

PERFORMANCE AND YIELD STABILITY AMONG FIVE RYEGRASS (*Lolium multiflorum* L.) VARIETIES UNDER DIFFERENT ENVIRONMENTAL CONDITIONS

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ABSTRACT

*This investigation was conducted at three locations representing North Delta (Sakha), Middle Delta (Gemmeiza) and Middle Egypt (Sids) in 1999/2000 and 2000/2001 growing seasons to estimate stability parameters of fresh and dry forage yield of introduced ryegrass (*Lolium multiflorum* L.) varieties. All varieties performed better at the first cut at Sids station than at other locations, whereas the varieties Tewera, Terwatco and Clipper were superior for both fresh and dry forage yield of first cut at Sakha, Gemmeiza and Sids stations, respectively. The variety Terwatco was superior for fresh and dry yield in the first cut over three locations. The varieties Primora, Caramba and Terwatco were superior for total fresh and dry forage yield at Sakha, Gemmeiza and Sids station, respectively. So, these varieties are suitable and recommended for growing in mixture with Berseem. Mean square of varieties was highly significant and significant for total fresh and dry forage yield, respectively. Mean squares of environments and variety x environments interaction were highly significant. The variety Terwatco followed by Caramba gave the highest total fresh and dry forage yield over all the environments. Nonsignificant values of b_i revealed average response for all varieties except Terwatco for total fresh and dry forage yield. All varieties showed significant non-linearity S^2d_i for total fresh forage yield except Terwatco and Primora, while all varieties showed nonsignificant non-linearity S^2d_i for total dry forage yield. On the basis of all the parameters, it was quite clear that Caramba has high yield, good response to change in environmental conditions and better stability for both total fresh and dry forage yield if used as hay. Therefore, this variety could be grown for high yield and better stability of forage production under different environmental conditions. So, only this variety is the most promising in forage breeding programs and recommended to be grown with Berseem as a mixture or in intercropping in farmers field.*

Key words: Winter grasses, Ryegrass, *Lolium multiflorum*, Performance, Genotypes X environments interactions, Stability parameters, Forage yield.

INTRODUCTION

Italian ryegrass (*Lolium multiflorum* L.) is a native annual winter grass in the Mediterranean region and adapted to a wide range of soil and climatic

conditions (Hitchcock, 1951). It could be grown alone or used with Berseem (*Trifolium alexandrinum* L.) in mixture or intercropping. The yielding ability of most of the varieties varied due to environmental conditions (Haggag *et al* 1995 and Sarhan and El-Selemy 1996). Seed production is difficult in ryegrass because seed shatter readily upon maturity (Frakes, 1973). So we introduced seeds of ryegrass varieties.

Genotype-environment interaction is one of major importance to the plant breeder in developing improved varieties. Several authors studied the interpretation of observed interactions between genotypes and environments (GE). The early attempt focused on the importance of GE interactions in plant breeding based on regression (Yates and Cochran 1938) to measure the adaptation of barley varieties. They proposed that when genotypes were tested in several environments, the yield of each genotype should be regressed on the mean yield of all genotypes in each environment. Finlay and Wilkinson (1963) proposed average yield of all varieties for each site and season, as a measure of that environment 'environmental value'. They considered the regression coefficient (b_i) of mean each genotype yield performance on the mean yield of all genotypes for each site and season, as a measure of adaptability. Eberhart and Russell (1966) suggested the use of 'environmental index' for each environments, as the deviation of mean performance under the environment from the grand mean of all environments. They pointed that both the regression coefficient (b_i) and the deviation from regression of a variety on the environmental indices (S^2d_i) considered as parameters for response and stability of a variety, respectively. So, stability in yielding ability is one of the most desirable properties of a variety to be released for cultivation. For this purpose the multilocations trials over a number of years should be conducted (Tehlan, 1973 and Luthra *et al* 1974).

Phenotypic stability studies for ryegrass yield have been reported by a few authors (Becker *et al* 1982).

So, the purpose of the present investigation is to study the performance and its stability of five introduced varieties of ryegrass (*Lolium multiflorum*, L.) for fresh and dry forage yield under different environmental conditions in Egypt.

MATERIALS AND METHODS

This study was conducted at three experimental stations representing North Delta (Sakha), Middle Delta (Gemmeiza) and Middle Egypt (Sids) during 1999/2000 and 2000/2001 seasons. Five introduced varieties of

ryegrass (*Lolium multiflorum* L.) i.e Terwatco, Tewera, Primora, Clipper and Caramba from Netherland were used.

