VIRUS DISEASES OF VICIA FABA AND SOME OTHER CROPS IN THE NILE VALLEY (SUDAN AND EGYPT) AND THE INVOLVEMENT OF ICARDA

SECOND REPORT

BY

DR. L. Bos
ICARDA CONSULTANT

ICARDA/IFAD

NILE VALLEY PROJECT ON FABA BEANS

ICARDA ALEPPO

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The author is a plant virologist working with the Research Institute for Plant Protection (IPO), Wageningen, The Netherlands.

This second consultancy report is based on field trips and visits to research stations in Sudan from Jan.3 to 16, 1981 as part of the ICARDA/IFAD Nile Valley Project.

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ABSTRACT

The author reports on a second two-week visit to Sudan as a virology consultant to visit farmer's fields of faba beans, field experiments at research stations and on-farm trials of the IFAD Nile Valley Project. This report further confirms and extends the observations and conclusions presented in the previous report.

This year, mosaic- and yellows-diseased plants occurred at most places visited but in low incidence. However, yellows incidence was high in trials at the Gezira Research Station, Wad Medani, and there was a severe outbreak of mosaic in faba beans in the horticultural enclosure at the Hudeiba Research station.

A necrotic disease, which usually is sporadic, attacked many plants of a Botrytis-resistant faba bean introduction at Hudeiba. The disease was found to be associated with a 650 nm long carlavirus, which occurred in high concentration in crude plant sap studied with the electron microscope at Wageningen.

Virus problems in faba beans may resemble those of other crops, such as the yellows disease of Vicia faba and red leaf of cotton, and may have identical or related causes.

Though not yet of evident direct economic importance, virus diseases of faba beans are potentially important and may increasingly become so through changing agricultural systems.

Research infrastructure is not yet prepared for national coordination of research on plant virus diseases. Hudeiba Research Station, assisted by ICARDA through its Nile Valley Project, may for the time being have to rely on its own. Research aspects and requirements at Hudeiba have been discussed.

INTRODUCTION

The concultancy visit to the faba bean project in Sudan reported here was meant as a follow-up of an earlier consultancy during the second half of February 1980. At that time crop development was too advanced in Sudan for appropriate evaluation of their state of health. This especially concerned the yellows disease, which has so far been mistaken for mere premature senescence or deficiency. The present consultancy took place from January 3rd to 16th at the time when faba beans were in full bloom.

For details on virus problems in Vicia faba in general and in some other crops with particular reference to the Nile valley and for the involvement of ICARDA see my detailed earlier report (Bos, 1980).

During all visits I was accompanied by Dr. Mustafa Mohamed Hussein, virologist/pathologist of Hudeiba Research Station, to whom I am greatly indebted for having efficiently organized the programme.

OBJECTIVES

The present terms of reference were to:

- visit experiment stations at Hudeiba, Wad Medani, Agricultural Faculty, Shambat, Khartoum, and farmers' fields to survey distribution and importance of virus diseases on *Vicia faba*;

- suggest laboratory and field techniques for survey of yield losses due to the virus diseases;

- assist and advise national programme in Sudan in setting up a laboratory, particularly for identification of virus diseases.

PROGRAMME

Jan. 3: Flight from the Netherlands to Sudan

4: Visit to Agricultural Faculty, Shambat (discussions with Dr Ahmed Hashim and Dr Feisal Mural Osman

5: Visit to Gezira Research Station, Wad Medani (discussions with Professor Abdel Mageid Yassin)

6: Morning flight Khartoum - Dongola and visits to on-farm trials and farmer's fields, Selaim basin

7: Flight Dongola-Khartoum

8: Transport by landrover Khartoum-Hudeiba, on the way visit to Shendi Horticultural Research Station (discussion with Dr Ali Khalifalla Mohamed)

9: Visits Zeidab Scheme

10: Visits Aliab Scheme. Evening discussion seminar on"Ecology of plant virus diseases and the role of man" for staff of the station

