Original Article

BROADCAST AND BAND APPLICATION OF POULTRY LITTER ON SOYBEAN CROP

APLICAÇÃO DE CAMA DE AVES A LANÇO E NO SULCO NA CULTURA DA SOJA

Darly Geraldo SENA JR.[1]; Vilmar Antonio RAGAGNIN[1]; Saulo Alves RODRIGUES JUNIOR[2]; Pedro Mesquita de LIMA NETO[2]; Phelipe Diego Moraes NOGUEIRA[2]

1. Professor, Dr. Federal University of Goiás – UFG, Regional Jataí, Jataí, GO, Brazil. darly.sena@gmail.com;
2. Agronomy undergraduate student, Federal University of Goiás – UFG, Regional Jataí, Jataí, GO, Brazil;

ABSTRACT: The development of the poultry industry in the central west region of Brazil have provided considerable quantities of organic waste, poultry litter, which have potential for use in agriculture. However there are few studies about the release dynamics of the poultry litter nutrients, what makes it difficult to define the dose as well the form of application of this organic residue. The present study aimed to evaluate the effect of different doses of poultry litter, with two forms of application, on growth and yield of soybean. The experiment was conducted in a randomized block design in a factorial scheme 5 x 2 + 2, being factors doses of poultry litter (0, 1, 2, 4 and 8 t ha^{-1}) and application forms, broadcast and band. On the control treatments were applied mineral fertilizer, one broadcast and one band. The variables plant height, shoot dry matter and chlorophyll were measured in stage R2 and yield at the end of the crop cycle. The increase in rates of poultry litter increases linearly the plant height while the shoot dry matter and yield had a quadratic response. The form of poultry litter application did not influence the yield and dry matter, affecting only plant height and leaf chlorophyll. The band application of poultry litter provides increased plant growth. The organic fertilization with poultry litter can replace mineral fertilizers on soybean.

KEYWORDS: Organic fertilizer. *Glycine max*. Yield.

INTRODUCTION

One of the most important crops cultivated worldwide is the soybean (*Glycine max)*, belonging to the family Fabaceae, and the main crop in Brazil, occupying around 25 millions of hectares, which represents almost half of the entire cultivated area in the country (CONAB, 2012). The soybean is cultivated as human and animal food, and the soybean meal is extensively used as an excellent protein source in formulating animal feed and the oil used on food and biodiesel production (COELHO et al., 2011).

The availability of animal feed ingredients stimulates the development of the poultry industry, and according with SEPLAN (2011) this industry in Brazil slaughtered about 4.99 billion of poultry in 2010. In the Goiás State, there was an increase in poultry slaughtering under sanitary inspection of 498.55% from the year 2000 to reach a value of 301.327 million in 2010.

The residues from intensive rearing of poultry are rich in nutrients and are available on the properties at a low cost can be used by producers in crop fertilization (MENEZES et al., 2004). The poultry litter currently is a fertilization option also due to the high cost of chemical fertilizers used in Brazilian agriculture. T he poultry litter is a good source of nutrients, especially nitrogen, and when handled properly can partially or completely replace the chemical fertilizer (BLUM et al., 2003). Furthermore, the current legislation precludes their use as cattle feed ingredient.

The poultry litter is a mixture of the substrate bed, usually wood chips or rice straw, bird droppings, feathers and leftover food. The composition can vary with the quantity and quality of substrate used. Generally, presents concentrations from 2.4 to 4.0% of N, 2.0 to 3.5% of P_2O_5, 1.8 to 3.5% K_2O and 65 to 90% dry matter (KONZEN; ALVARENGA, 2007).

The use of poultry litter as a fertilizer has been increasing and works such as Ávila et al. (2007), Konzen and Alvarenga (2003) e Menezes et al. (2004) demonstrate its potential use in annual crops by improving soil physical properties, promoting changes in pH, reducing erosion, improving aeration and creating a more appropriate environment for the development of the soil microbiota by adding organic matter. Moreover, in soils with high pH, high doses of poultry litter applied annually on the surface or semi-incorporated can cause damage in their physical characteristics (ANDREOLA et al., 2000).

