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APHELENCHOIDES BESSEYI ON ONION IN SRI LANKA

by

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Summary. A new disease of onion caused by *Aphelenchoides besseyi* is reported from Sri Lanka. Symptoms are similar to those of the white tip disease of rice, caused by the same nematode: distortion, twisting of stems and discoloration of the leaf apical portion. Chemical treatments increased quantitative and qualitative yields of onion bulbs. Correlations between final nematode populations in the stem tissues with percentage of plants with symptoms or with yields indicate that *A. besseyi* is a major factor in the disease.

In the years 1979 and 1980 during the inspection of onion (*Allium cepa* L.) fields at Trincomalee, Sri Lanka, plants were noted with distortions, twisting of stems and discoloration of the leaf terminal portion (Fig. 1). Nematodes extracted from the stems were identified as *Aphelenchoides besseyi* Christie.

To help the local researchers in the identification of this species, which seems to occur frequently in Sri Lanka (Lamberti and Ekanayake, 1980) a short description with illustrations and measurements was prepared. To assess the effect of nematode populations on the expression of disease symptoms and on the yield of onion bulbs, two nematicide trials were conducted in 1980 and 1981 in two adjacent fields where numerous plants had been found infested, at Trincomalee. The results are presented in this article.

Material and methods

Nematodes were extracted by 24 hours incubation of comminuted onion stems on Baermann funnels, fixed in 5% hot formalin and mounted in dehydrated glycerin. Specimens were measured with the aid of a camera lucida (Table I).

The two nematicidal trials were conducted with the same modalities in the periods April-August 1980 and September 1980-January 1981.

Treatments and rate and times of application are indicated in Tables II and III. The fumigant 1,3 dichloropropene-1,2 dichloropropane (D-D) was applied by injector gun on a 30x30 cm grid; the granular nematicides were broadcast on the soil surface and incorporated manually. Bulbs were soaked for two hours in 10 l water suspension or solution of the nematicides prior to planting. Plot size was 1.5x0.5 m in both experiments with six replicates of each treatment; plots and blocks were separated from each other by a 30 cm untreated strip. Small size bulbs, of the red onion cv. Vedalam were planted at an average of 90±5 bulbs per plot. Aliquots of 150 g of bulbs were comminuted before planting, and placed on Baermann funnels for 24 hrs, but no presence of *A. besseyi* was detected.

Fig. 1 - Onion plants with distorted and discolored leaves (top) and white leaf tips (bottom).

Planting was on 2 May and 14 October 1980, respectively, for the first and second experiment. Fields were hand weeded, fertilized and watered as usual in the area.

Four, six and eight weeks after planting and one week before harvest the number of plants with symptoms was counted in each plot. At the end of the experiments, total bulb weight and percentage of marketable bulbs per plot were determined. Nematodes were extracted from 5 g aliquots of stem tissue per each plot and counted.

Data were statistically analyzed and mean values compared by Duncan's multiple range test. Correlation coefficients and regression lines were also calculated.

Results and discussion

Morphometrics of *A. besseyi* from Sri Lanka are given in Table I and Fig. 2. Females are slender and when killed by heat are straight to slightly arcuate. The lip region is rounded, smooth, offset from the rest of the body with a faint hexaradiate framework. Stylet sharply pointed with moderately swollen basal knobs. Median bulb of the oesophagus oval, gland lobe very long overlapping the intestine dorsally. Vulva posterior, genital tract monodelphic with only the anterior gonad present; post-uterine sac elongated, extending more or less 1/3 of the distance of vulva from anus, devoid of sperms. Tail conoid, elongate, having at its ter-

TABLE I - *Morphometrics of* Aphelenchoides besseyi *from Sri Lanka (measurements are in µm).*