11: Visit trials Hudeiba Research Station. Evening discussion seminar on "From yellows disease of Vicia faba to whitefly-transmitted leaf curl of tomato" for staff of the station and teaching participants of ICARDA training course

12: Inspection station facilities and discussions with dr Mustafa M. Hussein

Jan. 13: Final discussions and afternoon flight Atbara-Khartoum

14: Preparative work on report. Evening flight Khartoum-Cairo

15: Visits to headquarters Nile Valley Project (discussions with Dr M.A. Nour and Dr B.P. Bhardwaj) and to Agricultural Research Centre Giza (discussions with Mr Nassib, breeder, and Dr M.A. Tolba and co-workers, Virus Research Centre)

16: Flight Cairo-The Netherlands

DISEASE OBSERVATIONS

Legumes

Vicia faba. Most of the *mosaic* symptoms observed were characteristic of the pea mosaic strain of bean yellow mosaic virus (BYMV), although symptoms alone are not conclusive for diagnosis. Earlier results by Dr Hussein indicated that broad bean mottle virus (BBMV) either alone or in combination with BYMV may also cause a similar mosaic. At Shambat the syndrome seemed to differ slightly from that in other places.

Mosaic occurred in farmers' as well as trial fields in most places visited, but usually incidence was low, viz a few plants erratically occurring throughout the field. Then often symptoms occurred on all leaves beginning with the oldest, suggesting infection from the seed. There was some secondary spread, as evident from plants with symptoms only starting in younger leaves. At Hudeiba Research Station in the "horticultural enclosure" late sowings of British material and some Hudeiba lines showed infection percentages of nearly 100%. Many aphids were observed on nearby weeds.

The *necrotic streak disease* already mentioned last year was again observed at the experiment stations in Shambat and to a high percentage at Wad Medani. At Hudeiba incidence was relatively low but newly introduced *V. faba* material, resistant to *Botrytis fabae* appeared much more susceptible and sensitive. In crude sap of plant samples brought along to the Netherlands I could readily observe with the electron microscope high concentrations of a carlavirus (ca 650 nm long). This in in line with results obtained last year with a $CaCl_2$-desiccated leaf sample from such plants obtained from Dr Hashim, Shambat. Serological tests performed at IPO by Mr D.Z. Maat did not indicate relationships to pea streak virus (PSV) or red clover vein-mosaic virus (RCVMV).

The *yellows disease*, most probably due to bean leafroll virus (BLRV), could be observed in practically all fields visited but incidence usually was low. Often only a few plants were observed. However, in trials at Wad Medani ca 50% of the plants or more were affected. Mostly the lowest leaves of diseased plants were normal and a series of yellow and leathery slightly upwards rolling leaves with green venation were mostly followed by normal tip leaves. In several places there was less tendency towards recovery and yellowing; leaf narrowing and upright growth of plant tips was more conspicuous. Root rots were more prevalent in yellows-diseased plants and they led to further plant decline.

Phyllody was again observed in a few plants only at Shambat, Dongola, Shimba and Aliab. Symptoms again indicated infection early during plant development with no secondary spread.

Cicer arietinum (chickpea) was only found at Hudeiba and in a few farmers' fields at Aliab. In the latter some plant showed stunting, yellowing and phloem necrosis characteristic of BLRV. The disease was more prevalent in trials at Hudeiba and most at the earliest planting dates. Symptoms also suggested early infection. Yellowing and stunting were often associated with various degrees of wilting due to secondary root-invading fungi (Nene et al., 1979).

Phaseolus vulgaris (bean)plants in trial fields at Hudeiba and Wad Medani research stations showed high percentages of severe stunting, yellowing, leaf curling and withering of lower leaves (see previous report).

Pisum sativum (pea) trials at Hudeiba contained a few plants with necrotic stem streaking and some with additional tip stunting,rosetting and leaf curling. In crude sap from a plant sample brought along to the Netherlands with the electron microscope high concentrations of carla-virus particles (ca 650 nm long) could be observed. Serological tests by Mr D.Z. Maat, IPO, Wageningen did not reveal relationships to PSV and RCVMV.