There are few studies on the dynamics of the availability of nutrients in the poultry litter,

Received: 20/09/12
Accepted: 20/02/14

making it difficult to define the dose and how to apply this organic residue on the crops. Traditionally these residues in no-tillage system are broadcasted, however applied this way it will be exposed to sunlight and high temperatures that can cause volatilization of some nutrients, especially nitrogen. On the other hand, there is no availability of planters equipped with fertilizer distribution devices which allow band application of poultry litter. These factors make it difficult to define the form of application and the appropriate doses of poultry litter for each situation and the need for supplementation with chemical fertilizers.

Thus, the present study aimed to evaluate the effect of different doses of poultry litter, broadcast and band, on growth and yield of soybean.

MATERIAL AND METHODS

The work was conducted in the city of Jataí, located at 17°53'S and 52°43'W and approximately 700 m altitude. Jataí is located in the Southwest Goiás region, with average annual temperature of 22 ºC and rainfall of 1,800 mm, approximately.

The experimental soil area was classified as oxisol (Latossolo Vermelho distroférrico) with contents of 40, 7 and 53% clay, silt and sand, respectively. The main chemical characteristics of the soil are given in Table 1, according to the methodology described by EMBRAPA (2009). The area where the experiment was conducted was occupied on the previous seven seasons by soybeans / sorghum succession in no-tillage system.

Table 1. Chemical analysis and organic matter (OM) of the experimental area, 0-20 cm layer.

pH	K	P	Ca	Mg	Al	H+Al	CTC	SB	V	MO
H_2O	-----mg dm^{-3}-----		----------$cmol_c$ dm^{-3}----------						--%--	-g dm^{-3}-
6.38	109.8	2.88	3.65	1.55	0.04	4.57	10.05	5.48	54.53	34.51

P and K: Mehlich1extractor; Ca, Mg and Al: KCI 1N; MO colorimetric method.

The experiment was conducted in a randomized block design in a factorial scheme 5 x 2 + 2, being factors doses of poultry litter (0, 1, 2, 4 and 8 t ha^{-1}) and application forms, broadcast on soil surface and band application on the planting line. Control treatments were used as a reference of the usual method adopted on soybean crops on the region, so mineral fertilizer was applied, mineral in one control broadcast and on the other band with 100 and 70 kg ha^{-1} of P_2O_5 and K_2O, respectively. The poultry litter had a content of 2.8, 3.0 and 3.4% of N, P_2O_5 and K_2O respectively. It was used plots of 7.0 m in length with five rows spaced 0.45 m with four replications. The preparation of the area was accomplished with the application of glyphosate at a dose of 4 L ha^{-1} (commercial product), 15 days before sowing, which was held on October 15, 2009, using the cultivar Msoy 7211RR. After emergency the population was estimated at 300,000 plants ha^{-1}. All cultural practices necessary for the soybean crop were performed.

With plants in the R2 stage (45 DAE), the plant height were determined by measuring ten plants per plot and the leaves chlorophyll by a portable chlorophyll meter model Clorofilog (Falker) also on ten plants. To determine the dry matter of shoots, three adjacent plants per plot were sampled, cut close to the ground, placed in paper bags and oven dried with air circulation at 60º C. To determine the yield five meters of the three central rows of plots were harvested and the mass corrected to 13% moisture.

RESULTS AND DISCUSSION

Climatic data during the experiment are presented in Figure 1. During the period, total rainfall was 1300 mm and the temperature ranged from 15 to 36º C. The rainfall distribution was considered sufficient for the soybean crop, providing suitable conditions for the development of the crop.

