CORN GROWTH AND YIELD IN COMPETITION WITH WEEDS[1]

Crescimento e Rendimentos do Milho em Competição com Plantas Daninhas

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ABSTRACT - Although labor is intensive, evaluating the growth of crops may allow a better understanding of crop performance, including the reasons why certain cultivars can compete better with weeds. This study aims at evaluating growth, green ear yield, and grain yield in corn when in competition with weeds. Cultivars AG 1051 and BRS 106 were grown with (two hoeings, at 20 and 40 days after sowing) or without weed control. In order to evaluate crop growth, six collections of the above-ground part and the root system of corn were performed, every 15 days, with the first collection made 30 days after sowing. A randomized complete block design was adopted, with split-split plots (weed control in plots, cultivars in subplots, and collections in sub-subplots) and ten replicates. Eighteen weed species were found in the experiment area. Increased values of corn leaf area, above-ground part and root system, due to plant age function, were smaller in non-hoed plots than in hoed plots and were dependent upon cultivar. The lack of weed control increased dry matter of weeds above-ground part and decreased green ear yield and grain yield. Cultivar AG 1051 had higher increases in leaf area, above-ground part of the plant and root system, due to plant age function, and controlled weeds better than cultivar BRS 106. In addition, cultivar AG 1051 was superior to other cultivars with respect to most traits used for green corn yield and grain yield assessment.

Keywords: *Zea mays*, green corn, grain yield, dry matter.

RESUMO - A avaliação do crescimento das culturas, embora trabalhosa, pode possibilitar o melhor entendimento do desempenho das culturas, inclusive das razões pelas quais determinadas cultivares são capazes de competir melhor com as plantas daninhas. O trabalho teve como objetivo avaliar o crescimento e os rendimentos de espigas verdes e de grãos do milho, em competição com plantas daninhas. As cultivares AG 1051 e BRS 106 foram cultivadas com duas capinas (aos 20 e 40 dias após a semeadura) e sem controle de plantas daninhas. Para avaliação do crescimento da cultura, foram realizadas seis coletas da parte aérea e do sistema radicular do milho, de 15 em 15 dias, a primeira sendo efetuada 30 dias após a semeadura. Utilizou-se o delineamento de blocos completos casualizados, com parcelas sub-subdivididas (controle de plantas daninhas nas parcelas, cultivares nas subparcelas e coletas nas sub-subparcelas) e dez repetições. Dezoito espécies de plantas daninhas ocorreram na área experimental. Os aumentos da área foliar, da parte aérea e do sistema radicular do milho, em função da idade, foram menores em parcelas não capinadas do que nas parcelas capinadas e dependeram das cultivares. A falta de controle das plantas daninhas aumentou a matéria seca da parte aérea das plantas daninhas e reduziu os rendimentos de espigas verdes e de grãos. A cultivar AG 1051 apresentou maiores aumentos da área foliar, da parte aérea da planta e do sistema radicular, em função da idade da planta, e controlou melhor as plantas daninhas, que a cultivar BRS 106. Além disso, a cultivar AG 1051 foi superior à outra cultivar, quanto à maioria das características utilizadas na avaliação do rendimento de milho verde e quanto ao rendimento de grãos.

Palavras-chave: *Zea mays*, milho verde, rendimento de grãos, matéria seca.

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INTRODUCTION

Corn is exploited all over Brazil mainly for the production of green corn and dry grain. The grain in green ears have moisture contents varying from 70 to 80% and are frequently used as human food. Dry grain have moisture contents around 15 to 20% and are used as human and animal foods. Green ear yield and grain yield losses caused by weeds may reach 60% (Silva et al., 2004a) and 80% (Silva et al., 2004b), respectively.

Green ear yield and grain yield are usually evaluated without considering crop growth. However, although labor-intensive, evaluating corn growth has theoretical and practical implications. For this reason, in some cases (Aflakpui et al., 2002) the researcher is not concerned about evaluating economic yield, focusing on crop growth alone. By evaluating growth, information can be obtained in order to enable a better understanding of crop performance. For example, growth analysis was employed to identify potential causes of losses in corn grain yield due to interference with weeds (Evans et al., 2003). On the other hand, growth evaluation may even indicate the reasons why certain cultivars can compete better with weeds (Fleck et al., 2003; Lamego et al., 2005).

