COMMUNICATIONS IN PLANT SCIENCES

Can herbicides increase the content of crude protein in corn silage?

Adrian Rauy Lopes[1], **Fábio Augusto Manetti**[1]*, and **Leonardo Bianco de Carvalho**[2]

[1] Faculdades Gammon, Paraguaçu Paulista, SP, Brazil.
[2] São Paulo State University, Jaboticabal, SP, Brazil.
*Author for correspondence: fabiomanetti37@gmail.com.

Received on November 13, 2017
Accepted on December 15, 2017
Published on December 15, 2017

Keywords
Atrazine
Post-emergence
Zea mays
Silage quality

The objective was to determine the impact of herbicides on plant growth and to test if the use of herbicides could improve the crude protein content in corn for silage. Treatments consisted of the post-emergence application of atrazine, atrazine + 2,4-D (two doses) and tembotrione, in addition to a herbicide-free control. We evaluated plant growth and crude protein content. Reduction of plant height (15%), fresh mass (35%) and dry mass (45%) was observed by using atrazine and atrazine + 2,4-D. However, we also observed an increase (mean of 82%) of crude protein content by using these herbicides. In addition, atrazine provided the higher improvement (124%) in the crude protein content. So, the post-emergence application of atrazine alone or combined with 2,4-D reduced plant growth however improving the content of crude protein.

Highlighted Conclusion
Atrazine can double the content of crude protein in corn for silage.

Corn silage is used as an energy and fiber source mainly for dairy cows (Borreani and Tabacco 2010, Bernardes 2012), being necessary to improve its nutritional value to decrease the participation of the concentrate in the diets with no effect on animal physiology and performance (Silva et al. 2015). The nutritive value of the corn silage depends on the hybrid, crop density, growing conditions, degree of maturity and moisture of the crop when harvested and ensilage conditions (Satter and Reis 2012). Applying inadequate management practices during crop growing may lead to poor-quality silage (Silva et al. 2015). On the other hand, adequate management practices permit a well-development of the crop and, as a consequence, it can assure better growing conditions to the crop, leading to high-quality silage.

Weeds are problematic pests in many crops, competing for light, nutrients and water in addition to allelopathic potential and indirect impacts. Weed interference in corn caused an average of 50% yield loss in the United States and Canada, which evidenced a loss of 148 million tonnes (over US$ 26.7 billion annually), as observed by Soltani et al. (2016). Yield loss occurred due to modification in plant morphology (Wandscheer and Rizzardi 2013), biomass accumulation and plant growth (Rajcan and Swanton 2001). Quality of corn can also be affected, including corn silage.

The control of weeds in corn is based on the use of selective herbicides, as atrazine and mesotrione, with non-significant impact on crop yield. However, we do not know if there is some impact (positive or negative) of herbicides on corn silage quality. So, the objective was to determine the impact of herbicides on plant growth and to test if the use of herbicides could improve the crude protein content in corn for silage.

MATERIAL AND METHODS

The field experiment was carried out in Borá, SP, Brazil (Latitude 22°16’11’’ S, Longitude, 50°32’04’’ W, Altitude 582 m). We used seeds of a hybrid corn AG 9045 PRO2YG for silage, being cropped in accordance to EMBRAPA (EMBRAPA 2017) and IAC (IAC 1997). Corn was sowed in 0.8-m spaced lines, maintaining 5 plants per meter. Experimental plots were composed by seven lines of 10 meters.

Treatments consisted of the application of herbicides (atrazine, 2,4-D and tembotrione) in addition to a herbicide-free control. The used herbicide doses were in accordance to manufacturer recommendation, except for 2,4-D, being: atrazine (800 g ai ha^{-1}), atrazine + 2,4-D_low (800 g ai ha^{-1} + 67 g ae ha^{-1}), atrazine + 2,4-D_high (800 g ha^{-1} + 134 g ae ha^{-1}) and tembotrione (84 g ha^{-1}). The post-emergence application of the herbicides was performed at the V6 corn growth stage (when the growing point and tassel rise above the soil surface), using a CO_2 backpack sprayer, coupled to a 2-m bar with 4 nozzles (TTI-11003 hydraulic nozzles) spaced 0.5 m, and a spray volume of 200 L ha-1. The applications were performed during 7h00 am and 9h00 am, with no clouds and slight winds.

Evaluations of plant growth were performed at the R5 corn growth stage (when all or nearly all kernels are dented or denting), when corn was harvested for making silage, according to EMBRAPA (2017). In addition, the bromatological analyzis for crude protein determination by Kjeldahl method.

The experiment was carried out in a randomized block design with 5 treatments and 4 replicates. Data were tested by ANOVA and means were compared by Tukey test, at 5% probability.

