REVISTA CAATINGA — ISSN 0100-316X
UNIVERSIDADE FEDERAL RURAL DO SEMI-ÁRIDO (UFERSA)
Pró-Reitoria de Pesquisa e Pós-Graduação

PLANTING TIMES OF COWPEA INTERCROPPED WITH CORN IN THE WEED CONTROL

Paulo Igor Barbosa e Silva
Estudante do curso de Doutorado da UFV – Universidade Federal de Viçosa. E-mail: pauloigor@alunos.ufersa.edu.br

Paulo Sérgio Lima e Silva
Professor Adjunto, Departamento de Ciências Vegetais da UFERSA, Bolsista do CNPq, Caixa Postal 137, 59625-900, Mossoró-RN, Brazil, e-mail: paulosergio@ufersa.edu.br (corresponding author)

Odaci fernandes de Oliveira
Professor Adjunto, Departamento de Ciências Vegetais da UFERSA, Caixa Postal 137, 59625-900, Mossoró-RN, Brazil, e-mail: odaci@servpro.com.br

Roberto Pequeno de Sousa
Professor Adjunto, Departamento de Ciências Vegetais da UFERSA, Caixa Postal 137, 59625-900, Mossoró-RN, Brazil, e-mail: rpequeno@ufersa.edu.br

ABSTRACT - Corn yield losses caused by weeds may reach up to 80%. Reducing the use of herbicides is one of agriculture's major goals and several alternatives are currently being investigated, including intercropping. In the Brazilian Northeast, corn intercropping with cowpea (*Vigna unguiculata* (L.) Walp.) is extensively practiced, and there is interest in evaluating weed control under this type of intercropping. The objective of this work was to evaluate the effects of different cowpea planting times, intercropped with corn, on green ear yield of two corn cultivars. The experiment was carried out under randomized design blocks with four replications. AG 1051 and AG 2060 corn cultivars were submitted to the following treatments: no hoeing, two hoeings (20 and 40 days after planting), and cowpea planting (BR 4 – Mulato cultivar, with indeterminate growth) at corn planting and at 5, 10, and 15 days later. Twenty-eight weed species were found in the experiment area. In all characteristics evaluated, except for plant height, ear height, and total number of green ears, where no difference occurred between treatments, the lack of weeding determined the smallest means, while weed control determined the highest. In plots where cowpea was sown, intermediate means were obtained for number and weight of marketable unhusked green ears and for number and weight of marketable husked ears. This suggests that cowpea controlled weeds to a certain extent, especially when it is planted earlier, which was, however, insufficient to avoid green ears yield loss. The corn cultivars evaluated were not different among themselves, except with regard to ear height. The cowpea grain yields were practically null in all plots.

Key words: *Zea mays, Vigna unguiculata,* green corn

ÉPOCAS DE SEMEADURA DO FEIJÃO-CAUPI EM CONSORCIAÇÃO COM O MILHO NO CONTROLE DE PLANTAS DANINHAS

RESUMO - As perdas de produção do milho devidas às plantas daninhas podem atingir até 80 %. A redução do uso de herbicidas é um dos maiores interesses da agricultura e várias alternativas estão sendo investigadas, inclusive a consorciação de culturas. No Nordeste brasileiro, a consorciação do milho com o feijão-caupi (*Vigna unguiculata* (L.) Walp.) é extensivamente praticada, sendo de interesse a avaliação do controle de plantas daninhas com esse tipo de consórcio. O objetivo do trabalho foi avaliar os efeitos de períodos distintos de implantação do feijão-caupi, em consorciação com o milho, sobre os rendimentos de espigas verdes de duas cultivares de milho. O experimento foi realizado em blocos ao acaso com quatro repetições. As cultivares de milho AG 1051 e AG 2060 foram submetidas aos seguintes tratamentos: sem capinas, duas capinas (20 e 40 dias após o plantio) e plantio do feijão-caupi (cultivar BR 4 - Mulato, de crescimento indeterminado) por ocasião do plantio do milho e aos 5, 10 e 15 dias depois. Vinte e oito espécies de plantas daninhas ocorreram na área experimental. Em todas as características avaliadas, exceto nas Alturas da planta e de inserção da espiga, onde não existiram diferenças entre tratamentos, a falta de controle das plantas daninhas determinou as menores médias e o controle de plantas daninhas, as maiores. Nas parcelas onde o feijão-caupi foi semeado, médias intermediárias foram observadas no número e peso de espigas comercializáveis, empalhadas e despalhadas. Isso sugere que a leguminosa controlou as plantas daninhas em certa extensão, especialmente quando plantada precocemente, que foi, todavia, insuficiente para evitar perda do rendimento de espigas verdes do milho. As cultivares de milho avaliadas não diferiram entre si, exceto quanto à altura de inserção da espiga. O rendimento de grãos do feijão-caupi foi praticamente nulo em todas as parcelas.

