Rev. Fac. Agron. (LUZ). 2006, 23: 373-382

Assessment of the influence of *Rottboellia cochinchinensis* on corn (*Zea mays* L.) through an additive method

A. Anzalone[1], L. Meléndez[1] y A. Gamez[2]

[1]Departamento de Fitotecnia. Decanato de Agronomía. Universidad Centroccidental "Lisandro Alvarado" (UCLA). Apartado postal 400. Venezuela.
[2]Estudiante graduado. UCLA. Decanato de Agronomía. Programa de Ingeniería Agronómica.

Abstract

An essay was established at the experimental station "Miguel Angel Luna Soto" of the deanship of the agronomy faculty of the University "Lisandro Alvarado" with the aim of evaluating the assessment of *Rottboellia cochinchinensis* on the height, number of leafs, total dry aerial biomass, estimated yield 90 days after the sow, longitude of the ear, number of grains per grains' row in the ear, a 100 grains' weight and yield of a corn crop (*Zea mays* L.) through an additive method. The design used was randomized blocks with five treatments and four replications. Treatments consisted on 0, 2, 4, 8 and 12 plants^{-2} of *R. cochinchinensis* associated to the corn's crop. The different densities of *R. cochinchinensis* did not affect significantly the evaluated variables of vegetative development, but did have an effect on the estimated yield, longitude of the ear, number of grains per grains' row in the ear, a 100 weight of grains and the yield in grain of the corn's crop. The yield losses in grain, caused by the weed were of 84.76; 72.93, 50.99 and 55.21% for densities of 2, 4, 8 and 12 plants.m^{-2} of weed, respectively. The lowest yield of corn was obtained with the presence of 2 plants.m^{-2} of *R. cochinchinensis*, so it is assumed that there was a strong intraspecific competence for the weed.
Key words: corn, *Rottboellia cochinchinensis* interference, weeds.

Introduction

Corn represent one of the most important crops worldwide for the human and animal alimentation. In Venezuela, corn has always been qualified as one important product from the economical and social point of view, due to its contribution in the national agriculture production; corn

Received April 30, 2003 ● Accepted October 10, 2005
[1]Authors emails: aanzalone@ucla.edu.ve; lmelendez@ucla.edu.ve; ajgamezlopez@yahoo.com

is the base of the energetic alimentation of animals in the poultry and bovine production, as well as for most of the population. Also, it constitutes one of the agriculture activities of poor families, becoming one of their main income sources. In 2003, the estimated production of corn in Venezuela was of 1.504.800 meter tons, with a sowed are of 449.047 hectares and an average yield of 3.351,1 $kg.ha^{-1}$ (4)

Corn production in Venezuela and in other countries of the world is being affected by biotic and abiotic factors, and by the handle of the crop. Within the biotic factors are damages caused by pests and illnesses, for example, damages caused by weeds, since it reduces yields by effect of alelospoly and allelopathy, and are host of other pests and illnesses; besides, these damages increment the production's costs, due to the application of control measures. In fact, excluding the environmental variables, yield losses in corn are mainly caused by the competence with weeds (17).

Within the group of most important weeds in the corn's crop are *Rottboellia cochinchinensis (Lour.) W.D. Clayton* (synonym of *Rottboellia exaltata*) commonly known as "paja peluda o paja rolito". It is characterized as an annual weed, and bunchy, with robust, solids, grouped and straight stalks that may reach a height of 3 m and are roughly hairy. Leafs are simples and sparse, with a pale green, and with a linear-lanceolate shape, flat limbs with saw borders, rough pubescence and a dimension of approximately 20 to 60 cm of length per 1 to 3 cm of width.

Inflorescence consists on widely conic bunches similar to spikes, terminals or axilars (frequently grouped) from 5 to 10 cm of length and hairless. The spike becomes thinner towards the apex; and it is composed by internodes, each segment presents a deep excavation in the superior part and supports two spikes without beards and flats: one sessile and the other one pedicelled by the posterior peduncle, merging through the entire bunch's longitude (2, 5, 8, 15, 18 and 21).

