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RESEARCH PAPER

Prevalence and population dynamics of whitefly transmitting horsegram yellow mosaic disease in northern Karnataka

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Abstract: Horsegram (*Macrotyloma uniûorum* (Lam.) Verdc.) is an underutilized multi-purpose legume crop with inherent stress tolerance, high seed protein, dietary fibre, micronutrients and nutraceutical properties. Yellow Mosaic Disease (YMD) poses a significant challenge to horsegram production in India, potentially resulting in complete yield loss. Accordingly, fixed plot survey for incidence of YMD in horsegram across northern parts of Karnataka during summer 2023-24 and population dynamics of whitefly transmitting YMD in horsegram at Dharwad was carried out. Survey indicated the present status of YMD of horsegram in four districts of northern parts of Karnataka during summer 2023-24. Highest disease incidence was observed in Agricultural Research Station, Bailhongal (48.72%), followed by Regional Agricultural Research Station, Vijayapura (40.18%), Main Agricultural Research Station, Dharwad (35.98%) and least disease incidence was observed in Agricultural Research Station, Bagalkot (20.47%). The whitefly population was highest during 11th and 10th Standard Meteorological Weeks (SMWs), with mean values of 81.2 and 70.3, respectively. The whitefly population buildup showed significant positive correlation with temperature and sunshine duration and negative correlation with relative humidity and rainfall. The whitefly population increased with the rise of maximum temperature and decline of rainfall.

Key words: Horsegram, Population dynamics, Survey, Whitefly, Yellow mosaic disease

Introduction

Horsegram (*Macrotyloma uniflorum* (Lam.) Verde.) popularly known as poor man's pulse crop, is a hardy legume valued for its quickly digested high-quality protein. It belongs to family *Leguminosae* and sub-family *Papilionaceae*.

It is an indigenous plant cultivated in dry lands of India, Australia, Burma, Sri Lanka, Nepal and Malaysia. It is mainly cultivated in the states of Karnataka, Andhra Pradesh, Orissa, Tamil Nadu, Madhya Pradesh, Chhattisgarh, Bihar, West Bengal, Jharkhand and in foot hills of Uttaranchal and Himachal Pradesh in India. In Karnataka, it is grown in districts like Mysuru, Tumakuru, Ballari, Raichur, Bagalkot, Mandya, Hassan, Chamarajanagar, Vijayapura, Chitradurga, Kolar and Koppal districts. In India, it is cultivated in 0.507 m ha area with total production of 0.262 m t and productivity of 516 kg/ha. Karnataka ranks first in production with 0.096 m t and covers an area of 0.147 m ha with productivity of 655 kg/ha (Anon., 2022).

Major diseases that impact horsegram production are powdery mildew, anthracnose, dry root rot, leaf spot, rust and cottony stem rot. Among the viral diseases, the yellow mosaic disease poses considerable challenge to its cultivation in peninsular India. The YMD of horsegram was first time reported by Williams *et al*. (1968). Initially, the symptoms manifest as yellow-colored spots scattered on young leaves followed by yellow mosaic pattern. Later, the spots gradually increase in size resulting in complete yellowing of leaves that slowly dry and wither. Infected plants bear few flowers and pods with some immature and deformed seeds, thus affecting the yield both qualitatively and quantitatively. YMD is a critical disease that primarily affects crops during the summer and late *Rabi* seasons. Four distinct species are responsible for YMD in various leguminous plants: Mungbean Yellow Mosaic India Virus (MYMIV), Mungbean Yellow Mosaic Virus (MYMV), Horsegram Yellow Mosaic Virus (HgYMV) and Dolichos Yellow Mosaic Virus (DYMV) (Appu and Prema, 2024).

There is a need to initiate studies on YMD of horsegram since this virus is transmissible to other leguminous hosts. Thus, the present investigations on prevalence and population dynamics of whitefly transmitting YMD in horsegram across northern Karnataka were carried out at Dharwad.

Material and methods

Fixed plot survey was carried out in four selected locations of northern parts of Karnataka during summer 2023-24. Details of fixed plot survey are given below.

