Plant Health Innovation Platform at Qob Elias, Lebanon: farmer participatory approaches for wide dissemination of pest management innovations

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BACKGROUND

Integrated pest and disease management (IPDM) represents a range of environmentally-sound approaches to crop protection and is increasingly recognized as an essential component of sustainable agricultural development. To promote the use of IPDM, it is necessary to validate and disseminate effective IPDM options to farming communities. To this end, the CGIAR Plant Health Initiative (PHI) has initiated nine Innovation platforms (IPs) in Africa, Asia, and Latin America, to develop and validate pest management solutions for major crops in real-life environments. One of these IPs was launched in Lebanon (Qob Elias Village, Beqaa Valley).

The PHI-IP plays a key role in the participatory analysis of pest constraints, validation of farm-level pest management options, and scaling innovation broadly to reduce productivity and quality losses and increase the incomes of rural farming communities.

The PHI-IP brought key partners together and provided solutions to the existing production challenges. IP is one of the approaches to validate innovations and getting feedback from users. The primary purpose of these PHI-IPs is to co-create and/or identify/validate IPDM packages that are highly effective and affordable. This is done with the engagement of multiple and relevant institutions, including CGIAR, IARCs, NARES and private sector partners. The identified IPDM packages coming out of this work at the Innovation Platform can then be potentially scaled up/deployed in farmers' fields. These platforms can also serve to demonstrate the efficacy of identified IPDM packages to diverse stakeholders, including farmers and policy makers, in addition to providing an opportunity for training/capacity strengthening of partners, including young researchers.

OBJECTIVE

The main objective of the PHI-IP established in Qob Elias, Lebanon is to prioritize crops and pest challenges, test pest management solutions, improve knowledge and skill of farmers to innovate in pest management.

INNOVATION PLATFORM

The PHI-IP in Lebanon was selected in Qob Elias, a municipality within Zahle District, in eastern Lebanon. Qob Elias is 15 km from Zahle and 45 km from the Lebanese capital Beirut, and 30 km from ICARDA's research station in Terbol (Fig. 1). Its average elevation above sea level is 950 m with an area of approximately 32 km². Qob Elias is the third largest location in the Beqaa Valley, after Zahle and Baalbek in terms of area and geography.

The agricultural sector is very important for the local economy, and it provides employment to both Lebanese and displaced Syrian population. In Qob Elias, around 60% of the local population and 90% of the Syrian refugees living there depend on the agricultural sector for their incomes. The town has the largest vegetable market in Lebanon with an area of more than 35,000 m^2. In this region vegetables, faba bean, maize, potato, wheat and fruit trees are important crops.

ASSESSMENTS OF PRODUCTION CONSTRAINTS AT THE INNOVATION PLATFORM

At the first meeting with farmers, extension workers and researchers from LARI filled in a questionnaire to evaluate the IP site (Fig. 2). The questionnaire was designed to collect information about the respondents, their agricultural products and practices applied in their farms, pest constraints, and attitudes towards farming. The survey was based on asking farmers to agree or disagree with statements representing different viewpoints,

asking simple questions with multiple choice answers and some open-ended questions. Only 45 farmers responded to the questionnaire and their feedback is summarized in Fig. 3.

Most farmers at PHI-IP (89% of respondents) grow multiple crops, and the most important crops grown are fruit trees (e.g. peaches, apples, pears, cherries, almonds), potato, many types of vegetables including tomatoes, food legumes (faba bean and chickpea), cereals (wheat and barley), summer maize and forages (Fig. 4).

Farmers reported various crop production constraints at the PHI-IP site, such as aphids (on vegetable, fruit trees and food legumes), viruses (on food legumes and vegetables), wheat rust, powdery mildew (on vegetable, food legumes, fruit trees), bacterial wilt on potato and fall armyworm insect pest on summer maize.



Figure 1. Map of Lebanon showing Qob Elias location (PHI-IP site).
Source: https://www.mapsofindia.com/world-map/lebanon/



Figure 2. First meeting with farmers at Qob Elias (PHI-IP site), Lebanon, 2023.

