WEED CONTROL AND GREEN EAR YIELD IN MAIZE[1]

Controle de Plantas Daninhas e Rendimento de Espigas Verdes de Milho

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ABSTRACT - The objective of this work was to evaluate the influence of weeding frequency on cultivar Centralmex green corn yield. Two experiments were conducted in Mossoró-RN (Brazil), with the use of sprinkler irrigation. A random block design with four replicates was used. It was observed that the total number and weight (TW) of unhusked green ears, the number and weight of marketable unhusked ears and the number and weight of marketable husked ears were reduced under no weeding treatment. The number timing of weedings did not influence green corn yield, except for one weeding at 60 DAP, which was equivalent to the "no weeding" treatment, for TW. When maize is marketed considering the total number of green ears, higher net income is obtained when one weeding is carried out 45 days after planting.

Key words: *Zea mays*, green corn.

RESUMO - O objetivo deste trabalho foi avaliar as influências da freqüência de capinas sobre o rendimento de milho-verde do cultivar Centralmex. Dois experimentos foram realizados em Mossoró-RN, com irrigação por aspersão. Utilizou-se o delineamento de blocos ao acaso, com quatro repetições. Verificou-se que a ausência de capinas reduz o número e o peso (PT) totais de espigas verdes empalhadas, o número e o peso de espigas empalhadas comercializáveis e o número e o peso de espigas despalhadas comercializáveis. O número e a época de realização das capinas não influenciaram o rendimento de milho-verde, exceto uma capina aos 60 DAP, que é equivalente ao tratamento "sem capina", para PT. Quando o milho é comercializado considerando-se o número total de espigas verdes, maior receita líquida é obtida com a realização de uma capina, aos 45 dias após o plantio.

Palavras-chave: *Zea mays*, milho verde, planta daninha.

INTRODUCTION

Maize is cultivated in all municipal districts in the state of Rio Grande do Norte (Brazil), especially under dryland conditions, but it is also grown under irrigation to produce ears that are either green or have mature kernels, practically throughout the year. The irrigated area is expected to increase in the future, due to incentives provided by the federal and state governments.

The mean maize dry grain yield in Rio Grande do Norte is around 500 kg ha^{-1}. No information is available on mean green maize yield in this state, but it is assumed to be low, too, since the same cultivars and cultural practices are adopted. Experience and a survey on the problems involving maize production systems in Rio Grande do Norte (Silva et al., 1994) have shown that many of these problems are associated with low productivity levels, such as inadequate weed control, which not received adequate attention from farmers. The season weeding operations are performed frequently depends on the availability of time and laborers. It is known that, however, that there is a critical crop-weed competition period with grain losses reaching between 35 and 70%, if weeds are not controlled (Ford and Pleasant, 1994; Teasdale, 1995).

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Although some growers now use herbicides to control weeds, most farmers continue to control weeds by manual hoeing. There is a trend in many countries to use mechanical weed control methods to reduce the use of herbicides (Liebman & Dick, 1993; Carruthers et al., 1998). Weed resistance to herbicide is increasing these products are expensive and may cause environmental problems (Carruthers et al., 1998).

No information was found in the literature on the effects of weed control on green maize yields. Researchers have focused on studying those effects on dry grain yield. Two types of approaches are utilized in most competition studies between weeds and maize (Rajcan & Swanton, 2001): determination of the critical crop weed competition period; and, evaluation of the threshold above which weed infestation becomes detrimental to the crop. Hall et al. (1992) defined the 3-leaf and 14-leaf stages of plant development as the critical period for weed control in maize. Grain yield in maize can be increased by increasing the number of hoeings, even though differences are not always significant (Bezerra et al., 1995). Hoeing is as effective or more effective than herbicides with regard to their effects on maize grain yield (Jat et al., 1998; Saikia & Pandey, 1999). Several factors influence the response of maize to weed control, including cultivars (Begna et al., 2001), weeds (species and density) (Bendixen, 1986; Young et al., 1984), type of control (Jat et al., 1998; Saikia & Pandey, 1999) and other cultural practices (Begna et al., 2001).

The objective of this work was to evaluate the influence of weeding frequency and the period it is performed on cultivar Centralmex-3 green ear yield.

