

Survey for legume and cereal viruses in Iraq

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Summary. A survey was conducted in April 2000 to identify virus diseases affecting legume (chickpea, faba bean and lentil) and cereal (wheat and barley) crops at different locations in Iraq (Baghdad, Al-Anbar, Diyala, At-Tamim and Ninawa governorates). The survey covered 54 randomly selected legume fields (36 faba bean, 8 chickpea, and 10 lentil) and 23 cereal fields (18 wheat and 5 barley). All viruses were identified and their incidence determined by laboratory testing 100–200 randomly collected samples and 20–25 symptomatic samples from each field. A total of 7663 legume and 3455 cereal samples was collected and tested for 12 legume and 5 cereal viruses by tissue blot immunoassay (TBIA). In faba bean fields, *Bean yellow mosaic virus* (BYMV, genus *Potyvirus*, family *Potyviridae*) was the most common, followed by *Bean leaf roll virus* (BLRV, family *Luteoviridae*). In the 18 most extensively infected faba bean fields (more than 50%), total virus incidence ranged from 80 to 100%, and BYMV was by far the most common. Other viruses that were detected in legumes at low incidence were: *Alfalfa mosaic virus* (AIMV, genus *Alfavirus*, family *Bromoviridae*), *Faba bean necrotic yellows virus* (FBNYV, genus *Nanovirus*), *Cucumber mosaic virus* (CMV, genus *Cucumovirus*, family *Bromoviridae*), *Broad bean wilt virus* (BBWV, genus *Fabavirus*, family *Comoviridae*), *Beet western yellows virus* (BWYV, genus *Polerovirus*, family *Luteoviridae*) and Chickpea chlorotic dwarf virus (CpCDV, genus *Mastervirus*, family *Geminiviridae*). This is the first report of FBNYV, BWYV and CpCDV infecting legumes in Iraq. In the cereal fields, *Barley yellow dwarf virus-PAV* (BYDV-PAV, genus *Luteovirus*, family *Luteoviridae*) was detected in about 1% of random samples. Virus disease incidence in all cereal fields based on field observations was less than 5%. Other viruses were rarely detected in cereals: BYDV-MAV (genus *Luteovirus*, family *Luteoviridae*) and *Cereal yellow dwarf virus-RPV* (CYDV-RPV, genus *Polerovirus*, family *Luteoviridae*).

Key words: Iraq, cereals, legumes, viruses, *Bean yellow mosaic virus*, *Faba bean necrotic yellows virus*, *Chickpea chlorotic dwarf virus*, *Beet western yellows virus*, *Barley yellow dwarf virus*.

Introduction

Cereals and legumes are important and widely cultivated crops in West Asia and North Africa (WANA) where they provide good sources of protein and calories for a large portion of the population. In Iraq, the total area under cereal cultiva-

tion in the 1999–2000 cropping season was around 1,400,000 ha for wheat (*Triticum aestivum* L.) and 1,200,000 ha for barley (*Hordeum vulgare* L.). In food legumes, about 29,000 ha of faba bean (*Vicia faba* L.), 12,500 ha of chickpea (*Cicer arietinum* L.) and a modest 450 ha of lentil (*Lens culinaris* Medik.) were planted (FAO, 2000). However, yield in Iraq is generally low, and pests are a major production constraint.

Numerous viruses are known to infect legume crops worldwide, some causing serious economic losses, and 15 of these are also reported from WANA

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(Makkouk *et al.*, 1988a, 1997; Katul *et al.*, 1993; Makkouk, 1994; Horn *et al.*, 1995; Najar *et al.*, 2000). Many viruses in legumes are known to be seed-borne, such as *Pea seed-borne mosaic virus* (PSbMV, genus *Potyvirus*, family *Potyviridae*) (Hampton and Muehlbauer, 1977; Makkouk *et al.*, 1993), *Bean yellow mosaic virus* (BYMV, genus *Potyvirus*, family *Potyviridae*) (Bos *et al.*, 1970; Kumari *et al.*, 1994), *Broad bean mottle virus* (BBMV, genus *Bromovirus*, family *Bromoviridae*) (Makkouk *et al.*, 1988b; Fortass and Bos, 1992), *Broad bean stain virus* (BBSV, genus *Comovirus*, family *Comoviridae*) (Makkouk and Azzam, 1986; Makkouk *et al.*, 1987), *Broad bean wilt virus* (BBWV, genus *Fabavirus*, family *Comoviridae*) (Makkouk *et al.*, 1990b), *Alfalfa mosaic virus* (AIMV, genus *Alfavirus*, family *Bromoviridae*) and *Cucumber mosaic virus* (CMV, genus *Cucumovirus*, family *Bromoviridae*) (Jones and Coutts, 1996).

