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Meteorological factors attributing yellow mosaic virus severity on greengram*

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Greengram (*Vigna radiata* (L.) Wilczek.) is a short-duration, highly remunerative crop sown throughout the years in India under different climatic zones as *kharif* (rainy) season, *rabi* (winter) and *zaid* (spring and summer) crop. The crop is grown as rainfed during *kharif* and on residual moisture in *rabi* in eastern and southern, whereas as *zaid* and *kharif* in northern part of the country. Thus crop appears to have wide adaptability to various weather factors, which have direct impact on YMV incidence, which can inflict yield losses up to 85% (AVRDC 1999). Widely applicable and economical technology to manage YMV is the host plant resistance, though apparently, there seems to be no variety of mungbean completely and consistently resistant to YMV (Kaur *et al*. 2009). This instigated to initiate studies on relationship of weather parameters on yellow mosaic virus (YMV) and its vector (white fly) to ascertain the most critical parameter/s affecting disease epidemic and the vector population.

The material comprised advance breeding lines in coordinated trials from various State Agricultural Universities, obtained under All India Coordinated Research Programme of Pulses Improvement from Indian Institute of Pulses Research, Kanpur, advance breeding and elite greengram lines with long-term resistance to YMV from Punjab Agricultural University, Ludhiana. Sowing were done in third week of July 2006, 2007 and 2008 in 4 m rows, spaced at 40 cm, 40 seeds/row, replicated twice. A row of indicator-cum-infector of susceptible varieties ('RMG 353' and 'PS 16') was planted after every 4 test rows and all around the experimental plots. Two rows of released variety 'PAU 911' were planted in each trial along with test rows as resistant check. Normal cultural practices were followed to raise the crop and no insecticidal spray was done to encourage the natural development and build-up of whitefly population for the rapid spread of the disease. The disease observations were recorded when there was maximum disease severity on the indicator rows using 1–9 point scale (Singh and Bhan 1998). The final observations on disease severity were recorded in the third week of September in 2006 and 2008 but in first week of September in 2007. The data on disease severity was converted in to the per cent disease index (PDI). Whitefly

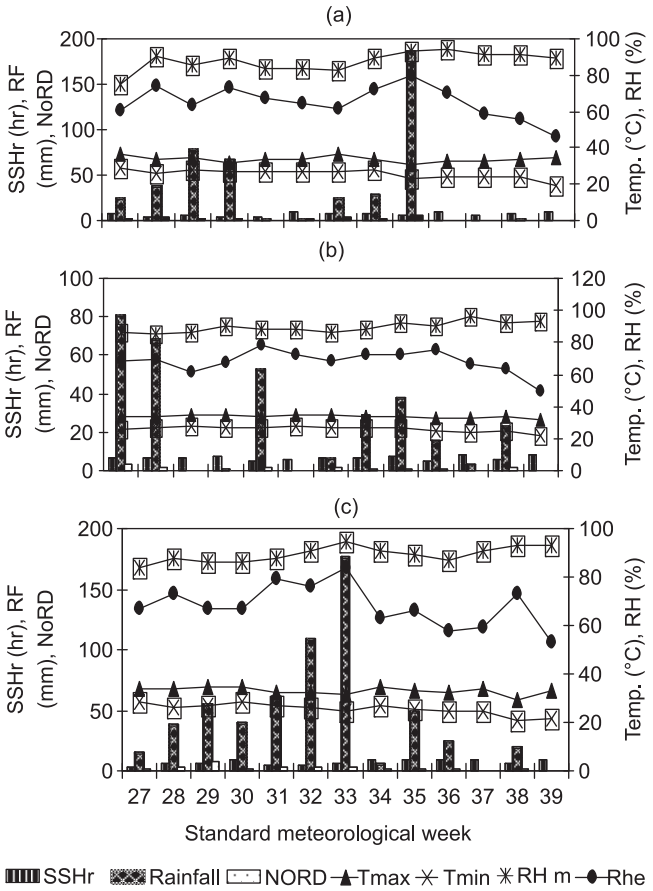

Fig 1 Weekly weather parameters in mungbean growing period during (*a*) 2006 (*b*) 2007 and (*c*) 2008

