EFFECT OF RUST AND MOTTLE VIRUS INFECTION ON THE GROWTH AND YIELD OF GROUNDNUT

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ABSTRACT

Two-week old groundnut seedlings (Coronadal variety) were inoculated with rust, *Puccinia arachidis* Speg. and mottle virus alone or in combination, either simultaneously or a week earlier than the other. Plant height was significantly reduced in plants inoculated with rust a week earlier than the virus but was not affected when each of the pathogens was inoculated alone, simultaneously or when virus was inoculated a week before the rust. Flower formation was delayed in plants simultaneously inoculated with rust and virus and in plants inoculated with rust first before the virus. Neither the different disease combinations nor groundnut mottle alone had a significant effect on maturity, however, rust alone caused the plants to dry up and wither before the expected maturity date. Plants simultaneously inoculated with rust and mottle virus had the least number of rust pustules per leaflet and fewer number of rust-infected leaflets. When yield was expressed in terms of weight of dried seeds, greatest reduction (50%) was obtained in plants inoculated with virus first and rust after one week, followed by plants inoculated first with rust then virus later (43%). Least percentage reduction (19%) was obtained in plants inoculated with virus alone but this had greatest seed discoloration. The least weight of 50 seeds was obtained in plants inoculated with rust first one week prior to virus inoculation. Yield in terms of number and weight of productive pods and number and dry yield of seeds was least in plants inoculated with virus one week prior to rust inoculation.

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KEY WORDS: Coronadal groundnut. Rust. *Puccinia arachidis*. Mottle virus. Symptomatology. Disease interaction. Yield and yield components.

INTRODUCTION

Some of the major constraints in groundnut production are the crop's vulnerability to diseases and inadequate disease management practices. One of the diseases affecting groundnut is rust caused by a fungal pathogen *Puccinia arachidis* Speg. (Benigno and Quebral, 1977). Although no information is available regarding yield losses due to groundnut rust, a 40-80% decrease in soybean yield or an equivalent of ₱1,980-₱2,640 per hectare is incurred due to rust (Catedral, 1976). Another common disease affecting groundnut is mottle disease caused by a virus. In a greenhouse study, yield loss due to groundnut mottle disease ranged from 17-30% (Kuhn, Paguio and Adams, 1978). An annual yield loss of over $10 million was estimated in Georgia (Demski, 1975).

An important criterion in any computation of yield loss is the identity of the disease that affected a specific crop. In many instances, reduction in crop yield is assessed based on the individual occurrence of diseases. However, under field conditions, a combination or complex of diseases may occur wherein one disease may affect the severity or may mask the development of the other. Therefore, knowledge of the combined effect of these diseases will help one to determine the degree of loss or damage that the diseases inflict, which is an essential consideration in deciding whether control measure is necessary.

This study was conducted to assess the growth and yield of groundnut individually or simultaneously infected with rust and mottle virus diseases and to investigate a possible interaction between these diseases and their consequent effect on the host plants.

MATERIALS AND METHODS

Preparation of Soil and Seeds. —Well-pulverized garden soil was sterilized mechanically by baking it for about 2 hr in a vat. The sterilized soil was mixed thoroughly and was placed in 19.2 cm diameter clay pots.

Groundnut seeds (Coronadal variety) obtained from the Department of Agronomy and Soil Science were dusted with a mixture of Brassicol (PCNB) and Captan at a rate of 2-3 g/kg seeds to protect them from seedborne diseases.

Planting and Care of Plants. — Complete fertilizer (14-14-14) at the rate of 5 g/pot was placed 5 cm from the seeds and approximately 2.5 cm below the seed level, then covered with 2.3 cm of fine soil before sowing to prevent fertilizer injury to the germinating seeds and young seedlings.

The treated seeds were planted at the rate of 3-4 seeds per pot at 2-3 cm deep and covered with fine moist soil. Thinning and replanting were done after 90% of the seeds had germinated, maintaining 3 plants per pot. Weeding and watering were done whenever necessary. Malathion insecticide was applied using the recommended rate to

keep the plants from being attacked by insect pests.

Preparation of Stock Cultures. — Fifteen groundnut plants were inoculated with rust uredospores while another 15 were inoculated with peanut mottle virus. The infected plants were placed at opposite ends of the screenhouse to prevent cross-infection.