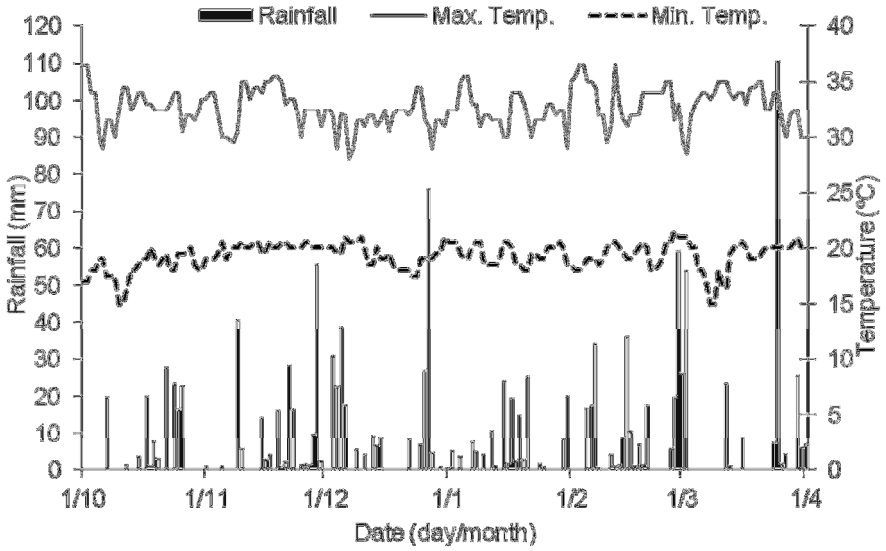

Figure 1. Rainfall (mm) and maximum and minimum temperature (° C) recorded in the 2009/2010 season.

The results of the analysis of variance (ANOVA) are presented in Table 2.

Table 2. Values of mean square of ANOVA for plant height (PLHE); shoot dry matter (SDM); chlorophyll (CHLO) and yield (YLD) - 2009/2010 season.

Sources of Variation	PLHE	SDM	CHLO	YLD
Application form (AF)	25.82**	5.63	6.04*	52374.89
Poultry Litter (PL)	221.57**	576.16*	3.23*	488004.48**
interaction (AF x PL)	6.68**	65.68	0.72	110451.10
Controls (CT)	79.06**	3.13	0.02	92856.80
Controls vs. Factorial	124.03**	205.35**	0.01	21833.24
residue	1.25	47.92	11.80	97389.18
CV(%)	2.50	14.57	2.66	12.14

**, * Significant at 1% and 5% probability by the F test, respectively.

The results indicate that the form of distribution of the mineral fertilizer and poultry litter influence the expression of plant height, since this variable also differed for the controls. Analyzing the chlorophyll content on the leaves in the R2 stage, only the form of distribution of poultry litter was significant. The poultry litter factor influenced all the studied variables, but the interaction of the two factors was observed only for the variable plant height. The contrast between controls and the factorial was significant for plant height and shoot dry matter.

Linear response was observed, in terms of plant height, to the increase of doses of poultry litter band applied and broadcast and when poultry litter was band distributed, the response was more pronounced. Carvalho et al. (2011) obtained similar results in which the maximum height of soybean plants was associated with high doses of poultry litter and noting also that the plant height is higher when the mineral fertilizer is associated with organic.

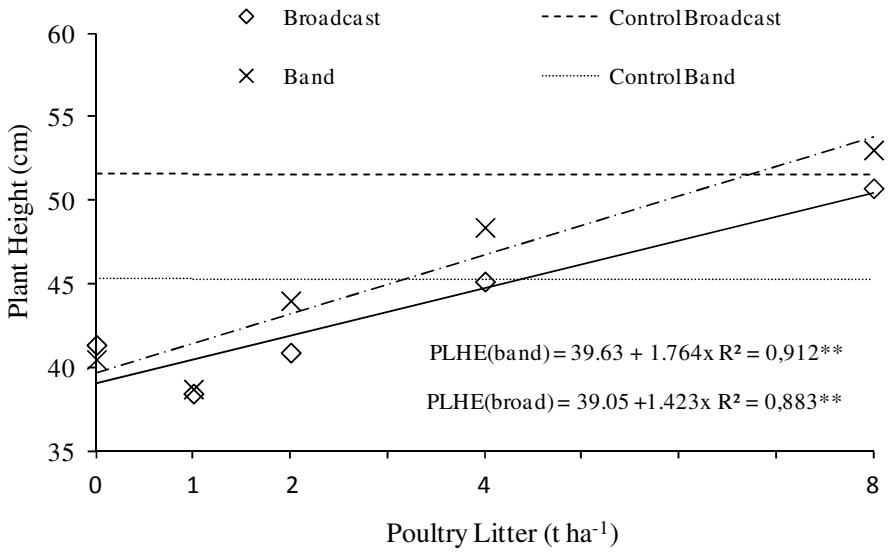

Figure 2. Height of soybean plants (PLHE) with doses of poultry litter broadcast and band - 2009/2010 season.

