Evaluation of Exotic Lines of Maize for Forage Traits

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One hundred and thirty-seven lines of maize were evaluated against African Tall and J 1006 at Indian Grassland and Fodder Research Institute, Jhansi, in an unreplicated design for various forage traits. All the lines exhibited lesser green fodder yield as compared to African Tall. African Tall recorded green yield/3 plants as 3.8 kg whereas maximum yields *i.e.* 2.62 kg was recorded in Hyd 9997-1580. African tall recorded high DMY (1.2 kg) as compared to maximum yield recorded in germplasm line Hyd 99-129 (0.544 kg). Lines such as Hyd 997-1544, -1551, -1552, -1577, and -1666 showed at par or slightly better (%) dry matter as compared to African Tall. Except dry matter per cent and the days to 50% flowering, the various morphological traits under study showed positive correlation with green fodder yield. A total of 50% flowering among the germplasm lines was attained as early as within 48 days of sowing. African tall and J1006 were quite late and showed 50% flowering after 70 to 73 days of sowing. Per day per plant green as well as dry matter productivity of African Tall was very high. Certain germplasm lines with comparatively high per day productivity, green and dry matter productivity can be further exploited in breeding programmes in order to breed early flowering varieties with high biomass productivity. The values of skewness were found to be very low for leaf width, number of nodes, green fodder yield and per day productivity indicated a marginal deviation of modal value from the mean. The values of kurtosis for all the traits were in low range sketching platycurtic curve indicating high range of variability in the population. The quality parameters estimated on selected lines revealed that the crude protein (CP) ranged from 9.3% to 10.64% at 50% flowering stage. Natural detergent fibre content ranged from 67.32% to 72.13, acid detergent fibre ranged from 38.91% to 42.57%, lignin content and ash content ranged from 6.98% to 9.67% and 9.63% to 12.08 respectively.

Key Words: Forage Traits, Maize, Morphology, Nutritional Evaluation, *Zea mays*

Maize is a crop which is grown in almost all parts of the country irrespective of latitude, longitude and altitude. In India it occupies nearly 9 m ha land area with an average productivity of 3035 t/ha (Hazra, 1995) The crop has also been exploited to the maximum by scientists for its improvement utilizing cytogenetical, breeding and biotechnological methods. The crop has attracted the attention primarily as grain crop in spite of the fact that for centuries the crop has also been used by farmers as fodder crop. The mode of utilization as fodder may vary from its use as green fodder, hay (*kadavi*) or silage. Due to less attention to improve maize for fodder purpose, presently there are very few varieties in the market since long. The breeding objectives defined by Mishra (1988) indicated for improvement in terms of dry matter content, early maturing, resistance for lodging, and the nutritional value of the crop as fodder. Hence, the present investigation was undertaken to evaluate some exotic lines of maize received from CIMMYT with respect to extent of variability and nature of association among forage yield and related traits.

Materials and Methods

One hundred thirty seven maize lines (Table 1) were grown at Central Research Farm of Indian Grassland and Fooder Research Institute (IGFRI), Jhansi, in an unreplicated plot. Each entry was grown in one row plot of 4 m length keeping 50 cm distance between the rows and 15 cm between the plants within a row. The two checks *i.e.* African Tall and J 1006 were put after every 10 rows. The data recorded on these checks was averaged individually and then compared with different genotypes. The crop was raised adopting standard package and practice under rainfed condition. Data was recorded on three randomly selected plants at 50% flowering stage. Nutritional parameters such as crude protein content (CP), neutral detergent fibre (NDF), acid detergent fibre (ADF), inorganic matter (ash) and lignin were measured on percentage of dry matter. The representative samples of whole plant were analyzed in duplicate for selected proximate constituents (AOAC, 1980) and fibre content (Goering and Van Soest, 1970).

Results and Discussion

African tall is a fodder maize variety with its known high biomass yield potential but the variety is long duration which restricts its acceptability among farmers. In the present investigation the germplasm lines of maize were evaluated for yield and other forage traits against the two fodder type of varieties. The study revealed that all the lines showed lesser green fodder yield as compared to African Tall (Table 2). African Tall recorded

