Management of persistently aphid-transmitted faba bean viruses in Tunisia

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SUMMARY

Faba bean is the most important cool season legume crops grown in Tunisia. Productivity is affected by several biotic factors including viruses. Most plant viruses are transmitted by several aphid species and therefore vector management is one of the main options for controlling them. On-farm experiments were conducted at Menzel Bourguiba and Mornag INRAT Station during the 2023/2024 growing season to manage faba bean viruses and their aphid vectors. Two faba bean varieties (Najeh and Chourouk), two planting dates, and seed treatment with two doses of Cruiser® (Thiamethoxam) (1.00 and 1.2 cc/kg) compared to untreated seeds (control) were used as treatments. The results showed that no virus infection was detected in plots with the 1st planting date and plots treated with Cruiser on the 2nd planting date at both sites, whereas viruses were detected at low rate (0.4-0.7%) in untreated plots only on the 2nd planting date. Both faba bean varieties (Chourouk and Najeh) produced significantly higher yields than the untreated control for both doses of Cruiser. Low rainfall and high temperature during the 2023/2024 growing season at both sites negatively affected aphid activity and hence virus infection, but the results obtained indicated that the virus and aphid vector management could be achieved by adjusting the planting date of faba bean crops and seed treatment with Cruiser.

BACKGROUND

Faba bean (*Vicia faba* L.) is the most cultivated legume in Tunisia, with an area of 54,700 ha, representing 72% of the total food legumes planted in the country (FAOSTAT, 2021). Faba bean is cultivated for its high protein content in human diets, as well as for animal forage, and plays a major role in the sustainability of Tunisian agriculture. In fact, to encourage farmers to introduce faba bean into the cropping system, the Tunisian Ministry of Agriculture has allocated a budget to purchase 150,000 tons of faba bean from farmers in order to promote local faba bean and increase the cultivated area up to two-fold (Khamassi *et al.,* 2021). Faba bean is susceptible to nearly 50 viruses worldwide (Kumari and Makkouk, 2007; Makkouk *et al.,* 2003, 2012). In Tunisia, 7 viruses transmitted by aphids have been reported to infect the faba bean crop, five of which are transmitted persistently and two non-persistently by aphids (Najar *et al*., 2000; 2003; 2011).

Faba bean viruses cause significant reduction in crop yield depending on the type of virus, stage of growth at time of infection. Control measures aim either to reduce the virus source or to prevent the spread of the virus within the legume crop, usually via a vector. It is therefore necessary to develop a better management strategy for controlling aphids in faba bean. Chemical control has been the main tool for controlling aphids, and the application of insecticide seed treatments reduces the spread of some legume viruses transmitted by vectors (Makkouk and Kumari, 2001). They also provide protection for some time after seedling emergence. However, little is known about the effect of Thiamethoxam in reducing the spread of viruses in legume crops through aphid control. Integrated pest management (IPM) is the management of resources under sound ecological principles, to ensure plant health. This discipline promotes the judicious and integrated use of tactics that include mechanical, biological, cultural, and chemical options for pest management and pest resistance (Makkouk and Kumari, 2009; Makkouk *et al*., 2014).

The present study focused on reducing the spread of persistently aphids-transmitted viruses by using Thiamethoxam insecticide (Cruiser®) applied as a seed dressing using two Tunisian faba bean varieties at two locations and planted at two different dates.

METHODOLOGY

Field experiments were carried out during the 2023/2024 growing season in two locations in Tunisia under different climate conditions: one trial in a farmer's field in Menzel Bourguiba (semi-humid) and the other in Mornag INRAT station (semi-arid), using the following options:

- Two small seeded faba bean varieties (Najeh and Chourouk) were used.
- Seeds were treated with the insecticide Cruiser® (Thiamethoxam) at two doses (1.00 and 1.20 cc/kg) compared with untreated seeds (control).
- Experiments were designed using a split-plot design with three replicates, each plot measuring 40x36 m (1440 m²), with subplots of 5x3 m (15 m²). Each replicate plot consisted of six rows (5 m long), spaced 50 cm apart, with a plant density of 375 seeds per subplot (25 seeds/m²) (Figure 1).
- Experiments were planted manually (Figure 1-C) in two planting dates: November 22 and December 6, 2023 in the Menzel Bourguiba (farmer's field), and December 7 and 26, 2023 in the Mornag INRAT station.
- Due to high temperatures and low rainfall during the period from January to March 2024, irrigation was applied twice during the flowering and pod growth stages at the Mornag station site to prevent crop loss due to drought.
- Data such as numbers of aphids on faba bean, and virus incidence (%) on faba bean were recorded based on symptoms observed (chlorosis, stunting, yellowing, reddening, curling and mosaic/mottling) (Figure 1-D).
- At the flowering stage, random leaf samples were taken from 400-500 plants/treatment (Figure 1-E) at both sites and tested serologically by Tissue blot Immunoassay (TBIA) (Makkouk and Kumari, 1996) using antibodies against FBNYV, CpCSV and Bean yellow mosaic virus (BYMV).
- Faba bean plants were hand-harvested during the second half of June, and grain yield (Kg) was recorded

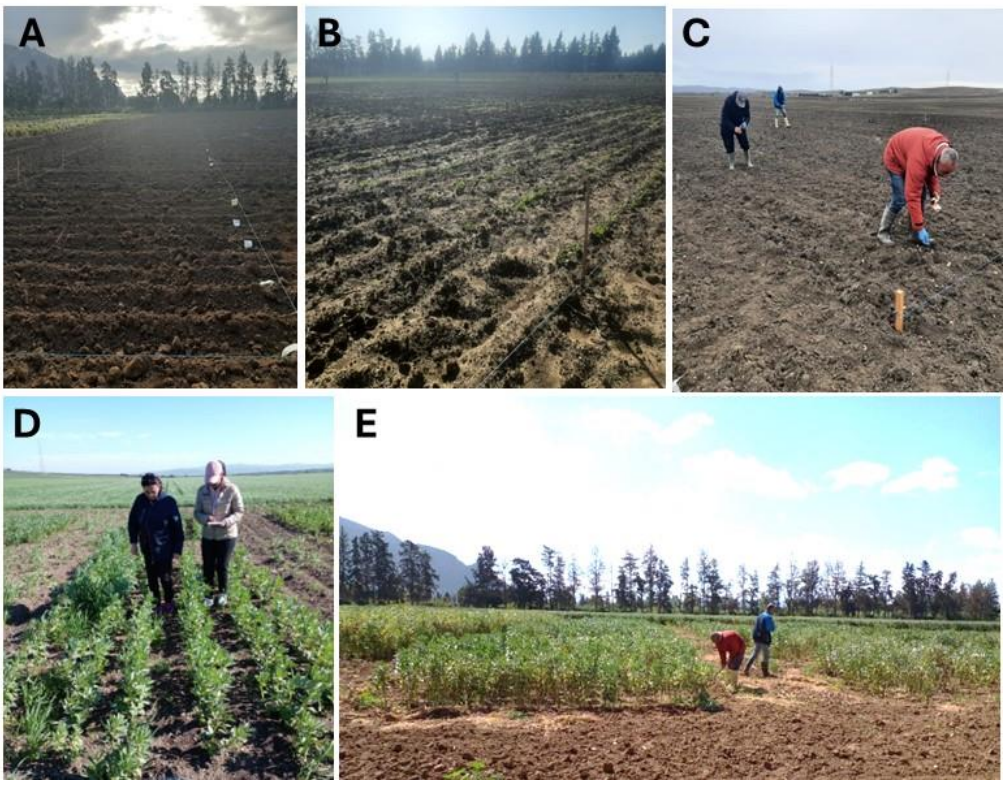

Figure 1. Faba bean trials (A & B), hand-planting (C), taking readings (D), and samples collection (E) at the Mornag INRAT station, Tunisia (2023/2024 growing season).

RESULTS

Insect status

- At the Menzel Bourguiba site, severe infestation of Sitona weevil was observed on the 1st planting date in untreated plots since February 2024 (plant height about 30 cm), and at the end of February, *A. pisum* was observed on the faba bean varieties Chourouk and Najeh. *Aphis craccivora* high infestation was observed in the untreated plots in the 2nd planting date (flowering stage) and less so in the 1st planting date (Figure 2).
- Field observation during the 2nd week of March showed some symptoms associated with viral infection such as stunting, leaf curling, thickening and yellowing of leaf tips in plots planted at the 2nd planting date (Figure 2).