Working with sorghum, Andrade et al. (2011), found that in all treatments where organic fertilizer was applied the average plant height were higher than those in the control and the poultry litter showed better results for the growth and development of culture when compared with cattle and sheep manure. Similar results were found by Freitas et al. (2012) with an increase in mean values of sorghum plant height as a function of doses of poultry litter.

The band application of poultry litter provided a greater plant growth, probably due to the higher availability of nutrients when it was incorporated into the soil. Gomes et al. (2005) obtained a similar result with organic compost in corn and have ascribed the result to the greater amount of fertilizer per soil volume with greater availability of nutrients to plants. Furthermore, these results may have occurred due to more favorable conditions for microbial action, improved plant uptake of less mobile nutrients or even lower losses by volatilization, particularly nitrogen. On the other hand the chemical fertilizer applied broadcast resulted in higher plant height compared to the same band distributed. One possible explanation is the effect of the fertilizer saline potential, especially potassium, which concentrates in the planting furrow, may damage the seeds (EMBRAPA, 2010).

The way of distribution of poultry litter has no influence on shoots dry matter accumulation and responded to increased doses of poultry litter according to a quadratic model (Figure 3)

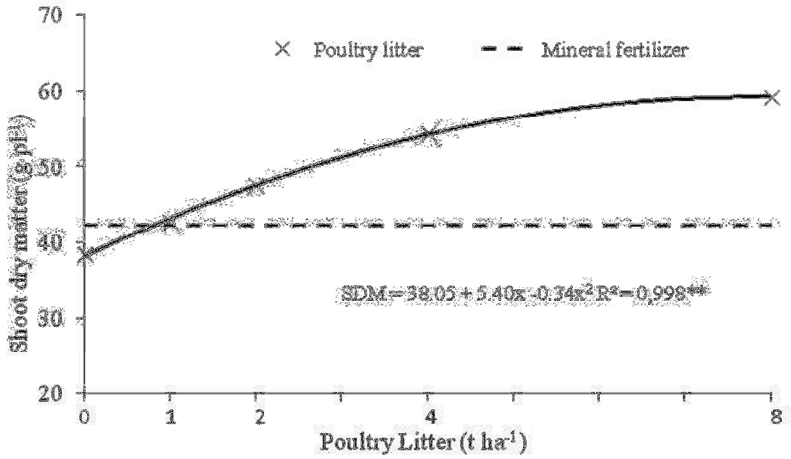

Figure 3. Shoot dry matter of soybean in response to doses of poultry litter - 2009/2010 season.

The results agree with those obtained by Portugal et al. (2003) with sorghum and Vieira et al. (2008) with common beans under no-tillage system, where higher plants tended accumulate higher amount of dry matter. However, in the present work unlike height, higher doses of poultry litter

negatively affected the dry matter accumulation, and a quadratic model was adjusted. The decreasing increments starting from certain dose may be due to imbalance of nutrients in the soil (RODRIGUES; CASALI, 1999). The results corroborate with Silva et al. (2009) and Mondardo et al. (2011) who achieved quadratic effects for dry matter with increasing doses of poultry litter in corn and oats, respectively.

The variable chlorophyll was influenced by the rates of poultry litter and application form, but the interaction between the factors was not significant. Since the levels of chlorophyll are closely correlated with levels of available nitrogen (CASTELLI et al., 1996), and can be used to check the adequacy of nitrogen fertilization, the differences obtained are attributed to the nitrogen supplied by the poultry litter and influenced by its form of distribution. Nogueira et al. (2010), working with different levels of nitrogen fertilization on soybean observed that increasing doses of N linearly increased the chlorophyll readings. It is believed that the poultry litter applied broadcasted lose greater amounts of N by volatilization since it is more exposed to sunlight than that band applied. However, the regression curve of chlorophyll as a function of poultry litter doses was not significant.

The yield variable results showed that only the factor poultry litter was significant, indicating that the culture responds to the increasing doses of poultry litter and the form of distribution of the residue and mineral fertilizer do not influence the expression of this feature. This result is consistent with those obtained by Broch and Chueiri (2005), in which the application methods of chemical fertilizers on soybean in soils with at least medium levels of nutrients and good rainfall conditions do not differ.