Palavras-chave: *Zea mays*, *Vigna unguiculata*, milho verde

INTRODUCTION

Corn (*Zea mays* L.) is grown in all Brazilian states, for green ear and grain production. Green corn is a product much appreciated by Brazilians, and is also used in the preparation of typical dishes. In the Northeastern region of Brazil, corn used to be considered a subsistence crop by most growers, with great socioeconomic importance, but started to be explored as well by large companies, which practice for-export agriculture. Until recently, the crop was explored mainly under dryland conditions, but the corn irrigated area has been expanding, due to incentives offered by the state and federal governments. Under irrigation, green ear or grain crops can be grown practically throughout the year, and up to three crops can be cultivated per year.

Corn yield losses due to weeds depend on the corn cultivar grown (Rossi *et al*. 1996) and may reach up to 80%, according to the species and number of weeds per area, competition period, and corn development stage. In addition, weeds can deplete nutrients from soils (Sreenivas & Satyanarayana, 1996). Besides reducing yield, weeds can reduce grain quality, cause irregular maturation, losses, and harvesting difficulties, and serve as hosts for pests and pathogens (Silva *et al*., 2004a). Additionally, weeds can compete with corn for water, a scarce resource in many areas of the Brazilian Northeast. This is a more serious problem, since many weeds that are common in those areas are species with the C_4 photosynthetic pathway, such as nutsedge (*Cyperus rotundus* L.) and southern sandbur (*Cenchrus echinatus* L.), which are capable of using less water per dry matter unit yielded (Silva *et al*., 2004a).

Many cultural practices for weed control, including intercrops, have been studied in the past. Herbicides have simplified weed control and started to be extensively used, replacing cultural weed control methods in several regions. However, the extensive use of herbicides, which are costly, resulted in the selection of weed biotypes resistant to these products, and has become an environmental contamination factor. Reducing the used of herbicides is one of modern agriculture's major goals (Ngouajio *et al.*, 1999) and several alternatives are currently being investigated with this objective (Carruthers *et al.*, 1998). The weed-control cultural practices studied in the past have again become interesting (Nalewaja, 1999) and are once again being studied, including intercroppings (Gomes *et al*., 2007).

Reducing the incidence of weeds in corn by intercropping depends on several factors, including planting season and intercrop species used (Skóra Neto, 1993), fertilizer doses (Olasantan *et al*., 1994), corn cultivar and year of evaluation (Kuchinda *et al*., 2003), among others factors. The effects of cover crop are achieved by a rapid occupation of the open space between the rows of the main crop, which prevents germination of weed seeds and reduces the growth and development of weed seedlings. Germination of weed seeds may be inhibited by complete light interception by the cover crop or by secretion of allelo-chemicals. After establishment of weed seedlings, resource competition becomes the main weed suppressing mechanism of the cover crop (Hollander *et al*., 2007).

Intercropping with four (Martins, 1994) or seven (Skóra Neto, 1993) legume species, when sown simultaneously with corn, did not decrease weed infestation (Skóra Neto, 1993) and reduced corn grain growth and yield (Martins, 1994). However, intercropped legumes reduced weed populations without affecting corn plants or their productivity when seeded 21 days after corn (Martins, 1994).

Cowpea can both produce abundant biomass and fix substantial quantities of atmospheric nitrogen (Creamer & Baldwin, 2000). In addition, cowpea rarely requires fertilizes and can suppress weeds (Hutchinson & McGiffen, 2000). Cowpea has been identified as an ideal cover crop for many areas (Wang *et al*., 2006). In the Brazilian Northeast, corn intercropped with cowpea (*Vigna unguiculata* (L.) Walp.) is extensively practiced, although the objective is not weed control, but a greater use of environmental resources. Therefore, there is interest in evaluating weed control in corn by intercropping with cowpea, when the legume is sown at different seasons. It has been demonstrated that intercropping with cowpea sown at the same planting time as corn reduced most morphological characteristics, green ear yield, and grain yield (Gomes *et al*., 2007).