The date of sowing varied between locations and seasons and ranged from the end of October and to the beginning of November in both seasons. A randomized complete block design with three replicates was used, plots were 2 x 3m and consisting of 10 rows 3m long 20cm apart. Plots were seeded at the rate of 15 Kg/Fed. Phosphorus (15.5% P₂O₅) was applied before sowing at 150 Kg/Fed during soil preparation. Nitrogen (46% N) was applied after seedling emergence and after each cut at 30 Kg N/Fed. Four cuts were taken during each season. The first, second, third and fourth cuts were taken at the period of 60, 50, 40, and 30 days consecutively. Fresh and dry forage yields (105°C) were recorded in ton/fed. The relative yield of each cut was computed as % of total yield/season. A combined analysis of variance over seasons and locations was carried out for fresh and dry yield of each cut and seasonal total as outlined by Steel and Torrie (1960) and McIntosh (1983). Stability parameters were estimated considering seasons – locations as separate environment following the model Eberhart and Russell (1966). The stable variety has a high mean yield, b_i value equal one and the deviation from regression near zero. Also, (Eberhart and Russell (1969) reported that the most important stability parameter appeared to be the minimum deviations mean squares.

The climatic data i.e., mean monthly temperature at each location during both ryegrass growing season are presented in Figs 1 and 2.

RESULTS AND DISCUSSION

Mean performance for fresh forage yields

Absolute and relative fresh forage yield (ton/fed) of the five ryegrass varieties over both seasons in each cut and total cuts at the three experimental stations and combined over all locations are listed in Table 1.

Results showed significant differences among the locations at each cut and total cuts for absolute and relative fresh forage yield. The highest absolute fresh yield of ryegrass varieties was recorded at Sids station in the first, second and total cuts followed by Sakha station in the third and fourth cuts. The same trend of absolute fresh yield was obtained for the relative fresh yield except the highest relative yield was recorded at Gemmeiza station in the third cut.

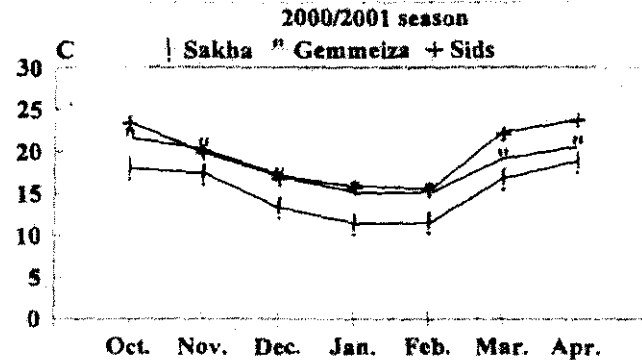
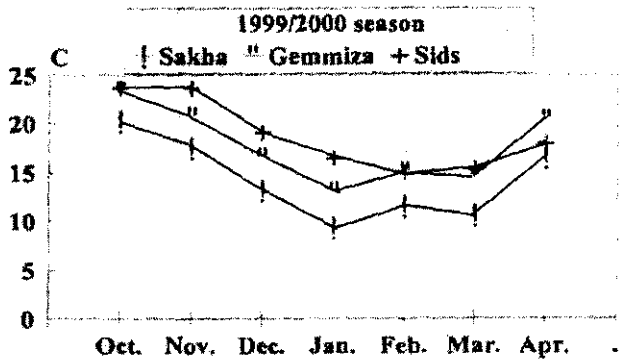


Fig.(1): Mean monthly temperature at three locations in the two successive seasons 1999/2000 and 2000/2001

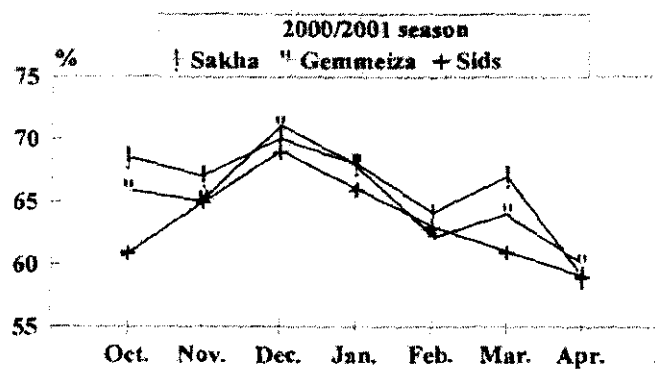
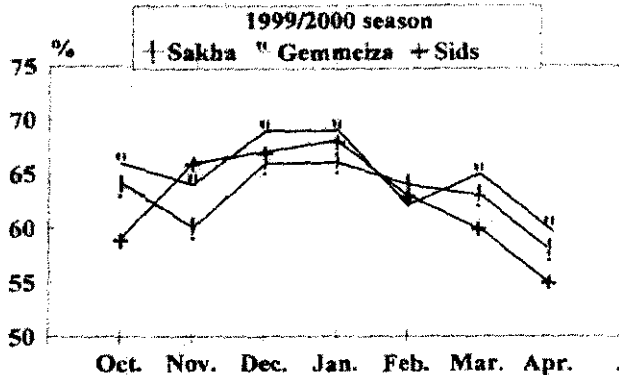


Fig.(2): Mean monthly air humidity % at three locations in the two successive seasons 1999/2000 and 2000/2001

Table 1. Mean performance of the studied ryegrass varieties over both seasons at each location and over locations for absolute and relative fresh forage yield (ton/fed) of each cut and total cuts.