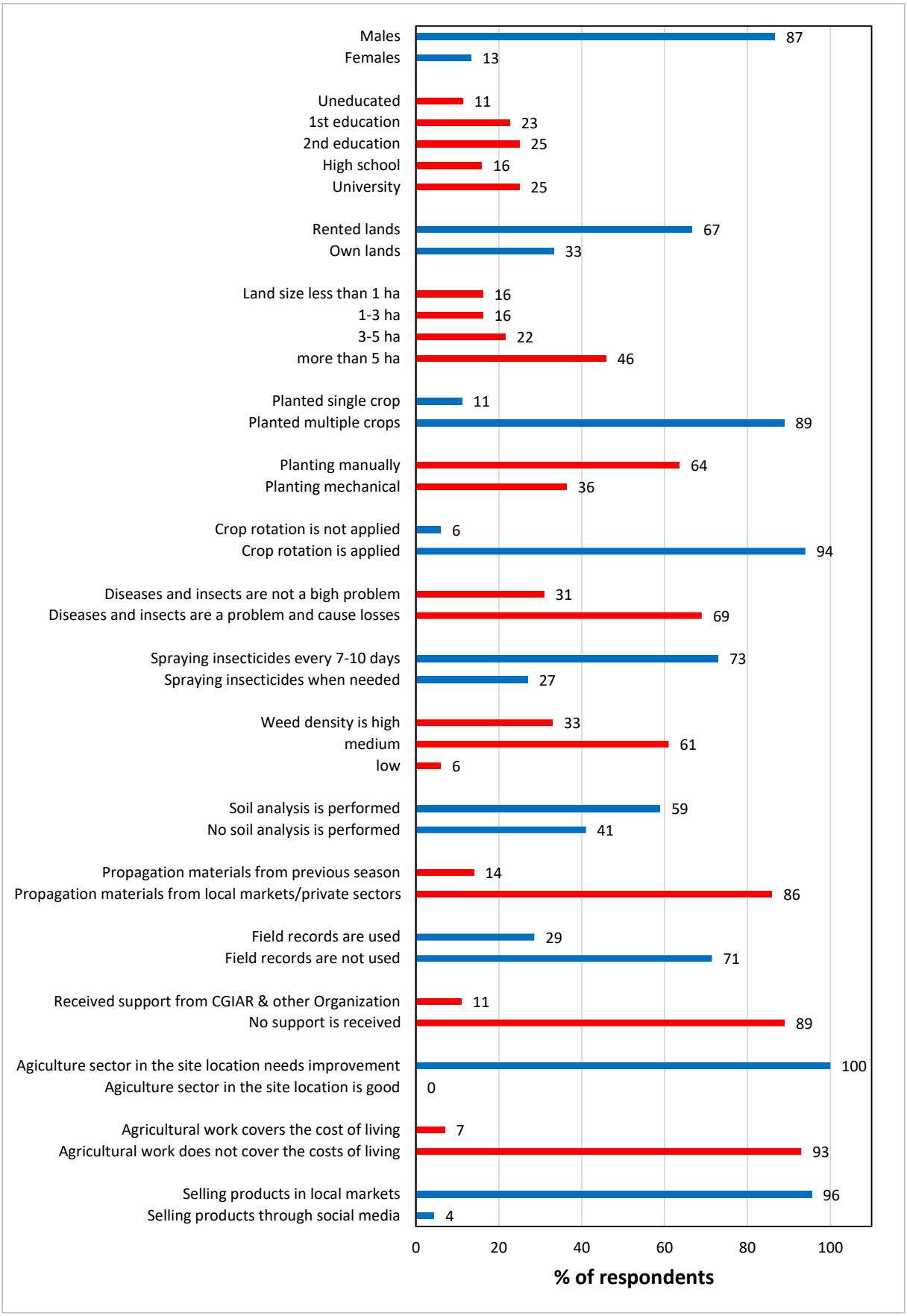


Figure 3. Summary of farming system analyses at Qob Elias (PHI-IP site), Lebanon, 2023

