EFFECT OF WEED CONTROL IN CORN WITH COWPEA INTERCROPPING ON SOIL CHEMICAL CHARACTERISTICS

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Abstract - Weeds interfere with nutrient absorption by crops. Therefore, there has been interest in knowing the effects of weeds on soil chemical characteristics, aiming at better fertilization management in order to save fertilizers and reduce pollution problems. The objective of this work was to evaluate the effects of weed control on soil pH and soil Ca, Mg, K, Na, P, and SB contents (sum of bases), when the soil is cultivated with corn. The experiment was conducted as random blocks with 5 replicates and split-plots. Four cultivars (BA 8512, BA 9012, EX 4001 and EX 6004) were grown with weed control (two hoeing operations, or intercropped with cowpea, *Vigna unguiculata* (L.) Walp.) or without weed control. The weed control measures were assigned to subplots, while cultivars were assigned to plots. Ten weed species predominated in the experiment. The weeding operations increased P content, but reduced S content, while the lack of weed control increased pH (in water). These effects were independent from the cultivars evaluated, which were not different with regard to their effects on soil characteristics.

Keywords: *Zea mays, Vigna unguiculata*, hoeing, cultivars, nutrients.

EFEITO DAS PLANTAS DANINHAS NO CONSÓRCIO MILHO COM FEIJÃO-CAUPI SOBRE AS CARACTERÍSTICAS QUÍMICAS DO SOLO

Resumo – As plantas daninhas interferem na absorção de nutrientes pela cultura. Portanto, existe interesse em se conhecer os efeitos das plantas daninhas sobre as características químicas do solo, visando melhor manejo da adubação para economia de adubos e redução de problemas de poluição. O objetivo do trabalho foi avaliar os efeitos do controle de plantas daninhas sobre o pH e os teores de Ca, Mg, K, Na, P e SB (soma de bases) cultivado com milho. O experimento foi realizado em blocos ao acaso com 5 repetições com os tratamentos arranjados em parcelas subdivididas. Quatro cultivares (BA 8512, BA 9012, EX 4001 e EX 6004) foram cultivadas com controle de plantas daninhas (duas capinas à enxada ou com consorciação com feijão-caupi, (*Vigna unguiculata* (L.) Walp.) ou sem esse controle. Os controles de plantas daninhas foram aplicados às subparcelas e as cultivares, às parcelas. Dez espécies de plantas daninhas predominaram no experimento. As capinas aumentaram o teor de P, mas reduziram o teor de SB, enquanto a falta de controle das plantas daninhas elevou o pH (em água). Esses efeitos foram independentes das cultivares avaliadas, as quais não diferiram em seus efeitos sobre as características do solo.

Palavras-chave: *Zea mays, Vigna unguiculata*, capinas, cultivares, nutrientes.

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Introduction

Cultural practices in the control of weeds, studied in the past, have once again drawn interest, include intercropping (Abreu, 2004). Another aspect related to environmental degradation refers to fertilizer application. To keep the soil's fertility levels, nutrients removed with the harvest of the culture or system losses, such as those caused by weeds, should be replenished annually (Heckman et al., 2003).

The objective of this work was to evaluate the effects of weed control in four corn cultivars, with hoeing operations and intercropping with cowpea, on soil chemical features.

Material and Methods

The experimental soil was classified according to the Brazilian Soil Classification System as Argissolo Vermelho-Amarelo Eutrófico (Emabrapa, 1999). The experimental design was in randomized complete blocks, arranged in split-plots, with five replications. The main plots consisted of four maize cultivars: BA 8512, BA 9012, EX 4001 and EX 6004. And the subplots consisted of the following treatments: no-weeding; twice hand-weeding, at 20 and 40 days after sowing; intercropping with cowpea, 'Sempre Verde' cv, both maize and cowpea seeded at the same time. Each subplot consisted of four 6.0m-length rows, but only the two central rows were the usable experimental unity, that is, were actually used for the plant evaluations and harvest, discarding the border rows and the two plants at each row extremity.

At 100 days after planting, the ripe corn ears were harvested and eight soil samples were removed between the two center rows in the useful area of each experimental unit, at 0-20 cm depth. The samples were combined and the material submitted to chemical analysis (Embrapa, 1999). The data was submitted to analyses of variance and the means were compared by the Tukey test ($P < 0.05$).