Varieties	Absolute fresh forage yield					Relative fresh forage yield			
	Cut				Total cuts	Cut			
	1	2	3	4		1	2	3	4
Sakha									
Terwatco	6.45	9.73	12.60	11.08	39.86	16.18	24.41	31.61	27.80
Tewera	6.63	10.15	11.55	11.84	40.17	16.50	25.27	28.75	29.47
Primora	5.93	10.62	12.02	11.89	40.46	14.65	26.25	29.71	29.39
Clipper	5.62	9.31	10.59	11.78	37.30	15.07	24.95	28.39	31.58
Caramba	5.67	9.28	12.04	11.78	38.77	14.62	23.94	31.05	30.38
Mean	6.06	9.82	11.76	11.68	39.32	15.41	24.97	29.91	29.70
L. S.D. (0.05) V	NS	NS	0.95	NS	NS	NS	NS	NS	NS
Gemmeiza									
Terwatco	7.48	10.68	10.03	3.83	32.01	23.37	33.36	31.33	11.97
Tewera	6.11	11.43	10.34	4.63	32.52	18.79	35.15	31.80	14.24
Primora	7.00	9.59	11.11	4.57	32.27	21.69	29.72	34.43	14.16
Clipper	5.68	11.82	11.96	4.41	33.87	16.77	34.90	35.31	13.02
Caramba	6.45	12.19	12.06	4.52	35.22	18.31	34.61	34.24	12.83
Mean	6.55	11.14	11.10	4.39	33.18	19.74	33.57	33.45	13.23
L. S.D. (0.05) V	0.88	1.14	1.23	NS	NS	2.56	2.15	3.02	NS
Sids									
Terwatco	17.83	19.83	11.97	6.03	55.66	32.03	35.63	21.51	10.83
Tewera	14.58	17.67	9.67	5.50	47.42	30.75	37.26	20.39	11.60
Primora	12.71	16.33	10.83	5.42	45.29	28.06	36.06	23.91	11.97
Clipper	18.33	17.58	12.33	5.42	53.66	34.16	32.76	22.98	10.10
Caramba	14.33	20.00	10.83	5.75	50.91	28.15	39.29	21.27	11.29
Mean	15.56	18.28	11.13	5.62	50.59	30.76	36.13	22.00	11.11
L. S.D. (0.05) V	1.95	2.31	0.73	NS	3.53	3.28	3.09	1.37	NS
Over Locations									
Terwatco	10.59	13.41	11.53	6.98	42.51	24.90	31.55	27.13	16.42
Tewera	9.11	13.08	10.52	7.32	40.03	22.75	32.68	26.28	18.29
Primora	8.55	12.18	11.32	7.29	39.34	21.73	30.96	28.77	18.54
Clipper	9.88	12.90	11.63	7.20	41.61	23.74	31.01	27.94	17.31
Caramba	8.82	13.82	11.64	7.35	41.63	21.18	33.20	27.97	17.65
General Mean	9.39	13.08	11.33	7.23	41.02	22.89	31.88	27.61	17.62
L. S.D. (0.05) V	0.74	0.94	0.54	NS	1.79	1.43	1.44	1.35	NS
L. S.D. (0.05) L	0.57	1.11	0.60	0.46	1.75	0.90	1.59	1.58	1.20

NS = not significant V = varieties L = locations

Under Sakha station significant differences among the five varieties for absolute fresh forage yield were recorded only in the third cut. The variety Terwatco gave the highest fresh yield (12.6 ton/fed), while Clipper gave the lowest fresh forage yield (10.59 ton/fed) in this cut.

