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Evaluation of Some Species of Warm-Season Turfgrasses in Riyadh Region

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Abstract. Evaluation study was made on ten selected turfgrasses species; namely, local bermudagrass, common bermudagrass, Tifgreen bermudagrass, Tifway bermudagrass, Adalyd seashore paspalum, Variegata St. Augustinegrass, Floratine St. Augustinegrass, Floratam St. Augustinegrass, Korean velvetgrass, and Egyptian crabgrass. The adaptation of these ten turfgrasses under the field conditions in Riyadh area was investigated. The establishment rate, yield fresh weight and quality assessments, as evaluation parameters, showed that the differences among these turfgrasses were significant. Tifgreen bermudagrass and Adalyd seashore paspalum showed the best adaptation if properly managed, while Tifway bermudagrass and Variegata St. Augustinegras showed poor adaptation. In addition, there were some observations that may limit the use of other turfgrasses, such as the cold stress effect on the common bermudagrass and Egyptian crabgrass, the very slow establishment rate of Korean velvetgrass, the vertical growth habit and low density of the local bermudagrass and finally the seed head formation and fungal infestation on Adalyd paspalum. The other turf types showed intermediate adaptation since they did not give high quality during the study.

Introduction

There are various types of turfgrasses grown all over the world under different climatic conditions. The main grasses, suitable for turfgrass establishment, are divided into two groups, namely, cool-and warm-season grasses. The cool-season group prefers a low temperature of 10-15°C commonly associated with Europe and Central and Northern regions of USA. On the other hand, the warm-season group prefers warmer temperature of 27-35°C [1, p. 162]. In Riyadh, Saudi Arabia, the temperatures of the cold months (November to January) are low and vary from 5 to 20°C. On the contrary, the temperatures of the warm months (May to September) are high, with an average range of 30-45°C. Besides, the relative humidity of Riyadh is low during the summer months [2, p. 8]. Most of the grasses found in Saudi Arabia are wild or grown in cultivated lands and considered as weeds [3, p. 26]. Bermudagrass *(Cynodon dactylon* L.) is the most common perennial turfgrass primarily grown in

Saudi Arabia. It provides a very good turf if properly managed, however, the grass color becomes yellow to brown during the cold winter months [4].

This study is very important for a big country like Saudi Arabia with different environmental regions in order to select the most suitable turfgrass type that can be grown successfully under the conditions of Riyadh area. Very few, if any, studies were conducted in this regard. Various turfgrasses were collected from inside and outside the Kingdom of Saudi Arabia for the need of this study.

Materials and Methods

This study was conducted at the Agricultural Research and Experimental Station at Dirab, College of Agriculture, King Saud University, Riyadh, from October 1989 to the end of December 1990. Ten different species and cultivars of warm-season turfgrasses were selected and obtained from various sources for the use of these studies (Table 1). Each of these turfgrasses was vegetatively propagated by spriggins and planted in an open field containing soil consisted of 3:1 sandy loam soil and peat-moss respectively (by volume). The initial soil pH was 7.9 and the EC was 0.24 dsm^{-1}. A secondary treated municipal sewage water with an EC of 1.6 dsm^{-1} was used to irrigate the grasses throughout this study. Turfgrass sprigs were planted in 1 × 2m plots about 10 cm apart of each other. The plots were arranged in a randomized complete block design (RCBD) with four replicates. The turfs were mowed every 2-3 weeks at about 5 cm height with clippings removed by using a rotary mower. The Korean velvetgrass was not mowed throughout the study because of its slow growth rate. Irrigatioin using sprinkler system was applied every 2-3 days and as needed throughout the study to prevent visual wilt. N.P.K. fertilizer 18-18-5) was added at the rate of 2.2 Kg/100 m^2 (44 gm/plot), per the growing month. The soil was treated with Benlate (fungicide) before planting to eliminate any possible infection with fungus diseases. Insecticides were applied on the growing grasses, only as needed during the study period, to prevent a total loss of stand. Turfgrass growth characters for each of the selected types were determined and evaluated in this study, and also for the other studies according to one or more of the following scales:

1. Rate of establishment: It represents the percentage of area covered with each turfgrass type which was visually and periodically measured every month during the growing season.

2. Color: It was determined by measuring the total chlorophyll content on a fresh weight basis as mg/100g according to Al-Saadi and Al-Mosawi [5, p. 89].

