European Journal of Plant Pathology **101**: 221–224, 1995.
© 1995 *Kluwer Academic Publishers. Printed in the Netherlands.*

Short communication

Assessment of yield losses caused by chickpea chlorotic dwarf geminivirus in chickpea (*Cicer arietinum*) in India[1]

N.M. Horn*, S.V. Reddy and D.V.R. Reddy
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh 502 324, India
* *Address for correspondence: Schuurhoven 9, 6721 SM Bennekom, The Netherlands*

Accepted 21 October 1994

Key words: chickpea stunt

Abstract

Yield losses caused by chickpea chlorotic dwarf virus in chickpea were estimated by comparing uninfected and infected plants in the field at two locations in India. When infection was before flowering, yield losses of individual plants amounted to nearly 100% in the three cultivars studies. Plants that became infected during flowering had yield losses of 75–90%. Percentage of crop loss is likely to equal percentage of disease incidence, since plant densities in farmers' fields are probably too low to allow uninfected plants around infected ones to compensate the yield losses of infected plants.

Chickpea chlorotic dwarf virus (CCDV) is a newly-described geminivirus infecting chickpea, *Cicer arietinum* [Horn et al., 1993]. This virus is transmitted by the leafhopper *Orosius orientalis*, and infects tobacco species and so-called 'cool-season' legumes, like Phaseolus bean (*Phaseolus vulgaris*), faba bean (*Vicia faba*), lentil (*Lens esculenta*) and pea (*Pisum sativum*). Surveys conducted during the 1991/1992 season revealed that CCDV is widely distributed in India, and that it was the most important chickpea virus in Rajasthan (India) and in Pakistan [Horn, 1994]. It is one of the viruses causing symptoms similar to those described for chickpea stunt by Nene et al. [1991]. They include plant stunting, internode shortening, phloem browning in the collar region, and leaf reddening in desi-type, and yellowing in kabuli-type chickpeas [Horn et al., 1993]. Other viruses associated with chickpea stunt symptoms in the literature are bean leafroll luteovirus (BLRV; synonym for pea leafroll virus) in Iran and India [Kaiser, 1972; Reddy et al., 1979], beet western yellows luteovirus, legume yellows luteovirus (probably a strain of BLRV), and subterranean clover red leaf luteovirus in California, USA [Bosque-Perez and Buddenhagen, 1990]. An additional luteovirus, tentatively called chickpea luteovirus (CpLV), found in India, Pakistan, Syria and Turkey [Horn, 1994], is yet to be characterized. Since these viruses cause symptoms in chickpea that are indistinguishable, serological techniques, such as ELISA, are essential to distinguish them.

Chickpea plants that become infected with CCDV at an early stage of development normally do not produce any pods. The above-described symptoms are followed by rapid plant decline, and very few early infected plants survive. Kaiser and Danesh [1971] reported that in Iran BLRV caused 90–100% yield loss in chickpea when plants were aphid-inoculated. In chickpea naturally infected with chickpea stunt in India, Kotasthane and

[1] Submitted as Journal Article No. 1624 by ICRISAT.

Gupta [1978] reported 80–95% yield reduction. This observation was based on natural incidence of chickpea stunt and the causal virus was not identified.

This paper reports on the yield losses caused by CCDV in chickpea under natural conditions as determined by comparing the yield of infected plants with those of uninfected neighbouring plants during the 1991/1992 season.

Two chickpea genotypes, viz. 'ICCV 10' (desi) and 'ICCV 2' (kabuli), were tested at ICRISAT Center (Patancheru, Andhra Pradesh, South India, 18° N), and one, viz. 'WR 315' (desi), at Hisar (Haryana, North India, 29° N). In each experiment, plants with stunt-like symptoms were selected, numbered and tagged on two different dates. From each tagged plant three leaves were collected and tested in DAS-ELISA with CCDV antiserum, as described by Clark and Adams (1977). ELISA plates were incubated with CCDV-IgG (2 μg ml^{-1}) for 2 h at 37 °C and washed. Triturates from the samples in buffer (10 ml g^{-1} tissue) were added to the wells and incubated for 2 h at 37 °C. After washing, the plates were incubated with CCDV-IgG alkaline phosphatase conjugate (μg ml^{-1}) for 1 h at 37 °C. After another washing, the substrate p-nitrophenyl phosphate was added. Plants that were found infected with CCDV were used for the yield-loss assessment. When harvesting the tagged, CCDV-infected plants, three healthy-looking neighbouring plants were also harvested (Fig. 1). The yield of individual infected plants was compared with the average yield of its three apparently healthy neighbouring plants. These differences were then statistically analysed, using a t-test. In each field 50 randomly selected, healthy-looking plants were also harvested individually for measuring their yield.

