PLANTING DENSITY OF GLIRICIDIA WHEN INTERCROPPED WITH CORN FOR WEED CONTROL[1]

Densidade de Plantio da Gliricídia em Consórcio com Milho, para Controlar Plantas Daninhas

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ABSTRACT - Reduced use of herbicides that cause environmental pollution problems is of great interest in modern agriculture. Soil mulching with gliricidia (*Gliricidia sepium*) branches does not have an allelopathic effect on corn, but decreases weed populations. The objective of this study was to evaluate the effects of gliricidia planting density, when grown as an intercrop, on weed control and corn yield parameters. A randomized block design with split-plots and ten replicates was adopted. Corn cultivars AG 1051 and BM 3061 were grown without hoeing, with two hoes (at 24 and 44 days after planting), and intercropped with gliricidia (planted simultaneously with corn, between crop rows, using two seedlings/pit, spaced at 30, 40, or 50 cm). Twenty-one weed species were found in the experimental area. Increased gliricidia planting density reduced weed biomass, but no difference was found between weed biomass in the intercrop and weed biomass in non-hoed corn. Gliricidia intercropped with corn, planted at a row spacing of 30 cm, did not significantly differ from hoed corn in most characteristics considered to evaluate green corn yield, although mean values were smaller. As to the number and weight of marketable green ears, reductions of 5% and 13%, respectively, were observed. Intercropping caused a 17% reduction in grain yield, reducing the losses (36%) observed in non-hoed corn by more than 50%. The highest green ear yield and grain yield values were obtained with two hoeings, while the lowest values were observed for non-hoed corn. The cultivars did not differ regarding green ear yield and grain yield.

Keywords: *Zea mays*, *Gliricidia sepium*, green ear yield, grain yield.

*RESUMO - A redução do uso de herbicidas, em razão dos problemas de poluição ambiental, é de grande interesse da agricultura moderna. A cobertura do solo com ramos de gliricídia (**Gliricidia sepium**) não tem efeito alelopático no milho, mas diminui a população de plantas daninhas. O objetivo deste trabalho foi avaliar os efeitos da densidade de plantio da gliricídia, em consorciação, sobre o controle de plantas daninhas e sobre os rendimentos do milho. Utilizou-se o delineamento de blocos casualizados com parcelas subdivididas e dez repetições. Os cultivares de milho AG 1051 e BM 3061 foram cultivados sem capinas, com duas capinas (aos 24 e 44 dias após o plantio) e consorciados com a gliricídia (plantada por ocasião do plantio do milho, entre as fileiras da gramínea, usando-se duas mudas/cova, distanciadas de 30, 40 ou 50 cm). Vinte e uma espécies de plantas daninhas ocorreram na área experimental. O aumento da densidade de plantio da gliricídia reduziu a biomassa das plantas daninhas, porém não houve diferença entre biomassa de plantas daninhas dos consórcios e biomassa de plantas daninhas do milho não capinado. Na maioria das características avaliadoras do rendimento de milho-verde, a consorciação com a gliricídia, plantada no espaçamento de 30 cm, não diferiu significativamente do milho capinado, embora as médias tenham sido menores. No número e peso de espigas verdes comercializáveis, as reduções com essa consorciação foram de 5% e 13%, respectivamente. No rendimento de grãos, a consorciação referida causou redução de 17%, diminuindo em mais da metade as perdas (36%) observadas no milho não capinado. Os maiores rendimentos de espigas verdes e de grãos foram obtidos com duas capinas, e os menores, quando o milho não foi capinado. Os cultivares não diferiram quanto ao rendimento de espigas verdes e de grãos.*

Palavras-chave: *Zea mays*, *Gliricidia sepium*, rendimento de espigas verdes, rendimento de grãos.

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INTRODUCTION

Corn is cultivated in all the 167 municipalities of the state of Rio Grande do Norte, Brazil, either to obtain green ears or dry grain (Gomes et al., 2007) and occupies, on average, 82.6 thousand hectares of planted area, with a dry grain yield of 545 kg ha^{-1} (CONAB, 2007). This crop was exploited mainly in small agricultural properties in the state but has recently attracted the interest of large fruit growing companies that cultivate melon plants (*Cucumis melo*) under irrigation during the dry season and exploit corn during the rainy season. Interest in corn in the region resulted from its easy cultivation, without significant problems with pests, diseases, and lodging, as well as from the great demand for its products (green ears, grain, and straw).