Table 1. The ten turfgrass types selected for these studies

Common name	Scientific name	Source
Local bermudagrass	*Cynodon dactylon* (L.)	Dirab Station, Riyadh
Common bermudagrass	*Cynodon dactylon* (L.)	Dirab Station, Riyadh
Tifgreen bermudagrass	*Cynodon dactylon* (L.)	Southern Turf Nurseries, Georgia, USA (imported)
Tifway bermudagrass	*Cynodon dactylon* (L.)	Southern Turf Nurseries, Georgia, USA (imported)
Adalyd paspalum grass	*Paspalum vaginatum* (S.)	Local nurseries, Riyadh
Variegata St. Augustin grass	*Stenotaphrum secundatum* (Walt)	Nursery Department, International Airports Projects, Jeddah
Floratine St. Augustin grass	*Stenotaphrum secundatum* (Walt)	Nursery Department, International Airports Projects, Jeddah
Floratam St. Augustin grass	*Stenotaphrum secundatum* (Walt)	Nursery Department, International Airports Projects, Jeddah
Korean velvet grass	*Zoysia tenuifolia* (Will)	
Egyptian crab grass	*Dactyloctenium aegyptium* (L.)	

3. **Turfgrass growth rate (gm/m²):** All plots were mowed every 2-3 weeks and the fresh hand cut clippings per plot were collected and weighed each month to determine the growth rate during the growing season.

4. **Turfgrass quality:** The plots of each turfgrass type were visually scored on a monthly basis to determine turfgrass quality based upon uniformity, density and color, in addition to the turf ability to compete with weed invasion. Scores ranged from (1) for low quality turfgrass to (9) for excellent turfgrass. Any value below 5 was considered as unacceptable quality.

To study the effect of planting date on their growth and establishment rate, these turfgrasses were also planted in fall and in spring seasons. In the fall season, sprigs were planted in October 1989 with an average temperatures of 15-20 °C± and 35±5% relative humidity. However, in the spring season, sprigs were planted in February 1990 with 20 ± °C temperatures and 30 ± 5% relative humidity [2, p. 62]. Informations on weed invasion, pests, and other pathogens in turf types were collected and considered in the prementioned evaluation parameters.

Results

There were significant differences among the mean values of clipping weight of the various turf types, cutting months and the interaction between these two factors as shown in Table 2. Egyptian crabgrass gave the highest significant overall mean clipping weight (505 gm), as compared to the other types, it was followed by seashore paspalum (418 gm) which was significantly less than the crabgrass. On the other

Table 2. Clipping fresh weight of the different turfgrass types at different cutting months

Turfgrass type	1st cut May	2nd cut Jun	3rd cut Jul	4th cut Sep	5th cut Nov	6th cut Jan	Overall mean
Local bermuda	235.0	241.0	214.0	179.0	205.0	137.7	202 f Y
Common bermuda	273.5	290.0	250.7	377.0	296.0	175.0	277 e
Tifgreen bermuda	353.7	422.0	438.7	319.7	317.7	236.2	348 d
Tifway bermuda	235.0	204.2	148.7	157.0	187.7	- - X	155 g
Adalyd paspalum	537.5	462.0	492.7	404.0	362.7	247.7	418 b
Variegata St. Aug	282.5	317.2	240.0	209.0	317.0	145.5	252 e
Floratine St. Aug	400.0	356.7	498.7	404.0	427.7	205.0	382 c
Floratam St. Aug	419.7	389.0	492.0	299.0	400.0	212.7	369 cd
Korean velvet Z	–	–	–	–	–	–	–
Egyptian crab	628.5	475.0	625.0	512.0	472.0	317.7	505 a
Overall mean	374 ab	351 bc	378 a	318 d	332 cd	186 e	

L.S.D. (0.05) for turf types = 28.8

L.S.D. (0.05) for cutting months = 23.5

L.S.D. (0.05) for interaction = 72.2

X This grass was not clipped in January because of its slow growth rate.

Y Means followed by the same letter(s) are not significantly different at 0.05 level.

Z Korean velvetgrass was not clipped because of its slow growth rate.

hand, Tifway bermudagrass produced the least significant weight (155 gm). The other turf types gave intermediate mean values of weight. Moreover, these results revealed that the growth rates of both Egyptian crabgrass and seashore paspalum were faster than the other turfgrasses, despite the cutting months. Among the four selected bermudagrass cultivars there were also significant differences. Tifgreen gave the highest weight among the bermudagrass cultivars (348.0 gm), while Tifway gave the lowest weight (155 gm).

Cutting months data indicated that the third cut in July produced the highest overall mean clipping weight (378 gm), compared to the other cutting months (Table 2). Although this cutting month was not significantly differnt from the first cut in May, it was significantly different from the other cutting months. Moreover, the 6th cut in January gave the least significant weight (186 gm).

The highest (537 gm) and the lowest (138 gm) clipping fresh weights were those of Adalyd paspalum in May and local bermuda in January, respectively. This confirms the significant interaction between turf types and cutting months for clipping fresh weight (Table 2).

