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

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A Consultant Report Based on Field Visits to
Egypt & Sudan During 1980 As Part of the
Nile Valley Project (Sponsored by IFAD)

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ABSTRACT:

The author reports on a 2½-week study tour through Sudan and Egypt to visit the ICARDA Nile Valley project on *Vicia faba* as a virology consultant. In view of ICARDA's collaboration with national research organizations, national institutes of virus research in both countries were also visited.

Bean yellow mosaic virus and broad bean mottle virus do already play a role in certain areas although infection mostly comes late during development. These and a number of other viruses are known to be seed transmitted in faba bean, and in addition some three or four others have already been reported in the region. Their potential importance depends on possibilities of spread by vectors and the availability of cultivated or wild plant hosts and thus to a great extent on crop ecology.

A yellows disease, now generally explained as a mere physiological disorder, has been found to occur incidentally in Egypt but to be prevalent in many faba bean crops in Sudan and perhaps in *Phaseolus vulgaris*. It is most probably due to the persistent aphid-transmitted (broad) bean leafroll virus, in several countries known to be damaging in various legumes and often to be symptomless in lucerne.

With plant virus diseases visual diagnosis in the field is practically never reliable. Laboratory experiments are required to prove the actual cause of the disorders tentatively reported here. More detailed surveys are needed to determine their incidence and to assess their economic importance.

National endeavours, internationally supported by ICARDA, to improve crop production by crop intensification and diversification are bound to increasingly and continualy lead to virus problems. Further identification and evaluation of these problems through research and support of breeding for resistance seem justified. This could be done by national researchers and research organizations, which then have to be better equipped. ICARDA may have to coordinate and stimulate such work and will have to keep an eye on developments in its home institute. This particularly pertains to its food legume crops improvement programme but also concerns its international germplasm transfer.

INTRODUCTION:

ICARDA is the international centre designated by CGIAR for research into and the improvement of barley, lentils (*Lens culinaris*) and faba beans (*Vicia faba*), and to act as regional centre in cooperation with other CGIAR centres for research on wheat (CYMMIT) and chickpeas (*Cicer arietinum*) (ICRISAT). It also conducts research into and develops improved systems of farming and livestock husbandry and therefore stimulates and improves the cultivation of forage legumes, including peas and clovers. The institute started its work in 1977 and is gradually expanding. It is still at the stage of further identifying the problems involved.

Viruses are intricate factors in constraining crop production and are rarely limited in their effects to special crops. With changing agriculture - partly as a result of ICARDA activities - more and new virus problems are likely to come to the fore. Several viruses are international in spread and in spite of precautions further spread with germplasm and commercial seed seems inevitable.

In Sudan and Egypt *V. faba* is an ancient but still important food crop with a potential for further improvement. It is suffering from infection by certain viruses. I was asked to evaluate their present and future importance and to advise on measures to be taken. The problems in this crop, however, are linked to virus problems in other crops.

OBJECTIVES:

The main aim of my visit was to identify virus problems in faba beans in Sudan and Egypt, to assess their extent, and to indicate possible ways of control and/or of further research required.

1. Visit farmers'fields of faba beans and other neighbouring crops and ICARDA field trials.

2. Visit national research institutes involved in plant virus research and discuss with national virologists on the existing information and further research required, and

3. Discuss with breeders on possibilities for achieving cultivar resistance to viruses.

VIRUS DISEASES OF FABA BEAN:

Literature:

Vicia faba is susceptible to artificial infection by a great number of plant viruses. It is a popular test and trap plant for research on many plant viruses. Hence, as a crop it is potentially vulnerable to virus diseases. Natural infection, however, depends on availability of sources of infection and vectors of spread. In nature viruses do indeed play a role in reducing faba bean yields. Table 1 presents a (tentative) list of viruses reported to naturally infect faba bean crops, and assembles some information on their properties and ecology and occurrence in Sudan and Egypt. This list indicates that so far few viruses have been reported on faba beans in Sudan (alfalfa mosaic virus AMV, bean yellow mosaic virus BYMV, and only recently broad bean mottle virus BBMV) and in Egypt (AMV and only recently BYMV, broadbean true mosaic virus BBTMV, and broadbean wilt virus BBWV). Very little information exists on virus incidence and on ensuing crop losses. In fact, most reports, notably from Egypt are on single isolates of the viruses. Table 1 shows that several of the viruses listed are seed transmitted, although often in low percentage and in some of their hosts or in certain cultivars only.