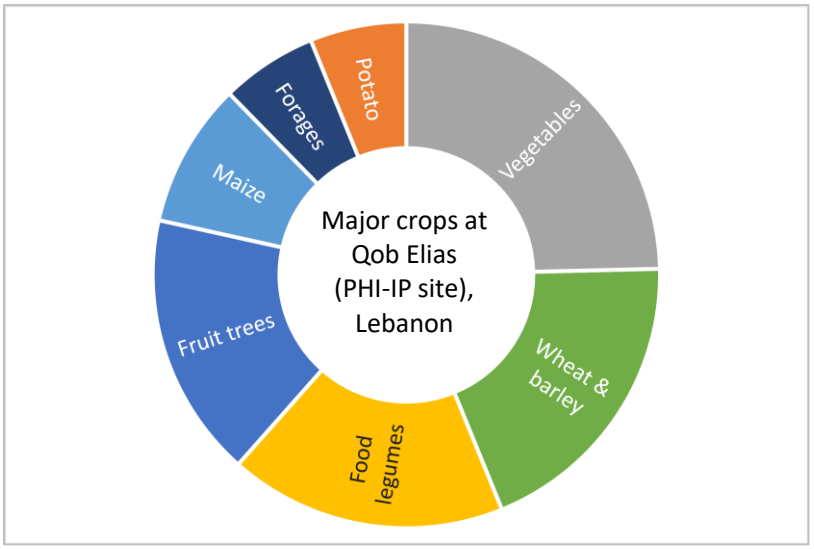


Figure 4. Major crops at Qob Elias (PHI-IP site), Lebanon.

ON-FARM VALIDATION OF PEST MANAGEMENT INNOVATIONS THROUGH THE IP SITE

Through consultation meetings with lead farmers, LARI and ICARDA scientists agreed to validate IPDM options to manage (i) viruses and aphids on faba bean, and (ii) fall armyworm (FAW) insect on summer maize. In addition, the incidence of seed-borne viruses in faba bean and chickpea seed lots was determined, as 86% of farmers at the PHI-IP site (Fig. 3) get their seeds from local markets.

METHODOLOGY AND ACHIEVEMENTS

On-farm validation of Integrated virus and vector management innovations on faba bean

Faba bean viruses are the major problem for Lebanese farmers, including Qob Elias village, which has led to decline in faba bean productivity. In addition, aphids are the most serious insect which attack faba bean. Besides the direct damage they cause, aphids transmit devastating virus diseases. In Lebanon, the major faba bean aphids that attack legumes are *Aphis craccivora*, *A. fabae* and *Acyrthosiphon pisum*. To salvage the crop in this region and to restore farmers' confidence in growing faba bean, a field trial was conducted in farmers' field to evaluate IPDM options to control viruses and their aphid vectors on faba bean crop during the 2022/2023 growing season.

The innovations validated at the PHI-IP site were: (i) three faba bean imported varieties (Italian, Moroccan and Spanish); (ii) two sowing dates (24 November 2022 and 5 January 2023); (iii) faba bean seeds treatment with the pesticide Celest top (25g/L difenoconazole + 25 g/L fludioxonil + 262.5 g/L thiamethoxam) at the rate of 1 cc/kg of seeds and untreated seeds as checks. The experiment was conducted in two replications using split-plot design (planting date as main plot), and the plot size was 36 m^2. No insecticides were applied during the growing season.

At the crop podding stage, the number of infected plants with viruses based on observed symptoms (yellowing, stunting, mosaic, mottling) followed by serological tests at the Laboratory, and number of plants infested with aphids for each plot were counted.

Results **-** The results obtained showed that the number of infected plants by viruses and aphids were higher at the 2nd sowing date than at the 1st sowing date (Fig. 5). In addition, viruses and aphids incidence was lower in the plots planted with treated seeds compared to the untreated plots and for both sowing dates. Moreover, no aphids were recorded in the plots planted with treated seeds on all faba bean varieties sown in November. When virus-infected plants were tested serologically, four viruses were identified: Faba bean necrotic yellows virus (FBNYV), Chickpea chlorotic stunt virus (CpCSV), Beet western yellows virus (BWYV) and Bean yellow mosaic virus (BYMV). Three of these viruses (FBNVY, CpCSV and BWYV) are transmitted by aphids in a persistent manner, and one virus (BYMV) is transmitted by aphids in a non-persistent manner.

Neighboring farmers and members of the local community visited the on-farm validation at the PHI-IP site to exchange information about the IPDM innovations on faba bean (Fig. 6).