Some other crops

Cotton (Hibiscus spp) trials at Wad Medani showed many plants with reddening and curling of lower leaves, reminiscent of cotton anthocyanosis described as a virus disease in Brazil (Costa, 1956). Tentative experiments by Professor Yassin's student G.A. Abdallah do already suggest graft transmissibility in cotton and from Sida alba to cotton. Similar symptoms have also been observed there in Euphorbia sp. and okra (Hibiscus esculentus).

A small trial of lettuce (Lactuca sativa) at Shambat again contained a few plants with blotchy yellowing in outer leaves reminiscent of infection by beet western yellows virus (BWYV).

Tomato (Lycopersicon esculentum) everywhere again showed severe symptoms of leafcurl. Different syndromes are being distinguished by Prof Yassin and his student Mr Abdallah.

Okra (Hibiscus esculentum) showed severe leaf curl in all plants of horticultural experiments at Hudeiba Research Station.

Wild plants

Interveinal yellowing followed by plant recovery characteristic of faba bean yellows was observed in the Dongola area and in some other places in the woody desert weed Calotropis procera. Similar symptoms were seen in legume weeds, such as Tephrosia sp., near crops. Leaf reddening was observed in some weeds, including Sida, especially at Shambat, and leaf curl in some wild-growing Malvaceae at a number of places. A wild Vigna sp. showed golden yellow mosaic suggestive of a whitefly-borne virus.

Research facilities

Facilities and infrastructure for plant virus research in Sudan still are practically nil (see also my previous report). At Shambat, Dr Osman has recently joined Dr Hashim to share the task of teaching plant virology. Dr Hashim will concentrate on vegetable crops and Dr Osman will start work on fruit tree viruses, but emphasis almost exclusively is on teaching. Laboratory and greenhouse facilities are practically absent and documentation is very poor. The modern air-conditioned glasshouse is in a neglected state and unfit for growing plants because of lack of spare parts and maintenance. At Wad Medani practically no greenhouse and poor screenhouse facilities are available.

At Hudeiba the plastic greenhouse with two compartments, each of 200 m^2, provided by the Nile Valley Project on faba beans, has recently been completed. Temperature control is with desert coolers with large fans. At Giza, Egypt, temperature in an identical house can be reduced with such coolers by ca 10 ^{o}C. At Hudeiba putting into use of the greenhouse awaits purchase and installation of a generator to cope with prevalent power cuts. Frequent dust storms may require frequent washing of the plastic roof and may further reduce light intensity. In Egypt such washings take place twice a week. The Hudeiba house is (not yet) insect proof for virus work. The ventilation system does not allow compartmentalization required for work with different viruses or to separate the virus work from breeding experiments. Laboratory facilities other than a few light microscopes are lacking. The vacant post of entomologist still awaits filling. Thus, expertise and facilities for vector transmission studies are still absent.

DISCUSSION

The observations made will now be further evaluated following the objectives of my consultancy.

Survey of virus problems

Visits to farmers' fields and trials have shown that incidence of virus diseases in faba bean so far is low, at least this year. Even yellows seems to be less prevalent than last year (Bos, 1980). However, at Wad Medani, where the crop is not yet grown commercially, infection rates were very high. Present occurrence in faba beans and chickpeas suggests virus infections early during the winter season with little secondary spread thereafter.

Egyptian researchers participating in a training course at Hudeiba during my visit, have reported this years' occurrence of yellows in faba beans near Seds, Egypt, in ca 5% of the plants.

The type of yellows observed in most yellows-diseased faba plants in Sudan with relatively rapid recovery suggests the presence of a strain of the BLRV with low virulence and limited influence on yield. The other syndrome observed to a lesser extent may be more drastic in its effect on yield. It more closely resembles the type of disease described in Iran by Kaiser (1973), where yield may be nil if plants are infected at the pre-bloom stage.