We found a small number of studies in the consulted literature dealing with the relation between reduced growth due to competition with weeds and green ear yield. Observed growth values for corn above-ground part and root system were 30% smaller in non-hoed plots as compared with hoed ones, implying reductions in the numbers of marketable green ears, both unhusked and husked (Silva et al., 2009). *Brassica kaber* decreased the growth and weight of marketable sweet corn ears; there was a negative correlation between corn yield losses and *B. kaber* biomass (Davis & Liebman, 2001). On the other hand, many studies have demonstrated that reduced corn growth due to weeds is associated with reduced grain yield (Evans et al., 2003; Lum et al., 2005; Silva et al., 2009; Silwana & Lucas, 2002).

Losses in corn green ear yield and grain yield in relation to growth as a consequence of weeds are due to several causes. Weeds delay corn female flowering and maturation and reduce corn leaf area, biomass, plant height, and biomass partitioning (Evans et al., 2003). The presence of *Setaria viridis*. Beauv. reduced the rate of appearance of leaves, leaf area index, growth rate, plant height and dry matter of the above-ground part in corn (Cathart & Swanton, 2004). Besides reducing corn leaf area and biomass, infection with *Striga hermonthica* also reduced the photosynthesis rate of both young and adult corn leaves (Aflakpui et al., 2002). In plots without weed control, corn showed smaller leaf area index (Lum et al., 2001) and lower plant height (Silwana & Lucas, 2002).

The objective of this work was to evaluate grain and green ear growth and yield in two corn cultivars when in competition with weeds.

MATERIAL AND METHODS

The experiment was conducted at the Rafael Fernandes Experimental Farm (latitude -5° 3' 38", longitude -37° 23' 46" W, and 18 m elevation), in the period from September 2006 to January 2007. According to Gaussen's bioclimatic classification, the climate in the Mossoró region is classified as type 4ath, or distinctly xerothermic, which means tropical hot with a pronounced, long dry season, lasting from seven to eight months and with a xerothermic index between 150 and 200. The bioclimate in the region is a BSwh, that is, hot, with heavier precipitations delayed toward the fall (Köppen, 1948). The mean minimum temperature in the region is 32.1 °C and the maximum is 34.5 °C, with June and July being the coolest months, while the mean annual precipitation is around 825 mm.

The experimental soil, classified as Arenic Hapludult according to the Brazilian Soils Classification System (Embrapa, 1999a) and as Ferric Lixisol according to the Soil Map of the World (FAO, 1998), was tilled by means of two harrowings and fertlized with 30 kg N (ammonium sulfate), 60 kg P_2O_5 (single superphosphate), and 30 kg K_2O (potassium chloride) per hectare. The fertilizers were applied in furrows located alongside and below the sowing furrows. The analysis of a sample taken from the experimental soil (Embrapa, 1999b) indicated: pH = 6.4; Ca = 1.80 $cmol_c$ dm^{-3}; Mg = 0.60 $cmol_c$ dm^{-3}; K = 0.14 $cmol_c$ dm^{-3}; Na = 0.04 $cmol_c$ dm^{-3}; Al = 0.00 $cmol_c$ dm^{-3}; P = 38 mg dm^{-3}; Org. Mat. = 1.40 g kg^{-1}.

Seeding was performed on 9/18/2006, and four seeds/pit were used. The spacing between rows was 1.0 m, and pits on each row were spaced by 0.4 m. Thinning was performed 15 days after planting, leaving the two more vigorous plants in each pit. Therefore, after thinning the programmed population, 50 thousand plants ha^{-1} were kept in the experiment. Two deltamethrin sprays (250 mL ha^{-1}) were performed at 7 and 14 days after seeding, respectively, in order to control the fall armyworm (*Spodoptera frugiperda* Smith), the main corn pest in the region. A sidedressing application with 30 kg ha^{-1} N (ammonium sulfate) was made at 20 and 40 days after seeding.

