

Reaction of twenty sugarcane clones to smut disease *Ustilago scitaminea* Sydow.

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Abstract

An experiment design was established to determine the performance of 20 sugarcane (*Saccharum* spp., hybrid) clones (17 experimental and 3 commercial checks) to Smut disease (*Ustilago scitaminea*, Sydow). An artificial inoculation method was used by immersing 1 bud cutting in a spores suspension for 20 min. Sixty buds per cultivar were inoculated, then transplanted in pots. Passed a month, sugarcane plants were transplanted into the field using a randomized complete block design with three replications. The evaluations were made every two weeks during plant crop and ratoon cycles. The percentage of stool infection was measured to determine the sugarcane reaction to the disease, according to a scale established by the Sugarcane Breeding Program at Instituto Nacional de Investigaciones Agrícolas (INIA). During both cycles, ten varieties reacted from moderately resistance to resistance, and the other ten ranged from susceptible to highly susceptible. The V91-4, V91-7, V91-11 and V91-14 varieties were eliminated from the program due to their extremely susceptibility to this disease. The V91-8, V91-9, V91-13 and V98-76 clones resulted susceptible, however, it is recommended to evaluate them for another cycle to give the recommendations. On the other hand, V91-1, V91-2, V91-3, V91-5, V91-6, V91-10, V91-12, V91-13, V91-15 and V91-16 showed moderately resistance to resistance.

Key words: Inoculation, resistance, clones, sugarcane, smut.

Introduction

Sugarcane smut disease caused by the *Ustilago scitaminea* Sydow fungus is classified as one of the main illnesses of this crop, this is due to it causes total lost in highly sensitive

cultivars, even detecting severe epidemics in he areas around the world (9).

The first report of the illness was seen in South Africa in 1877, then it

appears in Argentina in 1940, affecting POJ 36 and POJ 213, consequently it expands to more of 20 countries of the American continent, where causes damages when finding sensitive varieties and environmental conditions that propitiate its reproduction.

In Venezuela, the first source of infection were detected in 1978, in the variety B49-119, in the influence areas of Tacarigua, Carabobo state, and in Aragua, Monagas, Yaracuy and Lara states in the varieties B49-119, CP57-603, H38-2915, HJ57-41 and CL41-223, also in 1979 in Portuguesa and Sucre states (7).

In sugarcane the infection happens when released spores are in contact to buds that are about to germinate. The fungus enters and the mycelium reaches the merystematic region, stimulates the variation of the tissue causing that the plant creates a modified floral structured known as whip, where black telio-spore masses are produced, guarded in a silver membrane that when breaks are released and spread by the wind toward other stems and buds to initiate the new cycle of the illness (2). It is important to mention that a mud whip can release from 10^8 and 10^9 spores per day and can produce 10^{11}

spores during an infectious period that might last more than three months (5).

Lost caused by the illness might vary from tolerant levels to highly significant, and might affect the agriculture economy of a specific area. Even though these lost vary according to the sensitive levels of varieties, generally these are higher at the time that increased the number of cuts of the crop and are submitted to the effectiveness of the crops handle and to the control practices (10). The severity of the illness, mainly depends on three factors: type of infection, either primary or secondary; type of crop, plant or soca, and time of the infection, either early or delay (6).

The National Institute of Agricultural Researches (INIA) has done studies from 1979, with the aim of obtaining varieties resistant to mud, and nowadays, tests of artificial inoculation are being done in the first phases of selection, in the Program of Genetic Improvement of sugarcane. The purpose of this research was to evaluate the reaction of 20 varieties of sugarcane with the smut disease (*Ustilago scitaminea* Sydow), using the methodology of cuttings immersion in a smut spores suspension.

Materials and methods

This essay was carried out in the fourth phase of selection for the production of Venezuelan varieties of sugarcane, called «First replicated essay», located at the experimental field of the local station Yaritagua of CIAE,

Yaracuy, Peña municipality, Yaracuy state, at $10^{\circ} 04' LN$ and $69^{\circ} 07' LO$, and an altitude of 325 msnm with a mean annual precipitation of 953 mm and average annual temperatures of $30.6^{\circ}C$ (maximum) and $20.3^{\circ}C$ (minimum) (4).