Weeds reduce corn yield, can be hosts to pests and pathogens, make harvest difficult, and can depreciate the quality of the harvested product. Several studies have demonstrated the interference of plants in corn crops (Borghi et al., 2008; Freitas et al., 2008; Trezzi et al., 2008). In the Northeastern region of Brazil, weed control is performed mainly with a hoe, but in large agricultural companies, herbicides are frequently used. It is possible that interest for herbicides has increased in smaller properties, at least in some areas.

Herbicides have simplified weed control, becoming extensively used, replacing cultural weed control methods in several regions. However, the extensive use of herbicides has resulted in the selection of weed biotypes resistant to these products. Such biotypes already exist at low frequencies in cultivated areas; however, because they are resistant to herbicides, at each generation they leave a higher number of offspring than of non-resistant biotypes. Consequently, after a few generations, the proportion of resistant biotypes present in the weed population tends to increase. In addition, herbicides have become an environmental contamination factor. The weed control practices studied in the past have again gained interest (Nalewaja, 1999) and are once again being studied (Borghi et al., 2008; Trezzi et al., 2008), including intercrops (Abreu, 2004; Freitas et al., 2008). Reducing the use of herbicides is one of the major goals of modern agriculture (Ngouajio et al., 1999) and several alternatives are currently being investigated with this objective (Carruthers et al., 1998).

Gliricidia (*Gliricidia sepium*) is a perennial, fast-growing legume native to Mexico (Drumond & Carvalho Filho, 2005). It is used for soil recovery in agro-forestry systems, for animal nutrition as a source of timber, and as a medicinal plant (Drumond & Carvalho Filho, 2005). Soil mulching with *G. sepium* and *Senna siamea* branches reduced weed density and biomass, while mulching with *Leucaena leucocephala* de Wit had a smaller effect on the reduction of those traits (Kamara et al., 2000). No data were found in the consulted literature comparing soil mulching and intercropping in corn. In rice, it was observed that the application of wheat residues as soil mulch and intercropping with *Sesbania rostrata* were equally effective in controlling weeds (Singh et al., 2007). There have been recent indications that gliricidia intercropped with cotton (Silva et al., 2009a) or corn (Silva et al., 2009b), planted at 0.50 m spacing between rows in both crops does control weeds. Increased planting density in other intercropped species resulted in greater weed suppression (Aladesanwa & Adigun, 2008; Fujiyoshi et al., 2007).

There is interest in verifying whether increases in gliricidia planting density would increase weed control. Therefore, the objective of this study was to evaluate the effects of increased gliricidia planting densities, when intercropped with corn, on weed control and on corn green ear yield and grain yield.

MATERIAL AND METHODS

The studies were conducted at "Rafael Fernandes" Experimental Farm, Universidade Federal Rural do Semi-Árido (UFERSA), in the period from July to December 2007. This farm is located in the district of Alagoinha, 20 km from the municipality of Mossoró-RN (latitude 5° 11' S, longitude 37° 20' W, and 18 m elevation). The soil in the experimental area, classified as Red-Yellow Argisol (PVA) (Embrapa, 1999), was analyzed and indicated the following results: pH = 6.40; P = 27.46 mg dm^{-3}; K^+ = 0.23 $cmol_c$ dm^{-3}; Ca^{2+} = 3.40 $cmol_c$ dm^{-3}; Mg^{2+}

=1.50 $cmol_c$ dm^{-3}; Al^{3+} = 0.00 $cmol_c$ dm^{-3}; Na^+ = 0.31 $cmol_c$ dm^{-3}; organic matter = 0.93 g kg^{-1}; and Sum of bases = 5.44 $cmol_c$ dm^{-3}. Weed control in this area, where corn or cowpea (*Vigna unguiculata*) were previously grown, has always been achieved by means of two hoeings, performed at 20 and 40 days after seeding.