Witches'broom growth and floral phyllody of faba bean, usually occurred in 2 to 8 percent of the plants in the Sudan but in some fields during the 1959/60 season it reached 16 percent (Nour , 1962). Such diseases are now generally assumed to be caused by mycoplasma-like organisms instead of viruses. They are transmitted by leafhoppers, and some by Psylla spp, like persistent viruses.

Observation in Sudan:

Mosaic was rather prevalent in trials and farmers'fields at Shambat and Hudeiba and especially in late sowings. Most of the infected plants, however, showed symptoms in top leaves only suggesting a late infection. Then the effects on yield are mild. At Zeidab near Hudeiba infection, I was told, often occurs early during the season (seed-transmission and infection from wild legumes), and the effect on yield may be considerable (cf. Nour and Nour, 1962[a]).

The type of mosaic may vary considerably, presumably partly due to genotype variation, and it is impossible to diagnose the mosaics by their symptoms. At Hudeiba'the mosaic' is now ascribed to the infection by pea mosaic virus or BBMV (which cannot be distinguished symptomatologically) or by both occurring together (Hussein,1979). Pea mosaic virus is no longer considered a separate virus but a pea mosic strain of BYMV (Bos et al.,1974). Strains of this virus can be rather reliably recognized and often distinguished with the light microscope with a simple staining procedure for inclusion bodies in epidermal strips (Bos, 1969), as demonstrated during my visit at Hudeiba.

BBTMV and broad bean stain virus (BBSV), which are seed-borne in faba bean and are closely related mutually, can be expected to show up in imported material, but they cause a more characteristic malforming mosaic often with alternating acute and more mild phases of symptom expression during plant development.

In Shambat a small V. faba trial of unknown origin and purpose near lentils showed 100% and most of them early infection, with a very severe but regular curling mosaic differing from the above mosaics.

At the Hudeiba Research Station some plants showed stem necrosis usually occurring in streaks and often girdling the upper part of the stem which may then characteristically droop. Such symptoms have not yet been observed in farmers'fields but can very well be caused by necrotic strains of BYMV (Bos et al., 1974), although several other viruses are able to induce necrosis in faba bean such as AMV(Nour and Nour, 1962b) and BBWV. Again, the strains of BYMV can easily be recognised by their characteristic inclusion bodies.

Phyllody, as earlier described for Sudan by Nour (1962), could indeed be observed everywhere but was claimed at Hudeiba never to go beyond some 1 to 2% of the plants. Infection seems to be early during plant development and not much secondary spread was said to occur. This could point to an early disappearance of the vector or of the sources of infection. The leaf hopper vectors are known, once they are infected, to remain so for the rest of their lives. Potentially (cf. infection rates up to 16% according to Nour, 1962), however, the disease remains of importance since infected plants always turn sterile.

Alarming was the occurrence of plant yellowing (yellows disease), described by anybody with whom I discussed the matter as a mere physiological disorder due to premature senescence or to mineral deficiency. All those to whom I showed colour slides of yellowing, caused by (broad) bean leafroll virus BLRV (or pea leafroll virus) in the Netherlands, positively identified its symptoms with those observed in Sudan. The disease was found to be prevalent in experiments and farmers'fields at Hudeiba and Wad Medani and sometimes in over 50% of the plants. It will later be discussed in some more details.

Observations in Egypt

It was almost unbelievable to see thriving and practically disease-free faba bean crops in middle Egypt. Mosaic disease is causing concern in the Nile delta where it is being ascribed to BYMV. Rates of infection were high at some places. Several infected plants showed symptoms starting in young leaves, thus suggesting infection from the seed. Such plants occurred at random. In the irrigation scheme at Nubaria imported gladiolus crops were grown nearby. In such gladiolus crops, BYMV, cucumber mosaic virus (CMV) and tobacco rattle virus (TRV) had been detected at Giza (Gamel El-Din, personal communication). In fact, the first two viruses are practically omnipresent in gladiolus, and infection by them often is symptomless. The occurrence of mosaic in faba bean at Nubaria, however, did not suggest a direct infection from the nearby gladiolus crop.

At the Agricultural Research Institute, Giza, field experiments are going on to investigate the effect of two strains of BYMV and one of BBWV on 22 lines of Vicia faba to study the effect of these viruses after inoculation at varying times during development. One new plant introduction and 4 selections from Egyptian cultivars Giza 3 and 4 show promising resistance. It is questionable whether the virus isolates used are representative of the Egyptian field situation.