The yield response of the crop with increasing doses of poultry litter occurred according to a quadratic model (Figure 4). According to the equation adjusted the greater yield would be obtained with the dose of 6.5 t ha^{-1} of poultry litter which corresponds to a grain yield of approximately 4050 kg ha^{-1} (67.5 sc ha^{-1}). The adjustment of a quadratic model, similar to the shoot dry matter, probably occurred due to an unfavorable nutrient balance for soybean at higher doses of poultry litter, reason why the nutritional constitution of poultry litter must be considered compared to the need of the culture (WESTERMAN; BICUDO, 2005). Furthermore, attention should also be given to the rate of mineralization of organic fertilizers, since some nutrients like potassium are readily totally available on the first year while others like phosphorus are only 60% available on the same period (CFSEMG, 1989).

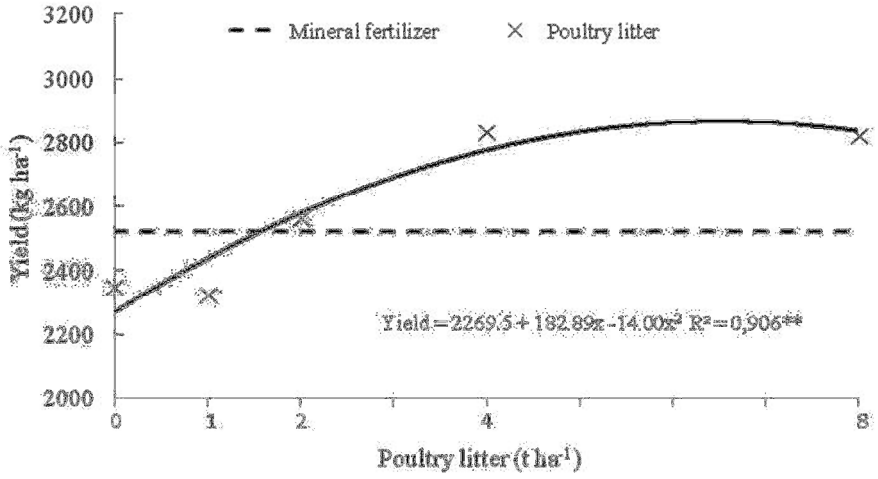

Figure 4. Yield of soybean in response to doses of poultry litter - 2009/2010 season.

The dose of poultry litter that would provide similar yield to the mineral fertilizer would be approximately 1575 kg ha^{-1}, which can be considered a relatively low dose, since with it the poultry litter will incorporate 44.1, 47.2 and 53.5 kg ha^{-1} N, P_2O_5 and K_2O respectively. This fertilization corresponds to approximately 76% of potassium fertilization and only 50% of the phosphate fertilizers used in the control. It is also important to note that poultry litter has in its composition along with organic matter, other nutrients that can contribute to the yield of soybean. These results demonstrate that the substitution of mineral fertilizers by organic fertilization with poultry litter can be viable, which agrees with Carvalho et al. (2011) who working with organic and mineral

fertilizers verified the feasibility of using poultry litter as a substitute for mineral fertilizer in soybeans.

CONCLUSIONS

The increase in rates of poultry litter increases plant height, dry matter and yield of soybean.

The form of poultry litter application did not influence the yield and dry matter affected only plant height and leaf chlorophyll, and the band application provides increased plant growth.

The organic fertilization with poultry litter can replace mineral fertilizers on soybean.

RESUMO: O desenvolvimento da indústria avícola na região centro oeste têm disponibilizado quantidades consideráveis de resíduos orgânicos, cama de aves, que apresentam potencial para utilização na agricultura. Entretanto ainda há poucos trabalhos sobre a dinâmica da disponibilização dos nutrientes, o que dificulta a definição da dose e a forma de aplicação desse resíduo orgânico. O presente trabalho teve como objetivo avaliar o efeito de diferentes doses de cama de aves, a lanço e no sulco de plantio, sobre desenvolvimento e produtividade da cultura da soja. O experimento foi instalado no delineamento em blocos casualizados, no esquema fatorial de 5 x 2 + 2, sendo os fatores doses de cama de aves (0, 1, 2, 4 e 8 t ha^{-1}) e formas de aplicação, a lanço e no sulco de semeadura. As testemunhas foram adubadas com fertilizante mineral, uma a lanço e outra no sulco de semeadura. Foram avaliadas a altura de plantas, matéria seca da parte aérea e clorofila foliar no estádio R2 e a produtividade no final do ciclo da cultura. O acréscimo nas doses de cama de aves aumenta a altura de plantas linearmente enquanto que a matéria seca e produtividade com resposta quadrática. A forma de aplicação da cama de aves não influencia a produtividade e matéria seca, afetando apenas a altura de plantas e clorofila foliar, com a aplicação no sulco de plantio proporcionando maior crescimento das plantas. A adubação orgânica com cama de aves pode substituir a adubação mineral na cultura da soja.