This specie is reported among the 18 most troublesome weeds worldwide, causing higher damages in the sugar cane and corn crops (9). Likewise, it affect soy crops, peanut, cotton, sorghum and rice (11, 13 and 19) where depending on the infestation level, it may originate yield reductions of even 100% as a product of its competitive and allelopathy characteristic. For all these characteristics, *Rottboellia cochinchinensis* is considered one of the most important gramineae weeds in Venezuela, by being highly dangerous, of fast grow, aggressive and by the allelopathy affects on many crops (12).

It has been mentioned that the interference that *R. cochinchinensis* produces in the corn's crop may cause the reduction in the yield of grains in 20% and 37% (12). Other studies indicate that a plant per square meter of *R. cochinchinensis* reduces the yield of corn in 5% and 8% of $plants^{-2}$, and reduce the yield in 11% (19) Zimdhal (22) indicate that densities from 10 to 50 $plants.m^{-2}$ of *R. cochinchinensis* may affect the total

yield and the grains of the corn plant in such a way that it might involve the economical viability of the crop in vary conditions of the production.

The interference that weeds exert on the different crops may be studied and evaluated through different methods, which allows obtaining ideas about the way of interaction that occurs between the weed and the crop. The most used methods are the additive, the replacement series, the systematic method and the one of the nearest neighbor.

The additive method is probable the most used method in the interference experiments in the malherbology, and consists on keeping constant the crop's density and vary the density of the weed (3, 14 and 16). This method allows knowing the weeds' density that cause significant reductions in the crop's yield, that is, it provides an interference to decide the infestation levels of the weed that produce economical damage.

The decision for the application of a control measure of weeds must be based in the infestation levels and the economical impact that it generates, that is why it is important to determine the weeds density where most adequate control measures must be applied, in order to avoid that the population reaches an economical level of infestation.

This necessity promoted as an objective for this research to evaluate the interference between *Rottboellia cochinchinensis* and corn (*Zea mays* L.) through an additive method, quantifying the effect of different densities of *R. cochinchinensis* on some parameters of vegetative development and production of the crop.

Materials and methods

An essay was done at the experimental station "Miguel Angel Luna Lugo", located at the agronomy faculty of the "Lisandro Alvarado" university (UCLA). This area is characterized, according to Holdridge, as a very dry tropical forest, with 510 msnm of elevations, annual average precipitation of 658.3 mm, average evaporation of 2048.1 mm annuals, average annual temperature of 25.1ºC, and average daily sunstroke of 7.9 hours and mean relative humidity of 70%.

The experimental design used was randomized blocks with 5 treatments and 4 replications, for a total of 20 experimental plots. Treatments consisted on different densities of *Rottboellia cochinchinensis:* 0, 2, 4, 8 and 12 plants.m^{-2}.

Each experimental plot consisted on 6 corn rows of 4 m of length and separated 0.8 m among them; 2 external rows were considered. The total area per plot was of 19.2 m^2 with an effective area of 10.24 m^2 for the evaluations.

Handle of the crop

An hybrid of white corn was used (HIMECA 2000). It was sowed manually 21 days after the emergency

of the weed, at a distance between plants of 0.2 m and putting 3 seeds per point; then, a planned elimination was done 10 days after the sow, leaving 2 plants per point. The sow density of the corn's crop was of 240 plants per experimental plot (around 125.000 plants.ha^{-1})

Two fertilizations were done manually: one at the same moment of the sow, with formula 12-12-17/12, applying a dose of 0.07 kg of the fertilizer per lineal meter (875 kg.ha^{-1}), thus supplying half of the nitrogen, all the phosphorus and all the required potassium for the crop. The second fertilization (re-manure) was done with urea, 30 days after the harvest of corn, at a dose of 0.08 kg per lineal meter (1000 kg of urea.ha^{-1}).The irrigation was done by spraying, according to the humidity condition of the soil, with an average of 3 irrigations per week. For the pest control, the following products were used: diazinon 2.5%, which was applied at a reason of 15 kg.ha^{-1}, 3 days after the corn's emergency to control the "cogollero" (*Spodoptera frugiperda*), and cutter worms; metomilo 25%, which was applied at a dose of 700 ml of the commercial product.ha^{-1} to control the «cogollero» worm (*Spodoptera frugiperda*) and fenthion 3%, locally to control ants (*Atta* sp.).