Phyllody has not been observed during my brief survey in Egypt and has so far not been reported there.

Broadbean yellows did also occur in Egypt and was observed at the Giza Agricultural Research Station as well as in practically all fields that were visited, but infection usually was limited to a few incidentally occurring plants. Symptoms usually differed slightly from those in Sudan. Plants were less yellow but top leaves were erect and narrow with more upward rolling, and plant tips were usually severely stunted.

Some details on (broad)bean leafroll virus

The occurence of broad bean yellows was alarming indeed since it was generally considered to be a mere physiological disorder and was not associated with a virus infection.

The symptoms usually consist of leaf chlorosis, which often is interveinal, and is accompanied by starch accumulation. The leaves concerned are thicker than normal and feel leathery. The phenomenon starts at a certain height of the plant with the lower leaves still normal. young leaves may be considerably reduced in size and upright, and plant tops stunted, Such plants with top yellowing readily attract attention. If infection occurs early, plants may also tend to recover with top leaves again becoming more or less normal.

The virus is known to be phloem limited and to primarily cause degneration (necrosis) of the phloem. Phloem necrosis can be easily observed with the naked eye in the vascular layer at the plant root crown of infected pea and chickpea plants after superficial scratching with a knife. The phloem necrosis then triggers consecutive series of secondary symptoms, such as poor root growth (depletion of starch), poor uptake of nutrients (perhaps leading to mineral deficiency), starch accumulation in leaves (and often increased susceptibility to Botrytis fabae), and poor pod formation and poor seed set. Such secondary symptoms are truly physiological in nature. This explains why such yellows diseases, of which there is a great number caused by so-called luteoviruses(see Duffus, 1977), are so easily misdiagnosed.

In England yield reductions of up to 50-80% have been reported (Tinsley, 1959; Heathcote and Gibbs, 1962).

Transmission cannot be achieved with plant sap but by certain aphid species that feed on phloem contents, and such transmission is in the persistent manner. Proof of the virus nature of these diseases has thus to be provided with help of aphid-transmission experiments. Such tests have already been initiated at Giza, and hopefully also at Hudeiba and possibly at Wad Medani as well.

The virus disease is wellknown in peas and faba beans in Western Europe and has more recently been reported from the USA. It occurs in many legumes including Phaseolus beans (see also this report p.6), cowpeas, lentils, and chickpeas in Iran (Kaiser, 1972), in chickpeas in India(where I have seen the disease during a recent visit to ICRISAT and it is claimed by Y.L. Nene (personal communication) to also occur in ICRISAT chickpea trials in Sudan), and finally in subterranean clover, peas, faba bean, Phaseolus vulgaris, and various other legumes in Australia and New Zealand (Ashby et al.,1979). It has recently been possible to isolate and characterize the Dutch isolate of the virus in our laboratory at Wageningen(Ashby and Huttinga,1979). The antiserum produced was used to demonstrate close relationships between the Dutch bean leafroll virus and chickpea dwarf virus at ICRISAT and between the dutch virus and the New Zealand subterranean clover red-leaf virus. Slight differences in host range between the European virus and that in New Zealand are explained by host preferences of the main vectors which are Acyrtosiphon pisum in Europe and Aulacorthum Solani in New Zealand.

Particularly the studies in Iran by Kaiser (for a summary of data see Kaiser, 1972) on various legumes, and his observations of the disease in bean and faba bean on a field trip to Turkey make it very likely that the virus does occur in Syria as well.

Perennial clovers are important sources of infection for annual crops. Medicago sativa (lucerne, alfalfa) is one of the main sources in the Netherlands and in Iran. Infection is completely symptomless in this host at high temperatures. In Sudan broad bean yellows turned out to be particularly prevalent in crops near lucerne. The proposed intensification of cultivation of clovers and other forage legumes in Syria by ICARDA may very well stimulate the virus to (further)come to the fore.

Breeding for resistance has solved the problem in peas in the Netherlands (Drijfhout, 1968) and recently some resistant faba bean lines have been developed. Kaiser (1972) did not find resistance in 115 lines tested in Iran, and Vicia narbonensis is susceptible.

As with other persistent viruses positive results have also been obtained in controlling the disease with systemic insecticides.