Vegetal matter

17 experimental clones were used, 16 of them belong to the Venezuelan series 1991 (V91) and one belongs to the Venezuelan series 1998 (V98), and three commercial clones (PR61-632, PR980 and V64-10).

The sow was done on February 2001, using a completely randomized split-plot design with three replications, swing experimental plots of three rows of 10 m each and separated at 1.5 m.

A fourth row was included in each plot of sowed variety, belonging to the inoculated material. Twenty treatments were formed, located in an effective area of 2700 m². The essay was evaluated in two cycles: plant and first soca.

Inoculation

The inoculum was collected from the Germplasm Bank of sugarcane, located at the local station Yaritagua; in the varieties V66-31, B81-7 and B49-119, highly sensitive to the illness. Young whips were collected with abundant spore masses that were devoid of leaves and buds as well of the basal area, where spores were not ripped. Spores were extracted carefully from whips, eliminating the silver membranes that covered the smutted bags. Subsequently, the inoculum was prepared using 2 g.L⁻¹ of smutted dry matter with a concentration of approximately 6 x 10⁷ spores.ml⁻¹.

The used methodology for the inoculation was the cutting immersion in the suspension of spores already mentioned; for this 20 healthy cuts from a bud were chosen, from each of the used varieties. Buds, already identified, were submerged

for 20 minutes for the inoculation; lately, once dried at room temperature, were sowed individually in plastic pots, with a substrate of 2:1 land and sand; buds kept in greenhouse conditions for 30 days. When plants had a height of approximately 30 cm were transplanted to the field; sowing 12 of them in rows of 10 m, with a separation of 0.80 m between them.

Determination of the reaction

The observation period was of four months and a half, for the cycle of the plant as well for soca. Evaluations were done every 15 days, determining the percentage of infected strains, the presence of smut whip and the total population of evaluated strains in the different plots. The reaction determination showed in the infection percentage of strains was done according to the following scale (8):

Percentage of sick strains (%)	Reaction
0 to 10	Resistant (R)
10.1 to 20	Partly resistant (MR)
20.1 to 30	Sensitive (S)
30.1 to 100	Highly sensitive (AS)

Statistical analysis

The analysis of the information was done based on the percentage of infected strains of the last observation for both cycles (plant and soca); these were processed using the statistical non parametric analysis for randomized blocks of Friedman.

Results and discussion

The incidence of the illness was determined for both cycles of the crop (plant and soca), for four months and a half of observations. The progress of the illness showed an increment in the time, for the plant cycle as well as for the soca cycle (figure 1). In Soca cycle, was observed a slightly increment of 2.09% of infected strains compare to the plant cycle, specially from August to September. Previous researches mentioned the obtaining of lineal increments of the illness in the time for both cycles of plant and soca (2). This happened because the infection of sugarcane stems by the *U. Scitaminea* fungus only happens through buds and in young buds, increasing at the time that the crop cuts initiate, and incrementing the sources of inoculum or infected stems. The infection was also affected by the environmental conditions that was during the two years of evaluation.

Chao *et al.* (3), affirm that the environmental conditions affect the infection and severity of the smut in and between different seasons or moments of evaluations.

The reaction of varieties of sugarcane in this illness for the plant cycle, based on the percentage of sick strains of the last observation; had statistical significant differences between materials ($P < 0.05$) (figure 2). The V91-14 variety presented the highest infection of the illness with 54.36% followed by varieties V91-4, V91-11 and V64-10, indicating a high susceptibility. On the contrary, materials as V91-1, V91-5 and V91-12 were observed, with a high level of resistant by not being infected.