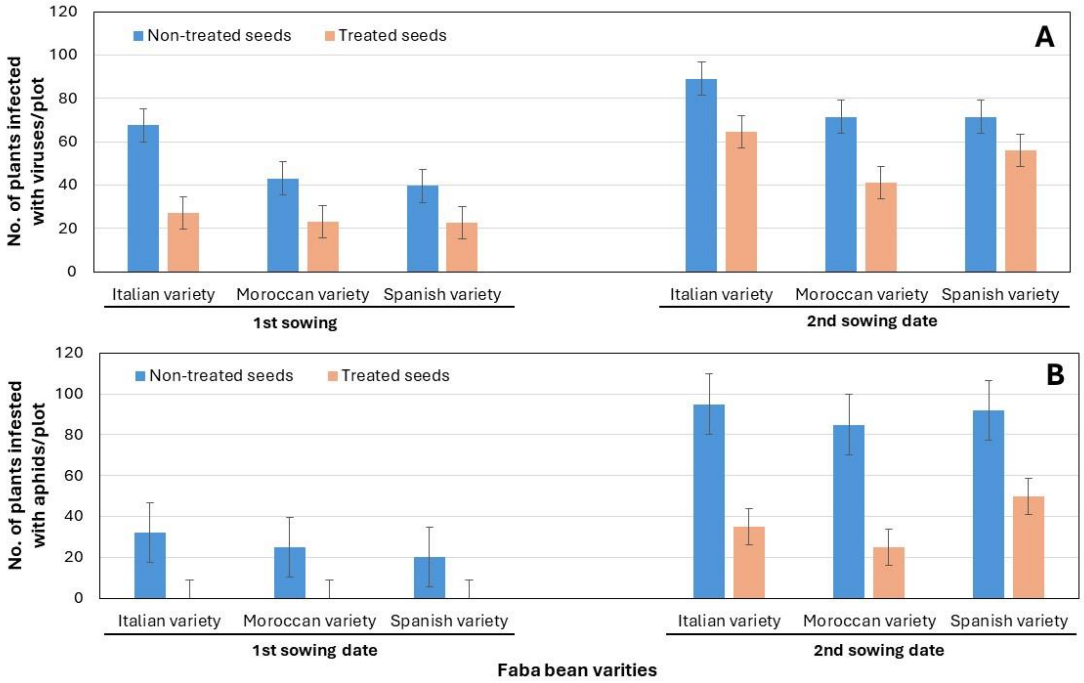


Figure 5. Effects of seed treatment with Celest top on faba bean viruses (A), and aphids (B), during 2022/23 growing season, Beqaa valley, Lebanon.

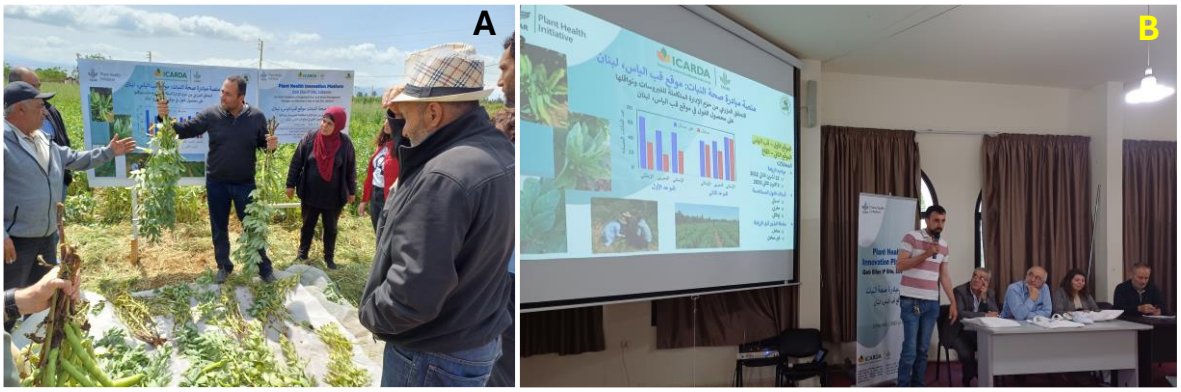


Figure 6. Lead farmers, Mr Mohamed Abou Nasif (A) and Mr Alaa Ahmad Tarchichi (B), explain the difference between treatments and faba bean varieties to the neighboring farmers in Qob Elias (PHI-IP), Lebanon, 2023.