VIRUS DISEASES OF SOME OTHER CROPS:

As far as time permitted other crops were also examined for virus symptoms in view of the possible role of such crops as sources of infection for faba bean viruses. Emphasis was on legume crops. In Sudan winter crop development was rather advanced already.

Observation in Sudan:

At Shambat and at Wad Medani in lettuce trials several plants were observed with symptoms characteristic of infection by the persistent aphid-transmitted beet western yellows virus. This virus is related to (broad) bean leafroll virus but has a wider non-legume host range. It is held responsible for part of the yellows diseases in legumes in California (Duffus, 1977) and is now considered closely related if not identical to the subterranean clover stunt virus (J.W. Ashby, New Zealand, personal communication), one of the two causes of severe yellowing and stunting of food legumes in Australia and New Zealand, including Phaseolus vulgaris.

Both at Hudeiba and Wad Medani Phaseolus vulgaris tests were nearly finished. The crop is said to severely suffer from stunting, leaf curling and yellowing. Most of the plants that were left in the fields, indeed showed such symptoms to a severe degree, but were near senescene. Most plants may also have suffered from salinity. The symptoms I saw at Hudeiba and Wad Medani were highly reminiscent of the syndromes ascribed to pea leafroll virus in Iran (Kaiser, 1972) and to subterranean clover redleaf and stunt viruses and to pea leafroll virus in New Zealand and Australia (Grylls and Butler, 1959; Kellock, 1971; Wilson and Close, 1973). In fact, in Sudan the bean disease was observed near faba beans with yellows. In Australia another symptomatologically somewhat related disease, described by the name summer death (Ballantyne, 1968), has more recently been associated with the leafhopper-borne beet curly-top virus (Bowyer and Atherton, 1971). None of these diseases is sap transmissible.

Unfortunately, the season was too advanced for chick peas, and time too limited to search for them. According to Y.L. Nene (ICRISAT, personal communication, 1979) ICRISAT trials in Sudan suffer from stunt (dwarf) now known to be due in India to (broad) bean leafroll virus. The few plants seen at Hudeiba did not show typical symptoms of the disease.

Tomatoes were practically 100% infected by (yellow) leaf curl, an extremely damaging disease generally ascribed to a whitefly-transmitted virus.

At Hudeiba two types of disease are being distinguished. Type B is the most severe with purpling, extreme stunting and total cessation of fruit production. The two diseases seem to differentially interact with tomato cultivars. At Wad Medani common leaf curl, which is very mild on tobacco, is distinguished from a vein-thickening and enationproducing form, which produces typical leafcurl on tobacco. The disease is (or the diseases are) highly prevalent in tomato all over the middle east and in India. In other parts of the world tomato yellow top has been associated with the aphid-transmitted potato leafroll virus.

Everywhere onions looked free of virus, but garlic plants were often found with mosaic striping.

In other countries, garlic is known to often be totally infected with one or three viruses whose role in causing garlic mosaic is not yet well understood.

Observations in Egypt

A number of lettuce crops visited in middle Egypt showed some to a rather high percentage of plants with characteristic symptoms of lettuce big vein, not reported in Egypt before. The virus is transmitted by the soil fungus *Olpidium brassicae*, which requires water (irrigation) for plant infection and for part of its spread.

Onion crops observed were free of onion yellow dwarf. A gladiolus crop grown from imported corms contained plants with leaf streaking, possibly caused by virus. From such crops bean yellow mosaic, cucumber mosaic and tobacco rattle viruses had been isolated at Giza (Gamel El-Din, personal communication).

Trifolium alexandrinum, intensivily grown on irrigated land as a fodder crop, did not show apparent symptoms of virus infection but the crops are usually short-lived.

At Giza a number of potted plants of lucerne (*Medicago sativa*) showed symptoms of vein enations and leaf curling characteristic of lucerne enation disease (as studied in France (Alliot and Signoret, 1972)) later associated with a rhabdovirus (Alliot *et al.*, 1972) and transmitted in a persistent way by *Aphis craccivora* (Leclant *et al.*, 1972). The disease has also been observed in Romania and Spain.

Tomato crops were commonly infected by leaf curl. At Cairo some ICARDA chickpea plants showed leaf reddening and yellowing suggesting bean leafroll virus infection.

DISCUSSION:

The time of my visit has been too short and the number of experiments and farmers'fields visited too limited to systematically report on the viruses that are of actual or potential importance to faba bean and other crops in Sudan and Egypt in general, and that should be taken into account in the Nile Valley *Vicia faba* project in particular.