PALAVRAS-CHAVE: Fertilizante orgânico. *Glycine max*. Produtividade.

REFERENCES

ANDRADE, A. R. S.; MACHADO, C. B.; VILELA, E. L.; CAMÊLO, D. L.; SILVA, L. C. C. Desenvolvimento da cultura do sorgo em um Latossolo Amarelo submetido à adubação orgânica. **Revista Brasileira de Tecnologia Aplicada nas Ciências Agrárias,** Guarapuava, v. 4, n. 2, p. 137–151, 2011.

ANDREOLA, F.; COSTA, L. M.; OLSZEVSKI, N. Influência da cobertura vegetal de inverno e da adubação orgânica e, ou, mineral sobre as propriedades físicas de uma terra roxa estruturada. **Revista Brasileira de Ciência do Solo,** Viçosa, v. 24, n. 4, p. 857-865, 2000.

ÁVILA, V. S.; ABREU, V. M. N.; FIGUEIREDO, E. A. P.; OLIVEIRA, U.; BRUM, P. A. **Valor agronômico da cama de frango após reutilização por vários lotes consecutivos**. Concórdia - SC: Embrapa Suínos e Aves, 2007. (Embrapa Suínos e Aves. Comunicado técnico,46).

BLUM, L.E.B.; AMARANTE, C.V.T.; GÜTTLER, G.; MACEDO, A. F.; KOTHE, D.; SIMMLER, A.; PRADO, G.; GUIMARÃES, L. Produção de moranga e pepino em solo com incorporação de cama aviária e casca de pinus. **Horticultura Brasileira**, Brasília, v. 21, p. 627-631, 2003.

BROCH, D. L.; CHUEIRI, W. A. **Estratégia de Adubação Cultura da Soja Cultivada Sob Sistema Plantio Direto**: Parceria FUNDAÇÃO MS e MANAH, 2005. 53 p.

CARVALHO, E. R.; REZENDE, P. M.; ANDRADE, M. J. B.; PASSOS, A. M. A.; OLIVEIRA, J. A. Fertilizante mineral e resíduo orgânico sobre características agronômicas da soja e nutrientes no solo. **Revista Ciência Agronômica**, Fortaleza, v. 42, n. 4, p. 930-939, 2011.

CASTELLI, F.; CONTILLO, R.; MICELI, F. Non-destructive determination of leaf chlorophyll content in four crop species. **Journal of Agronomy and Crop Science**, Berlin, v. 177, p. 275-283, 1996.

COELHO, H. A.; FILHO, H. G.; BARBOSA, R. D.; ROMEIRO, J. C. T.; POMPERMAYER, G. V.; LOBO, T. F. Eficiência agronômica da aplicação foliar de nutrientes na cultura da soja. **Revista Agrarian**, Dourados, v. 4, n 11, p. 73-78, 2011.

COMISSÃO DE FERTILIDADE DO SOLO DO ESTADO DE MINAS GERAIS. **Recomendações para o uso de corretivos e fertilizantes em Minas Gerais**. 4ª Aproximação. Lavras, CFSEMG, 1989. 159p.

CONAB. Companhia Nacional de Abastecimento. **Acompanhamento de safra brasileira: grãos**, oitavo levantamento, maio/2012. Brasília, 2012. 36 p.

