Reactions of rust-infected groundnut genotypes following treatment with fosetyl-Al, α-aminooxyacetate, and inoculation with *Puccinia sorghi* Schw.

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Abstract. — Reactions, including variations in the components of resistance (incubation period, latent period, infection frequency, lesion diameter and percent lesions with necrosis) of two rust-resistant and one rust-susceptible groundnut genotypes were studied in glasshouse following artificial inoculations with *Puccinia arachidis* and treatment with fosetyl-Al or α-aminooxyacetate (AOA) or inoculation with *Puccinia sorghi*. Effects of treatments with fosetyl-Al, AOA and inoculation with *P. sorghi* were not consistent on total phenolic content and total concentration of antifungal compounds. Fosetyl-Al inhibited *in vitro* spore germination and germ-tube growth of *P. arachidis* and prolonged latent periods of the treated plants. Prior inoculation with *P. sorghi* had also prolonged latent period besides reducing infection frequency and lesion diameter. AOA treatment had no effect on any of the components of resistance studied. The significance of these effects in host defences against pathogenic infections is discussed.

Key words. — Rust, groundnut, fosetyl-Al, *Puccinia arachidis*, *Puccinia sorghi*, cross-protection, defense reactions, components of resistance.

INTRODUCTION

Rust caused by *Puccinia arachidis* Speg. is one of the major foliar diseases of groundnut (*Arachis hypogaea* L.) world-wide (Subrahmanyam *et al.*, 1985). It causes yield losses up to 50% under farmers' field conditions (Subrahmanyam and McDonald, 1983; Savary *et al.*, 1988) and up to 79% under artificial disease epidemics (Mayee and Baheti, 1983). Field screening of germplasm has been successful and several rust resistance sources have been identified (Subrahmanyam and McDonald, 1987). Inspite of the availability of good disease resistance sources and the development of various techniques to study the host-pathogen interactions, the mechanisms of host resistance have so far been poorly understood.

As part of our efforts to understand disease resistance mechanisms of groundnut, reactions of rust-resistant and rust-susceptible genotypes following artificial inoculations with *Puccinia arachidis* were studied at both cellular and molecular levels. Results obtained during these studies indicated existence of differences in the total phenolic contents and total concentration of antifungal compounds between resistant and susceptible genotypes (Subba Rao, 1987). Following these indications, it was further aimed at understanding the possible role of these compounds in host resistance mechanisms either by stimulating or by inhibiting their production in the host tissues.

· Fosetyl-Al [Aluminium tris (O-ethyl phosphonate)], an anti--oomycete compound is known to be effective in controlling diseases caused by *Phytophthora* species (Schwinn, 1983) and downy mildews (Chalandon *et al.*, 1979) either by activating host defences (Vo-Thi-Hai *et al.*, 1979; Bompeix

et al., 1980; Fettouche *et al.*, 1981; Guest, 1984), or by directly affecting the fungus itself (Coffey and Bower, 1984; Fenn and Coffey, 1984, 1985; Derks and Buchenauer, 1986, 1987).

Artificial induction of disease resistance in crop-plants' against pathogenic infections could also be achieved by stimulating host defences using prior inoculations of the host with a non-pathogen (Kuc *et al.*, 1975; Kuc, 1983).

α-aminooxyacetate (AOA), a competitive inhibitor of Phenylalanine ammonia lyase (PAL) has been used to reduce the production of phenolic compounds derived from phenyl alanine (Massala *et al.*, 1980) and to modify the host reactions to pathogenic infections (Taquet, 1985; Vernenghi, 1985; Ralton *et al.*, 1988).

Basing on the information available in the literature, we have utilised fosetyl-Al treatment and inoculation with *Puccinia sorghi* to stimulate the host defences, and treatment with AOA to supress them. Results of the investigations carried out on the influence of treatments with fosetyl-Al, AOA and inoculation with *P. sorghi* on the total phenolic content, total concentration of antifungal compounds, and on the components of rust resistance, such as incubation period, latent period, infection frequency, lesion diameter and percent lesions with necrosis and on the *in vitro* inhibition of uredospore germination and germ-tube growth by fosetyl-Al are reported in this paper.

MATERIALS AND METHODS

Two rust-resistant (PI 259747 and NC Ac 17090) and one rust-susceptible (a short-duration local variety of Côte-d'Ivoire) genotypes were grown in the glasshouse using 15 cm diameter plastic pots containing sterilized soil. Three seeds were sown in each pot and the seedlings were later thinned to two per pot. The plants were watered daily.