MATERIAL AND METHODS

Two experiments were carried out at Fazenda Experimental "Rafael Fernandes", of Escola Superior de Agricultura de Mossoró (ESAM), located 20 km from the municipal seat of Mossoró-RN (5°11' S latitude, 37°20' W longitude and 18 m altitude), in 1996 and 1997. According to Gaussen's bioclimatic classification, the climate in Mossoró region is classified as type 4aTh, or distinctly xerothermic, i.e., tropical hot with a pronounced dry season, lasting from seven to eight months and with a xerothermic index between 150 and 200. According to Köppen, the bioclimate in the region is a BSwh, i.e., hot, with heavier precipitations delayed toward the fall. The mean minimum temperature in the region is between 21.3 and 23.7 °C and the mean maximum is between 32.1 and 34.5 °C, with June and July being the coolest months, while the mean annual precipitation is around 825 mm (Carmo Filho & Oliveira, 1989). Insolation increases from March to October, with a mean of 241.7 h; the maximum relative humidity reaches 78% in April, while the minimum is 60% in September (Chagas, 1997).

First experiment

The experimental soil was tilled by means of two harrowings and fertilized 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 soil sample from the experimental area, a Red Yellow Argisol (RYA), 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}. Irrigation time was based on the water retained in the soil at a tension of 0.04 MPa, transformed into available water according to the particular curve for that soil, with an availability factor of 40% being obtained. Net irrigation requirement during crop cycle was 360 mm estimated based on evaporation from a class A pan, and water application efficiency was 23%. This low efficiency was due to losses by deep percolation (72%). Total irrigation depth and water distribution uniformity coefficient were 1,565 mm and 83%, respectively. Irrigation shift was set up as 1 day.

Planting was carried out on 08-08-1996, and four seeds of cultivar Centralmex-3 were utilized per pit. The spacing between rows was 1.0 m, and pits on each row were spaced by 0.4 m. Thinning was performed 14 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^{-1}. Two deltamethrin sprays (250 mL ha^{-1}) were performed at 16 and 29 days after planting, respectively, in order to control the fall armyworm (*Spodoptera frugiperda*), the major maize pest in the region. Sidedressing applications were performed at 20 and 40 days after planting with 60 kg ha^{1} of ammonium sulfate. Weedings were made by hand hoeing in numbers and times compatible with the evaluated treatments, with the same worker being assigned for this task at each block.

A completely randomized block design with four replicates was used. Each plot consisted of four 6.0 m long rows. The usable area was considered as the central 5.2 m from the two central rows. The treatments under evaluation were as follows: no weeding; C-15 = weeding at 15 days after planting (DAP); C-30 = weeding at 30 DAP; C-45 = weeding at 45 DAP; C-60 = weeding at 60 DAP; C-15-30 = weedings at 15 and 30 DA; c-15-45 = weedings at 15 and 45 DAP; C-15-60 = weedings at 15 and 60 DAP; C-30-45 = weedings at 30 and 45 DAP; C-30-60 = weedings at 30 and 60 DAP; C-45-60 = weedings at 45 and 60 DAP; C-30-45 = weedings at 15, 30 and 45 DAP; C-15-30-60 = weedings at 15, 30 and 60 DAP; C-30-45-60 = weedings at 30, 45 and 60 DAP; and C-15-30-45-60 = weedings at 15, 30, 45 and 60 DAP. The identified weeds were collected from an area measuring 0.5 m × 0.5 m, in the center of the plots that were hoed for the first time at 15, 30,45 and 60 days after planting.

Weed composition in the experiment was evaluated in plots submitted to weeding, at 45 DAP. The weeds were collected from an area measuring 1.0 m (measured across the plot's width, between the two central rows) × 0.4 m (measured along the plot's length, including the two central pits from each row).

Two green maize harvests were performed, the first at 74 days after planting and the second five days after the first. Green maize yield was evaluated by the total number and weight of unhusked green ears, and by the number and weight of both marketable unhusked and husked ears. The marketable unhusked ears were considered to have a length equal to or above 22 cm and without blemishes or evident signs of attack by diseases or pests. The marketable husked ears were considered to have a length equal to or above 17 cm, and showing health and grain set suitable for commercialization.

Soil tillage was performed with a tractor; herbicides were applied using a back-pack sprayer; weedings were performed with a hoe and the other experiment operations were performed manually.