Status of seed-borne viruses in faba bean and chickpea seed lots

Since there is no certification program for seed multiplication in Lebanon, 86% of farmers participating in the PHI-IP obtain their seeds from the local sources and imports (Figure 1). Therefore, knowing the health status of the seeds that farmers use for planting is essential. A total of 107 seed lots (53 chickpea and 54 faba bean) were collected by LARI Virologist from different sites and sources that represent most of the local markets available in the Beqaa valley of Lebanon (Table 1). Around a thousand seeds from each sample were planted in plastic trays containing sterilized sand and incubated for 1-2 weeks under greenhouse conditions at LARI station in Tel Amara, Beqaa valley (Fig. 7). After emergence, seedlings were serologically tested at ICARDA's Virology Laboratory for the presence of six seed-borne viruses affecting food legumes.

Results **-** The results showed that only one imported chickpea seed lot was infected with Pea seed-borne mosaic virus (PSbMV) (Table 1). This result suggests that viral diseases in farmers' fields are not seed-sourced, and this was proven by tests during the growing season, where it was found that the most important viruses affecting faba bean and chickpea are those that are transmitted by insects (e.g. Faba bean necrotic yellows virus, Chickpea chlorotic stunt virus) and they are not seed-transmitted viruses.

Table 1. Occurrence of seed-borne viruses* in faba bean and chickpea seed lots collected from farmers, local markets and private sectors available in Beqaa valley, Lebanon, during 2023 cropping season.

Source/ Location	Crop	No. of seed lots			No. of seeds tested for seed-borne viruses	No. of seeds infected with PSbMV
		Local varieties	Imported varieties	Total		
Farmers						
Qob Elias	Faba bean	0	4	4	4,000	0
	Chickpea	1	0	1	1,000	
Tourbul	Faba bean	2	0	2	2,000	0
Local markets and Private sectors						
Dalhamieh	Faba bean	2	0	2	2,000	0
Dhour Zahle	Faba bean	2	2	4	4,000	0
	Chickpea	2	3	5	5,000	0
El Karak	Chickpea	1	0	1	1,000	0
Ferzoul	Faba bean	5	9	14	14,000	0
	Chickpea	7	5	12	12,000	1
Houch El Oumara	Faba bean	1	0	1	1,000	0
	Chickpea	2	0	2	2,000	0
Jalala	Faba bean	1	1	2	2,000	0
	Chickpea	0	3	3	3,000	0
Moualaka	Faba bean	1	4	5	5,000	0
	Chickpea	2	1	3	3,000	0
Mrayjat	Faba bean	3	1	4	4,000	0
	Chickpea	2	5	7	7,000	0
Rayak	Faba bean	2	0	2	2,000	0
	Chickpea	0	2	2	2,000	0
Saednail	Faba bean	1	3	4	4,000	0
	Chickpea	2	1	3	3,000	0
Taalabaya	Faba bean	1	0	1	1,000	0
	Chickpea	1	0	1	1,000	0
Wadi El Arayesh	Faba bean	1	0	1	1,000	0
	Chickpea	1	1	2	2,000	0
Zahle	Faba bean	4	4	8	8,000	0
	Chickpea	5	6	11	11,000	0
Total	**Faba bean**	**26**	**28**	**54**	**54,000**	**0**
	Chickpea	**26**	**27**	**53**	**53,000**	**1**

* All seeds tested were negative to BBSV, BBMV, BYMV, CMV and AMV.
Virus abbreviation: PSbMV= Pea seed-borne mosaic virus, BBSV= Broad bean statin virus, BBMV= Broad bean mottle virus, BYMV= Bean yellow mosaic virus, CMV= Cucumber mosaic virus, AMV= Alfalfa mosaic virus.