At 30 days after sowing, third from the fully expanded leaf on the main stem was labelled and was inoculated with uredospores of *P. arachidis*. The inoculum was obtained from a rust isolate collected from the southern parts of Côte-d'Ivoire in 1982 and multiplied in the laboratory on deta-

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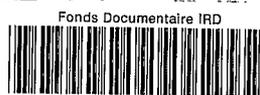
ched leaflets of the rust-susceptible cultivar maintained in moist petri plates. Uredospores of *P. sorghi* were collected from infected maize leaves in the farmer's field and were harvested using a sterile razor blade. Inoculum mixture was prepared using kaolin powder (Sigma, USA) at the rate of 1000 mg/15 mg of uredospores (Savary, Comm. Pers.). The Kaolin-spore mixture was dusted onto the labelled leaves using a hand dust depositor. Care was taken to limit the inoculum to the target leaves. Following the inoculation, plants were incubated in a humid chamber at 25.5°±1°C for 24 h in dark, and later were transferred to light with 12 h photoperiod, where they remained for the rest of the experimental period. Humid chambers were removed 48 h after inoculation. The light intensity was maintained at 200 lux (Philips fluorescent tubes) during the experimental period.

❏ **Experiment involving treatment with AOA and fosetyl-Al**

Treatment with fosetyl-Al began from 6 days before inoculation. Fosetyl-Al was applied at the base of the plant every six days until 10 days after inoculation with *P. arachidis*. Two concentrations of fosetyl-Al (5 or 10 mg in 25 ml water per pot per application) were used in the study.

AOA was applied in a similar way at the rate of 1.25 mg in 25 ml water per pot, per application, every two days during the same period as described for fosetyl-Al. Effect of AOA and of fosetyl-Al on the components of resitance to *P. arachidis* was studied in two separate experiments. In the first experiment, plants received either five AOA applications or two fosetyl-Al applications while, in the second one, they received eight and three applications respectively. Experimental design, number of replications, mode of application and the experimental material remained the same for both the experiments.

❏ **Cross protection experiment**

The following treatments were included:

- 1- Groundnut plants - healthy (uninoculated)
- 2- Maize plants - healthy (uninoculated)
- 3- Groundnut plants - inoculated with *P. arachidis* only
- 4- Groundnut plants - inoculated with *P. sorghi* only
- 5- Maize plants - inoculated with *P. sorghi* only
- 6- Groundnut plants - inoculated simultaneously with *P. arachidis* and *P. sorghi*
- 7- Groundnut plants - inoculated first with *P. sorghi* followed by inoculation with *P. arachidis*, 48 h later.

While inoculating groundnut plants with both *P. sorghi* and *P. arachidis* at the same time, standard spore mixtures of *P. arachidis* and *P. sorghi* prepared separately were mixed in 50:50 W/W ratio and were dusted onto the target leaves.

❏ **Estimation of total phenolic content**

Total phenolic contents of different genotypes with different treatments were estimated using Folin-Ciocalteu method with chlorogenic acid as reference compound and the concentration is expressed in µg of phenols equivalent to chlorogenic acid per mg of fresh host tissue.

❏ **Estimation of total concentration of antifungal compounds**

Total concentration of antifungal compounds was estimated in terms of unit areas covered by the peaks of these compounds in a HPLC analysis as described by Subba Rao (1987).

❏ *In vitro* **inhibition of spore germination and germ-tube growth by fosetyl-Al**

In vitro inhibition tests of *P. arachidis* spore germination were conducted using the method described earlier (Subba Rao, *et al.*, 1988) at fosetyl-Al concentrations ranging from 10 µg/ml to 250 µg/ml in two experiments. In the first experiment, in addition to spore germination, inhibition of germ-tube growth was also measured at concentrations ranging from 10 µg/ml to 50 µg/ml by comparing the lengths of uredospore germ-tubes in fosetyl-Al treatments with the controls and calculating percentage values from these data.

From eight days after inoculation with *P. arachidis*, the inoculated leaves were observed daily and numbers of total and ruptured uredosori were recorded. Lesion diameter was measured using an occular micrometer of 30 lesions per leaf selected at random when the increase in total number of uredinia ceased. Infection frequency (number of lesions per cm^2 of leaf area) was calculated by dividing the total lesion number with the leaf area (A) obtained by the formula $A = \pi(L*l)/4$ where, L and l represent the length and breadth of the leaflet (Savary, 1985). Percentage of lesions with necrosis was obtained by estimating number of lesions with necrosis using an optical hand lens and calculating their percentages out of total lesion numbers.