AIMV, CMV, BYMV, BBWV and PSbMV are vectored by various aphid species in a non-persistent manner (Bos *et al.*, 1988), whereas BBSV and BBMV are transmitted by beetle species, such as *Apion* spp. and *Sitona* spp. (Cockbain *et al.*, 1975; Fischer and Lockhart, 1976; Makkouk and Kumari, 1989, 1995). Other viruses that infect legume crops in many countries of WANA but are not seed-borne are: *Faba bean necrotic yellows virus* (FBNYV, genus *Nanovirus*), Chickpea chlorotic dwarf virus (CpCDV, genus *Mastervirus*, family *Geminiviridae*) and three luteoviruses: *Bean leafroll virus* (BLRV, family *Luteoviridae*), *Beet western yellows virus* (BWYV, genus *Polerovirus*, family *Luteoviridae*) and *Soybean dwarf virus* (SbDV, family *Luteoviridae*) (Horn *et al.*, 1993, 1995; Katul *et al.*, 1993; Makkouk *et al.*, 1995, 1997; Najar *et al.*, 2000). The luteoviruses and FBNYV are transmitted by aphids in the persistent manner and CpCDV is transmitted by leafhoppers.

Many viruses affect cereal crops in the world, of which only a few have been reported from WANA (Nienhaus and Saad, 1967; El-Yamani and Hill, 1990; Makkouk *et al.*, 1990a; Makkouk and Kumari, 1997; Najar *et al.*, 2000). *Barley yellow dwarf virus-PAV* (BYDV-PAV, genus *Luteovirus*, family *Luteoviridae*) is the most common in WANA where it has a high incidence of occurrence in some countries, but no information is available on viruses affecting cereals in Iraq.

In Iraq, a great variety of virus-like symptoms

have been observed on legumes (particularly faba bean), but only a few viruses on legumes have been identified: BYMV, BBMV, BLRV and PSbMV (Ismael, 1983; Al-Ani and El-Azzawi, 1987; Kassim, 1997). However, some of these viruses were only identified by their characteristic symptoms, or by the reaction of indicator plants, using small numbers of samples and collected from few locations. Thus, information on viruses in legume and cereal crops is limited and no meaningful conclusions can yet be drawn about the impact on production. The purpose of this survey was to identify virus diseases of legume and cereal crops in the major production areas in Iraq, and to determine their incidence and importance.

Materials and methods

Field visits and sample collection

A total of 54 legume and 23 cereal fields were randomly selected on the basis of predetermined distance criteria. The fields were in the following Governorates: (1) Baghdad (Baghdad, Abu-Ghreib, Yousfiya, El-Rashdiya, El-Tarmiya), (2) Al-Anbar (Amriya, Saklawiya, Faluja, Khaldiya), (3) Diyala (Baqubah, Al-Khalis), (4) At-Tamim (Kirkuk, Huweija, Abbasi), and (5) Ninawa (Mosul, Hamam El-Alil, Namrod, Ayn Sifni, Tal Askof, Al-Qosh, Fida, El-Walid, Rabiaa, Tal Afar). The location of the fields is shown in Fig. 1. Virus disease incidence in each field was determined on the basis of visual inspection and by counting the percentage of infected plants at randomly selected locations in the field. From each field, two types of samples were collected: 20–25 samples from symptomatic plants and 100–200 randomly collected samples. The samples were placed in labelled plastic bags and taken to the Virology Laboratory of IPA in Baghdad or Mosul for testing.

