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WEED MANAGEMENT ON THE CORN CROP FERTILIZED WITH POULTRY LITTER

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ABSTRACT - In this work, the application of poultry litter for corn crop, its influence on the weed community and the interrelation with mechanical and chemical control methods were investigated. Before management, weed phytosociological analysis were done, adopting six treatments and six replications. A randomized blocks design in a factorial 2x5+2 was adopted to evaluate the control methods. The first factor was the form of control, application of herbicide nicosulfuron in post emergence and mechanical control (hand weeding). The second factor was the doses of poultry litter that corresponded to 0, 50, 100, 200 and 300% of corn N recommendation. The checks consisted of the two methods of weed control associated with recommended N using mineral fertilizer. The corn plant height was evaluated at 14 and 28 days after management. The results showed that the incorporation of poultry litter promoted changes in the relative importance of weed species, until the time of control. The weed control method did not affect corn yield; however, the plant height 47 days after sowing with mechanical control was higher. With the poultry litter dose corresponding to 200% of the recommended nitrogen, corn grain yield was similar to that obtained with mineral fertilizers.

Key words: Systems fertilization, anticipation of fertilization, organic fertilization, *Zea mays.*

MANEJO DE PLANTAS DANINHAS NA CULTURA DO MILHO SUBMETIDO À ADUBAÇÃO COM CAMA DE FRANGO

RESUMO - Na pesquisa, investigou-se a incorporação de cama de frango na cultura do milho, sua influência na comunidade de plantas daninhas e inter-relação com os controles mecânico e químico. Antes do controle, realizou-se a análise fitossociológica de plantas daninhas, adotando-se seis tratamentos e seis repetições. Para avaliação dos métodos de controle, foi adotado o delineamento de blocos ao acaso, em um esquema fatorial 2x5+2. O primeiro fator foi a forma de manejo, herbicida nicosulfuron em pós-emergência e controle mecânico (capina manual). O segundo fator foram doses de cama de frango correspondendo a 0, 50, 100, 200 e 300% do N recomendado para o milho. As testemunhas consistiram dos dois métodos de manejo com aplicação do N mineral. A altura das plantas de milho foi avaliada aos 14 e aos 28 dias após o manejo. A cama de frango promove mudanças na importância relativa de espécies de plantas daninhas até o momento do controle. Os controles mecânico e químico não afetam a produtividade, embora com maior altura de plantas aos 47 dias após a semeadura com controle mecânico. Com dose de cama de frango correspondente a 200% do nitrogênio recomendado, a produtividade de milho é similar à obtida com fertilizante mineral.

Palavras-chave: Adubação de sistemas, antecipação de adubação, adubação orgânica, *Zea mays*.

Due to the large number of poultry farms located in Central Brazil, large quantities of poultry litter are available, a residue rich in essential nutrients used in agriculture. This residue contains, among others, the elements nitrogen, potassium, phosphorus, calcium, magnesium and sulfur (Kiehl, 2010). Farmers are adopting it for crop fertilization (Cantarella & Duarte, 2004), with broadcast distribution over the area to be cultivated with corn or soybeans. The mechanical incorporation of organic compound in the soil provides greater accumulation of macronutrients influencing positively the growth and yield of corn plants (Silva et al., 2011; Favarato et al., 2013)

The prior distribution of poultry litter increases the sowing efficiency, a desirable situation in regions where two crops are grown each year. Fertilization with poultry litter in some cases replaces the mineral fertilizer, minimizing the farmers' investment, since it is a byproduct of the properties that integrate the poultry and grain production. The anticipation in nutrient availability accelerates the initial development of plants, including weeds, requiring anticipated management. Improvements in the fertility of nutrient-poor soils might increase weed pressure and make more critical the development of effective weed management strategies (Major et al., 2005). According to Rizzardi et al. (2008), based on the time of nitrogen availability to corn plants a variation in the density of plants in the weed community may occur. Phytosociological parameters are frequently used to the characterization of weed community, with the aim of developing strategies for management (Adegas et al., 2010; Maciel et al., 2010).