A comparison between the fall and spring plantations for the various turfgrasses showed that planting time had an effect on the estimation of establishment rate values (Figs. 1-3). Tifgreen and local bermudagrass had faster establishment rate within 5 months than other bermudagrass types in fall plantation (Fig. 1). However, some bermudagrasses that were sprigged in spring showed faster establishment rate than those sprigged in fall. Tifway bermuda gave 100% coverage within 4 months, followed by the other bermuda cultivars (Fig. 1). The difference among the bermudagrass cultivars was significant in the fall plantation, however, there was no significant difference between Tifway and Tifgreen in the spring plantation (Fig. 1). Among the St. Augustinegrass cultivars, there was a significant difference in the fall, however, the difference between Floratam and floratine was insignificant (Fig. 2). Variegata St. Augustine did not achieve more than 75% coverage from October to December in the spring plantation (Fig. 2). Tifgreen and Adalyd seashore paspalum in the fall plantation had faster establishment rate than other entries since they achieved about 100% coverage in about 6 months, while the Korean velvetgrass did not reach more than 84% at the end of the year (October) (Fig. 3).

In fall plantation, Tifway had the lowest overall mean establishment rate (60%) among the bermudagrasses, although the Korean velvetgrass was the lowest among all turfgrass types (46%) (Fig. 4). On the other hand, Tifway gave the highest overall mean of establishment rate in spring plantation (81%) (Fig. 4). Moreover, Floratine St. Augustinegrass ranked the best in the fall plantation with overall mean establish-

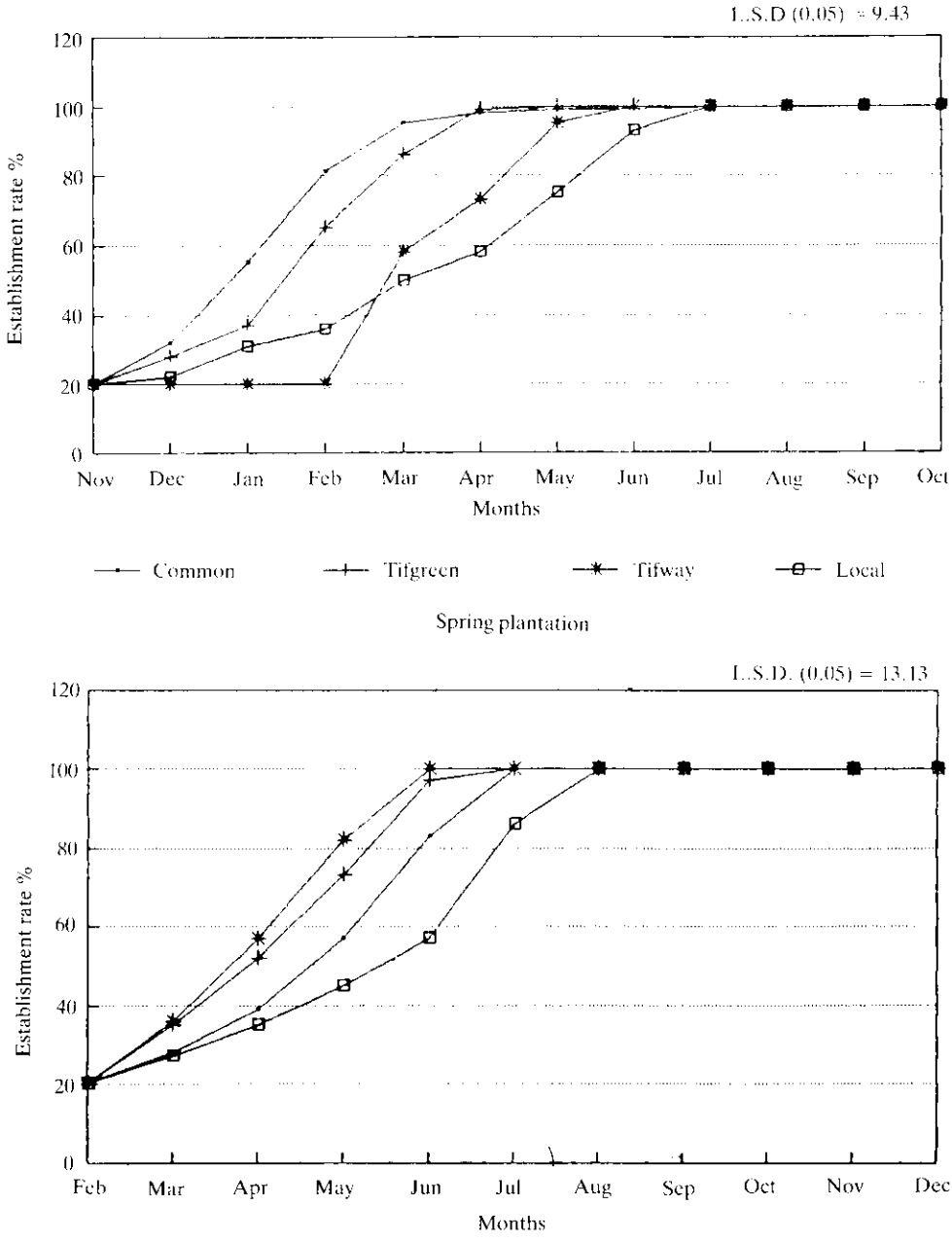

Fig. 1. Estimation of establishment rate (%) for bermudagrass cultivars fall plantation

