FIELD DISPERSAL OF BEMISIA TABACI, VECTOR OF AFRICAN CASSAVA MOSAIC VIRUS

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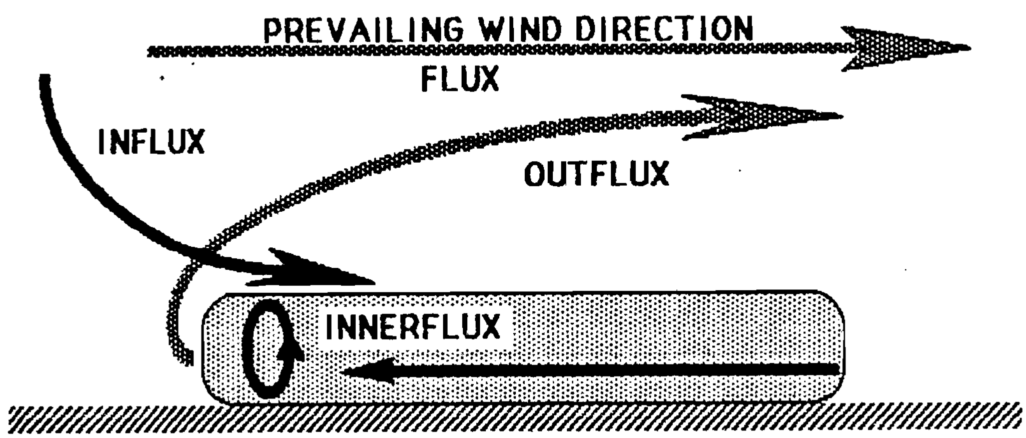
African cassava mosaic virus (ACMV) is transmitted, in a persistent manner, by Bemisia tabaci Gennadium (Aleyrodidae). Epidemiological studies have shown that several features of ACMV spatial spread (disease gradients, rates of primary and secondary spread) are likely to be linked to whitefly movements ("Spatial pattern of ACMV spread," "Primary and secondary spread of ACMV", same issue). To define these movements and their relation with infection, we studied whitefly dispersal in a cassava field. This dispersal is composed of four different movements: 1) the flux of whiteflies flying above the field (not studied here), 2) the influx of landing whiteflies, 3) the innerflux including the movements inside the field and the multiplication of the insect, and 4) the outflux of whiteflies taking off from the cassava field.



All four categories of flux occur simultaneously but their relative importance changes during the culture. Furthermore, the climatic conditions (particularly the wind direction and intensity) could obviously influence some of them.

MATERIALS AND METHODS

We planted, with the CB clone, a 0.5-ha cassava field facing the prevailing wind. The trial was planted at the beginning of the dry season to get a high multiplication rate of the insect.

The experiment is based on two main principles: 1) a wide range of insect traps, and 2) the duration of the experiment for 5 months. Some traps screen the air and gather passively the insects whereas others imply their active movement.

The catching techniques used were the following: 1) counting of the adults on 490 plants; 2) counting the larvae on 14 plants; 3) unattractive sticky traps - distributed at four levels (0.5 to 2.5 m) in 18 sites, inside and outside the field; 4) attractive yellow sticky traps: each sticky trap is made of 10 yellow rings (10 cm wide), separated in eight directions and distributed on 10 levels (0.1 to 3.0 m), 12 of these sticky traps were placed in and out of the field; 5) a suction trap, situated 20 m up-wind of the field. The wind speed was registered in 10 points of the field, allowing the detection of a vertical and horizontal gradient in the cassava field.

RESULTS

The comparison of the catches of the different categories of insect traps allowed us to describe the different movements involved.

Influx. The influx appears all along the experiment but, compared with the other movements, was predominant in the first 50 days of the culture.

Innerflux.

a. Population dynamics. It is composed of three different parts: i) a setting phase corresponding to the influx contribution during 50 days, ii) a multiplication phase during 50 days, and iii) a decreasing phase of 50 days. This dynamic was observed in all parts of the field and with all the different traps. A good correlation also exists between the adult and larvae population dynamics (all instars cumulated).

b. Vertical distribution of the vectors. Whatever the stage of plant growth, 90% of the counted adults feed on the five upper leaves. During the plant growth, the insects follow the canopy rise. However, when the canopy is closed (1-1.20 m), the vectors fly in the morning at the apex level, then fly downwards at mid-day and upwards in the evening.

c. Horizontal distribution of the vectors. Whatever the wind direction, whiteflies are scattered in the field following a gradient: the maximum is in the up-wind border and the minimum in the down-wind border. This gradient is always observed even for low or high populations. The number of flying insects is related to the total number of whiteflies present and to the wind speed in that place. Thus the highest whitefly activity is registered in the down-wind blocks in phase i, in the center blocks in phases ii and iii, and as the plants are canopied, the vectors are more active in the up-wind blocks.

d. Flying direction of the vectors. Before the establishment of the canopy, the whiteflies are flying windward, but in the down-wind blocks the wind speed is so low, it enables the insects to fly against the wind. When the canopy is continuous, the vectors keep flying against the prevailing wind, between the ground and the canopy, and windward above. The results are always the same for any wind direction (N, W or SW) and when it is windless catches happen in all directions.

e. Daily activity of the vectors. We performed eight experiments with catches of 10 to 2000 insects, and all the maxima were recorded between 6 h and 8 h A.M. and all the minima between 12 h and 14 h P.M.

Outflux. The traps placed exactly on the edge of the up-wind blocks show an abnormal increase of the ratio in the beginning of phase iii. It may correspond to the outflux of the vectors against the wind in the canopy (up to the up-wind edge of the field) and windward outside, and above, the canopy of the field.

DISCUSSION

The whiteflies' movements are conditioned to the existence of the "Boundary layer" (1), which depends on the wind speed (2) and on the plant growth. The drastic decrease of the population in the beginning of the third phase cannot be induced by biological or climatic factors, but a change in the insect behavior could account for it. Our observations confirm the hypothesis of a whitefly migration, but we need further proofs.

The distribution of the vectors following a gradient explains the disease gradient observed in all the cassava fields ("Spatial spread of ACMV", same issue). The fact that the horizontal movements depend very much on the establishment of a continuous canopy and that the whiteflies fly against the wind, explains the minor importance of the secondary spread and the up-wind spread around an infected source ("Primary and secondary spread of ACMV", same issue). Furthermore, the canopy establishment coincides with the outflux and thus reinforces the lesser importance of the secondary spread. The huge contamination registered each year in April-May ("Temporal pattern of ACMV spread," same issue) could be understood by the great multiplication of the vector 4 wk before, but these populations need to "migrate" from the old fields to the new ones, as suggested by our results.

REFERENCES

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