The relative importance is an index that involves the sum of factors constancy, density and relative dominance, which has been used by the scientific community to determine the floristic composition in different agroecosystems (Kuva et al., 2007; Lima et al., 2014)

Split application or controlled release of nitrogen may be a useful practice for managing weeds, so farming systems that minimize nutrient availability early in the growing season should limit the growth of small-seeded weeds without compromising the growth or yield of crops with large seeds (Efthimiadou et al., 2012).

Herbicide weed control in corn is frequently adopted due its efficacy and practicability. Among the main herbicides adopted on corn, nicosufuron associated with atrazine can be cited (Timossi & Freitas, 2011). However when one intends to adopt the organic cultivation, it becomes necessary the use of mechanical methods for controlling weeds (Chiovato et al., 2007; Silva et al., 2010). Major et al. (2005) observed that fertilization with organic and inorganic materials on central Brazilian Amazon resulted in increases in weed ground cover and species richness especially when chicken manure was applied. With this fertilizer, the dominance by a few weed species was reduced. On the other hand, Sediyama et al. (2010) evaluate the effect of mulching and doses of swine culture waste water sedimentation pond sludge on weed incidence and yield of sugar beet and observed that increasing doses of sludge caused a linear reduction in the dry mass of monocot weeds.

In the research it was investigated the influence of poultry litter incorporation on the soil in the weed community and its impact on corn yield under two weed management systems.

Material and Methods

The work was conducted in the field during the growing season of 2009/10 in the city of Jataí,

located at 17°53'S and 52°43'W and approximately 700 m altitude. The soil of the region is classified as Latossolo Vermelho distroférrico (Brazilian Soil Classification System) with soft relief. The experimental area had the following characteristics, detected by soil chemical analysis, pH in $CaCl_2$ of 4.8, K and P with 35 and 2.7 mg dm^{-3} respectively; V% 31 and organic matter of 34.5 g dm^{-3}.

According to the results of soil chemical analysis and nutrients concentrations in poultry litter, the doses were settled. They were incorporated in the topsoil (0-15 cm) with rotary hoe, simulating disc harrowing, fully anticipating the nutrients for the corn crop. The nutrient concentrations found in poultry litter were 28, 30, and 34 g kg^{-1} de N, P_2O_5 and K_2O, respectively. Two days after poultry litter broadcast distribution and incorporation, the hybrid DKB 350 Yieldgard was sowed (28/10/2009), in row spacing of 0.45 cm with seeds necessary to a population of 60,000 plants ha^{-1}.

To study the weed community, phytosociological indices were determined as proposed by Mueller-Dombois & Ellemberg (1974), 16 days after sowing, before the herbicide application and mechanical control. A metal square of 0.5 x 0.5 m was launched randomly two times in each replication, totaling 0.5 m^2. In this evaluation was possible to adopt six treatments with six replications, since in this period the first factor proposed (mechanical and chemical management of weeds) it has not yet been established.

To study the effects of the weed control methods, a randomized block design in a 2x5+2 factorial arrangement was used, with three replications. Each plot consisted of five rows with seven meters in length, 15.8 m^2 of total area. The first factor was the two weed control methods, nicosulfuron herbicide application in post emergence and mechanical control (hand weeding). The second factor was the doses of poultry litter (0, 2.88, 5.76, 11.52 and 17.28 Mg ha^{-1}) that corresponded to 0, 50, 100, 200 and 300% of corn N recommendation. The checks consisted of the two methods of weed control associated with the application of the recommended N using ammonium sulfate (160 kg N ha^{-1}) accomplished 18 days after sowing (DAS). Urea, simple super phosphate and potassium chloride at doses of 20, 120 and 80 kg ha^{-1}, of N, P_2O_5 and K_2O respectively, were used as mineral fertilizer at sowing. The mineral fertilizer was used only on the checks.