Table 1. List of maize germplasm evaluated

Accession	Pedigree	Origin Mexacc	Accession	Pedigree	Origin Mexacc
Hyd 997-1514	O2POOL 27 C8	6083	Hyd 997-1686	CUBA T-15	6255
Hyd 997-1515	O2POOL 28 C8	6084	Hyd 997-1687	CUBA T-79	6256
Hyd 997-1517	O2POOL 32 C16	6086	Hyd 997-1688	CUBA T-82	6257
Hyd 997-1518	O2POOL 33 C23	6087	Hyd 997-1689	CUBA T-87	6258
Hyd 997-1519	O2POOL 34 C24	6088	Hyd 997-1697	V-33	6266
Hyd 997-1520	POBLAC 61 C1	6089	Hyd 997-1698	MONARC	6267
Hyd 997-1521	POBLAC 63 C2	6090	Hyd 997-1700	OAXA 821	6269
Hyd 997-1522	POBLAC 65 C6	6091	Hyd 997-1701	OAXA 814	6270
Hyd 997-1523	POBLAC 66 C0	6092	Hyd 997-1704	OAXA 711	6273
Hyd 997-1524	POBLAC 67 C1	6093	Hyd 997-1707	COMPUE BLANCO	6276
Hyd 997-1525	POBLAC 68 C0	6094	Hyd 997-1715	CHIH 43	6284
Hyd 997-1526	POBLAC 69 C4	6095	Hyd 997-1716	CHIH 4	6285
Hyd 997-1527	POBLAC 70 C0	6096	Hyd 997-1718	OAXA SEQUIA	6287
Hyd 997-1533	GUAT 209	6102	Hyd 997-1719	GUAD 15	6288
Hyd 997-1543	SNLP 104	6112	Hyd 997-1721	GUAD 6	6290
Hyd 997-1553	BRAZ 859	6122	Hyd 997-1722	RDOM 300	6291
Hyd 997-1566	BRAZ 1006	6135	Hyd 997-1724	GUAD GP 1	6293
Hyd 997-1568	BRAZ 1114	6135	Hyd 997-1725	PUER 5	6294
Hyd 997-1570	BRAZ 1151	6139	Hyd 997-1730	CUBA 94	6299
Hyd 997-1571	BRAZ 1177	6140	Hyd 997-1731	PUER GP 6	6300
Hyd 997-1573	BRAZ 1644	6142	Hyd 997-1732	SVIN GP2	6301
Hyd 997-1574	BRAZ 1720	6241	Hyd 997-1743	CUBA 134	6312
Hyd 997-1580	BRAZ 2121	6149	Hyd 997-1744	HAIT GP3	6313
Hyd 997-1581	BRAZ 2146	6150	Hyd 997-1750	CUBA 113	6319
Hyd 997-1582	BRAZ 2148	6151	Hyd 997-1755	PUER GP4	6324
Hyd 997-1583	BRAZ 2305	6152	Hyd 997-1758	CUBA 126	6327
Hyd 997-1591	OAXA 246	6160	Hyd 997-1762	TRIN GP1	6331
Hyd 997-1595	URUG 215	6164	Hyd 997-1784	GUAD GP2	6353
Hyd 997-1596	URUG 59	6165	Hyd 997-1786	CUBA 85	6355
Hyd 997-1597	URUG 80	6166	Hyd 997-1790	CUBA 83	6359
Hyd 997-1598	URUG 138	6167	Hyd 997-1793	CUBA 82	6362
Hyd 997-1603	JALI 281	6172	Hyd 997-1799	CUBA 130	6368
Hyd 997-1604	NAYA 154	6173	Hyd 997-1501	BRAZ 2461	6070
Hyd 997-1605	NAYA 166	6174	Hyd 997-1507	ARZM 01113	6076
Hyd 997-1609	BRAZ 2234	6178	Hyd 997-1508	ARZM 01114	6077
Hyd 997-1620	BRAZ 1711	6189	Hyd 997-1509	SINA 25	6078
Hyd 997-1626	SUWAN TUXP	6195	Hyd 997-1510	MART 10	6079
Hyd 997-1627	CMS 06	6196	Hyd 997-1512	BRAZ 1116	6081
Hyd 997-1629	COPM MANAUS	6198	Hyd 997-1513	SONO 144	6082
Hyd 997-1634	BRAZ SEO28	6203	Hyd 997-1517	O2POOL 32 C16	6086
Hyd 997-1635	BRAZ SEO32	6204	Hyd 997-1528	SNLP 105	6097
Hyd 997-1641	CHZM 04030	6210	Hyd 997-1529	SNLP GP 15	6098
Hyd 997-1642	CHZM 05015	6211	Hyd 997-1530	VERA 213	6099
Hyd 997-1647	SNMART 126	6216	Hyd 997-1531	JALI GP 5	6100
Hyd 997-1648	ARZM 13026	6217	Hyd 997-1532	VERA 190	6101
Hyd 997-1649	ARZM 16021	6218	Hyd 997-1540	GUAD GP 5	6109
Hyd 997-1650	ARZM 16026	6219	Hyd 997-1542	GUAD 9	6111
Hyd 997-1651	ARZM 16035	6220	Hyd 997-1544	SNLP 99	6113
Hyd 997-1652	ARZM 17026	6221	Hyd 997-1545	SNLP 136	6114
Hyd 997-1653	ARZM 17056	6222	Hyd 997-1547	RIGS GP5	6116
Hyd 997-1657	CUBA T-4	6226	Hyd 997-1548	VERA 147	6117
Hyd 997-1658	CUBA T-7	6227	Hyd 997-1551	VERA 207	6120
Hyd 997-1659	CUBA T-12	6228	Hyd 997-1552	VERA 217	6121
Hyd 997-1662	CUBA T-30	6231	Hyd 997-1554	BRAZ 881	6123
Hyd 997-1664	CUBA T-1-41	6233	Hyd 997-1556	BRAZ 928	6125
Hyd 997-1665	CUBA T-1-44	6234	Hyd 997-1557	BRAZ 931	6126
Hyd 997-1666	CUBA T-1-48	6235	Hyd 997-1559	BRAZ 972	6128
Hyd 997-1668	CUBA T-52	6237	Hyd 997-1560	BRAZ 981	6129
Hyd 997-1669	CUBA 1-56	6238	Hyd 997-1561	BRAZ 988	6130
Hyd 997-1670	CUBA 1-60	6239	Hyd 997-1562	BRAZ 993	6131
Hyd 997-1672	CUBA 1-63	6241	Hyd 997-1563	BRAZ 1019	6132
Hyd 997-1673	CUBA 1-67	6242	Hyd 997-1565	BRAZ 917	6134
Hyd 997-1674	CUBA 1-71	6243	Hyd 997-1567	BRAZ 1058	6136
Hyd 997-1675	VENE BG002	6244	Hyd 997-1569	BRAZ 1133	6138
Hyd 997-1676	VENE 07403	6245	Hyd 997-1572	BRAZ 1192	6141
Hyd 997-1679	VENE 07809	6248	Hyd 997-1577	BRAZ 1847	6146
Hyd 997-1681	CUBA 1-61	6250	Hyd 997-1699	OAXA 803	6268
Hyd 997-1682	CUBA 1-69	6251	African Tall		
Hyd 997-1684	CUBA T-78	6253	J 1006		
Hyd 997-1685	CUBA T-83	6254			