Virus incidence

- Serological testing (TBIA) indicated that no virus infection was detected on the 1st planting date at both sites.
- CpCSV was detected at a low rate (0.4% on Najeh and 0.7% on Chourouk varieties) at the Menzel Bourguiba site of the 2nd planting date in untreated plots (Figure 3).
- At the Mornag site, FBNYV (0.4% in the two faba bean varieties) and BYMV (0.6% on Najeh and 1.0% on Chourouk varieties) were detected at a very low rate in untreated plots on the 2nd planting date (Figure 3).
- No virus infection was detected in the plots treated with Cruiser® (Thiamethoxam) at 1 cc/kg and 1.2 cc/kg.
- Low rainfall and high temperature during the 2023/2024 growing season at both sites negatively affected aphid activity and thus the virus infection rate.

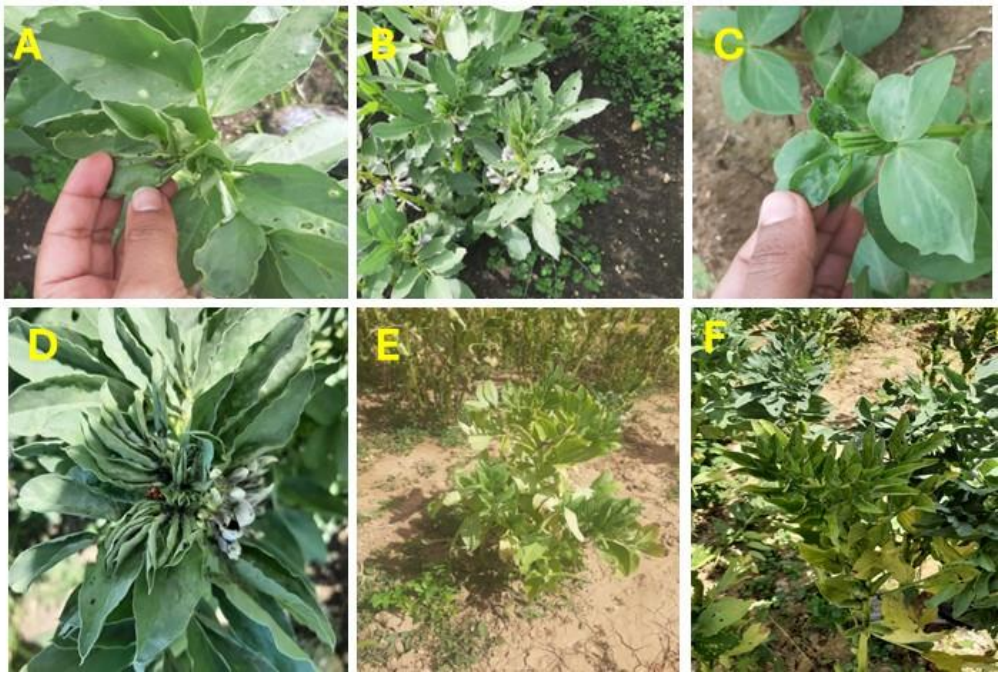

Figure 2. Different types of symptoms observed on faba bean Chorouk in untreated plots in Menzel Bourguiba site: (A & B) Sitona damage, (C) *A. pisum*, (D), *Aphis craccivora*, (E & F), leaf curling/rolling and yellowing.