At 19 DAS, in corn stage of five fully expanded leaves, herbicide application (nicosulfuron at 60 g a.i. ha^{-1}) and mechanical control (hand weeding) were performed. Herbicide application was accomplished with pressurized sprayer maintained at constant pressure per CO_2, and 200 L ha^{-1} volume, with a bar equipped with four spray nozzles AXI 11002. The atmospheric conditions observed during the 14 and 16 h and 20 min period were: air temperature of 34.1 °C, relative humidity 60%; cloud cover 60% and soil moisture at the surface.

In the corn crop, the plant height was evaluated at 14 and 28 days after management, measuring the distance between the ground and the last visible ligule in ten plants randomly taken per plot. By harvest time, the corn cobs were collected from three central lines (15 m) and subsequently threshed to estimate grain yield (kg ha^{-1}). The grain weight was standardized to 13% moisture.

The data, when appropriate, were subjected to analysis of variance, mean comparison by Dunnet test ($p < 0.05$) and regression analysis.

The monthly average weather conditions during the experiment obtained in Instituto Nacional

de Meteorologia (INMET) are shown in Figure 1.

Results and Discussion

Phytosociology of the weed community

By determining the specific composition of the weed community it can be verified the presence of seven botanical families (Table 1). The fertilization affected the average weed density, increasing both with the application of poultry litter as with mineral fertilizer (Figure 2). However, the weed population density has not greatly varied with different doses of poultry litter.

The values of Relative Importance (RI) on the investigated weed community can be verified on Figure 3. The RI results until the moment of weed control showed that, with fertilization, both mineral and organic, the weed shift occurred. Some species like *Euphorbia heterophylla* (EPHHL)*, Pennisetum setosum* (PESSE) and *Bidens pilosa* (BIDPI) were favored with fertilization. On the other hand, other species like *Alternanthera tenella* (ALRTE) was not observed on the higher doses of organic fertilizer, where the major expressive species favored was PESSE.

The community had more uniformity of

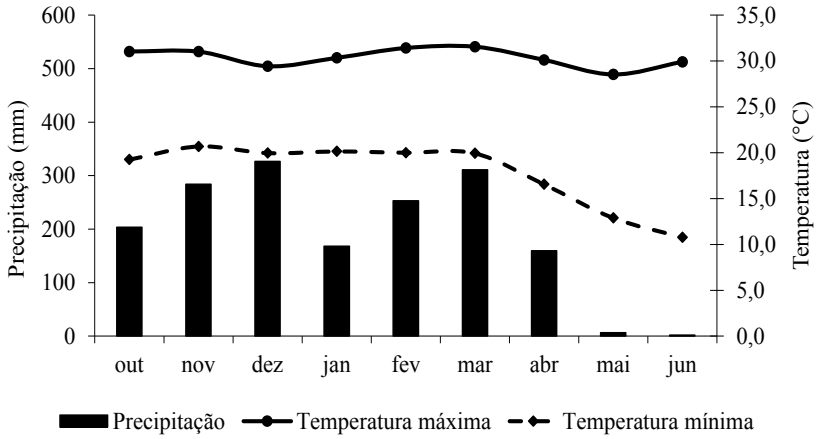

Figure 1. Monthly average climatological conditions related to rainfall, maximum and minimum temperature observed during the months of October 2009 to June 2010 at the weather station of INMET in Jataí – GO (INSTITUTO NACIONAL DE METEOROLOGIA , 2010).

Table 1. List of weeds identified by botanical family, scientific name and international code 'Bayer Code'.

Botanical family	Scientific name	Bayer Code
Euphorbiaceae	*Euphorbia heterophylla*	EPHHL
Poaceae	*Pennisetum setosum*	PESSE
	Digitaria horizontalis	DIGHO
Asteraceae	*Bidens pilosa*	BIDPI
Amaranthaceae	*Alternanthera tenella*	ALRTE
Commelinaceae	*Commelina benghalensis*	COMBE
Rubiaceae	*Spermacoe latifolia*	BOILF
Convolvulaceae	*Ipomoea triloba*	IPOTR

