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Effects of seeding rates and harvest date on forage yield and nutritive value of pea-triticale intercropping

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Abstract. In recent years the intensification in the forage production of dairy farms in Galicia (Northwest Spain) has led to the need of an alternative to Italian ryegrass as an annual winter crop in rotation with maize. The reasons were: the low content in protein and the harvesting costs of Italian ryegrass. In the region, the intercropping of pea (*Pisum sativum* L.) with triticale (x *Triticosecale* Witt.) was suggested as a potential alternative. The objective of this research was to evaluate the effects over forage yields and nutritive value of the seeding rate of pea:triticale (200:0, 150:75, 100:150, 50: 225 and 0:300 seeds m^{-2}) and harvest date (middle of April and middle of May), to determine the most appropriate mixture and the optimal harvest date. The highest contents of crude protein (CP) were obtained in the first harvest date. Pea monoculture provided the highest CP (18.5% dry matter), followed by the mixture with seeding ratio 150:75. In contrast, triticale monocultures had the lowest CP. The increase of pea seeding ratio proportion in mixture increased crude protein and decreased neutral detergent fiber. The first harvest date was the optimal, according to protein content, although dry matter yields were lower.

Keywords. Winter forage – Protein – Dry matter yield.

Effets des taux de semis et date de récolte sur le rendement en matière sèche et sur le valeur nutritive des cultures intercalaires de pois et triticale

Résumé. *Lors les dernières années, l'intensification de la production fourragère dans les exploitations laitières en Galice (nord-ouest de l'Espagne) a conduit à la nécessité d'une alternative au ray-grass italien comme culture fourragère d'hiver dans la rotation avec le maïs. Les raisons étaient la faible teneur en protéines et les coûts de récolte du ray-grass italien. Dans cette région, le culture associée de pois (*Pisum sativum *L.) et triticale (x* Triticosecale *Witt.) a été proposé comme une alternative. Les objectifs de ce travail ont été d'évaluer les effets des doses de semis de la culture associée pois:triticale (200:0, 150:75, 100:150 et 50:225 semences m^{-2}) et de la date de récolte (mi-avril et mi-mai) sur la production et sur la valeur nutritive du fourrage. De cette façon, on pourra déterminer le mélange le plus approprié et le moment parfait de récolte. Les teneurs les plus élevés de protéines brutes ont été obtenues dans la première date de récolte. La monoculture de pois a eu la teneur en protéines brutes la plus élevée (18,5% sur matière sèche), suivie par le mélange avec la dose de 150:50 pois:triticale. Par contre, la monoculture de triticale avait la plus faible teneur en protéines brutes. L'augmentation de la proportion de pois dans le mélange de semis a augmenté la protéine brute et a diminuée la fibre neutre détergente. La date de la première récolte a été optimale pour la teneur en protéine, bien que le rendement en production de matière sèche était plus faible.*

Mots-clés. *Fourrage d´hiver – Protéine – Rendements en matière sèche.*

I – Introduction

In recent years the forage production of dairy farms in Galicia (Northwest Spain) has experimented an intensification, mainly, due to limitations of farm land. The most common annual rotation is composed for maize, as a summer crop, and Italian ryegrass, as a winter crop cut once or twice (Fernández-Lorenzo *et al.*, 2009). However, the high harvesting cost and the low protein content of Italian ryegrass has led to the need of an alternative to Italian ryegrass as

an annual winter crop. Legume and cereal intercropping has been reported to enhance yield and yield stability (Ofori and Stern, 1987), to increase nutrients use efficiency, especially of nitrogen (Jensen, 1996), to reduce weed infestation (Hauggaard-Nielsen *et al.*, 2001) and plant diseases and pests occurrence (Jensen *et al.*, 2005). In Northwest Spain, the pea and triticale intercropping was indicated as alternative winter crop (Fernández-Lorenzo *et al.*, 2007). The objective of this study was to evaluate the effects of seeding rate and harvest date of pea-triticale intercropping over forage yield and nutritive value, in order to determine the most appropriate mixture and the optimal harvest date.

II – Materials and methods

A field experiment was performed during 2007 at the Centro de Investigacións Agrarias de Mabegondo (A Coruña), at 100 m altitude, in order to compare the effects of five seeding rates of pea (*Pisum sativum* L. cv. Gracia): triticale (x *Triticosecale* Witt. cv. Noe), 200:0, 150:75, 100:150, 50: 225 and 0:300 seeds m^{-2}. Following a split plot design with four blocks, the harvest dates were assigned to the whole-plots and the seeding rates, to the subplots. The size of the plot units was 1.2 x 15 m. The plots were sown on 2 February and the forage mixture were cut to 10 cm stubble height, using a reciprocating mower, in the two harvest dates, the first on 22 May and the second on 12 June. The proportion of pea, triticale and weeds was measured on two strips per plot, 1.2 x 0.9 m each and the whole production per plot was weighted. Four representative samples were taken per plot, 2 kg of the mixture, 1 kg of peas, 1 kg of triticale and 1 kg of weeds. The samples were oven dried at 80ºC for 16 hours for dry matter content (DM) determination. They were milled at 1 mm and analyzed for the next nutritive value constituents: organic matter (OM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), water soluble carbohydrates (WSC), not structural carbohydrates (NSC) and *in vitro* organic matter digestibility (IVOMD). This analysis were made using a spectofotometric NIRSystems 6500 (FOSS NIRSystems, Inc., Silver Spring, Washington, USA) and the calibrations developed by Fernandez-Lorenzo *et al.* (2004). Data were subjected to ANOVA and multiple comparison of means by Fisher's Least Significant Difference procedure using Proc GLM of SAS (SAS Institute, 2000).