Experimental details:

YMD susceptible genotype	BGM-1
Plot size	10 m × 10 m
Spacing	45 cm × 10 cm
Crop grown condition	Need based irrigation
Season	Summer 2023-24

Observation on per cent disease incidence was taken at physiological maturity by using the formula mentioned below (Wheeler, 1969).

$$\text{Per cent disease incidence} = \frac{\text{Total number of infected plants}}{\text{Total number of plants observed}} \times 100$$

The observation was taken on whitefly population at weekly interval at MARS, Dharwad. A set of five yellow sticky traps were installed each week above the crop canopy. These traps were removed after 7 days of installation in the field and the whiteflies were collected and their numbers were recorded from each trap weekly. Meteorological data, including temperature, humidity, rainfall and sunshine hours during the cropping period, was obtained from the Meteorological Observatory at MARS, Dharwad. A basic correlation analysis was conducted between the whitefly population and various abiotic environmental factors using the following formula.

$$r_{xy} = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{n}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{n}\right]}}$$

Where,

r_{xy} = Simple correlation coefficient

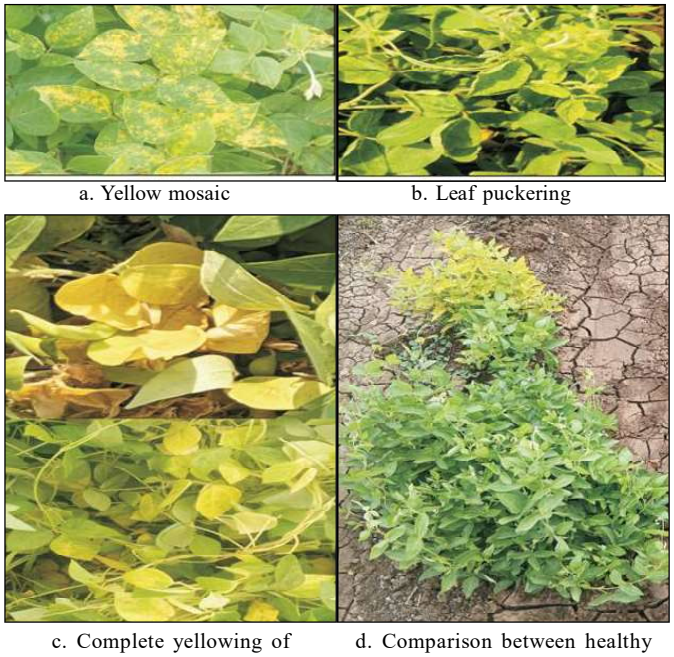
X = Abiotic components

Y = The mean number of whiteflies

n = Number of observations

Results and discussion

The data revealed incidence of YMD in all surveyed locations. During the survey, it was noticed that different kinds of symptoms appeared in the fields of horsegram *viz*., initially yellow-colored spots scattered on young leaves followed by yellow mosaic pattern and puckering and slow drying of yellow leaves which gradually wither. Infected plants had few flowers and pods with some immature and deformed seeds (Fig. 1).



a. Yellow mosaic b. Leaf puckering

c. Complete yellowing of leaves due to YMD d. Comparison between healthy and stunted plant (YMV infected)

Fig. 1: Symptoms of YMD on horsegram observed during survey (summer 2023-24)

Highest disease incidence was observed in Agricultural Research Station, Bailhongal (48.72%), followed by Regional Agricultural Research Station, Vijayapura (40.18%), Main Agricultural Research Station, Dharwad (35.98%) and least disease incidence was observed in Agricultural Research Station, Bagalkot (20.47%) (Table 1 and Fig. 2).

Similar results were reported by Ganesh *et al.* (2020) who conducted a roving survey to assess the status of yellow mosaic disease incidence on horsegram in major horsegram growing areas of north eastern Karnataka. The highest disease incidence was observed in Koppal (37.25% to 44.91%), followed by Bellary (26.75% to 43.00%) and Raichur (10.68 % to 33.50 %). Similar results were reported by Patel and Mahatma (2023) who conducted a roving survey at different districts of South Gujarat and a fixed plot survey at the farms of Pulses and Castor Research Station, Navsari Agricultural University, Navsari, during summer 2019, to know the status of the mungbean yellow mosaic virus on mung bean. The results of the roving field survey revealed that the per cent disease incidence ranged from 0.00 to 99.60. The highest average per cent disease incidence of 14.48 per cent was recorded in Valsad district followed by Dangs, Tapi, Surat and Navsari districts with 10.49, 8.38, 6.43 and 1.63 per cent disease incidence, respectively. Among the surveyed villages, Hathuka of Tapi district and Chival of Valsad district had maximum PDI of 99.60 and 96.0 per cent, respectively. The PDI of the fixed plot survey ranged from 0.00 to 94.00 per cent.