Cultivars AG 1051 and BRS 106 were grown with two hoeings, (at 20 and 40 days after sowing) or without weed control. In order to evaluate crop growth, six collections of corn plants, were performed every 15 days, until 105 days after seeding, with the first collection made 30 days after sowing. Therefore, the experiment consisted of three treatment groups. A randomized complete block design was adopted, with split-split plots (weed control in plots, cultivars in subplots, and collections in sub-subplots) and ten replicates. Each experimental unit consisted of three 6.0 m - long rows. The area employed for evaluation (usable area) was considered as that occupied by the 5.2 m in the central row.

Leaf area was evaluated using three plants from each experimental unit, at 30, 45, 60, 75, and 90 days after sowing, with a model 3100 LICOR (LI-COP, Inc. Lincoln) automatic leaf area integrator. Green matter and dry matter of the root system and the above-ground part were evaluated using ten plants from five pits, at six different ages (from 30 to 105 days after sowing). The root system was collected with a straight shovel by cutting the soil vertically between rows and between pits of the same row at a 25 cm depth. The roots were washed and the excess water was discarded. The above-ground part included stem, leaves, tassels, and ears (if they existed). The materials were weighed, ground in a forage grinder, homogenized, sampled (samples weighed around 500 g) and placed in a forced air circulation oven adjusted at 70 °C until constant weight was achieved.

Four green corn harvests were performed, at intervals of two or three days; the first harvest was accomplished 68 days after planting and the last was made 75 days after planting. Green corn yield was evaluated by the total number and weight of unhusked green ears, and by the number and weight of both unhusked and husked marketable ears. The marketable unhusked ears were considered when with a length equal to or above 22 cm and without blemishes or evident markings of attack by diseases or pests. The marketable husked ears were considered when with a length equal to or above 17 cm that showed health and grain set suitable for commercialization.

Ripe ears were harvested at 105 days after planting. The following parameters were evaluated: number of ears ha^{-1} (based on ears harvested from the usable area), number of kernels ear^{-1} (in ten ears), 100-kernel weight (based on 10 samples), grain yield (based on harvested ears), number of kernel rows (in ten ears), and kernel size (in 20 kernels, measured with a digital caliper rule).

Weed composition and dry biomass of the above-ground part were evaluated at 105 days after sowing. The weeds were collected from a 1.0 m^2 area (four 0.25 m^2 subsamples, obtained with a 0.5 x 0.5 m wooden frame laid randomly at four places in the usable area of each plot). Dry biomass was obtained in a similar way to corn dry biomass. Based on the floristic composition of weeds and their distribution in the experimental field, we calculated the occurrence index, defined as the number of plots where a given species occurred divided by the total number of plots (40, if only plots harvested in the last sampling are considered; 2 cultivars, 2 weed control methods x 10 replicates).

Soil tillage was done by means of two cross harrowings performed with an implement attached to a tractor; sprays were performed with a backpack sprayer, and the other operations were accomplished by hand.

The data were submitted to analysis of variance, using a software developed by the Universidade Federal de Viçosa (SAEG, 1997), while regression analyses were made with a software developed by Jandel (1992). The data were submitted to the variance homogeneity test prior to the statistical analyses (Bartlett, 1937). Since count data tend to follow the Poisson distribution, counts were submitted to the square root transformation prior to being analyzed (Bartlett, 1947). The regression equations were selected based on the following criteria: phenomenon biological, equation simplicity, and equation parameters testing, by Student's test at a 5% probability.

RESULTS AND DISCUSSION

Eighteen weed species occurred in the experiment area, and some were more frequent than others (Table 1). The *Commelina benghalensis* species occurred in 90% of the experimental plots, while species such as *Spigelia anthelmia*, *Turnera ulmifolia*, and *Waltheria indica* occurred in only 3% of the plots. It is important to highlight that more species must have occurred in the field, but they were not included because sampling was conducted at the end of the crop cycle. The distribution of weeds in the experimental field was not uniform (Table 2). For example, the species *Cenchrus equinatus* and *Digitaria sanguinalis* tended to occur more in plots to the right of the experiment area.

