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Prospects of *Acacia saligna* for Improvement of the Deteriorated Rangelands under Rainfed Harvesting Conditions

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Abstract. About two years field experiment was conducted at El-Negila, North-Western Coast of Egypt. The area received annual winter rains of 120 mm in average. Growth characters of acacia *Acacia saligna* (Labil) H. Wendl. in response to plant ages (cutting season) and stubble heights were studied. Plants were cut after 17,20,23 and 26 months from transplanting date (first cut) corresponding to summer, fall, winter and spring seasons, respectively.

Superior foliage weight and other plant characters were associated with cutting after 26 months (spring season) from transplanting date (first cut). Cutting at ground surface (zero level) was preferable for producing virtual yield. Foliage production valuation on the basis of season was more convenient than on cutting interval or plant age. *Acacia saligna* had a perceptible capability to recover under severe cutting.

Introduction

The Mediterranean climate is characterized by wet cool winters and dry hot summers. Such condition's incidence varies from year to another and is reflected on rangeland productivity being largely dependent on the amount of vegetation engendered by the winter rains [1]. Most of rangelands in El-Negila area, North-Western Coast of Egypt are predominantly composed of *Haloxylon articulatum* in dry seasons with few annual herbs in wet ones [2]. Insufficient fodder production and harmful soil erosion are two serious problems in such semi-arid area. Utilizing annual revenue of rains, selecting suitable plant species and exploiting the ecological conditions of soil are the key factors in range development [3]. Water conservation by a ridge-trench system and open-pit sunken planting give a conventional survival with acacia under

rainfed conditions [4,5]. Representatives of acacia genus are wide spread: foliferous members are quite cosmopolitan in tropical and subtropical regions. Phyllodineous forms are almost entirely indigenous to Australia. Habitats of acacia are mostly characterized by arid areas of low seasonal rainfall [6-9].

Acacia saligna, a promising arboreal legume, has an acceptable palatability and could be taken as a source of fuelwood under Mediterranean conditions [10]. Hence, the scope of this work was focused on studying plant growth characters of *Acacia saligna* in response to plant age (cutting season) and stubble height under rainfed harvesting conditions in the North-Western Coast of Egypt.

Materials and Methods

About two years field experiment was conducted from January 1989. The study area is located at El-Negila, North-Western Coast of Egypt (31° 20¯ N, 27° 13¯ E). The site elevates 30 m above sea level. The area has a Mediterranean climate with an annual minimum and maximum temperature of 8 and 40°C, respectively. The annual precipitation averages about 120 mm, distributed as 80% in winter, 10% in late fall, 10% in spring seasons. Precipitation does not only vary from one year to another, but also in distribution within the season. Monthly evaporation averages 182 mm in summer and 69 mm in winter seasons. The soil, in general is shallow loamy sand overlying a gravely calcareous substratum with a hardpan at depths ranging from 40 - 60 cm.

Seeds of *Acacia saligna* (Labil) H. Wendl. previously collected from adult stands grown at the North-Eastern Coast of Sinai were sown in plastic bags filled with a mixture of soil (obtained from the same area) and sand at a ratio of 1:1 in August 1988. Bags were arranged in a greenhouse existed at the same location (El-Negila). Daily irrigation was applied via sprinklers. The irrigation water (Total soluble salts (TSS) = 500 ppm) was obtained from rain's runoff previously collected and stored in underground rooms, lined with cement namely Roman wells. In January 1989, seedlings of 40 - 50 cm tall were transplanted into the permanent site in open-pit sunkens of 50 cm diameter and 60 cm deep. The distance between every two adjacent pits was 3 m. The whole planted area was surrounded by 2 m high ridgetrench in three directions. The fourth one (in front of land slope direction) was left for receiving and collecting more amounts of the runoff water. The planted shrubs were not provided with any source of irrigation water other than harvested precipitation.

