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Research Article

Effects of Different Plant Species and Different Sowing Dates on Forage Yield, Grazing Capacity and Estimated Carcass Weight in the Continental Climate Zones

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Abstract: This research was conducted to study the effects of artificial sowing with various plant species and different sowing dates on forage yield, grazing capacity and estimated carcass weight in rangelands under continental dry conditions. Artificial rangelands were established on Akpınar plateau near Kemer-Burdur 1675 m above sea level using 4 different plant species sown at 5 different sowing dates. Later, grazing capacity and carcass weight were estimated in terms of forage yield. The results showed that the best sowing date of alfalfa (*Medicago sativa* L.) was sowing date 4 (the last week of October) and 1447 cattle could graze in an area of 1800 ha over a 3-month grazing period. The best sowing date for sainfoin (*Onobrychis sativa* Lam.) was sowing date 1 (the last week of September) with a grazing capacity of 3178 cattle units. In smooth brome (*Bromus inermis* Leyss.), the best sowing was achieved at the sowing date 4 with 1575 cattle units. Unfortunately, bluegrass (*Poa pratensis* L.) did not yield any plant growth at any sowing date. The Akpınar rangeland presently has a grazing capacity of 208 cattle units. When this value is compared with the values mentioned above, it is clear that both grazing capacity and the amount of quality forage will be increased considerably by the reclamation of rangeland. At present, the estimated carcass weight of 57,200 kg will be increased to 873,950 kg when the rangeland is sown with sainfoin at sowing date 1 in the last week of September. It is obvious that grazing capacity and estimated carcass weight can be increased by rangeland improvement.

Key Words: Grazing capacity, sowing date, plant species, rangeland, carcass weight

Karasal İklime Sahip Bölgelerdeki Meralarda Farklı Bitki Türü ve Ekim Zamanlarının Yeşil Ot Verimi, Otlatma Kapasitesi ve Tahmini Karkas Ağırlığı Üzerine Etkileri

Özet: Bu araştırmada, kurak bölge koşullarındaki meralarda yapay tohumlama ile mera ıslahı çalışmalarında farklı kışlık ekim zamanları ve bitki türlerinin yeşil ot verimi, otlatma kapasitesi ve tahmini karkas ağırlığına etkileri incelenmiştir. Burdur-Kemer ilçesinde yer alan 1675 m rakımlı Akpınar yaylası merasında kışlık 5 farklı ekim zamanında 4 farklı bitki türü ile ayrı ayrı suni mera alanları oluşturulmuştur ve elde edilen yeşil ot verimine bakılarak otlatma kapasiteleri ve tahmini toplam karkas ağırlıkları hesaplanmıştır. Sonuçta yonca (*Medicago sativa* L.) ile tesis edilen alanda en iyi ekim zamanı 4. dönem (Ekim ayının son haftası) ve 3 aylık otlatma periyodunda 1800 ha'lık alanda otlayabilecek BBHB sayısı 1447; korungada (*Onobrychis sativa* Lam.) 1. ekim dönemi (Eylül ayının son haftası) ve 3178 BBHB; kılçıksız bromda (*Bromus inermis* Leyss.) ise 4. ekim dönemi ve 1575 BBHB sayısı elde edilmiştir. Çayır salkım otunda (*Poa pratensis* L.) ise hiçbir dönemde bitkisel gelişme olmamıştır. Meranın mevcut durumdaki otlatma kapasitesi 208 BBHB'dir. Bu sayı ile yukarıdaki değerler karşılaştırıldığında mera ıslah çalışmaları sonucunda hem otlatma kapasitesi hem de kaliteli kaba yem miktarının oldukça iyi düzeylere çıkartılacağı görülmektedir. Mevcut durumda elde edilen tahmini karkas ağırlığı 57.200 kg iken mera Eylül ayının son haftası olan 1. ekim döneminde korunga ile ıslah edildiğinde bu değer 873.950 kg olarak gerçekleşebilecektir. Bu durum mera ıslahı ile hem otlatma kapasitesinin hem de karkas ağırlığının arttırılabileceğini göstermektedir.