The objective of this work was to evaluate the effects of cowpea planting times, intercropped with corn, on weed control and green ear yield of two corn cultivars.

MATERIAL AND METHODS

The experiment was carried out at Fazenda Experimental "Rafael Fernandes" (experimental farm), of Universidade Federal Rural do Semi-Árido (UFERSA), located 20 km away from the municipal seat of Mossoró-RN (5° 11' S latitude, 37° 20' W longitude, and 18 m elevation), under sprinkling irrigation. The experimental soil, classified according to the Brazilian Soil Classification System as Argissolo Vermelho-Amarelo Eutrófico

(EMBRAPA, 1999) and as Ferric Lixisol according to the Soil Map of the World (FAO, 1988), was prepared with two plowings and fertilized with 30 kg N (urea) 60 kg of P_2O_5 (simple superphosphate) and 30 kg of 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 indicated: pH = 6.8; Ca = 1.80 $cmol_c^{-1} dm^{-3}$; Mg = 0.40 $cmol_c\ dm^{-3}$; K = 0.10 $cmol_c\ dm^{-3}$; Na = 0.01 $cmol_c\ dm^{-3}$; Al = 0.00 $cmol_c\ dm^{-3}$; P = 25mg dm^{-3}; Org. Mat. = 1.90 g kg^{-1}.

Soil tillage was done with a tractor. Planting was carried out on 08.19.2004, and four seeds were used per pit. A spacing of 1.0 m was used between rows, with pits on the same row spaced at 0.4 m. A thinning operation was performed 17 days after planting, leaving the two more vigorous plants in each pit. Therefore, after thinning the programmed population stand in the experiment was 50 thousand plants/ha. Deltamethrin (250 ml/ha) was sprayed 12 days after planting, in order to control the fall armyworm (*Spodoptera frugiperda* Smith), the main pest of corn in the region. The sprays were performed with a back-pack sprayer. Sidedressing applications were performed at 22 and 41 days after planting, with 30 kg/ha of urea.

A completely randomized block design with split-plots and four replications was used. Each subplot consisted of four 6.0-m-long rows. The usable area was considered as that occupied by the 5.2 m in the central row. AG 1051 and AG 2060 cultivars were submitted to the following treatments: no hoeing, two hoeings (22 and 41 days after planting), and cowpea sowing (BR 14 - Mulato cultivar, with indeterminate growth) at corn planting or at 5, 10, and 15 days later. The cowpea was planted between the corn rows, in pits spaced at 1.0 m, with two plants per pit. Cultivars were assigned to plots and weed control was assigned to subplots. Weedings were performed with a hoe and the same employee was assigned to perform the service in each block. The other experiment operations were done by hand.

Four green corn harvests were performed, at intervals of two or three days; the first harvest was accomplished 68 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 as those 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 as those with a length equal to or above 17 cm that showed health and grain set suitable for commercialization. After the green ears were harvested, plant height and ear height were evaluated. Plant height and ear height were evaluated in ten plants taken at random among the plants used in the green ear yield assessment. The distance from ground level to the insertion point of the highest leaf blade was considered as plant height. The distance from ground level to the ear insertion node was considered as ear height. Harvest of cowpea pods was performed in four steps, during the period from 60 to 75 days after sowing.

The composition, distribution, and weight of biomass from the above-ground part of weeds found in the experiment were evaluated after harvesting the ears for the last time. The weeds were cut even with the ground, in two areas delimited by a wooden frame measuring 0.5 m × 0.5 m, selected at random from the usable area of each plot.

Analysis of variance for the data was carried out using SAEG (Ribeiro Júnior, 2001), while a software by Jandel (1992) was used in the regression analysis.

RESULTS AND DISCUSSION

Twenty-eight weed species were found in the experiment area (Table 1). The area where the study was conducted had been fallowing for at least five years. The composition and density of weed species is quite variable (Silva *et al.*, 2004b) and is closely associated with the area's cropping history (Buhler, 1999). The biomass of the above-ground part of weeds, as well as the density and diversity of these plants are smaller under conventional cultivation (tillage and high doses of chemical products), intermediate in reduced tillage systems, and greater in organic systems (Menalled *et al*., 2001).

Table 1. Weed species found at green ear yield assessment in two corn cultivars, grown with or without hoeing and intercropping with cowpea, sown at corn planting or until 15 days later.

