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Plant Production

Evaluation of 24 Local Seed Sources of Buffelgrass for Persistence and Forage Yield in the Riyadh Area

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Abstract. Naturalized populations of buffelgrass (*Cencchrus ciliaris* L.) grow wild in some range areas and around farms in the Kingdom of Saudi Arabia. However, no attempt was made to study forage yield potential of these populations for use in range improvement or as a forage crop with low water requirement. This study was conducted to evaluate 24 seed sources collected from different places in the Riyadh area for forage yield, seasonal yield variation and persistence. Thirty plants from each seed source were planted per plot in a randomized complete block design with four replications. Four seasonal cuts were made every year for three years. Results indicated significant differences among populations in total forage yield and seasonal yield. Maximum seasonal yield and variation among populations were obtained in the summer while the lowest yield and variation among populations were found in the winter. Most of the variation in yield could be attributed to variation in seedling survival and establishment during the first year. Persistence varied among populations ranging from 7% to 92%.

Introduction

Buffelgrass (*Cenchrus ciliaris* L.) is an obligate apomictic drought-tolerant perennial warm season grass [1, p.382]. The plant is native to Africa and is adapted to arid and semi-arid areas with mild winter. It is found wild or cultivated in many regions in Africa, Asia, Australia and North America [2, p.63,3]. It is vigorous and productive grass when adequate moisture is available, and has the ability to survive long periods of drought and recover rapidly following rainfall [3]. Ibarra [4] reported that buffelgrass produce 4 to 10 times more forage than native western grasses on sandy, low-fertile and relatively saline soils. Jones [5 p.419] stated that bufflegrass is a high quality forage that gives good animal gains. However, nutritive value of buffelgrass is typical of warm-season grasses, having high fiber and low crude protien (CP) content. Sanderson *et al*. [6] reported a value of about 66% of neutral detergent fiber and a CP of 5.6-7%. Buffelgrass has been seeded successfully in southwestern United States and Mexico to revegetate degraded rangelands and to reclaim farmed and disturbed soils [3].

Buffelgrass has been naturalized in all regions in the Kingdom of Saudi Arabia. It is found wild in some rangelands or around farms [7]. This study was conducted to evaluate 24 local seed sources of buffelgrass collected from different areas around the Riyadh area in the fall of 1995 (Table 1). The objectives were to determine the potential of these populations for seasonal forage yield, persestence and to select superior lines for use as pasture crop or for use in reclamation of abandoned farmland.

Table 1. Seed sources of local buffelgrass collected from different areas around the Riyadh area in the fall of 1995.

Pop. No.	Collection site	Status	Remarks
1- 6	Agriculture research station in Deirab	Weed	Selected from different stands
7	Farm south of Riyadh	Weed	Grow near center pivot
8-12	King Saud University campus	Wild	Different locations
13-16	Wadi Hanifah	Wild	Different locations
17	Farm south of Riyadh near Alhayer	Weed	In date palm field
18, 19	Near Al-Deriyah town	Wild	Different locations
20, 21	Damam road Northeast of Riyadh	Wild	Different locations
22-24	AlQaseem road north of Riyadh	Wild	Different locations

Materials and Methods

This study was conducted at King Saud University Agricultural Research Station in Deirab (24 42° N, 44 46° E) near Riyadh, Saudi Arabia. The site of the experiment was a sandy soil (clay 8.5%) that contained moderate level of soluble salts (EC=3.5 dsm^{-1}), moderate level of $CaCO_3$ (25%), low organic matter (0.5%), and a pH value of 7.3.

The experiment was arranged as randomized complete block design with four replications and 24 seed sources of local buffelgrass. Ten seeds of each seed source were planted in the field in 12 Feb 96 in hills 30-cm apart along three rows within a plot and 1-m between plots. Seedlings were thinned to single seedling per hill in 15 March 1996. Each plot consisted of three rows with 30 plants per plot.

Plants were irrigated once a week during summer and every two weeks during fall and spring using sprinkler irrigation system. No irrigation was applied during winter. A total of 480 mm of water was applied yearly at rate of 20 mm of water per application. Plots were fertilized with 70 kg N ha^{-1} and 78 kg P_2O_5 ha^{-1} in March of each year. Weather data during the experiment are presented in table (2).

Seedling growth was harvested in June 15, 1996. Three seasonal yields were made during the first year and four seasonal yields were made every year for the next two years as follows: winter yield March, 15, spring yield June, 15, summer yield Sep., 15 and fall yield Dec., 15. Plant persestence was monitored during the first year and at the end of each following year.

Table 2. Monthly average temperature and precipitation during 1996, 97 and 98 in the Agricultural Research and Experimental Station in Deirab, near Riyadh, Saudi Arabia.