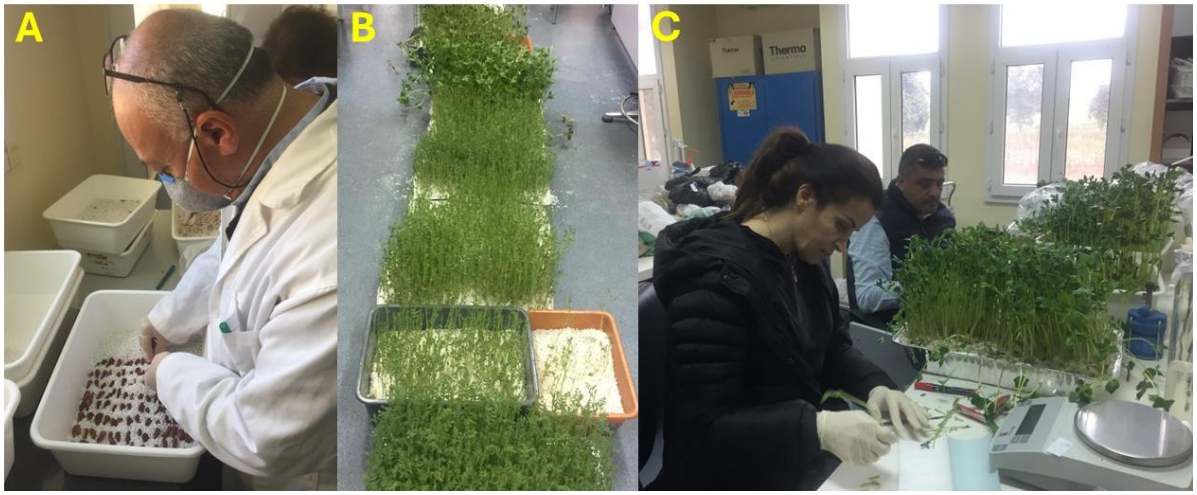


Figure 7. (A) Planting faba bean seeds in plastic trays at greenhouse of LARI station; (B) Chickpea and faba bean seeds after emergence are ready for testing; (C) Blotting faba bean seedlings on Nitrocellulose membranes (NCMs) by LARI research assistants.

Management of fall armyworm on summer maize

The fall armyworm (FAW), *Spodoptera frugiperda*, is the most important insect pest of maize crop worldwide, and it has recently become a harmful and invasive pest of summer planted maize in Lebanon. This led to the excessive and misuse of chemical pesticides to combat it, sometimes reaching the extent of spraying weekly using 2 to 3 unsafe pesticides in each spray.

The infestation rate with FAW in farmers' fields can be monitored using pheromone traps. Pheromones are natural compounds emitted by female FAW moths to attract male moths for mating. Synthetic compounds that mimic natural FAW pheromones are placed in traps to attract and trap male moths. The number of male FAW moths captured will inform farmers if FAW is present in their fields and whether or not there is a need to apply a chemical spray.

To save maize crop at Qob Elisa village, a field observation was carried out during the summer of 2023 in the farmers' field to study the effect of pheromone traps and spraying with environmentally safe and low-risk insecticides recommended by FAO and Lebanese Ministry of Agriculture to combat FAW (FAO, 2023). The treatments/options used in this study were:

- Maize field (1.2 ha) was planted on 25 July 2023 using imported cultivar "Nour".
- Specific commercial FAW pheromone used: Z9-tetradecenyl acetate (1.96 mg), Z7-dodecenyl acetate (0.02 mg), and E7- dodecenyl acetate (0.02 mg) produced by Sanidad Agricola ECONEX S.L., Spain.
- Trap used: Funnel or bucket (unitrap, universal trap) (Figure 9-A). One trap/field and it was placed in the field 5 days after planting.
- Foliar insecticides were sprayed every 10 days and started on August 5th using the following recommended insecticides: 2 times with Emamectin benzoate + Alpha-cypermethrin (5 and 15 August); 2 times with Indoxacarb + Alpha-cypermethrin (25 August and 5 September); and one time with Deltamethrin (15 September).
- The number of captured FAW males and non-FAW moths were counted 2 times/week starting on 31 July 2023 (Fig. 8).

Results **-** The results obtained showed that the peak of FAW population in the maize filed in Qob Elisa was during the period of August 22 to September 15 (Fig. 8). The management of FAW before reaching this date is very important to avoid the high FAW infestation in the field.

FAW damage on maize production in the field that used pheromone traps and recommended insecticides was almost unobservable compared to neighboring farmers, who followed their own practices (Figure 9-E and 9-F).

Neighboring farmers were invited to visit the trial, and the lead farmer presented to them the treatments he applied, and the experience gained through this experiment and the advantages gained from participating in the PHI-IP in collaboration with ICARDA and LARI scientists (Fig. 9).

