Role of Barrier and Intercrops in the Management of Mungbean Yellow Mosaic Virus (MYMV) Disease in Jharkhand, India

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Authors' contributions

This work was carried out by author PK under the guidance and supervision of author SMP. Author PK designed the study, performed the statistical analysis managed the analyses of the study, wrote the first draft of the manuscript and the protocol. Both the Authors have read and approved the final manuscript.

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ABSTRACT

Field trials were carried out during 2018-2019 and 2019-2020 autumn seasons to study the role of barrier and intercrops against whitefly-borne Mungbean yellow mosaic virus (MYMV) disease. In the treatment (T₂) two rows of Maize sown after 15 rows of Mungbean, the lowest mean population of whitefly 7.03 per plant was recorded which was followed by 7.42 whitefly per plant in the treatment (T₄) with two rows of Sorghum after 15 rows of Mungbean. In barrier crops, the lowest disease incidence of 28.94% was recorded in the treatment (T₂), two rows of maize after 15 rows of Mungbean. The mean seed yield recorded was 6.75 q/ha. The treatment (T₂), two rows of Maize after 15 rows of Mungbean was recorded to be effective in the management of MYMV disease. The lowest mean whitefly population of 4.71 per plant was recorded in the above treatment, Mungbean sown with Maize in 4:2 ratio. Mungbean sown with Maize in 4:2 ratio was recorded to be efficacious in the management of MYMV disease. The results indicated that the barrier crop of maize interfered with the movement of vector whiteflies.

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1. INTRODUCTION

Mungbean yellow mosaic virus (MYMV) disease is a major constraint in Mungbean production in India [8,4]. The disease was first recorded from New Delhi in 1955 [7] on Mungbean. The virus belongs to the Family, Geminiviridae and Genus Begomovirus consisting of virus particles with circular (20×30 nm) single stranded ss-DNA genome [6]. The disease is spread in nature through the whitefly vector, Bemisia tabaci in the persistent (circulative) manner, and by inoculation with sap. [1]. Nymphs of Bemisia tabaci acquires the virus from diseased leaves [8]. Female adults are over three times more efficient as vectors than males. As observed, infection usually spreads during the beginning of monsoon in India. Higher incidences occur in regions where the temperature ranges between 31 to 35°C with relative humidity of around 70 percent [13]. These conditions favour disease development and multiplication of the whitefly vector, Bemisia tabaci. Infected crops produce different kinds of symptoms including yellow mosaic on leaves and pods [12]. The infection causes irregular green and yellow patches on older leaves and completes yellowing of younger leaves [8]. Infected plant produces less flowers and pods, pods remain small, contain few seeds which are often malformed, shrieved, discolored, affecting the crop qualitatively and quantitatively. Cultural practices play a significant role in management of whitefly population that leads to subsequent reduction in MYMV disease occurrence. Hence the present study was conducted to investigate the effect of barrier crop and intercrop on management of MYMV disease in Mungbean.

2. MATERIALS AND METHODS

Field trials were conducted during 2018-2019 and 2019-2020 Kharif (autumn) at demonstration Farm of Krishi Vigyan Kendra, Hazaribagh, Jharkhand. using the susceptible mungbean variety, SML 668. The soil of experimental field was red soil loamy sand with 5.72 pH and medium Organic Carbon (0.57 %), N- 228.0 kg/ha, P- 13.67 kg/ha, K- 125.0 kg/ha, S- 12.5 kg /ha.

The trials were conducted in Randomized Block Design and included barrier crops in seven treatments viz., T1 - 1 row of Maize after 10 rows of Mungbean, T2 - 2 rows of Maize after 15 rows of Mungbean, T3 -1 row of Sorghum after 10 rows of Mungbean, T4 - 2 rows of Sorghum after 15 rows of Mungbean, T5 - 1 row of Pearl millet after 10 rows of Mungbean, T6 - 2 rows of Pearl millet after 15 rows of Mungbean and T7 - Control.

The trial also included nine intercropping treatments viz., T1 - Mungbean + Pigeonpea (4:1), T2 - Mungbean + Pigeonpea (4:2), T3 - Mungbean + Maize (4:1), T4 - Mungbean + Maize (4:2), T5 - Mungbean + Sorghum (4:1), T6 - Mungbean + Sorghum (4:2), T7 - Mungbean + Pearl Millet (4:1), T8 - Mungbean + Pearl Millet (4:2), and T9 - Control.

The percentage MYMV incidence was recorded by counting the number of plants infected by MYMV and the total number of plants in the plot and converted to the incidence percentage. The Mungbean seed yield from each plot assessed separately and converted to quintal per hectare (q/ha).

Disease incidence was calculated by the following formula:

\[
\text{Percentage of disease incidence (\%)} = \frac{\text{Number of infected plants in a row}}{\text{Total number of Plants in a row}} \times 100
\]

2.1 Vector Population

Observations on population of adult whiteflies in each treatment were recorded. The number of whiteflies on top 3 trifoliate viz., top, middle and bottom leaves per plant from each of five randomly selected plants at one day before was recorded in each treatment. Analysis of variance was done using OPSTAT statistical package [14].