Concerning the performance at Gemmeiza station, significant differences among the five varieties were detected in the first three cuts for absolute and relative fresh forage yield. Also, the variety Terwatco and Clipper gave the highest (7.48 ton/fed) and the lowest (5.68 ton/fed) fresh forage yield in the first cut, respectively. The variety Caramba gave the highest fresh yield in the second and third cuts (12.19 and 12.06 ton/fed,

respectively). While, the lowest fresh forage yield was obtained from the variety Primora (9.59 ton/fed) in the second cut and from the variety Terwatco (10.03 ton/fed) in the third cut. For the relative fresh forage yield, the same trend was obtained in the first cut, where the highest relative yield (23.37%) was obtained from the variety Terwatco and the lowest relative yield (16.77%) was obtained from the variety Clipper. In the second cut, the variety Tewera produced the highest relative yield (35.15%) while, the variety Primora produced the lowest relative yield (29.72%). In the third cut, the variety Clipper was the highest relative yield (35.31%). On the contrast, the variety Terwatco was the lowest relative yield (31.33%).

With respect to the performance of varieties at Sids station, insignificant differences among the varieties for absolute and relative fresh forage yields was recorded only in fourth cut. The variety Clipper gave the highest fresh yield (18.33 ton/fed), while primora gave the lowest fresh forage yield (12.71 ton/fed) in the first cut. The highest fresh yield was obtained from the variety Caramba (20.00 ton/fed) in the second cut and from the variety Clipper (12.33 ton/fed) in the third cut. On the other hand, the lowest fresh forage yield was recorded of the variety Primora (16.33 ton/fed) in the second cut and of the variety Tewera (9.67 ton/fed) in the third cut. For the total fresh yield; the highest yield (55.66 ton/fed) was obtained from the variety Terwatco, while the lowest yield (45.29 ton/fed) was obtained from the variety Primora. For the relative fresh forage yield, the same trend was obtained in the first cut, where the highest relative yield (34.16%) was obtained from the variety Clipper and the lowest relative yield (28.06%) was obtained from the variety Primora. Also the same trend was obtained in the second cut where, the variety Caramba produced the highest relative yield (39.29%) and the variety Clipper produced the lowest relative yield (32.76%). The variety Primora was the highest relative yield (23.91%) in the third cut. On the contrast, the variety Tewera produced the lowest relative yield (20.39%).

The performance of the five varieties at different cuts combined over the three locations showed insignificant differences among the five varieties for absolute and relative fresh forage yields only in fourth cut. The variety Terwatco gave the highest fresh yield (10.59 ton/fed), while Primora gave the lowest fresh forage yield (8.55 ton/fed) in the first cut combined over locations. The variety Caramba yielded the highest fresh forage in the second and third cuts (13.82 and 11.64 ton/fed, respectively). However, the lowest fresh forage yield occurred in variety Primora with value of (12.18 ton/fed) in the second cut and in variety Tewera (10.52 ton/fed) in the third cut. For the total fresh yield, the highest yield (42.51 ton/fed) was obtained

from variety Terwatco, while the lowest yield (39.34 ton/fed) was obtained from the variety Primora. For the relative fresh forage yield, the same trend was obtained in the first and second cuts. Where the highest relative yield 24.90% was obtained from the variety Terwatco, while the lowest relative yield 21.18% was obtained from the variety Caramba in the first cut. The variety Caramba produced the highest relative yield (33.20%), while the variety Primora produced the lowest relative yield (30.96%) in the second cut. The variety Primora was the highest relative yield in third cut, the relative yield of this variety was (28.77%). On the contrast, the variety Tewera was the lowest relative yield (26.28%) in third cut.

In general, as shown in Table 1, the performance of the five ryegrass varieties for fresh forage yield at first cut at Sids station were higher than under other locations. This increase in the yield of varieties at Sids station may be due to the effect of the environment conditions on the yield. It is worth to mention that the air temperature at Sids station recorder somewhat higher values than at other stations particularly during the early of both seasons (Fig. 1). The environmental conditions included many factors i.e. air temperature and humidity etc.

Mean performance for dry forage yields

Absolute and relative dry forage yield (ton/fed) of the five ryegrass varieties over 1999/2000 and 2000/2001 seasons in each and total cuts at Sakha, Gemmeiza and Sids experimental stations and combined over locations are presented in Table 2.

Results showed significant differences among the locations at each cut for absolute and relative dry forage yield. For the effect of locations on the yield of ryegrass varieties, the same trend of absolute and relative fresh forage yield was obtained for dry forage yield.

At Sakha Station differences among the studied varieties were significant for absolute dry forage yield at third cut and for relative dry forage yield at both third and fourth cuts. The variety Terwatco gave the highest dry yield (1.953 ton/fed), while Clipper produced the lowest dry forage yield (1.591 ton/fed) in third cut. For the relative yield, also Terwatco was superior in third cut (34.54 %) and Clipper was superior in fourth cut (36.73%). On the other hand, the lowest relative dry yield was obtained from the varieties Clipper in third cut (30.04%) and Terwatco in the fourth cut (32.04%).