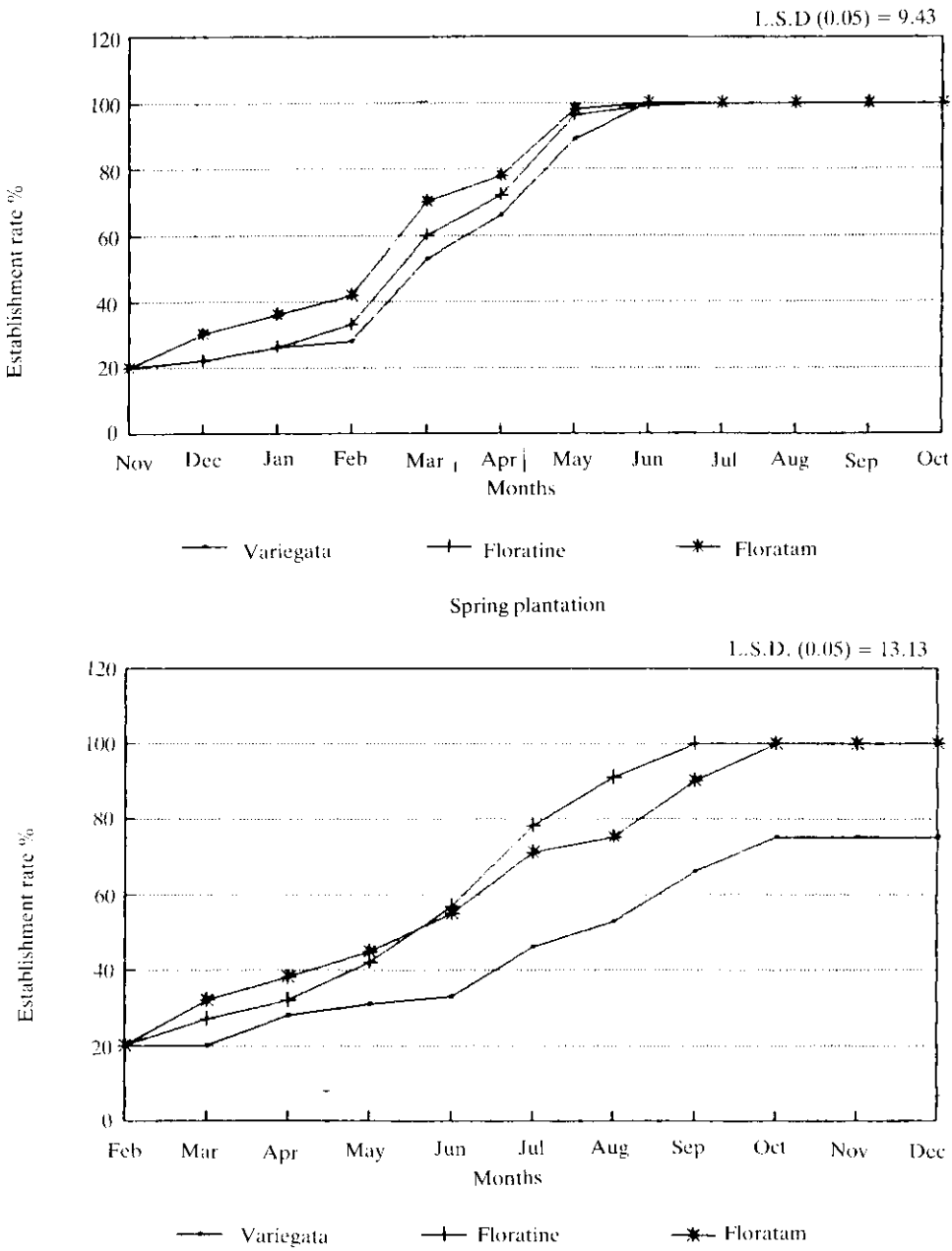

Fig. 2. Estimation of establishment rate (%) for St. Augustinegrass cusltivars fall plantation