Results and Discussion

Only ten weed species, majority of which were grass, occurred in the experiment (Table 1). Probably, this small number of the species is associated to intensive cultivation (two crops per year, involving harrowing and fertilizing) with corn in the experimental area for over 10 years (Menalled et al., 2001).

There was not cultivars x weed control interaction in the evaluated characteristics. For this reason, only the averages of main cultivar effects (Table 2) and weed controls (Table 3) are presented.

Although there may be differences between cultivars in uptake, translocation, accumulation and use of mineral elements, the cultivars evaluated in the present work do not influence the studied soil characteristics (Table 2). The removal of nutrients by the corn varies much with the environmental conditions (Heckman et al., 2003) and this variation may have masked the effects of the cultivars on the chemical characteristics evaluated. Besides, although the existence of uniformity in each experimental block is assumed, the type, number and growth of the weeds vary among experimental plots (SILVA, 2005).

Table 1. Main species of weeds identified in the experimental area.

Botanical name	Common name	Family
Alternanthera ficoidea (L.) P. Beauv.	Joseph's coat	Amaranthaceae
Borreria verticilata (L.) G.F.W. Meyer.	Rubiaceae	Rubiaceae
Cenchrus echinatus L.	Bur	Gramineae
Commelina sp. L.	Comelina	Commelinaceae
Cucumis anguria L.	Maxixe	Cucurbitaceae
Dactyloctenium (L.) Beauv.	Chicken feet grass	Gramineae
Digitaria sanguinalis (L.) Scop.	Cushion grass	Gramineae
Melochia pyramidata L.	-	Sterculiaceae
Phyllanthus niruri L.	Stone breaker	Euphorbiaceae
Senna uniflora (P.Mill) Irwin &Barneby	One-leaf senna	Leguminosae

Table 2. Contents of some chemical elements of a Argissolo Vermelho-Amarelo Eutrófico soil (Ferric Lixisol) after cultivation of corn with or without weed control.[1]

Cultivars	pH (water)	Ca	Mg	K	Na	SB	P
		(cmol dm^{-3})					(mg dm^{-3})
				c			
BA 8512	8.0 a	4.69 a	2.17 a	0.42 a	0.26 a	7.54 a	62.0 a
BA 9012	8.0 a	4.57 a	2.21 a	0.41 a	0.25 a	7.44 a	64.5 a
EX 4001	8.0 a	4.73 a	2.23 a	0.40 a	0.27 a	7.63 a	64.6 a
EX 6004	8.0 a	4.76 a	2.03 a	0.43 a	0.26 a	7.48 a	55.5 a
Means	8.0 a	4.68 a	2.16 a	0.42 a	0.26 a	7.52 a	61.6 a
C.V. a, %	1.7	20.7	27.9	21.8	9.8	18.4	58.3

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

Weed control treatments influenced the evaluated soil chemical characteristics differently (Table 3). Soil pH was higher in the plots without hoeing than in those with hoeing, which in their turn, was higher than the plots where intercrops were cultivated. Hoeing correspond, in a certain way, to incorporation of plant material into the ground. Some authors (Meda et al., 2002) verified that the incorporation of plant extracts into the soil substantially elevated its pH.

Table 3. Contents of some chemical elements in a Argissolo Vermelho-Amarelo Eutrófico soil (Ferric Lixisol) after the cultivation of corn with or without weed control

Control of weeds	pH (water)	Ca	Mg	K	Na	S	P
		(cmol dm^{-3})					(mg dm^{-3})
				c			
No hoeing	8.05 a	4.60 a	2.25 a	0.43 a	0.27 a	7.53 a	61.5 b
With hoeing	8.01 b	4.69 a	2.09 a	0.40 a	0.26 a	7.43 b	66.4 a
Intercropping	7.97 c	4.77 a	2.15 a	0.43 a	0.27 a	7.61 a	57.1 c
Means	-	4.69	2.13	0.42	0.27	-	-
C.V.b. %	1.0	10.0	14.8	14.7	9.1	7.3	22.0

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

As corn, cowpea and weeds remove soil nutrients, one can admit the hypothesis that the highest nutrient levels occur in general in the hoed plots as in them, only the corn would remove the nutrients. In the other two type's plots, nutrients removal would occur by corn + weeds or corn + cowpea + weeds. This hypothesis would only be true is there were not interactions among species. In other words, when two or more species, crops or weeds, occur in the same plot, removal of soil nutrients from it is not the sum of nutrient removal if each species were cultivated separately. This distinct behavior of cultures and weeds when hoed or not would be due to the interaction between the root systems of the species. The root system of corn develops less in the presence of weeds (Thomas & Allison, 1975) and probably, the root system of the weeds should also be reduced in the presence of corn or other crop. Another possibility would be the exudates of weeds containing toxins that could inhibit root growth of corn (Rajcan & Swanton, 2001).