Comparing these results to those obtained in **soca** (figure 3), most of the highly sensitive materials kept this condition, increasing the number of sick strains. In this cycle (soca)

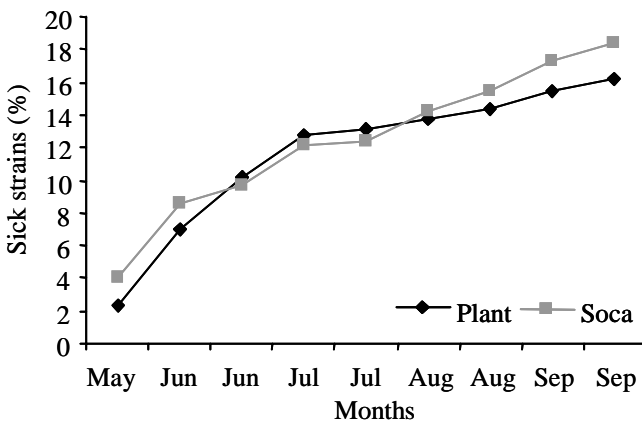


Figure 1. Progress of the illness, for the percentage of sick strains during nine observations. Cycles: Plants and soca.

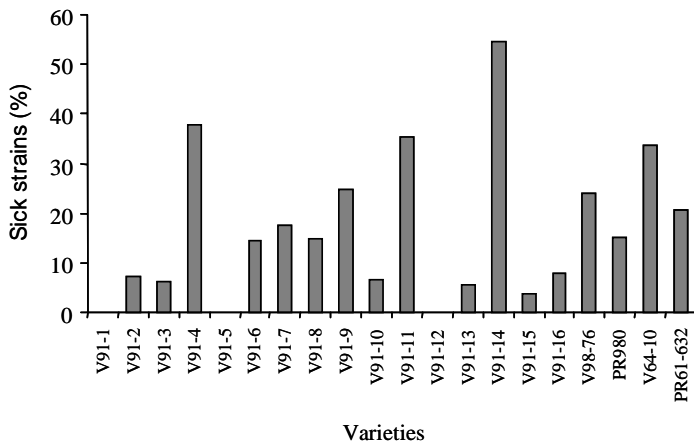


Figure 2. Percentage of sick strains with smut in 20 clones of sugarcane. Plant's cycle.

were also detected statistical differences ($P \leq 0.05$) between materials for the percentage of sick strains. The fact that in varieties as V91-45, the infection percentage of the illness varied in relation to the cycle of the plant might have been due to the loss of strains caused by the illness, influencing the infection of the

cultivar. These results agreed to those obtained by Hoy and Grisham (5) who suggested that changes of the smut incidence from a cycle to another were affected by the interaction between the infection characteristics of the cultivar and the environmental factors; however for soca cycle plants without inoculation manifested the

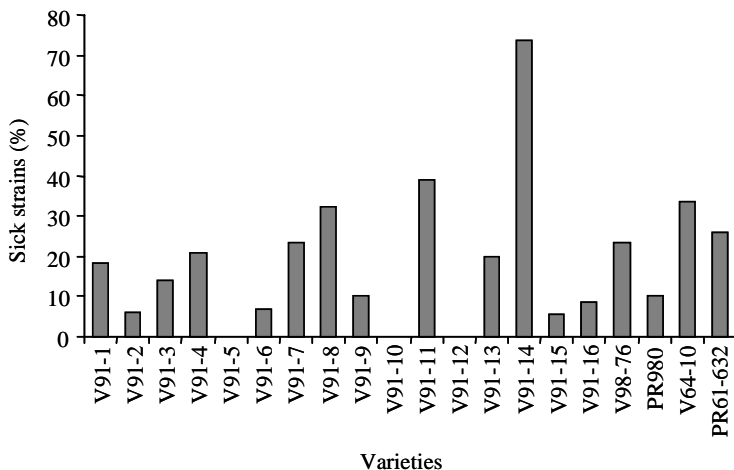


Figure 3. Percentage of sick strains with stunt in 20 clones of sugarcane. Soca cycle.

illness being determinant at the moment of eliminating the sick materials. On the other hand, varieties V91-1, V91-3, V91-8 and V91-13 that showed an apparent resistance in the plant, developed higher levels of smut in soca.