EGHBALL, B., GINTING, D., GILLEY, J. E. Residual effects of manure and compost application on corn production and soil properties, **Agronomy Journal**, Madison, n. 96, p.442–447, 2004.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. Manual de análises químicas de solos, plantas e fertilizantes. Brasília: Embrapa Informação Tecnológica, 2009, 627p.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. **Tecnologias de produção de soja – região central do Brasil 2009 e 2010**. Londrina: Embrapa Soja/ Embrapa Cerrado/ Embrapa Agropecuária Oeste. 2010.

FREITAS, G. A., SOUZA, C. R., CAPONE, A., AFFERRI, F. S., SILVA, R. R. , MELO, A. V. Adubação orgânica no sulco de plantio e sua influência no desenvolvimento do sorgo. **Journal of Biotechnology and Biodiversity**, v. 3, n. 1, p. 61-67, 2012.

GOMES, J. A., SCAPIM, C. A., BRACCINI, A. L., VIDIGAL FILHO, P. S., SAGRILO, E., MORA, F. Adubações orgânica e mineral, produtividade do milho e características físicas e químicas de um argissolo vermelho – amarelo. **Acta Scientiarum Agronomy**, Maringá, v. 27, n. 2, p. 521-529, 2005.

KONZEN, E, A, Aproveitamento de Dejetos Líquidos de Suínos para Fertirrigação e Fertilização em Grandes Culturas, Sete Lagoas: EMBRAPACNPMS, 2003, 11 p,(EMBRAPA-CNPMS, Circular Técnica, 32),

KONZEN, E. A.; ALVARENGA, R. C. **Adubação Orgânica.** Embrapa Milho e Sorgo, Sistemas de Produção, 2 Versão Eletrônica - 3ª edição, 2007. Disponível em <http://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Milho/CultivodoMilho_2ed/ferorganica.htm>. Acesso em setembro de 2008.

MENEZES, J. F. S.; ALVARENGA, R. C.; SILVA, G. P.; KONZEN, E. A.; PIMENTA, F. F. **Cama de frango na agricultura: perspectivas e viabilidade técnica e econômica**. Boletim técnico 3: Rio Verde, FESURV, 28p. 2004.

MONDARDO, D.; OHLAND, T.; BANDEIRA, K.; ROSSOL, C.; GERHARDT, I. F. S. **Curva de acúmulo de massa verde e seca na aveia preta fertilizada com doses crescentes de cama de frango**. Anais do Congresso Latino Americano de Suinocultura e Sustentabilidade Ambiental. p. 1-10. 2011.

NOGUEIRA, P. D. M., SENA JUNIOR, D. G., RAGAGNIN, V. A. Clorofila foliar e nodulação em soja adubada com nitrogênio em cobertura, **Global Science and Technology**, Rio Verde, v. 3, p. 117-124, 2010.

PORTUGAL, A. F.; ROCHA, V. S.; SILVA, A. G.; PINTO, G. H. F.; FILHO, O. C. P. F.; Rendimento de matéria seca e proteína de cultivares de sorgo forrageiro no primeiro corte na rebrota. **Revista Ceres**, Viçosa, v. 50, p. 357-366, 2003.

SEPLAN. **Goiás em dados 2011** – Aves. <http://www.seplan.go.gov.br/sepin/pub/goiascn/2011/04-tab08.htm>. Acesso em agosto de 2012.

SILVA, T. R.; MENEZES, J. F. S.; SIMON, G. A.; SANTOS, C. J. L.; SILVA, A.; GONÇALVES, M. E. M. P. **Produtividade de massa seca da parte aérea e de raízes de milho adubado com cama de frango**. I Simpósio Internacional sobre Gerenciamento de Resíduos de Animais. Uso dos Resíduos da Produção Animal como Fertilizante. Florianópolis, SC – Brasil. 2009.

VIEIRA, N. M. B.; ANDRADE, M. J. B.; CARVALHO, J. G.; ALVES JUNIOR, J.; MORAIS, A. R.; Altura de planta e acúmulo de matéria seca do feijoeiro cvs. BRS MG Talismã e Ouro Negro em plantio direto e convencional. **Ciência e Agrotecnologia**, Lavras, v. 32, n. 6, p. 1687-1693 2008.

WESTERMAN, P. W.; BICUDO, J. R. Management considerations for organic waste use in agriculture. **Bioresource Technology**, London, v. 96, n. 2, p. 215-221, 2005.