Anahtar Sözcükler: Otlatma kapasitesi, ekim zamanları, bitki türleri, mera, karkas ağırlığı

Introduction

A great proportion of rangelands in Turkey is in poor condition due to unplanned and excessive grazing, and insufficient precipitation (1). It is necessary to re-establish the rangelands by artificial methods where vegetation cover falls below 25% in order to improve both animal products and to feed the people of the country properly (2).

In Turkey, the best estimate of forage from rangelands is about 12-13 million tons and 3-4 million tons of forage is produced from all forage crops in total; therefore there is a shortage of approximately 10 million tons (3). In order to overcome this shortage, alternative solutions for rangelands and forage crops must be taken into account in the future strategies of animal feeding.

In particular, high quality and quantity forage is needed for high productivity of the cattle races and their hybrids imported from abroad, because the performance of ruminant animals on pasture, within the bounds of their genetic capability, is largely determined by digestible nutrient intake (4). This is because the shortage in quality forage leads to an increase in the consumption of concentrate feed and poor quality forage and therefore to higher cost and prices of animal products. Substitution of concentrate feed and poor quality forage-based diets in growing animals could reduce feeding costs (5,6).

Taking into consideration the fact that most of the rangelands exist in the continental climate zone in Turkey, forage crop seeds were sown in the Akpınar rangeland in the study.

The main aim of this study was to determine the most suitable sowing dates of plant species to be used in rangeland management and to assess the grazing capacity and estimated carcass weights of animals grazing under these conditions.

Materials and Methods

This research was carried out in Tahtalıbaşı in the Akpınar rangeland near Kemer-Burdur, 1675 m above sea level. Total grazing land is 1800 ha. The experimental site was located on a slope of 10-12%. Soil in the experimental site was sandy-clay loam in texture (Soil Laboratories-Antalya, Ministry of Forests) with acidity pH 7.73, $CaCO_3$ content 1-13%, organic matter 6.8%, salinity 0.4 mmhos/cm, and Na content 0.22 (me/100 g soil).

Meteorological data are given in Table 1 for the experimental period starting from the establishment of the experiments and ending with the harvest of forage plants. Differences between years are obvious in all climatic data. The region is characterized by cold and wet winters, and hot and dry summers. For instance, a considerable amount of rainfall is received during the fall and winter. Rainfall, number of rain days and temperature considerably affected plant growth and development.

In the experiments 2 leguminosae species, alfalfa and sainfoin (*Medicago sativa* L. and *Onobrychis sativa* Lam.), and 2 gramineae species, smooth brome and bluegrass (*Bromus inermis* Leyss. and *Poa pratensis* L.), were used as the plant materials. The experiments were conducted according to randomized complete block design with 3 replications over 3 years. Experimental plots were 2 x 3

Table 1. Monthly average climate data during the conducted the experiment period.*

	Precipitation Amount (mm)			Average Temperature (°C)			Relative Moisture (%)			Number of Rainy Days		
Months	1999	2000	2001	1999	2000	2001	1999	2000	2001	1999	2000	2001
January	-	34.8	31.3	-	1.3	4.5	-	71	74	-	12	6
February	-	35.1	30.2	-	2.1	4.7	-	69	68	-	8	11
March	-	42.1	19.0	-	5.1	12.1	-	62	57	-	7	6
April	-	73.9	48.1	-	12.3	11.8	-	66	64	-	12	12
May	-	84.1	61.1	-	15.7	16.0	-	63	59	-	14	12
June	-	17.8	2.3	-	21.3	22.9	-	50	52	-	2	3
July	-	1.3	28.7	-	26.6	26.6	-	43	45	-	1	3
August	-	2.6	-	-	24.5	-	-	48	-	-	1	-
September	21.4	35.5	-	19.6	19.5	-	55	56	-	5	3	-
October	13.0	10.6	-	15.2	13.3	-	64	61	-	3	6	-
November	4.6	57.7	-	9.2	9.8	-	63	61	-	3	3	-
December	29.4	49.4	-	6.0	4.1	-	75	74	-	6	7	

*Turkish State Meteorological Service, Burdur Meteorology Station

m, with 40 cm spacing. Spacing was wider in arid areas in comparison with wet areas in order to reduce the competition between plants in terms of moisture, temperature, light and plant nutrition (7,8).