Under conditions of winter cultivation, aphid-transmitted viruses do not yet seem to play an important role in Egypt, except in the delta where BYMV had already reached high incidence in some fields. The same holds for Sudan, where infection usually is late. The virus has been reported to be prevalent (up to 72%) in V. faba fields in East Germany (Schmidt and Rollwitz, 1978) and in Iran (Kaiser, 1973).

The prevalent occurrence of yellows in Sudan, most probably caused by (broad) bean leafroll virus (BLRV), is alarming. This is especially so in view of experiences obtained in a number of countries including Iran (Kaiser, 1972, 1973), and its reported usually symptomless occurence in clovers (notably lucerne, Medicago sativa).

Potentially, the yellows disease is of great importance to ICARDA in view of the institute's plans for Iran, its occurrence in Turkey and most probably in Syria as well, and in view of ICARDA's plans to stimulate fodder legume production. It was therefore unfortunate that Syria could not be visited for a more detailed discussion and that time was too early for observing crops there.

Aphid-transmitted yellows diseases caused by so called luteo-viruses have been postulated to be among the economically most wide-spread and most devastating virus diseases in many parts of the world ("The yellow plague"; Duffus, 1977). In agricultural practice, however, so far their true nature is usually being misunderstood. Beet western yellows virus may already occur in Sudan (see P_6). Banana bunchy plant virus, another luteovirus, is thought to be prevalent in Egypt (Tolba, personal communication). The actual cause of cotton leaf redden-ing, prevalent in Sudan and Egypt and now ascribed to mineral deficiency, might well be related to cotton anthocyanosis in South America, there known to be caused by virus (Costa, 1956). Its symptoms resemble those of magnesium deficiency, and, in fact, magnesium content is lower in diseased cotton leaves. It is only recently that such disorders are increasingly being associated with yellows viruses.

With further proposed changes in crop ecosystems in developing countries, the future introduction of new crops and germplasm, and the high incidence of virus transmission through seed, notably of legumes (Bos, 1977b), new virus problems are likely to pop up. To a great extent the chance of introduced viruses spreading will depend on local vector situations. In V. faba the rate of seed transmission of BYMV is known to be low, but new strains could easily be introduced from elsewhere with germplasm.

Other seed-borne viruses such as BBSV and BBTMV, that are beetle transmitted (Apion vorax and inefficiently by Sitona), have been found to be self-eliminating in crop perpetuation in the absence of the vector.

BBTMV has already been reported to occur in Egypt (Eid and Tolba,1979). The same holds for the polyphagous and virulent BBWV reported on pea in Egypt (Eid and Tolba, 1979), but this virus is not (yet) known to be seed transmitted.

In future, with ever changing farming systems, international exchange of germplasm and continuing interference with genetic make-up (possible introduction of genotypes sensitive to endemic viruses),the virus situation in ICARDA crops is likely to be dynamic. Care will have to be taken with imports and exchange of germplasm. Foolproof systems to prevent virus spread may be impossible, but certain risks will have to be accepted. ICARDA will need continuing virological support. Possibly breeding for resistance will be a continuing effort. However, the nature and extent of present and future virus problems at ICARDA require further definition.

First of all the yellows disease has to be properly diagnosed, and in case of virus etiology, possibly existing strains in the diverse regions be compared. The existence of strains is suggested by differences in symptoms between the disease in Egypt and Sudan. Further research on chemical vector control and on breeding for resistance is then required.

Further and more systemic surveys for viruses in V. faba and in crops that may harbour threatening viruses are also needed, together with proper crop loss assessment studies. The viruses have to be reliably identified and related to other problems in the diverse ICARDA region. These in turn must be related to those studied elsewhere to enable the utilization of data reported in the literature. Proper identification and routine tests are also essential for surveying work.

So far, facilities to do such work are meagre in both Sudan and Egypt. Simple insect-proof greenhouses/screenhouses to work under infection-proof conditions for simple biological tests (as with indicator plants and insect vectors) are highly inadequate or totally lacking, not to mention facilities for electron microscopy. To get such work off the ground national centralization seems essential (Bos, 1979a), as has already been more or less achieved for applied plant virus research in the Virus Research Centre of the Institute of Agricultural Research at Giza, Egypt. It is still embryonic and scattered in Sudan.