Table 2. Yield and yield attributes in exotic gemplasm lines of maize

Accession	Plant height (cm)	Leaf width (cm)	Leaf length (cm)	Stem dia. (cm) (cm)	Number of nodes	GFY (kg) (3 plants)	Dry wt (kg) (3 plants)	DM%	Days to 50% flower	Per day GFY (g)/ plant	Per day DMY (g)/ plant
Hyd 997-1514	149.3	5.5	50.8	1.4	10.0	0.855	0.122	14.27	48.00	5.94	0.85
Hyd 997-1515	166.0	5.5	61.5	1.4	9.7	1.060	0.136	12.83	50.00	7.07	0.91
Hyd 997-1517	182.0	7.6	6.10	1.6	10.7	1.100	0.136	12.36	51.00	7.19	0.89
Hyd 997-1518	174.7	6.1	70.4	1.8	10.7	1.010	0.122	12.08	51.00	6.60	0.80
Hyd 997-1519	188.3	7.7	66.4	1.8	11.0	1.425	0.222	15.58	50.00	9.50	1.48
Hyd 997-1520	149.3	8.2	63.0	1.7	10.3	1.200	9.248	20.67	9.00	6.78	1.40
Hyd 997-1521	226.7	9.0	62.5	2.2	16.5	1.810	0.351	19.39	57.00	10.58	2.05
Hyd 997-1522	279.0	6.2	52.5	1.7	14.7	1.700	0.279	16.41	52.00	10.90	1.79
Hyd 997-1523	201.7	8.8	64.1	2.1	12.5	1.900	0.294	15.47	51.00	12.42	1.92
Hyd 997-1524	190.0	7.3	66.9	1.7	12.0	1.200	0.178	14.83	50.00	8.00	1.19
Hyd 997-1525	198.3	7.3	61.7	1.6	10.0	1.050	0.159	15.14	52.00	6.73	1.02
Hyd 997-1526	185.7	8.2	70.7	1.8	9.7	1.420	0.180	12.68	51.00	9.28	1.18
Hyd 997-1527	200.3	8.2	68.5	1.9	12.0	1.865	0.297	15.92	50.00	12.43	1.98
Hyd 997-1533	216.3	7.6	61.0	1.7	12.7	1.525	0.252	16.52	52.00	9.78	1.62
Hyd 997-1543	247.3	7.6	67.0	1.6	15.3	1.580	0.297	18.80	56.00	9.40	1.77
Hyd 997-1553	234.0	6.3	66.6	1.6	11.7	1.320	0.234	17.73	50.00	8.80	1.56
Hyd 997-1566	178.3	9.1	81.8	2.0	12.3	1.500	0.237	15.80	57.00	8.77	1.39
Hyd 997-1568	208.3	8.1	75.4	1.9	13.3	1.950	0.341	17.49	56.00	11.61	2.03
Hyd 997-1570	222.5	8.6	68.0	2.0	12.0	1.480	0.268	18.11	57.00	8.65	1.57
Hyd 997-1571	192.5	9.8	75.1	1.9	12.5	1.020	0.259	25.39	61.00	5.57	1.42
Hyd 997-1573	247.7	9.4	65.8	1.6	13.7	1.600	0.297	18.56	56.00	9.52	1.77
Hyd 997-1574	229.7	8.7	80.8	2.0	13.0	1.800	0.291	16.17	54.00	11.11	1.80
Hyd 997-1580	227.0	8.7	8.0	2.5	14.0	2.620	0.415	15.84	55.00	15.88	2.52
Hyd 997-1581	220.0	7.7	73.0	2.2	13.5	1.520	0.280	18.42	54.00	9.38	1.73
Hyd 997-1582	148.7	6.6	73.0	1.5	12.0	0.850	0.213	25.06	59.00	4.80	1.20
Hyd 997-1583	195.3	8.1	78.0	1.9	13.0	1.480	0.377	25.47	59.00	8.36	2.13
Hyd 997-1591	214.7	8.6	73.3	1.7	12.7	1.520	0.328	21.58	57.00	8.89	1.92
Hyd 997-1595	187.3	8.6	70.7	1.7	10.0	1.265	0.163	12.89	50.00	8.43	1.09