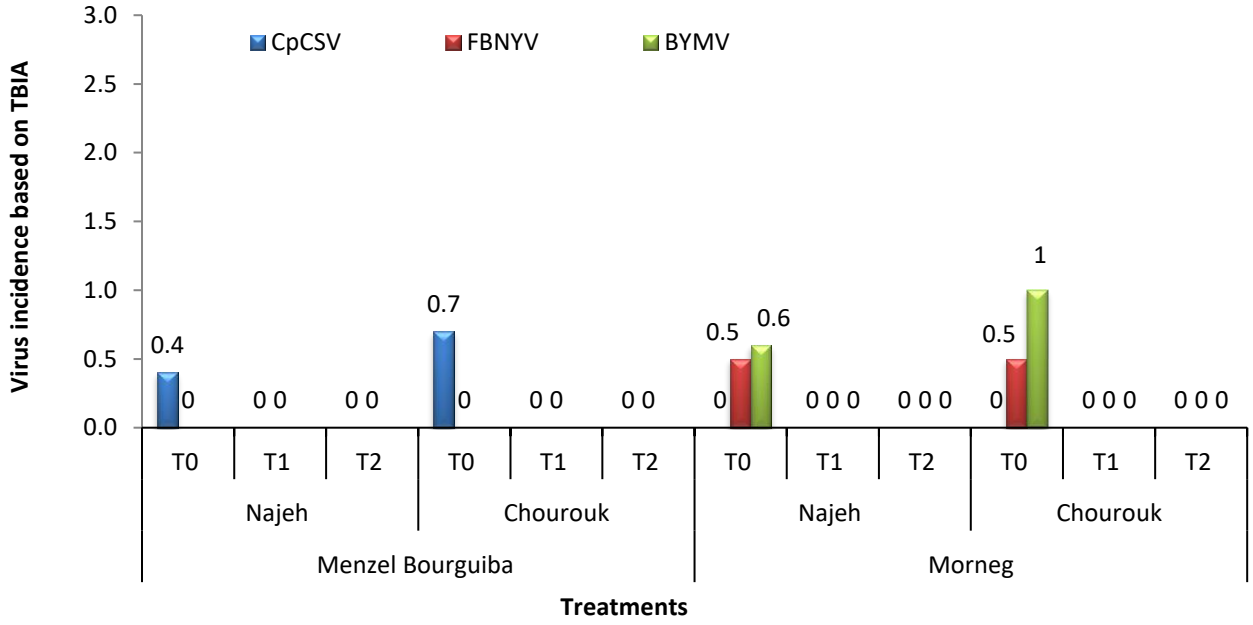

Figure 3. Virus incidence based on TBIA testing at the 2nd planting date in the Menzel Bourguiba and Mornag sites. T0= untreated seeds, T1= seeds treated with Cruiser® (Thiamethoxam) at the rate of 1.0 cc/kg, T2= seeds treated with Cruiser® (Thiamethoxam) at the rate of 1.2cc/kg.

Grain Yield

Menzel Bourguiba site

- Grain yield analysis showed significant effects of variety, planting date and seed treatment. However, ANOVA indicated that the interaction between variety and planting date was significant (Figure 4).
- Both faba bean varieties (Chourouk and Najeh) produced significantly higher yields in both Cruiser treatments (1.0 and 1.2 cc/kg) compared to the untreated control (Figure 4).
- Both faba bean varieties (Chourouk and Najeh) gave the highest yield at the 2nd planting date (December 6th) in plots treated with with Cruiser® (Thiamethoxam) at 1.2cc/kg.
- Under rainy conditions at the Menzel Bourguiba site, Cruiser at 1.0 cc/kg was more effective on both faba bean varieties at the 1st planting date. For the 2nd planting date, Najeh variety treated with Cruiser at 1.0 cc/kg is recommended, unlike Chourouk where the dose (1.2 cc/kg) gave better yield.

Mornag INRAT station site

- Both faba bean varieties (Chourouk and Najeh) produced significantly higher yields compared to the untreated control for both doses of Cruiser (1.0 and 1.2 cc/kg) (Figure 5).
- The difference in yields between the two sites was mainly due to the supplementary irrigation that was applied twice at Mornag station to prevent experimental losses under severe drought conditions.