A total of 844 legume samples (618 faba bean, 107 chickpea and 119 lentil) with symptoms suggestive of virus infection, and 6819 randomly selected legume samples (3863 faba bean, 1256 chickpea and 1700 lentil) from 36 faba bean, 8 chickpea and 10 lentil fields were collected. Similarly, 362 cereal samples (55 barley and 307 wheat) with symptoms suggestive of virus infection, and 3093 randomly selected cereal samples (642 barley and 2451 wheat) from 5 barley and 18 wheat fields were collected.

Laboratory tests

Legume crops

All legume samples were tested against a battery of polyclonal and monoclonal antibodies. Rabbit polyclonal antiserum for CpCDV was provided by D.V.R. Reddy, ICRISAT, India; polyclonal antisera for AIMV, BYMV, BBMV, BBSV, BBWV, CMV, PSbMV, *Broad bean true mosaic virus* (BBT-MV, genus *Comovirus*, family *Comoviridae*) and

Pea enation mosaic virus (PEMV, genus *Enamovirus*, family *Luteoviridae*) by the Virology Laboratory of ICARDA, Aleppo, Syria. In addition, two monoclonal antibodies for the detection of FBNYV and broad-spectrum legume luteoviruses (5G4) were provided by A. Franz and L. Katul, Federal Biological Research Centre for Agriculture and Forestry, Braunschweig, Germany.

To identify individual luteoviruses affecting leg-



Figure 1. Map of Iraq showing the location of the legume (x) and cereal (o) fields surveyed in April 17–28, 2000.

ume crops in Iraq, those samples that reacted positively to the broad-spectrum monoclonal 5G4 were further tested against six specific monoclonals: BWYV (ATCC PVAS-647), SbDV (ATCC PVAS-650), *Potato leaf roll virus* (PLRV, family *Luteoviridae*) (ATCC PVAS-649), BLRV (4B10), and two monoclonals (6F9 and 3B11) which react with both BLRV and SbDV (Katul, 1992).

Cereal crops

For the detection of viruses in cereals, five rabbit polyclonal antisera were used: *Barley yellow stripe mosaic virus* (BYSMV, genus *Cytorhabdovirus*, family *Rhabdoviridae*) provided by E. Luisoni, Istituto di Fitoviologia applicata, Torino, Italy; *Wheat dwarf virus* (WDV, family *Geminiviridae*) by J. Vacke, Research Institute of Crop Production, Prague, Czech Republic; *Barley yellow dwarf virus-PAV* (BYDV-PAV, genus *Luteovirus*, family *Luteoviridae*), *Barley stripe mosaic virus* (BSMV, genus *Hordeivirus*) and *Wheat streak mosaic virus* (WSMV, genus *Tritimovirus*, family *Potyviridae*) by the Virology Laboratory of ICARDA, Aleppo, Syria. Those samples that reacted positively to BYDV-PAV polyclonal antiserum were further tested against two specific monoclonal antibodies, BYDV-MAV (genus *Luteovirus*, family *Luteoviridae*) (ATCC PVAS-673) and *Cereal yellow dwarf virus-RPV* (CYDV-RPV, genus *Polerovirus*, family *Luteoviridae*) (ATCC PVAS-669).

Both legume and cereal samples were tested

for the presence of viruses using the tissue blot immunoassay (TBIA) (Makkouk and Comeau, 1994) at the Virology Laboratory of IPA in Baghdad or Mosul, Iraq.

Results

Virus incidence by visual inspection of symptomatic samples

Legume crops

The virus symptoms most commonly observed in faba bean fields were mottling, mosaic, chlorosis, stunting, and yellowing. Virus incidence based on field inspection is summarized in Table 1. About 55% of legume fields (30 fields) had a virus incidence of 5% or less, 37% an incidence of 6–20% and four faba bean fields an incidence of more than 20%.

Cereal crops

The symptoms observed in the barley and wheat fields were stripping and yellowing of the leaves. In general, the virus incidence in cereals was less than that in the legumes (Table 1). On the basis of visual inspection, most cereal fields (83%) had a virus incidence of less than 1%.