Hyd 997-1596	176.3	7.5	53.0	1.8	10.7	1.250	0.185	14.80	53.00	7.86	1.16
Hyd 997-1597	220.3	7.2	68.8	1.8	11.0	1.445	0.238	16.47	50.00	9.63	1.59
Hyd 997-1598	221.0	7.0	62.4	1.8	11.7	1.700	0.241	14.18	51.00	11.11	1.58
Hyd 997-1603	252.3	8.4	66.5	1.8	12.0	1.870	0.310	16.58	56.00	11.13	1.85
Hyd 997-1604	241.2	8.1	77.6	1.8	15.3	1.710	0.354	20.70	59.00	9.66	2.00
Hyd 997-1605	233.0	7.2	65.7	1.8	14.3	1.310	0.273	20.84	57.00	7.66	1.60
Hyd 997-1609	216.7	9.3	81.7	1.9	14.0	1.850	0.324	17.51	54.00	11.42	2.00
Hyd 997-1620	192.0	8.0	75.3	2.4	14.0	1.230	0.267	21.71	59.00	6.95	1.51
Hyd 997-1626	228.0	8.6	70.6	1.7	11.3	1.430	0.243	16.99	54.00	8.83	1.50
Hyd 997-1627	225.0	8.9	67.7	2.0	14.0	2.400	0.479	19.96	54.00	14.81	2.96
Hyd 997-1629	230.3	8.3	73.7	1.8	11.7	1.880	0.292	15.53	51.00	12.29	1.91
Hyd 997-1634	180.3	8.5	72.4	2.1	15.3	2.380	0.446	18.74	56.00	14.17	2.65
Hyd 997-1635	197.7	7.4	67.7	1.9	13.0	1.250	0.285	22.80	57.00	7.31	1.67
Hyd 997-1641	133.0	6.5	58.4	1.3	9.0	0.470	0.093	19.79	59.00	2.66	0.53
Hyd 997-1642	138.5	6.7	71.0	1.7	9.0	0.440	0.098	22.27	59.00	2.49	0.55
Hyd 997-1647	187.7	9.2	89.8	2.1	1.37	2.030	0.512	25.22	61.00	11.09	2.80
Hyd 997-1648	201.7	7.2	70.7	2.0	11.0	1.360	0.259	19.04	57.00	7.95	1.51
Hyd 997-1649	177.0	7.9	62.9	1.8	9.7	0.930	0.174	18.71	54.00	5.74	10.7
Hyd 997-1650	126.0	6.8	59.5	1.5	9.0	0.350	0.068	19.43	59.00	1.98	0.38
Hyd 997-1651	170.3	7.1	66.1	1.8	9.0	1.330	0.135	10.15	51.00	8.69	0.88
Hyd 997-1652	180.7	7.4	73.5	2.1	9.7	1.260	–	–	55.00	7.64	–
Hyd 997-1653	183.0	6.5	49.2	1.6	12.0	1.450	0.146	10.07	51.00	9.48	0.95
Hyd 997-1657	221.3	8.8	74.3	1.7	12.7	1.250	0.238	–	56.00	7.44	–
Hyd 997-1658	229.5	9.4	68.0	2.1	13.5	1.180	0.255	21.61	57.00	6.90	1.49
Hyd 997-1659	194.0	9.0	74.7	1.7	1.25	0.800	0.176	22.00	61.00	4.37	0.96
Hyd 997-1662	234.3	9.6	75.5	1.9	13.3	1.950	0.368	18.87	57.00	11.40	2.15
Hyd 997-1664	245.7	9.3	70.8	1.7	14.0	2.030	0.349	17.19	54.00	12.53	2.15
Hyd 997-1665	216.3	9.6	75.2	2.1	14.0	2.420	0.422	17.44	55.00	14.67	2.56
Hyd 997-1666	196.0	9.6	69.1	2.2	12.0	1.120	0.331	29.55	57.00	6.55	1.94
Hyd 997-1669	232.0	7.6	56.0	1.7	13.3	1.030	0.202	19.61	54.00	6.36	1.25
Hyd 997-1670	272.2	6.7	58.4	1.5	14.7	1.250	0.268	21.44	54.00	7.72	1.65
Hyd 997-1672	262.7	6.6	57.3	1.6	14.7	1.340	0.255	19.03	54.00	8.27	1.57
Hyd 997-1673	224.0	9.2	73.3	1.8	13.3	1.690	0.323	19.11	54.00	10.43	1.99

Contd.