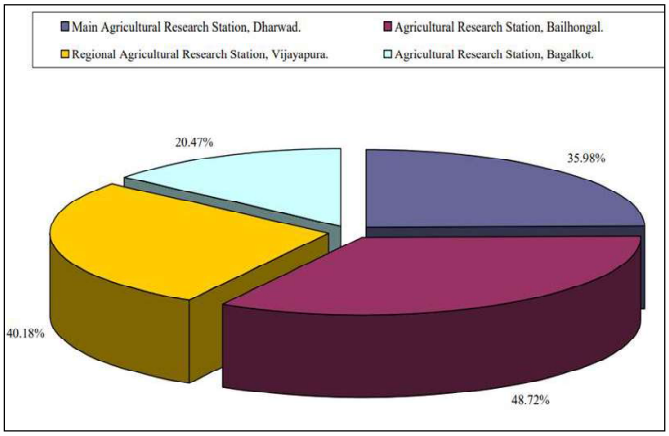


Fig 2. Disease incidence of YMD in horsegram at different locations of northern parts of Karnataka during summer 2023-24

Table 1. Disease incidence of YMD in horsegram at different locations of northern parts of Karnataka during summer 2023-24

Districts	Taluks	Locations	Soil type	Date of sowing	Crop stage	Disease incidence(%)
Dharwad	Dharwad	Main Agricultural Research Station, Dharwad	Black soil	28/12/2023	Physiological maturity	35.98
Belagavi	Bailhongal	Agricultural Research Station, Bailhongal	Black soil	11/01/2024	Physiological maturity	48.72
Vijayapura	Vijayapura	Regional Agricultural Research Station, Vijayapura	Black soil	20/01/2024	Physiological maturity	40.18
Bagalkot	Bagalkot	Agricultural Research Station, Bagalkot	Black soil	30/01/2024	Physiological maturity	20.47

Table 2. Influence of weather parameters on population of whiteflies transmitting HgYMD at weekly intervals during summer 2023-24

Weekly intervals	Standard Meteorological Weeks	Maximum temperature (°C)	Minimum temperature (°C)	Max. RH (%)	Min. RH (%)	Sunshine duration (hr)	Rainfall (mm)	Mean whitefly population
07-01-2024	1	29.8	16.6	74.0	46.3	5.8	3.6	10.4
14-01-2024	2	29.7	16.4	71.7	43.4	6.3	0.0	16.8
21-01-2024	3	30.4	15.0	70.6	34.9	8.4	0.0	21.2
28-01-2024	4	31.8	14.8	67.1	31.7	9.3	0.0	39.4
04-02-2024	5	31.4	14.2	68.6	30.9	10.0	0.0	51.5
11-02-2024	6	34.3	16.9	57.9	30.3	9.8	0.0	54.8
18-02-2024	7	34.1	17.2	49.6	24.0	10.0	0.0	62.2
25-02-2024	8	33.9	17.6	54.0	27.3	8.0	0.0	57.1
03-03-2024	9	34.9	19.3	65.7	30.0	9.2	0.0	64.6
10-03-2024	10	35.4	18.9	52.9	29.9	9.6	0.0	70.3
17-03-2024	11	35.9	19.9	54.4	33.7	8.6	0.0	81.2
24-03-2024	12	35.7	20.9	53.6	31.4	8.2	0.1	52.8
31-03-2024	13	37.0	21.9	70.0	41.3	8.5	0.0	68.2
07-04-2024	14	36.3	20.8	67.2	30.3	8.3	0.0	54.6
14-04-2024	15	36.7	21.4	69.3	30.6	7.7	0.0	61.1
21-04-2024	16	32.6	18.6	68.9	39.3	5.2	38.31	45.8
28-04-2024	17	36.4	19.9	59.6	28.4	7.8	0.0	56.2