	Females n = 9		Males n = 5	
	x±s.d.	range	x±s.d.	range
L	653.4±61.0	558.9-734.4	571.9±77.7	467.1-648.0
Head width	6.3±0.7	5.3-7.3	5.9	–
Head height	2.4±0.26	1.9-2.6	2.3±0.20	2.0-2.6
Stylet length	12.1±0.3	11.9-12.5	12.0±0.56	11.2-12.5
Conus length	5.7±0.49	5.3-6.6	5.3±0.65	4.6-5.9
Oesophagus length excl. overl.	61.2±2.21	58.8-64.7	60.4±2.46	58.1-63.4
Oesophagus length incl. overl.	131.3±8.4	122.7-145.2	133.8±13.4	120.8-151.8
Excretory pore from ant. end	70.5±4.58	64.0-75.2	77.5±9.	69.0-89.1
Maximum body width	21.0±1.11	19.8-23.1	17.6±1.27	16.1-19.1
P.u.s. length	57.7±15.2	36.3-79.2	–	–
Tail length	41.5±6.7	32.0-53.5	40.0±4.59	35.6-44.9
Anal body width	10.8±0.98	8.6-11.2	11.8±0.8	10.9-13.0
Spicules length (dorsal limb)	–	–	21.1±1.3	19.8-22.4
a	31.2±3.81	26.6-37.0	34.5±3.5	30.1-38.1
b	10.5±1.04	9.5-11.8	9.9±0.68	8.9-10.4
b'	5.1±0.59	4.3-5.6	4.5±0.4	4.2-5.1
c	15.9±1.18	15.4-17.9	14.4±0.86	13.1-15.4
c'	3.9±0.52	3.0-4.1	3.4±0.45	2.9-4.0
MB%	41.5±1.61	39.6-44.1	40.6±3.3	36.1-43.1
V%	70.3±1.41	68.0-72.0	–	–

TABLE II - *Effect of nematicidal treatments on the yield of onion bulbs and nematode infestation of the stem in the trial April-August 1980.*

Soil treatments	Rate of application (l or kg a.i./ha)	Time of application	Soaking treatments of bulbs (a.i./l water)	% of symptomless plants at harvest (early August)	Bulb yield (kg/plot) (middle August)	% Unmarketable bulbs	No. nematodes in 5 g of stem tissue at harvest
D-D	300	3 wks before planting		58.9 A	1.8 abc	0.0 A	0.5 A
D-D	500	3 wks before planting		56.6 AB	1.9abc	0.0 A	0.0 A
Fenamiphos	20	at planting		56.3 AB	1.9 abc	4.1 AB	0.7 A
Fenamiphos	40	at planting		55.0 AB	1.7 abc	0.0 A	0.0 A
Carbofuran	10	at planting		41.0 BC	1.9 abc	15.5 BCDEF	14.7 C
Carbofuran	10	1 wks after planting		57.1 AB	2.0 bc	9.5 ABCDEF	0.7 A
Carbofuran	10	2 wks after planting		55.5 AB	1.9 abc	6.6 ABCD	2.5 AB
Carbofuran	10	3 wks after planting		52.6 AB	2.1 bc	6.7 ABCDE	0.7 A
Oxamyl	10	at planting		53.7 AB	2.0 bc	18.7 DE	10.3 ABC
Oxamyl	10	1 wks after planting		55.8 AB	1.9 abc	0.0 A	0.0 A
Oxamyl	10	2 wks after planting		58.5 A	2.3 c	6.1 ABC	0.7 A
Oxamyl	10	3 wks after planting		46.7 ABC	1.9 abc	17.6 CDEF	12.8 BC
D-D	300	3 wks b. pl.	1 g/l carbofuran	45.1 ABC	2.1 bc	6.8 ABCDEF	15.7 C
D-D	300	3 wks b. pl.	1 g/l oxamyl	50.9 ABC	2.0 bc	0.0 A	0.0 A
D-D	300	3 wks. b. pl.	2 g/l fenamiphos	48.4 ABC	2.1 bc	0.0 A	0.0 A
Fenamiphos	20	at planting	2 g/l fenamiphos	49.6 ABC	1.8 abc	0.0 A	0.0 A
Fenamiphos	40	at planting	1 g/l carbofuran	53.8 AB	1.5 abc	3.8 AB	2.3 AB
Water			plane	41.3 BC	1.7 abc	11.7 ABCDEF	9.8 ABC
Water			+ 0.5% Formalin	43.5 ABC	1.9 abc	6.1 ABC	2.2 AB
Carbofuran			1 g/l	54.8 AB	1.7 abc	0.0 A	0.0 A
Carbofuran			2 g/l	56.1 AB	1.8 abc	7.2 ABCDEF	1.0 A
Oxamyl			1 g/l	53.1 AB	2.1 bc	4.8 AB	1.3 A
Oxamyl			2 g/l	56.0 AB	1.9 abc	6.2 ABC	1.2 A
Fenamiphos			1 g/l	51.5 ABC	1.7 abc	15.5 BCDEF	7.8 ABC
Fenamiphos			2 g/l	56.4 AB	1.8 abc	3.3 AB	3.2 AB
Control				35.3 C	1.3 a	41.7 G	59.2 D