Ninety-six adult plants were used in this study. In June 1990 the cutting treatments started at 17,20,23 and 26 months from transplanting date, corresponding to summer, fall, winter and spring seasons, respectively at 4 stubble heights *i.e.* 0,30,60,

and 90 cm from soil surface were distributed randomly in a split plot design with three replications. Plant age and stubble height treatments occupied the main and sub-plots, respectively. Every two contiguous shrubs were used as an experimental unit. Plant fresh weight, leaves and stems fresh and dry weights in kilograms and fresh leaf/ fresh stem ratio for each plant were recorded. One hundred gram samples of both leaves and stems fresh materials of individual plants were obtained and oven dried at 70°C to constant weight to determine dry weight. Additionally, plant height (m) and average foliage diameter (m) were recorded.

Data were subjected to statistical analysis and the means were compared using LSD test at 5% level according to Gomez and Gomez [11].

Results and Discussion

Data presented in Table 1 show the effects of both plant ages and stubble heights on growth characters of acacia during first cutting.

Table 1. Growth characters of acacia as affected by plant age (cutting season) and stubble height (first cut)

Treatments		Fresh weight (kg/pl.)			Dry weight (kg/pl.)		
Season of cut	Levels	Total	Leaves	Stems	Leaves	Stems	L/S
Plant ages (months)							
Summer	17	3.881	1.412	2.467	0.692	1.423	0.578
Fall	20	3.265	1.362	1.903	0.685	1.083	0.716
Winter	23	3.188	1.668	1.503	0.770	0.743	1.100
Spring	26	5.358	3.225	2.150	1.048	0.757	1.500
	LSD 5%	1.678	1.216	0.696	NS	0.338	0.540
Stubble heights (cm)							
	0	6.397	3.189	3.206	1.398	1.619	0.995
	30	4.357	2.082	2.273	0.834	1.153	0.926
	60	2.743	1.234	1.513	0.500	0.747	0.816
	90	2.197	1.163	1.031	0.464	0.487	1.128
	LSD 5%	0.575	0.317	0.445	0.176	0.258	0.294
	Mean	3.973	1.967	2.006	0.799	1.001	0.973

NS = No significant differences at 5% level.

1. Plant age and season of cut effects

Individual plant fresh weight significantly differed from season to another. The maximum average was associated with cutting after 26 months from transplanting date (5.358 kg/plant). This increase was not only related to delaying cutting up to 26 months but also to cutting during flourish growth season (sping), as plants received a lot of rain's water during late winter. Inversely, cutting at 20 months of age (early winter) produced the lowest individual fresh weight (3.188 kg/plant). This was mostly caused by loss of the majority of leaves and soft sprouts due to exhibiting plants to severe drought stress during summer and fall seasons.

Leaves fresh weight of each plant at 26 months of age (spring season) was significantly enhanced over other ages. Cutting at 17,20 and 23 months of age (summer, fall and winter seasons, respectively) were insignificantly different and ranged from 1.362 to 1.668 kg/plant. Vast disproportion between 20 and 26 months of age respecting leaves fresh weight existed. Varying water availability during the above two dates (fall and spring) is considered as an acceptable exegesis, so the soil was still saturated via late winter rains in case of harvesting at spring. Moreover, distinct water penury was evident with cutting in fall (20 months age) due to prolonging drought during summer and fall seasons.

Concerning stems fresh weight, marked adverse trend was noticed. Plants cut at 17 months of age (summer) yielded the highest average (2.467 kg/plant). The lowest weight was obtained at 23 months of age (1.503 kg/plant). Evidently, stems had less forfeiture than leaves in response to drought stress.

Leaves dry weight obtained through cutting at 26 months of age (in spring) insignificantly exceeded those of other seasons. Increments in leaves dry weight due to cutting in spring was not parallel to that in leaves fresh weight. It could be attributed to raising moisture content in leaves tissue during wet season.

Obviously, both fresh and dry leaves weight attained their maximum in spring (26 months of age) followed by cutting in winter (23 months of age), summer (17 months of age) and in fall (20 months of age), sequentially. It means that availability of water in season of cut was more limiting than plant age in respect to either fresh or dry leaves weight. It may be explained by reaching the culminated growth of leaves in spring, while leaf growth is stimulated during winter precipitation. In early summer, soil water deficiency begins to arise, whereupon leaves start to drop down, then denuded plants appear in fall due to long severe drought.

