MANAGEMENT PRACTICES AND MAIZE (*Zea mays*, L.) QUALITY FOR BEER INDUSTRY

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INTRODUCTION

Maize grain is utilized as starch source in the industrial process of beer production. The quality of maize grain for beer production is related to kernel hardness and particle size after grinding, two attributes strongly related to flint character of maize (i.e., vitreousness). In Argentina, the Ministry of Agriculture specifies the flint maize as "Plata" (MOA 757/97, www.infoleg.gov.ar) and, according to this definition, this maize meets the quality required by beer industry since its greater particle size after grinding and its easy separation between germen and endosperm. Grain hardness is related with biochemical composition of endosperm, mainly the relative content of protein (zein) and starch (Robutti et al, 2000). Although hardness is mainly associated to genotype, this trait may be modified by agronomic practices and environment conditions during harvest (Cirilo et al, 2003) and variations may be quantified by using floating test (FL). As source-sink ratio increases, protein and starch content in the grain also increases resulting in greater hardness (Borrás et al, 2002). In the Northeast Region of Argentina, both high temperature and erratic rains during reproductive stages might alter both grain yield and quality of flint hybrids. In addition, nowadays trend to intensify land use by double cropping along normal delaying of sowing and changes in final plant population density might modify hardness of flint hybrids. The objective of this study was to quantify the impact of changes in both and planting date on mechanical and shape-size kernel parameters of two most demanded flint maize hybrids for beer industry in the Northeast of Argentina.

MATERIALES Y METODOS

The experiment was carried out in Corrientes, Argentina (27º 28'S; 58º 47' W; elevation 50 m above sea level) during 2007/8 growing season. Two flint hybrids (AVANT and P3041) were sown at September (early=E) and December (late=L) under two plant population densities (5.8 and 7.5 plants m^{-2}). The experiment was conducted without water and nutrient limitations. Levels of the three factors were combined in a factorial experiment with four replications arranged in a randomized block design.

Reproductive growth was estimated by cutting twelve plants at ground level 15 days before and 15 days after R1 (Ritchie y Hanway, 1982), oven dried at 80 ºC until constant weight. Ears from 40 plants per plot were hand shelled and grains from the middle section of the ear were separated by quality analysis. Floating test (FL) was performed according to MOA 757/97. Test weight (WE) was performed by using a TR-400 devices, and kernel weight (KW) were determined on two samples of 500 grains each. Source-sink ratio was estimated as the quotient between accumulated dry matter by 15 days after R1 and kernel number per square meter. Data were analyzed by using ANOVA, lineal regression and correlation procedures included at Infostat (2002).

Table 1. Analysis of variance for flotation test (FL), test weight (TW), and kernel weight (KW) in two flint maize hybrids growing in two sowing dates (SD) and two plant population densities (D).

SD	D	H	FL	TW	KW
	Pl m^{-2}		%	Kg 100 l^{-1}	g m^{-2}
EARLY	7.5	AVANT	12.5	78.60	350.0
		P3041	1.75	80.70	361.8
	5.8	AVANT	8.50	78.75	360.8
		P3041	1.25	81.03	369.8
LATE	7.5	AVANT	4.50	79.53	356.8
		P3041	4.25	81.83	355.3
	5.8	AVANT	1.75	81.63	368.8
		P3041	1.75	81.13	361.5
				P value	
Sowing date (SD)			<0.0001	0.0654	>0.999
Plant population density (D)			<0.0001	0.0851	<0.0001
Híbrid (H)			<0.0001	0.0175	<0.0001
SD x D			0.6200	0.2118	0.8690
SD x H			<0.0001	0.0398	<0.0001
D x H			0.0192	0.5316	0.0096
SD x D x H			0.0396	0.4182	0.3306
*LSD (0.05) **			*0.770*	*0.955*	*1.558*
*LSD (0.05) ***			*1.089*	*1.350*	*2.204*
*LSD (0.05) ****			*1.540*	*1.910*	*3.117*

** Least significance difference to compare individual factors*
***Least significance difference to compare two way interaction*
**** Least significance difference three way interaction*

RESULTS AND DISCUSSION

Analysis of variance is shown in Table 1. Hybrids presented comparable WE and KW and strongly differed for FL (2.25 vs.6.81 for P3041 and AVANT, respectively).

Sowing date and plant population density differentially altered FL of two hybrids. There was a significant (p<0.0001) *sowing date x hybrid* interaction for floating test. Thus, while both hybrids had comparable floating test when sown late (FL=2.9%), FL showed a three fold increasing for AVANT (FL=10.1) and two fold decreasing for P3041 (FL=1.3) when sown early. In respect to plant population density, while P3041 showed a stable FL across both plant population density, AVANT increased it around 89% as plant population density increased.

Hybrids differed in a different way in terms of kernel weight as sowing date was delayed. While KW in AVANT was greater than in P3041 when sown late, KW of P3041 was around 3% greater than that of AVANT when sown early.

There was a significant (p<0.0398) *sowing date x hybrid* interaction for test weight. While P3041 had similar values at both sowing dates, AVANT increased WE as sowing date was delayed.