The soil was tilled by means of two harrowings, and fertilization at sowing consisted of 30 kg ha^{-1} N (ammonium sulfate), 60 kg ha^{-1} P_2O_5 (single superphosphate) and 30 kg ha^{-1} K_2O (potassium chloride). Corn was seeded on 07.12.2007, with four seeds per pit. A spacing of 1.0 m was used between rows, with pits on the same row spaced at 0.40 m. Presently, there is a tendency to use smaller spacing between rows for weed control (Trezzi et al., 2008). However, studies accomplished in the area where this experiment was conducted showed that the ideal planting density for corn is, in general, from 40 to 50 thousand plants ha^{-1} (Silva & Silva, 1985; Silva et al., 2007). Thinning was performed 24 days after sowing, leaving the two more vigorous plants in each pit. Thus, after thinning, the programmed population stand in the experimentl area was 50 thousand plants ha^{-1}.

A randomized block design in split-plots with ten replicates was adopted. Each subplot consisted of four 6.0 m-long rows. The area occupied by the two central rows was considered as usable area, and one pit at the end of each central row was eliminated. Cultivars AG 1051 and BM 3061 were submitted to the following treatments: no hoeing; two hoeings (at 24 and 44 days after sowing, DAS); and corn intercropped with gliricidia. The intercropped gliricidia was planted at corn planting, between the corn rows, using two seedlings/pit, spaced at 30, 40 or 50 cm, corresponding to planting densities of 66,666, 50,000, or 40,000 plants ha^{-1}, respectively. Cultivars were assigned to plots and weed control was assigned to subplots. After each hoeing, side-dressing fertilizations with 30 kg ha^{-1} N (ammonium sulfate) were applied.

The gliricidia seedlings were produced in trays with 35 ml-volume cells. The substrate used consisted of 1/3 humus (pH = 7.9; P = 120.1 mg kg^{-1}; K^+ = 0.67 $cmol_c$ dm^{-3}; Ca^{2+} = 19.5 $cmol_c$ dm^{-3}; Mg^{2+} = 15.00 $cmol_c$ dm^{-3}; Al^{3+} = 0.00 $cmol_c$ dm^{-3} ; Na^+ = 0.19 $cmol_c$ dm^{-3} ; Zn = 6.83 mg kg^{-1}; Fe = 1.75 mg kg^{-1}; Mn = 14.62 mg kg^{-1} and organic matter = 29.79 g kg^{-1}) and 2/3 of soil with the following characteristics (pH = 7.2; P = 51.97 mg kg^{-1}; K^+ = 0.20 $cmol_c$ dm^{-3}; Ca^{2+} = 4.50 $cmol_c$ dm^{-3}; Mg^{2+} = 1.60 $cmol_c$ dm^{-3}; Al^{3+} = 0.00 $cmol_c$ dm^{-3} ; Na^+ = 0.10 $cmol_c$ dm^{-3}; organic matter = 14.65 g kg^{-1}). The seedlings were transferred to the field three days after seed germination.

The fall armyworm (*Spodoptera frugiperda*), this crop's main pest in the region, was controlled with two sprays of clorpirifos (100 mL ha^{-1}) at 18 and 30 DAP. The experiment was sprinkler-irrigated, with experimental plots arranged perpendicularly in relation to the row of sprinklers. The daily water depth required for corn (5.6 mm) was calculated considering an effective depth of the root system of 0.40 m. Irrigation time was based on water retained by the soil at a tension of 0.40 Mpa. A two-day watering schedule was adopted, with three weekly applications. Irrigation was initiated after planting and suspended 15 days before harvesting the dry corn.