Second experiment

The experiment was conducted in a similar way to the previous one, except for with the following: planting was carried out on 09-10-1997; the pests were controlled with a single spray applied at 34 days after sowing; sidedressings were performed at 33 and 53 days after planting and harvests at 78, 81 and 83 days after planting.

The data from each experiment were analyzed by analysis of variance followed by the Tukey test. A joint analysis of variance was also performed. The statistical analyses were performed according to Banzatto & Kronka (1989).

The economical analysis of the data consisted in calculating the Operating Income (Net Revenue), by subtracting the Total Cost from the Gross Revenue. The Gross Revenue was obtained by multiplying the total number of unhusked ears by the price of one thousand ears (R$70.00). Total Cost was obtained by adding the Fixed and Variable costs. We considered as Fixed Cost the labor supplied by a property manager plus the depreciation, maintenance and conservation, insurance and interest on the fixed capital represented by tools (irrigation system and back-pack sprayer). Variable Cost included labor spent on management practices, inputs (fertilizers, etc), machinery and tool rental (harrowing and grooving operations), electric energy for irrigation (1,500 kw), technical assistance and PROAGRO (both 2% of the Variable Cost value) and interest on the working capital (6% APR of the Variable Cost).

RESULTS AND DISCUSSION

The same weeds were verified in both experiments, certainly because they were conducted in neighboring areas: *Alternanthera ficoidea*, *Boerhavia coccinea*, *Borreria verticillata*, *Carnavalia brasiliensis, Cassia duckeana*, *Cassia sericea*, *Cassia tora*, *Cenchrus echinatus, Cucumis anguria*, *Dactyloctemium aegyptium*, *Digitaria sanguinalis*, *Eragrostis amabilis*, *Euphorbia hirta*, *Herissantia nemoralis*, *Ipomoea asarifolia*, *Ipomoea salzmannii*, *Mentzelia fragilis*, *Merremia aegyptia*, *Mollugo verticillata*, *Phyllantus niruri*, *Portulaca oleracea*, *Richardsonia grandiflora*, *Solanum ambrosiacum* and *Waltheria indica*. No quantitative evaluations of weeds were performed; however, the species *Cenchrus echinatus* was the most frequent weed.

A higher total number of green unhusked ears ha^{-1} was obtained when three or four weedings were performed (Table 1). This number, however, was only significantly different from the "no weeding" treatment, which provided the poorest result. With regard to total weight of unhusked green ears (Table 1), the best result was attained when four weedings were performed, at 15, 30, 45 and 60 days after planting. This treatment was only superior to the two poorest treatments, i.e., one weeding at 60 days after planting and, especially, to the "no weeding" treatment. No effect of cropping year on the total number and weight of green ears was observed.

The smallest numbers of marketable unhusked green ears were obtained with the "no weeding", one weeding (at 15, 30 or 45 days after planting) and two weeding treatments (at 30 and 45 days after planting) (Table 2). Among these, only "no weeding" was different from the more productive treatments. With respect to marketable unhusked green ear weight (Table 2), treatments involving weedings did not differ among themselves, and all but the "weeding at 60 days" treatment, were superior to the "no weeding" treatment. For both characteristics, no effect of cropping year was observed.

Table 1 - Means for the total number and weight of unhusked green ears/ha of maize cultivar Centralmex-3, as a function of the number and frequency of weedings, in two years[1/]

Treatments (Days after planting, DAP)	Number of ears		Means	Ear weight		Means
	1996	1997		1996	1997	
	(Number ha^{-1})			($kg\ ha^{-1}$)		
No weeding	35,912	45,524	40,718 b	7,411	8,433	7,922 c
Weeding at 15 DAP	46,976	45,577	46,277 ab	12,758	10,782	11,770 ab
Weeding at 30 DAP	51,964	45,805	48,885 ab	14,032	10,295	12,164 ab
Weeding at 45 DAP	47,883	51,860	49,872 ab	13,229	11,695	12,462 ab
Weeding at 60 DAP	45,966	49,623	45,794 ab	10,936	9,298	10,117 bc
Weedings at 15 and 30 DAP	47,626	51,081	45,353 ab	12,770	13,247	13,009 ab
Weedings at 15 and 45 DAP	48,934	48,139	48,537 ab	13,603	11,933	12,768 ab
Weedings at 15 and 60 DAP	46,495	47,941	47,218 ab	12,528	10,718	11,623 ab
Weedings at 30 and 45 DAP	45,635	47,438	46,536 ab	13,748	11,723	12,736 ab
Weedings at 30 and 60 DAP	49,587	48,470	49,029 ab	13,329	11,678	12,504 ab
Weedings at 45 and 60 DAP	49,451	50,520	49,986 ab	13,233	12,032	12,633 ab
Weedings at 15, 30 and 45 DAP	49,913	52,315	51,114 a	13,485	12,334	12,910 ab
Weedings at 15, 30 and 60 DAP	49,479	50,520	49,993 a	13,686	12,216	12,951 ab
Weedings at 30, 45 and 60 DAP	46,995	46,516	46,756 a	13,366	10,821	12,094 ab
Weedings at 15, 30, 45 and 60 DAP	49,046	48,485	48,766 a	14,266	12,801	13,534 a
Means	47,457 A	48,387 A	47,923	12,832 A	11,334 A	12,080
CV %	9.7	9.0	-	15.5	13.7	-

