Effects of triticale cultivars grown in a Mediterranean environment on biomass yield and quality

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RIASSUNTO – Effetti della scelta varietale sulla produzione di biomassa e sulla qualità di triticale coltivato in ambiente Mediterraneo. *Quattro varietà di triticale, Antares, Rigel, Eureka e Magistral, caratterizzate da differente habitus (invernale vs. primaverile) sono state coltivate a due densità di semina (350 vs. 700 semi/m²) per due anni. Le piante sono state quindi campionate allo stadio di fioritura e di maturazione latteo-cerosa. La densità di semina non ha influenzato la produzione di biomassa e la composizione chimica. Le varietà ad habitus primaverile hanno avuto, in entrambe le annate, una migliore composizione chimica di quelle invernali, mentre non ci sono state differenze per la produzione di biomassa. Fra le due epoche di raccolta quella più anticipata (fioritura) è risultata meno condizionata dall'andamento meteorologico ed ha consentito di ottenere erbe con concentrazione di SS ottimale per la produzione di insilati.*

Key words: triticale, phenological stage, quality, biomass

INTRODUCTION – Triticale is a valuable crop in Mediterranean environments because its growth capacity at low temperatures and its precocity make it possible to obtain high biomass yields in early spring. Precocity of triticale is particularly appreciated in Mediterranean environment, where irrigation allows the sowing of a spring–summer corn crop after a winter cereal crop has been harvested for silage. In these conditions, early planted corn can take advantage of both longer-cycle cultivars and of the lower incidence of the European corn borer *Ostrinia nubilalis* attacks. Nutritional quality of triticale as forage is related to the phenological stage at harvest, cultivar choice, seeding rate and environmental conditions. The work reported in this paper was aimed at verifying if the hypothesized effects of the different *habitus* (cold requirement) of triticale cultivar grown at different seeding rates affect biomass quantity and quality at the stages of flowering and milk-waxy-maturity, which are the most relevant for triticale silage production.

MATERIALS AND METHODS – A two-year experiment was carried out in a experimental farm located near Oristano (40 °N, 8 °E, 15 m a.s.l.), Sardinia, in the years 1999-2000 and 2000-2001. The comparison involved 4 triticale (*x Triticosecale Wittmack*) varieties seeded in mid-December. Two varieties had winter *habitus* (Eureka and Magistral) and two spring habitus (Antares and Rigel). For each variety two seeding rates (350 and 700 viable seeds m^2) were used. A randomized blocks experimental design with four replicates (four plot each) was used for each experimental year. Plant sampling was carried out at flowering (Eureka and Magistral: 26/4/2000 and 5/5/2001; Antares and Rigel: 13/4/2000 and 9/4/2001) and milk-waxy stage (Eureka and Magistral: 18/5/2000 and 23/5/2001; Antares and Rigel: 15/5/2000 and 9/5/2001). From each sample, after measuring fresh weight, two subsamples were obtained. They were partitioned in fresh leaves, dry leaves, stems and ears. On each part fresh weight, dry weight at 105°C, crude protein, and Van Soest fiber fractions were measured. On stems only, total ethanol-soluble carbohydrates (mostly soluble sugars) (TESC) (Hall, 2000) were also measured. Whole plant composition was calculated on the basis of the composition of its fractions.

RESULTS AND CONCLUSIONS – In both seasons the total amount of rainfall of the period December–May was lower than the long-term average of 340±8 mm, with particularly low values in the months of April and May, when the rainfall was only 50% of the long-term average of 80 mm. The two seasons differed in the total amount and distribution of rainfall. In 1999-2000 (2000 season) the total amount of rainfall was 134 mm, in 2000-2001 (2001 season) it was 294 mm. This difference mostly derived from the higher rainfall during the December-February period. The two seasons also differed for the rainfall during the critical months of April and May, as April was more rainy than May in 2000 (31 *vs.* 9 mm), whereas it was less rainy than May in 2001 (13 *vs.* 26 mm). In 2000 season the winter minimum temperatures were lower than in 2001, whereas the maximum temperatures during April and May were on average warmer of about 2°C.
The sowing rate treatment did not significantly affect the total biomass production or the chemical composition of stems or whole plant. For this reason the effects of seeding rate are not reported in the tables.
In the year 2000 there was a marked decrease in stem quality as the plants passed from flowering to milk-waxy stage, with increase in NDF and decrease in TESC concentrations, while in the year 2001 there were not clear changes between stages (Table 1). The spring in 2000 was more rainy than in 2001 (105 *vs.* 51 mm) and hotter. This caused a fast maturation of the plants, with an increase in their fiber content, and a decrease in their photosynthetic activity, with a decrease in soluble sugars. As a whole, these facts quickly reduced stem nutritional quality.

Table 1. Chemical composition (% of DM) of stems.