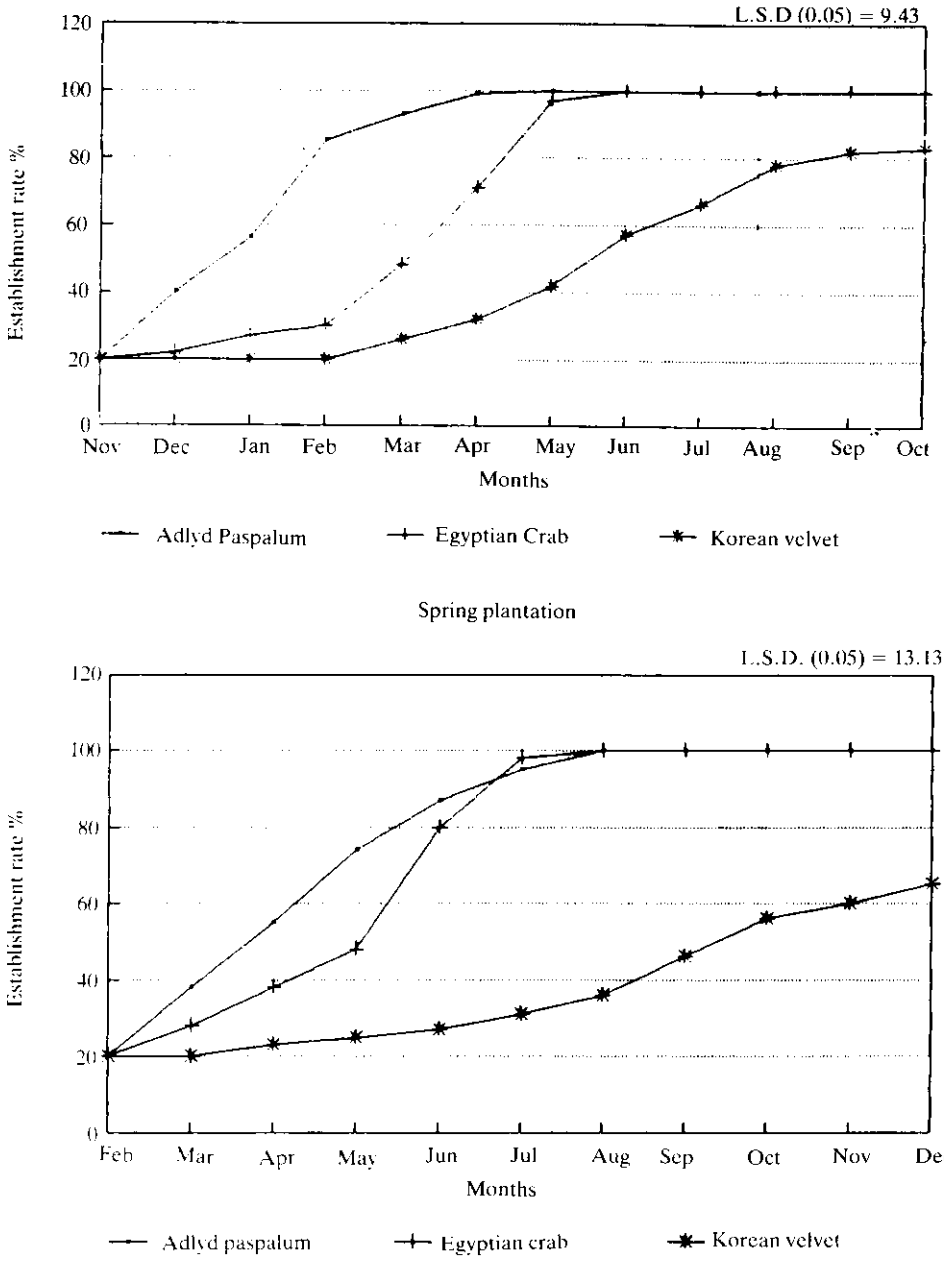

Fig. 3. Estimation of establishment rate (%) for other Turfgrass species fall plantation

ment rate of 73%, but it showed lower rate in the spring plantation with overall mean rate of 66% (Fig. 4). The Korean velvetgrass was the lowest in both spring and fall, however, its establishment rate was better in fall (45.8%) than in spring (37.3%).

Some turf types ranked before other types in spring planting and vise versa in fall (Fig. 4). In the spring plantation, Floratam St. Augustinegrass showed a greater establishment rate (72%) than Floratine St. Augustinegrass (69%), while in fall plantation, Floratine (68%) ranked before Floratam (47%). Similarly, the common bermudagrass with an establishment rate of 81% was superior to Tifgreen (78%) in the fall. However, Tifgreen (79%) was superior to common bermuda (75%) in the fall planting. In general, most of the turf types; *i.e.* paspalum, common bermuda, Floratam St. Augustine, Floratine St. Augustine Variegata St. Augustine local bermuda, and Korean velvet grasses, exhibited better establishment rate in the fall plantation. On the contrary, the other grasses, Tifway, Tifgreen, and Egyptian crabgrass were superior in the spring plantation than in fall.