[1/] Means followed by a common lower case letter, in the columns, and by a common upper case letter, in the row, do not differ among themselves, at 5% probability, by Tukey test.

Table 2 - Means for the number and weight of marketable unhusked green ears of maize cultivar Centralmex-3, as a function of the number and frequency of weedings, in two years[1/]

Treatments (Days after planting, DAP)	Number of ears		Means	Ear weight		Means
	1996	1997		1996	1997	
	(Number ha^{-1})			(kg ha^{-1})		
No weeding	21,257	32,414	26,981 b	5,356	6,978	6,167 b
Weeding at 15 DAP	41,995	39,356	40,675 ab	11,878	9,923	10,900 a
Weeding at 30 DAP	45,076	39,356	39,631 ab	13,225	8,633	10,929 a
Weeding at 45 DAP	43,366	43,527	43,446 a	12,498	10,733	11,615 a
Weeding at 60 DAP	38,627	33,463	36,045 ab	9,931	7,639	8,785 ab
Weedings at 15 and 30 DAP	43,082	47,451	45,267 a	12,151	12,728	12,440 a
Weedings at 15 and 45 DAP	43,429	43,266	43,348 a	12,899	11,749	12,324 a
Weedings at 15 and 60 DAP	44,427	39,870	42,148 a	12,194	9,789	10,592 a
Weedings at 30 and 45 DAP	42,485	40,201	41,343 ab	13,323	10,733	12,028 a
Weedings at 30 and 60 DAP	46,326	40,504	43,415 a	12,842	10,755	11,799 a
Weedings at 45 and 60 DAP	44,782	41,842	43,312 a	12,616	10,195	11,406 a
Weedings at 15, 30 and 45 DAP	44,261	47,636	45,949 a	12,622	12,482	12,552 a
Weedings at 15, 30 and 60 DAP	46,354	44,438	45,396 a	13,335	11,357	12,346 a
Weedings at 30, 45 and 60 DAP	44,449	39,091	41,769 a	13,034	9,993	11,535 a
Weedings at 15, 30, 45 and 60 DAP	47,043	42,522	44,783 a	14,033	11,809	12,921 a
Means	244 A	216 B	-	12,134 A	10,367 A	11,251
CV %	14.4	16.2	-	19.6	18.0	-

[1/] Means followed by a common lower case letter, in the columns, and by a common upper case letter, in the row, do not differ among themselves, at 5% probability, by Tukey test.

For the number of marketable husked green ears, again no differences could be detected between treatments involving weedings (Table 3), the same occurring for marketable husked green ear weight (Table 3). However, for both characteristics, some treatments involving weedings did not differ from the “no weeding” treatment. This occurred when only one weeding was performed, either at 15, 30 or 60 days after planting (DAP), and when two weedings were performed, at 30 and 45 DAP or at 45 and 60 DAP. As to the number of ears, the three-weeding treatment (at 30, 45 and 60 DAP) did not differ from the “no weeding” treatment as well. With regard to ear weight, the two-weeding treatment (15 and 60 DAP) also did not differ from the “no weeding” treatment.

