Using accurate detection tools to develop a successful management strategy for lentil and chickpea viruses in farmers' fields in the highlands of Ethiopia

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Description

Since 2019, farmers in the highlands of Ethiopia are losing their chickpea and lentil crops because of virus epidemics, and lentil production area in Ethiopia was reduced due to the virus infection. Based on FAOSTAT, lentil production (tonnes) and Area Harvested (ha) in Ethiopia decreased from 166,274 tonnes and 113,685 ha during 2016 to 113,018 tonnes and 84,512 ha during 2020, respectively (FAOSTAT, 2022).

Knowing the exact identity of viruses affecting both crops is essential for breeding for resistance and crop management purposes. To achieve this, field surveys were carried out for four consecutive seasons (2019-2022) in collaboration between ICARDA and Ethiopian researchers, using up-to-date detection tools to monitor virus incidence and distribution on lentil and chickpea crops in the highlands of Ethiopia. Data generated can be used by plant pathologists, scientists, breeders, plant protection organizations, policy makers, National agricultural research, and extension agencies to mitigate the viral diseases.

Results, Innovations, findings

Field observation showed that mottling, yellowing, stunting, and reddening were the most frequently observed symptoms, suggesting the possibility of virus infection (Figure 1). Virus incidence based on symptoms varied with seasons and locations. Around 40% of the 200 fields visited had virus incidence higher than 50%. The major vectors observed were green aphid (*Acyrthosiphon pisum*) and black aphid (*Aphis fabae, A. craccivora*), and both are key factors in virus diseases spread.

Figure 1. *Virus symptoms on lentil (A & B), chickpea (C) and lentil (D) fields with around 100% virus infection.*

Laboratory serological tests of more than 2000 samples showed that most of the samples reacted to Chickpea chlorotic stunt virus (CpCSV) with an incidence of 70% and 50% on chickpea and lentil crops, respectively. The highest mean incidence of Pea seed-borne mosaic virus (PSbMV) (40%) was recorded on lentil samples. Faba bean necrotic yellows virus (FBNYV), Beet western yellows virus (BWYV) and Soybean dwarf virus (SbDV) incidence was less than 1% in both lentil and chickpea. In addition, the results indicated that PSbMV was widely distributed in the Amhara region, whereas CpCSV prevalence was higher in Oromia region. Polyclonal antibodies used in this study were provided by ICARDA (Makkouk *et al*., 1993, 1997), and Monoclonal antibodies were provided by Julius Kuehn Institute, Federal Research Center for Cultivated Plants, Braunschweig, Germany (Abraham *et al*., 2009; Franz *et al*., 1996; Katul, 1992).

To confirm the serological results obtained, 150 samples from central highlands of Ethiopia were selected and tested by reverse transcription-polymerase chain reaction (RT-PCR) using different primer pairs (Moukahel *et al.,* 2001; Roberts *et al.,* 2003). DNA amplicons of interest obtained were directly sequenced, and sequences were compared with available sequences in the database using the basic local alignment

search tool (BLAST) program. The sequence analysis confirmed presence of the following major viruses in Ethiopia: CpCSV, PSbMV and SbDV on chickpea and lentil, and BWYV on chickpea only.

The Phylogenetic comparison of the nucleotide sequence of 6 Ethiopian PSbMV samples (1 chickpea and 5 lentil) grouped Ethiopian isolates in distinct clusters. Based on the GenBank data, the sequencing of our PSbMV isolates is the first record of PSbMV in Ethiopia based on molecular characterization. In addition, sequences of DNA virus amplicons for the following viruses were submitted to the GenBank: 3 isolates of BWYV, 5 isolates of CpCSV, and 3 isolates of SbDV.

Evaluation of PSbMV seed transmission rate in 66 different lentil genotypes were done during 2020-2022 at Amhara Agricultural Research Institute, Bahir Dar, Ethiopia. The seed transmission rate of PSbMV obtained ranged between 0.94 to 17.14% based on the lentil genotype. This study was carried out by a PhD student from Addis Ababa University, Ethiopia (Mr Anteneh Ademe Mengistu).

In virus-infected fields, over 50% yield reduction was estimated in August planted lentil and up to 100% in late (August-October) planted lentil on residual moisture did occur. It was concluded that new management strategies should be developed during the coming growing seasons and introduced to manage viruses and their vectors in both crops to minimize yield losses. In addition, research centers and farmers were advised to plant healthy seeds to combat emerging virus epidemics in the country, especially in regions where PSbMV incidence is high.

ICARDA researchers have carried out the virus surveys in Ethiopia in collaboration with Ethiopian scientists working in agriculture and research. During field visits, Ethiopian farmers and research assistants were trained to recognize virus symptoms, virus vectors and available virus management/control practices (Figure 2).

Figure 2. *ICARDA and Ethiopian scientists are explained to students and farmers the virus symptoms.*

Users/beneficiaries

- Small holder farmers.
- National agricultural research and extension agencies and NGOs involved in rural community development.
- Private sector, including agricultural inputs dealers.
- Resource-limited farmers, farming communities and support groups.
- Government policy makers,
- IARCs and Advanced Research Institutes scientists.
- NARES in CWANA region.
- Donor agencies.

Important activities that helped in achieving this outcome

Safaa Kumari (ICARDA's Virologist) has longstanding successful collaborations with a number of research groups around the world, including Australia (Department of Agriculture and Fisheries, Brisbane, Queensland), and Germany (Julius Kuehn Institute, Federal Research Center for Cultivated Plants, Braunschweig). She has also good collaborations with Ethiopian scientists and most of CWANA countries. Seid & Safaa currently have a joint project with Australian & Ethiopian scientists on Protecting Ethiopian Lentil Crops Projects funded by ACIAR. Over the last 20 years, ICARDA's Virology Lab focused on the development of diagnostic kits for detection of viruses affecting legume crops in CWANA. So far, sixteen kits for the detection of the most important legume viruses are available for use by NARS scientists in CWANA.

In addition, ICARDA has a well-equipped Virology Laboratory at Terbol Station in Lebanon to carry out molecular virus characterization.

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