Accession	Plant height (cm)	Leaf width (cm)	Leaf length (cm)	Stem dia. (cm) (cm)	Number of nodes	GFY (kg) (3 plants)	Dry wt (kg) (3 plants)	DM%	Days to 50% flower	Per day GFY (g)/ plant	Per day DMY (g)/ plant
Hyd 997-1674	230.7	8.0	76.5	2.0	13.7	1.480	0.292	19.73	56.00	8.81	1.74
Hyd 997-1675	198.0	8.0	61.7	1.6	10.7	1.080	0.190	17.59	52.00	6.92	1.22
Hyd 997-1676	159.7	7.4	67.4	1.7	12.3	1.160	0.245	21.12	59.00	6.55	1.38
Hyd 997-1679	168.3	7.1	79.4	1.7	12.7	1.120	0.305	27.23	59.00	6.33	1.72
Hyd 997-1681	203.0	8.8	76.9	2.0	12.0	0.930	0.182	19.57	57.00	5.44	1.06
Hyd 997-1682	171.5	6.9	65.0	1.9	11.0	0.560	0.110	19.64	57.00	3.27	0.64
Hyd 997-1684	208.3	8.1	74.8	1.7	11.7	1.640	0.204	12.44	51.00	10.72	1.33
Hyd 997-1685	239.0	7.5	77.7	1.8	15.3	1.480	0.200	13.51	6.100	8.09	1.09
Hyd 997-1686	271.7	7.0	65.7	1.9	14.3	1.810	0.376	20.77	54.00	11.17	2.32
Hyd 997-1687	232.7	8.2	65.4	1.9	15.3	1.710	0.319	18.65	54.00	10.56	1.97
Hyd 997-1688	247.3	8.5	72.7	2.1	14.0	2.000	0.444	22.20	57.00	11.70	2.60
Hyd 997-1689	227.0	8.6	71.3	2.0	15.0	1.850	0.293	15.84	55.00	11.21	1.78
Hyd 997-1697	157.3	5.9	59.7	1.4	9.0	0.835	0.092	11.02	48.00	5.80	0.64
Hyd 997-1698	185.7	7.7	56.4	1.9	10.3	1.420	0.145	10.21	48.00	9.86	1.01
Hyd 997-1700	195.0	9.4	88.0	2.0	14.0	1.150	0.245	21.30	59.00	6.50	1.38
Hyd 997-1701	175.5	7.3	68.0	1.9	12.0	0.780	0.199	25.51	59.00	4.41	1.12
Hyd 997-1704	207.7	8.3	67.8	1.8	10.3	1.580	0.198	12.53	51.00	10.33	1.29
Hyd 997-1707	175.7	7.4	61.1	1.9	9.0	1.080	0.103	9.54	51.00	7.06	0.67
Hyd 997-1715	168.0	7.6	61.1	1.6	10.3	0.800	0.137	17.13	45.00	4.94	0.85
Hyd 997-1716	135.3	6.9	54.0	1.5	12.0	0.500	0.085	17.00	56.00	2.98	0.51
Hyd 997-1718	167.3	7.2	66.5	1.6	11.3	0.850	0.149	17.53	56.00	5.06	0.89
Hyd 997-1719	153.7	5.6	65.4	1.6	10.0	0.870	0.120	13.79	51.00	5.69	0.78
Hyd 997-1721	216.3	7.0	64.9	1.7	11.7	1.660	0.238	14.34	51.00	10.85	1.56
Hyd 997-1722	211.0	7.0	61.8	1.8	11.3	1.580	0.188	11.90	51.00	10.33	1.23
Hyd 997-1724	205.0	8.1	73.5	1.7	12.3	1.680	0.270	16.07	51.00	10.98	1.76
Hyd 997-1725	214.0	7.3	59.9	1.5	12.3	1.260	0.232	18.41	54.00	7.78	1.43
Hyd 997-1730	222.0	6.9	60.7	1.6	12.0	1.320	0.245	18.56	56.00	7.86	1.46
Hyd 997-1731	253.7	7.1	81.7	1.9	14.3	1.970	0.387	19.64	56.00	11.73	2.30
Hyd 997-1732	205.7	8.8	64.3	1.4	12.3	1.630	–	–	56.00	9.70	–
Hyd 997-1743	223.7	8.0	65.0	1.6	12.3	1.240	0.265	21.37	57.00	7.25	1.55