Weed control and cultivars had effects on dry matter weight of weeds above-ground part. Hoed plots had weeds with smaller growth than non-hoed plots (Table 3). Weed growth in plots of cultivar AG 1051 was smaller than the growth observed in plots cultivated withcultivar BRS 106, suggesting a higher competitive ability of cultivar AG 1051 towards weeds (Table 3). The influence of corn cultivars over the number of weeds m^{-2} depended on whether hoeings were performed or not. When weeds were hoed, the cultivars did not differ with regard to number of weeds m^{-2} (Table 3). When no hoeing was performed, a smaller number of plants was observed in plots of cultivar AG 1051 (Table 3). Therefore, cultivar AG 1051 controlled weeds better than other cultivars. Regardless of cultivar, hoed plots were inferior to non-hoed ones with regard to number of weeds m^{-2}.

There were effects of weed control (D), cultivars, plant age (I), and of the D x I interaction on leaf area. Cultivar AG 1051 had higher leaf area than cultivar BRS 106 at most ages (Table 4). Such higher leaf area in cultivar AG 1051 relative to other cultivars may have contributed to reduce dry matter of the above-ground part and the number of weeds previously reported, possibly because of greater shading. The D x I interaction occurred due to the fact that increased leaf area due to plant age was higher in hoed plots than in non-hoed ones (Table 4). The leaf area in both cultivars in hoed and non-hoed plots at 75 and 90 days were smaller than those obtained in the samplings made at 45 and 60 days (Table 4). This was certainly due to leaf losses that occurred in the field, during collection, and transport, which take place more easily as plants become older, since senescent leaves dry out and are shed more easily.

The increases in dry matter of the root system and corn plants above-ground part, due to plant age function, were higher in cultivar AG 1051 than in cultivar BRS 106, both with and without hoeing. Nevertheless, increases in those traits in both cultivars in hoed plots were different from those observed in non-hoed plots. In other words, there was an effect of weed control (D), cultivars (C), plant age (I), and of the D x C, D x I, and C x I interactions (Table 4).

There was an effect of the cultivars x weed control interaction (C x D) on the total number and weight of green ears, on the number of marketable unhusked ears and on the weight of marketable husked ears (Table 5). There was no effect of the C x D interaction on the other traits used to assess green ear yield (Table 6). Under weed control, cultivar AG 1051 was better with regard to total weight and husked ear weight (Table 5). Without weed control, this cultivar was better for most traits used to assess green corn yield (Tables 5 and 6), suggesting higher tolerance of cultivar AG 1051 to weeds. Lack of weed control reduced all traits used to assess green corn yield in cultivar AG 1051, except for total

Table 1 **-** Main species of weeds observed in plots cultivated with two corn cultivars, with or without hoeing

Nº	Botanical name	Occurrence index[1/] (%)	Nº	Botanical name	Occurrence index[1/] (%)
1	*Acanthospernum hispidum* L.	8	10	*Ipomoea asarifolia* (Desr.) Roem. et Schult.	18
2	*Alternanthera tenella* Colla	48	11	*Ipomoea* sp.	3
3	*Cenchrus echinatus* L.	25	12	*Merremia aegyptia* (L.) Urban	28
4	*Chamaesyce hirta* (L.) Millsp.	5	13	*Panicum maximum* Jacq.	33
5	*Commelina benghalensis* L.	90	14	*Phyllanthus amarus* Schumach. et Thonn	10
6	*Cucumis anguria* L.	63	15	*Senna obtusifolia* (L.) Irwin et Barneby	5
7	*Dactyloctenium aegyptium* (L.) P. Beauv.	10	16	*Spigelia anthelmia* L.	3
8	*Desmanthus virgatus* (L.) Willd.	8	17	*Turnera ulmifolia* L.	3
9	*Digitaria sanguinalis* (L.) Scop.	23	18	*Waltheria indica* L.	3

[1/] Occurrence index = number of plots where a given species occurred/total number of plots in the experiment (40).