Handle of weeds

Rottboellia cochinchinensis seeds were recollected in lands of the agronomy deanship of UCLA; seeds were pre-germinated leaving them in water for 24 hours prior to be sowed. Subsequently, seeds were sowed manually and 12 days after being sowed, some plants were eliminated in the different plots, leaving in the plots the corresponding densities to treatments that were previously described.

An elimination of the other species of weeds were done during the first 30 days of the crop's cycle, and only *R. cochinchinensis* plants were let in interference with the crop.

Collection of the data

The studied variables were divided in:

1. Variables related to the vegetative development of the crop: selecting 10 plants at random, inside the effective rows of each experimental plot, the following variables were evaluated: height of the plant (from the stalk to the ligule of the last leaf totally expanded); number of leafs totally expanded (with visible ligule) and total dry aerial biomass. The first two variables were evaluated weekly and the third 35 days and 65 days after the sow (dds).

2. Production variables of the crop: 90 dds (as an ear) an estimation of the production was done, using a methodology proposed by Falcón (1990) cited by González (7). The number of commercial corns was determined in a lineal meter of the crop, on an effective row of each experimental plot; there 3 ears were taken and on each ear were determined the number of average rows and the number of grains per row. Later, the following formula was applied:

$$P = \frac{AxBxC}{D} \text{ x } 2{,}4$$

where: P = production in kg.ha^{-1}; A = N° of ears.m^{-1}; B = number of rows expressed in grains in the ear; C = number of grains per row of corn's and D = distance between rows of plants.

At the moment of the crop, were evaluated the longitude of ears, the number of grains per row in ears, the weight of 100 grains taken at random and finally, the yield in grain (kg per experimental plot).

During the development of the essay, mainly on the first 15 days of established the crop, was observed the attack on some isolated plants, and according to symtoms observed, all agreed to the description to the damage caused by the dwarf mosaic virus of corn MDMV-*maize dwarf mosaic virus*). These plants were not considered for the evaluations that were done on the crop.

The information obtained was analyzed with the statistical software Statistix V.1.0 (©Analytical Software, 1996) through the variance analysis, after verifying the fulfillments of the analysis. For those variables that showed significant differences ($P<0.05$) the mean comparison test LSD was done ($\alpha = 0.05$).

Results and discussion

Variables related to the vegetative development of the crop

In regards of the effect of the interference of the weed on the vegetative development of the crop, the analysis did not determine significant differences on the different densities of *R. cochinchinensis* on any of the studied variables (height of the plant, number of totally expanded leafs, and dry aerial biomass) in the evaluated dates. However, it is important to mention that in all cases was observed that the treatment free of weed (o plants.m^{-2} o *R. cochinchinensis*) registered higher values than treatments with some density of *R. cochinchinensis*; likewise, it was observed that among treatments with weed, the lowest values for the parameters of vegetative development were always obtained for the treatment corresponding to 2 plants.m^{-2} of *R. cochinchinensis* (table 1).

Considering the tendencies described in the results for the development variables of the crop, the fact of not detecting differences among treatments for these variables does not implies that there is not an interference effect of the weed on the crop. Rajcan and Swaton (17) have reported that many species of plants respond to the presence of neighbor plants, accumulating higher quantity of dry matter in the aerial buds than in roots. In corn, this response might generate as a consequence of changes in the quality of light (relation between infrared/red radiations) received by the canopy due to the presence of neighbored plants.

The modifications in the distribution of dry matter among aerial buds and roots imply that during the vegetative growth of weeds and the crop, there might not exhibit signs of competence, especially by water, and reductions are not

Table 1. Parameters values of the vegetative development of corn's plants, growing on interference with *Rottboellia cochinchinensis*. (Averaged 60 days after the sow; letters indicate the statistical group).

Density *Rotboellia cochinchinensis* (plants.m^{-2})	Height (cm)	Number of leafs	Aerial dry biomass (g)
0	139.70^{a}	10.43^{a}	690.0^{a}
2	117.30^{a}	9.93^{a}	475.0^{a}
4	138.50^{a}	10.48^{a}	517.5^{a}
8	134.52^{a}	10.20^{a}	492.5^{a}
12	142.03^{a}	10.30^{c}	540.0^{a}

observed in the accumulation of dry matter in the aerial part. When the crop gets in the reproductive growth phase, a period very sensitive to the interference of corn, since the requirements of nutrients, water and products of metabolism are high (1), the obstacle factor for the absorption of water and nutrients for the accumulation of dry matter during this phase is not the availability of water or nutrients, but it is the lower development of the radical system, as a result of the interference effect generated by the weed.