Adalyd seashore paspalum showed significantly the highest significant quality (7.7) than the other turfgrass types (Table 3).The overall mean values for turf quality showed that most of the selected turfgrass types produced an acceptable turf with a minimum value of 5.0, except for Tifway bermudagrass and Variegata St. Augustinegrass which gave a quality scale lower than 5. There were significant differences in turfgrass quality among the selected bermuda turfgrasses (Table 3). Tifgreen had the highest quality (7.4) followed by common bermuda (6.5), local bermuda (6.4) and finally Tifway which exhibited the lowest turf quality (4.9). Among the St. Augustinegrass cultivars, there was no significant difference between Floratine and Floratam in quality (averaged about 6.8), however, the difference between these two cultivars and Variegata (4.1) was signficant (Table 3).

The overall mean value for the quality of all turfgrasses was larger in September (6.8) and lower in May (5.6) (Table 3). Some turfgrasses, such as common bermudagrass, produced the lowest turf quality in December (4.2), while others, such as Tifgreen bermudagrass, exhibited the greatest turf quality in this month (7.3). Seashore paspalum also produced the best turf quality in December (8.4), while Tifway bermudagrass exhibited the lowest in the same month (3.5). This reveals the significant interaction between turfgrasses and growth months (Table 3).

Data on chlorophyll content (mg/gm fresh weight) in the three seasons, summer, fall and winter, at various light intensities was determined and presented in Table 4. The results indicated that chlorophyll content decreased as temperature light intensity increased (Table 4). Among the selected turf types, the Korean velvet-

Table 3. Seasonal turfgrass quality for the different Turfgrass types at different months

Turfgrass types	May	June	July	Aug	Sept	Oct	Nov	Dec	Overall mean
Local bermuda	4.9 X	6.4	7.0	7.7	7.4	6.4	5.8	5.8	6.44 d X
Common bermuda	6.3	6.5	7.3	7.7	7.9	7.4	4.9	4.2	6.54 d
Tifgreen bermuda	7.3	7.6	5.6	7.8	8.3	7.7	7.5	7.3	7.39 b
Tifway bermuda	6.4	7.4	4.6	6.6	4.6	3.6	2.4	3.5	4.90 f
Adalyd paspalum	7.2	7.5	7.4	7.3	7.6	8.4	7.9	8.4	7.70 a
Variegata St. Aug	3.3	3.8	4.2	3.5	4.1	4.6	4.4	4.7	4.09 g
Floratine St. Aug	5.4	5.9	7.2	7.5	7.6	7.4	6.9	6.9	6.85 c
Floratam St. Aug	5.4	5.9	6.7	7.2	7.4	7.8	7.2	6.9	6.83 c
Korean velvet	2.7	2.8	5.1	5.4	5.9	6.8	7.1	6.9	5.34 e
Egyptian crab	6.7	7.1	7.3	7.5	7.5	6.5	7.3	7.3	7.16 b
Overall mean	5.57 c	6.11 b	6.25 b	6.83 a	6.84 a	6.67 a	6.15 b	6.17 b	

L.S.D. at (0.05) for turf types = 0.24

L.S.D. at (0.05) for months = 0.21

L.S.D. at (0.05) for interaction = 0.68

X Rating scale based on 9=best and 1=poorest; 5 represents the minimal acceptable turfgrass quality.

Y Means followed by the same letter are not significantly different at 0.05 level.