Order number	Botanical name	Order number	Botanical name
1	*Adenocalymma* sp.	15	*Evolvulus ovatus* Fernald
2	*Alternanthera ficoideae* (L.) R. Br.	16	*Herissantia crispa* (L.) Briz.
3	*Bauhinia heterandra* Benth.	17	*Hyptis suaveolens* L.
4	*Borreria scabiosoides* Cham. et Schlecht	18	*Ipomoea Bahiensis* Willd. Ex Roemer et Schultes
5	*Borreria verticillata* G.F.W. Meyer	19	*Jacquemontia* sp.
6	*Chamaecrista* sp.	20	*Marsypianthes chamaedrys* Kuntze
7	*Commelina* sp.	21	*Mitracarpus selloanus* Cham. Et Schlecht
8	*Crumenaria decumbens* Mart.	22	*Panicum maximum* Jacq.
9	*Dactyloctenium aegyptium* (L.) Beauv.	23	*Panicum repens* L.
10	*Desmanthus virgatus* (L.) Willd.	24	*Phyllanthus niruri* L.
11	*Digitaria sanguinalis* (L.) Scop.	25	*Portulaca mucronata* Link.
12	*Eragrostis ciliaris* (L.) R.Br.	26	*Schranckia leptocarpa* DC.
13	*Euphorbia hirta* L.	27	*Senna* sp.
14	*Euphorbia hyssopifolia* L.	28	*Urochloa mosambicensis* (Hackel.) Dandy

The distribution of weeds in the experiment area was not uniform (Table 2). Some plots showed a higher number of species than others. In addition, some species occurred in most plots, while others were restricted to a smaller number of plots. It is likely that the treatments had some influence on weed species distribution, but other factors, especially those associated with the soil, might also be involved. The fact that the first two blocks showed plots with a higher number of species suggests that this is the case. The weed population in a given area varies with many factors, and although this population comprises many species, a few dominant species make up 70% to 90% of the total number of species (Buhler, 1999). Weeded plots showed the smallest dry matter weight of the above-ground part of weeds, and plots intercropped 15 days after corn was planted showed the highest weight (Table 3).

In all characteristics evaluated, except for plant height, ear height, and total number of green ears, where no difference occurred between treatments, the lack of weeding determined the smallest means, while weed control determined the highest (Table 3). In plots where cowpea was sown, intermediate means were obtained for number of marketable unhusked green ears and for number and weight of marketable husked ears. This suggests that cowpea aids in corn weed control when intercropped, especially when it is planted earlier. This observation is verified from the number of marketable ears, both unhusked and husked, and from husked ear weight (Table 3). For these traits, earlier cowpea planting dates did not differ from the "no hoeing" treatment, but also did not differ from the "two-hoeing" treatment. The following regression equations (obtained considering cowpea sowing times as the independent variable), adjusted for the above-mentioned traits, reinforce this observation: $y = 36253.5 – 812.9\ x^{0.5}$, $R^2 = 67\%$ (number of marketable unhusked ears), $y^2 = 51574100 – 86455.0\ x^2$, $R^2 = 88\%$ (weight of marketable unhusked ears), $y^2 = 683792000.0 - 189100.0\ x^2$, $R^2 = 94\%$ (number of marketable husked ears), and $y^2 = 10287000.0 – 1851.9\ x^3$, $R^2 = 73\%$ (weight of marketable husked ears). In these equations, the coefficient associated with *x* was significant at 5% probability by t test, except in the second equation, where the coefficient was significant at 10% probability, by the same test. Probably, retarding the seeding date of cowpea this crop does not produce plantlets capable of competing with already-grown weeds, which will determine progressively smaller corn yields. The corn cultivars evaluated were not different among themselves, except with regard to ear height (AG 1051 = 86 cm and AG 2060 = 74 cm). It is important to mention that the cowpea grain yields were practically null in all plots. For this reason, analyzing this trait was not considered.

The coefficient of variation value was relatively high for green ear-related traits. This is due to the fact that in plots without any weed control, there is a frequent occurrence of plants that do not yield ears (especially marketable ones), which helps to reduce the general mean. Besides, there is a degree of subjectivity in the evaluation of marketable green ears, which must contribute to increase the experimental error. The reduction in the experiment's general mean and the increase in experimental error increase the coefficient of variation value.