It is also known that *Rottboellia cochinchinensis* is a weed able to reduce the index of the foliar area in corn during the fill of grains, which may generate a reduction in the weight of grains and in the total yield, but not necessarily in the production of dry matter during the vegetative period. That is why it is important to evaluate, not only the impact of weeds on the parameters of vegetative development of crops, but also the way it affects directly in the production, since, as happens on this research, the effects on the production in the vegetative period are not always related to the effects on the production in the reproductive period.

Production variables of the crop

The variance analysis determined significant differences ($P<0.05$) of the treatments on the yield estimated in 90 dds. In table 2, it is observed that the treatment free of weed reached an estimated yield higher than treatments with presence of weed, the treatments corresponding to 2 plants.m^{-2} of weed had the lowest estimated yield.

For the longitude of the ear, the analysis showed significant differences ($P<0.05$) among the different densities of *Rottboellia cochinchinensis* (table 2). The crop free of *Rottboellia cochinchinensis* had a higher longitude of the ear (13.33 cm) compare to densities 2, 4, 8 and 12 plants.m^{-2} of weed (7.44, 7.81, 10.37 and 9.04 cm respectively). The crop's plants that grew with 8 and 12 plants.m-2 of weed surpass in longitude of the ear those with

Table 2. Values of the estimated yield, longitude of the ear and weigh of 100 grains for a corn's crop growing in interference with *Rottboellia cochinchinensis*. CV= variation coefficient for the variance analysis. Letters indicate the statistical groups for the means test LSD (α=0.05).

Density *Rotboellia cochinchinensis* (plantas.m^{-2})	Estimated yield (kg.ha^{-1})	Longitude of the ear (cm)	Weight of 100 grains (g)
0	5501^{a}	13.33^{a}	31.78^{a}
2	1302^{c}	7.44^{d}	26.25^{b}
4	1710^{bc}	7.81^{d}	27.53^{b}
8	3035^{b}	10.37^{b}	28.48^{b}
12	2395^{bc}	9.04^{c}	28.38^{b}
CV (%)	43.38	7.81	5.09

densities of 2 and 4 plants.m^{-2}, mentioning that the weed treatment of 2 plants.m^{-2} was the one which registered the lowest longitude of the ear.This indicates that the different variables of *Rottboellia cochinchinensis* affected the longitude of the ear, especially at low densities of the weed. A similar result was obtained for the number of grains per grains' row in the ear, where the analysis determined significant differences (P<0.05) among the different treatments used on this variable; on this case, the treatment free of weed obtained an average of 25.7^{a} grains per row, while, treatments 2, 4, 8 and 12 plants.m^{-2} of weed obtained 10,7^{d}; 15,0^{c}; 19,1^{b} y 17,5^{bc} per row respectively (letters indicate the statistical groups).

Also, the variance analysis determined significant differences (P<0.05) among the different variables of *Rottboellia cochinchinensis* on the variable weight of 100 grains. In table 2, is observed that the weight of 100 grains of corn for the treatment free of weed surpasses the rest of treatments. In spite that the means comparison indicates that treatments 2, 4, 8 and 12 plants.m^{-2} belong to a same statistic group, it must be mentioned that a similar tendency is presented to the one observed in the variables longitude of the ear and number of grains per grains' row in the ear, where the treatment corresponding to 2 plants.m^{-2} of weed has the same value.