Table 2. Mean performance of the studied ryegrass varieties over both seasons at each location and over locations for absolute and relative dry forage yield (ton/fed) of each cut and total cuts.

Varieties	Absolute dry forage yield					Relative dry forage yield			
	Cut				Total cuts	Cut			
	1	2	3	4		1	2	3	4
Sakha									
Terwatco	0.726	1.164	1.953	1.812	5.655	12.84	20.58	34.54	32.04
Tewera	0.727	1.224	1.700	1.952	5.603	12.98	21.85	30.34	34.84
Primora	0.664	1.275	1.795	1.970	5.704	11.64	22.35	31.47	34.54
Clipper	0.609	1.151	1.591	1.945	5.296	11.50	21.73	30.04	36.73
Caramba	0.618	1.139	1.778	1.936	5.472	11.30	20.82	32.50	35.39
Mean	0.669	1.191	1.764	1.923	5.546	12.06	21.47	31.80	34.67
L. S.D. (0.05) V	NS	NS	0.134	NS	NS	NS	NS	2.55	2.86
Gemmeiza									
Terwatco	1.207	1.654	1.466	0.501	4.828	25.00	34.26	30.36	10.38
Tewera	1.031	1.839	1.570	0.654	5.094	20.24	36.10	30.82	12.84
Primora	1.123	1.521	1.692	0.651	4.987	22.52	30.50	33.93	13.05
Clipper	0.908	1.836	1.820	0.626	5.190	17.50	35.38	35.07	12.06
Caramba	1.034	1.903	1.757	0.617	5.311	19.47	35.83	33.08	11.62
Mean	1.060	1.751	1.661	0.610	5.082	20.86	34.45	32.68	12.00
L. S.D. (0.05) V	0.014	0.022	0.021	NS	NS	2.67	2.06	2.78	NS
Sids									
Terwatco	1.840	2.423	1.745	1.143	7.151	25.73	33.88	24.40	15.98
Tewera	1.433	2.197	1.317	1.090	6.037	23.74	36.39	21.82	18.06
Primora	1.312	1.985	1.505	0.932	5.734	22.88	34.62	26.25	16.25
Clipper	1.854	2.006	1.611	0.927	6.398	28.98	31.35	25.18	14.49
Caramba	1.362	2.532	1.517	1.089	6.500	20.95	38.95	23.34	16.75
Mean	1.560	2.229	1.539	1.036	6.364	24.51	35.03	24.18	16.28
L. S.D. (0.05) V	0.251	0.289	0.155	NS	0.543	3.16	3.17	1.64	NS
Over Locations									
Terwatco	1.258	1.747	1.721	1.152	5.878	21.40	29.72	29.28	19.60
Tewera	1.064	1.753	1.529	1.232	5.578	19.07	31.43	27.41	22.09
Primora	1.033	1.594	1.664	1.184	5.475	18.87	29.11	30.39	21.63
Clipper	1.124	1.664	1.674	1.166	5.628	19.97	29.57	29.74	20.71
Caramba	1.005	1.858	1.684	1.214	5.761	17.44	32.25	29.23	21.07
General Mean	1.096	1.724	1.655	1.190	5.664	19.36	30.43	29.21	21.00
L. S.D. (0.05) V	0.097	0.122	0.085	NS	0.267	1.39	1.40	1.30	NS
L. S.D. (0.05) L	0.06	0.13	0.11	0.08	0.25	0.53	1.47	1.89	1.21

NS = not significant V = varieties L = locations

Concerning to the performance of varieties at Gemmeiza station, significant differences among the five varieties were recorded for absolute and relative dry forage yield in the first three cuts. The same trend of fresh forage yield at Gemmeiza station was obtained for dry forage yield. The variety Terwatco gave the highest dry yield (1.207 ton/fed), while Clipper gave the lowest dry forage yield (0.908 ton/fed) in the first cut. However, varieties Caramba and Clipper gave the highest dry yield in the second cut (1.903 ton/fed) and third cut (1.820 ton/fed), respectively. While, the varieties Primora and Terwatco produced lowest dry forage yield in the second cut (1.521 ton/fed) and the third cut (1.466 ton/fed), respectively. For the relative dry forage yield, the same trend was obtained in the first cut, where the highest relative yield (25.00%) was obtained from the variety

Terwatco and the lowest relative yield (17.50%) was obtained from the variety Clipper. In the second cut, the variety Tewera produced the highest relative dry yield (36.10%) while the variety Primora produced the lowest relative dry yield (30.50%). In the third cut the variety Clipper was the highest relative yield (35.07%), but variety Terwatco yielded the lowest relative dry forage (30.36%).