Month	Average Temperature (°C)			Precipitation (mm)		
	1996	1997	1998	1996	1997	1998
January	14.44	14.36	12.66	132.38	18.80	1.02
February	17.33	15.16	13.2	22.35	0	0
March	20.42	19.37	20.27	174.24	39.88	56.55
April	25.06	24.10	26.36	130.10	21.85	53.32
May	30.87	31.23	32.15	14.73	1.27	7.87
June	33.87	34.21	34.27	0	0	0
July	35.26	34.74	36.39	0	0	0
August	35.06	33.65	35.04	0	0	0
September	30.31	31.65	33.68	0	9.65	0.51
October	25.06	26.81	25.71	0	47.50	1.52
November	18.34	19.84	20.05	7.11	119.64	0
December	15.82	16.14	16.88	0	0	0

The experiment was analyzed as a randomized complete block design with 4 replications as blocks. A combined ANOVA indicated significant year effect but no year by entry interaction. Analysis of variance were made for seasonal forage yield, total annual yield and plant survival using SAS software [8].

Results and Discussion

Forage yield data (Table 3) revealed signififcant variation among the three years. As expected, forage yield yield obtained during the first year (1.06 ton ha^{-1}) was very low compared to yields obtained during the second and third years (21.373 and 21.217 ton ha^{-1}). The first year is considered an establishment year and only three cuts were made compared with four cuts made during the second and third years. Theunissen [9] stated that *C. ciliaris* has the potential of producing 30 ton ha^{-1} under irrigation.Variation among seasonal yield was significant in which fall yield was the highest during 1996 (0.482 ton ha^{-1}). Summer yield was the highest during 1997 and 1998 (10.32 and 9.29 ton ha^{-1}). Forge yield during winter was the lowest among all seasonal yields (1.847 and 0.980 ton ha^{-1} for 1997 and 98 respectively). There were significant variations in winter and spring yields between the 1997 and 1998 due in part to variation in weather conditions. In 1998, lower than average winter and warmer spring (Table 2) has affected winter forage yield negatively and spring forage yield positively. There was no significant difference in total annual yield between 1997 and 1998 (Table 3).

Table 3. Mean for total and seasonal forage yield (ton/ha) over the three years period (1996, '97 and '98) for local buffelgrass populations

Year	Winter	Spring	Summer	Fall	Total
1996	--	0.257	0.321	0.482	1.06
1997	1.847	4.901	10.32	4.305	21.373
1998	0.980	7.836	9.286	3.115	21.217
$LSD_{(0.05)}$	0.370	1.143	1.262	0.549	3.251

Significant differences were obtained among the 24 local buffelgrass lines in total and seasonal forage yield (Table 4). Average annual yield ranged between 26.16 ton ha^{-1} for population 1 and 2.94 ton ha^{-1} for population 20. The highest yielding populations were 1, 7, 10 and 13 that yielded 26.16, 23.21, 23.19 and 23.03 ton ha^{-1} respectively. Population 7 produced an average of 3.37 ton ha^{-1} during winter that was significantly higher than any other population. The highest yielding populations during spring were 1, 10, 13 and 7 that yielded 8.00, 7.10, 7.02 and 6.97 ton ha^{-1} respectively. The top yielding populations during summer were 1, 10, 2, and 13 that yielded 11.83, 10.06, 10.03 and 9.99 ton ha^{-1} respectively. Fall forage yield was generally lower than that in spring and summer and the top yielding populations were 7, 13, 10 and 1 that yielded 4.47, 4.45, 4.32 and 4.31 ton ha^{-1} respectively.

Table 4. Means for annual and seasonal forage yield (ton ha^{-1}) for 24 local buffelgrass populations.

Pop no.	Total	Winter	Spring	Summer	Fall
1	26.16	2.01	8.00	11.83	4.31
2	21.42	1.77	6.79	10.03	2.82
3	9.42	0.92	2.81	4.33	1.36
4	7.64	0.66	2.44	3.23	1.31
5	7.37	0.74	1.79	3.67	1.16
6	14.57	1.68	5.21	5.90	1.77
7	23.21	3.37	6.97	8.39	4.47
8	7.56	0.66	2.62	2.95	1.33
9	2.60	0.18	0.88	0.76	0.78
10	23.19	1.72	7.10	10.06	4.32
11	20.13	1.60	6.21	8.67	3.64
12	7.65	0.62	1.90	4.12	1.01
13	23.03	1.56	7.02	9.99	4.45
14	7.19	0.53	1.44	3.45	1.76
15	19.62	1.66	5.06	9.48	3.43
16	7.28	0.71	1.80	3.01	1.75
17	20.63	1.82	5.69	9.39	3.73
18	18.90	2.02	5.21	7.94	3.73
19	14.53	1.28	4.42	7.22	1.60
20	2.94	0.18	1.17	1.07	0.51
21	17.06	1.62	4.81	7.38	3.26
22	20.84	2.30	5.22	9.64	3.68
23	15.96	2.13	3.90	7.27	2.66
24	21.67	2.18	5.51	9.58	4.39
$LSD_{(0.05)}$	8.37	1.06	2.53	3.97	2.15

Significant variations among the 24 local buffelgrass lines were observed in seedling establishment. At seedling harvest, only 50% of the populations maintained over 80% establishment while some populations had very low establishment such as population 20 and 16 (Table 5). Population 1 and 7 had 100% establishment while populations 2, 10, 11, 13, 22, 23 and 24 had over 90% establishment. A reduction in stand was also observed at the first regrowth harvest (summer yield, 1996). Population seven was the only entry that maintained over 90% establishment while population one and 23 had over 80% establishment. Population 20 had the lowest number of established plants [7%] and 50% of the populations had less than 50% establishment (Table 5).