N.B.: Data followed by equal letters on the same column are not statistically different according to Duncan's multiple range test; small letters for P = 0.05, capital letters for P = 0.01.

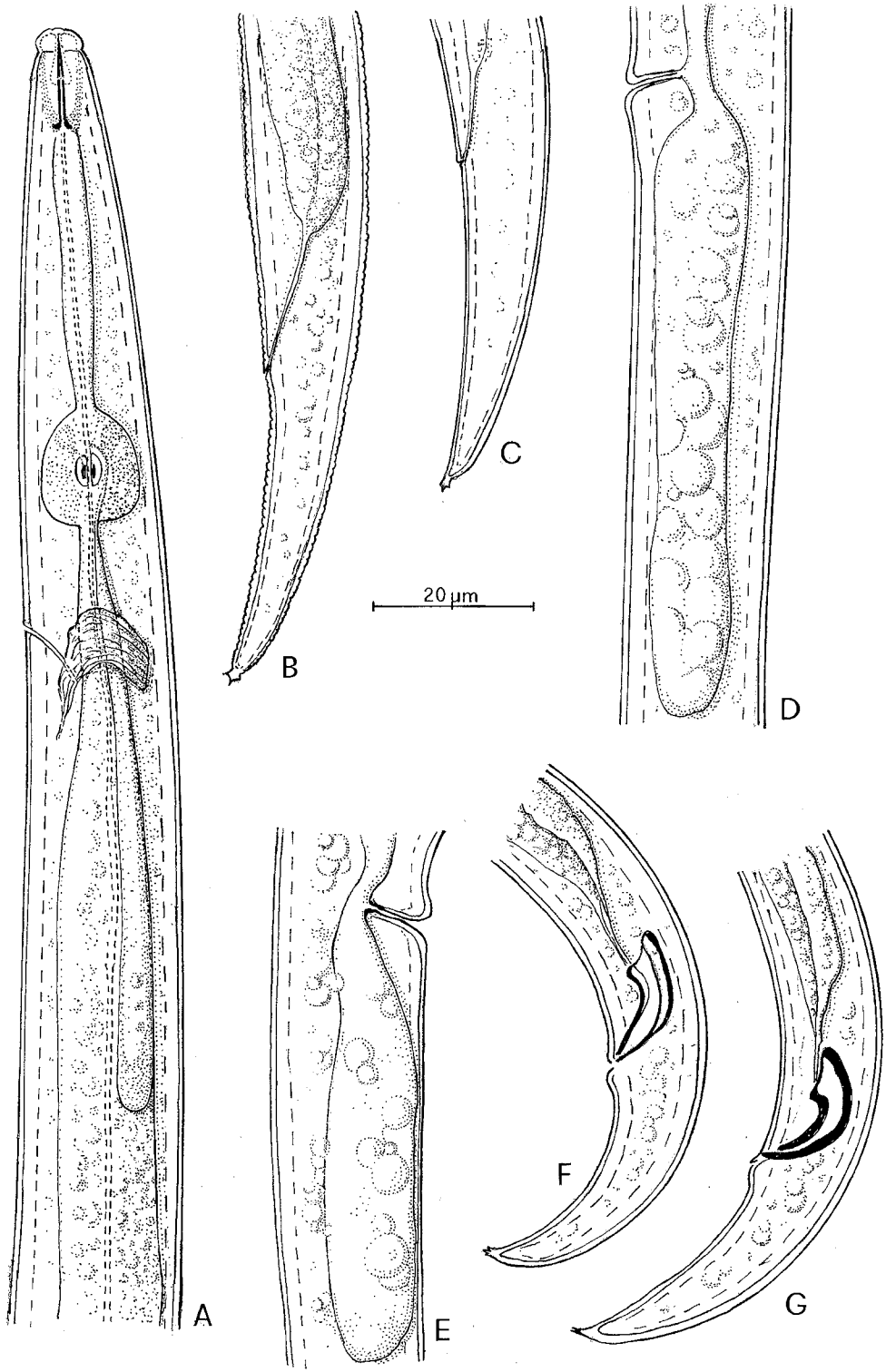

Fig. 2 - *Aphelenchoides besseyi* from Sri Lanka: A, female anterior region; B, C, female posterior region; D, E, post-uterine sac; F, G, male posterior region. Scale bar: 20 µm.

TABLE III - *Effect of nematicidal treatments on the yield of onion bulbs and nematode infestation of the stem in the trial September 1980 - January 1981.*

Soil treatments	Rate of application (l or Kg a.i./ha)	Time of application	Soaking treatments of bulbs (a.i./l water)	% of symptomless plants		Bulb yield (kg/plot) (20 Jan.)	% Unmarketable bulbs	No. nematodes in 5 g of stem tissue at harvest
				8 wk after planting (middle Dec.)	at harvest (middle Jan.)			
D-D	300	3 wks before planting		96.1 A	94.3 A	1.4 A	4.4 A	3.3 A
D-D	500	3 wks before planting		98.8 A	98.3 A	1.6 ABC	2.4 A	1.5 A
Fenamiphos	20	at planting		99.2 A	98.4 A	2.0 C	0.9 A	0.7 A
Fenamiphos	40	at planting		98.0 A	97.7 A	1.5 AB	2.6 A	1.2 A
Carbofuran	10	at planting		98.3 A	98.0 A	1.8 ABC	2.5 A	2.0 A
Carbofuran	10	1 wk after planting		91.9 A	91.3 A	1.6 ABC	3.5 A	3.0 A
