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Yield and nutritive value of cereal-legume forage mixtures as an alternative to Italian ryegrass used as a winter crop in Galicia (NW Spain)

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Abstract. The aim of the present work was to transfer to dairy farms research results achieved during the last eight years on mixtures made of triticale (x *Triticosecale* Wittm.) and pea (*Pisum sativum* L.) (t-p), triticale and vetch (*Vicia sativa* L.) (t-v) and triticale and fava bean (*Vicia faba* L.) (t-f) to be compared with Italian ryegrass (*Lolium multiflorum* L.) as the winter phase of a two-crops per year rotation with forage maize (*Zea mays* L.), which is widely used but that shows some management problems. Fields were planted in autumn 2006 and harvested in spring 2007 in farms associated to the following cooperatives, located in different regions of Galicia: Os Irmandiños (A Mariña Oriental and Terra Chá), Melisanto (Terra de Melide), Feiraco (Xallas) and Cobideza (Deza). Yield (Y, t/ha DM), crude protein content (CP, %DM) and neutral detergent fibre (NDF, %DM) values varied according with the following intervals for the different mixtures and for the Italian ryegrass monoculture: 't-p' (Y: 4.3-7.5; CP: 13.7-18.7; NDF: 44.1-56.2), 't-v' (Y: 3.0-6.4; CP: 11.2-19.4; NDF: 50.8-58.6), 't-f' (Y: 4.4-4.8; CP: 11.1-11.9; NDF: 39.2-43.4), 'Italian ryegrass' (Y: 5.0-8.2; CP: 7.8-12.4; NDF: 54.3-55.7).

Keywords. Cereal-legume association – Two-crops per year rotation.

Rendement et valeur nutritive de mélanges fourragers de céréales-légumineuses comme une alternative au ray-grass italien utilisé comme récolte d'hiver en Galice (Nord-Ouest de l'Espagne)

Résumé. *L'objectif du présent travail était de transférer les résultats des recherches réalisées au cours des huit dernières années dans des exploitations laitières. Les auteurs ont comparé le ray-grass italien (*Lolium multiflorum *L.) avec des mélanges de triticale (*x Triticosecale *Wittm.) et pois (*Pisum sativum *L.) (t-p), de triticale et vesce (*Vicia sativa *L.) (t-v) et de triticale et féverole (*Vicia faba *L..) (t-f) comme phase d'hiver d'une rotation de deux cultures par an avec du maïs fourrager (*Zea mays *L.), ce qui est largement pratiqué, mais qui soulève quelques problèmes de gestion. Les champs ont été plantés à l'automne 2006 et récoltés au printemps 2007 dans des fermes associées aux coopératives suivantes, situées dans différentes régions de la Galice : Os Irmandiños (A Mariña Oriental et Terra Chá), Melisanto (Terra de Melide), Feiraco (Xallas) et Cobideza (Deza). Les valeurs du rendement (R, t/ha MS), de la teneur en matières azotées totales (MAT, % MS) et en fibre neutro-détergente (FDN, % MS) varient pour les différents mélanges et pour la monoculture de ray-grass italien dans les intervalles suivants: 't-p' (R : 4,3-7,5 ; MAT : 13,7-18,7 ; FDN : 44,1-56,2), 't-v' (R : 3,0-6,4 ; MAT : 11,2-19,4 ; FDN : 50,8-58,6), 't-f' (R : 4,4-4,8 ; MAT : 11,1-11,9 ; FDN : 39,2-43,4), 'Ray-grass italien' (R : 5,0-8,2 ; MAT : 7,8-12,4 ; FDN : 54,3-55,7).*

Mots-clés. *Association de céréales et légumineuses – Rotation de deux récoltes par an.*

I – Introduction

An increasing demand on information about annual winter growing high protein forage crops is taking place in Galicia (NW Spain) in order to replace Italian ryegrass, the most commonly used winter crop of a two crops per year forage rotation, with maize in summer, at Galician dairy farms (Flores *et al*., 2003).

Italian ryegrass was a well appreciated winter growing crop in the past because provided green forage through the winter to feed animals indoor, but changes experienced over the last 20 years on dairy animals feeding, towards the use of rations based on ensiled forages through the whole year round, made Italian ryegrass less attractive because it is difficult to harvest it through the winter due to the frequent rains that keep the soil too wet, to drive heavy machinery, and make grass wilting previous to ensiling almost impossible.