With respect to the varietal performance at Sids station, insignificant differences was detected for absolute and relative dry forage yield only in fourth cut. In the first cut, the variety Clipper recorded the highest dry yield (1.854 ton/fed) and Primora gave the lowest one (1.312 ton/fed). In the second cut the highest dry yield produced from variety Caramba (2.532 ton/fed), while variety Primora gave the lowest dry forage yield (1.985 ton/fed). In the third cut the variety Terwatco gave the highest dry yield (1.745 ton/fed) while, the variety Tewera produced the lowest dry forage yield (1.317 Ton/ Fed). For the total dry yield, the highest yield (7.151 ton/fed) was obtained from Terwatco, but the lowest one (5.734 ton/fed) was obtained from Primora. For the relative dry forage yield, the same trend was obtained in the first cut, where the highest relative yield (28.98%) was obtained from the variety Clipper, while the lowest relative yield (20.95%). was obtained from the variety Caramba. In the second cut, the variety Caramba produced the highest relative dry yield (38.95%), while the variety Clipper produced the lowest relative dry yield (31.35%). The variety Primora was the highest relative yield (26.25%), on the contrast, the variety Tewera produced the lowest relative dry yield (21.82%) in the third cut.

Significant differences were recorded among varieties during various cuts combined over locations for absolute and relative dry forage yield except in the fourth cut. The variety Terwatco gave the highest dry yield (1.258 ton/fed), while Caramba gave the lowest dry forage yield (1.005 ton/fed) in the first cut combined over locations. However, Caramba and Terwatco gave the highest dry yield in the second cut (1.858 ton/fed) and third cut (1.721 ton/fed), respectively. While, the varieties Primora and Tewera gave the lowest dry forage yield in the second cut (1.594 ton/fed) and third cut (1.529 ton/fed), respectively. For the total dry yield, the highest yield (5.878 ton/fed) was obtained from Terwatco, while the lowest one (5.475 ton/fed) was produced by Primora. For the relative dry forage yield, in the first cut the highest ratio (21.40%) was obtained from Terwatco and the lowest one (17.44%) from Caramba. But, in the second cut, Caramba produced the highest relative yield (32.25%) and Primora recorded the lowest ratio (29.11%). In contrast Primora detected the highest relative

yield (30.39%) in the third cut with lowest ratio (27.41%) obtained by Tewera.

Generally, it could be concluded that the varieties Tewera, Terwatco and Clipper were superior for fresh and dry forage yield in the first cut at Sakha, Gemmeiza and Sids stations, respectively. Moreover, the variety Terwatco yielded better fresh and dry yield in the first cut over locations. Because the first cut of Berseem is characterized with low production and high moisture content (Rammah and Radwan 1977). Thus, these varieties i.e. Tewera, Terwatco and Clipper may be recommended for growing with Berseem as a mixture for improving the first cut.

Stability analysis

Combined analysis of variance for total fresh and dry forage yield over all environments are listed in Table 3. Mean squares of environments and varieties by environments interaction were highly significant for both total fresh and dry forage yield. Mean squares of varieties was highly significant for total fresh forage yield and was significant for total dry forage yield. Significant (or highly) variance due to varieties revealed the presence of genetic variability for total fresh and dry forage yield. Highly significant mean squares of environments indicated that the performance of these traits differed largely affected by environmental conditions. The significance of varieties x environments interactions proved that the performance of different varieties varied from environment to another. Significance of varieties by environment interaction is in agreement with that of Haggag *et al* (1995) and Sarhan and El-Selemy (1996).

Table 3. Combined analysis of variance for total fresh and dry forage yield over environments.

Source of variance	d.f.	Mean squares	
		Fresh forage yield	Fresh forage yield
Varieties (V)	4	30.495 **	0.450 *
Environments (E)	5	996.026 **	8.018 **
Reps within (E)	12	5.829	0.141
V X E	20	26.264 **	0.413 **
Pooled error	48	7.103	0.160

* and **Indicate significant at 0.05 and 0.01 levels of probability, respectively.

Table 4 showed the performance of the studied five ryegrass varieties under the given six environments for total fresh and dry forage yield. Sids station in 2000/2001 season recorded the highest total fresh forage yield (52.25 ton/fed). However, Gemmeiza station in 1999/2000 season gave the lowest yield (30.97 ton/fed). Regarding to the varieties effect, Terwatco gave the highest total fresh forage yield (42.51 ton/fed) over all six environments with significant difference from Tewera and Primora. As previously shown in the combined analysis of variance from the highly significance mean square of V x E interaction, the ranking of varietal performance for total fresh yield varied from environment to another (Table 4). Terwatco variety ranked the first under Sakha and Sids stations in the second season, whereas it yielded the fifth at Gemmeiza in the first season and intermediate otherwise. The other four varieties, each occupied the first rank for total fresh yield production in one of the other environments.