The corn characteristics evaluated were: plant and ear height, area of the leaf associated with the ear, green corn yield, and grain yield and its components. Plant height and ear height were measured in fifteen plants taken at random from the usable area of each plot at green ear harvest (88 DAS) and at ripe ear harvest (125 DAS). The distance from ground level to the insertion point of the highest leaf blade was considered as plant height. Ear height was measured from ground level to the base of the tallest ear (first ear, in the case of prolific plants). Three leaves, each associated with the ear of three plants, taken at random from the usable area of the plot, were employed to determine mean leaf area. This area was obtained by multiplying leaf length x leaf width x 0.76 (Vieira Junior et al., 2006). One of the usable rows was selected at random for green ear yield assessment, and the other was used for grain yield assessment. The green corn was harvested at three stages, 82, 86, and 92 days after sowing. Yield was evaluated by the total number and weight of ears and number and weight of marketable, unhusked, and husked ears. Marketable unhusked ears were considered as those having an aspect suitable for commercialization and length equal to or above 22 cm. Marketable husked ears were considered as those displaying health and grain set suitable for commercialization, and with a length equal to or above 17 cm. Dry corn was harvested at 103 DAS. Evaluations were made for number of ears ha^{-1} (based on ears harvested from the usable area of one of the usable rows), number of kernels ear^{-1}, number of kernel rows ear^{-1}, and 100-grain weight (in 10 samples). Grain yield was corrected for 15.5% water content (wet basis). No phyto-sociological survey was performed on the weeds present in the experimental area before the experiment was installed.

The gliricidia plants were collected at 95 DAS by cutting the plants even with the ground, in the entire usable area of each subplot. A 500 g sample was placed in a forced air circulation oven adjusted to 70 to 75 ºC, to estimate dry biomass of the above-ground part.

Weeds were collected at 105 DAS, after harvesting the ripe ears, in a 1.0 m x 0.8 m area in the center of each experimental unit, for botanical identification. Dry biomass of the above-ground part of those plants was collected and estimated in a similar way as for gliricidia plants.

The data were submitted to analysis of variance using the SISVAR version 5.0 software, developed by Universidade Federal de Lavras (Ferreira, 2003), while regression analysis was carried out with the software developed by Jandel (1992). The data were submitted to the variance homogeneity test before conducting the statistical analyses (Bartlett, 1937). Before the analysis of variance was performed, the corresponding data were transformed to square root (Bartlett, 1947), as weed count tended to follow the Poison distribution.

RESULTS AND DISCUSSION

The idea of planting seedlings instead of using direct gliricidia sowing rose from the need to obtain a rapid establishment of plants in the field, providing greater gliricidia competition with weeds. The use of transplanting as a weed control method is not new. It has been successfully attempted in corn (Oswald et al., 2001; Oswald & Ranson, 2003) for the control of *Striga hermonthica*, a species that parasitizes the roots of corn and other grasses. In this case, it was observed that transplanting of the main crop itself was an effective method to enhance corn yield and reduce *Striga* infestation (Oswald et al., 2001; Oswald & Ranson, 2003). Although seedling production and transplanting increase production costs, transplanting methods have been developed for areas under irrigation and intensively mechanized corn cultivation systems (Maranthée, 1991). Similar methods can be potentially developed for other species in which transplanting is advantageous for weed control. In addition, when analyzing transplanting costs, it can be interesting to take into account the environmental benefits and the potential to obtain higher prices for products grown without the use of herbicides. There has been increased interest worldwide for healthier products (Guivant, 2003). Anyhow, the idea of sowing gliricidia directly, as well as its vegetative propagation, can and should be tested for weed control.

Twenty-two weed species occurred in the experiment (Table 1). The species *Digitaria sanguinalis*, which occurred in practically all experimental units, was the most frequent, while 25% of the species occurred in only 1% of the experimental units (data not shown). The weed population that occurs in a given area depends on several factors (soil, climate, etc.) and although the population comprises different species, few of them are predominant, and correspond from 70 to 90% of the species total (Buhler, 1999).

No effect was found for the interaction between cultivars x "weed control treatments" in any of the characteristics evaluated. For this reason, only means for the main effects of both treatment groups are presented here.

The cultivars did not differ significantly with respect to the evaluated characteristics (cultivar means in Tables 2 to 5), except for ear height. Cultivar AG 1051 had plants with greater ear height (103 cm) than cultivar BM 3061 (95 cm).