Treatments. — The treatments used were as follows:

T_1 - Control (uninoculated with any of the pathogens)
T_2 - Inoculated with rust alone
T_3 - Inoculated with virus alone
T_4 - Inoculated with rust and virus simultaneously
T_5 - Inoculated with rust first plus virus after one week
T_6 - Inoculated with virus first plus rust after one week

Inoculation. — This was made 2 weeks after the seeds germinated. For the control, healthy peanut leaves were macerated and celite was combined with the resulting sap. Inoculation was done by rubbing the leaf surface of the test plants with cotton wad moistened with sap from the macerated leaves.

For virus inoculation, mottle-infected leaves obtained from the stock culture plants were used instead of the healthy leaves. For rust inoculation, rust uredospores taken from the stock culture plants were sprayed to the test plants using an atomizer at a concentration of 100 spores per microscopic field. The inoculated plants were then covered with plastic bags for about 21-48 hr to allow the spores to germinate and start infection. For the rest of the treatments, inoculation was made as previously enumerated.

Harvesting and Threshing. — Harvesting was done when the leaves of the majority of the plants had begun to wither and turned yellow and most of the pods had hardened and the kernels had fully grown. Harvesting was done by pulling the plants with the aid of a bolo. The pulled plants were then piled in stocks to aerate and dry the pods. The pods were then sundried for 8 hr. After drying, the seedbearing pods were threshed, split opened and then winnowed.

RESULTS AND DISCUSSION

Symptomatology

Development of Rust and Mottle Virus Diseases.

The first symptoms of rust infection which appeared about 7 days after inoculation on the under surface of the leaves were pin-prick spots which later became visible on the upper surface as yellowish spots. Later on, the epidermis of the spots ruptured with orange-red pustules appearing on the surface. Pustules were larger and more numerous on the under surface with older leaves showing the symptoms earlier than the younger ones. Individual pustules were circular and often surrounded by a dull green,

yellowish or chlorotic zone of leaf tissue (Fig. 1). Later on, the pustules turned dark brown and coalesced. The leaf tissues around