At Patancheru, 32 plants of 'ICCV 10' were found to be infected during flowering and only 9 plants of 'ICCV 10' in the same field were found to have become infected since the first observation date. In the case of 'ICCV 2', 80 and 39 plants were found to have become infected when the crop was at the flowering and pod-setting stages,

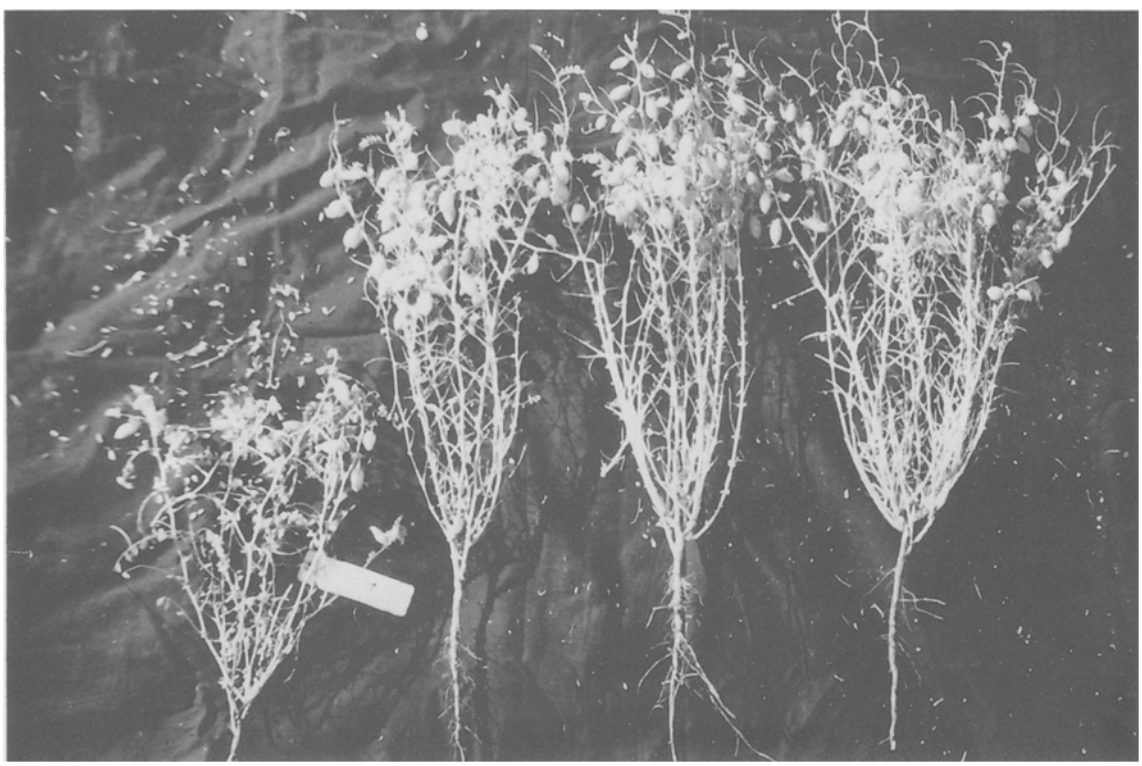

Fig. 1. CCDV-infected chickpea plant (left) and three healthy neighbouring plants, immediately after harvest.

respectively. At Hisar, 42 plants of 'WR 315' were found to be infected before flowering and an additional 24 during flowering.