In the absence of sufficient national facilities, central work on viruses could be done at the central ICARDA institute or in virus laboratories in advanced countries. Such countries, however, are increasingly reluctant to accept alien viruses for research in view of risks of escape. It is felt that such risks could be reduced to almost nil with samples of virus containing plant material dried over $CaCl_2$ in the developing country and processed elsewhere by direct serology and electron microscopy, as recently described (Bos and Benetti, 1979).

Depending on further assessment of the importance and on developments and requirements, ICARDA could consider building up expertise and facilities of its own for virus work at Aleppo, like several other CGIAR institutes have already done. At any rate, it has to be aware of the problems involved, of where and how to solve them, and of how to coordinate the work, and it has to keep an eye on germplasm acquisition, propagation and distribution.

Stimulation and coordination of the V. faba virus work immediately required in Sudan and Egypt is essential. In Sudan there is little coordination in plant virus research, and even at Shambat (Agricultural Faculty) information on plant viruses (journals and books) is not up-to-date. Decisions will have to be made as to who is going to do what, and where. Facilities for virus work (in general) will have to be improved. Suggestions should be made as to which organization could provide financial support.

In Egypt, the Giza group has a reasonable background already. Further support of this group for greenhouse and laboratory facilities (among others, electron microscopy is not yet available to plant virus research in Egypt) is justified.

In most developing countries highly sophisticated air-conditioned glasshouses are too vulnerable and expensive. Frequent interruptions in electricity supply or any other breakdown of the cooling system can cause temperatures to jump quickly to plant and experiment suffocating levels. Ready-packaged "Rossel-screenhouses" with forced ventilation, as developed at IITA, Nigeria (Intern. Inst. Trop. Agric., 1979) have already proved inexpensive and are reliable tools for test-plant studies with viruses in the tropics. They can be easily assembled on site.

Rapid changes in agriculture in Sudan and Egypt will undoubtedly lead to a rapidly increasing need for plant virus research in general in these countries. Improvements to the infrastructure of research and facilities are overdue.

Developing countries mostly lack infrastructures to provide farmers with certified virus-free seed and farmers mostly lack knowledge to apply hygienic measures for virus control. In such situations breeding for resistance is the only or most efficient way of control. So far, however, in V. faba very little has been done on breeding for resistance to viruses. With BYMV varietal differences in susceptibility have been observed. In Egypt Eid and Tolba (1979) found 5 faba bean introductions to be resistant when tested with one strain of BYMV. In field trials at Giza I saw one new introduction and 4 Giza 3 and 4 selections with promising resistance to two strains of BYMV and one of BBWV (see P. 3).Kaiser (1972) did not find resistance in Iran to bean leafroll virus in 115 lines tested (see p. 4).

However, in the Netherlands some promising differences have been found. For such breeding work appropriate knowledge is essential (1) of the viruses and their natural variation in the area to be covered,(2) of which strain(s) can be representatively used for screening for resistance, and (3) of whether screening should be done under field conditions for proper symptom expression or in the laboratory or greenhouse for optimal chance of infection. One should also be aware of the fact that in resistant material new strains or viruses that hitherto were of no importance may come to the fore, so that even breeding may not be able to provide the final answer.

CONCLUSIONS AND RECOMMENDATIONS:

1. So far, mosaic diseases caused by the pea mosaic strain of bean yellow mosaic virus in Egypt and Sudan and by broad bean mottle virus in Sudan usually do not occur in alarming proportions and plant infection is often late. Incidence may already be high in the Nile delta and sometimes in Sudan. Future developments will depend on sources of infection (other crops, such as gladiolus, clovers, wild plants, and infected seed) and on vector populations.

2. In addition to the above viruses there are several others that are seed transmitted. Alfalfa mosaic virus and perhaps a necrotic strain of bean yellow mosaic virus have already been reported in Sudan, and broad bean true mosaic virus and broad bean wilt virus (on pea) in Egypt.

3. With increasing seed imports such as germplasm, and with national and international division of labor and/or specialization in seed production, more viruses could be introduced and existing ones be further spread. Their possible establishment and reaching epidemic proportions will depend on availability of natural (cultivated and wild) hosts and of vectors and their population densities.

4. Broad bean phyllody caused by leafhopper-borne mycoplasma is now claimed not to exceed 1 to 2% in Sudan, but it remains of potential importance since it has been reported to sometimes occur in up to 16% of all plants of one field, and infection renders plants totally sterile.