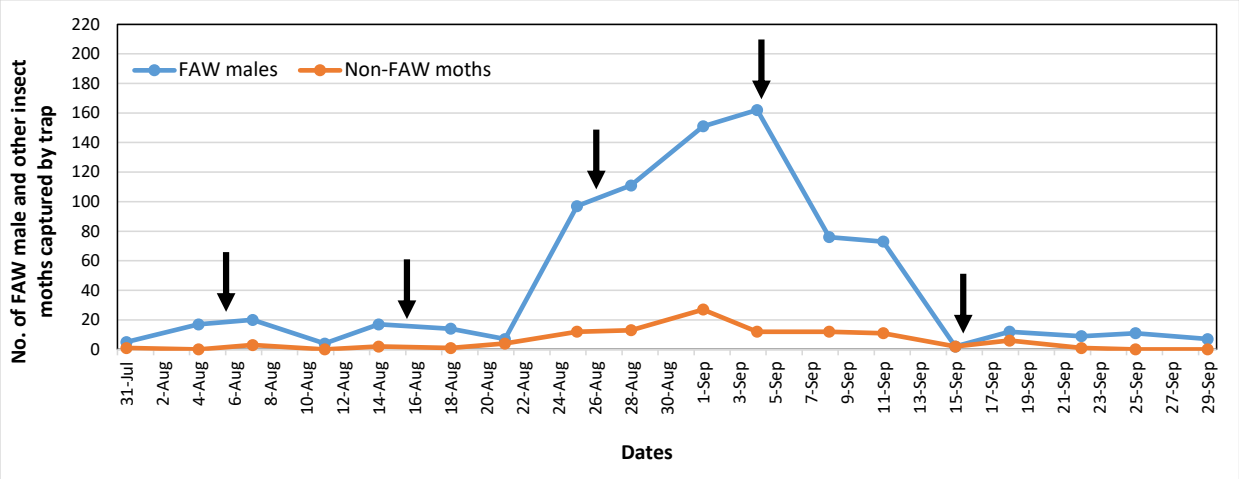


Figure 8. Number of FAW males and non-FAW insect moths captured by a pheromone trap from 31 July to 29 September 2023, Qob Elias (PHI-IP site), Lebanon. The arrow indicates the date of insecticide spraying.



Figure 9. (A) Pheromone trap in a maize field, (B) trapped moths, (C) FAW male, (D) Mr Abdulrahman Moukahel (ICARDA) trained farmers on the use of the pheromone trap, (E) Lead maize farmer, Mr Ahmad Ali Salloun, explains to neighboring farmers the difference between his maize crop and that of other fields, (F) maize production from the field that used pheromone traps and recommended insecticides (right) compared to maize production from other fields that applied their own practices (left), (G) famers during their visit to the lead farmer's field, Qob Elias (PHI-IP site), Lebanon, 2023.

PHI-IP site and ICARDA station visits

Neighboring farmers were invited to visit on-farm demonstration of IPDM innovations hosted by farmers at the PHI-IP site. Fields of lead farmers were used as training sites for neighboring farmers throughout the growing season. These fields were visited by around 100 farmers (12 females) in addition to the agricultural experts. Furthermore, farmers had the opportunity to visit ICARDA station in Terbol, Beqaa valley and observe the best varieties developed by ICARDA (Fig. 10). The discussion between LARI & ICARDA researchers, and lead farmers with other farmers during the field days was very useful.



Figure 10. Farmers from Qob Elias during their visit to ICARDA Terbol station, Beqaa Valley, Lebanon, 2023.

CONCLUSIONS & FUTURE OUTLOOK

- Based on the results obtained from the faba bean trial of integrated virus and vector management, November planting combined with seed treatment minimized aphids and infection of faba bean with viruses.
- Result obtained from FAW management showed that pheromone trap is very useful for reducing the number of FAW males and help farmers to improve timing of insecticide applications.
- Using the IP approach, farmers got the opportunity to discuss challenges they are facing under the increased threat of climate and farming systems changes.
- PHI-IP achievements have attracted the attention of many farmers in the PHI-IP site and increased their confidence in planting faba bean and summer maize.
- In the future, a series of similar demonstrations and scaling up activities are needed to narrow yield gaps caused by pests.

- The Lebanon PHI-IP represents another tool in the ICARDA integrated innovation packages towards sustainable agriculture in the CWANA region, providing resilient livelihoods for farmers struggling with increasing climate change impact.
- Most importantly, during the field day, some participants expressed their opinions. One lead farmer said: ***"PHI-IP has been a valuable addition to our knowledge and experience; we have learnt a lot and next year my brothers will use the same options I used this year to combat fall armyworm."***

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FAO. 2023. Fall armyworm *Spodoptera frugiperda:* biological characteristics and integrated management in Lebanon (in Arabic). FAO Lebanon. TCP/RAB/3803. 12 pages.

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