Carbofuran	10	2 wks after planting		92.5 A	91.2 A	1.7 ABC	2.4 A	2.5 A
Carbofuran	10	3 wks after planting		98.9 A	97.9 A	2.0 C	0.8 A	1.5 A
Oxamyl	10	at planting		99.1 A	98.6 A	1.5 AB	3.9 A	0.7 A
Oxamyl	10	1 wk after planting		98.8 A	98.4 A	1.4 A	1.9 A	0.5 A
Oxamyl	10	2 wks after planting		98.2 A	97.0 A	1.5 AB	2.7 A	1.3 A
Oxamyl	10	3 wks after planting		95.5 A	94.5 A	1.5 AB	4.4 A	3.3 A
D-D	300	3 wks b. pl.	1 g/l carbofuran	99.0 A	99.0 A	2.0 C	0.8 A	0.5 A
D-D	300	3 wks b. pl.	1 g/l oxamyl	96.2 A	93.2 A	1.5 AB	5.9 A	2.5 A
D-D	300	3 wks b. pl.	2 g/l fenamiphos	95.4 A	92.7 A	1.6 ABC	3.8 A	2.3 A
Fenamiphos	20	at planting	2 g/l fenamiphos	94.9 A	91.2 A	1.6 ABC	5.1 A	3.2 A
Fenamiphos	40	at planting	1 g/l carbofuran	98.8 A	98.2 A	1.8 ABC	1.5 A	1.0 A
Water			plane	99.7 A	98.8 A	1.8 ABC	1.9 A	0.8 A
Water			+ 0.5% Formalin	99.1 A	97.7 A	1.7 ABC	1.0 A	0.8 A
Carbofuran			1 g/l	97.5 A	94.6 A	1.5 AB	1.0 A	0.7 A
Carbofuran			2 g/l	91.5 A	87.7 A	1.5 AB	11.4 B	5.8 A
Oxamyl			1 g/l	97.5 A	96.2 A	1.9 BC	3.6 A	1.3 A
Oxamyl			2 g/l	97.4 A	96.2 A	1.5 AB	3.3 A	2.5 A
Fenamiphos			1 g/l	96.4 A	94.0 A	1.8 ABC	4.2 A	1.8 A
Fenamiphos			2 g/l	100.0 A	99.8 A	1.9 BC	0.0 A	0.0 A
Control				70.4 B	63.3 B	0.6 D	46.6 C	37.0 B