In the present work, the soil of the plots hoed presented higher P level but reduced sum of bases, although the control of weeds has not influenced the content of Ca, Mg, K and Na, individually (Table 3). Many factors can contribute to such differences, including soil pH. One of these factors would be the manner of the soil nutrients move from soil to plant (Schachtman et al., 1998). Another factor would be the point of entry of the minerals (Taiz & Zeiger, 2004). In addition, corn's root exudates may have influenced the differences in the concentration of soil nutrients of plots with and without weed control (Fan et al., 2001; Hinsiger, 2001). Finally, it should be mentioned that the formation of Mycorrhizae, which increase the uptake by corn of relative immobile nutrients such as P, Cu and Zn (Liu et al., 2000) may be involved in the chemical differences of soil cultivated with and without weed control. Other authors (Menyailo et al., 2002) verified that the perennials species did not have an effect on individual nutrient contents such as NO_3^-, N, Al^{3+}, Ca^{2+}, Fe^{3+}, K^+, Mg^{2+} e Cl^-.

Conclusions

Weed control increased the P content but reduced S content, while the lack of control of weeds increased the pH (in water). These effects were regardless of the cultivars evaluated, which did not differ in their effects on soil chemical characteristics.

References

ABREU, N. A.A. de. Infestação de plantas daninhas e desenvolvimento da cultura do milho em consorciação com variedades de mandioca. 2004. 49p. Dissertação (Mestrado em Fitotecnia) – Universidade Federal de Lavras, Lavras.

EMBRAPA. **Manual de análises químicas de solos, plantas e fertilizantes**. Brasília: Embrapa, 1999. 370p.

FAN, T.W.M.; LANE, A.N.; SHEWKER, M.; BARTLEY, J.P.; CROWLEY, D.; HIGASHI, R.M. Comprehensive chemical profiling of gramineous plant root exudates using high-resolution NMR and MS. **Phytochemistry**, Oxford, v.57, p.209-221, 2001.

HECKMAN, J.R.; SIMS, J.T.; BEEGLE, D.B.; COALE, F.J.; HERBERT, S.J.; BRUULSEMA, T.W.; BAMKA, W.J. Nutrient removal by corn grain harvest. **Agronomy Journal**, Madison, v.95, n.1, p.587-591, 2003.

HINSINGER, P. Bioavailability of soil inorganic P in the rhizosphere as affected by root induced-chemical changes: a review. **Plant and Soil**, Dordrecht, v.237, p.173-195, 2001.

LIU, A.; HAMEL, C.; HAMILTON, R.I.; SMITH, D.L. Mycorrhizae formation and nutrient uptake of new corn (Zea mays L.) hybrids with extreme canopy and leaf architeture as influenced by soil N and P levels. **Plant and Soil**, v. 221, n.1, p.157-166, 2000.

MEDA, A.R.; PAVAN, M.A.; MIYAZAWA, M.; CASSIOLATO, M.E. Plantas invasoras para melhorar a eficiência da calagem na correção da acidez subsuperficial do solo. **Revista Brasileira de Ciência do Solo**, Campinas, v.26, p.647-654, 2002.

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.

MENYAILO, O.V.; HUNGATE, B.A.; ZECH, W. Tree species mediated soil chemical changes in a Siberian artificial afforestation experiment. **Plant and Soil**, Dordrecht v. 242, p.171-182, 2002.

RAJCAN, I.; SWANTON, C.J. Understanding maize-weed competition: resource competition, light quality and the whole plant. **Field Crops Research**, Amsterdam, v. 71, n. 2, p.139-150, 2001.

SCHACHTMAN, D.P.; REID, R.J.; AYLING, S.M. Phosphorus uptake by plants: from soil to cell. **Plant Physiology**, Rockville, v.116, v.2, p.447-453, 1998).

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.

TAIZ, L.; ZEIGER, E. **Plant physiology**. Sunderland: Sinauer Associates, 2004. 690 p.

THOMAS, P.E.L.; ALLISON, J.C.S. Competition between maize and Rottboellia exaltata. **Journal of Agricultural Science**, Cambridge, v.84, n.1, p.305-312, 1975.