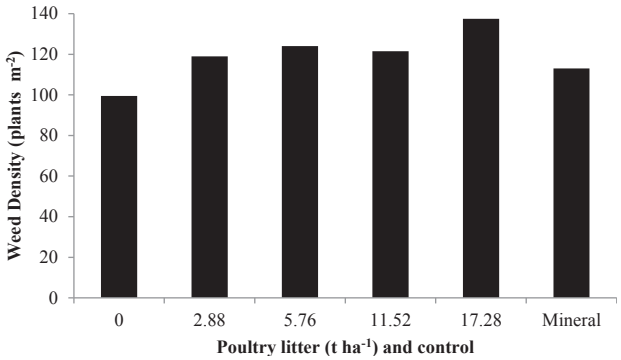

Figure 2. Weed density at different levels of organic fertilization and check with mineral fertilizer.

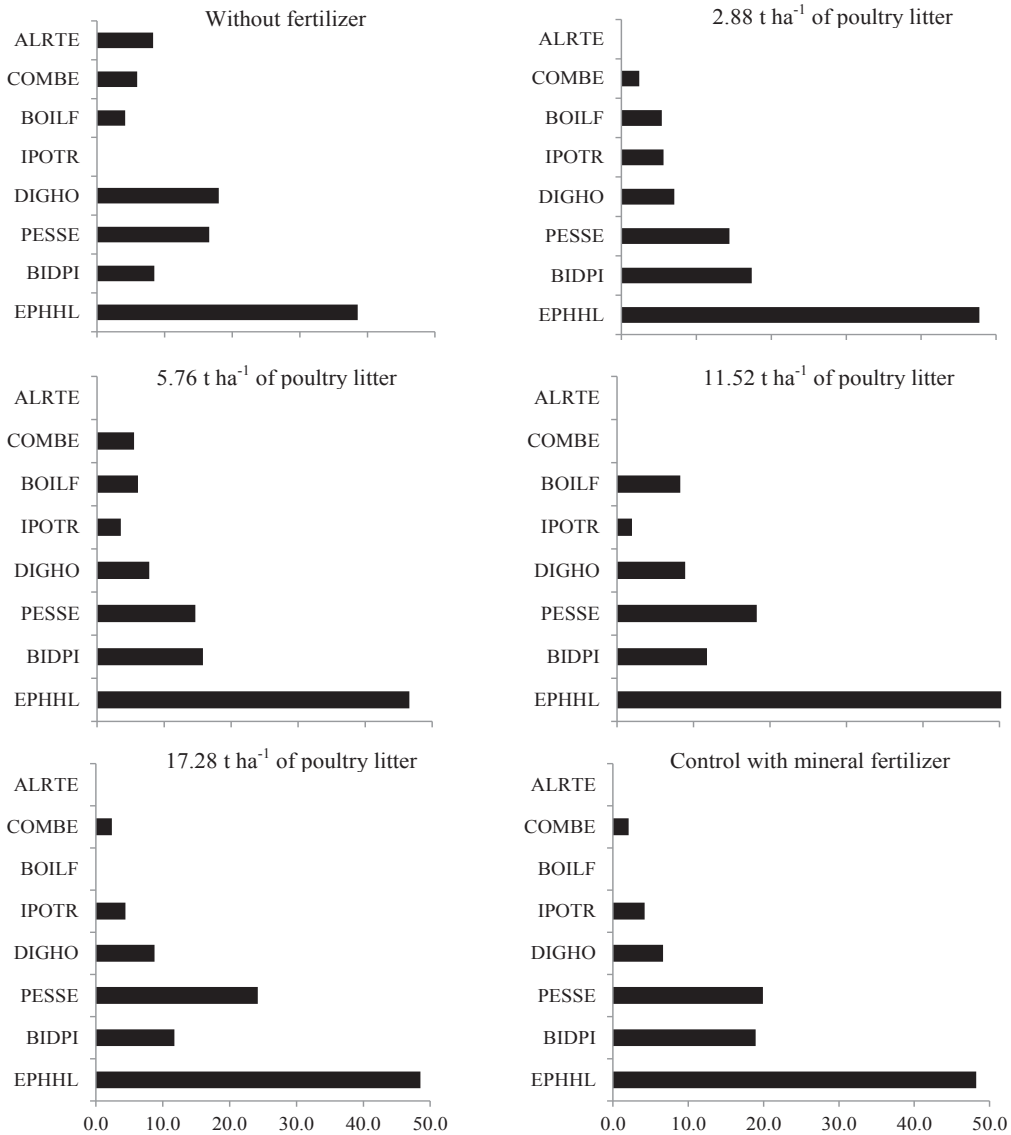

Figure 3. Relative importance of weeds due to different levels of organic or mineral fertilization in corn.

distribution where there was no nutrient application, reducing the relative importance degree of EPHHL.

Weed Management in corn crop

The statistical analyses resume of the studied variables related to corn growth are shown on Table 2.

For all the variables studied, significant interaction between the factors was not observed, allowing this way the study of the effects separately. The treatments were significant for the three variables, but only the factor poultry litter was significant for all of them. Weed management method was only significant for plant height 28 days after management, where the heights with mechanical control were 143.79 cm and 139.74 with chemical control. Zagonel et al. (2000) observed increased plant height in the treatments with hand weeding relative to those with herbicides. The authors attributed this result to the absence of phytotoxic effects and immediate elimination of weeds, since in herbicide treatments plants remained few more days competing with the crop. In this work, phytotoxic effects were not noticed, but a greater competition period could explain the results on the treatments with herbicides.

The results of Dunnett's test are presented on the Table 3, comparing the checks with the other treatments.

The checks did not differ for the three analyzed variables. Observing the results of plant height at 14 DAM it could be noticed that the absence of fertilization presented lower plant height compared to the checks, either with mechanical or chemical control. With the doses of 11.52 and 17.28 Mg ha^{-1} of poultry litter the plants reached higher values compared to the checks. The lower dose of poultry litter when associated with chemical control presented lower value of plant height compared to the checks, strengthening the results observed on the F test when comparing the two control methods.