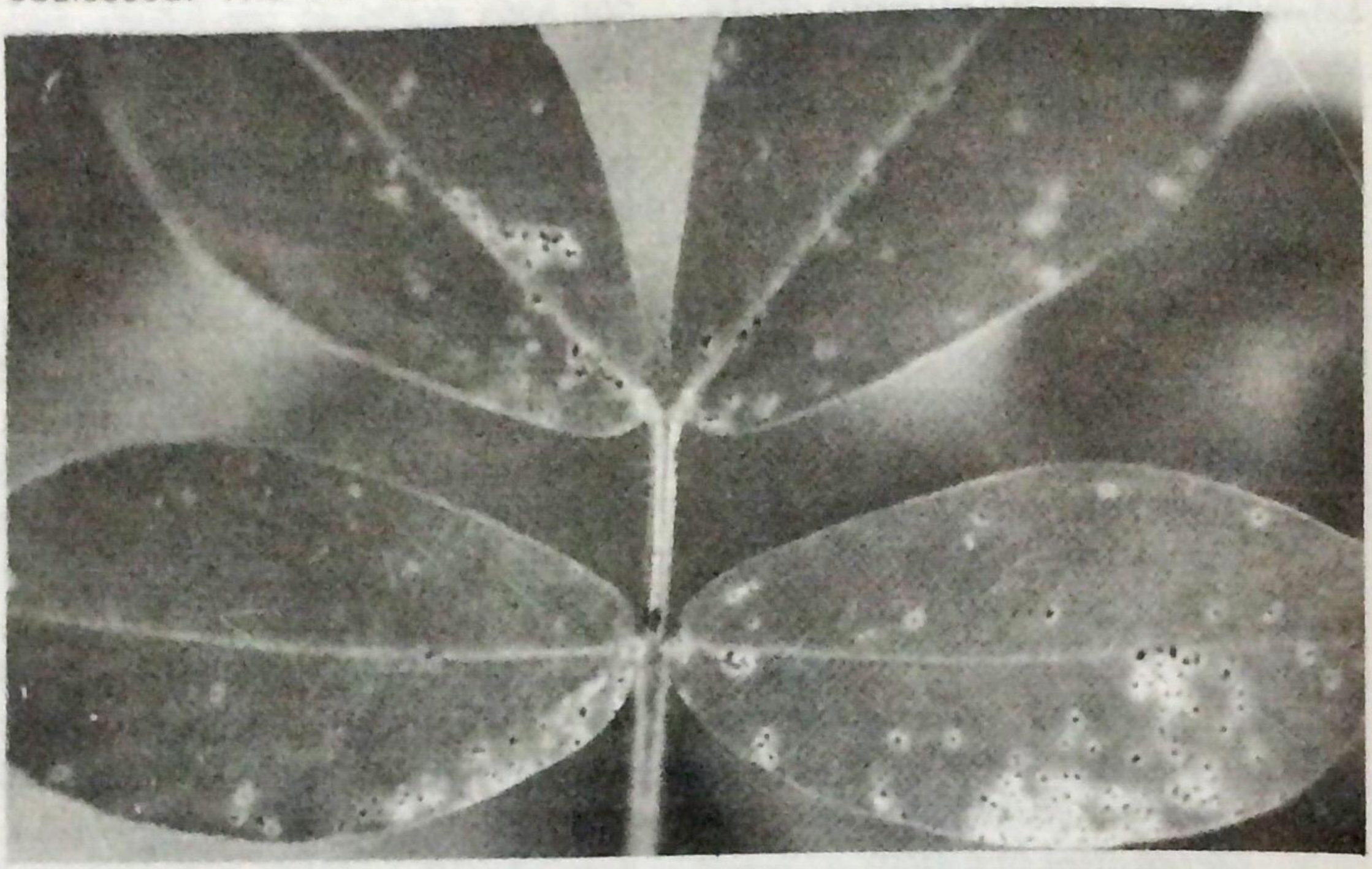

Fig. 1. Rust-infected leaves of groundnut showing the characteristic pustules on the upper leaf surface.

the pustule eventually turned necrotic in irregular patches. The time of appearance of rust pustules in the rest of the treatments was similar in those inoculated with rust alone.

In groundnut mottle virus infected plants, the initial symptom of infection was recognized by the presence of dark-green dots on the unopened youngest leaf about 3 days after inoculation. The infected leaves became mottled 8 days later which usually started from the margin as small, irregularly shaped and dark green islands on a light background (Fig. 2). As infection advanced, the infected leaf curled and became smaller with distinct differentiation of light and dark green areas. Mottle symptoms were more pronounced in plants inoculated with virus alone. With rust and virus in combination, the time of appearance of the virus symptom was the same as those inoculated with virus alone although mottling was often masked by the preponderance of the rust pustules. Since rust disease could be easily quantified through the number of rust pustules produced, its degree of infection was subsequently determined.

Number of Rust-infected Leaflets.

Table 1 shows that plants inoculated with rust alone (T_2) had the greatest number of rust-infected leaflets per plant, however, this was not statistically different from the staggered disease combination in T_5 and T_6. Plants inoculated with rust and virus simultaneously (T_4) had

