

Effect of seeding rates of oats (*Avena sativa* L.), wheat (*Triticum aestivum* L.) and common vetch (*Vicia sativa* L.) on the yield, botanic composition and nutritive value of the mixture

M.P. Castro¹, F. Sau², J. Piñeiro¹

¹Centro de Investigacións Agrarias de Mabegondo. Xunta de Galicia
Apartado 10. 15080 A Coruña, Spain ²Escola Politécnica Superior 27002 Lugo, Spain

Summary - Seven seeding rates were sown, ranging from oats and wheat monoculture (300-0) to vetch monoculture (0-300), following a changing series scheme, with a total (cereal+vetch) of 300 viable seeds m⁻² as objective in each treatment. Yield was measured in April 1998 with the oats at heading, wheat at beginning of heading, and the vetch at preflowering stage. Botanical analysis showed more weeds in the vetch and cereal monoculture plot and more vetch in the wheat-vetch mixtures. The increase of the relative number of vetch seeds at sowing lead to highly significant decreasing yields harvested that were 9, 7 and 4 t/ha of dry matter for oats, wheat and vetch monoculture respectively, more crude protein content (8 and 12 to 20 for oats, wheat and vetch monocultures), and highly significant decrease of acid and neutral detergent fibers and organic matter contents.

Key- words: winter forage, dry matter yield, mixtures

Résumé - Afin d'étudier l'effet de la dose relative de semis de l'avoine, du blé et de la vesce commune sur le rendement et la qualité du fourrage, sept doses de semis ont été employées allant de la monoculture de l'avoine ou du blé (300-0 semences m⁻²) à la monoculture de la vesce (0-300), en suivant un schéma variable, avec une dose objectif totale (céréale+vesce), pour chacun des traitements, de 300 semences viables m⁻². Les rendements ont été mesurés au stage montaison de l'avoine, début de montaison du blé et préfloraison de la vesce. L'analyse botanique a montré que les mauvaises herbes étaient plus abondantes dans les parcelles de monoculture (céréale ou vesce) et qu'il y avait plus de vesce dans les mélanges blé-vesce. L'augmentation de la proportion de semences de vesce dans le mélange a conduit à une diminution très significative des rendements en matière sèche récoltés, qui furent de 9, 7 et 4 t ha⁻¹ pour les monocultures d'avoine, de blé et de vesce, respectivement, plus de protéine (8, 12 et 20% pour l'avoine, le blé et la vesce en monoculture), et une diminution très significative des fibres acides et neutres détergent, ainsi que du contenu en matière organique.

Mots-clés: fourrage d'hiver, matière sèche, mélange

Introduction

Cereals as rye and oats were traditionally used at dairy farms in the humid areas of Northwestern Spain (Galicia) for green forage production in winter or early spring. In order to improve their nutritive value some attempts were made to use oats mixed with common vetch at farm level with varied results. There is some information about the oats-vetch mixture (Lloveras, 1984; Alba, 1994; Castro y Piñeiro, 1998) which shows the variability of the mixture that tends to give low protein content due to the presence of the oats. The forage yield of the oats-vetch mixture crop may vary according to the seeding rates (Tavares, 1986; Roberts *et al.*, 1989) so it is important to study this factor in detail. Replacing oats by a short lodging resistant wheat variety can improve the protein content. This are the reasons why both cereals are used in this trial.

Materials and methods

Location, climate and soil

A field trial was conducted from September 1997 to April 1998 at the Agricultural Research Center of Mabegondo, Abegondo, near A Coruña (Galicia, Spain). Climatic type is temperate-Mediterranean, according with the agroecological classification of Papadakis. Average mean temperature and monthly rainfall during the growing season are shown in Table 1.

Table 1. Average air mean temperature (°C) and monthly rainfall (mm) during the growing season Mabegondo 1997-98.

	Oct	Nov	Dec	Jan	Febr	March	April	May	Jun	Jul	Aug	Sep
Temperature	15.9	12.5	9.7	9.6	10.0	11.0	10.1	13.8	16.2	17.4	19.3	17.8
Rainfall	99	222	166	81	27	31	303	76	57	47	0	75

The soil is sandy loam, developed from "Ordenes schists" and more than 60 cm deep. The soil analysis, previous sowing, showed the following results: pH (H₂O) = 5.3; Al saturation in change complex: 4%; assimilate elements (ppm) = P (18.6) and K(200); organic matter = 4.2%.