Virus identification and incidence from laboratory testing

Legumes

When 3863 randomly collected faba bean samples were tested for viruses in the laboratory,

Table 1. Virus incidence in legume and cereal crops as determined from symptomatic samples in the field and from laboratory testing of randomly collected samples, during a survey conducted in Iraq, April 18–27, 2000.

| Crop | No. of fields surveyed | Number of fields with virus incidence (%) of | | | | | | | | | |
|--------------------------|------------------------|--|----------------|-----|---|------|---|-------|---|-----|----|
| | | <1 | | 1–5 | | 6–20 | | 21–50 | | >50 | |
| | | S ^a | L ^a | S | L | S | L | S | L | S | L |
| Faba bean | 36 | 3 | 1 | 9 | 2 | 20 | 2 | 4 | 7 | 0 | 24 |
| Lentil | 10 | 10 | 8 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| Chickpea | 8 | 7 | 7 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| <u>Legumes Sub-total</u> | 54 | 20 | 16 | 10 | 4 | 20 | 3 | 4 | 7 | 0 | 24 |
| Barley | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Wheat | 18 | 14 | 12 | 4 | 4 | 0 | 2 | 0 | 0 | 0 | 0 |
| <u>Cereals Sub-total</u> | 23 | 19 | 17 | 4 | 4 | 0 | 2 | 0 | 0 | 0 | 0 |
| <u>Grand total</u> | 77 | 39 | 33 | 14 | 8 | 20 | 5 | 4 | 7 | 0 | 24 |

^aS, based on symptomatic samples; L, based on laboratory testing of randomly collected samples.

BYMV was the most common with an overall incidence of 63.1%, followed in descending order by the luteoviruses (3.4%), CMV (0.2%), AIMV (0.16%) and FBNYV (0.13%) (Table 2). The incidence of BBWV and CpCDV was extremely low (less than 0.1%). In the 618 symptomatic samples from faba bean fields BYMV was also the most common, followed by the luteoviruses and CpCDV, while FBNYV and BBWV were detected in only 2 samples each (Table 2). In 31 of the 36 faba bean fields surveyed, the virus incidence of randomly collected samples was 21% or more, while in 24 fields it was more than 50% (Table 1). The infection of all randomly

collected faba bean samples was about 65% (Table 2).

In lentil fields, virus incidence in randomly collected samples was low (2.18%) (Table 2), and BYMV was again the most common followed by the luteoviruses. FBNYV was detected only in two lentil plants out of the total of 1819 samples tested (including 119 with virus-like symptoms), whereas in chickpea CpCDV was detected in 12 and luteoviruses in 3 out of 1363 samples tested (including both randomly collected and symptomatic samples) (Table 2).

When 182 samples (168 faba bean, 11 lentil, and

Table 2. Laboratory tests on legume samples randomly collected and samples with symptoms suggestive of virus infection from 54 fields in Iraq during April 18–27, 2000. Viral identification was based on serological reactions (tissue blot immunoassay).

| Crop/ Governorate | Sample collection method | No. of fields surveyed | No. of samples tested | Number of samples found positive to ^a | | | | | | | No. of samples negative to all antisera used | Total incidence (%) ^b |
|----------------------|--------------------------------|------------------------------|-----------------------------|--|----------------|-------|------|------|------|-----|---|--|
| | | | | FBNYV | 5G4 Luteov. | CpCDV | BBWV | BYMV | AIMV | CMV | | |
| Faba bean | | | | | | | | | | | | |
| Baghdad | Random | 10 | 952 | 0 | 3 | 0 | 0 | 886 | 2 | 0 | 66 | 93.1 |
| | Symptoms | 10 | 202 | 0 | 5 | 0 | 0 | 296 | 0 | 0 | 6 | |
| El-Anbar | Random | 9 | 960 | 0 | 17 | 0 | 1 | 715 | 4 | 8 | 226 | 76.5 |
| | Symptoms | 9 | 140 | 0 | 4 | 4 | 2 | 133 | 0 | 0 | 5 | |
| Diyala | Random | 3 | 344 | 0 | 3 | 0 | 0 | 140 | 0 | 0 | 201 | 41.6 |
| | Symptoms | 3 | 41 | 0 | 0 | 0 | 0 | 36 | 0 | 0 | 5 | |
| At-Tamim | Random | 5 | 672 | 0 | 1 | 0 | 0 | 376 | 0 | 0 | 295 | 56.1 |
| | Symptoms | 5 | 77 | 0 | 0 | 0 | 0 | 65 | 0 | 0 | 12 | |
| Ninawa | Random | 9 | 935 | 5 | 108 | 1 | 1 | 320 | 0 | 0 | 573 | 38.7 |
| | Symptoms | 9 | 158 | 2 | 27 | 3 | 0 | 82 | 0 | 0 | 73 | |
| Sub-total | Random | 36 | 3863 | 5 | 132 | 1 | 2 | 2437 | 6 | 8 | 1361 | 64.8 |
| | Symptoms | 36 | 618 | 2 | 36 | 7 | 2 | 612 | 0 | 0 | 101 | |
| Chickpea | | | | | | | | | | | | |
| Ninawa | Random | 8 | 1256 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1254 | 0.2 |
| | Symptoms | 8 | 107 | 0 | 2 | 11 | 0 | 0 | 0 | 0 | 94 | |
| Lentil | | | | | | | | | | | | |
| Ninawa | Random | 10 | 1700 | 2 | 4 | 0 | 0 | 31 | 0 | 0 | 1663 | 2.2 |
| | Symptoms | 10 | 119 | 0 | 7 | 0 | 0 | 3 | 0 | 0 | 109 | |