5. The high incidence in Sudan of a yellows disease of faba beans is alarming because of its prevalence, its obvious economic importance, and its generally being ascribed to mere premature senscence or mineral deficiency. It is most probably due to infection by the persistent aphid-transmitted (broad)bean leafroll virus (syn. pea leafroll virus), which is prevalent in many food and fodder legumes in various countries including Iran and Turkey. It might also be the cause of a severe leaf curl disease of *Phaseolus* beans. Overwintering is in various clovers including lucerne, in which infection may be symptomless at high temperature.

6. Further crop diversification and intensification (as of fodder legumes) by national institutes and by ICARDA will certainly effect crop ecology and thus incidence and spread of the above-mentioned viruses, and further introduction and establishment of new ones.

7. The total absence of golden yellow mosaics of legumes and many other plant species is remarkable since both in Sudan and Egypt whitefly (Bemisia tabaci)-transmitted leafcurl diseases of tomato and to a lesser extent of cotton are a national problem.

8. It is now advised to further, and more systematically, survey faba bean crops, and other crops and wild species, that may act as sources of infection, for viruses and to reliably identify them and their strains and to assess their economic importance (incidence X severity of symptoms on individual plants). Proper identification with greenhouse and laboratory techniques is essential for enabling the relating of problems concerned with those already reported in the literature. Virus diagnosis on the basis of symptoms in the field is highly unreliable.

9. Those viruses or those strains that are found to be of direct or potential economic importance,(such information is still largely lacking), have to be studied for their natural ecology so as to devise ways of control and to enable support of breeding for resistance. Screening for resistance may be inadequate or unreliable under natural conditions and may depend on artificial application of inoculum. Establishment of national collections of viruses and their strains will further this aim.

10. Since ICARDA for its Nile Valley project on Vicia faba greatly depends on national organizations, these will have to be further equipped for applied virus research. Such facilities will also be required in Sudan and Egypt for continuing virological support to the increasingly changing agriculture in general with the advent and increase of irrigation, crop diversification and other advanced technologies. Greenhouse/screenhouse facilities are inadequate in both countries, facilities for electron microscopy are totally lacking, and documentation (literature) is poor and lagging far behind. Some new virus diseases other than broad bean yellow, which were tentatively identified during my short stay are beet western yellows in lettuce and garlic mosaic in Sudan and lettuce big-vein and lucerne enation in Egypt.

11. At ICARDA, central expertise on viruses of Vicia faba and other crops is required for continuing evaluation of virus problems, for coordination of the work done in collaborating countries and for keeping an eye on germplasm transfer. ICARDA will have to be prepared for the dynamic and continuing nature of virus problems in its crops. Preparation of an illustrated bulletin on faba bean viruses may help ICARDA collaborators to identify their problems.

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Table 1. Tentative list of viruses reported from naturally infected faba bean (_Vicia faba_).

Name of virus	Main symptoms	Main other natural hosts	Type of virus	Transmission: insects or nematodes	Transmission: sap	Transmission: seed	Reported in broad bean: in Sudan	Reported in broad bean: in Egypt	Reported in broad bean: in other Middle East Countries
alfalfa mosaic virus	leaf and stem necrosis, sometimes recovery	many legumes and non-legumes	bacilliform multicomponent	several aphids, non-persistent	+	+	Nour & Nôur, 1962b	El-Attar et al., 1971, 1974	Israel: Nitzany and Cohen (1964)
bean leafroll virus (syn: pea leafroll virus)	(interveinal) chlorosis, leaf narrowing and rolling, upright growth and plant stunting	pea, chickpea, lentil, _Phaseolus_ bean, cowpea, soybean, clovers among others alfalfa (in this host mostly symptomless)	luteovirus (spherical)	certain aphids, persistent	-	-			Iran : Kaiser, 1972
cucumber mosaic virus	leaf and stem necrosis	many non-legumes legumes, sometimes attacked by special legume strains	cucumovirus (spherical)	several aphids, non-persistent	+	+			
bean yellow mosaic (virus strains)	mosaic esp. by pea mosaic str) necrosis (esp. by pea necrosis str)	several legumes	polyvirus (flexible 750 nm)	several aphids, non-persistent	+	+	Nour & Nour, 1962a	Eid & Tolba 1979	Nitzany & Cohen 1964, 1965.
broad bean mottle virus	mosaic		bromovirus spherical		+	+	Hussein, 1979		

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Table 1..... cont'd...