Table 2 **-** Distribution of weeds (numbers in boldface correspond to those in Table 1) in plots cultivated with two corn cultivars (AG 1051 and BR 106), with or without hoeing

Block	Weed control method			
10	No hoeing		With hoeing	
	AG 1051	BR 106	BR 106	AG 1051
	5, 6, 12	**2, 5, 6, 13, 15**	**2, 5, 14**	**1, 2, 3, 5, 9**
9	No hoeing		With hoeing	
	BR 106	AG 1051	AG 1051	BR 106
	5, 6, 10, 13	**5, 10, 13**	**5, 6**	**1, 5, 6, 7, 16**
8	With hoeing		No hoeing	
	BR 106	AG 1051	BR 106	AG 1051
	2, 5, 6	**2, 4, 5, 10**	**3, 5, 6, 10, 13**	**5, 6, 12, 13**
7	With hoeing		No hoeing	
	BR 106	AG 1051	BR 106	AG 1051
	2, 5	**5, 10**	**3, 6, 8, 12, 13**	**5, 6, 12, 13**
6	No hoeing		With hoeing	
	BR 106	AG 1051	AG 1051	BR 106
	2, 5, 6, 12, 13	**5, 12**	**5, 8, 14**	**2, 5, 6, 9**
5	With hoeing		No hoeing	
	BR 106	AG 1051	AG 1051	BR 106
	2, 5	**2, 3, 5, 6, 8**	**2, 3, 5, 6**	**2, 5, 6, 9**
4	With hoeing		No hoeing	
	AG 1051	BR 106	BR 106	AG 1051
	2, 5, 14	**2, 3, 5, 6, 7, 9, 10, 12**	**3, 5, 6, 7**	**3, 5, 6, 9**
3	With hoeing		No hoeing	
	BR 106	AG 1051	AG 1051	BR 106
	4, 5, 6	**5, 6, 9, 1011, 14, 18**	**2, 5, 12, 13, 15**	**5, 6, 13**
2	No hoeing		With hoeing	
	AG 1051	BR 106	AG 1051	BR 106
	5, 12	**12, 13**	**1, 2, 5, 6, 9**	**2, 3, 7, 9**
1	No hoeing		With hoeing	
	AG 1051	BR 106	AG 1051	BR 106
	5, 6, 13	**5, 12, 13**	**2, 5, 6**	**2, 3, 6, 9, 17**

Table 3 **-** Mean dry matter weight of the above-ground part and number of weeds in plots cultivated with two corn cultivars, with or without hoeing

Dry matter of weeds above-ground part				Number of weeds m^{-2}		
Two hoeings	$g\ m^{-2}$	Cultivar	$g\ m^{-2}$	Two hoeings	Cultivar	
					AG 1051	BRS 106
Yes	161.0 b	AG 1051	277.4 b	Yes	45.4 Ab	56.2 Ab
No	435.8 a	BRS 106	319.4 a	No	92.9 Ba	137.7 Aa
CV_{plots}, %	21.0	-	-	-	8.0	
$CV_{subplots}$, %	-	21.0	-	-	10.0	

Means followed by the same lower case letter, in the column, and by the same upper case letter in the row are not different from one another at a 5% probability, by Tukey's test.

Table 4 **-** Mean leaf area values for two corn cultivars, with or without weed control, evaluated at different plant ages

Age (days after sowing, x)	Leaf area (cm^2 per plant)			
	Two hoeings		No hoeing	
	Cultivar			
	AG 1051	BRS 106	AG 1051	BRS 106
30	477	394	468	469
45	3,630	3845	2,399	2,135
60	4,669	4095	3,714	3,449
75	4,266	3939	3,210	2,869
90	3,439	2956	3,087	2,645
CV_{plots}, %	18.6			
$CV_{subplots}$, %	19.8			
$CV_{sub\text{-}subplots}$, %	19.3			
Equation[1/]	$y = 33682.6 - 1080.4\ x/\ln x - 786829.4/x$	$y = -16874.8 - 1242670.0\ x/\ln x - 3810700.0/x$	$y = 12061.0 - 76.7\ x - 1847700.0/x^{1.5}$	$y = 29030.7 - 2133.7\ x^{0.5} - 559284.8/x$
LSD – ca[2/]	336			
LSD – cv[2/]	165			
R^2	0.99	0.98	0.98	0.97

[1/] All regression equation coefficients were significant at a 5% probability by the t test. [2/] LSD – ca and LSD – cv = minimum significant difference by Tukey's test, at a 5% probability, to test hoeings and cultivars at each age, respectively.

number of ears (Table 6), again indicating a higher competitive ability of this cultivar toward weeds. In general, these results agree with those obtained by other authors (Silva et al., 2004a).

