1.75
11	1.62	1.63	1.52	1.52	1.80	1.62
16.6	1.56	1.39	1.50	1.55	1.76	1.60
22	1.68	1.55	1.76	1.78	1.84	1.50
se	0.073	0.136	0.136	0.136	0.136	0.136
b	-0.012	-0.017	-0.011	-0.013	0.018	-0.014
	NS	NS	NS	NS	NS	NS

Diameter Third Harvest 2007-Elora

Seeding rate kg/ha	Varieties pooled	54V46	54V54	Ascend	Magnum IV	OAC Superior
5.5	1.73	1.65	1.84	1.86	1.70	1.62
11	1.68	1.69	1.72	1.87	1.58	1.57
16.6	1.73	1.93	1.74	1.57	1.54	1.85
22	1.72	1.81	1.83	1.92	1.55	1.47
se	0.049	0.109	0.109	0.109	0.109	0.109
b	-0.001	0.016	0.001	-0.002	0.000	-0.006
	NS	NS	NS	NS	NS	NS