	Flowering stage				Milk-waxy stage			
	Ash	CP	NDF	TESC	Ash	CP	NDF	TESC
				2000				
Habitus	n.s.	n.s.	**	**	n.s.	**	n.s.	**
Winter type	6.5	5.5	69.4	16.1	7.0	4.0	79.8	5.9
Spring type	6.6	5.2	65.7	19.9	6.6	2.2	78.8	8.6
Cultivar (habitus)	n.s.	**	**	**	*	**	**	*
Eureka	7.0	6.0	65.5	18.9	7.9	5.2	76.5	7.1
Magistral	6.0	5.0	73.3	13.3	6.0	2.8	83.1	4.7
Antares	6.9	5.5	68.3	18.8	6.6	2.2	79.5	6.8
Rigel	6.3	4.9	63.2	21.0	6.5	2.3	78.1	10.4
$LSD_{0,05}$	1.2	0.4	1.4	1.9	0.6	0.3	1.3	1.4
				2001				
Habitus	**	n.s.	**	n.s.	n.s.	**	**	**
Winter type	6.1	5.0	62.3	19.6	5.7	3.5	61.0	18.3
Spring type	8.5	5.3	70.3	17.7	5.9	2.9	59.1	22.4
Cultivar (habitus)	n.s.	**	**	n.s.	n.s.	**	**	**
Eureka	62	5.8	59.2	19.3	5.7	4.3	60.7	21.1
Magistral	8.9	4.1	65.3	19.8	5.7	2.6	61.3	15.4
Antares	8.3	5.4	68.9	19.7	5.7	2.9	58.3	21.3
Rigel	8.6	5.1	71.6	15.7	6.1	3.0	60.0	23.6
$LSD_{0,05}$	0.2	0.3	0.8	1.9	0.2	0.2	0.9	1.6

n.s. = P>0.05; * = P<0.05; ** = P<0.01.
LSD =least significant difference at P < 0.05 among cultivars within *habitus*.

The temporal evolution of the chemical composition of the whole plants showed that NDF and CP concentrations decreased as plants aged (Table 2), as an effect of the accumulation of reserve carbohydrates in the kernels. Winter *habitus* varieties had, for both stages and years, higher fiber, and, to a lesser extent, crude protein concentrations. The higher fiber concentration can be due to the fact that winter varieties reached the two stages studied later than spring varieties, when the climatic conditions were less favorable (high temperatures and little rain). The higher CP concentration probably occurred because the winter varieties had a longer seeding to flowering interval, with more time available to absorb and accumulate nitrogen from the soil. Dry matter concentration at the flowering stage ranged, depending on the years and on the treatments, between 25 and 32%, being close to the optimal DM concentration for silage production (Van Soest, 1994). At milk-waxy stage, DM concentration ranged between 44 and 48% in 2000 and between 37 and 42% in 2001 (Table 2). In both years it was higher than the optimal values suggested for grass silage production (Van Soest, 1994). Seeding rate did not affect DM concentration at the two stages studied.

Table 2. Biomass yield (DM basis) and chemical composition (% of DM) of whole plants.

	Flowering stage					Milk-waxy stage				
	g/m^2	DM	Ash	CP	NDF	g/m^2	DM,	Ash	CP	NDF
					2000					
Habitus	n.s.	**	n.s.	n.s.	**	n.s.	n.s.	n.s.	n.s.	n.s.
Winter type	878	28.6	7.8	10.1	65.4	944	46.4	8.0	8.8	53.7
Spring type	834	24.7	7.8	11.3	62.5	1104	46.4	7.6	7.6	53.4
Cultivar (habitus)	n.s.	**	n.s.	n.s.	**	n.s.	n.s.	n.s.	n.s.	n.s.
Eureka	899	29.2	7.9	9.6	63.3	946	44.3	8.5	9.4	51.2
Magistral	856	28.	7.6	10.5	67.5	943	48.5	7.5	8.2	56.1
Antares	781	22.2	8.5	10.9	64.1	1158	48.3	8.4	7.2	55.9
Rigel	887	27.1	7.0	11.8	61.0	1042	44.4	6.8	8.1	50.9
$LSD_{0,05^2}$	-	1.4	0.8	1.2	1.1	-	3.9	1.0	0.9	3.2
					2001					
Habitus	n.s.	**	**	**	**	**	*	**	**	**
Winter type	972	28.9	11.7	8.3	67.0	1003	42.2	8.2	6.2	58.5
Spring type	989	22.7	9.4	7.5	63.4	1347	37.6	10.7	5.7	53.0
Cultivar (habitus)	n.s.	**	n.s.	**	**	n.s.	n.s.	*	**	**
Eureka	920	25.9	10.0	8.5	61.7	981	42.2	9.0	7.1	55.7
Magistral	1024	32.0	8.9	6.5	65.1	1033	42.1	7.3	5.2	61.3
Antares	932	22.5	11.0	8.7	65.9	1316	37.1	9.8	5.7	51.5
Rigel	1045	22.9	12.5	8.0	68.1	1377	38.1	11.7	5.7	54.6
$LSD_{0,05}$	-	1.6	0.9	0.2	0.5	-	2.9	0.7	0.2	1.0

n.s. = P>0.05; * = P<0.05; ** = P<0.01.
LSD = least significant difference at P<0.05 among cultivars within *habitus*.

At the flowering stage the winter varieties had, in both years, higher DM concentration than spring varieties, probably because they reached this stage later on in the spring season. At the milk-waxy stage DM concentration was not affected by *habitus* in the 2000, while it was higher for winter varieties in the 2001. In 2000 the higher temperatures and the lower water availability probably increased maturation rate, reducing *habitus* differences among varieties. Biomass harvested at the milk-waxy stage was 15-20% higher than biomass at flowering (Table 2).

The differences above mentioned might affect the suitability of the plants to produce silages. In both years at flowering DM and TESC concentrations were more suitable for silage production compared to the concentrations observed at the milk-waxy stage. At this stage both DM and TESC concentrations were highly affected by environmental conditions.

In conclusion, spring varieties had better chemical composition than winter varieties. If harvested at flowering, they might allow early harvest of triticale and early seeding of corn, with reduction of the probability of insect damages on the latter species.

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