Stems dry weights take an opposite aforesaid trend. Plants harvested in summer and fall seasons (17 and 20 months of age) produced higher stems dry weight than those harvested in winter and spring (23 and 26 months of age). Hardness of stems and diminishing its moisture contents in dry seasons may set behind such increments.

Logically, fresh leaf/fresh stem ratio decreased due to losing more leaves as a result of extending dry season. Fresh leaf/fresh stem ratio attained its peak when cutting in spring (26 months of age) was considered. This ratio was approximately averaged 2.5 fold of summer cutting (17 months of age).

2. Stubble height effects

Results in Table 1 show the effects of stubble height on growth characters of acacia in the first cut.

Significant differences were detected among stubble heights respecting total fresh weight. Cutting at zero level produced the greatest plant fresh weight (6.397 kg/plant), while leaving 90 cm above ground surface as a stubble height reduced foilage yield to minimum (2.197 kg/plant). It means that the majority of biomass was lost by leaving taller stubble height.

Regarding leaves fresh weight, significant impacts were detected due to varying stubble heights. Iniquitous cutting (zero level) produced superior leaves fresh weight (3.189 kg/plant) followed by cutting at 30 cm stubble height (2.082 kg/plant), while 60 and 90 cm stubble heights came latter (1.234 and 1.163 kg/plant, respectively). It could be due to obtaining almost the whole leaves through cutting exactly above ground surface, while palpable amount of leaves was left with raising stubble height.

A noticeable decrement in stems fresh weight corresponded to stubble height augment. The distinguished average was associated with cutting at zero level because of obtaining all above ground woody parts, while leaving the majority of stems was necessary for cutting at 90 cm of ground surface.

Retarding leaves dry weight from 1.398 to 0.464 kg/plant (about 67% decrease) was significantly associated with raising stubble height from 0 to 90 cm, respectively. Simultaneously, stems dry weight showed similar aforesaid trend, but the reduction was about 70%.

Fresh leaf/fresh stem ratio varied from 0.816 to 1.128 by varying stubble height from 60 to 90 cm, respectively, whereas cutting at 0 and 30 cm stubble height averaged moderate values.

In conclusion, stubble height showed a perceptible role on foliage yield. Removing plants from exactly ground surface yielded the greatest leaves and fuelwood production. Moreover, cutting at the same level had no harmful effects on acacia regrowth as shown afterward.

3. Plant age (cutting season) × stubble height interaction effects

Taking interactions between plant age (cutting season) and stubble height into consideration, results in Table 2 indicate that considerable effects were realized among foliage fresh weight, and its components and stems dry weight. Both total

Table 2. Growth characters of acacia as affected by plant age (cutting season) × stubble height interactions (first cut)

Plant age (month)	Stubble ht.(cm)	Fresh weight (kg/pl.)			Dry weight (kg/pl.)		
		Total	Leaves	Stems	Leaves	Stems	L/S
17	0	6.867	2.133	4.733	1.133	2.873	0.45
(Summer)	30	3.967	1.633	2.333	0.750	1.370	0.62
	60	2.697	0.933	1.767	0.420	0.930	0.52
	90	1.993	0.950	1.033	0.460	0.517	0.91
20	0	4.800	2.100	2.700	1.060	1.486	0.77
(Fall)	30	3.433	1.261	2.167	0.637	1.243	0.55
	60	2.627	1.017	1.610	0.550	0.957	0.64
	90	2.200	1.067	1.133	0.493	0.643	0.94
23	0	5.080	3.023	2.057	1.557	0.963	1.74
(Winter)	30	3.930	1.793	2.123	0.756	1.150	0.84
	60	2.030	1.020	1.010	0.393	0.503	1.01
	90	1.660	0.837	0.823	0.373	0.357	1.02
26	0	8.830	5.500	3.333	1.840	1.058	1.65
(Spring)	30	6.100	3.633	2.467	1.193	0.850	1.47
	60	3.634	1.967	1.667	0.630	0.597	1.18
	90	2.933	1.800	1.133	0.530	0.430	1.58
LSD 5%		1.146	0.632	0.888	NS	0.513	NS