Seeds were sown in winter on 5 different dates as follows:

1. Sowing date: September 20
2. Sowing date: October 1
3. Sowing date: October 11
4. Sowing date: October 24
5. Sowing date: November 15

Six kg ha^{-1} N and four kg da^{-1} P_2O_5 were used during the sowing as fertilizer. Plants were grown in natural conditions without any irrigation. The harvesting time was determined for all plant species when alfalfa flowering was 10% at each sowing date.

Half of the harvested green forage was regarded as usable forage. It is necessary to leave half of the total forage harvest on the ground while the other half is consumed by the livestock in arid and semi-arid regions (9). Determination of grazing capacity was based on these values of usable forage. The grazing capacity of the Akpınar rangeland was determined for the present situation and the sowing period by multiplication of unit area values by the total area. The covered area with vegetation was measured by the transect method in 14 different areas of the Akpınar rangeland, and each area received 10 transects.

Determination of grazing capacity was based on a cattle unit of 500 kg live-weight (10), a daily forage consumption of 1/10 animal weight (50 kg d^{-1}) (9), and a 3 month-grazing period (90 days, routine in the region).

Estimated carcass weights were calculated as follows:

A: grazing capacity

B: a cattle unit of 500 kg live-weight

C: carcass ratio (55%) (11,12)

Estimated carcass weights = A x B x C

Results

The overall average plant cover was 18.8%. The forage yield was determined to be 261.3 kg ha^{-1} by the method of cutting, and grazing capacity was 208 cattle units for the Akpınar rangeland.

Results of forage yield and grazing capacity of artificially established grazing land for plant species and estimated carcass weight are shown in Table 2.

When each plant was compared in terms of sowing dates, the best sowing date was sowing date 4. (24 October) (grazing capacity = 1447 cattle units; estimated carcass weight = 379,925 kg) for alfalfa and (grazing capacity = 1575 cattle units; estimated carcass weight = 433,125 kg) for smooth brome and sowing date 1 (20 September) (grazing capacity = 3178 cattle units; estimated carcass weight = 873,959 kg) for sainfoin, whereas sowing date 5 (15 November) for alfalfa and

Table 2. Forage yield, grazing capacity for 3 months and estimated carcass weight of plant species used for artificial range improvement in Akpinar rangeland at different sowing dates.

	Plant Species								
	Alfalfa			Sainfoin			Smooth Brome		
Sowing Dates	Forage Yield (kg ha^{-1}) ± $s_{\bar{x}}$	Grazing Capacity (Cattle Unit)	Total Estimated Carcass Weight (kg)	Forage Yield (kg ha^{-1}) ± $s_{\bar{x}}$	Grazing Capacity (Cattle Unit)	Total Estimated Carcass Weight (kg)	Forage Yield (kg ha^{-1}) ± $s_{\bar{x}}$	Grazing Capacity (Cattle Unit)	Total Estimated Carcass Weight (kg)
1	5678^{ab*} ± 86.46	1135	312125	15890^{a} ± 153.8	3178	873950	7388^{a} ± 19.92	1477	406175
2	4863^{ab} ± 86.46	972	267300	8953^{b} ± 153.8	1790	492250	6095^{b} ± 19.92	1219	335225
3	5222^{ab} ± 86.46	1044	287100	6222^{b} ± 153.8	1244	342100	3740^{c} ± 19.92	748	205700
4	7238^{a} ± 86.46	1447	379925	11220^{ab} ± 153.8	2244	617100	7875^{a} ± 19.92	1575	433125
5	3873^{b} ± 86.46	774	212850	7410^{b} ± 153.8	1482	224153	3058^{d} ± 19.92	611	168025
Mean	5375	1075	295625	9939	1988	546700	5631	1126	309650

*Means followed by the same letters are not significantly different based on a Duncan test ($P \leq 0.05$)

smooth brome and sowing date 3 (11 October) for sainfoin were found not to be suitable for the region. The results also showed that the values of all plant species were higher than those of the present situation of the rangeland. In particular, artificial seeding would give better results in rangelands with low measurements of vegetation coverage.