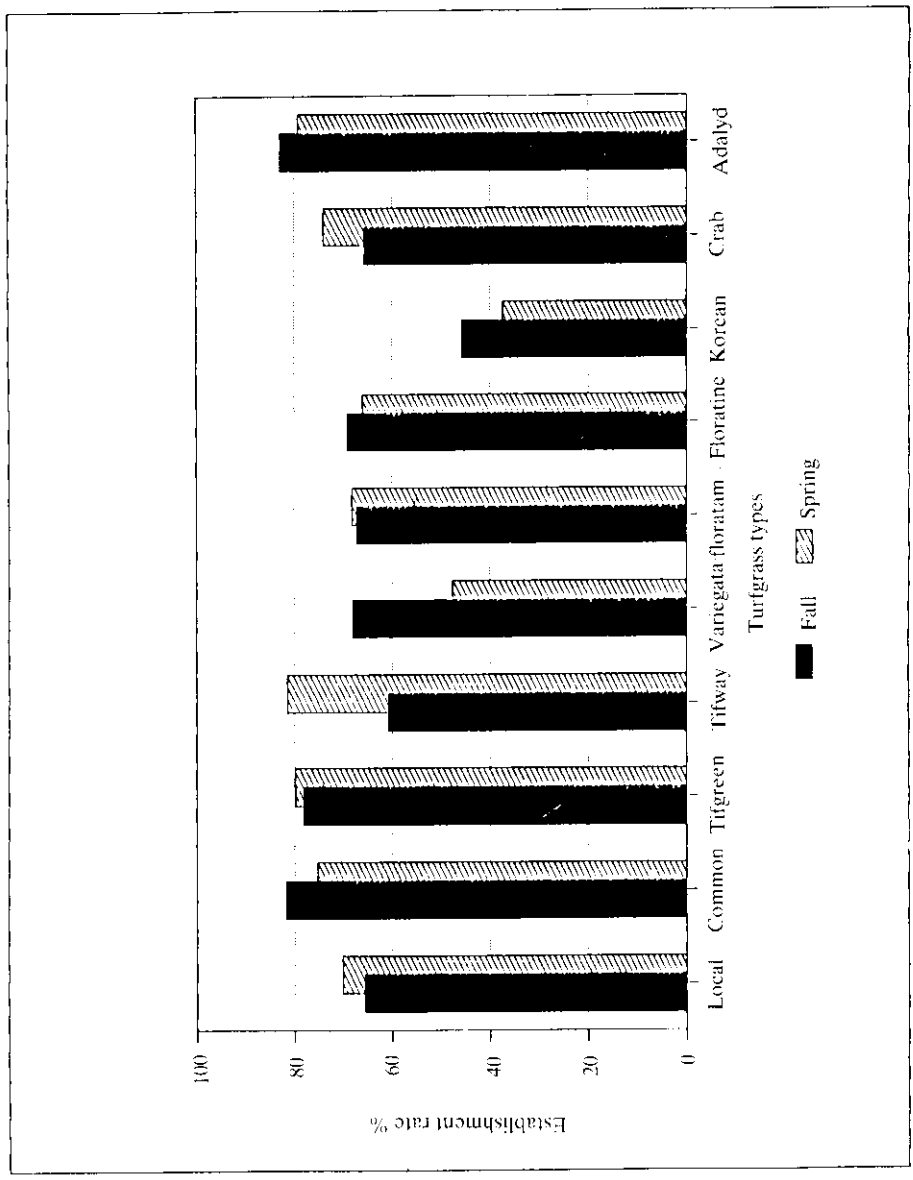

Fig. 4. Overall means (12 months) of estimation of establishment rate (%) for the fall and spring plantations

Table 4. Assessment of the chlorophyll content (mg/gm fresh weight) for the selected turfgrass types at different seasons

Turfgrass type	Summer (Aug) *	Fall (Oct)	Winter (Dec)	Overall mean
	chlorophyll content (mg/gm)			
Local bermuda	0.76	0.80	0.85	0.80
Common bermuda	0.63	0.67	0.81	0.70
Tifgreen bermuda	0.75	0.79	0.84	0.79
Tifway bermuda	0.72	0.76	0.83	0.77
Adalyd paspalum	0.88	0.96	0.99	0.94
Varriegata St. Aug	0.40	0.45	0.51	0.45
Korean velvet	1.03	1.10	1.25	1.13
Floratine St. Aug	0.72	0.76	0.81	0.76
Floratam St. Aug.	0.42	0.47	0.53	0.47
Egyptian crab	0.87	0.95	0.99	0.94

*The average light intensity was about 91 klux in summer (Aug), 80 klux in fall (Oct), and 64 klux in winter (Dec).

grass showed the greatest chlorophyll content with an overall mean value of 1.13 mg/gm fresh weight for the three seasons, while the variegated St. Augustinegrass had the lowest mean value of 0.45 mg/gm. There was no much difference among the bermuda cultivars in chlorophyll content, however among the St. Augustinegrass cultivars, Floratine gave higher chlorophyll content (0.76 mg/gm), compared to Floratam (0.47) and Variegata (0.45 mg/gm) (Table 4).

Discussion

Generally, Egyptian crabgrass produced the heaviest fresh clipping weight as compared to the other selected species and cultivars. Similar performance was also observed by Sharma and Chiving [6] who reported that crabgrass was a perennial mat-forming grass, which could reach up to 30-40 cm height. In this study, the common bermuda gave the highest fresh weight among the bermuda cultivars, followed by local bermuda, Tifgreen and finally Tifway bermuda which gave the lowest growth rate among the selected turf types. These results are partly in agreement with those of Beard [7, p. 244] who reported that Tifway bermudagrass and Floratam St. Augusutinegrass had rapid shoot growth rate. The reason for the low growth rate of Tifway may be because it could not tolerate the drought and the high heat up to 45-48°C, as also indicated by Beard [7, p. 263] and Kim *et al.* [8, p. 6]. Among St. Augustinegrasses, Floratam was superior in growth rate to Floratine, while Variegata produced the least growth. These results are similar to those of Riordan [9, p. 2].