Since the experimental unit was one plant, each inoculated/treated plant was considered as one replication. All treatments in the experiments with fosetyl-Al and AOA were replicated thrice, while the ones in cross-protection experiment had four replications. The experimental data was subjected to analysis of variance and the percentage values were transformed using angular transformation before analysis. Duncan's multiple range test and Newman-Keuls tests were used to separate treatment means.

RESULTS

❏ **Treatment effect on total phenolic content and on the total concentratration of antifungal compounds**

None of the three treatments (fosetyl-Al, AOA and inoculation with *P. sorghi*) had consistent effect on either total phenolic content or total concentration of the antifungal compounds, rendering the data difficult to interpret.

❏ *In vitro* **inhibition of uredospore germination and germ-tube growth of *P. arachidis* by fosetyl-Al**

Uredospore germination was adversely affected by fosetyl-Al when tested *in vitro* at concentrations ranging from 10 µg/ml to 250 ug/ml. Percent inhibition of spore germination increased with increase in fosetyl-Al concentrations up to 150 µg/ml and beyond that concentration the inhibition was total (Table I). Similarly, inhibition of germ-tube growth also increased as fosetyl-Al concentrations increased and there was nearly 50 % inhibition of germ-tube growth at a concentration of 20 µg/ml of fosetyl-Al (Table I).

❏ **Influence of treatment with fosetyl-Al and with AOA on components of rust resistance**

The influence of treatment with fosetyl-Al and AOA on the components of resistance was studied in two similar but separate experiments which differed in the number of fosetyl-Al or AOA applications only. Increase in number of application from two (in Experiment 1) to three (in Experiment 2) with fosetyl-Al and from five (in Experiment 1) to eight (in Experiment 2) with AOA did not have any additional influence on the components of resistance considered in this study. Hence data from Experiment 2, which also included study of the effects of increased fosetyl-Al concentration on

TABLE I. — *In vitro* **inhibition of uredospore germination and germtube growth of** *Puccinia arachidis* **by fosetyl-Al at increasing concentrations**

Expt No.[1]	Fosetyl-Al concentration (ug/ml)	Spore germination (%)	Inhibition of spore germination (%)[2]	Germtube length (mm)	Inhibition of germtube growth (%)[2]
1	Control	76.3 a[3]	–	0.18 a	–
	10	60.4 ab	20.8	· 0.12 b	33
	20	65.3 ab	14.4	0.09 c	50
	30	56.6 b	25.8	0.08 d	55
	50	9.3 c	87.8	0.05 e	72
	SEM[4] ±	5.45		0.004	
	SD[5]	9.44		0.007	
	CV (%)[6]	17.6		6.1	
2	Control	54.3 a	–	–	–
	50	8.4 b	84.5	–	–
	100	6.1 b	88.8	–	–
	150	0.01 c	99.98	–	–
	200	0.01 c	99.98	–	–
	250	0.01 c	99.98	–	–
	SEM ±	1.355		–	
	SD	2.347			
	CV (%)	20.5			

(1) Experiment number
(2) With reference to control
(3) Values followed by the same letter within a column are not significantly different according to Duncun's multiple range test at α = 0.05
(4) Standard Error of Means
(5) Standard Deviation
(6) Coefficient of variation (%)

TABLE II. — **Influence of fosetyl-Al or α-aminooxyacetate on components of rust resistance in two groundnut genotypes**

Treatment	Components of resistance[1]									
	IP[2]		LP[3]		IF[4]		LD[5]		LN[6]	
	L[7]	NC[8]	L	NC	L	NC	L	NC	L	NC
In[9] alone	11.0[10] a	22.0 a	13.0 a	27.7 a	10.4 a	4.5 a	0.74 a	0.66 a	–	50.2 a
In+AOA[11]	11.0 a	20.0 a	12.7 a	29.0 a	15.4 a	6.8 a	0.85 a	0.60 a	–	71.1 a
In+fosetyl-Al[12]	11.0 a	21.3 a	14.3 a	28.3 a	9.3 a	4.8 a	0.64 b	0.46 b	–	72.4 a
In+fosetyl-Al[13]	11.0 a	22.5 a	15.3 a	29.5 a	9.7 a	2.1 a	0.75 b	0.44 b	–	64.6 a
SEM[14] ±	0.759		0.498		1.788		0.033		6.928	
CV (%)[15]	11.4		5.7		55.5		11.7		18.6	