The results obtained in the present study are in agreement with those of other authors, when weeded plots are compared against plots without weed control. With regard to plant height and ear height, for example, weed control may or may not exist (Begna *et al*., 2001; Duarte *et al*., 2002; Rossi *et al*., 1996), such as found in this study (Tables 1 and 3). Other authors (Silva *et al*., 2004b) also verified a green ear yield reduction as a result of corn competition with weeds.

With regard to cowpea sowing times, the results are partly contradictory in relation to results obtained by other researchers. Seven legumes, including cowpea, reduced corn grain yield (without significant differences) when seeded simultaneously with this grass (Skóra Neto, 1993), similarly as observed in the present work with green corn. Other authors (Agboola & Fayemi, 1971; Martins, 1994) made similar observations. In some studies where legume seeding was delayed, this did not affect corn yield, but in such cases hoeing was provided (Skóra Neto, 1993; Carruthers *et al*., 1998). In the present work, however, no hoeing was performed in intercropped plots, because the objective was to control weeds via cowpea intercropping only.

The weeds reduced most of the evaluated characteristics in this study (Table 3). The weeds reduce crop yield by competing with them for water, nutrients and light (Carruthers *et al*., 1998). The removal of nutrients by weeds has an impact on nutrient availability for the crop, thus affecting its accumulation of dry matter (Sreenivas & Satyanarayana, 1996). Actually, N absorption by weeds can vary from 32.4 kg ha^{-1} to 52.3 kg ha^{-1}, depending on the type of control; in the case of P_2O_5, the variation was 4.3 kg ha^{-1} to 7.2 kg ha^{-1} and in the case of K_2O, from 32.1 kg ha^{-1} to 38.9 kg ha^{-1}. Nitrogen deficiency symptoms develop earlier in corn infested with weeds than in corn that has been cleared of weeds, which implies N depletion in the soil with corn planted with weeds (Rajcan & Swanton, 2001).

Furthermore, reductions in corn yield are less with high doses of nitrogen than with small doses (Tollenaar *et al*., 1997). But another aspect must be involved.

Table 3. Plant height and ear height, total and marketable green ear yield of corn cultivars, and dry matter weight of the above-ground part of weeds resulting from weed control (means of four replicates and two cultivars).[1]

Weed control	Plant height (cm)	Ear height (cm)	Total ears ha^{-1}		Marketable unhusked ears ha^{-1}		Marketable husked ears ha^{-1}		Weed dry matter weight ($g\ m^{-2}$)
			Number	kg	Number	kg	Number	kg	
With hoeing	163 a	80 a	48517 a	11640 a	46305 a	11441 a	36401 a	5163 a	366.8 a
Simultaneous cowpea and corn planting (SP)	162 a	84 a	46635 a	8126 b	36491 ab	7300 b	24798 ab	2989 ab	650.9 ab
Cowpea planted 5 days after SP	161 a	82 a	43930 a	7497 b	33354 ab	6742 b	26503 ab	3093 ab	449.0 ab
Cowpea planted 10 days after SP	159 a	81 a	45081 a	7872 b	34880 ab	6836 b	22834 ab	3435 ab	596.9 ab
Cowpea planted 15 days after SP	157 a	80 a	46815 a	6748 b	32752 ab	5594 b	15805 b	1931 b	712.6 b
No hoeing	149 a	74 a	43875 a	5601 b	25865 b	4190 b	13407 b	1640 b	514.0 ab
Means of cultivars	159	-	45809	7914	34941	7017	23291	3042	548.5
CV, %	9	12	13	29	26	27	37	45	45

[1]Means followed by the same letter are not different at 5% probability by Tukey test.
[2]Cowpea planted intercropped with corn.

The corn root system is less developed with weed presence (Thomas & Allison, 1975). Thus, a smaller corn root system due to weed presence would be less efficient in nutrient absorption.

The corn crop develops stress symptoms due to lack of water earlier when it is infested by weeds than when it is weed free (Young *et al*., 1984; Tollenaar *et al*., 1997). Nevertheless, there are no differences in water content in the profile of the soil for corn with or without weeds (Young *et al*., 1984; Tollenaar *et al*., 1997). In reality, water content in corn plots with weeds was greater than in the crop plots without weeds (Thomas & Allison, 1975). The development of water stress symptoms with the presence of weeds may not be caused by water availability, but by the reduced ability to absorb water through the root system. Therefore, despite the fact that the experiment on which this study was based used irrigation, the reduction in the corn root system caused by the weeds would reduce water absorption capacity. Water deficiency induces the closing of stomata thus paralyzing photosynthesis and drastically reducing production in corn competing with weeds (Silva *et al*., 2004a). Another possibility would be the invader root exudates that could inhibit corn root growth (Rajcan & Swanton, 2001).