The whitefly population was highest during the 11th and 10th Standard Meteorological Weeks (SMWs), with mean values of 81.2 and 70.3 per yellow sticky trap, respectively, and lowest during the 1st and 2nd SMWs, with a mean value of 10.4 and 16.8. The population of whitefly was highest during the 11th Standard Meteorological Week (SMW), when the maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, sunshine duration and rainfall were 35.9°C, 19.9°C, 54.4 per cent, 33.7 per cent, 8.6 hours and 0.0 mm, respectively, followed by 10th SMW with maximum temperature (35.4°C), minimum temperature (18.9°C), maximum relative humidity (52.9%), minimum relative humidity (2%), sunshine duration (9.6 hours) and rainfall (0.0 mm). The population of whitefly was lowest during the 1st Standard Meteorological Week (SMW), when the maximum temperature, minimum temperature, maximum relative humidity, minimum relative humidity, sunshine duration and rainfall were 29.8°C, 16.6°C, 74.0 per cent, 46.3 per cent, 5.8 hours and 3.6 mm, respectively, followed by 2nd SMW with maximum temperature (29.7°C), minimum temperature (16.4°C), maximum relative humidity (71.7%), minimum relative humidity (43.4%), sunshine duration (6.3 hours) and rainfall (0.0 mm) (Table 2 and Fig. 3).

The population buildup showed a strong significant positive correlation with maximum temperature (r = 0.848), minimum temperature (r = 0.576) and sunshine duration (r = 0.588). There was a significant negative correlation with maximum relative humidity (r = - 0.618), minimum relative humidity (r = - 0.597) and rainfall (r = - 0.543) (Table 3). The present findings align with the results demonstrated by Srivastava *et al.* (2021) who reported a significant positive relationship between maximum temperature, sunshine hours and the number of whitefly populations with YMD in soybean. Conversely, rainfall and evening relative humidity exhibited a negative correlation.

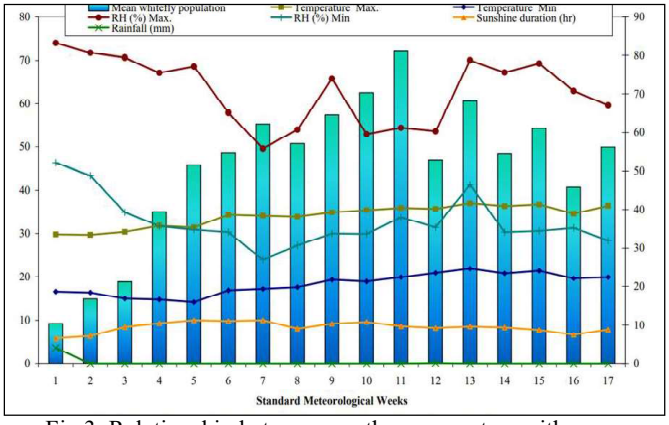


Fig 3. Relationship between weather parameters with mean whitefly population transmitting HgYMD at different SMWs during summer 2023-24

Table 3. Correlation analysis between the whitefly population transmitting HgYMD and weather parameters during summer 2023-24

Whitefly population	Maximum temperature (°C)	Minimum temperature (°C)	Max. RH (%)	Min. RH (%)	Sunshine duration (hr)	Rainfall (mm)
r	0.848^{S**}	0.576^{S**}	-0.618^{S**}	-0.597^{S*}	0.588^{S*}	-0.543^{S*}

r- Correlation co-efficient NS- Non significant S- Significant

**Correlation is significant at the 0.01 level *Correlation is significant at the 0.05 level

Conclusion

Survey indicated the present status of YMD of horsegram in the four districts of northern parts of Karnataka during summer 2023-24 which ranged from 20.47 per cent (ARS, Bagalkot) to 48.72 per cent (ARS, Bailhongal).

The whitefly population was highest during the 11th and 10th Standard Meteorological Weeks (SMWs), with mean values of 81.2 and 70.3, respectively. The whitefly population buildup showed significant positive correlation with maximum temperature, minimum temperature and sunshine duration and negative correlation with maximum relative humidity, minimum relative humidity and rainfall. The whitefly population increased with the rise of maximum temperature and decline of rainfall.

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