(1) Mean of three replications
(2) Incubation period (days)
(3) Latent period (days)
(4) Infection frequency (Number of lesions/cm^2 leaf area)
(5) Lesion Diameter (mm)
(6) Lesions with necrosis (%)
(7) Local (susceptible variety)
(8) NC Ac 17090 (resistant genotype)
(9) Inoculation with *Puccinia arachidis*
(10) Values within a column followed by the same letter are not significantly different according to Newman-Keuls test at α = 0.05
(11) α - aminooxyacetate applied eight times at two days interval @ 1.25 mg in 25 ml water per pot containing two plants
(12) Fosetyl-Al applied three times at one week interval @ 5 mg in 25 ml water per pot containing two plants
(13) Fosetyl-Al applied three times at one week interval @ 10 mg in 25 ml water per pot containing two plants
(14) Standard Error of Means
(15) Coefficient of variation (%)

the components of rust resistance, are presented in table II. Fosetyl-Al treatment had significant influence on lesion diameter ($P \leq 0.001$), the treated plants having smaller lesions compared to the 'control' plants which did not receive fosetyl-Al treatment. Fosetyl-Al treatment had a significant effect ($P \leq 0.05$) also on latent period according to the analysis of variance (Table III), but, the means were not designated to be significantly different according to Newman-Keuls test (Table II). However, treatment with fosetyl-Al did not have significant effect on other components of resistance such as incubation period, infection frequency and percent lesions with necrosis. Interestingly, groundnut genotypes did not draw additional benefit (except for a marginal increase in latent period) even when the fosetyl-Al concentration was doubled

(Table II). Treatment with AOA had, on the contrary, no significant effect on any of the components of resistance studied (Table II).

❏ **Effect of inoculation with *P. sorghi* on components of rust resistance**

Symptoms did not develop in the treatment numbers (Nos.), 1 (uninoculated groundnut plants), 2 (uninoculated maize plants) and 4 (groundnut plants inoculated with *P. sorghi*). Treatment Nos. 3 (groundnut plants inoculated with *P. arachidis*) and 5 (maize plants inoculated with *P. sorghi*) developed the appropriate pustules indicating that both pathogens were virulent on their respective hosts.

TABLE III. — Analysis of variance for "latent period", a component of rust resistance measured to estimate the effect of treatment with fosetyl-Al or α-aminooxyacetate in two groundnut genotypes in a glasshouse experiment

Source of variation	DF	Sum of suares	Mean square	"F" value	Probability of "F"	Level of significance
Genotype	1	1312.76	1312.76	881.29	0.0000	**
Treatment with fosetyl-Al or with α-aminooxyacetate.	3	14.28	4.76	3.20	0.0514	*
Genotype × treatment	3	5.11	1.70	1.14	0.3619	NS
Error	16	23.83	1.49			
Total	23	1355.99	58.96			

DF : Degrees of freedom   * : 5 %   ** : 0.1 %   NS : Not significant

TABLE IV. — Effect of cross-protection with *Puccinia sorghi* on components of resistance in two groundnut genotypes artificially inoculated with *Puccinia arachidis*

Inoculation with	Treat No.[6]	Components of resistance [1]							
		IP(2)		LP[3]		IF[4]		LD[5]	
		L[7]	PI[8]	L	PI	L	PI	L	PI
P. arachidis alone	3	9.0 a[9]	14.6 a	13.0 a	18.1 a	11.5 a	1.9 a	0.77 a	0.69 a
P. arachidis + *P. sorghi* simultaneously	6	8.8 a	15.6 a	12.8 a	22.0 b	11.9 a	2.3 a	0.65 a	0.69 a
P. sorghi followed by *P. arachidis* 48h later	7	10.8 a	15.4 a	14.8 a	22.5 b	5.6 b	0.5 b	0.62 b	0.47 b
SEM[10] ± CV (%) [11]		0.544 12.4		0.499 7.4		1.078 54.3		0.028 11.8	

(1) Mean of four replications
(2) Incubation period (days)
(3) Latent period (days)
(4) Infection frequency (Number of lesions/cm^2 leaf area)
(5) Lesion Diameter (mm)
(6) Treatment number
(7) Local (susceptible variety)
(8) PI 259747 (resistant genotype)
(9) Values within a column followed by the same letter are not significantly different according to Newman-Keuls test at α = 0.05
(10) Standard Error of Means
(11) Coefficient of variation