^a All samples were negative to BBMV, BBSV, PEMV, PSbMV and BBTMV.

Virus acronyms used are: FBNYV= *Faba bean necrotic yellows virus*; CpCDV= *Chickpea chlorotic dwarf virus*; BYMV= *Bean yellow mosaic virus*; BBMV= *Broad bean mottle virus*; PEMV= *Pea enation mosaic virus*; BBTMV= *Broad bean true mosaic virus*; BBSV= *Broad bean stain virus*; PSbMV= *Pea seed-borne mosaic virus*; BBWV= *Broad bean wilt virus*; CMV= *Cucumber mosaic virus*; AIMV= *Alfalfa mosaic virus*; 5G4= broad spectrum monoclonal reacting with all legume luteoviruses.

^b Total incidence was calculated only on randomly collected samples.

3 chickpea) that gave a positive reaction with the broad-spectrum legume luteovirus monoclonal antibody (5G4) were tested with specific monoclonals, two luteoviruses, BWYV and BLRV, were identified (Table 3).

Cereals

Laboratory testing of the 3093 randomly collected samples (642 barley and 2451 wheat) detected BYDV in one barley and 30 wheat samples. Symptomatic cereal samples (Table 4) showed more or less similar patterns of viral infection and incidence. BSMV, BYSMV, WSMV and WDV were not detected in cereals in Iraq. Only two wheat fields had a virus incidence in the 6–20% category as determined by testing randomly collected samples (Table 1).

When 55 samples (2 barley and 53 wheat) that gave a positive reaction to the BYDV-PAV polyclonal antiserum were tested against two specific monoclonal antibodies, BYDV-MAV and CYDV-RPV, six wheat samples were positive to BYDV-MAV, and five to CYDV-RPV.

Discussion

Both field inspection and the laboratory tests indicated that the major virus problem on faba bean in Iraq was BYMV, because of its high incidence and the potential yield loss it caused. In previous studies, experimental crop yield losses induced by this virus ranged from 40 to 80% at 100% incidence in faba bean, and from 34 to 96% in lentil (Makkouk *et al.*, 1988a; Kumari *et al.*, 1994). However, the yield loss caused by this virus is worth closer

scrutiny since BYMV is seed-borne in faba bean and lentil (Bos *et al.*, 1988; Makkouk *et al.*, 1988a; Kumari *et al.*, 1994; Jones and Coutts, 1996) and is transmitted by aphids (Bos, 1970). *Aphis craccivora* and *Aphis fabae*, the known aphid vectors of this virus (Skaf and Makkouk, 1988), were detected in large numbers in some of the faba bean fields, especially those in the Diyala and Ninawa Governorates. However, aphid activity observed was low in many fields. The fact that some fields had a very high incidence of mosaic, mostly caused by the aphid-transmitted BYMV, suggests that the activity of winged aphids had been high at some earlier time. It should be mentioned here that the BYMV transmission rate through faba bean and lentil seeds is low (1% or less) (Makkouk *et al.*, 1988b; Kumari *et al.*, 1994; Jones and Coutts, 1996), so that having a number of aphid foci inside the fields early in the growing season will facilitate virus spread by the aphids. In addition, the virus is endemic in wild vegetation (Bos, 1970), from where aphid vectors can introduce it to the faba bean crop. The high incidence of BYMV in the fields surveyed suggests that farmers most likely sow already infected faba bean seeds. Accordingly, ensuring healthy seeds should become an important element in the production package of faba bean for Iraq.