Table 4. Total fresh and dry forage yield (ton/fed) of five varieties of ryegrass under six environments.

Varieties (V)	Environments (E)						Mean
	1999/2000 Season			2000/2001 Season			
	Sakha station	Gemmeiza station	Sids station	Sakha station	Gemmeiza station	Sids station	
Total fresh forage yields (Ton/fed)							
Terwatco	40.72	27.98	53.00	39.01	36.05	58.33	42.51
Tewera	42.14	32.48	45.67	38.20	32.55	49.17	40.03
Primora	42.58	29.66	41.67	38.31	34.88	48.91	39.34
Clipper	38.76	32.43	54.00	35.86	35.30	53.33	41.61
Caramba	40.02	32.29	50.30	37.52	38.15	51.50	41.63
Mean	40.84	30.97	48.93	37.78	35.39	52.25	41.02
L. S.D. at 0.05 (V) = 1.79							
L. S.D. at 0.05 (E) = 1.92							
L. S.D. at 0.05 (V X E) = 4.38							
Total dry forage yields (Ton/fed)							
Terwatco	6.146	4.145	6.907	5.165	5.511	7.397	5.878
Tewera	6.122	4.835	5.730	5.084	5.351	6.345	5.578
Primora	6.308	4.499	5.623	5.100	5.475	5.844	5.475
Clipper	5.779	4.810	6.530	4.813	5.568	6.265	5.628
Caramba	5.844	4.824	6.088	5.099	5.799	6.913	5.761
Mean	6.040	4.623	6.176	5.052	5.541	6.553	5.664
L. S.D. at 0.05 (V) = 0.268							
L. S.D. at 0.05 (E) = 0.299							
L. S.D. at 0.05 (V X E) = 0.657							

For total dry forage yield behaved similar to fresh one. In other words, the data indicated that Sids station in 2000/2001 season gave the highest production (6.553 ton/fed) and Gemmeiza station in 1999/2000 season yielded the lowest dry forage (4.623 ton/fed). Concerning the varieties

effect, the same trend of total fresh forage yield was obtained for total dry forage yield (Table 4).

Analysis of variance for total fresh and dry forage yields when stability parameters are estimated in Table 5. As shown, the linear response of environment as well as varieties by environments interaction were highly significant for both total fresh and dry forage yield. Mean squares of pooled deviation was significant for total fresh forage yield, while it was not significant for total dry forage yield. The same results obtained by Sharma *et al* (1984), who found significant mean squares due to pooled deviation only for fresh yield, revealed the presence of non-linear portion of V x E interactions. They also indicated that if mean squares due to V x E (linear) were significant for the trait, this means that a major portion of V x E interactions was linear and so prediction was possible for this trait.

Table 5. Analysis of variance for total fresh and dry forage yield when stability parameters are estimated.

Source of variance	d.f.	Mean squares	
		Fresh forage Yield	Dry forage yield
Total (VE-1)	29	64.6572	0.5766
Varieties (V-1)	4	10.1527	0.1500
E+ V X E (V(E-1))	25	73.3779**	0.6449**
Environments (E) (Linear)	1	1659.587**	13.3686**
V X E (V-1) (Linear)	4	21.0737**	0.3326**
Pooled deviation (V(E-2))	20	4.5283*	0.0712
Terwatco	4	1.4375	0.0681
Tewera	4	3.7845	0.0368
Primora	4	8.0606*	0.1568*
Clipper	4	7.2503*	0.0394
Caramba	4	2.1086	0.0548
Pooled error [E(R-1)(V-1)]	48	2.368	0.0533

* and ** indicate significant at 0.05 and 0.01 levels of probability, respectively.

Therefore, the regression coefficient (b_i) on the environmental index and deviation from regression mean squares (S^2d_i) pooled over all environments were calculated for each variety and presented in Table 6.

Table 6. Mean values and stability parameters for total fresh and dry forage yield.

Varieties	Fresh forage yield			Dry forage yield		
	X̄	b _i	S ² d _i	X̄	b _i	S ² d _i
Terwatco	42.51	1.3699*	-0.9305	5.878	1.5962*	0.0151
Tewera	40.03	0.8159	1.4165*	5.578	0.7754	-0.0162
Primora	39.34	0.7564	5.6926*	5.475	0.7021	0.1038
Clipper	41.61	1.1344	4.8823*	5.628	0.9517	-0.0136
Caramba	41.63	0.9233	-0.2595	5.761	0.9746	-0.0018
Means	41.02	1.0000	2.6363	5.664	1.0000	0.0301
Standard error	± 0.952	± 0.117	± 0.503	± 0.117	± 0.163	± 0.066

* indicate significant at 0.05 level of probability.