Results of the investigations on the effect of inoculation with *P. sorghi* on four components of rust resistance are presented in table IV. Simultaneous inoculation with both fungi (Treatment No. 6) did not have significant effect on any of the components of resistance estimated except latent period. The effect on latent period was however significant ($P \leq 0.05$) only in case of the resistant genotype, PI 259747. On the other hand, both susceptible and resistant genotypes had significantly longer latent periods, lower infection frequencies and smaller lesion diameters when inoculated first with *P. sorghi* followed by inoculation with *P. arachidis*, 48 h later (Treatment No. 7). Interestingly, this treatment had no significant effect on incubation period (Table IV).

DISCUSSION

Since total phenolic content and accumulation of antifungal compounds were considered to be some of the important host resistance factors (Kosuge, 1969; Ingham, 1982), investigations were carried out to understand their possible role in host resistance in relation to pathogen development either by stimulating their production (using treatment with fosetyl-Al and inoculation with a non-pathogen) or by suppressing them (using α-aminooxyacetate).

Many workers (Vo-Thi-Hai *et al.*, 1979; Bompeix *et al.*, 1980; Guest, 1984; Derks and Creasy, 1989) have observed significant increase in phenolic content and accumulation of antifungal compounds following treatment with fosetyl-Al. The present investigations also recorded similar trend but, the effect was not consistent. During our investigations, it

was observed that the effect of fosetyl-Al on total phenolic content was similar when either sprayed on the foliage or fed through roots indicating that host reactions did not vary irrespective of the mode of application.

In addition to its influence on two components of rust resistance in two groundnut genotypes, indications of marked effect of fosetyl-Al were observed on one unidentified compound (with a retention time of 2.1 min., localized in the antifungal compounds zone in a HPLC analysis) during the present investigations. However, further studies are necessary to confirm these observations. Fosetyl-Al also had an inhibitory effect on uredospore germination and germ-tube growth suggesting that in case of *A. hypogaea-P. arachidis* interactions, fosetyl-Al could act both directly and indirectly on the pathogen development and spread. Our results concerning the direct mode of action of fosetyl-Al are in agreement with those of Coffey and Bower, 1984; Fenn and Coffey, 1984, 1985; Derks and Buchenauer, 1986, 1987 but differ with those of others (Vo-Thi-Hai *et al.*, 1979, Bompeix *et al.*, 1980; Fettouche *et al.*, 1981, Guest, 1984). The dual mode of action of fosetyl-Al in groundnut-rust interactions suggests that an effective check is operating on the rust development. This suggestion was further strengthened by the observation of significant reduction in disease levels (Subba Rao, 1987) calculated by fitting the data obtained in the present investigations into a preliminary simulation model developed by Savary *et al.*, (1988). Nevertheless, influence of fosetyl-Al was limited to either a few specific compounds and/or specific components of rust resistance.

Reasons for the observed inconsistency in the effect of AOA on the total phenolic content and on the total concentrations of antifungal compounds could be either that the

concentrations used during the present investigations were insufficient or that its take-up via the root-system was inefficient. It is to be investigated, if a different mode of application (foliar spray, for example) would work better. However, in recent studies AOPP (L-2-aminooxy-3-phenyl-propionic acid), a more specific compound (Bompeix, G. Pers. Comm.) is being increasingly used for similar studies. It would be interesting to compare effects of both these compounds on the reactions of groundnut genotypes.

Drastic reduction in infection frequency of the cross-protected plants (Treatment No. 7) observed during our investigations (Table IV), is in agreement with the results of Kuc et al., (1975). Significant reduction in latent period and lesion diameter in Treatment No. 7 supports the hypothesis that a more effective check compared to that with fosetyl-Al treatment has been imposed on pathogen development and spread by stimulation of host defences. Absence of such an effect in the plants inoculated simultaneously with both the fungi (Treatment No.6) could be due to lack of enough time-gap between the two inoculations to allow effective stimulation of host defences.