Hyd 997-1744	255.3	7.2	74.3	1.9	13.7	1.630	0.316	19.39	56.00	9.70	1.88
Hyd 997-1750	261.5	10.2	66.5	2.3	16.5	2.010	0.379	18.86	56.00	11.96	2.26
Hyd 997-1755	220.3	7.1	66.3	1.7	14.3	2.00	0.368	18.40	54.00	12.35	2.27
Hyd 997-1758	285.7	7.2	58.3	1.6	1.80	0.327	54.00	11.11	2.02	–	–
Hyd 997-1762	261.7	9.2	67.6	2.2	15.0	2.225	0.476	21.39	59.00	12.57	2.69
Hyd 997-1784	219.3	6.0	53.3	1.5	13.3	1.080	0.190	18.43	54.00	6.67	1.23
Hyd 997-1786	226.0	5.7	64.0	1.6	14.0	1.490	0.265	17.79	55.00	9.03	1.61
Hyd 997-1790	249.3	7.5	63.3	1.7	14.0	1.570	0.294	18.73	52.00	10.06	1.88
Hyd 997-1793	230.0	7.1	60.9	2.0	14.7	1.790	0.343	19.16	55.00	10.85	2.08
Hyd 997-1799	222.3	7.6	67.3	1.9	13.0	1.510	0.326	21.59	56.00	8.99	1.94
Hyd 997-1501	111.5	7.5	68.0	1.8	11.0	0.455	0.316	21.72	65.00	7.46	1.62
Hyd 997-1507	184.5	9.9	70.8	2.0	14.0	1.200	0.286	23.83	61.00	6.56	1.56
Hyd 997-1508	159.3	7.3	75.7	2.0	12.0	1.720	0.225	13.08	51.00	11.24	1.47
Hyd 997-1509	187.0	6.4	65.2	1.7	12.3	0.980	0.193	19.69	57.00	5.73	1.13
Hyd 997-1510	200.0	6.1	48.6	1.6	13.0	1.800	0.183	10.17	51.00	11.76	1.20
Hyd 997-1512	183.3	7.5	60.9	1.7	14.3	1.800	0.268	14.89	61.00	9.84	1.46
Hyd 997-1513	207.7	6.4	67.0	1.6	11.7	1.300	0.180	13.85	55.00	7.88	1.09
Hyd 997-1517	262.7	7.3	69.3	1.7	13.0	1.480	0.199	13.45	54.00	9.14	1.23
Hyd 997-1528	263.3	7.7	73.3	1.7	15.3	1.460	0.337	23.08	56.00	8.69	2.01
Hyd 997-1529	227.0	9.2	86.4	2.0	13.3	2.370	0.544	22.95	59.00	13.39	3.07
Hyd 997-1530	236.7	8.1	75.0	2.3	16.0	2.390	0.520	21.76	59.00	13.50	2.94
Hyd 997-1531	174.0	7.7	80.7	1.6	11.7	1.250	–	–	56.00	7.44	–
Hyd 997-1532	220.0	10.4	80.2	2.3	13.5	1.360	0.326	23.97	58.00	7.82	1.87
Hyd 997-1540	202.3	7.4	60.6	1.6	13.7	1.325	0.276	20.83	58.00	7.61	1.59
Hyd 997-1542	195.2	7.7	65.7	1.7	11.0	1.150	0.187	16.26	52.00	7.37	1.20
Hyd 997-1544	244.0	8.6	76.3	1.8	13.3	1.645	0.481	29.24	59.00	9.29	2.72
Hyd 997-1545	237.2	7.9	84.8	1.7	14.3	1.360	0.336	24.71	62.00	7.31	1.81
Hyd 997-1547	219.3	7.0	77.9	1.9	13.7	1.430	0.299	20.91	58.00	8.22	1.72
Hyd 997-1548	192.3	7.3	8.00	1.8	15.0	1.370	0.356	25.99	66.00	6.92	1.80
Hyd 997-1551	191.7	8.3	76.0	1.7	13.7	1.290	0.428	33.18	66.00	4.80	1.43
Hyd 997-1552	191.7	8.3	76.0	1.7	13.7	1.290	0.428	33.18	66.00	6.52	2.16
Hyd 997-1554	198.0	8.3	69.3	1.7	14.3	1.270	0.289	22.76	59.00	7.18	1.63