The aim of the work presented in this paper was to transfer to dairy farms research results achieved in recent years on mixtures made of triticale and forage peas, triticale and vetch and triticale and fava bean, as winter growing forage crops to rotate with forage maize in summer, in comparison with Italian ryegrass.

II – Materials and methods

The demonstration trials were sown in autumn 2006 on dairy farms associated to Melisanto, Os Irmandiños, Feiraco or Cobideza Cooperatives, located in the regions of Terra de Melide (South-East A Coruña), Terra Cha (Center Lugo), A Mariña Oriental (North-East Lugo), Xallas (Center-West A Coruña) and Deza (North-East Pontevedra). As a complement, some trials were located on Finca Robles, a CIAM experimental farm located on Terra de Lemos region (South Lugo).

Sowing took place by late October or early November except for Terra de Lemos, where it was delayed until late December due to autumn frequent rains. Soil nutrients content ranges were: pH (H_2O) 5.1-5.8; P (Olsen, extracted in CO_3HNa) 49-77 mg kg^{-1}, K (extracted in NH_4NO_3) 203-472 mg kg^{-1}, Al (% on soil exchange capacity) 1-14.

Seeding rates (seeds/m^2) were: 180 for triticale, 120 for peas, 180 for vetch and 30 for fava beans. The rate was 45% greater at Xallas due to problems on the sowing machine regulation. The legumes establishment was poor at Terra Chá for unknown reasons, although the residual effect of forage maize herbicides used is suspected as the main cause.

Four to six strips of 5.4 m^2 (6 m x 0.90 m) were cut in each demonstration plot with a sickle bar mower to measure yield, some days in advance to the date programmed by the farmer for harvesting within his ensiling programme, depending on cooperative or contractor equipment availability (Table 1). The forage cut in each strip was weighed in the field and a 2 kg sample was taken and transported to the laboratory. In the laboratory, the sample was subdivided in two sub-samples: one of 500 g, for DM content determination and chemical analysis, and another of 500-1000 g for botanical analysis. DM was calculated after drying for 17 hours in an air forced oven. This sample was ground at a Christian Norris mill to 1 mm for chemical analysis. The 500-1000 g sample was were manually separated into components, either peas, vetch, fava beans, triticale or other species, and oven dried for 17 hours at 80ºC to calculate botanical composition on dry matter basis.

III – Results and discussion

Yields (Table 2) are lower than other previously published from small plots trials (Piñeiro *et al*., 2004). If Terra Chá data are excluded due to poor establishment, yield was within the following intervals: 'triticale-peas': from 7.5 t ha^{-1} in Deza to 4.3 in Terra de Melide; 'triticale-vetch': from 6.4 in Deza to 3.0 in Terra de Lemos; 'triticale-fava beans': from 4.8 in Terra de Melide to 4.4 in A Mariña Oriental, and 'Italian ryegrass': from 8.2 in Xallas to 5.0 in Deza. It is observed that mixtures yield ranges are, in general, similar to the Italian ryegrass ones, with the exception of fava beans mixtures, that show lower yields. The very high yield of Italian ryegrass in Xallas is not representative because it was due to a high rate of slurry spread.

Table 1. Sowing and cutting dates, and plant development stage at harvesting

Region and mixture†	Sowing date	Cutting date	Stage at harvesting
Region of Terra de Melide			
t 'Noe'-p 'Gracia'	30-10-06	27-04-07	t: beginning of heading, p: flowering
t 'Noe'-p 'Forrimax'	30-10-06	27-04-07	t: beginning of heading, p: pod beginning
t 'Noe'-v 'Nitra'	30-10-06	27-04-07	t: beginning of heading, v: flowering
t 'Noe'-f 'Prothabon 101'	30-10-06	27-04-07	t: beginning of heading, f: beginning of flowering
'Italian ryegrass'	30-10-06	27-04-07	headed
Region of Terra Cha			
t 'Senatrit'-p 'Gracia'	02-11-06	26-04-07	t: headed, p: beginning of flowering
t 'Senatrit'-v 'Gravesa'	02-11-06	26-04-07	t: headed, v: beginning of flowering
Region of A Mariña Oriental			
t 'Senatrit'-p 'Forrimax'	06-11-06	27-03-07	t: beginning of heading, p: pod beginning
t 'Senatrit'-v 'Gravesa'	06-11-06	27-03-07	t: beginning of heading, v: beginning of flowering
t 'Senatrit'-f 'Prothabon 101'	06-11-06	27-03-07	t: early heading, f: flowering
Region of Xallas			
t 'Senatrit'-p 'Gracia'	09-11-06	03-05-07	t: headed, p: flowering
t 'Senatrit'-v 'Gravesa'	09-11-06	03-05-07	t: headed, v: beginning of flowering
'Italian ryegrass'	30-09-06	03-05-07	beginning of heading
Region of Deza			
t 'Noe'-p 'Gracia'	05-11-06	02-05-07	t: headed, p: flowering
t 'Noe'-v 'Gravesa'	05-11-06	02-05-07	t: headed, v: beginning of flowering
'Italian ryegrass'	05-11-06	02-05-07	beginning of heading
Region of Terra de Lemos			
t 'Noe'-p 'Gracia'	28-12-06	28-05-07	t: headed, p: pod beginning
t 'Noe'-p 'Forrimax'	28-12-06	28-05-07	t: headed, p: full pods
t 'Noe'-v 'Gravesa'	28-12-06	28-05-07	t: headed, v: flowering