Regression analysis revealed that floating test was negatively associated (p<0.001) with source-sink ratio only for AVANT in early sowing date and P3041 in late sowing late (Fig. 1). In turn, FL was negatively correlated (r=-0.72, p<0.0001) with KW.

For all variables related to quality of flint hybrids, the sowing date x plant population density interaction was not significant (p>0.2118).

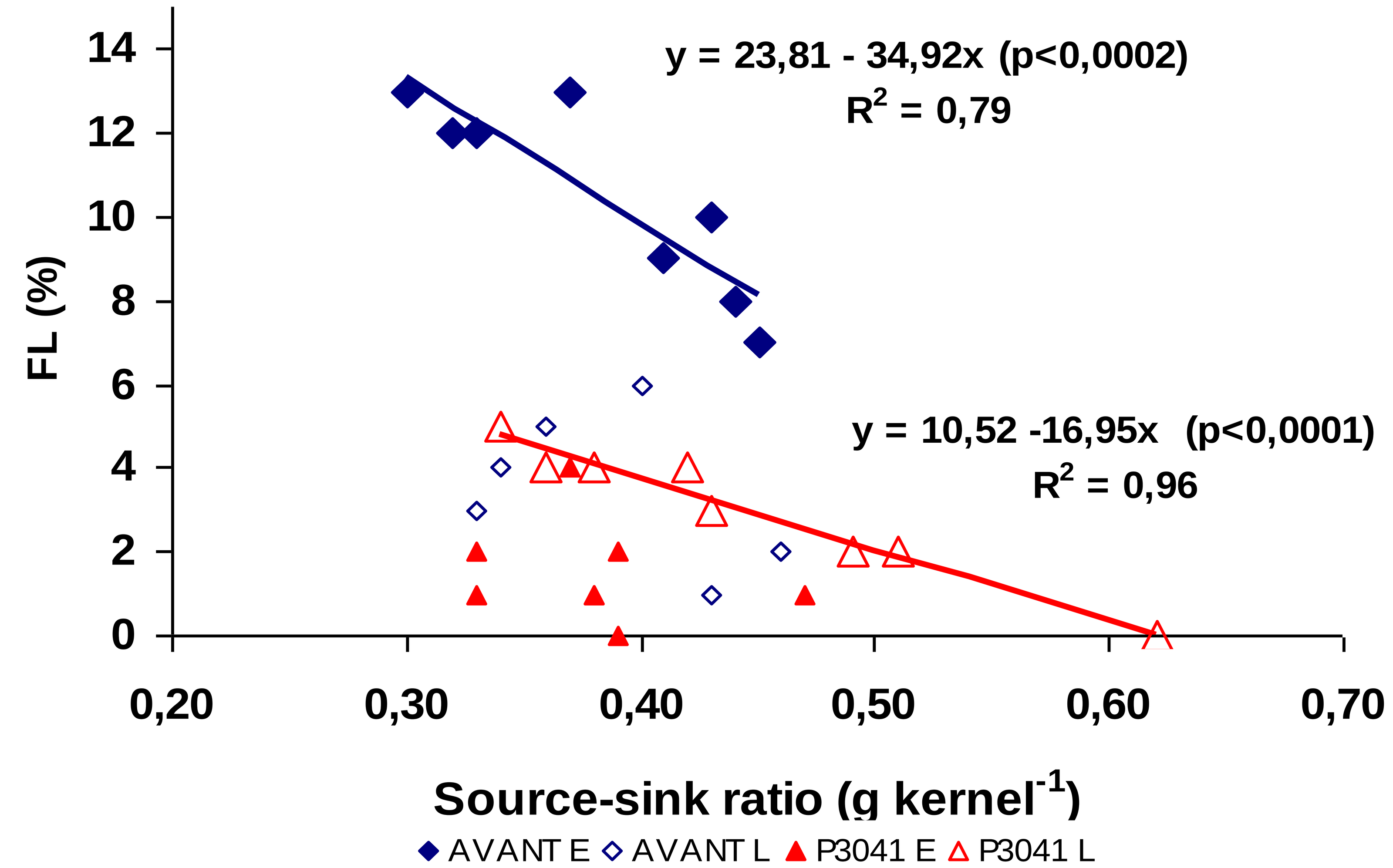

Fig. 1. Relationship between flotation test (FL) and source-sink ratio for two flint maize hybrid grown under two sowing date (early=E; late=L).

CONCLUSIONS

Results of this work indicate that the two most common agronomic practices (i.e., sowing date and plant population density) which strongly interact with grain yield, did not alter the variables related to quality of flint hybrids. Our results also show that one out three quality variables (i.e., floating test) was strongly modified by sowing date and plant population densities.

In spite of the range of source-sink ratio generated for combination of sowing dates and plant population densities was similar for both hybrids, FL was more sensitive in AVANT than in P3041, mainly for early sowing dates. Nevertheless, floating test values were lower that the threshold required for beer industry (FL< 25). In addition, our results indicated that flint hybrids used in this study could qualify as "Premium" (FL<12), an specific type of maize required by overseas buyers.

ACKNOWLEDGMENTS: This work was supported byl PINCER 2345 (INTA) and PI 25/07 (UNNE)

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