Sowing date effects on yield of three winter forage crops in the northern oasis of Mendoza

Efecto de la fecha de siembra en el rendimiento de tres verdeos invernales en el oasis norte de Mendoza

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Abstract

The increasing livestock farming in the province of Mendoza requests the acquisition of further knowledge on winter forage crops, annual grasses that produce a large volume of good quality biomass in a short time. The most widely used winter forage crops in Argentina are oats, rye and barley. To assess forage productivity in the northern oasis of Mendoza, an experimental factorial design combined 2 sowing dates (March 21, 2019, and April 29, 2019) and three winter forage crops: oats (Blanca Cristal INTA), rye (Lisandro INTA) and barley (Alicia INTA). Results showed no interaction between sowing dates and forage species. March sowing date was 27% more productive and offered a longer grazing period than April sowing (more than five months in March sowing and more than one month in April sowing). Oat showed the highest yield, differing significantly from rye and barley.

Keywords
Avena sativa • *Secale cereale* • *Hordeum vulgare*

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Resumen

La intensificación de la producción animal en la provincia de Mendoza requiere ampliar el estudio de recursos forrajeros. Los verdeos de invierno son gramíneas anuales que producen gran volumen de forraje de buena calidad, y son importantes en las cadenas forrajeras desde comienzos de otoño hasta avanzada la primavera. En Argentina, los verdeos invernales más utilizados son: avena, centeno y cebada. En el oasis norte de Mendoza, se planteó un experimento factorial combinando 2 fechas de siembra (21 de marzo de 2019 y 29 de abril de 2019) y los tres verdeos invernales: avena (Blanca Cristal INTA), centeno (Lisandro INTA) y cebada (Alicia INTA). No hubo interacción entre fechas de siembra y especies de verdeos invernales. La primera fecha de siembra resultó un 27% más productiva y su ventana de aprovechamiento fue mayor que en la segunda; resultando de más de cinco meses en la siembra de marzo y de un mes en la siembra de abril. La avena fue el cultivo con mayor producción, diferenciándose significativamente del centeno y la cebada.

Palabras clave
Avena sativa • *Secale cereale* • *Hordeum vulgare*

Introduction

Winter forage crops are annual grasses that produce a large volume of good-quality biomass in a short time. They play an important role in the forage chains from early autumn to late spring, when perennial cultivated or natural pastures show low forage availability (1, 9). Thus, given high seasonal production, winter forage crops are one efficient resource to be supplemented with perennial pastures, besides supporting stable forage production all year round (6). In addition, given they extend the grazing season through winter, they constitute an economically valuable alternative to the generally more expensive reserves (hay or silage).

According to the Ministerio de Agricultura, Ganadería y Pesca de Argentina, the most widely used winter forage crops in Argentina are oats (*Avena sativa*), barley (*Hordeum vulgare*) and rye (*Secale cereale*)(4). The average cultivated area during the 2020 campaign was: 1,405,535 ha of oats; 1,237,023 ha of barley and 667,809 ha of rye. These numbers represent the total planted area (hectares) regardless of whether they are harvested, grazed or two-fold purpose (8). Livestock migration to extra-pampean regions after the intrusion of agriculture has allowed Mendoza to develop intensive livestock farming activities.

The available information on forage crops in the irrigated oases of Mendoza is scarce. In the last years, some studies on alfalfa (12), corn and sorghum silages (5, 13) were reported. In this sense, determining the best sowing date is key for forage production. Records from different cultivated areas of the country show that, in general, early sowing of winter forage crops results in more productivity (1, 3, 10), However, species production potential may vary among environments (11). Given this situation and aiming to generate information on winter forage production in the northern oasis of the Mendoza Province, the following hypotheses were formulated: depending on the species (oats, rye, barley), early sowings (March) produce higher forage yields than late sowings (April).