With reference to the number of mature ears, the behavior of cultivars was similar to the behavior observed on the total number of green ears (Table 5). In other words, there were effects of cultivars (C), weed control (D), and of the C x D interaction (Table 7). With respect to grain yield and its components (except for number of mature ears) and to other traits relative to ears and grain there were effects of C and D only. The lack of hoeing reduced all those traits, except for 100-kernel weight and grain thickness (Table 7). Cultivar AG 1051 was superior to cultivar BRS 106 with regard to grain yield and its components and to other traits relative to ears and grain, except for 100-kernel weight and grain thickness (Table 8). Decreased grain yield due to lack of weed control, such as observed in this investigation has been found by other authors (Silva et al., 2004a).

The weeds caused decreases in most corn traits evaluated in this study, competing with the crop for growth factors (Carruthers et al., 1998). Below the soil surface, weeds would influence corn behavior by affecting the resources availability (Sreenivas & Satyanarayana, 1996) or by inhibiting corn root access to the resources by allelopathy (Schenk, 2006). Water deficit, caused by

Table 5 **-** Mean dry matter weight of the root system and the above-ground part of two corn cultivars, with or without weed control, evaluated at different plant ages

Age (days after sowing, x)	Dry matter of root system, y (kg ha^{-1})				Dry matter of the above-ground part, y (kg ha^{-1})			
	Two hoeings		No hoeing		Two hoeings		No hoeing	
	Cultivar							
	AG 1051	BRS 106	AG 1051	BRS 106	AG 1051	BRS 106	AG 1051	BRS 106
30	101	105	86	90	504	528	418	442
45	583	469	546	433	2,789	2,429	2,361	2,032
60	820	626	665	471	4,914	4,285	4,341	3,713
75	876	712	683	519	9,306	7,910	6,572	5,176
90	765	584	646	465	10,300	9,651	7,604	6,950
105	780	676	638	535	11,960	10,750	9,653	8,440
CV_{plots}, %	21.5				23.7			
$CV_{subplots}$, %	21.9				17.6			
$CV_{sub-subplots}$, %	18.9				17.1			
Equation[1/]	$y = -31.08\,x + 428.33\,x^{0.5} - 39427.83/x$	$y^2 = -605135.62 + 24970.81\,x - 147.32\,x^2$	$y = -26.3\,x + 358.9\,x^{0.5} - 32227.1/x$	$y^2 = -365581.7 + 15197.7\,x - 89.86\,x^2$	$y^{0.5} = -57.86 + 3.05\,x - 0.014\,x^2$	$\ln y = -0.076\,x + 1.687\,x^{0.5}$	$y = 105.7\,x - 15230.7/x^{0.5}$	$\ln y = -0.069\,x + 1.591\,x^{0.5}$
LSD – ca[2]	33.7				384.4			
LSD – cv[2]	31.9				264.8			
R^2	0.99	0.98	0.98	0.93	0.99	0.99	0.99	0.99

[1/] All regression equation coefficients were significant at a 5% probability by the t test. [2/] LSD – ca and LSD – cv = minimum significant difference by Tukey's test, at a 5% probability, to test hoeings and cultivars at each age, respectively.

Table 6 **-** Mean number and total weight of ears, number of unhusked green ears and marketable husked green ear weight of two corn cultivars, with or without hoeing[1/]

Two hoeings	Total no. of ears ha^{-1}		Total ear weight (kg ha^{-1})		Nº of marketable unhusked ears ha^{-1}		Marketable husked green ear weight (kg ha^{-1})	
	Cultivar							
	AG 1051	BRS 106	AG 1051	BRS 106	AG 1051	BRS 106	AG 1051	BRS 106
Yes	46,875 bA	52,500 aA	14,279 aA	11,787 bA	43,750 aA	44,444 aA	8,433 aA	3,949 bA
No	45,139 aA	41,723 aB	7,338 aB	7,418 aB	33,854 aB	21,250 bB	2,128 aB	1,244 bB
CV_{plots}, %	13.6		14.1		14.0		25.6	
$CV_{subplots}$, %	11.3		15.5		10.5		21.1	

Means followed by the same lower case letter, in the column, and by the same upper case letter in the row do not differ from one another at a 5% probability, by Tukey's test.

competition between roots, would induce stomatal closure, reducing photosynthesis (Silva et al., 2004c) and, consequently, reducing stems, leaves, and ears growth.