RESULTS

We observed plant height (15%), fresh mass (35%) and dry mass (34%) of corn reduced with application of atrazine and atrazine + 2,4-D, and no effect of tembotrione, comparing to the control treatment (Figure 1a, 1B and 1C, respectively). On the other hand, the use of these herbicides increased (82%) the crude protein content (Figure 1D). In addition, atrazine provided the higher improvement (124%) in the crude protein content in the crop (Figure 1D).

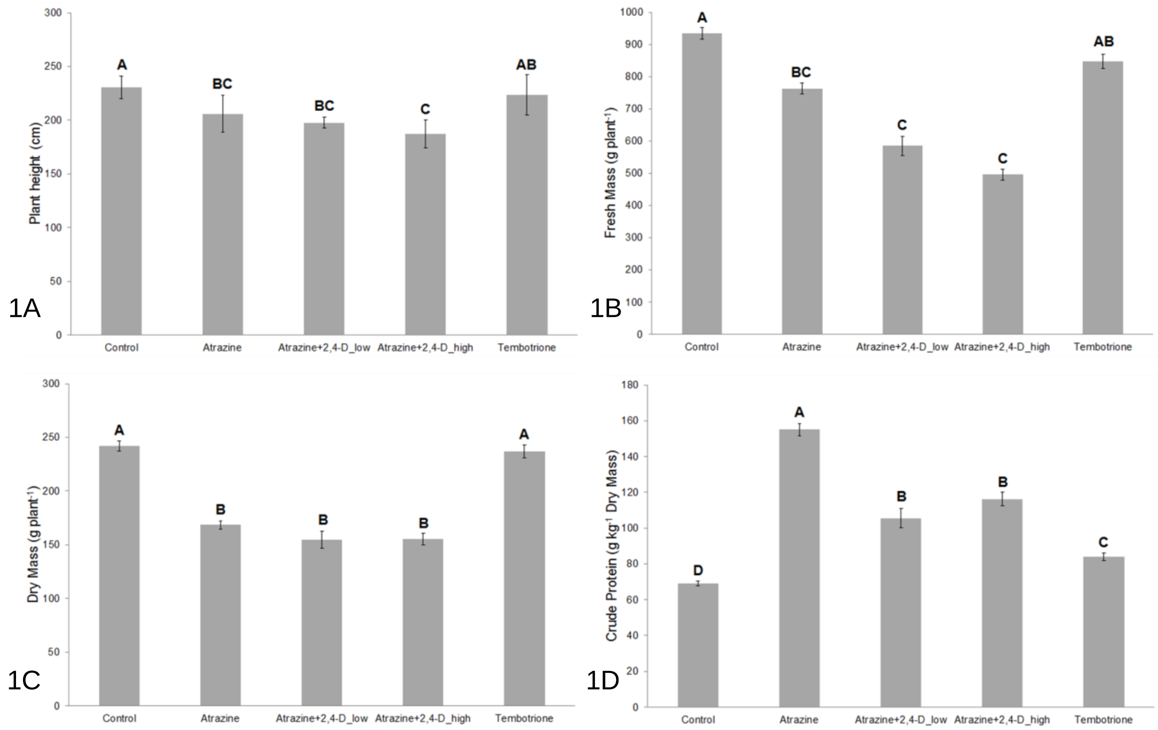

Figure 1. Plant height, fresh mass, dry mass and crude protein of corn for silage cropped with (atrazine (800 g ai ha^{-1}), atrazine + 2,4-D_low (800 g ai ha^{-1} + 67 g ae ha^{-1}), atrazine + 2,4-D_high (800 g ha^{-1} + 134 g ae ha^{-1}) and tembotrione (84 g ha^{-1}) or without (control) using post-emergence herbicides.

DISCUSSION

Atrazine and tembotrione were post-emergence selective herbicides to corn (MAPA 2017), so that we expected no impact on plant growth. However, atrazine reduced plant height, fresh mass and dry mass. The selectivity of atrazine to corn plants is due to herbicide degradation (Vidal 2001), so that the used dose was probably high to plant support the effect of the herbicide, in spite of being a recommended dose. In addition, 2,4-D can cause negative impact on corn plants (Pacheco et al. 2007, Dan et al. 2010), depending on the used dose, in spite of being a hormonal herbicide that also can provide improvement in plant height, as observed by Cobucci (2004) and Cavalcante (2010).

Corn is the most widely used, energy-rich and low in protein, mainly lysine, among cereal grains (Teixeira 1988). It is also rich in pro-vitamin A (beta carotene) and pigments (e.g. xanthophyll). Low levels of tryptophan, lysine, calcium, riboflavin, niacin and vitamin D exist in corn plants (Lana 2000). Corn can be used in a variety of ways as a bulky source or energy concentrate, being considered a standard energetic food. However, the level of proteins in corn silage is not sufficient to supply animal diet requirements.