The dry biomass values for the above-ground part of weeds when two hoeings were performed were smaller than those obtained

Table 1 - Occurrence index (number of plots where a certain weed species occurred/total number of experimental plots) for weed species identified in the experiment

Species name	Occurrence index (%)
Adenocalymma sp.	8
Alternanthera tenella Colla	12
Amaranthus viridis L.	49
Cenchrus echinatus Steud. ex Döll	6
Commelina benghalensis L.	74
Cucumis anguria L.	40
Dactyloctenium aegyptium (L.) P. Beauv.	3
Digitaria sanguinalis (L.) Scop.	96
Herissantia crispa (L.) Brizicky	7
Hyptis suaveolens (L.) Poit.	1
Ipomoea asarifolia (Desr.) Roem. Et Schult.	2
Ipomoea bahiensis Willd. ex Roem et Schult.	63
Merremia aegyptia (L.) Urb.	14
Mimosa quadrivalvis var leptocarpa (DC.) Barneby	1
Mitracarpus sp.	2
Physalis angulata L.	1
Senna obtusifolia (L.) H. S. Irwin et Barneby	1
Sida spinosa L.	4
Trianthema portulacastrum L.	2
Turnera ulmifolia L.	1
Waltheria indica L.	2

with the other treatments, which were not different from one another (Table 2). However, considering gliricidia row spacing as an independent variable and weed dry biomass as a dependent variable, the regression analysis indicated that reductions in gliricidia spacing resulted in weed biomass reductions (Table 3). Reductions in weed density and biomass as planting density of the intercropped species increased were also observed by other authors (Fujiyoshi et al., 2007; Aladesanwa & Adigun, 2008).

There were no differences between the "weed control treatments" as to the final number of plants and biomass of the above-ground part of gliricidia (Table 2), indicating that part of the gliricidia plants was suppressed by the weeds and perhaps by corn. In addition, there were no differences between treatments with regard to plant height and ear height (Table 2). This was also observed by Silva et al., (2008). Because weeds compete with crops for water, light, and nutrients, smaller corn plants are expected in plots where no weed control is performed. It is expected that when no differences in plant height and ear height are observed in hoed and non-hoed corn in competition with weeds, corn plants may show some degree of etiolation (Hartmann et al., 2001), at least at their initial growth stages. At those stages, corn competition with weeds for light should be higher. Anyhow, several researchers (Silva et al., 2004a, b; Gomes et al., 2007) have observed reductions in corn plant height due to competition with weeds.

Leaf area was higher in hoed corn as compared to the other treatments, which were not different from one another (Table 2). It is important to point out that in corn intercropped with gliricidia planted at a row spacing of 30 cm, corn leaf area did not differ from that obtained in hoed corn. Considering gliricidia row spacing as independent variable and corn leaf area as dependent variable (Table 3), the regression analysis indicated that decreased gliricidia planting density in the intercrop contributed to reduce in corn leaf area, probably favoring corn competition with weeds.

Green corn was harvested in three stages, 70, 72, and 75 days after sowing. The Tukey's test indicated an effect of the "weed control treatments" on all characteristics employed to evaluate green ear yield, except for total number of green ears (Table 4). For characteristics where these treatments showed an effect (total green ear weight and number and weight of unhusked and husked marketable green ears), the highest yield values were obtained with hoed corn, while the lowest were obtained with non-hoed corn. In those characteristics, corn intercropped with gliricidia spaced at 30 cm did not differ from hoed corn, although smaller yield values were obtained. That is, those yield values were 5% lower, on average, for number of marketable unhusked and husked ears, and 13% smaller for total ear weight and for marketable unhusked and husked ear weight. In those characteristics, the fitted equations (Table 3) indicated that reductions in gliricidia row spacing contributed to increase corn green ear yield values. Negative effects on corn green ear yield due to weeds were also observed by Gomes et al. (2007), Silva et al. (2004a) and Silva et al. (2008).