Materials and methods

The experiment was conducted at the San Antonio farm of the Facultad de Ciencias Agrarias, Universidad Nacional de Cuyo, at 33°00'38" S and 68°52'28" W, on poorly developed alluvial silt loam soil. Mean annual temperature is 16.5°C, average relative humidity is 50% and average annual rainfall is 225 mm. Table 1 (page 34) shows monthly mean, minimum and maximum temperatures during the forage growing period:

Table 1. Monthly mean, minimum and maximum temperatures in degrees Celsius, from March to November 2019, Luján de Cuyo, Mendoza.

Tabla 1. Temperaturas medias, mínimas y máximas mensuales en grados centígrados, de marzo a Noviembre 2019, Luján de Cuyo, Mendoza.

	March	April	May	June	July	August	September	October	November
Mean T (°C)	17.6	16.1	10.6	7.6	7.1	9.1	11.9	15.1	21.4
Minimum T (°C)	11.3	9.1	5	0.7	0.1	1.1	4.2	7.7	14.7
Maximum T (°C)	24	23.1	16.2	14.6	15.2	17.2	19.6	22.4	28.2

The factorial experimental design was conducted in random blocks with 3 replications on 18 experimental plots: Two sowing dates (March 21, 2019, and April 29, 2019) for 3 winter forage crops: oats (Blanca Cristal INTA), rye (Lisandro INTA) and barley (Alicia INTA), and 3 replications per treatment. Table 2 shows crop management. Ten m^2 experimental plots (ten rows, 5m long and spaced 0.20 m), were sowed at a rate of 250 pl/m^2 (1, 3, 4, 9). Cuts were made at 40 cm forage height (ensuring appropriate plant anchorage and coverage between rows), leaving a remnant of 10 cm. Forage fresh weight was determined after each cut. Then, the percentage of oven-dried dry matter (% MS) was obtained at 60°C with forced-air circulation (on a 200 g sample). Finally, forage production per surface unit (kg DM/ha) was calculated. Each treatment was cut as many times as possible. At the end of the growing season, accumulated dry matter was determined.

Table 2. Crop management of experimental plots.

Tabla 2. Manejo de las parcelas experimentales.

	First sowing	Second sowing
Soil preparation	2 harrowing operations	2 harrowing operations
Sowing date	3/21/2019	4/29/2019
Fertilization	At-sowing fertilizer 150 kg/ha of 18-46-0	At-sowing fertilizer 150 kg/ha of 18-46-0
Irrigation	8 irrigations of 30 mm= 240 mm Rainfall: 83.7 mm Total: 313.7 mm	7 irrigations of 30 mm= 210 mm Rainfall: 77.6 mm Total: 287.6 mm

Data on accumulated dry matter (kg) were analyzed through ANOVA and mean comparison (Tukey test) with Infostat, student's version (2).

Results and discussion

Sowing date and species showed no interaction (p=0.9990). March sowings were significantly more productive (p=0.0017) than April sowings. In turn, considering annual kg of dry matter/ha, oat was significantly different (p=0.0037) from rye and barley (table 3, page 35). Previous studies at INTA EEA Barnetche have also shown more productive early sowings (late February/early March), than late sowings (end of March). However, they identified barley as the most productive crop (10) while our results show oats yielding the highest dry matter. Another study conducted by INTA EEA General Villegas found no differences in dry mass accumulation among barley, triticale, oats, wheat and rye (7).

Table 3. Accumulated forage biomass (kg DM/ha/year), number of cuts, sowing to first grazing (days), availability period for grazing and days of use for oats, rye and barley during a productive cycle, 2019.

Tabla 3. Biomasa forrajera acumulada (kg MS/ha/año), número de cortes, siembra a primer pastoreo (días), período de disponibilidad para pastoreo y días de uso para avena, centeno y cebada, ciclo 2019.