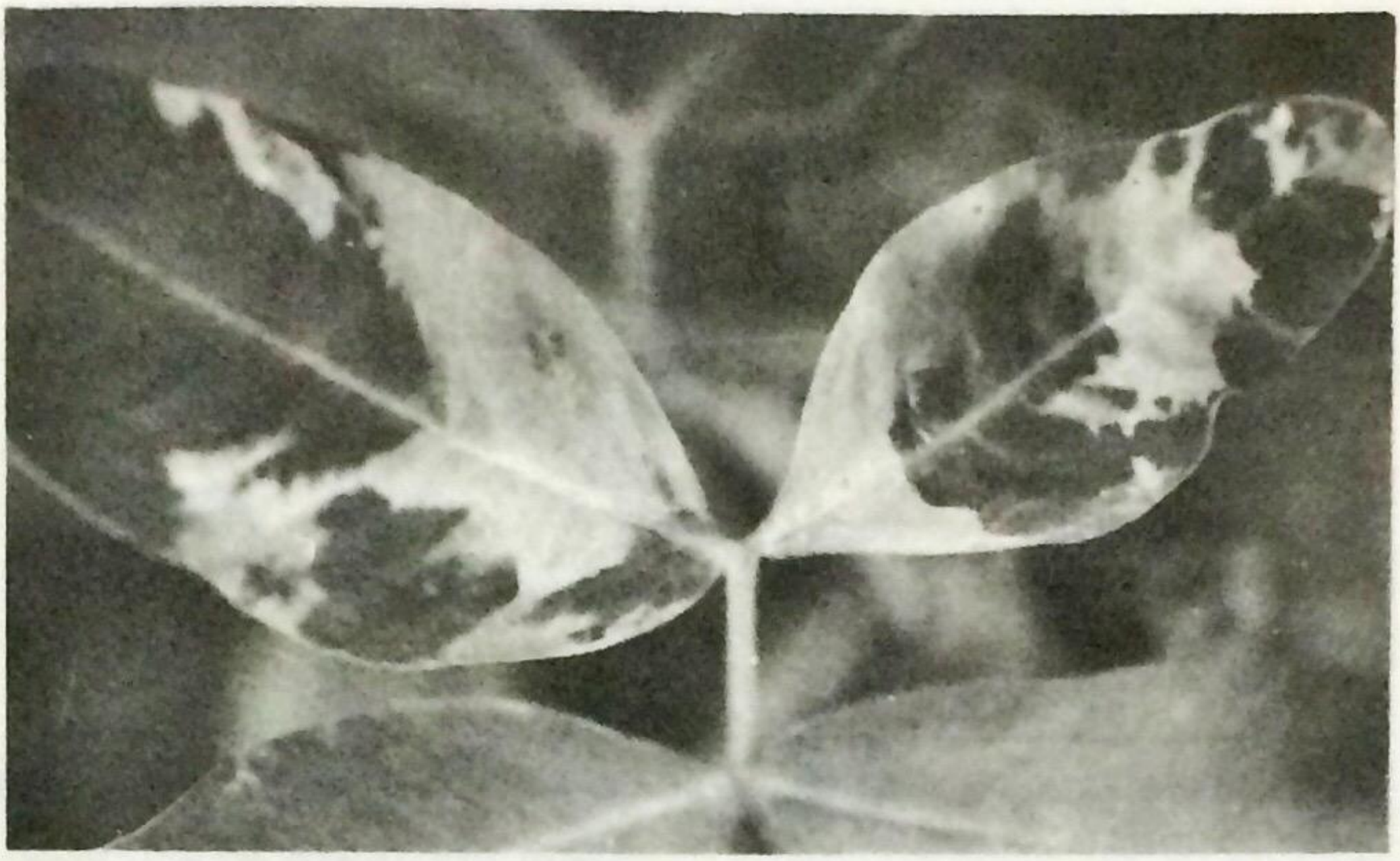

Fig. 2. Groundnut leaves inoculated with mottle virus showing light yellow areas on a green background.

the least number of rust-infected leaflets. This means that upon simultaneous inoculation of rust and virus, rust was not favored to develop in a way it had freely done when inoculated alone. Virus infection therefore seemed to inhibit the action of rust on the host, however, when either of the pathogens was inoculated a week earlier than the other, the resulting number of infected leaflet per plant did not differ significantly from those inoculated with rust alone. These suggest that the pathogens involved have a common infection count but competition for space occurs only when inoculation was done simultaneously.

Number of Rust Pustules Per Leaflet.

Plants inoculated with virus first plus rust after one week (T_6) had the highest number of rust pustules per leaflet but this was not statistically different with plants inoculated by rust alone (T_2) nor with plants inoculated with rust first plus virus after one week (T_5) as shown on Table 1. The least number of rust pustules per leaflet was obtained in plants inoculated with rust and virus simultaneously. These again suggest that rust formation is inhibited when inoculation occurred simultaneously with the virus due to competition for space which becomes apparent when they are inoculated at the same time. The relationship between mottle and rust was difficult to define because of the uneven distribution of pustules in every leaflet, a characteristic feature of rust diseases.

Table 1. Number of rust-infected leaflets per plant and number of rust pustules per leaflet of groundnut inoculated with rust alone or in combination with peanut mottle virus.[1]

Treatment	Number of rust-infected leaflets per plant	Number of rust pustules per leaflet
T_2 - Rust alone	**72.8a**	**16.2a**
T_4 - Rust and virus simultaneously	**37.4b**	**6.8b**
T_5 - Rust first plus virus after one week	**57.5a**	**10.8ab**
T_6 - Virus first plus rust after one week	**57.6a**	**17.7a**

[1] Data taken 6 weeks after inoculation. Means followed by a common letter are not significantly different at 5% level using DMRT.

Effect on Growth

Plant Height.