The reduction in maize yield due to the presence of weeds is attributed to the crop weed competition for water, light and nutrients. When infested by weeds, maize develops stress symptoms earlier due to the lack of water than when it is weed-free (Tollenaar et al., 1997). However, there are no differences between soil water contents in maize with and without weeds (Tollenaar et al., 1997). Actually , Thomas & Allison (1975) observed that the water content in maize plots infested with weeds was greater than in maize plots without weeds. Thus, in the presence of weeds, the water stress symptoms may not be caused by water availability, but by a poor ability of the root system to absorb water. Maize grown in the presence of weeds would have a less developed root system than when grown without weeds. Another possibility would be that weed root exudates contain toxins that could inhibit root growth in maize (Rajcan & Swanton, 2001).

Nitrogen deficiency symptoms develop earlier in maize infested with weeds than in maize kept weed-free. This would imply in soil N depletion in maize grown with weeds, since maize yield reductions due to weeds are lower under high nitrogen rates than under lower rates (Rajcan & Swanton, 2001). For instance, Tollenaar et al. (1997) verified that, under limiting nitrogen conditions, maize yield was reduced due to weeds by 47%. Under higher levels of N, the reduction was only 14%. However, another aspect must be involved. Thomas & Allison (1975) verified that the maize root system becomes less developed in the presence of weeds. Thus, a smaller root system would be less efficient in absorbing nutrients. Little is known about the P and K interaction effects on the influence of weed competition with maize (Rajcan & Swanton, 2001), but the occurrence of processes similar to those occurring with nitrogen is likely.

Maize-weed competition, as observed in the present work, has been viewed traditionally as a process driven by limiting resources, but other factors may be involved. Some aspects involved in this competition are discussed here based on review published by Rajcan & Swanton (2001).The amount and quality of light are involved in the competition for this resource. The amount of light determines photosynthetic activity, while its quality influences plant morphology (Rajcan & Swanton, 2001). In maize, most of the light is intercepted by the younger and more efficient leaves, located above the ear, with less than 10 % of the photon flux density (PFD) reaching the leaves below 1 m. On the other hand, most weeds, during and after blooming, are below 1 m. Thus, the direct competition between maize and weeds for the incident photon flux is relatively small. Even in weed-free maize fields, the leaves below the ear are older and shaded by the upper leaves. Consequently, their photosynthetic rates are smaller than the rates observed in the upper leaves. This means that the maize yield loss due to weed competition for the incident photon flux cannot be explained by the reduced photosynthetic rates in the bottom leaves, which are shaded by weeds. The leaf area index (LAI) defines a plant's ability to intercept the incident photon flux and is an important factor in determining dry matter accumulation (Rajcan & Swanton, 2001). It has been verified (Tollenaar et al., 1994) that high competition by weeds reduced the LAI in maize at blooming by 15%. Thus, grain yield losses resulting from competition for light are better explained by the reduction in LAI than by lower photosynthetic rates in shaded leaves (Rajcan & Swanton, 2001).

Table 3 - Means for the number and weight of marketable husked green ears of maize cultivar Centralmex-3, as a function of the number and frequency of weedings, in two years[1/]

Treatments (Days after planting, DAP)	Number of ears		Means	Ear weight		Means
	1996	1997		1996	1997	
	(Number ha^{-1})			(kg ha^{-1})		
No weeding	13,625	21,514	17,570 b	2,197	3,167	2,682 b
Weeding at 15 DAP	35,821	31,491	33,656 ab	6,003	4,970	5,487 ab
Weeding at 30 DAP	41,243	23,131	32,187 ab	7,393	3,679	5,536 ab
Weeding at 45 DAP	37,974	33,482	35,728 a	6,511	5,265	5,888 a
Weeding at 60 DAP	29,926	25,352	27,639 ab	4,845	3,758	4,302 ab
Weedings at 15 and 30 DAP	39,053	42,736	40,895 a	6,508	6,987	6,748 a
Weedings at 15 and 45 DAP	38,173	36,497	37,335 a	6,776	6,165	6,471 a
Weedings at 15 and 60 DAP	39,442	30,963	35,203 a	6,391	5,192	5,792 ab
Weedings at 30 and 45 DAP	35,955	32,010	33,983 ab	6,352	5,157	5,755 ab
Weedings at 30 and 60 DAP	40,978	35,257	38,118 a	6,833	5,605	6,219 a
Weedings at 45 and 60 DAP	38,667	26,606	32,637 ab	6,544	4,214	5,379 ab
Weedings at 15, 30 and 45 DAP	40,389	36,587	38,488 a	6,737	6,332	6,535 a
Weedings at 15, 30 and 60 DAP	41,208	38,917	40,063 a	6,958	6,099	6,529 a
Weedings at 30, 45 and 60 DAP	39,017	28,501	33,759 ab	6,802	4,564	5,683 a
Weedings at 15, 30, 45 and 60 DAP	40,771	36,391	38,581 a	7,145	6,236	6,691 a
Means	36,816 A	31,962 A	34,389	6,266 A	5,159 A	5,712
CV %	17.8	23.40	-	21.0	25.0	-