BLRV was reported earlier on chickpea from Iraq (Kassim, 1997), but identification was based on reaction to a rabbit polyclonal antiserum, which is known to have wide cross-reactivity to different luteoviruses (Waterhouse *et al.*, 1988). In the present study, the identification of BLRV was based on its reaction with the specific monoclonal anti-

Table 3. Reaction with specific monoclonal antibodies of legume samples infected with luteoviruses collected in Iraq during April 18–27, 2000.

| Crop | No. of samples tested | Monoclonal antibodies | | | | |
|-----------|-----------------------|-----------------------|-------------|-----------------|-----------------|-----------------|
| | | 5G4 (broad-spectrum) | 4B10 (BLRV) | ATCC 650 (SbDV) | ATCC 647 (BWYV) | ATCC 649 (PLRV) |
| Faba bean | 11 | + | - | - | - | - |
| Faba bean | 3 | + | - | - | + | - |
| Faba bean | 22 | + | + | - | - | - |
| Faba bean | 132 | + | - | + | + | + |
| Lentil | 11 | + | + | - | - | - |
| Chickpea | 3 | + | - | + | + | + |

Table 4. Laboratory tests on cereal samples randomly collected and samples with symptoms suggestive of virus infection from 23 fields in Iraq during April 18–27, 2000. Identification was based on serological reactions (tissue blot immunoassay).

| Crop/ Governorate | Sample collection method | No. of fields surveyed | No. of samples tested | Number of samples found positive to BYDV-PAV ^a | Average incidence (%) ^b |
|-------------------------|--------------------------------|---------------------------|--------------------------|--|---------------------------------------|
| Barley | | | | | |
| Diyala | Random | 1 | 110 | 0 | 0.00 |
| | Symptoms | 1 | 15 | 0 | |
| Ninawa | Random | 4 | 532 | 1 | 0.19 |
| | Symptoms | 4 | 40 | 1 | |
| Barley Sub-total | | | | | |
| | Random | 5 | 642 | 1 | 0.16 |
| | Symptoms | 5 | 55 | 1 | |
| Wheat | | | | | |
| Baghdad | Random | 4 | 456 | 25 | 5.48 |
| | Symptoms | 4 | 100 | 20 | |
| Al-Anbar | Random | 1 | 92 | 2 | 2.20 |
| | Symptoms | 1 | 16 | 0 | |
| Diyala | Random | 1 | 175 | 0 | 0.00 |
| | Symptoms | 1 | 20 | 0 | |
| Ninawa | Random | 12 | 1728 | 3 | 0.17 |
| | Symptoms | 12 | 171 | 3 | |
| Wheat Sub-total | | | | | |
| | Random | 18 | 2451 | 30 | 1.20 |
| | Symptoms | 18 | 307 | 23 | |
| Grand Total | | | | | |
| | Random | 23 | 3093 | 31 | 1.00 |
| | Symptoms | 23 | 362 | 24 | |

^a All samples were negative to WSMV, BSMV, WDV and BYSMV.

Virus acronyms used are: BYDV-PAV= *Barley yellow dwarf virus-PAV*; BSMV= *Barley stripe mosaic virus*; WSMV= *Wheat streak mosaic virus*; WDV= *Wheat dwarf virus*; BYSMV= *Barley yellow striate mosaic virus*.

^b Total incidence was calculated only on randomly collected samples.

body so that its occurrence was established beyond doubt. Other luteoviruses were also found to affect legumes in Iraq, such as BWYV; however, when 182 samples that gave a positive reaction with the broad-spectrum legume luteovirus monoclonal antibody 5G4 were tested with specific monoclonals, 135 samples (132 faba bean and 3 chickpea) gave a positive reaction with three specific monoclonals for SbDV, BWYV and PLRV, suggesting that the luteoviruses in Iraq are slightly different from those reported in other countries (Makkouk *et al.*, 1997, 1998b; Najjar *et al.*, 2000) (Table 3). More work in Iraq is needed to identify these viruses/isolates.