†t (triticale), v (vetch), p (peas), f (fava beans). The name of the variety used is in between inverted commas.

The contribution of peas to yield was over 45% in all the cases but Terra Chá and Deza. Protein content of the triticale-forage peas mixtures was over 14% in the cases contribution of peas were above 45%. In general, the contribution of vetch to yield was lower than in the cases of mixtures with peas, being under 45% in all places but in Terra de Melide and Terra the Lemos, and only in these places protein content was over 14%. There was then a clear cut relationship between contribution of peas or vetch to yield and protein content. Protein content of the mixtures with fava beans was low, even in the case of Terra de Melide where the percentage of fava beans was near 45%. Italian ryegrass protein content was lower than in the case of mixtures in all the places were it was sown.

NDF Italian ryegrass content was in the range 55.7-54.3%, in agreement with the results shown by Martínez *et al.* (2005) for the same growth stage. NDF mixtures content tended to decrease as legume content increased as published by Strydhorst *et al.* (2008).

IV – Conclusions

These results allow concluding that vetch and forage peas, associated to triticale, are good options to substitute Italian ryegrass, as a winter crop, cultivated in the rotation with forage maize.

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Table 2. Total forage yield and its standard deviation, proportion of legume in the cereal-legume mixtures, crude protein (CP) and neutral detergent fibre (NDF) content

Region and mixture†	Yield (t ha^{-1} DM)	Proportion of legume (%)	CP (% DM)	NDF (% DM)
Region of Terra de Melide				
t 'Noe'-p 'Gracia'	4.3 ± 0.9	63.6	16.8	44.5
t 'Noe'-p 'Forrimax'	5.6 ± 1.0	80.8	14.3	47.4
t 'Noe'-v 'Nitra'	4.5 ± 1.0	46.3	15.1	54.1
t 'Noe'-f 'Prothabon 101'	4.4 ± 1.1	44.9	11.9	43.4
'Italian ryegrass'	5.4 ± 0.5	0.0	11.6	55.7
Region of Terra Cha				
t 'Senatrit'-p 'Gracia'	3.8 ± 1.0	21.5	10.4	56.2
t 'Senatrit'-v 'Gravesa'	4.2 ± 0.3	8.3	9.8	58.1
Region of A Mariña Oriental				
t 'Senatrit'-p 'Forrimax'	4.6 ± 0.8	46.8	15.9	55.0
t 'Senatrit'-v 'Gravesa'	5.5 ± 0.5	28.2	12.8	58.6
t 'Senatrit'-f 'Prothabon 101'	4.8 ± 0.4	28.4	11.1	42.9
Region of Xallas				
t 'Senatrit'-p 'Gracia'	6.8 ± 0.6	67.1	14.3	49.8
t 'Senatrit'-v 'Gravesa'	5.0 ± 0.8	25.1	11.3	53.7
'Italian ryegrass'	8.2 ± 0.5	0.0	7.8	55.0
Region of Deza				
t 'Noe'-p 'Gracia'	7.5 ± 0.7	36.1	13.7	53.4
t 'Noe'-v 'Gravesa'	6.4 ± 2.0	21.9	13.9	58.6
'Italian ryegrass'	5.0 ± 0.6	0.0	12.4	54.3
Region of Terra de Lemos				
t 'Noe'-p 'Gracia'	4.7 ± 2.5	80.6	18.7	44.1
t 'Noe'-p 'Forrimax'	7.6 ± 1.1	100.0	15.5	42.3
t 'Noe'-v 'Gravesa'	3.0 ± 1.1	80.9	19.4	50.8

†t (triticale), v (vetch), p (pea), f (fava bean). The name of the variety used is in between inverted commas.

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