	Species	Kg DM/ha year	Number of cuts	Sowing to first grazing (days)	Availability period for grazing	Days of use
First sowing 3/21/2019	Oat	7646.4 **a**	4	68	5/28 to 11/14	170
	Rye	5668.2 **b**	6	77	6/6 to 11/14	161
	Barley	5682.1 **b**	4	57	5/17 to 10/29	165
First sowing average		**6332.2 A**				**165**
Second sowing 4/29/2019	Oat	6217.5 **a**	2	155	1/10 al 29/10	28
	Rye	3524.5 **b**	4	127	3/9 al 14/11	41
	Barley	4206.5 **b**	2	150	26/9 al 22/10	26
Second sowing average		4649.5 **B**				**32**

Means in capital letters indicate significant differences among sowing dates ($p<0.05$).

Means in lowercase letters indicate significant differences among species ($p<0.05$).

Medias en mayúsculas indican diferencias significativas entre fechas de siembra ($p<0,05$).

Medias en minúsculas indican diferencias significativas entre especies ($p<0,05$).

The number of cuts obtained (table 3) in each species differed from other growing sites in Argentina. Experiences at INTA Manfredi report 4 to 5 cuts for oat cultivars and 3 cuts for rye cultivars (14). In this sense, local studies are especially relevant since environment and crop management might condition productive performance. Special emphasis lies on cutting time since such a decision may affect yield. In this study, cutting was made at 40 cm plant height, while in Manfredi, cuts were made at 25-30 cm plant height.

On the other hand, the number of days from sowing to grazing was lower in March than in April (table 3), meaning that for earlier sowings, the first grazing can occur earlier, as observed in Alto Valle de Río Negro (3) and Bordenave, Province of Buenos Aires (15).

Concerning forage availability period for grazing purposes, sowing in March provides forage between May and October/November, depending on the species, while if sowing occurs during the second half of April, the first grazing can occur in early September. Considering forage availability periods of early sowed crops, they may constitute an alternative to dormant alfalfa, from late April/early May to late October/early November.

Table 4 (page 36) shows cutting dates and yield for each treatment. For the March sowing date, barley was the most precocious forage, first cut on May 17, agreeing with the results obtained in Bolívar, Buenos Aires, where barley also resulted to be the most precocious species (10). By contrast, during April sowing, the most precocious forage was rye, first cut on September 3. On both sowing dates, rye production remained steady until mid-November. It should be pointed out that the cutting criteria adopted in this paper, only considering forage height, may have influenced the results obtained since such height could be related to different phonological stages of forage crops.

Table 4. Cutting dates and dry matter obtained from each forage crop, 2019.
Tabla 4. Fechas de corte y materia seca obtenida de cada verdeo invernal, 2019.

		First sowing 3/21			Second sowing 4/29		
		Oats	**Rye**	**Barley**	Oats	**Rye**	**Barley**
Cut 1	**Date**	**28-may**	**6-jun**	**17-may**	**1-oct**	**3-sept**	**26-sept**
	kg DM/ha	1494.2	1128.1	1568.1	4974.2	1728.2	3429.2
Cut 2	Date	26-sept	1-ago	12-sept	29-oct	1-oct	22-oct
	kg DM/ha	4903.9	863.33	2871.68	1243.4	968.0	777.27
Cut 3	Date	22-oct	3-sept	10-oct		22-oct	
	kg DM/ha	792.2	2589.6	1032.8		475.9	
Cut 4	Date	14-nov	26-sept	29-oct		14-nov	
	kg DM/ha	456.2	422.98	209.47		352.4	
Cut 5	Date		22-oct				
	kg DM/ha		356.23				
Cut 6	Date		14-nov				
	kg DM/ha		307.97				

Conclusions

Early sowings (March) yielded more forage than late sowings (April) in all three species. Forage availability period for grazing purposes, as well as cutting number, was higher for March sowings.

Considering environmental effects and the adopted cutting criterion, oats yielded more forage during both sowing dates.

The obtained results show that winter forage crops could constitute a forage resource for livestock systems in Mendoza, which could be complemented with alfalfa.

Future studies should compare cultivars and cutting criteria, and include forage quality determinations.

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