N.B.: Data followed by equal letters on the same column are not statistically different (P=0.01) according to Duncan's multiple range test.

minus a mucro with 3-4 pointed appendices. The posterior region of the male body is dorsally curved after fixation. The robust spicules are thorn-shaped with rostrum and apex little developed. The tail mucro is bifurcate or similar to that observed in females.

Morphometrics of *A. besseyi* from Sri Lanka agree with those of populations reported in the literature (Franklin and Siddiqi, 1972; Rajan *et al.*, 1990), with the exception of the post-uterine sac, which is sacciform and narrow according the description of Franklin and Siddiqi (1972). In some males, the spicules have a slightly developed dorsal process, which has never been illustrated in previous descriptions, but clearly appearing in the micrograph of an Italian population (Vovlas and Lamberti, 1973).

In the control plots of the first trial, four weeks after planting, 39% of the plants showed symptoms of the disease. This percentage increased to 40% at six weeks, to 52 eight weeks after planting and to 75 at harvest. Differences between treatments in the first eight weeks were very erratic; data are therefore omitted. At harvest the percentage of symptomless plants in treated plots was significantly higher than in the control plots; however, treatments did not seem very effective in controlling the disease (Table II). Bulb yield was also inconsistent and only when oxamyl was applied two weeks after planting or when bulbs were presoaked in water suspensions of carbofuran, oxamyl or fenamiphos, before being planted in D-D fumigated soil, were yields statistically increased with respect to the control. However, percentage of unmarketable bulbs was considerably higher in the control plots although for some treatments quantities as high as 15-19% had to be discarded because of poor quality.

In the second experiment, symptoms of disease were not apparent until six weeks after planting when 22% of the plants in the control plots were diseased. The percentage of diseased plants increased to 30% eight weeks after planting and to 37% at harvest (Table III). Bulb yields and percentage of unmarketable bulbs were statistically different between treatments and control. In treated plots yields doubled to tripled and the percentage of discarded bulbs ranged from 5 to 47%, except in the treatment presoaking with 2 g of carbofuran. Nunbers of nematodes ranged from nil to 6 per 5 g of stem tissue in the treated plots compared with 37 in the controls.

In both experiments, there were positive correlations between the number of *A. besseyi* in the plants tissues at harvest and percentage of diseased plants and unmarketable bulbs; number of nematodes in the stems at harvest and marketable yield was negatively correlated (Fig. 3).

Conclusions

The purpose of the experiments was mainly to investigate the relationships between *A. besseyi* and onion, with particular regard to symptom expression and crop losses rather than testing methods of control. However, all treatments were very effective in increasing yields (Fig. 4) and controlling the nematode, including, inexplicably, the pre-sowing soaking in water. The degree of control was higher in the experiment undertaken in the period September 1980 to January 1981, which coincided with the dry season. During the first trial the environmental conditions were more favourable to *A. besseyi.* As it was in the rainy season, nematodes could have been spread on the crop by water splashes and run offs from near by fields or from infested weeds.

The positive correlation between final populations of *A. besseyi* and percentage of plants with symptoms of the disease clearly indicates that the nematode is the cause or one of the casual agent and certainly an important one. Moreover the correlations between nematode population and symptom expression or qualitative and quantitative productions of the plots