It is important to mention that highly sensitive variables in the plant's cycle reached infection values superior to 50%, while resistant variables in the same cycle and sensitive

in soca cycle did not show infection values higher of 40%. This indicates that a test carried just in a plant, might be good to indicate the highly sensitive varieties, but if identification security of all sensitive materials are required, the test must be done for at least two cycles. These results agreed to those obtained by Ordosgoitti *et al.* (8).

In table 1, is presented the final reaction of the evaluated variables of

Table 1. Evaluated strains, sick strains (inoculated and non inoculated), whips and reaction of twenty clones of sugarcane to must disease.

Variety	Evaluated strains		Sick strains (inoculated)		Sick strains (non inoculated)		Whips		Reaction
	Plant	Soca	Plant	Soca	Plant	Soca	Plant	Soca	
V91-1	28	22	0	4	0	0	0	8	MR ¹
V91-2	34	34	2	2	0	0	4	5	R
V91-3	31	29	2	4	0	0	3	14	R
V91-4	27	17	10	3	0	14	18	3	AS
V91-5	21	21	0	0	0	0	0	0	R
V91-6	28	23	4	2	0	0	4	2	MR
V91-7	33	25	6	6	0	77	14	9	AS
V91-8	29	18	4	5	0	1	7	8	S
V91-9	30	21	8	2	0	3	25	3	S
V91-10	29	20	2	0	0	0	2	0	R
V91-11	26	20	9	2	0	3	30	5	S
V91-12	20	18	0	0	0	2	0	0	R
V91-13	30	30	9	6	0	36	4	11	S
V91-14	31	24	16	15	0	49	33	24	AS
V91-15	26	23	1	1	0	0	1	2	R
V91-16	24	19	2	1	0	0	8	1	R
V98-76	25	17	6	4	0	2	13	7	S
PR980	33	27	5	3	0	3	18	8	MR
V64-10	30	13	9	4	0	6	20	15	AS
PR61-632	34	30	7	8	0	6	16	2	S

¹MR: partly resistant, R: resistant, S: sensitive, AS: highly sensitive.

the smut disease in sugarcane. The witness sick strains, correspondent to rows without inoculation, had the illness just in soca cycle for some of the materials, due to a secondary infection. According to these and to the percentage of sick strains of the inoculated material, the reaction to the illness was determined where seven materials resulted to be resistant: V91-2, V91-3, V91-5, V91-10, V91-12, V91-15, V91-16, three were partly resistant V91-1, V91-6, PR980, five were sensitive: V91-8, V91-9, V91-13, V98-76 and PR61-632

an five were highly sensitive: V91-4, V91-7, V91-11, V91-14 and V64-10.

50% of the evaluated clones resulted to be resistant or partly resistant, being the recommended for the selection of materials in this phase. Those materials classified as sensitive, but that had good agronomical characteristics must be tested in different environments in the phase of regional essays.

On the other hand materials as V91-4, V91-7, V91-11, and V91-14, were eliminated by their high sensitiveness to the illness.

Conclusions

The method of artificial inoculation by cuttings immersion in a suspension of smut spores of sugarcane, resulted to be effective to evaluate the resistant of this illness in experimental materials of sugarcane. Four Venezuelan experimental varieties (V91-4, V91-7, V91-11 and V91-14) were eliminated by their high sensitiveness to this illness. Materials V91-2, V91-3, V91-5, V91-10, V91-12, V91-15, V91-16, V91-1 and V91-6, resulted resistant and partly resistant, recommending them for the selection.

On the other hand materials V91-8, V91-9, V91-13 and V98-76 resulted to be sensitive, recommended to be tested in different environments. Commercial varieties used as witness in this selection phase presented different reactions to this illness (PR980: MR, PR61-632: S and V64-10: AS).

To achieve an effective determination of the reaction of materials in the action of this pathogen, was necessary to carry this essay in two crop's cycle (plant and soca).

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