NS = No significant differences at 5% level.

individual plant weight and leaves weight reached their peak by cutting at 26 months of age (spring season) and zero stubble height (8.83 and 5.50 kg/plant, respectively). Adversely, the lowest averages of the above two characters corresponded to 23 months of age (winter season) × 90 cm stubble height interaction (1.660 and 0.837 kg/plant, respectively). Furthermore, cutting at ground surface level averaged the superior foliage yield followed by cutting at 30 cm stubble height within either cutting season. Fresh and dry stems weight attained their peak in summer (17 months of age) when plants were cut at ground surface (zero treatment). Insignificant differences were detected among fresh leaf/fresh stem ratio as influenced by interactions, but the greatest averages were estimated in spring season (26 months of age). It may be due to flourish growth in spring, particularly with leaves.

Virtually, it seemed that season of cut played a conspicuous role in browse productivity and plant characters of acacia due to corresponding to favorable precipitated rains. Most of the plant characters attained their peak in spring season at time when sufficient soil moisture was available. Leaves were defoliated in dry season due to indigent available water as a tool of drought resistance. A ridge-trench and open-pit sunken planting had a distinguished role in keeping water from rain for longer time. Cutting at ground surface was convenient for obtaining the greatest biomass.

In conclusion, rangelands development depends mainly upon the tangible receipt water, particularly under rained conditions. Precipitation (amount and distribution) is considered the major limiting factor in such development. However, if the rain drops adhere to the plant, it may evaporate, drip off, drain down stems to the soil or pass directly into leaves through the stomata or cuticle [12]. Plants start to grow vigorously in rainy season. Winter annuals disappear, while perennials dry out in dry seasons. Contrary to this result, Peterson *et al.* [13] found that preferential partitioning of dry matter to leaves occurred when forage legumes were subjected to water deficit.

Regarding convenient cutting date, considering season of usage as a base of suitable cutting date was preferable over taking absolute cutting intervals, particularly under such harsh environmental conditions. However, cutting in spring or early summer seasons produced feasible foliage yield of acacia, while delaying cutting up to severe dry season led to a decline in edible parts production. Simultaneously, cutting at zero level (from ground surface) tended to give superior forage and fuelwood yields. It means that *Acacia saligna* has a convenient ability to recover under any harmful level.

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دراسة إمكانية استخدام نبات الأكاسيا في تنمية المراعي المتدهورة تحت ظروف الحصاد المطري

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ملخص البحث. أجريت الدراسة لتقدير بعض صفات النمو والمحصول الغض والجاف لنبات *Acacia saligna* تحت الظروف المطرية (١٢٠مم/ سنة) في منطقة النجيلة بالساحل الشمالي الغربي بمصر ولمدة سنتين بهدف تقويم إمكانية استخدام هذا النبات لتحسين المراعي المتدهورة في المنطقة بالزراعة في حفر مع استخدام الحواجز الترابية في اتجاه الميول. وقد طبقت معاملات قطع النبات في أعمار ١٧ و٢٠ و٢٣ و٢٦ شهرًا من تاريخ الزراعة للحصول على القطعة الأولى. وقد كانت هذه التواريخ متزامنة مع مواسم الصيف والخريف والشتاء والربيع على التوالي. وفي الوقت نفسه كان ارتفاع القطع هو صفر و٣٠ و٦٠ و٩٠سم من فوق سطح الأرض في كل من الارتفاعات السابقة. وقد أظهرت النتائج مايلي:

١ ـ قطع النباتات بعد ٢٦ شهرًا من تاريخ الزراعة أعطي أعلى محصول غض وجاف وأفضل صفات النمو.

٢ ـ القطع من فوق سطح الأرض مباشرة (المعاملة صفر) كانت أفضل معاملات ارتفاع القطع.

٣ ـ اتخاذ موسم النمو لتحديد أنسب ميعاد للقطع كان أفضل من اتخاذ عمر النبات كأساس لذلك.

٤ ـ نبات *A. saligna* له قدرة عالية على إعادة النمو ومقاومة أي مستوى من القطع الجائر.