At 28 DAM the results are the same, except on

Table 2. Summary of analysis of variance (F test result) for Plant Height 14 days after management (PH14DAM) , Plant Height 28 days after management (PH28DAM) and grain yield (YIELD) as a function of doses of poultry litter (PL) and weed management methods (WMM) with control treatment with mineral fertilizer.

Sources of Variation	DF	PH14DAM	PH28DAM	YIELD
Treat x Controls	1	0,20 ^{ns}	1,51 ^{ns}	16,97 **
Between controls	1	0,00 ^{ns}	0,27 ^{ns}	2,32 ^{ns}
Weed management method	1	2,63 ^{ns}	6,46 *	1,82 ^{ns}
Poultry Litter	4	148,37 **	162,18 **	19,99 **
WMM x PL	4	0,72 ^{ns}	0,58 ^{ns}	1,40 ns
(Treatments)	11	54,47 **	59,94 **	9,70 **
Blocks	2	3,56 *	4,49 *	5,73 **
Error(QM)	22	7.00	19.08	407354.83
CV%		5,51	3,07	7,60

^{ns}, *, and **: not significant, significant at 5 and 1% probability by the F test, respectively.

the 2.88 Mg ha^{-1} of poultry litter with chemical control that presented plant height similar to the checks, showing the possible nutrient release from the organic fertilizer. With the doses of 11.52 and 17.28 Mg ha^{-1} of poultry litter the yield was similar to the checks with mineral fertilizer, expressing the potential of organic fertilizing. These results also allow conclude that is safe using nicosulfuron with organic fertilizer, without phytotoxic effects on growing and yield of corn crop. The only difference observed with the control methods was on the dose of 5.76 Mg ha^{-1} of poultry litter, where the chemical control produced lower yield compared to the mineral fertilizer checks. Is worth mentioning that this result could be occurred due to the lower availability of nutrients associated with the greater competition period between corn and weeds until the total control of weeds on the chemical control method.