Two components are involved in the competition for light: the quantity and quality of light. The quantitative component of light determines photosynthetic activity, whereas the quality of light influences plant morphology. An important characteristic of corn is that most of the light is intercepted by the younger, more efficient leaves above the ear and less than 10% of the photon flux density (PFD) reaches the leaves below 1 m. On the other hand, most weeds are under 1 m in height at blooming and after blooming. Thus, direct competition for PFD between corn and weeds is relatively small. Even in weed free crops, the leaves below the ear are in the shadows of the upper leaves and are older. Consequently, their photosynthetic rates are smaller than those of the upper leaves. That means that corn yield loss due to competition with weeds for PFD cannot be explained by the reduced photosynthetic rates of the lower leaves in the shadow of weeds. The leaf area index (LAI) defines the ability of a plant to intercept PFD and it is an important determining factor for the accumulation of dry matter. A high degree of competition with weeds was seen (Tollenaar et al., 1994) to reduce corn LAI at blooming by 15%. Thus, grain yield loss resulting from competition for light is best explained through the reduction in LAI than in lower photosynthetic rates of shaded leaves (Rajcan & Swanton, 2001). Actually, a reduction was observed in the corn leaf area (Aflakpui et al., 2002), due to competition with weeds. Other authors (Ford & Pleasant, 1994) also verified a reduction in the number of corn leaves due to weeds. It is interesting to mention that the reduction in leaf area should reduce shadows on weeds making them more aggressive towards corn, and therefore generating a vicious cycle for the crop: the weeds reduce the corn leaf area, and this reduction favors the growth of weeds, and so on.

The lower leaves are not only exposed to a reduced amount of PFD, but they also receive a quality of light that differs from the total sunlight received by the upper leaves. The light within the crown is rich in far red radiation, FR (730 at 740 nm). This is caused by the selective absorption of red light, R (660-670 nm) by photosynthetic pigments and the reflection of FR light by green leaves. This makes the far-red/red (FR/R) ratio greater in the lower part of the crown than on the upper part of the crown. The FR/R ratio plays an important role in the induction of many morphological changes in plant architecture (lengthening of the stem, apical dominance, reduced branching, thinner leaves, leaf area distribution, etc.)

(Salisbury & Ross, 1991). Consequently, plants that grow in FR rich light tend to have a different architecture than plants that grow in complete sunlight. Shaded plants tend to allocate more leaf area in the upper portion of the crown where more light is available, whereas plants grown in complete sunlight have a more pyramid-shaped leaf area distribution, which limits the shading of lower leaves by upper ones. Although, as mentioned before, weeds generally do not shade corn, there are indications that corn grown in the presence of weeds receives a greater FR/R ratio than the weed free crop (Rajcan & Swanton, 2001).

Table 2. Weed species distribution at green ear yield assessment in two corn cultivars, grown with or without hoeing and intercropping with cowpea, sown at corn planting or until 15 days later. Numbers represent order numbers in Table 1.

Blocks	Treatments (**in boldface**)/weeds[1]											
4	**AG 2060**						**AG 1051**					
	11	**10**	**12**	**8**	**9**	**7**	**5**	**4**	**3**	**2**	**1**	**6**
	3, 5, 7, 9	5, 7, 9, 23	3, 5, 9	3, 9,15, 16, 22	3, 9, 16	1, 3, 9,16	3, 7, 9	3, 7, 9	3, 7, 9, 28	3, 5, 9	3,5,7	2,3,5,18
3	**AG 1051**						**AG 2060**					
	4	**1**	**3**	**6**	**5**	**2**	**12**	**10**	**11**	**8**	**9**	**7**
	3, 5, 9	2, 3, 5, 9	7, 9, 24	7, 9	3, 7, 9, 10	3	3, 7, 9, 12	9,11	1, 3, 7, 9	3, 9, 12	3, 9	3, 5, 9
2	**AG 2060**						**AG 1051**					
	8	**11**	**7**	**10**	**12**	**9**	**3**	**6**	**2**	**1**	**4**	**5**
	3, 9, 24	3, 5, 7, 9, 23	2, 3, 5, 7, 10, 14, 17,19, 25	1, 2, 3, 5, 6, 7	3, 5, 7, 9, 20, 27	3, 5, 7,16	1, 3, 7, 16	3, 4, 9, 16	3, 6, 9, 26	1, 3, 5, 20	3,5,9,20	3, 5, 9
1	**AG 2060**						**AG 1051**					
	9	**11**	**8**	**10**	**7**	**12**	**2**	**4**	**3**	**1**	**6**	**5**
	2, 3, 7, 11, 15	1, 3, 7, 9	3, 6, 9,16	2, 3, 7, 11,16	3, 5, 7, 11	2, 3, 5, 6, 8, 16	3, 5, 6, 7, 9, 11, 16, 24	3, 5, 7, 9, 11, 12, 16	3,5,7,9, 16	3, 5, 7, 14, 21	2, 3, 5, 9	3, 5, 9, 13