*Short note

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Table 1 PDI (YMV), weekly mean (27–39 SMW) weather parameters and their correlations during 2006, 2007 and 2008

Year	PDI (%)	SSHr	Rainfall (mm)	No of rainy days	Max T (°C)	Min T (°C)	RH (M) (%)	RH (E) (%)
2006	21.1	6.8	455.5	1.5	33.8	25.7	87.5	65.2
2007	55.3	6.7	320.1	1.1	33.8	25.9	89.2	67.8
2008	21.2	7.3	596.2	2.1	33.1	25.5	89.4	68.1
Corr.		–0.54	–0.86	–0.84	0.57	0.75	0.44	0.42
p value		0.31	0.17	0.18	0.30	0.23	0.35	0.36

PDI, Per cent disease index; SSHr, sunshine hours; Max T, maximum temperature; Min T, Minimum temperature; RH (M), relative humidity morning; RH (E), relative humidity evening; Corr, correlation

Table 2 Whitefly populations/cage (/plant) and weekly mean (27–39 standard meteorological weak) weather parameters and their correlations during 2006, 2007 and 2008

Year	Whitefly pop	SSHr	Rainfall (mm)	No of rainy days	Max T (°C)	Min T (°C)	RH (M) (%)	RH (E) (%)
2006	2.79	7.37	246.30	1.33	33.62	24.96	88.67	64.00
2007	7.92	6.59	169.40	1.00	33.56	25.41	90.33	68.44
2008	1.93	7.74	446.30	1.56	32.54	24.64	90.89	67.89
Corr.		–0.98	–0.80	–0.96	0.57	0.96	0.15	0.48
p value		0.06*	0.20	0.09*	0.30	0.09*	0.45	0.34

pop, Population; SSHr, sunshine hours; Max T, maximum temperature; Min T, minimum temperature; RH (M), relative humidity morning; RH (E), relative humidity evening; Corr, correlation; *significant

(*Bemisia tabaci*) population was taken at weekly intervals using the split cage, counting the actual number of whiteflies in a cage/plant of 50 random plants during August and September and calculated the mean population/plant.

The data on weather parameters commensurate with crop period, July to September (27 to 39) Standard Meteorological Weeks (SMW) each year (Fig 1) was obtained from Department of Agrometeorology. The meteorological observatory situated in Research Farm 30°–45'N, 75° 48/E and 247 m above mean sea level. The metrological parameters considered were maximum and minimum temperature, relative humidity (morning, evening), total rain, number of rainy days and sunshine hours.

The first YMV symptom on trifoliate in indicator-cum-infector rows and susceptible genotypes was observed on 15, 12 and 9 days of seeding in 2006, 2007 and 2008 crop seasons, respectively and maximum disease severity seen on 15 September 30 August and 15 September. Correlation between mean weekly (SMW 27 to SMW 39) meteorological parameters and PDI reflected YMV severity to be negatively correlated with total rainfall (r= –0.86), number of rainy days (r= –0.84) and sunshine hours (r= –0.54) but positively correlated with minimum temperature (r= 0.75) and maximum temperature (r= 0.57). Relative humidity both during morning (r=0.44) and evening (r=0.42) showed positive correlation with the PDI (Table 1) conforming to Chahal *et al.* (2009). Correlation between mean weekly (SMW 31 to 39) meteorological parameters and WFP was highly negatively correlated with number of rainy days r = –0.96, p= 0.09) and total rainfall (r= –0.80), as also reported by (Chenulu 1984) that continues rain destroy the larvae and the instars. Higher r value indicated significantly correlation of whitefly population with minimum temperature (r=0.96, *p*=0.09) and evening relative humidity (0.48) than with morning relative humidity and maximum temperature (Table 2) in conformity to Chahal *et al.* (2009). Whereas significantly negative correlation with sunshine hours (r= –0.98, *p*=0.06) specify for the haziness or overcast weather favouring whitefly population.