Similarly, the variance analysis along to the means analysis determined significant differences (P<0.05) among the evaluated densities of *R. cochinchinensis* on the yield variable in grains of corn. In figure 1, is observed that the corn's yield in plots without interference of *R. cochinchinensis* was 13.85 kg per plot, while, the corn's yield with the presence of 2, 4, 8 and 12 plants.m-2 of *R. cochinchinensis* was 2.11, 3.74, 6.78 and 6.20 kg per plot respectively. Losses in the yield of different

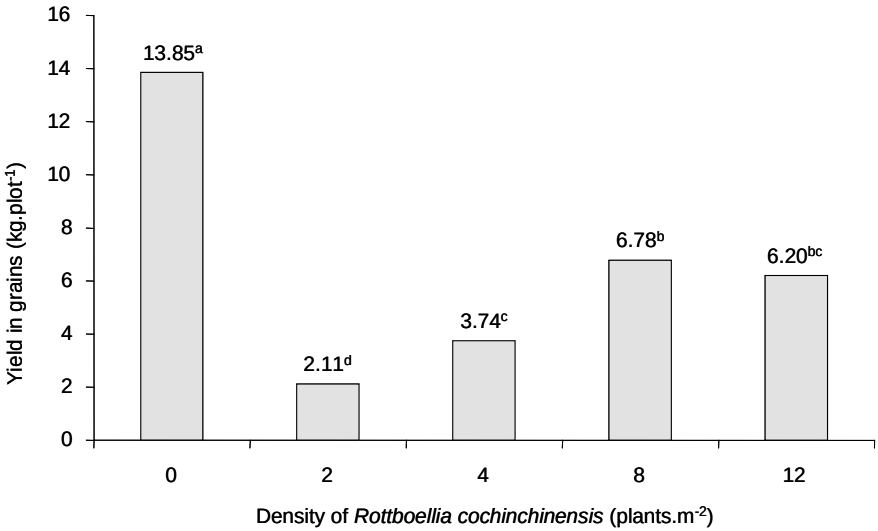

Figure 1. Effect of different densities of *Rottboellia cochinensis* on the yield of corn grains. Letters indicate the statistical groups for the mean analysis LSD (α=0,05); variation coefficient for the statistical analysis= 27.61%

densities of the evaluated weed in regards of the treatment free of wee were 84.76, 72.93, 50.99 and 55.21% for densities 2, 4, 8 and 12 plants of *R. cochinchinensis* respectively. It is evidenced that the different densities of weed had a noticeable effect on the corn's yield, and this effect was similar to the observed in the other evaluated production variables.

The estimated yield at 90 dds, was able to detect and predict the effect of treatments on corn, since the yield in grain per plot, as well as the components of the evaluated yield (longitude of the ear, number of grains per grains' row in the ear, and weigh of 100 grains) were affected similarly by the different densities of *R. cochinchinensis* to the estimated yield.

The lowest density of the weed (2 plants.m^{-2}) caused the highest reductions in the longitude of the ear, the weight of 100 grains, the estimated yield and the grains' yield per plot. This same tendency was observed in the vegetative development parameters of the crop, though differences were not statistical significant. These results corroborate what Vitta (20) says, who affirms that at low densities of weeds, the inter-specific competence (weed-crop) is maximum, but, on high densities of weeds the inter-specific competence is minimal, due to weeds compete among them (the intraspecific competence increases in the weed) producing lower interference on the crop. Obviously, this is fulfilled inside some density ranks of weed and crop. It can be then concluded that yield in

a crop does not reduce lineally at the same time that increases the density of a weed. The competence weed-crop problem is not a simple specie-specie relation; it is generated by several interactions between populations and proportions among species (10).

Indirect damages that weeds cause in the crops are also important. In this case *R. cochinchinensis* characterizes by being a host of certain pests and illnesses, according to the described by Garrido and Cuello (6), *R. cochinchinensis* hostages the MDMV virus, which vector is the aphid *Rhopalosiphum maidis* which was observed in the plot, along to other typical symptoms of the virus, though at very low incidence and on plants isolated from the crop.

Conclusions

The results obtained in this essay allow concluding that densities 2, 4, 8 and 12 plants of *R. cochinchinensis*.m^{-2} did not affect significantly the parameters of vegetative development, but did affect the evaluated yields in corn. Densities 2, 4, 8 and 12 *R. cochinchinensis* plants.m^{-2} caused a lost of yield in the crop of 84.76%; 72.93%; 55.21% and 50.99%, respectively.

It is concluded that under the agronomic production conditions described for corn, an infestation density of 2 plants.m^{-2} of *Rottboellia cochinchinensis* produces important losses in the crop's yield, value that may serve as reference in order to take decisions for the control of this weed.