The high incidence of faba bean yellows at Wad Medani parellel and may also be etiologically associated with problems in other crops such as yellows in lettuce (see last-year report) presumably due to BWYV and the prevalent red-leaf disease of cotton, presumably due to a related if not identical virus. These diseases may very well be of great economic importance in a number of crops, and high incidence at Wad Medani may be caused by more diverse crop cultivation and a longer history of large-scale disturbance of the natural ecology in the Gezira area. Yellows diseases are known to predispose plants to increased infection by other pathogens as of chocolate spot and rootrots in Vicia faba (Kaiser, 1973). The same holds for chickpea and wilt disease (Nene et al., 1979).

Most infection by mosaic virus(es) must have been from the seed with little secondary spread. However, there was much spread in some places, notably in the horticultural enclosure at Hudeiba, in late sowings and only late during crop development. High indicence of necrosis in imported genotypes resistant to Botrytis is an example of risks involved with the introduction of new cultivars.

These observations suggest that viruses, although perhaps not yet causing appreciable loss in faba beans in Sudan may increasingly come to the fore with further changing agriculture. Incidence, anyhow, may vary considerably from year to year with aphid population densities and occurrence and incidence of sources of infection.

Phyllody was again observed in a few plants only at Shambat, Dongola, Shimba and Aliab. The type of symptoms indicated infection during early plant development with no secondary spread. The virus-like mycoplasma is not seed transmitted and may infect crops from weeds. According to Dr Hussein, who made observations for a series of years, infection never exceeded 2%.

Yield loss assessment

The above indicates that faba bean viruses in Sudan can so far only be discussed in terms of potential importance. A number of these viruses is present in Sudan already, others are likely to be introduced in the future. In Iran BLRV and BYMV have been found to be prevalent in crops, and in field trials to reduce faba bean yield with over 50 to 100% and 25 to 45%, respectively, when inoculated at post-bloom up to pre-bloom stages, respectively. However, strains occurring there may differ from those in Sudan, and strain identification is needed to decide whether information obtained elsewhere can be utilised in Sudan.

Therefore experiments may be required in Sudan to study potential losses caused by the viruses or virus strains already present, and in future, actual losses may have to be determined in field experiments. For detailed information on methods and pitfalls in assessment of crop losses due to viruses see Bos (1981). They have been discussed with Dr Hussein.

Research on faba bean viruses in Sudan

In Sudan proof of the virus nature of the yellows disease in faba bean and chickpea has not yet been provided, although symptoms are typical of BLRV. The involvement of related viruses like BWYV (Duffus and Milbrath, 1979; Duffus, 1979) cannot yet be excluded. Through these viruses, the disease may be related with diseases in totally different crops and various weed species. The red-leaf disease of cotton closely resembles cotton anthocyanosis described as an aphid-transmitted virus disease in Brazil by Costa (1956). The virus nature of all these diseases as observed in Sudan has to be studied and proper virus identification comes first.

The same holds for the viruses associated with mosaic and necrosis in faba bean. Symptoms usually are unreliable for drawing conclusions as to the viruses involved.

Necrosis in faba bean may be caused by alfalfa mosaic virus, but also by necrotic strains of BYMV. Detection of (a) carlavirus(es) in samples of necrotic faba plants from Hudeiba, and earlier in such material from Shambat, as well as in peas from Hudeiba have already proved the presence of at least another faba virus in Sudan. Absence of serological reactions with antisera to pea streak virus and red clover vein mosaic virus suggest it to be different from these. In the USA an aphid-transmitted carlavirus latent in lucerne (alfalfa latent virus) has been described that may cause leaf necrosis in Vicia faba (Veerisetty and Brakke, 1977).

Another carlavirus of several tropical legumes already reported from a number of African countries is the cowpea mild mottle virus. This has been found to be seed-borne (2-90%) in cowpea, soybean and Phaseolus vulgaris (Brunt and Kenten, 1974). Such viruses do require reliable identification in view of their potential importance, especially if seed transmissible.

The nature of the stunt and yellows disease of Phaseolus vulgaris is still uncertain. The symptoms are suggestive of a virus disease and do not resemble any of the nutritional disorders of Phaseolus beans described by Howeler (1980).