Although the PDI was found highly correlated with minimum temperature, total rainfall and number of rainy days, their P values were not significant probably due to smaller data set and also that out of the 3 years of experimentation only 2007 was good epidemic year as compared to 2006 and 2008.

Fifty four elite genotypes evaluated for YMV during 2006, 2007 and 2008 consecutively revealed 14 genotypes with consistence YMV resistance scoring> 3.0 during the years of experimentation (Table 3), which may be attributed to dominant genes. Another 16 genotypes scored> 3.0 during 2006 and 2008 but scored 3.1 to 5.0 during 2007. These genotypes were 'ML707', 'ML818', 'ML933', 'ML1108', 'ML1268', 'ML1286', 'ML1296', 'ML1299', 'ML1330', 'ML1331', 'ML1447', 'ML1459', 'ML1472', 'ML1484', 'ML1488' and 'MH 96–1'. Twelve genotypes that were resistant during 2006 and 2008 showed moderately

Table 3 Reaction of greengram genotypes against yellow mosaic virus from 2006 to 2008

Genotype	YMV disease score (1–9 scale)			Mean disease score
	2006	2007	2008	
'ML 1194'	1.0	1.5	1.0	1.2
'ML 1229'	0.0	2.5	0.0	0.8
'ML 1294'	1.0	2.5	0.0	1.2
'ML 1349'	1.0	3.0	1.0	1.1
'ML 1352'	0.5	2.0	0.0	0.8
'ML 1354'	1.0	1.5	0.0	0.8
'ML 1361'	1.0	1.5	1.0	1.1
'ML 1369'	1.0	3.0	1.0	1.6
'ML 1392'	0.5	2.0	0.0	0.8
'ML 1464'	0.0	2.5	1.0	1.2
'ML 1465'	1.0	2.0	0.0	1.0
'ML 1451'	0.5	2.0	0.0	0.8
'ML 1455'	0.5	3.0	0.0	1.1
'ML 1470'	0.5	3.0	1.0	1.5
'PAU 911' (resistant check)	0.5	3.0	1.0	1.5

susceptible reaction in 2007 (scoring 5.1 to 7.0). These genotypes were 'ML 613', 'SML 668', 'ML 743', 'ML 763', 'ML 895', 'ML 1109', 'ML 1278', 'ML 1333', 'TM 98-50', 'MH 987', 'MH 25' and 'MH 216'. The resistance in these genotypes can be attributed to minor genes, where some genes may behave differently under stressed conditions. The resistant variety 'PAU 911' and susceptible checks 'RMG 353' and 'PS 16' remained resistant and susceptible respectively in all the 3 years.

Biology of vector in vector disseminated diseases can attribute to some seasonal variation seen on disease severity. The development of vector occurs in temperature ranging from 10 to 32°C with optimum 27°C. The average development time of *B. tabaci* from egg to adult is 23.6 days at 25°C. Eggs fail to hatch at 36°C (Butler *et al*. 1983). The study revealed meteorological factors such as number of rainy days and minimum temperature seem to have critical role on whitefly population and yellow mosaic virus severity. The concordant correlation results of these two meteorological parameters can be taken as positive correlation YMV with WFP.

SUMMARY

Correlation studies between mean weekly (standard meteorological week 31 to 39) meteorological parameters and whitefly population and yellow mosaic virus (SMW 27 to 39) from 2006 to 2008 mungbean growing season revealed that whitefly population was significantly correlated with number of rainy days (P=0.09) and minimum temperature (P=0.09), so was also yellow mosaic virus. The concordant correlation results of these two meteorological parameters can be taken as positive correlation yellow mosaic virus with whitefly population. Out of 54 genotypes, 14 showed consistent yellow mosaic virus resistance depicting resistance governed by major gene/s.

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