Literature cited

1. Cabrera, S. 1999. El desarrollo de la planta de maíz: Formación y tipos de grano. Etapas de Crecimiento. En: VI Curso sobre producción de maíz. ASOPORTUGUESA – F.O.N.A.I.A.P. Portuguesa. Venezuela.

2. Cárdenas, J., C. Reyes and D. Jerry. 1972. Malezas tropicales. ICA. Bogotá. Colombia.

3. Cousens, R. 1991. Aspects of the design and interpretation of competition (interference) experiments. Weed Technology. 5: 664-673.

4. Organización de las Naciones Unidas para la Agricultura y la Alimentación (FAO). 2004. Datos Agrícolas de FAOSTAT. [Documento en Línea] Disponible en: http://faostat.fao.org/. [Consulta: Julio de 2004].

5. García, J., M. Bruce, M. Antonio and O. Herrera. 1975. Malezas prevalecentes de América central. Internacional Plant Protection Center. San Salvador . El Salvador.

6. Garrido, M. and R. Cuello. 1992. Algunas malezas hospederas de virus que afectan al maíz en Venezuela. Resúmenes de la I Jornada Científica Nacional del Maíz. Guanare. Venezuela.

7. Gonzalez, C. 2001. Estimación de cosecha en maíz. VIII Curso de producción de Maíz. ASOPORTUGUESA-INIA. Portuguesa. Venezuela.

8. Hall, D. and D. Patterson. 1992. Itchrass- Stop the trains? Weed Technology. 6: 239-241.

9. Holm, L., P. Donald, P. Juan y J. Herberger. 1977. The world´s worst weeds. Distrbution and Biology. Univ. Press of Hawaii. Honolulu.

10. Lazo, J. 1994. Evaluación de la interferencia maleza-cultivo mediante series de reemplazo y análisis de crecimiento funcional entre *Amaranthus dubius* y *Euphorbia heterophylla*, con *Phaseolus vulgaris* y *Gossypium hirsutum*. Trabajo de ascenso presentado a la Universidad Central de Venezuela. Facultad de Agronomía. Maracay. Venezuela.

11. Lencse, R. and J. Griffin. 1991. Itchgrass (*Rottboellia cochinchinensis*) interference in sugarcane (*Saccharum* sp.). Weed Technology. 5: 396-399.

12. Mejia, J. and M. Hernández. 2000. Identificación, biología e interferencia de las principales especies de malezas en el cultivo de maíz (*Zea mays*). VI Curso sobre producción de maíz. ASOPORTUGUESA-FONAIAP, Portuguesa. Venezuela.

13. Milloholon, R. 1992. Effect of itchgrass (*Rottboellia cochinchinensis*) interference on growth of sugarcane (*Saccharum* spp. Hybrids). Weed Sciencie. 40: 48-53.

14. Oliver, R. and G. Buchanan. 1986. Weed competition and economic threshold. Research methods in weed science. N.D. Camper (ed). Southern weed sciencie society. Champaig. p. 71-97.

15. Pitty, A. and R. Muñoz. 1993. Guía práctica para el manejo de malezas. Editorial Zamora. Honduras.

16. Radosevich, S. 1987. Methods to study interactions among crops and weed. Weed Technology. 1: 190-198.

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

18. Schnee, L. 1984. Plantas comunes de Venezuela. Ediciones de la biblioteca UCV. Caracas Venezuela.

19. Strahan, R., G. James, R. Daniel and D. Miller. 2000. Interference between *Rottboellia cochinchinensis* and *Zea mays*. Weed Science. 48: 205- 211.

20. Vitta, J. 1994. Función de daños de malezas. [Documento en línea] Disponible en: www.fcagr.unr.edu.Ar/malezas/apuntes/funciones_dano.doc. [Consulta: Enero, 2003].

21. Watson, L. and M. Dallwitz. 1992. *Rottboellia cochinchinensis*. Descriptions, illustration, identification, and information retrieval. [Documento en línea] Disponible en: http://biodiversity.Uo.Edu/delta/. [Consulta: Agosto, 2003].

22. Zimdhal, R. 1980. Weed-Crop competition: A Review. Internacional Plant Protecction Center. Oregon. USA.