The results of fall plantation indicated that Adalyd paspalum had a superior establishment rate, achieving 100% coverage in 5 months. However, the results of the spring plantation were different. Tifway achieved a full coverage in 5 months and also produced the highest establishment rate, followed by Tifgreen bermuda. Similar results were obtained by Henry *et al.* [10] who indicated that it took 4 months for full establishment of bermuda hybrid and 5 months for paspalum when planted in spring or summer. Among the St. Augustinegrass cultivars, the growth of Floratam and Variegata was faster than that of Floratine in achieving a full coverage if planted in fall, but Floratine needed one extra month to have a full coverage. On the other hand, when these cultivars were sprigged in spring, Floratine achieved a full coverage in 7 months but Floratam needed an extra month, while Variegata never achieved a full coverage. These results were not in agreement with those of Menn *et al.* [11, p. 19] who reported that there were no significant differences among these entries, whereas in this study there were significant differences existed among the turfgrass types. This may be due to the differences in environmental conditions and cultivar adaptation. Egyptian crabgrass achieved a full coverage after 7 months in both spring and fall plantation, however, its establishment rate was larger in fall than in spring.

In terms of quality assessemnts, the comparative visual ratings of turfgrass quality for the selected turf types, grown in the field, showed that seashore paspalum had the best turf quality, followed by the common bermuda, the local bermuda and finally Tifway. Some of these resutls were not in agreement with those of Sifers *et al.* [12, p. 4] who reported that Tifway exhibited high quality. In this study such cultivar was severely affected by drought under Dirab environment and did not show drought tolerance, as previously reported by Beard [7]. The common bermuda was rated less than Tifgreen and other turfgrasses because of its light green color, maximum number of seed head formation, cold discoloration, and low shoot density. This was similarly reported by Mckarty and Cisar [13, p. 11]. Floratine and Floratam St. Augustine grasses showed medium quality rate. However, our results showed that both cultivars had higher quality rate than those given by Menn *et al.* [11] and Riordan [9] who rated these cultivars below the acceptable rate of 5. Crabgrass had a high quality turf because of its excellent growth rate, very good dark blue color, high density and rapid establishment rate. Although it had some problems, such as maximum number of seed forming heads and cold injury, it proved to be one of the highest recovering grasses in this study. The Korean velvet grass was rated as an acceptable turf even though it had the lowest establishment rate among the grasses.

It can be concluded that most of the evaluated turfgrasses were satisfactorily grown under Riyadh environment with regard to their growth, establishment and

quality rates. However, there were some observations that might limit the use of these turfgrasses, such as the poor adaptation of Tifway, the cold stress effect on the common bermudagrass and Egyptian crabgrass, the very slow establishment rate of Korean velvetgrass, the vertical growth habit and low density of the local bermudagrass.

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تقويم بعض أنواع من نباتات المسطحات الخضراء للموسم الدافىء في منطقة الرياض

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قسم الإنتاج النباتي، كلية الزراعة، جامعة الملك سعود، الرياض، المملكة العربية السعودية

ملخص البحث. يعتبر تقويم مسطحات النجيل الخضراء مهمًا لغرض تحديد أفضل الأنواع والأصناف تأقلمًا لظروف المنطقة موضع الدراسة وخاصة في ظروف المناطق الصحراوية كوسط للمملكة العربية السعودية. ويوجد عدد قليل من المسطحات الخضراء التي يمكنها تحمل مثل هذه الظروف، وهذه تنحصر في بعض أنواع مسطحات الموسم الدافىء.

وقد تم إجراء هذه التجربة على أنواع وأصناف مختارة من المسطحات الخضراء منها أربعة أصناف من عشب البرمودا Bermudagrass هي البرمودا البلدي Local والبرمودا المحلي Common ونوعان من البرمودا الهجين Tifgreen Tifway. وكذلك ثلاثة أصناف من النجيل الفرنسي St. Augustinegrass هي المبرقش Var-iegata Floratam, Floratine ، بالإضافة إلى نوع الباسبالم Adalyd Seashore paspalum (صنف رجل الغراب Egyptian crab) وقد أجريت هذه الدراسة لتقويم نمو وتحمل هذه المسطحات وتأقلمها للظروف البيئية في منطقة الرياض. وقد استعملت عدة مقاييس في هذه الدراسة تتمثل في تقدير معدل الانتشار كنسبة مئوية، وكذلك تقدير معدل النمو، وذلك بتقدير الوزن الرطب من مساحة كل قطعة تجريبية حيث وجد أن هناك علاقة طردية بين زيادة الوزن وزيادة معدل النمو في المسطح. كذلك فقد تم تقدير جودة نوعية Turf quality المسطح خلال عدة فصول. وقد دلت نتائج هذه الدراسة على أن هناك فروقًا معنوية بين الأنواع العشرة المذكورة من خلال القياسات التي تمت عليه. ومن خلال هذه القياسات اتضح أن البرمودا الهجين من صنف Tifgreen والباسبالم صنف adalyd وجنس *Zoysia* صنف Korean ونوع *Datylocteium* من صنف Egyp-tian crab كانوا من أفضل الأنواع والأصناف.

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(١) مدينة الملك عبدالعزيز للعلوم والتقنية ـ الرياض.