On Figure 4 it can be verified that poultry litter increased plant height but with a quadratic response on the two evaluation times. Accordingly with the adjusted equations, the optimal dose for corn growth was 15.52 Mg ha^{-1} evaluated at 14 days after management and 13.32 Mg ha^{-1} evaluated 28 days after management (47 DAS).

The plant heights are probably related to the availability and ideal balance of nutrients for plants, as Gomes et al. (2005) observed working with corn, where the height of plants is directly related to increasing doses of organic and mineral NPK fertilizer. The poultry litter provides several macro and micronutrients in addition to the organic matter beneficial effects which may have promoted the response observed.

Regarding the adoption of organic fertilization, although there is a rising curve in grain yield due to

Table 3. Dunnett's test results for Plant Height 14 days after management (PH14DAM), Plant Height 28 days after management (PH28DAM) and grain yield (YIELD), comparing doses of poultry litter and methods of weed management with control treatment with mineral fertilizer.

Treatment	Weed management	Poultry Litter (Mg ha^{-1})	PH14DAM (cm)	PH28DAM (cm)	YIELD (kg ha^{-1})
1	Mechanical	0	29.23*	105.50*	6889.03*
2	Mechanical	2.88	43.27	138.60	7800.27*
3	Mechanical	5.76	50.57	151.10	8580.83
4	Mechanical	11.52	59.70*	160.90*	8430.70
5	Mechanical	17.28	60.90*	162.87*	10087.10
6	Chemical	0	28.43*	104.70*	6267.57*
7	Chemical	2.88	41.40*	135.03	7707.17*
8	Chemical	5.76	46.53	142.73	7809.10*
9	Chemical	11.52	57.60*	156.90*	9103.17
10	Chemical	17.28	61.87*	159.33*	9330.77
Check 1	Mechanical	Mineral	48.47	145.10	8980.00
Check 2	Chemical	Mineral	48.50	143.23	9773.03

Means followed by * differ significantly from the controls by Dunnett's test ($p \geq 0.05$).