III – Results and discussion

On the first date of harvest, the pea was between the flowering and the flat pod stage and the triticale in the flowering stage. On the second, the pea was in pod fill and triticale between milky and smooth grain stage. The accumulated rainfall and cumulative degree days at 0℃ base, since sowing were 378 mm and 1286℃, for the first date, and 397 mm and 1622℃, for the second date.

The botanical composition of the mixtures, excluded monocultures is shown in Table 1. The percentage of pea and triticale increased with increasing the pea and triticale seeding rates, respectively, in according with the results obtained by Strydhorst *et al.* (2008) for intercropping of pea with barley. It was not detected a signification variation of weed content among seeding rates.

The dry matter yield (DMY) of intercropped mixtures (Table 2) was significantly affected by the seeding rates, in both dates. In the first date, DMY of pea monoculture was lower than the rest. In the second, DMY of pea monoculture was lower than 150-75 (pea-triticale) seeding rate, and this was lower than the rest. These results are in agreement with Strydhorst *et al.*, 2008 but in contrast to Izurralde *et al.* (1990) and Hall and Kephart (1991). DM and DMY were higher in the second harvest date, in accord with Salawu *et al.* (2001).

The increase of pea seeding rate was reflected on a increased of crude protein content of the mixture, in agreement with Chapko *et al.* (1991) and Carr *et al.* (1998), and a reduction in DMY

in contrast to Carr *et al.* (1998). The inclusion of legumes in forage intercrops can provide a more sustainable source of nitrogen to cropping systems through biological nitrogen fixation (Crews and Peoples, 2004).

Table 1. Percentage of pea, triticale and weeds over dry weight

Seed rates pea-triticale	Harvest date	Pea	Triticale	Weeds
200-0	1	-	-	-
150-75	1	62.8 *a*	22.7 *c*	14.5 *a*
100-150	1	41.4 *b*	44.8 *b*	13.8 *a*
50-225	1	26.4 *c*	62.6 a	11.0 a
0-300	1	-	-	-
p		***	***	ns
200-0	2	-	-	-
150-75	2	71.1 *a*	16.3 *c*	12.6 *a*
100-150	2	52.4 *b*	34.8 *b*	12.8 *a*
50-225	2	28.8 c	56.6 *a*	13.6 *a*
0-300	2	-	-	-
p		***	***	ns

***: p <0.001; **: p <0.01; *: p <0.05; ns: not significant. Means within the same column which are followed by the same letter are not significantly different.

Table 2. Dry matter yield (DMY); Dry matter (DM); Organic matter (OM); Crude protein (CP); Neutral detergent fiber (NDF); Acid detergent fiber (ADF); Non structural carbohydrates (NSC); *In Vitro* organic matter digestibility (IVOMD), as percentage of dry matter

Seed rates pea-triticale	Harvest date	DMY (t ha^{-1})	DM (%)	OM (%)	CP (%)	NDF (%)	ADF (%)	WSC (%)	NSC (%)	IVOMD (%)
200-0	1	4.83 b	19.3 b	88.6 c	18.3 a	45.7 d	38.3	7.0 d	8.3 c	62.4 c
150-75	1	6.68 a	16.6 c	92.1 b	15.7 b	51.9 c	39.2	9.0 cd	12.0 b	64.5 ab
100-150	1	7.02 a	18.2 bc	92.5 ab	14.2 b	53.8 c	39.0	10.5 cb	13.4 ab	65.6 a
50-225	1	6.77 a	20.5 b	94.6 a	12.2 c	57.2 b	39.3	11.8 b	14.2 ab	65.1 a
0-300	1	6.86 a	35.5 a	93.3 ab	7.4 d	65.1 a	39.9	15.4 a	15.3 a	63.3 bc
p		***	***	**	***	***	ns	***	**	*
200-0	2	5.93 c	31.1 a	91.6 c	15.9 a	47.5 c	35.3 ab	10.6 b	14.8 b	63.5 ab
150-75	2	7.98 b	24.7 c	93.7 b	12.7 b	50.7 bc	37.4 a	11.6 b	17.0 b	60.8 b
100-150	2	10.34 a	25.7 c	94.3 ab	11.5 b	47.4 c	33.5 b	16.2 a	26.5 a	67.9 a
50-225	2	10.67 a	29.2 b	95.1 a	8.4 c	53.6 b	35.8 ab	16.8 a	26.1 a	65.3 ab
0-300	2	10.99 a	37.9 a	94.8 a	5.5 d	57.3 a	34.6 ab	17.5 a	27.8 a	62.9 ab
p		***	***	***	***	**	**	**	**	**

***: p <0.001; **: p <0.01; *: p <0.05; ns: not significant. Means within the same column which are followed by the same letter are not significantly different.

The triticale as a sole crop had a higher NDF and ADF contents compared with intercrops and pea sole crop. Others authors have also reported higher NDF contents in cereal alone crops relative to pea-cereal intercrops (Carr *et al.*, 2004). In the second harvest date, the NDF content increased and the CP content decreased, reflecting a more advanced stage of maturity and a reduction in the leaf to stem ratio (Albrecht *et al.*, 1987).

IV – Conclusions

When harvesting the forage the mid of May, the seeding rates 150-75 and 100-150 (pea-triticale) are the best choice, in order to get the higher yield (6,7-7,2 t ha^{-1}) and IVOMD (64,5% - 65,6%) along with moderate CP content (15,7%-14,2%). When harvesting in the middle of June, the seeding rate 100-150 (pea-triticale) provides the higher DMY (10,3 t ha^{-1}) and IVOMD (67,9%) along with a moderate CP content (11,5%).

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