Cultivation, lime, fertilizers and varieties

Cultivation included ploughing, disk harrowing and seed bed preparation. Ground limestone and fertilizers were applied: 3 t ha⁻¹ of CaCO₃, and 100-100 kg ha⁻¹ of P₂O₅-K₂O. The trial was sown at the end of October by an experimental drill with rows 15 cm apart. The cultivars of each species were : *Avena sativa* L. cv. 'Previsión', *Triticum aestivum* L. cv. 'Alcotán' and *Vicia sativa* L. cv. 'Jaga'. 50 kg N ha⁻¹ were applied in February 1998.

Treatments and experimental design

A split-plot design with six replicates was used. The cereals, oats or wheat, were the main plots and the seven seeding-rates of oats-vetch and wheat-vetch mixtures the subplots. Subplot size was 6.75m x 3m. The seeding rates of oats-vetch and wheat-vetch mixtures were made following a changing series scheme (Tavares, 1986) : 300-0, 225-75, 180-120, 150-150, 120-180, 75-225 and 0-300 viable seeds m⁻² of oats-vetch or wheat-vetch. In January 1998, 30 countings were made in each subplot using an 0.1m x 0.1m square in order to determine plant density. The seeds established per m² were: 210-0, 185-88, 156-110, 131-159, 112-182, 78-217, 0-327 for oats-vetch, and: 163-0, 163-83, 161-130, 146-165, 92-184, 74-216, 0-303 for wheat-vetch.

Sampling and chemical analysis

At the end of April, the yield was estimated by harvesting a central strip of 1.20 m x 6.45 m with a sickle bar power mower. A sample of approximately 2 kg was taken from each subplot, cut into 5 cm length pieces. Of this 400 g were forced air dried at 80 °C for 17 hours for dry matter content (DM) determination, ground in Christy & Norris mill to pass a 1 mm screen and analyzed for quality constituents with Near Infrared Reflectance Spectroscopy: crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF) and organic matter (OM) with specific calibrations (unpublished data). A second subsample was collected and separated by hand into cereal (oats or wheat), vetch, weeds and dead matter.

An area of 0.48 m² of the remaining forage was manually cut per subplot with electric driven shears, in order to evaluate the unharvested yield due to lodging.

Results and discussion

Dry matter production

Lodging led to yield losses between 3.21 and 1.1 t ha⁻¹ DM for vetch and wheat monocultures, when harvested with a sickle bar power mower, as Table 2 shows, where two yield types are distinguished: 1) Harvested yield (HY) and 2) Total yield (TY), which adds to the HY by the power mower the forage harvested manually with electric shears.

The percentage of harvested yield over total yield ranged from 55%, for the vetch monoculture to 90% for oats monoculture. These results are lower than those obtained by Castro and Piñeiro (1998) with the same sowing rates and similar TY that were sown in December of 1996. The earlier sowing of the present trial allowed a better vetch growth in a mild autumn and winter, at a time where the cereals were not developed to protect the vetch from lodging. The association of vetch with oats or wheat led to a significant decrease on HY of 3.8 and 2.5 t ha⁻¹ for the mixtures with the lowest vetch seed rate (25%) and of 4.6 and 3.1 t ha⁻¹ for mixtures with highest vetch seed rate (75%) compared to the oats and wheat monocultures, respectively. In the previous experiment, sown later in December, Castro and Piñeiro (1998) did not find significant differences between a pure crop of oats and mixtures with 25 to 40 % vetch seeds. Similar results were obtained by Ouknider and Jacquard (1986), who found that the yield of oats-vetch association and of oats monoculture were similar, with evidence of interannual variability due to climatic factors. Roberts *et al.* (1989) mixed 324 viable seeds m⁻² of wheat with four hairy vetch seeding rates from 0 to 162 viable seeds m⁻² and found that DM yield decreased 11% for highest vetch seeding rate compared with pure crop of wheat. They also found some evidence that the contribution of vetch to yield was related to weather conditions.

All the mixtures oats-vetch were more productive than those of wheat-vetch, specially those with less proportion of vetch in seeding rates.