[1]Treatments 1 and 7 = "no hoeing", 2 and 8 = "with hoeing", 3 and 9 = "cowpea planted at corn planting, and so on.

The considerations made for the corn yield-reducing effect of weeds can be similarly made for cowpea in intercropped plots. Cowpea probably suppresses weeds, but the legume itself, together with non-suppressed plants, must compete with corn.

CONCLUSIONS

Higher marketable green ear yields are obtained with hoeing, while lower yields are obtained without hoeing. Intercropping corn with cowpea, especially when done early, provides intermediate results, indicating that cowpea controls weeds to a certain extent, which is, however, insufficient to avoid corn yield losses. The corn cultivars do not differ with regard to green ear yield. The cowpea grain yields were practically null in all plots.

REFERENCES

AFLAKPUI, G.K.S.; GREGORY, P.J.; FROUD-WILLIAMS, R.J. Growth and biomass partitioning of maize during vegetative growth in response to *Striga hermonthica* infection and nitrogen supply. **Experimental Agriculture**, Cambridge, v.38, N.1, p.265-276, 2002.

AGBOOLA, A.A.; FAYEMI, A.A. Preliminary trials on the intercropping of maize with different tropical legumes in Western Nigeria. **Journal of Agricultural Science**, Cambridge, v.77, n.3, p.219-225, 1971.

BEGNA, S.H., HAMILTON, R.I.; DWYER, L.M.; STEWART, D.W.; CLOUTIER, D.; ASSEMAT, L.; FOROUTAN-POUR, K.; SMITH, D.L. Morphology and yield response to weed pressure by corn hybrids differing in canopy architecture. **European Journal of Agronomy**, Amsterdan, v.14, n.4, p.293-302, 2001.

BUHLER, D.D. Weed population responses to weed control practices. I. Seed bank, weed populations, and crop yields. **Weed Science**, Lawrence, v.47, n.4, p.416-422, 1999.

CARRUTHERS, K.; FE, Q.; CLOUTIER, D.; SMITH, D.L. Intercropping corn with soybean, lupin and forages: weed control by intercrops combined with interrow cultivation. **European Journal of Agronomy**, Montrouge, v.8, n.3-4, p.225-238, 1998.

CREAMER, N.G.; BALDWIN, K.R. An evaluation of summer cover crops for use in vegetable production systems in North Carolina. **HortScience**, Alexandria, v.35, n.4, p.600-603, 2000.

DUARTE, N. de F.; SILVA, J.B. da; SOUZA, I.F. de. Competição de plantas daninhas com a cultura do milho no município de Ijaci, MG. **Ciência e Agrotecnologia**, Lavras, v.26, n.5, p.983-992, 2002.

EMBRAPA. Centro Nacional de Pesquisa do Solo. **Sistema brasileiro de classificação de solos.** Brasília: Serviço de Produção de Informação, 1999. 412p.

FAO. **Soil map of the world; revised legend**. Rome: UNESCO, 1988. 119p.

GOMES, J.K.O.; SILVA, P.S.L.; SILVA, K.M.B.; RODRIGUES FILHO, F.F.; SANTOS, V.G. Effects of weed control through cowpea intercropping on mayze morphology and yield. **Planta Daninha**, Viçosa, v.25, n.3, p.433-441, 2007.

HOLLANDER, N.G. de, BASTIAANS, L.; KROPFF, M.J. Clover as a cover crop for weed suppression in a intercropping design. I. Charcteristicas of several clover species. **European Journal of Agronomy**, Montrouge, v.26, n.2, p.92-103, 2007.