Virus identification (description of new viruses and diagnosis of virus diseases) usually starts with study of host ranges, symptomatology and manner of transmission. Many viruses are easily sap transmissible, such as mosaic viruses and the carlaviruses just mentioned. Several others, such as the yellows and leaf-curl viruses are only transmissible with insect vectors or by grafting. All these experiments need to be done in insect-proof greenhouse or screenhouse. The results obtained may also help in understanding the natural ecology of these viruses and possibilities of control. The work then has to be further completed with information on the viruses themselves as with electron microscopy and serology. Theoretically, assistance could be provided by specialists in an advanced country as already demonstrated by the few tests done at Wageningen with the carlavirus. Also ICARDA itself may have a task. Restriction of such tests to the two techniques mentioned will limit the risks of escape into the country of study to an utter minimum.

Research infrastructure in Sudan does not yet seem ripe to develop the latter expertise and facilities within the country e.g. at Shambat. Therefore the Nile valley project may for the time being have to rely on its own at Hudeiba. Further improvement of greenhouse facilities for virus work, as discussed with Dr Hussein, is a must. Construction of a small and inexpensive separate Rossel screenhouse to facilitate work with viruses, even though it may not be fit for use throughout the year, is worth consideration. For a general discussion of problems involved in virus identification see Bos (1977) and for techniques involved see Noordam (1973).

Efficient use of such facilities based on the availability of single experts, who meanwhile have to cover a wide field of work and may soon (have to) switch over to other tasks, seems questionable. Hence, success greatly depends on continuity of the programme and this to a great extent will depend on stability of the research infrastructure of the country. Present goodwill at Hudeiba is evident. With the vacancy in entomology, however, there is no support from this discipline vital to ecological studies and artificial transmission with vectors. Time hardly allows some reasonable reading of literature.

Through our visits at Wad Medani and joint discussions with Prof Yassin some pooling of interests has been achieved and there are prospects for some collaboration as far as insect-transmitted yellows viruses is concerned. Intensification of work on virus diseases of faba bean may also stimulate national research on virus-like diseases of other crops such as of the widespread red-leaf disorder of cotton. Leaf curl of tomato is another very damaging and internationally important virus disease that requires further study,in particular as far as breeding for resistance is concerned.

CONCLUSIONS AND RECOMMENDATIONS

1. The conclusions and recommendations presented in last years' report (Bos, 1980) still hold. The necessity of reliable identification of the incitants of the virus and virus-like diseases and of their strains is again stressed.

2. Incidence of faba bean yellows was less than last year at Hudeiba, but again high at Wad Medani. It might be a limiting factor if faba bean is introduced there as a crop. The disease has been observed in most places where faba beans were grown, and similar symptoms have been observed in other crops, which suggests its potential importance.

3. Incidence of mosaic was low, but the disease could be noticed everywhere presumably because of low rates of seed-infection. At Hudeiba an outbreak was observed in late-sown faba beans.

4. Necrosis occurred incidentally, but percentage of attack was high in imported Botrytis-resistant material. In infected plants no BYMV particles were detected, but high concentrations of a carlavirus.

5. Incidence of virus diseases varies according to year and greatly depends on conditions determining vector population density and sources of infection, including wild plant species.

6. Research infrastructure in Sudan is not yet prepared for national coordination in plant virus research. Hudeiba will, for the time being, greatly have to depend on its own and on foreign assistance, or assistance from ICARDA itself.

7. At Hudeiba, emphasis has to be on field observations and on tentative virus identification with test plants and vectors under insect-proof conditions. For those viruses that turn out to be of economic or potentially economic importance promising cultivars or breeding line may have to be screened for resistance. This can best be done under insect-proof greenhouse conditions after inoculation (if necessary with insects) or in the field under conditions of artificially increased infection pressure.

8. Research on virus diseases of faba bean may have a radiating effect on virus research in other Sudanese crops. Further research on cotton red leaf, a wide-spread and possible virus disease, is needed.