Plant mortality after the first regrowth harvest was very low (Table 5). Average plant persestence for the 24 local buffelgrass populations were 50, 47 and 46% measured at the end of year 1996, 1997 and 1998 respectively. Population seven maintained 92% stand at the end of year three while population one had 82% stand at the end of the study.

Table 5. Percentage of seedling establishment and plant survival at the end of year one, year two, and year three for 24 local buffelgrass population.

Pop no.	Seedling establishment	Plant persestence			
	(15/6/1996)	First regrowth (15/9/1996)	Year one (15/12/96)	Year two (15/12/97)	Year three (15/12/98)
1	100	87	87	82	82
2	90	72	72	66	64
3	67	38	38	35	35
4	56	27	27	27	25
5	60	31	31	30	30
6	81	54	54	52	52
7	100	93	93	92	92
8	50	21	21	19	19
9	40	15	11	11	11
10	95	75	73	70	70
11	97	77	76	72	72
12	52	22	21	20	20
13	98	88	85	80	75
14	48	25	19	19	18
15	84	55	54	52	51
16	39	15	10	10	10
17	77	48	48	46	45
18	63	34	34	32	32
19	69	40	37	35	33
20	36	7	7	7	7
21	84	58	58	52	52
22	97	80	72	66	66
23	93	82	82	82	80
24	92	80	78	73	72
Mean	74	51	49	47	46
$LSD_{(0.05)}$	17	22	22	21	20

Results of this study indicated that most of the variation in yield could be attributed to variation in seedling establishment and survival during the first year. Frasier *et al.* [10,11] indicated that wet-dry cycle affect seedling establishment of warm-season grasses. In this study, plants were irrigated weekly with 20mm of water during establishment. Nevertheless, there was significant variation in seedling establishment. The other factor that may have affected total forage yield was variation in cool season growth (winter and spring). Hussey *et al.* [12] reported that selection for winter survival has increased forage yield significantly through its effect on satand longevity.

Elite populations in this collection such as population one and seven should be propagated and distributed to farmers as a low input forage crop or for use as revegetation crop for abandoned farmlands. In southern Arizona, Cox and Madrigal [13] found buffelgrass to be the best range grass for revegetation of abandoned farmlands. Buffelgrass has also been used successfully for reseeding of degraded rangeland [2, p.64].

In coclusion, this study has demonstrated the potential of buffelgrass as resseding species under the Arabian environment. Significant variations exist among the collected local bufelgrass in seedling establishment, plant productivity, and plant persistence. More studies are required to determine the management practices needed for optimum productivity and persistence.

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تقويم ٢٤ سلالة محلية من عشبة البفل للاسترساء وإنتاج العلف في منطقة الرياض

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ص. ب ٢٤٦٠ الرياض الرمز البريدي ١١٥٤١ المملكة العربية السعودية

(قدم للنشر في ١٤٢١/١١/١١هـ، وقبل للنشر في ١٤٢٢/١٠/١٠هـ)

ملخص البحث. تنمو السلالات المستوطنة من عشبة البفل برياً في بعض المناطق الرعوية أو حول المزارع في المملكة العربية السعودية. ولا توجد دراسات على هذه السلالات لتقدير قدرتها الإنتاجية لاستغلالها في تنمية المراعي أو كمحصول علف ذي احتياجات مائية منخفضة. أجريت هذه الدراسة لتقويم ٢٤ مصدر للبذور جمعت من مناطق مختلفة في منطقة الرياض لمحصول العلف الكلي و التباين الموسمي في النمو و نسبة البقاء. زرع ٣٠ نباتاً من كل مصدر بذري في ثلاثة سطور باستخدام تصميم القطاعات العشوائية الكاملة في أربع مكررات. حشت النباتات أربع حشات موسمية في كل سنة لمدة ثلاث سنوات و أظهرت النتائج وجود اختلافات معنوية بين السلالات في محصول العلف الناتج و التوزيع الموسمي للمحصول و كان أعلى محصول موسمي و أعلى معدل للتباين بين السلالات في فصل الصيف بينما كان أقل محصول وأقل تباين بين السلالات في فصل الشتاء. ويمكن عزو معظم التباين بين السلالات في إنتاج العلف إلى اختلاف السلالات في قدرتها على التأسيس و البقاء حيث تراوحت نسبة البقاء عند نهاية التجربة من ٦٪ – ٩٢٪.