As shown in Table 2, average grazing capacity was 1075 cattle units for alfalfa, 1988 cattle units for sainfoin and 1126 cattle units for smooth brome. Sainfoin was found to be the most suitable plant for use in further rangeland improvement studies in the region, because the highest average forage yield (9,939 kg ha^{-1}), grazing capacity (1988 cattle units) and estimated carcass weight (546,700 kg) were obtained with sainfoin, followed by smooth brome and alfalfa.

The results indicated that when the plants were sown during the most suitable period, forage production increased considerably, resulting in an increase in grazing capacity and estimated carcass weights (Table 2).

Discussion

The forage yield values for all plant species are regarded to be satisfactory for such dry conditions as those in the experimental area. For example, Gençkan (13) reported that the green forage yield of sainfoin was 10,000 kg ha^{-1} for 1 cutting in arid conditions.

When the best sowing date is determined for plant species, the grazing capacity is increased for a 1800 ha grazing area for a 3-month grazing period. Because optimum grazing capacity is dependent on herbage mass, there was a quadratic relationship between forage allowance and average daily gain on pasture (14). The actual forage yield of the Akpınar rangeland is 261.3 kg ha^{-1} based on the method of cutting. For this reason, only 208 cattle units can graze on the rangeland; but this value is increased to 1447 cattle units by sowing of alfalfa in the last week of October. Likewise, grazing capacity can be increased to 3178 cattle units for sainfoin, and 1575 cattle units for smooth brome. As a result of such increases in the grazing capacity, 2970 (= 3178-208) more cattle units would be grazed if the rangeland were sown with sainfoin on the best sowing date. It is clear that the grazing capacity can be increased greatly by the application of rangeland improvement projects in Turkey, where 29% of the total land is covered by rangelands. This, in turn, will not only enhance the economic level and living standard of farmers, but also will help to reduce the importation of animal products. The importance of rangeland improvement is better understood when considering the fact that cultured animal races are not properly fed with sufficient forage.

It is reported that 550 kg of a 1000 kg cow is carcass, 147 kg is hide and other secondary products and 303 kg is material with no use (11). Similarly, Kumlu (12) reported that 274 kg of a 500 kg Holstein cow slaughtered at the age of 16 months was bone structure. Although the carcass weight proportion of the total weight depends on the race, age etc. of the animal, it generally varies in the range of 55-60%.

In the light of the information given above, the actual grazing capacity of 208 cattle units can produce 57,200 kg carcass weight in total. According to the records of the State Agriculture Office based in Antalya, carcass price was 4 million Turkish liras (TL) kg^{-1} in 2000 at the slaughterhouse. Therefore, 228.8 billion TL can be raised by meat sales. On the other hand, provided that 1800 ha of Akpınar rangeland is artificially sown with sainfoin on an optimum date, the grazing capacity would be increased to 3178 cattle units. This would fetch 3500 billion TL and an increase in income of 3300 billion TL would be added to the regional economy and therefore would enhance the local farmers' living standards (the same estimates were calculated for other plants used in study). However, the indicated increase was a result of increased grazing capacity. Carcass weight would also increase because the botanical composition of an improved rangeland comprises quality plants. It is known that inadequate intake of essential nutrients causes some deficiency symptoms and these symptoms persist even though other nutrients' consumption exceeds necessity (15). If nutrients are inadequate in the diet, necessities could be provided by greater amounts of forage or supplemental feed (16). Of course, all rangelands in the country cannot be improved at once. Rangelands must be improved step by step in order to achieve progress in animal farming and to allow meat in sufficient quantity to be produced and put on the market at reasonable prices. Although Karataş (17) stated that artificial rangeland establishment and management systems would establish 2,649,514 ha of rangelands, this has not been achieved. Cinemre et al. (18) reported that the yield increase in beef production was 0.2% between 1992 and 2000 worldwide and they

also stated that demands for food are related to population increases and increases in capital income. It is estimated that food prices will be higher in Turkey than average world food prices after 2050.

This research highlights the importance of range improvement and proper selection of plant species and sowing date in animal farming and animal production.

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