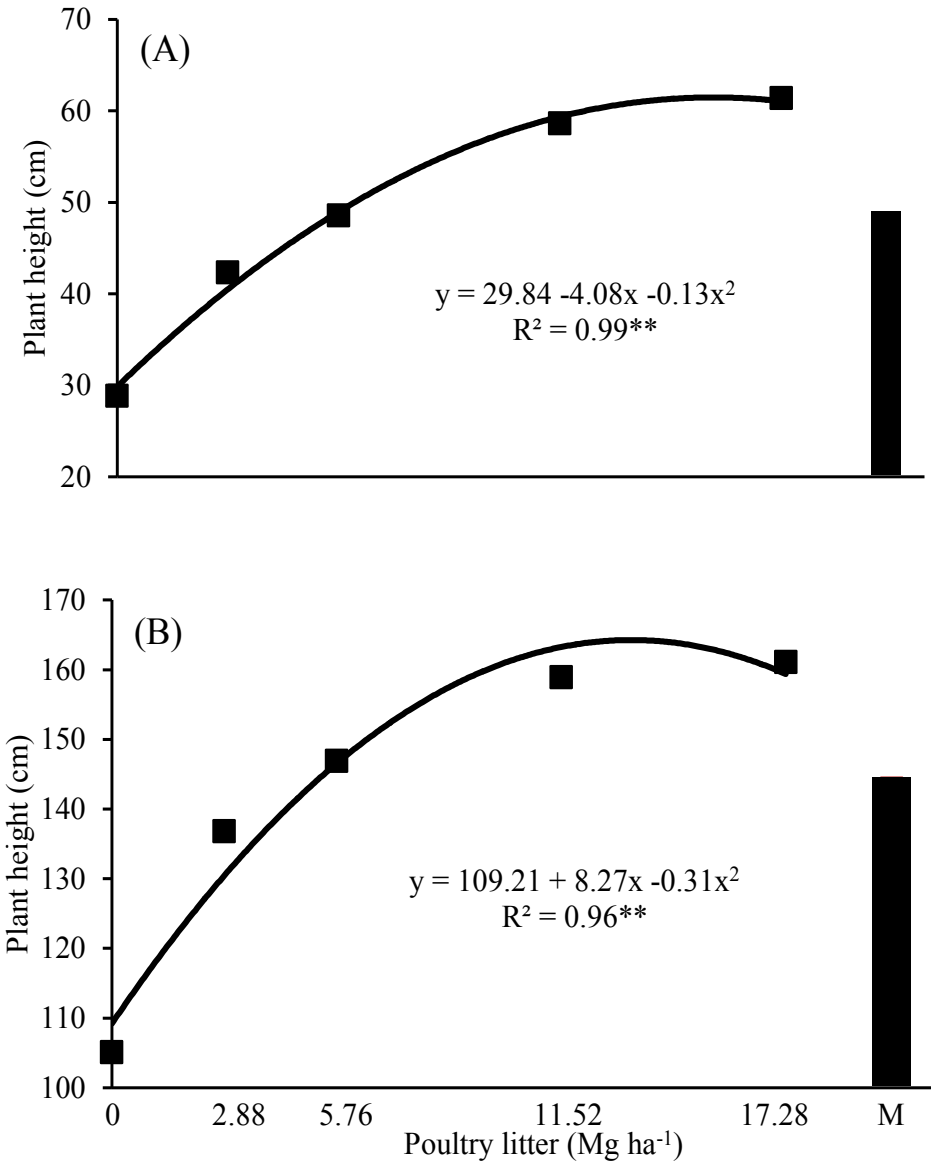

Figure 4. Plant height averages after 14 days of weed control (31 DAS) (A) and plant height averages after 28 days of weed control (45 DAS) (B) using chemical and mechanical methods, as a function of increasing rates of poultry litter. Vertical bar represents the height with mineral fertilizer.

the amount of poultry litter incorporated (Figure 5). Adami et al. (2012) also obtained positive response with the increase of poultry litter incorporation. Besides this, the increase in plant height was not followed by yield gains and a possible explanation is the difference in time of availability of the nutrients contained in poultry litter. The nitrogen in the poultry litter is not readily available to the crop, while the potassium has a higher availability (Lopes & Guimarães, 1989). The slow release of nitrogen did not impair plant height, but its early deficiency may have impaired the yield compared to the check with

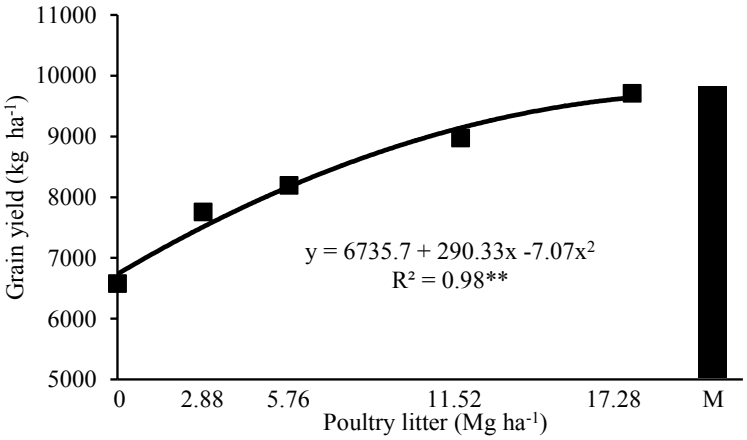

Figure 5. Corn grain yield averages as a function of increasing rates of poultry litter. Vertical bar represents the yield with mineral fertilizer.

mineral fertilizer. Such information can be useful when the aim is system fertilization, providing soil enrichment in the long-medium term.

Conclusion

The incorporation of poultry litter promotes changes in the relative importance of weed species present in the community, until the time of control. The mechanical and chemical control of weed does not affect the yield; however the plant height 47 days after sowing with mechanical control was higher. With the incorporation of poultry litter dose corresponding to 200% of the recommended nitrogen, corn grain yield becomes similar to that obtained with mineral fertilizers.

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