Name of virus	Main symptoms	Main other natural hosts	Type of virus	Transmission			Reported in broad bean		
				insects or nematodes	sap	seed	in Sudan	in Egypt	in other Middle East Countries
broad bean necrosis virus	leaf and stem necrosis, leaf flecking and recovery	sweet pea, pea and some others	tobra virus? rigid rods, two components	via soil	+				
broad bean stain virus	malforming mosaic, seed discoloration	some other legumes	comovirus spherical	Apion & Sitona spp.	+	+			
broad bean true mosaic virus	malforming mosaic, seed discoloration	some other legumes	comovirus spherical	Apion & Sitona spp.	+	+		Eid & Tolba, 1979	
broad bean wilt virus	necrosis terminal leaves, wilting, often plant death, sometimes partial recovery	very wide host range	spherical	several aphids, non-persistent	+	-		Eid & Tolba, 1979	
pea early-browning virus	symptomless	wide host range including several weeds	tobravirus, rigid rods, two components	via soil; nematodes	+	+ (not observed in *V. faba*)			
pea enation mosaic virus	translucent leaf flecks with enations	pea and some other legumes	spherical	aphids; persistent	+	-			
pea seed-borne mosaic virus	leaf narrowing and rolling, plant stunting	pea, lentil and some other legumes	polyvirus flexible 750mm	aphids: non-persistent	+	+			
Vicia cryptic vir.	symptomless		spherical		-	+			

Appendix 1

PROGRAMME:

Feb. 16	: Departure from The Netherlands to Sudan
Feb.17 & 18	: Visits to Department of Crop Protection, Faculty of Agriculture, Khartoum University, Shambat, Khartoum North (discussions with Dr. Ahmed Hashim, lecturer, and Mrs. Jane Nour, instructor plant pathology).
Feb. 19	: Travel by train to Hudeiba
Feb. 20 & 21	: Visits to Hudeiba Agricultural Research Station (discussions with Prof. Ibrahim Ahmed Babiker, director, Prof. Farouk Ahmed Salih, plant breeder, Dr. Mustafa Mohamed Hussein and Dr. Sami Osman Freigoun, plant pathologists) and to farmers' fields along Nile and in Zeidab Scheme (accompanied by Prof. Mahmood Ahmed, coordinator plant pathology, Agricultural Research Corporation).
Feb. 21/22	: Travel by train Hudeiba - Khartoum
Feb. 23	: Travel by car to Wad Medani; visit to Gezirah Research Station, Wad Medani (Dept. of Botany & Plant Pathology) (discussions with Prof. Abdel Mageed Yassin, nematologist/virologist and Prof. Mahmoud Ahmed, mycologist).
Feb. 24	: Return by car to Khartoum; further visit to Dept. Crop Protection, Faculty of Agriculture, Shambat.
Feb. 25	: Travel Khartoum - Cairo, Egypt.
Feb. 26	: Visit ICARDA office, Cairo (Dr. Bhardwaj); visits to Institute Agricultural Research, Ministry of Agriculture, Giza (discussions and visits to field experiments with Dr. Ali Abdel Aziz and Mr. Abdullah M. Nassib, of the section Food Legumes. Dept. Agronomy and Plant Breeding; leaders of the Egyptian part of the ICARDA/IFAD Nile Valley Project on Vicia faba, Dr. M.A. Tolba and co-workers and Dr. Nour El-Din, former head, Virus Research Centre of Plant Pathology Institute).

Feb. 27	:	Visit to Nubaria Research Station, experimental and farmers'fields in irrigation scheme and Nile delta (accompanied by Mr. Nassib, Dr. Gamel El-Din, virologist Giza, and another plant breeder).
Feb. 28	:	Visit to Agricultural Research Station Seds and to Menia for ICARDA on-farm trials (accompanied by Mr. Nassib, Dr. Tolba and an agronomist).
Feb. 29	:	Day off; discussion with Dr. M.A. Nour, deputy director ICARDA.
March 1	:	Short visits to Faculty of Agriculture, Giza, Virus Research Centre, Giza, Vegetable Research Station, Dokki; travel Cairo - Beirut , Lebanon
March 2 & 3	:	Vain endeavours (heavy snowfall) to pass mountain roads on the way to ICARDA Research Centre, Aleppo, Syria.
March 4	:	Premature return to The Netherlands.