The average yields of diseased and apparently healthy plants, estimated yield losses, and results of the statistical analysis are presented in Table 1. The results show that CCDV could cause considerable yield losses in chickpea plants, i.e. 75–100%, at both locations, in all three chickpea genotypes, and at both dates of observation. These losses were far beyond the standard error. When symptoms were already present at the flowering stage, yield losses were close to 100%. When they were only present at the pod-filling stage, indicating that the plants had become infected during flowering or later, yield losses were slightly lower, but still considerable (75–90%). The most vulnerable cultivar, WR 315, which suffered 100% yield loss when infected before flowering, is currently widely grown by farmers in North India.

If incidence of diseased plants is low and they are scattered throughout the field, neighbouring plants in dense crops (300,000 plants ha^{-1} for chickpea) and at high soil fertility may compensate for declining or dead plants [Bos, 1982]. The yields of healthy plants, which were randomly selected in each experiment, were all in the same range as those of healthy plants located near infected plants. This indicates that no significant compensation occurred in these experiments. On this basis it is assumed that in farmers' fields in North India and Pakistan, where the crops are often raised at medium densities (100,000–200,000 plants ha^{-1}), hardly any losses encountered by CCDV-infected plants were compensated for by the enhanced development of healthy neighbouring plants. Since infection often leads to complete loss of yield by the infected plant, under such conditions, percentage of yield loss per field is likely to be more or less the same as the percentage of diseased plants. This further emphasizes the potential threat of CCDV to chickpea cultivation.

Acknowledgements

The first author is greatly indebted to the Directorate General for International Cooperation (DGIS) of the Netherlands Ministry of Foreign Affairs and to the Director General of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) for financial support during his stay at ICRISAT. We would like to thank Dr S.C. Sethi and Mr Tomer for help with the experiment at Hisar, and to Dr L. Bos (IPO-DLO, Wageningen) for critical suggestions concerning the manuscript.

References

Bos L (1982) Crop losses caused by viruses. Crop Protection 1: 263–282

Bosque-Perez NA and Buddenhagen IW (1990) Studies on epidemiology of virus diseases of chickpea in California. Plant Disease 74: 372–378

Clark MF and Adams AN (1977) Characteristics of the microplate method of enzyme-linked immunosorbent assay for the detection of plant viruses. Journal of General Virology 34: 475–483

Horn NM, Reddy SV, Roberts IM and Reddy DVR (1993) Chickpea chlorotic dwarf virus, a new leafhopper-trans-

Table 1. Estimation of yield losses to chickpea plants due to CCDV at the ICRISAT Asia Center and at Hisar

Genotype	Location	Growth stage	N. of infected plants	Average yield p.plant (gr)		Yield loss %-age	Standard error %-age
				healthy	infected		
ICCV 10	ICRISAT	flowering	32	11.9	0.01	99.8	0.2
		pod setting	9	14.6	1.5	90.2	3.4
ICCV 2	ICRISAT	flowering	80	8.6	0.13	98.5	0.3
		pod setting	39	10.9	2.5	75.4	2.8
WR 315	Hisar	preflowering	42	na[1]	0	100	na
		flowering	24	na	0	100	na

[1] not applicable

mitted geminivirus of chickpea in India. Annals of Applied Biology 122: 467–479

Horn NM (1994) Viruses involved in chickpea stunt. Thesis Wageningen Agricultural University, 137 pp

Kaiser WJ and Danesh D (1971) Biology of four viruses affecting *Cicer arietinum* in Iran. Phytopathology 61: 372–375

Kaiser WJ (1972) Diseases of food legumes caused by pea leaf roll virus in Iran. FAO Plant Protection Bulletin 20: 127–132

Kotasthane SR and Gupta OM (1978) Yield losses due to chickpea stunt. Tropical Grain Legume Bulletin 11/12: 38–39

Nene YL, Reddy MV, Haware MP, Ghanekar AM and Amin KS (1991) Field diagnosis of chickpea diseases and their control. ICRISAT, Information Bulletin No 28

Reddy MV, Nene YL and Verma JP (1979) Pea leaf roll virus causes chickpea stunt. International Chickpea Newsletter 1: 8