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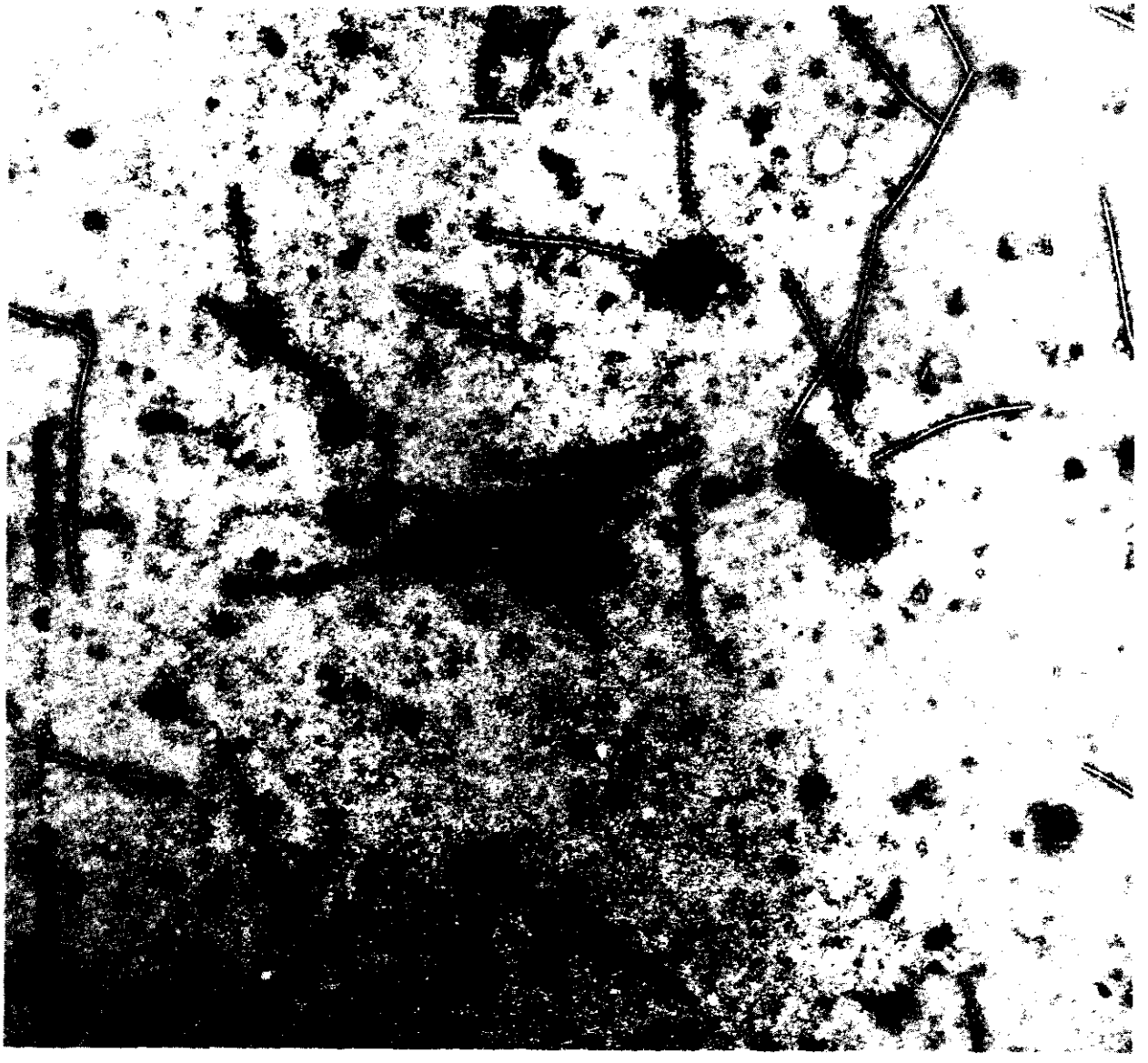

Electron micrograph of unknown virus of pea and faba bean at Hudeiba in crude sap from diseased pea leaves, magnification ca x 37500. (Photograph L. Bos, IPO, Wageningen 290-13).