Above the soil surface, competition for light between corn and weeds occurs, but, apparently, such competition does not take place directly by photon flux density (Rajcan & Swanton, 2001), since the most weeds height is lower than corn height. However, even without casting shade over corn plants, weeds influence corn growth via the radiation reflected by them. Plants absorb red light radiation (660-670 nm) and reflect far-red radiation (730 to 740 nm). The FR/R ratio plays an important role in the induction of many morphological changes in plant architecture (stem elongation, apical dominance, reduced branching, thinner leaves, leaf area distribution, etc.) (Ballaré et al., 1990; Ballaré, 1999). Additionally, weeds would influence the photosynthetic activity of corn via leaf area reduction, observed both in this study and by other authors (Silva et al., 2009), caused by weed root interference over corn roots. Another way by which weeds would influence growth of corn plants above-ground part would be via emission of biogenic volatile organic compounds. These compounds may act both as allelochemicals and as signals for detection of neighboring plants (Kegge & Pierik, 2009).

Table 7 - Mean weight of unhusked green ears and number of marketable husked green ears of two corn cultivars, with or without hoeing

Two hoeings	Weight of marketable unhusked ears (kg ha^{-1})	No. of marketable husked ears ha^{-1}	Cultivar	Weight of marketable unhusked ears (kg ha^{-1})	No. of marketable husked ears ha^{-1}
Yes	12,227 a	31,133 a	AG 1051	10,833 a	30,052 a
No	6,174 b	14,896 b	BRS 106	7,567 b	15,976 b
CV_{plots}, %	17.3	17.8	-	-	-
$CV_{subplots}$, %	-	-	-	12.6	23.2

Means followed by the same letter are not significantly different at a 5% probability, by Tukey's test.

Table 8 - Mean number of mature ears ha^{-1}, grain yield, number of kernels ear^{-1}, 100-kernel weight, number of kernel rows per ear and kernel size of corn cultivars, with or without hoeing

Two hoeings	Number of ears ha^{-1}		Grain yield (kg $ha^{-)}$)	Number of kernels ear^{-1}	100-kernel weight (g)	No. of kernel rows ear^{-1}	Kernel size (mm)		
	Cultivar								
	AG 1051	BRS 106					Length	Width	Thickness
Yes	48,150 Ba	56,939 Aa	6,602 a	368.2 a	29.7 a	13.3 a	11.6 a	9.0 a	4.0 a
No	45,875 Aa	49,165 Ab	4,223 b	276.6 b	27.8 a	12.5 b	11.0 b	8.8 b	3.9 a
CV_{plots}, %	12.6		12.7	15.4	9.1	4.1	4.5	2.6	16.7

Means followed by the same lower case letterand by the same upper case letter in the column do not differ from one another at a 5% probability, by Tukey's test.

Table 9 - Grain yield, number of kernels ear^{-1}, 100-kernel weight, number of kernel rows per ear, and corncob length and diameter of corn cultivars

Cultivar	Grain yield (kg $ha^{-)}$)	Number of kernels ear^{-1}	100-kernel weight (g)	No. of kernel rows ear^{-1}	Kernel size (mm)		
					Length	Width	Thickness
AG 1051	6007 a	368.2 a	29.2 a	14.5 a	11.9 a	9.1 a	4.0 a
BRS 106	4819 b	274.9 b	28.3 a	11.3 b	10.7 b	8.7 b	3.9 a
$CV_{subplots}$, %	13.4	16.3	10.0	4.7	7.1	2.4	13.9

Means followed by the same letter are not different at a 5% probability, by Tukey's test.

It can be concluded that eighteen weed species occurred more frequently in the experiment area, with a non-uniform distribution. Increased values of corn leaf area, above-ground part and root system, due to plant age function, were smaller in non-hoed plots than in hoed plots, and were dependent upon cultivar. The lack of weed control increased dry matter of weeds above-ground part and decreased green ear yield and grain yield. Cultivar AG 1051 had higher increases in leaf area, above-ground part of the plant and root system, due to plant age function, and controlled weeds better than cultivar BRS 106. In addition, cultivar AG 1051 was superior to other cultivars with respect to most traits used for green corn yield and grain yield assessment.

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