Table 2 - Means for above-ground dry biomass of weeds, number of plants, and above-ground dry biomass of gliricidia, plant height, and corn ear height after harvesting green and ripe ears, and leaf area of corn cultivars as a function of weed control (means of ten replicates and two cultivars)[1/]

Weed control methods[2/]	Dry weed biomass (g m^{-2})	Number of gliricidia (plants m^{-2})	Dry gliricidia biomass (g per plant)	Height after green corn harvest (cm)		Height after ripe corn harvest (cm)		Leaf area after green corn harvest (cm^2 leaf^{-1})
				Plant	Ear insertion	Plant	Ear insertion	
With hoeing	140 b	-	-	184 a	102 a	183 a	104 a	514 a
Intercropped with gliricidia at a 30 cm spacing	360 a	17.80 a	1.61 a	184 a	102 a	183 a	100 a	452 ab
Intercropped with gliricidia at a 40 cm spacing	386 a	17.00 a	2.01 a	177 a	99 a	178 a	97 a	426 b
Intercropped with gliricidia at a 50 cm spacing	418 a	15.35 a	1.87 a	181 a	101 a	181 a	98 a	422 b
No hoeing	362 a	-	-	175 a	94 a	178 a	95 a	438 b
Cultivar means	338	16.72	1.83	181	100	181	99	450
CVplots, %	45.22	93.65	49.99	13.32	14.62	11.88	18.10	15.10
CVsubplots,%	43.62	47.89	52.16	8.87	13.27	8.98	11.81	16.75

[1/] Means followed by the same letter are not significantly different at 5% probability by the Tukey's test.
[2/] In intercrops, three-day-old gliricidia seedlings were planted between the corn rows at corn seeding.

Table 3 - Regression equations fitted considering the row spacing between gliricidia plants grown between corn rows to control weeds (x, in cm) as independent variable, and weed biomass, leaf area, and corn green ear yield and grain yield as dependent variables (y)

Characteristic evaluated (y)	Regression equations fitted considering the row spacing (0.30; 0.40; and 0.50 m) between gliricidia plants grown between corn rows[1/]	$R^{2/}$
Dry weed biomass (g m^2)	$y = 273.2 + 2.87\ x$	0.99
Corn leaf area (cm^2 leaf^{-1})	$y = 402.0 + 43996.8/x^2$	0.96
Total no. of green ears ha^{-1}	$y = 49015$	-
Total green ear weight (kg ha^{-1})	$y^2 = 146965140 + 60643347000/x^2$	0.85
No. of marketable unhusked green ears ha^{-1}	$y^2 = 1593563300 + 470097870000/x^2$	0.93
Weight of marketable unhusked green ears (kg ha^{-1})	$y^2 = 127104180 + 65982257000/x^2$	0.87
No. of marketable husked green ears ha^{-1}	$y^2 = 900827600 + 597810430000/x^2$	0.91
Weight of marketable husked green ears (kg ha^{-1})	$y^2 = 34947036 + 33246116000/x^2$	0.91
Grain yield (kg ha^{-1})	$y = 6654$	-

[1/] The coefficients of all equations were significant at 5% probability by the t test.

Table 4 - Means for green ear yield of corn cultivars as a function of weed control (means of ten replicates and two cultivars)[1/]

Weed control methods[2/]	Green ear totals ha^{-1}		Marketable unhusked green ears ha^{-1}		Marketable husked green ears ha^{-1}	
	Number	kg	Number	kg	Number	kg
With hoeing	51.613 a	17016 a	48.620 a	16606 a	41.909 a	9784 a
Intercropped with gliricidia at a 30 cm spacing	50.387 a	14774 ab	46.209 ab	14296 ab	39.942 ab	8581 ab
Intercropped with gliricidia at a 40 cm spacing	47.875 a	13226 b	42.834 ab	12595 b	34.674 bc	7200 bc
Intercropped with gliricidia at a 50 cm spacing	48.783 a	13347 b	42.629 ab	12657 b	34.478 bc	7131 bc
No hoeing	47.946 a	12550 b	40.195 b	11765 b	31.801 c	6518 c
Cultivar means	49.321	14183	44098	13584	36561	7843
CVplots, %	16.45	30.47	26.39	35.22	24.07	34.36
CVsubplots, %	11.50	19.87	16.62	22.55	22.01	26.69

[1/] Means followed by the same letter are not different at 5% probability by the Tukey test.
[2/] In intercrops, three-day-old gliricidia seedlings were planted between the corn rows at corn seeding.