[1/] Means followed by a common lower case letter, in the columns, and by a common upper case letter, in the row, do not differ among themselves, at 5% probability, by Tukey test.

The bottom leaves are not only exposed to a reduced amount of PFD, but also receive light with a quality that is different from the light received by leaves bathed in full sunlight. The light inside the canopy is rich in ultraviolet radiation (730 to 740 nm). This is caused by the selective absorption of red light (660-670 nm) by the photosynthetic pigments and by the reflection of far-red light by green leaves. This makes the far-red/red ratio (FR/R) greater in the lower section than in the upper section of the canopy. 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.) (Salisbury & Ross, 1991). Consequently, plants that develop under FR-rich light tend to have an architecture that is different from plants that grow under full sunlight. Shaded plants tend to allocate a greater leaf area in the upper section of the canopy where more light is available, while plants grown under full sunlight have a more pyramidal leaf area distribution, which limits shading on the bottom leaves by the upper leaves (Rajcan & Swanton, 2001).

The poorest green maize yield was obtained without weeding (Tables 1 to 3). In that case, the Operating Income was only R$ 1186.43 (Table 4). When maize management included weedings, the number and time of the weedings did not influence green maize yield, except when only one weeding was performed (at 60 days after planting), for which the total green ear weight was reduced (Operating Income of R$ 1476.22). Thus, in order to obtain greater income, when maize is commercialized based on the total number of ears, a single weeding at 45 days after planting should be recommended (Operating Income of R$ 1761.68).

It can be concluded that the effects of weed control on maize green ear yield were independent of cropping season and that the poorest green maize yield was obtained without weeding. Weed control influences differently the characteristics for green maize yield. When maize management includes weedings, the number and time of the weedings did not influence green maize yield, except when only one weeding was performed (at 60 days after planting), for which the total green ear weight was reduced. When maize was marketed considering the total number of green ears, a higher net revenue was obtained when one weeding was performed 45 days after planting.

Table 4 - Mean number of unhusked green ears in cultivar Centralmex-3, in relation to the number of performed weedings and fixed costs, variable costs, total costs and operating income for the production and commercialization of these ears[1/]

Number of weedings (Days after planting=DAP)	Number of ears ha^{-1}	Total cost ha^{-1} (R$ 1.00)	Operating income (R$ 1.00)
No weeding	40,718	1,663.83	1,186.43
One weeding			
At 15 DAP	46,277	1,729.36	1,510.03
At 30 DAP	48,885	1,729.36	1,692.59
At 45 DAP	49,872	1,729.36	1,761.68
At 60 DAP	45,794	1,729.36	1,476.22
Two weedings			
At 15 and 30 DAP	45,353	1,794.79	1,379.92
At 15 and 45 DAP	48,537	1,794.79	1,602.80
At 15 and 60 DAP	47,218	1,794.79	1,510.47
At 30 and 45 DAP	46,536	1,794.79	1,462.73
At 30 and 60 DAP	49,029	1,794.79	1,637.24
At 45 and 60 DAP	49,986	1,794.79	1,704.23
Three weedings			
At 15, 30 and 45 DAP	51,114	1,857.42	1,720.56
At 15, 30 and 60 DAP	49,986	1,857.42	1,641.60
At 30, 45 and 60 DAP	46,756	1,857.42	1,415.50
Four weedings			
At 15, 30, 45 and 60 DAP	48,766	1,925.95	1,487.67

[1/] The Fixed Costs value was R$ 73.38. The Variable Costs values for no weeding and for one, two, three or four weedings were R$1,590.45, R$1,655.98, R$1,721.51, R$1,784.04 and R$1,852.57, respectively. The Operating Income was calculated under the assumption that the farmer could sell one thousand ears for R$ 70.00. All values refer to costs as of November 2002.

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