Contd.

Accession	Plant height (cm)	Leaf width (cm)	Leaf length (cm)	Stem dia. (cm) (cm)	Number of nodes	GFY (kg) (3 plants)	Dry wt (kg) (3 plants)	DM%	Days to 50% flower	Per day GFY (g)/ plant	Per day DMY (g)/ plant
Hyd 997-1556	191.0	8.4	88.3	2.0	11.3	1.380	0.345	25.00	62.00	7.42	1.85
Hyd 997-1557	147.5	8.2	64.8	1.7	9.5	0.875	0.104	11.89	58.00	5.03	0.60
Hyd 997-1559	96.5	7.5	62.7	1.4	11.7	0.890	0.172	19.33	56.00	5.30	1.02
Hyd 997-1560	157.5	7.3	7.15	1.8	13.0	0.700	0.164	21.30	66.00	3.89	0.83
Hyd 997-1561	221.7	9.0	69.6	2.1	12.0	1.750	0.287	16.40	54.00	10.80	1.77
Hyd 997-1562	215.0	7.7	67.4	2.1	13.5	1.400	0.206	14.71	58.00	8.05	1.18
Hyd 997-1563	217.0	6.7	63.9	1.8	13.7	1.330	0.233	16.77	56.00	7.92	1.33
Hyd 997-1565	160.7	8.9	85.1	1.9	12.0	1.330	0.249	18.73	58.00	7.64	1.43
Hyd 997-1567	213.3	7.5	79.5	1.7	14.7	1.530	0.397	25.95	61.00	8.36	2.17
Hyd 997-1569	188.7	7.1	62.2	1.7	11.3	1.900	0.208	10.95	55.00	11.52	1.26
Hyd 997-1572	179.3	7.7	81.3	2.1	12.3	1.330	0.261	19.62	58.00	7.64	1.50
Hyd 997-1577	202.7	9.1	85.2	2.0	13.3	1.610	0.488	30.31	61.00	8.80	2.67
Hyd 997-1699	229.3	6.7	69.7	1.7	12.0	1.130	0.213	18.85	54.00	6.98	1.31
African Tall	262.5	9.8	86.7	2.6	15.5	3.8	1.2	30.47	73.00	17.51	5.34
J 1006	221.5	9.8	67.8	2.4	15.0	2.1	0.6	27.83	70.00	9.76	2.72

green yield/3 plants as 3.8 kg whereas amongst the germplasm maximum yield *i.e.* 2.62 kg was recorded in Hyd 997-1580. This accession attained 50% flowering nearly 18 days in advance. Some other lines which showed GFY/3 plants above 2 kg were Hyd 997-1627, -1647, -1664, -1634, -1665, -1688, -1750, -1755, -1762, -1529 and –1530. As regards dry fodder yield, African tall recorded quite high DMY (1.2 kg) as compared to maximum yield recorded in germplasm line Hyd 997-1529 (0.544 kg). In terms of dry matter content also only few lines such as Hyd 997-1544, -1551, -1552, -1577, and -1666 showed at par or slightly better percent dry matter as compared to African Tall. It was observed that the lines with high dry matter content were also late flowering and out of these five lines identified for high or at par dry matter content two lines *i.e.* Hyd 997-1577 and -1544 were comparatively better in dry fodder yield also. Gupta *et al.* (1984) have recommended that fodder varieties should be early growth type and late flowering type as has been observed that late flowering types are better in quality. Bunting (1973) has indicated that there are genotypic differences in rate and duration of dry matter accumulation in maize which also depends on the canopy structure and barrenness. He emphasized that for selecting suitable canopy selection should be made for leaf size and shape.

Except dry matter per cent and the days to 50% flowering, the various morphological traits under study showed positive correlation with green fodder yield (Table 3). In view of this finding certain germplasm lines were identified for further exploitation in breeding programme. These lines showed superiority over the check variety African Tall e.g. Hyd 997-1670, -1686, -1758, -1528 were taller, Hyd 997-1750, -1507, -1532, -1571 possessed broader leaves; Hyd 997-1647, -1700 possessed longer leaves; Hyd 997-1530, -1750, -1521 possessed higher number of nodes per plant. Paramathma and Balasubramanian (1986) have also reported that stem girth, plant height and leaf width are important traits for improving fodder yield. Similarly Patel and Shelke (1984) reported that leaf area, internode number and stem girth have significant positive effect towards fodder yield in maize.

Fifty per cent flowering among the germplam lines was attained as early as within 48 days of sowing and that in some lines it was late. A few lines flowered 66 days after sowing. Both the checks African tall and J1006 were quite late and showed 50% flowering after 70 t0 73 days of sowing. Still, per day per plant productivity in terms of green as well as dry matter of African Tall was also very high. On account of this finding it seems that population improvement programme in African Tall could be an important breeding strategy. Only a few lines were close to per day productivity of African Tall. Thus, as such these lines can not compete with African Tall. However, the lines amongst the germplasm lines with comparatively high per day productivity, green and dry matter productivity can be further exploited in breeding programmes in order to breed early flowering varieties with high biomass productivity. It is possible that the lines so developed may show somewhat less green fodder yield but may outyield the African Tall in terms of per day productivity. Thus, introducing early flowering character in African tall may prove beneficial as the same is expected to increase its acceptability among farmers. Gupta *et al.* (1984) have recommended that fodder varieties should be early growth type and late flowering type as it has

Table 3. Range, mean and other statistical parameters of yield and yield attributes in 137 exotic germplam lines of maize

	Plant height (cm)	Leaf width (cm)	Leaf Length (cm)	Stem Diameter (cm)	Number of nodes	GFY (kg) (3 plants)	Dry wt (kg) (3 plants)	DM%	Days to 50% flowering	Per day green fodder productivity/ plant (g)	per day dry matter productivity/ plant (g)
Min	96.3	5.5	48.6	1.3	9.0	0.350	0.068	9.537	48	1.98	0.38
Max	285.7	10.5	89.8	2.5	16.5	2.62	0.544	33.18	66	15.88	3.07
Average	205.6	7.8	69.2	1.81	12.66	1.455	0.264	19,217	55.7	8.55	1.57
Kurtosis	0.146	-0.338	-0.083	0.163	-0.543	0.230	0.1196	0.361	0.167	-0.014	0.001
Skewness	-0.305	0.119	0.113	0.442	-0.136	0.136	0.4810	0.423	0.422	0.050	0.358
SD	35.211	1.026	8.365	0.220	1.765	0.432	0.100	4.599	3.916	2.682	0.559
Correlation coefficient with GFY	0.599	0.413	0.263	0.547	0.572		0.774	-0.199	-0.133		

been observed that late flowering types are better in quality. Thus, these lines can be used as donor for these traits and can be combined with African Tall in its improvement programme.