About 10% of symptomatic chickpea and 1% of symptomatic faba bean samples tested positive to CpCDV (Table 2). Chickpea and faba bean are known to be susceptible to this virus, which is transmitted by leafhoppers (Horn *et al.*, 1993). The natural occurrence of CpCDV on chickpea and faba bean has been recorded recently in Pakistan, Sudan, Turkey and Yemen (Makkouk *et al.*, 1995, 1998a, 1998b; Kumari *et al.*, 1997), but this is the first report of CpCDV on chickpea and faba bean in Iraq.

FBNYV is reported to infect food legumes in many countries of WANA (Katul *et al.*, 1993; Horn *et al.*, 1995; Makkouk *et al.*, 1998b; Najjar *et al.*,

2000). Even though this virus reaches epidemic proportions in some countries such as Egypt (Makkouk *et al.*, 1994), its incidence in Iraq as revealed by this study was very low. However, samples for the survey were collected in early April, and the virus incidence levels reported here could well increase towards the end of the growing season if environmental conditions were right. Because of the damage this virus can cause, it should be monitored more closely.

BBSV, BBMV and BBTMV were not detected in any of the legume samples. This is no surprise, as they are vectored by beetles (Cockbain *et al.*, 1975; Fischer and Lockhart, 1976; Makkouk and Kumari, 1989, 1995), and there was no sign of beetles feeding in any of the faba bean fields. The situation should however be monitored closely since these viruses, and especially BBSV, is common in lentil and faba bean fields in many WANA countries (Makkouk *et al.*, 1987; Kumari *et al.*, 1993; Bayaa *et al.*, 1998).

It is interesting to note that in chickpea and lentil fields, the virus incidence determined by visual inspection was very similar to that obtained from the randomly collected samples. By contrast, in faba bean fields visual inspection grossly underestimated virus incidence. For example, only four faba bean fields were put in the higher than 21% incidence category by visual observation, whereas 31 fields were so placed by the randomly collected samples.

Unlike what was found for chickpea and lentil, about 86% of the faba bean fields had a virus incidence of 21% or higher, and in 67% of the fields it was more than 50%. Faba bean fields thus suffer from virus infection far more than chickpea and lentil fields, with an average incidence of about 65%, ranging from 0 to 100%. The randomly collected faba bean samples suggested that around 15% of faba bean fields had a virus incidence of 6% or less. Most likely such fields will not suffer significant yield losses from viral infections. Nevertheless, in 86% of fields virus incidence was in the range of 21–100%, suggesting that in some parts of Iraq virus diseases are causing significant economic losses. Based on a total annual production of 46,000 ton of faba bean grain (6,000 ton dry and 40,000 ton green) (FAO, 2000), the annual economic loss due to BYMV is estimated at US\$ 1.5 million. This is a cause for concern for faba bean produc-

tion and one that requires corrective action.

In general, the virus incidence in cereals in the 1999–2000 growing season was low. However, this growing season was also relatively dry, so that the influence of factors that depress vector population, and consequently the chance of virus spread was reduced. In fact, aphid population were found to be low during this period. Accordingly, it is recommended that this survey should be continued for the next 2–3 years, to give a better picture of the true importance of virus infection of cereal crops in Iraq.

BYDV is reported to infect cereals in many countries of WANA (El-Yamani and Hill, 1990; Makkouk *et al.*, 1990a; Najar *et al.*, 2000), and it is the most common cereal virus, but so far no information was available on this virus in Iraq. In this survey, 1.6% of the cereal samples tested (both randomly collected and symptomatic samples) were positive to BYDV-PAV polyclonal antiserum. When using monoclonal antibodies, 0.17% cereal samples were positive to BYDV-MAV and 0.14% positive to CYDV-RPV. This is the first report of BYDV-MAV and CYDV-RPV in Iraq.

The survey indicated for the first time that in Iraq faba bean is infected with CMV, AIMV, CpCDV, FBNYV, BLRV and BWYV; lentil is infected with BLRV and chickpea is infected with CpCDV. A short note reporting these findings was recently published (Makkouk *et al.*, 2001).

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