Regarding to the botanic composition of harvested forage (Table 2), if we compare all of the seeding rates, but if monocultures are excluded, the differences are not statistically different. The cereal proportion in dry weight are lower than those obtained by López Goicoechea and Caballero (1980) for wheat cultivars and similar for oats cultivars. They are also lower than those given by Castro and Piñeiro (1998) for the higher oats seeding rates, due to the better vetch growth in the present trial that led to lodging and the vetch flattened the cereal, specially the wheat, which is shorter. The dead matter contents, not shown in Table 2, with a 6% maximum at pure crop of vetch, were lower than those by Castro and Piñeiro (1998) because of lower harvested forage percentage. Most of the dead matter was in the forage left unharvested. The weeds, mainly *Raphanus raphanistrum*, L. were more abundant in the vetch monoculture.

Forage quality

Nitrogen content in the mixture depends not only on vetch content at harvest time but also on nitrogen content of the associated cereal (Ouknider and Jacquard, 1986). Crude protein content in the wheat-vetch mixtures was significantly higher than in the oats-vetch mixtures (Table 2). It was due to the higher CP content of the wheat in relation to the oats, also found by Demarquilly (1970) and Lawes and Jones (1971), and, overall, to the higher vetch proportion in wheat-vetch mixtures.

Crude protein concentration in oats-vetch and wheat-vetch mixtures increased with increasing vetch seeding rate, while ADF, NDF and OM content decreased (Table 2). The N

contents were greater and FAD, FND and MO contents lower than those reported by Castro and Piñeiro (1998) due to the higher content in vetch of the harvested forage, and to the fact that more leafy material was harvested because of lodging. The high proportion of *Raphanus raphanistrum* L. within the weeds, cruciferous plant with high protein content (Castro y González, 1997) increased also the N content of the harvested forage.

Table 2. Harvested Yield (HY) and Total Yield (TY), t ha⁻¹ of Dry Matter (DM); Crude Protein (CP), Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), Organic Matter (OM), as percentage of DM; and percentage of vetch (V), cereal (C) and weeds (W) on dry matter basis.

Plants density		HY		TY		CP		ADF		NDF		OM		O-V			T-V		
O-V	T-V	O-V	T-V	O-V	T-V	O-V	T-V	O-V	T-V	O-V	T-V	O-V	T-V	%C	%V	%W	%C	%V	%W
210-0	163-0	9.35	7.2 a	10.4	8.3	8.2	11.8	36.6	37.4	63.5	58.3	95.0	92.8	81	-	16	73	-	22
		a		a															
185-88	163-83	5.55	4.7	8.75	7.7	14.6	17.8	33.9	33.2	52.9	46.6	92.9	91.5	52	34	13	25	51	18
		b		b															
156-110	161-130	5.13	4.6	8.40	7.3	15.7	17.9	32.7	32.1	49.5	45.3	92.6	91.4	53	32	12	16	63	16
		bc		b															
131-159	146-145	5.22	4.3	7.92	6.8	17.4	18.1	32.8	33.2	47.8	45.4	92.2	90.7	51	41	5	21	58	16
		bc		bc															
112-182	92-184	4.48	4.2	7.75	7.3	16.5	18.6	31.2	32.0	48.4	43.9	91.9	90.7	43	49	6	15	65	17
		dc		bc															
78-217	74-216	4.76	4.1	7.15	7.1	15.4	19.7	31.1	31.4	49.1	42.5	92.5	90.4	48	47	3	18	60	18
		dc		c															
0-327	0-303	4.16	3.9	6.84	7.2	19.8	20.4	30.8	31.3	41.9	41.1	91.5	90.3	-	64	33		62	33
		d		c															

Statistical significance																			
C		***		**		***		N.S.		***		***		***					***
D		***		***		***		***		***		***		***					***
C*D		N.S.		N.S.		N.S.		N.S.		N.S.		N.S.		N.S.					N.S.
CV (%)		15.45		13.18		8.8		4.55		5.48		0.86							

Values within a column followed by the same letter are not different (P<=0.05) by LSD test. O-V=oats-vetch T-V=wheat-vetch, C=cereal, D=sowing-rates. ***,** significative P<0.001 and P<0.01 N.S. non significative P>0.05.

Conclusions

Oats, harvested at heading, gave a higher dry matter yield and had a lower protein content and a higher neutral detergent fiber content than wheat, harvested at the beginning of heading.

Dry matter yield of oats-vetch mixtures was higher than that of wheat-vetch mixtures, specially in mixtures which lower percentage of vetch.

Forage of oats-vetch mixtures showed greater neutral detergent fiber and organic matter content, but lower crude protein content than wheat-vetch mixtures because of lower vetch percentage in the mixture.

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