The value of skewness were found to be very low for leaf width and number of nodes, green fodder yield and per day productivity which indicated a marginal deviation of modal value from the mean (Table 3). The values of kurtosis for all the traits were in low range sketching platycurtic curve which indicated high range of variability in the population. The low values of kurtosis for all the traits together with low values of skewness for most of the traits also showed better distribution of individuals yielding in a greater variance.

The quality parameters estimated on selected lines revealed that the crude protein (CP) percent ranged from 9.13% to 10.64% at 50% flowering stage. NDF content ranged from 67.32% to 72.13%, ADF ranged from 38.91% to 42.57% (Table 4). Lignin content and Ash content ranged from 6.98% to 9.67% and 9.63% to 12.08 respectively. *Ganga Safed* variety has 10.0% CP at 50% flowering stage (Pachauri *et al.*, 1988) whereas 5.35% CP was observed in seven germplasm lines of maize (Singh and Katiyar, 1999a). In another set of ten germplasm lines 10.17 to 12.92% CP in leaf and 3.49 to 12.92% CP in stem fraction was reported (Singh and Katiyar, 1999b). Thus, in the present set of germplasm lines there was not much variation for quality traits.

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Table 4. Forage quality parameters of exotic germplasm lines of maize

Accessions	CP%	NDF	ADF	Lignin	Ash
Hyd 997-1520	10.52	70.85	41.47	9.65	9.93
Hyd 997-1521	10.26	69.82	41.27	7.53	11.03
Hyd 997-1522	10.39	67.89	39.93	9.54	11.31
Hyd 997-1523	9.88	68.81	40.68	6.98	10.96
Hyd 997-1533	10.13	69.39	40.5	7.39	10.63
Hyd 997-1543	9.88	68.93	41.38	8.06	11.09
Hyd 997-1553	9.39	69.68	39.31	7.59	10.06
Hyd 997-1566	9.01	71.82	41.44	8.72	10.21
Hyd 997-1568	10.13	70.62	39.48	7.89	12.08
Hyd 997-1573	10.13	67.37	41.38	8.59	10.26
Hyd 997-1574	9.51	70.83	40.82	8.54	10.98
Hyd 997-1580	9.13	72.13	41.62	8.92	11.06
Hyd 997-1603	9.88	67.37	39.99	8.12	11.03
Hyd 997-1604	9.13	70.87	39.39	8.06	9.63
Hyd 997-1605	10.13	70.27	40.98	7.56	10.02
Hyd 997-1647	9.39	70.35	40.95	8.21	9.68
Hyd 997-1648	10.26	71.18	41.35	8.29	10.63
Hyd 997-1657	9.76	69.88	40.05	7.91	12.03
Hyd 997-1658	10.13	69.31	39.85	7.59	11.08
Hyd 997-1670	9.76	68.38	39.35	7.81	10.23
Hyd 997-1672	9.88	70.18	40.87	9.08	10.58
Hyd 997-1685	9.51	69.05	41.68	8.65	10.24
Hyd 997-1697	9.69	71.3	40.92	7.85	9.86
Hyd 997-1704	9.13	70.95	40.81	8.08	12.04
Hyd 997-1732	10.13	70.01	41.05	8.65	11.21
Hyd 997-1758	10.64	68.93	41.38	9.95	11.24
Hyd 997-1762	9.69	68.83	41.66	8.92	11.02
Hyd 997-1786	9.13	66.68	41.06	7.93	10.52
Hyd 997-1790	9.88	69.05	39.73	7.62	9.63
Hyd 997-1501	10.39	69.32	39.92	9.67	10.27
Hyd 997-1512	9.89	70.08	40.38	9.31	10.24
Hyd 997-1530	9.89	67.32	30.01	7.89	11.06
Hyd 997-1531	9.64	69.05	39.67	8.96	11.85
Hyd 997-1544	9.74	66.98	38.92	8.07	12.05
Hyd 997-1545	9.55	68.21	39.08	7.79	11.52
Hyd 997-1548	9.55	67.38	41.07	7.98	11.96
Hyd 997-1554	9.89	68.65	41.39	8.95	12.05
Hyd 997-1557	9.39	68.23	42.57	8.02	11.08
African Tall	9.39	64.14	33.18	8.59	10.97
J 1006	9.45	63.15	38.45	8.76	10.52

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