Plants inoculated with virus first plus rust after one week (T_6) were the shortest one week after inoculation (Table 2). This was statistically different from the rest of the treatments, but the difference could not be due to infection since plants in this group were also the shortest prior to inoculation. Besides, the interval from inoculation to initial reading was also not long enough for the disease or disease combination to show any appreciable effect. On subsequent readings from the third until the ninth week after inoculation, plants inoculated with rust first plus virus after one week (T_5) had the shortest height. Height of plants infected with virus alone (T_3) and those inoculated with rust alone (T_2) did not differ significantly from the control. This proves that infection by each of the diseases alone did not affect plant height. Plants in the rest of the diseases in combination (except T_5) had heights which did not differ significantly from the control. This could be due to the fact that rust infection prior to virus inoculation could have increased the infectivity of the virus thus enhancing the virus to express its most characteristic symptom which is height reduction or stunting. Plants inoculated with virus first plus rust after one week (T_6) and plants inoculated with rust and virus simultaneously (T_4) had heights which were not different from that of the control. This proves that virus infection prior to rust inoculation does not affect the height of plants. Predisposition of plants to viruses due to rust infection had been observed in beans wherein an increased virus infectivity was noted on rusted leaves but not on the non-rusted half leaves (Yardwood,

Table 2. Effect of rust and mottle virus, alone or in combination, on the growth parameters of groundnut (Coronadal variety).[1]

Treatment	Height of Plants (cm)						Number of days from sowing to	
	Before Inoculation	Weeks after inoculation					Flowering	Maturity
		1	3	5	7	9		
T_1 - Control	19.79	31.16a	45.80a	48.32a	48.85a	49.50ab	31.87bc	90.40a
T_2 - Rust alone	21.04	32.10a	44.04a	46.27a	46.53a	46.86b	37.33abc	82.07b*
T_3 - Virus alone	19.77	30.25a	44.05a	47.83a	48.50a	49.07ab	31.20c	91.80a
T_4 - Rust and Virus Simultaneously	21.21	32.98a	46.42a	48.53a	49.30a	50.12a	33.60a	91.60a
T_5 - Rust first plus virus after one week	20.55	31.27a	38.75b	41.53b	41.93b	42.28c	33.27ab	91.73a
T_6 - Virus first plus rust after one week	19.63	27.70b	44.54a	47.57a	47.99a	48.25ab	31.90bc	91.60a

[1]Means followed by a common letter are not significantly different at 5% level using DMRT.

*Leaves dried up and the plants wilted due to severe rust infection.

1951) as cited by Matthews (1970).

Number of Days from Planting to Flowering.

The onset of flowering did not vary greatly among the treatments. The only treatment which differed significantly from the control was T_4 (inoculated with rust and virus simultaneously) but this was not statistically different from T_5 (inoculated with rust first plus virus after one week). The slightly delayed flower formation in T_4 and T_5 could be attributed to the combined effect of the pathogens which were in association especially when inoculation of the two pathogens were done simultaneously or when rust was inoculated a week earlier than the virus but not when the virus was inoculated a week earlier than the rust.

Number of Days from Planting to Maturity.

Control plants reached maturity within 90.4 days (Table 2). Plants infected by rust alone dried up even before the expected maturity date (Fig. 3). In virus-infected plants, either alone or in combination with rust, maturity was reached in almost

Fig. 3. Rust-infected plants at 60 days after inoculation showing distinct drying and withering of the leaves.

the same number of days as that of the control. Plants infected with rust and virus in combination did not dry up compared to those inoculated with rust alone which dried up the fastest. The symptom of premature drying of the leaves due to rust infection was not exhibited when rust was in combination with the virus. This concurs with the findings of Polanco, Smith and Hancock (1969) in which virus infection tended to have a protective effect against *Fusarium solani,* thus, virus-infected squash plants survived longer than the virus-free plants when they were inoculated with *Fusarium solani.*

Effect on Yield

Number of Productive and Unproductive Pods.

Control plants produced the highest number of productive pods (Table 3). Plants infected by each of the diseases alone, or simultaneously, produced almost the same average number of productive pods. Yield reduction in terms of number of productive pods relative to the control, plants infected by virus alone was similar to that of bean plants infected by bean yellow mosaic virus which had 33% reduction in the number of productive pods per plant (Hampton, 1975).