HUTCHINSON, C.M.; McGIFFEN, M.E. Cowpea cover crop mulch for weed control in desert pepper production. **HortScience**, Alexandria, v.35, n.1, p.196-198, 2000.

JANDEL. Jandel TBLCURVE. Table Curve 3.0. **Curve fitting software**. Corte Madera, Jandel Scientific, 1992. 280p.

KUCHINDA N.C.; KUREH, I.; TARFA, B.D.; SHINGGU, C.: OMOLEHIN, R. On-farm evaluation of improved maize varieties intercropped with some legumes in the control of Striga in the Northern Guinea savanna of Nigeria. **Crop Protection**, Kidiglinton, v.22, n.3, p.533-538, 2003.

MARTINS, D. Comunidade infestante no consórcio de milho com leguminosas. **Planta Daninha**, Viçosa, v.12, n.2, p.100-105, 1994.

MENALLED, F.D.; GROSS, K.L.; HAMMOND, M. Weed aboveground and seedbank community responses to agricultural management systems. **Ecological Applications**, Washington, v.11, n.6, p.1586-1601, 2001.

NALEWAJA, J.D. Cultural practices for weed resistance management. **Weed Technology**, Champaign, v.13, n.1, p.643-646, 1999.

NGOUAJIO, M.; LEMIEUX, C.; LEROUX, G.D. Prediction of corn (*Zea mays*) yield loss from early observations of the relative leaf area and the relative leaf cover of weeds. **Weed Science**, Lawrence, v.47, n.2, p.297-304, 1999.

OLASANTAN, F.O; LUCAS, E.O.; EZUMAH, H.C. Effects of intercropping and fertilizer application on weed control and performance of cassava and maize. **Field Crop Research**, Amsterdam, v.39, n.1, p.63-69, 1994.

RAJCAN, I; SWANTON, C.J. Understanding maize-weed competition: resource competition, light quality and the whole plant. **Field Crops Research**, Amsterdan, v.71, p.139-150, 2001.

RIBEIRO JÚNIOR, J.I. **Análises estatísticas no SAEG.** Viçosa, Universidade Federal de Viçosa, 2001. 301p.

SKÓRA NETO, F. Controle de plantas daninhas através de coberturas verdes consorciadas com milho. **Pesquisa Agropecuária Brasileira**, Brasília, v.28, n.10, p.1165-1171, 1993.

SALISBURY, F. B.; ROSS, C. W. **Plant physiology**. 4 ed. Belmont: Wadsworth, 1991. 459p.

SILVA, A.A. da; VARGAS, L.; WERLANG, R.C. Manejo de plantas daninhas na cultura do milho. In: GALVÃO, J.C.C.; MIRANDA, G.V. **Tecnologias de produção do milho**. Viçosa, UFV, 2004a. 366p. cap.8, p.269-310.

SILVA, P.S.L. e; BARBOSA, Z.; OLIVEIRA, O.F. de; ANTONIO, R.P.; SILVA, P.I.B. e. Floristic composition and growth of weeds under custard apple (*Annona squamosa* L.) progenies. **Planta Daninha**, Viçosa, v.22, n.4, p.529-537, 2004b.

SREENIVAS, G.; SATYANARAYANA, V. Nutrient removal by weeds and maize. **Indian Journal of Agronomy**, New Delhi, v.41, n.1, p.160-162, 1996.

TOLLENAAR, M.; NISSANKA, S.P.; AGUILERA, A.; WEISE, S.F.; SWANTON, C.J. Effects of weed interference and soil nitrogen on four maize hybrids. **Agronomy Journal**, Madison, v.86, n.3, p.596-601, 1994.

TOLLENAAR, M.; AGUILERA, A.; NISSANKA, S.P. Grain yield is reduced more by weed interference in an old than in a new maize hybrid. **Agronomy Journal**, Madison, v.89, n.1, p.239-246, 1997.

WANG, G.; McGIFFEN, M.E.; EHLERS, J.D.; MARCHI, E.C.S. Competitive ability of cowpea genotypes with different growth habit. **Weed Science**, Lawrence, v.54, n.4, p.775-782, 2006.

YOUNG, F.L.; WYSE, D.L.; JONES, R.J. Quackgrass (*Agropyron repens*) interference on corn (*Zea mays*). **Weed Science**, Champaign, v.32, p.226-234, 1984.