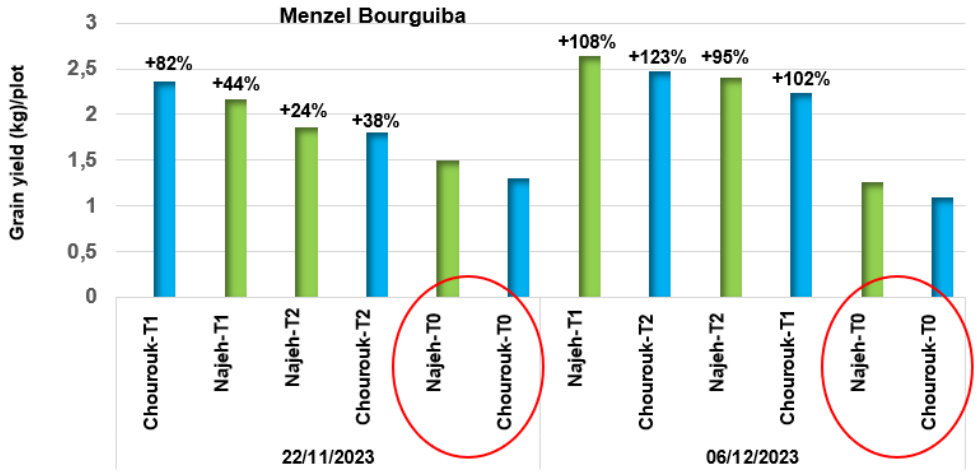

Figure 4. Effect of the Cruiser insecticide seed treatment on grain yield (Kg/plot) of two faba bean varieties (Chourouk and Najeh) in Menzel Bourguiba site. T0= untreated seeds, T1= seeds treated with Cruiser® (Thiamethoxam) at the rate of 1.0 cc/kg, T2= seeds treated with Cruiser® (Thiamethoxam) at the rate of 1.2cc/kg.

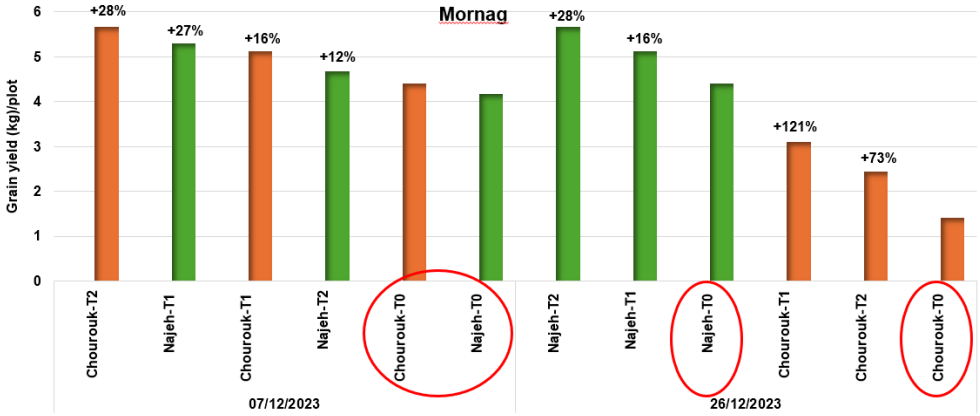

Figure 5. Effect of the Cruiser insecticide seed treatment on grain yield of two faba bean varieties (Chourouk and Najeh) in Mornag INRAT station site. T0= untreated seeds, T1= seeds treated with Cruiser® (Thiamethoxam) at the rate of 1.0 cc/kg, T2= seeds treated with Cruiser® (Thiamethoxam) at the rate of 1.2cc/kg.

CONCLUSION & RECOMMEDATIONS

- Viruses transmitted by aphids caused significant damage to faba bean crop in Tunisia, but climatic conditions were relatively unfavorable (drought and high temperature) at both the Menzel Bourguiba and Mornag sites during 2023-2024 growing season, and therefore aphid activity was very low, which affect the virus infection rate (0.4-1.0%) in the untreated plots.
- Interestingly, an improvement in production (121% better than the control) was recorded for the Chourouk variety at the Mornag site at the 1st planting date, and the improvement reached more than 100% for the two treatments and the two varieties planted later in Menzel Bourguiba. There may be two reasons behind these results: (i) Seed dressing with Cruiser appeared to stimulate germination of treated seeds (reached 37% and 65% higher in treated seeds compared to untreated plots in Najah and Shorouk, respectively); (ii) Although the aphid numbers were not very significant,

the insecticide treatment has been shown to work by reducing the impact of these insects, not as vectors of viruses but as pests.

- It may be concluded that Cruiser insecticide allowed significant yield improvement either at high (Menzel Bourguiba in 2022/2023) or at low viral infection rate (2023/2024) based on the results of this study.
- IPM strategies have been implemented in Tunisia, including early planting and seed treatment with Cruiser, resulting in reduced aphid numbers and virus symptoms and increased faba bean yield. Therefore, seed treatment with Cruiser can be recommended.

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