The greatest per cent reduction in the number of productive pods produced was obtained in plants inoculated with virus first plus rust after one week (T_4) but this was not statistically different from those inoculated with rust first plus virus after one week (T_5). This proves that pod formation is adversely affected when the pathogens were in combination, especially when one is given a chance to develop first. Control plants and those inoculated with rust alone had the highest number of underdeveloped or unproductive pods but they also were the highest in the total number of pods produced per plant.

Weight of Productive Pods.

Infection by rust and mottle virus alone or in combination tended to alter the yield as shown in the results in which all the treatments differed significantly from the control (Table 3). Since control plants had the highest number, consequently it also had the heaviest weight of productive pods. Although T_6 plants produced the least weight of productive pods it was not statistically different from T_5 . These indicate that disease infection alter the yield of infected plants especially when the pathogens are in combination wherein one is given a chance to establish first.

Average Number of Seeds Per Plant.

Control plants had the highest number of seeds compared to the rest of the treatments. Plants inoculated with rust alone (T_2) and plants inoculated with virus alone (T_3) did not differ significantly from each other which means that seed number was reduced in much the same

degree when each of the diseases occurred alone. However, when the diseases involved were in combination especially when one is given a chance to develop first, reduction in the number of seeds was more pronounced. The result could support the earlier observation that the activity of the pathogens may be greatly increased when they are in association.

Weight of 50 Seeds.

The weight of 50 seeds varied among the treatments and was highly significant at 5% level (Table 3). The heaviest weight of 50 seeds was obtained in plants infected by virus alone but this was not statistically different from the control and that of plants infected by rust alone (T_2). This proves that virus infection as well as rust infection alone does not reduce the weight of seeds. The only treatment which differed significantly from the control was T_5 (inoculated with rust first plust virus after one week). This further indicates that weight of seeds is reduced when rust is given a chance to establish first before the virus is inoculated. This could be due to the increased infectivity of the virus as predisposed by rust infection.

Yield Reduction.

Greatest yield reduction in terms of threshed peanut seeds was obtained in plants inoculated with virus first plus rust after one week (T_6) as shown in Table 3. Plants inoculated with virus alone (T_3) had the least reduction of 19.23%. This confirms the earlier report that peanut mottle virus does not cause a significant reduction in yield and is thus considered a disease of minor importance in the Philippines (Benigno and Quebral, 1975). Plants infected by rust alone had a per cent

Table 3. Effect of rust and mottle virus infection, alone or in combination, on the yield parameters of groundnut (Coronadal variety).[1]

Treatment	Number of Pods/Plant		Weight (g)		Number of Seeds/ Plant	Dry Yield t/ha	% Reduction
	Productive	Unproductive	Productive Pods	50 Seeds			
T_1 - Control	10.7a	6.6a	13.17a	31.35ab	19.7a	0.16	—
T_2 - Rust alone	7.0b	4.9ab	8.90bc	29.25b	13.3b	.111	30.89
T_3 - Virus alone	7.0b	2.2c	10.06b	31.85a	13.0b	.130	19.23
T_4 - Rust and virus simultaneously	6.9b	2.1c	8.57bcd	28.40b	12.1b	.099	38.17
T_5 - Rust plus virus after one week	5.7bc	2.9bc	7.13cd	24.48c	10.2bc	.091	42.98
T_6 - Virus first plus rust after one week	4.7c	1.3c	6.28d	29.95b	8.3c	.080	50.00

[1] Means followed by a common letter are not significantly different at 5% level using DMRT.

reduction greater than those infected by virus alone with per cent reduction of 30.89% and 19.23%, respectively. This was expected because of the early wilting of plants infected by rust alone. Yield reduction was greater when the pathogens are in combination than when they occurred alone as shown by plants inoculated with rust and virus simultaneously (T_4). The time of infection for each of the interacting pathogens affected the degree of yield reduction. When rust was inoculated a week first before the virus, yield reduction was greater than when inoculation was done simultaneously, however, yield reduction was even greater when virus was inoculated first before the rust.

Seed Quality.

Virus infection affected the coloration of seedcoat. Plants infected with virus alone had more pronounced seed coat discoloration than when infected with rust in combination. This could be due to the fact that in plants inoculated with virus alone, the virus could fully express its effect on the seeds but the presence of rust tended to suppress such effect. The seed coat had pinkish mottling although its size and shape were not altered. Therefore, even if the number and weight of seeds of virus-infected plants were not markedly reduced, market value might still be reduced because of the discoloration of seeds.

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