The Tukey's test indicated an effect of "weed control treatments" on grain yield and its components (Table 5). The highest means were observed in hoed corn, while the lowest values were found in non-hoed corn; the same occurred with most characteristics employed to evaluate green corn. A corn grain yield loss of 17% was determined for gliricidia planted at a 30 cm row spacing, while a 36% loss was observed for corn grown without hoeing. Similarly, other authors (Silva et al., 2004b; Gomes et al., 2007) have also observed grain yield losses caused by weeds.

The lowest means in almost all characteristics evaluated for corn were found in non-hoed corn. This may have occurred due to corn competition with weeds for water, light, and nutrients, but also or mainly because weeds cause reduction in the corn root system (Thomas & Alisson, 1975) and leaf area, such as those observed in the present work (Table 4), and may produce allelopathic substances (Rajcan & Swanton, 2001).

The means obtained with gliricidia cultivated at the lowest planting density for leaf area and for five of the six characteristics used for green ear yield assessment, although smaller, did not differ from the means obtained with hoed corn (Table 4). With regard to grain yield, the highest mean among the treatment means where corn was not hoed or was intercropped was obtained with gliricidia planted at a row spacing of 30 cm (Table 5). However, no significant reduction in dry biomass of the above-ground part of weeds was obtained when gliricidia was planted at the 30 cm row spacing (Table 2). A beneficial effect of gliricidia via nitrogen fixation does not seem very likely, considering the reduced gliricidia growth and permanence when planted in association with corn. It is more likely or acceptable that the beneficial effect of gliricidia on corn occurred via weed control. This indication is supported by the fact that mean weed species richness (measured by the number of weed species that occurred in each experimental unit) was 7.8% higher in non-hoed plots than in plots where gliricidia was planted at a 30 cm density (data not shown). At least 15 toxic substances were identified in the above-ground part of gliricidia that could have allelopathic action (Ramamoorthy & Paliwal, 1993).

It is interesting to note that the effects of intercropping with gliricidia on green corn and on grain yield assume different forms. Two facts can explain this difference. When corn is harvested "green", competition with weeds is smaller. In addition, ears that cannot be consumed as green corn can be utilized without problem when the objective is to obtain dry grain.

It can be concluded that increased gliricidia planting density reduced weed biomass, but there was no difference between weed biomass in the intercrops and weed biomass in non-hoed corn. Gliricidia intercropped with corn, planted at a row spacing of 30 cm, did not significantly differ from hoed corn in most characteristics used

Table 5 - Means for grain yield and its components in corn cultivars as a function of weed control (means of ten replicates and two cultivars)[1/]

Weed control methods[2/]	Number of ears ha^{-1}	Number of kernels ear^{-1}	100-kernel weight (g)	Grain yield (kg ha^{-1})
With hoeing	48595 a	513 a	38 a	8540 a
Intercropped with gliricidia at a 30 cm spacing	47024 ab	469 a	35 ab	7056 b
Intercropped with gliricidia at a 40 cm spacing	45776 ab	457 b	34 b	6214 bc
Intercropped with gliricidia at a 50 cm spacing	46213 ab	467 ab	35 ab	6692 bc
No hoeing	41792 b	435 b	34 b	5453 c
Cultivar means	45880	469	36	6792
CVplots, %	12.86	13.24	9.84	27.38
CVsubplots, %	15.03	13.49	9.52	23.19

[1/] Means followed by the same letter are not different at 5% probability by the Tukey test.

[2/] In intercrops, three-day-old gliricidia seedlings were planted between the corn rows at corn seeding.

to evaluate green corn yield, although it provided smaller mean values. A 5% reduction in number of marketable green ears was obtained with the intercrop. A 13% reduction in marketable green ear weight was also obtained. Intercropping caused a 17% reduction in grain yield, reducing the losses (36%) observed in non-hoed corn by more than 50%. The highest green ear yield and grain yield values were obtained with two hoeings, while the lowest values were observed for non-hoed corn. The cultivars did not differ with regard to green ear yield and grain yield.

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