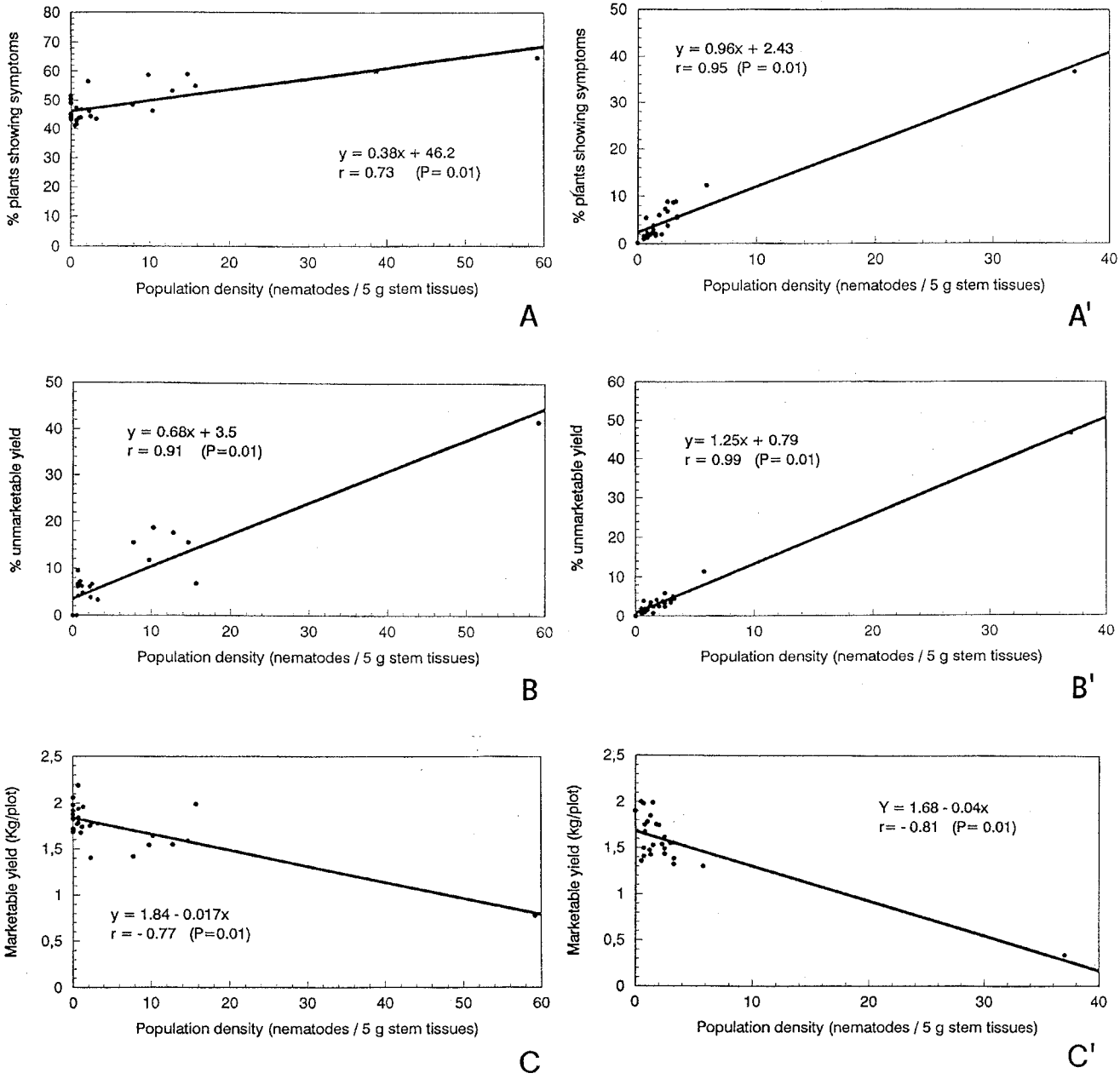

Fig. 3 - Correlations between population densities of *A. besseyi* and % of diseased plants (top), and qualitative and quantitative yields (A, B, C refer to the experiment carried out in the period April-August 1980, and A', B', C' to that undertaken in the period September 1980-January 1981).

Fig. 4 - General view in June 1980 of the field experiment, April-August, 1980. Differences between more or less successful treatments (at right) and control (the second plot below from the left, arrowed) are clearly visible.

show that *A. besseyi* is a major cause of loss of bulb yield.

Thus white tip disease of onion is a new disease in the tropics where *A. besseyi* occurs.

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