For total fresh forage yield, three varieties i.e. Terwatco, Clipper and Caramba performed better than the average performance. Only these varieties could be of some use to the breeders because the varieties with below average performances are of little practical utility even if they are stable. Regression coefficient (b_i) was nonsignificant for all varieties except Terwatco. Breese (1969) stated that the environmental condition was effective on the response of varieties. Four varieties i.e. Tewera, Primora, Clipper and Caramba possessed b_i values equal to one. Therefore, the above varieties were averages responsive to changes in environments and could perform well under average environmental conditions. All varieties showed significant trend for non-linearity except Terwatco and Caramba and therefore S²d_i value not equal zero for all varieties except Terwatco and Caramba. According to Eberhart and Russell (1966 and 1969), Caramba was more stable than others for this trait under the environmental conditions studied.

For total dry forage yield, two varieties i.e. Terwatco and Caramba performed better than the average performance. Considered the response of varieties to change in environmental conditions, all these varieties had a regression coefficient equal to one except Terwatco for this trait. Nonsignificant values of S²d_i revealed better stability for all varieties. According to these reports of Eberhart and Russell (1966 and 1969), the variety Caramba was more stable than others for this trait under the environments studied.

On the basis of all the parameters, it was quite clear that Caramba has high yield, good response to change in environmental conditions and better stability for both total fresh and dry forage yields. Therefore, this variety could be grown for high yield and better stability of forage production under different environmental conditions. So, only this variety is the most promising in forage breeding programs and recommended to be grown with Berseem as a mixture or in intercropping in farmers field.

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أداء وثبات حاصل العلف الأخضر والجاف لخمسة أصناف من الراي جراس تحت ظروف بيئية مختلفة

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أجرى هذا البحث بهدف دراسة أداء وثبات حاصل العلف الأخضر والجاف لعدد خمسة أصناف مستوردة من الراي جراس (*Lolium multiflorum* L.) في المحطات البحثية الممثلة لظروف شمال الدلتا (سغا) ، وسط الدلتا (الجميزة) و مصر العليا (سدس) خلال موسمي ٢٠٠٠/١٩٩٩ و ٢٠٠٠/٢٠٠١. قدرت ثوابت الأقلمة وتتلخص النتائج المتحصل عليها في الآتي:-

كمتوسط عام لسلوك الأصناف أظهرت الأصناف أعلى إنتاجية لها من العلف الأخضر والجاف في الحشة الأولى في محطة بحوث سدس بمقارنه إنتاجيتها من العلف الأخضر والجاف في المحطات البحثية الأخرى. أعطت الأصناف تيورا وتراوتكو وكذلك الصنف كليبر أعلى إنتاجية من العلف الأخضر والجاف في الحشة الأولى في المحطات البحثية سغا والجميزة وسدس على الترتيب كما أعطى الصنف تراوتكو أعلى إنتاجية من العلف الأخضر والجاف في الحشة الأولى كمتوسط عام للمحطات البحثية الثلاث. وكذلك أعطت الأصناف بريمورا، كرامبا وتراوتكو أعلى إنتاجية من العلف الأخضر والجاف الكلي. وتلك الأصناف يمكن أن يوصى بزراعتها مع البرسيم كمخلوط أو تحميل. كان التباين الراجع الي تأثير البيئات وكذلك التفاعل بين الأصناف مع البيئات عالي المعنوية لصفتي محصول العلف الأخضر والجاف الكلي بينما كان التباين الراجع الي تأثير الأصناف عالي المعنوية ل محصول العلف الأخضر الكلي و معنوي لصفة محصول العلف الجاف الكلي. و كمتوسط عام لجميع البيئات أعطى الصنف تراوتكو و يليه كرامبا أعلى محصول للعلف الأخضر والجاف وكذلك بالنسبة للمجموع الكلي للحشات الأربعة. كان معامل الاحدار غير معنوي لجميع الأصناف باستثناء الصنف تراوتكو لصفة محصول العلف الأخضر والجاف الكلي. أظهرت كل الأصناف معنوياتها بالنسبة لارتفاعها عن خط الاحدار باستثناء تراوتكو و بريمورا وذلك بالنسبة لصفة محصول العلف الأخضر الكلي بينما كانت غير معنوية بالنسبة لصفة محصول العلف الجاف الكلي .

كانت أعلى الأصناف و أفضلها من حيث الإنتاجية والأكثر ثباتا والمبشرة والتي يمكن أن يوصى باستخدامها في برامج التربية والزراعة في حقول المزارعين هي كرامبا بالنسبة لصفتي العلف الأخضر والجاف.