The mechanisms involved in the cross-protection of groundnut genotypes against rust infection are not known. Nevertheless, relevant information is available in the literature on the possible mechanisms involved in the protection of other crop-plants attacked by rust fungi. Yarwood (1956) suggested the inhibition of spore germination by the non-pathogen by producing gaseous substances while, Littlefield (1969) felt that either mechanical blockage of the pathogen or a phytoa-

lexin were involved in the process of cross-protection. Kochman and Brown (1975) attributed the protection of plants to physical blockage of the infection sites by the non-pathogen. Further, Xiang-Sheng Ye and Deverall (1989) showed that either competition between compatible and incompatible bean rust fungi or presence of phytoalexins could be the reasons for the slow growth of the compatible fungus. In case of groundnut rust, preliminary studies showed that there was a 20 % inhibition of P. arachidis spore germination in presence of P. sorghi spores (Subba Rao et al., unpublished data). However, further investigations are needed to improve our understanding on the mechanisms involved in the cross-protection of groundnut plants against rust infection.

In conclusion, fosetyl-Al did serve as an agent to boost host defences although its effect was limited while, AOA was not efficient enough to bring significant effect on the parameters considered in this study. Cross-protection using a non-pathogen such as P. sorghi did has considerable effect in reducing the disease intensity in groundnut genotypes inoculated two days in advance of inoculation with the rust pathogen, P. arachidis. This phenomenon has enough potential to be utilised for inducing resistance into other crop plants as well, against their pathogens and thus merits further investigations.

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RESUME

Comportement de génotypes d'arachide infectés par la rouille suivant un traitement au phoséthyl-Al et à l'acide α-aminooxyacétique, et l'inoculation de *Puccinia sorghi* Schw.

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Le comportement, y compris les variations des composants de la résistance (période d'incubation, période de latence, fréquence d'infection, diamètre des lésions et pourcentage de lésions associées à des nécroses) de trois génotypes d'arachide, dont deux résistants à la rouille et l'autre sensible, a été étudié en serre suivant des inoculations artificielles de *Puccinia arachidis* et un traitement au phoséthyl-Al, ou à l'acide α-aminooxyacétique (AOA), ou l'inoculation de *Puccinia sorghi*. Les effets des traitements au phoséthyl-Al et à l'AOA, et l'inoculation de *P. sorghi* ne donnent pas de résultats cohérents quant à la teneur phénolique totale et à la concentration totale des composés anti-fongiques. Le phoséthyl-Al empêche la germination *in vitro* des spores et la croissance des tubes germinatifs de *P. arachidis*, et augmente les périodes de latences des plantes traitées. Une inoculation préalable de *P. sorghi* augmente également la période de latence, fait baisser la fréquence d'infection et réduit le diamètre des lésions. Le traitement à l'AOA n'a aucun effet sur les composants de la résistance étudiés. La signification de ces effets pour la défense de l'hôte contre les infections pathogeniques est discutée.

Mots clés. — Rouille, arachide, phoséthyl-Al, *Puccinia arachidis*, *Puccinia sorghi*, prémunition, réactions de défense, composants de la résistance

RESUMEN

Comportamiento de genotipos de maní infectados por la roya a raíz de un tratamiento con phosetil-Al y con l'ácido α-aminooxiacético, y de la inoculación de *Puccinia sorghi* Schw.

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El comportamiento, hasta las variaciones de los componentes de la resistencia (período de incubación, período de latencia, frecuencia de infección, diámetro de las lesiones y porcentaje de lesiones asociadas con necrosis) de tres genotipos de maní, dos de los cuales eran resistentes a la roya y el otro sensible, se estudió en invernadero a raíz de inoculaciones artificiales de *Puccinia arachidis* y de un tratamiento con phosetil-Al, o con l'ácido α-aminooxiacético (AOA), o de la inoculación de *Puccinia sorghi*. Los efectos de los tratamientos con phosetil-Al y con AOA y la inoculación de *P. sorghi* no dan resultados coherentes para el contenido total de fenol y la concentración total de los compuestos de control de los hongos. Phosetil-Al impide la germinación *in vitro* de esporas y el crecimiento de los tubos germinativos de *P. arachidis*, aumentando los períodos de latencia de las plantas tratadas. Una inoculación previa de *P. Sorghi* incrementa también el período de latencia, disminuye la frecuencia de infección y reduce el diámetro de las lesiones. El tratamiento con AOA no surte ningún efecto en los componentes de la resistencia estudiados. Se discute el significado de estos efectos para la defensa del hospedero contra las infecciones patogénicas.

Palabras claves. — Roya, phosetil-Al, *Puccinia arachidis*, *Puccinia sorghi*, protección cruzada, reacción de defensa, componentes de la resistencia.