Proteins represent a maximum of 16-18% of total nutrients, if we consider a high performance animal, but they may represent less than (10-12%), depending on the category and the gains sought. In this way, the protein becomes the second most required nutrient, but in a much lower amount when compared to carbohydrates. Little importance is given to the protein concentration of silage, since the main crops used in Brazil (maize, sorghum, sugar cane and tropical grasses) are suppliers of carbohydrates and not protein (Silva 2014). According to Berchielli (2010), the protein content of corn (9-10%) is poor in lysine and tryptophan (essential amino acids), so the importance of the feeds being enriched with other protein sources. According to Lima (2010), the crude protein content of corn is related to the nitrogen level of the soil and that, at high levels, there is accumulation of non-protein nitrogen by the plant. We have also observed that the use of atrazine obtained the highest protein accumulation in the plant, and it is very well expressed when compared to the control. So, corn is not a good source of crude protein for animal diet (Silva 2014). However, providing an improvement of crude protein in the silage, associated with a lower plant growth (as we found by using atrazine), is an important result for the system of production. It is because less biomass was produced in relation to a gain in the quality of silage (crude protein).

We concluded that the post-emergence application of atrazine alone or combined with 2,4-D at the V6 growth stage can improve the content of crude protein in corn for silage.

References

Berchielli TT et al. 2011. Nutrição de ruminantes. Jaboticabal: Editora Funep.

Bernardes TF. 2012. Levantamento das práticas de produção e uso de silagens em fazendas leiteiras no Brasil. Lavras: UFV.

Borreani G and Tabacco E. 2010. The relationship of silage temperature with the microbiological status of the face of corn silage bunkers. Journal of Dairy Science 93:2620-2629.

Cavalcante LF et al. 2010. Água salina e esterco bovino líquido na formação de mudas de goiabeira cultivar paluma. Revista Brasileira de Fruticultura 32:251-261.

Cobucci T. 2004. Sistema Santa Fé: integração agricultura pecuária. In: Dourado Neto D and Fancelli AL (Ed.). Feijão irrigado: tecnologia e produtividade. Piracicaba: ESALQ.

Dan HA et al. 2010. Tolerância do sorgo granífero ao 2,4-D aplicado em pós-emergência. Planta Daninha 28:785-792.

EMBRAPA – Empresa Brasileira de Pesquisa Agropecuária. 2017. Plantio de milho para silagem. Available at https://www.embrapa.br/gado-de-leite/busca-de-publicacoes/-/publicacao/594900/plantio-de-milho-para-silagem. Accessed on: Nov. 08, 2017.

IAC – Instituto Agronômico de Campinas. 1997. Boletim Técnico 100: Recomendações de adubação e calagem para o Estado de São Paulo. Campinas: IAC.

Lana RP. 2000. Sistema Viçosa de formulação de rações. Viçosa: UFV.

Lima GJMM. 2010. Milho: o grão que vale ouro nas dietas de aves... mas que ainda não recebeu a devida importância do setor produtivo. Revista do AviSite 4:48-52.

MAPA – Ministério da Agricultura, Pecuária e Abastecimento. 2017. AGROFIT: Sistema de Agrotóxicos Fitossanitários. Available at: http://agrofit.agricultura.gov.br/agrofit_cons/principal_agrofit_cons. Accessed on: Nov. 08, 2017.

Pacheco LP et al. 2007. Tolerância do milheto (*Pennisetum americanum*) ao 2,4-D. Planta Daninha 25:173-179.

Rajcan I and Swanton CJ. 2001. Understanding maize-weed competition: resource competition, light quality and the whole plant. Field Crops Research 71:139-150.

Satter LD and Reis RB. 2012. Milk production under confinament conditions. Available at: <Available at: http://www.ars.usda.gov/research/publications/publications.htm? seq_no_115=84465> Accessed on: Sept. 3, 2012.

Silva AG et al. 2014. Desempenho agronômico e econômico de híbridos de milho na safrinha. Revista AgroAmbiente 8:261-271.

Silva MSJ et al. 2015. Production technology and quality of corn silage for feeding dairy cattle in Southern Brazil. Revista Brasileira de Zootecnia 44:303-313.

Soltani N et al. 2016. Potential corn yield losses from weeds in North America. Weed Technology 30:979-984.

Teixeira AS. 1998. Alimentos e alimentação dos animais. Lavras: UFLA.

Vidal RA. 2001. Herbicidologia. Porto Alegre: Evangraf.

Wandscheer ACD and Rizzardi MA. 2013. Interference of soybean and corn with Chloris distichophylla. Ciência e Agrotecnologia 37:306-312.