3. RESULTS AND DISCUSSION

The lowest mean population of whitefly was 7.03 per plant and were recorded in T2 (2 Row of Maize after 15 row of Mungbean) followed by 7.42 whiteflies per plant in T4 (2 Row of Sorghum after 15 row of Mungbean), 7.74 whiteflies per plant in T8 (2 Row of Pearl millet after 15 row of Mungbean) and 7.88 whiteflies per plant in T1 (1 Row of Maize after 10 row of Mungbean). The highest population of 10.26 whiteflies per plant was recorded in control Plot (T7) in sole Mungbean crop (Table 1).
Fig. 1. Effect of barrier crops on management of whitefly, *Bemisia tabaci* (*Gennadius*) transmitted MYMV in Mungbean in Jharkhand, India

Fig. 2. Effect of barrier crops on management MYMV in Mungbean in Jharkhand, India

Fig. 3. Effect of intercropping on management of whitefly, *Bemisia tabaci* (*Gennadius*) transmitted MYMV in Mungbean in Jharkhand, India
The MYMV disease incidence in barrier crop showed significant variation among the treatments during the period of experimentation. Pooled mean disease incidence ranged from 28.94 to 40.92% (Table 1; Fig. 3). Percentage of disease incidence followed the same trend as in the case of whitefly population among all the treatments. The highest disease incidence of 40.92% was recorded in T7 (Control) and the lowest of 28.94% recorded in T2 followed by T4 with 30.87% disease incidence. The mean seed yield varied from 4.30 to 6.98 q/ha among all the treatments. A decreasing order of yield were recorded among different treatments T2 (6.75 q/ha) > T4 (6.26 q/ha) > T1 (6.08 q/ha) > T3 (5.40 q/ha) > T5 (4.30 q/ha). The treatment T2 (2 Row of Maize after 15 rows of Mungbean) was found to be effective in the management of MYMV disease.

The data pertaining to disease transmission in intercropping trial is presented in Table 2, and Fig. 3. The lowest mean whitefly population of 4.71 per plant was recorded in T4 (Mungbean+ Maize (4:2)) followed by 5.63 whitefly per plant in T6 (Mungbean+ Sorghum (4:2), 6.17 whitefly per plant in T5 (Mungbean+ Pearl Millet (4:2) and 6.87 whitefly per plant in T2 (Mungbean+ Pigeonpea (4:2)) the highest population of 23.44 whitefly per plant recorded in control Plot (T0) in sole mungbean crop.

The MYMV disease incidence in intercropping trial showed significant variation among different treatments during the period. Pooled mean disease incidence ranged from 25.27 to 43.94% (Table 2, Fig. 4). Percentage of disease incidence also followed the same trend as in whitefly population in all the treatments. Highest disease incidence of 43.94 - % was observed in T9 (Control) and lowest 25.27 -% recorded in T4 followed by T6 with 26.38 -% disease incidence. Mean seed yield varied from 4.40 to 8.39 q/ha among the all treatments.

The following decreasing order of yield was obtained from different treatments T4 (8.39 q/ha) > T6 (7.51 q/ha) > T5 (6.54 q/ha) > T2 (6.45 q/ha) > T3 (6.34 q/ha) > T7 (6.29 q/ha) > T8 (5.32 q/ha) > T1 (4.39 q/ha) > T9 (4.40 q/ha). The treatment T4 (Mungbean+ Maize (4:2) was found efficacious in the management of MYMV disease. The results indicate that the barrier crop of maize interfered with the movement of vector whiteflies.

The efficacy of maize and pearl millet as a border crops which reduced 9.88 % and 9.81 % MYMV disease incidence in soybean as compared to control [11]. The efficacy of insecticides, barrier crops and spacing on the incidence of mosaic virus disease and yield of French bean [15]. [3] investigated and reported that five barrier plants were effective in reducing the occurrence of mosaic virus disease in French bean by breaking flight of the vector. [16] found that growing beans with maize resulted in less incidence of several diseases and pests including bean common mosaic virus compared with monoculture stands. [13] reported the efficacy of cultural practices on virus infection in cowpea. [10] showed growing maize with beans or weeds reduced leafhopper vector abundance and decreased...
Table 1. Effect of barrier crops on management of whitefly, *Bemisia tabaci* (*Gennadius*) which transmitted MYMV in Mungbean in Jharkhand, India

| Treatments                                      | Whitefly population/plant | Per cent MYMV disease incidence | Yield (q/ha) |
|-------------------------------------------------|---------------------------|---------------------------------|--------------|
|                                                 | 2018-19       | 2019-20  | Mean      | 2018-19 | 2019-20 | Mean | 2018-19   | 2019-20 | Mean |
| T1 1 row of Maize after 10 rows of Mungbean    | 8.11          | 7.66    | 7.88      | 33.47   | 32.94   | 33.20 | 6.01      | 6.15    | 6.08 |
|                                                 | (2.92) **     | (2.85)  | (2.73)    | (35.34)*|(34.94)  |
| T2 2 rows of Maize after 15 rows of Mungbean   | 7.10          | 6.96    | 7.03      | 30.61   | 27.28   | 28.94 | 6.87      | 7.10    | 6.98 |
|                                                 | (2.76)        | (2.73)  | (2.73)    | (33.56) | (31.43) |      |           |         |      |
| T3 1 row of Sorghum after 10 rows of Mungbean  | 9.11          | 8.14    | 8.63      | 35.27   | 33.47   | 34.37 | 5.44      | 5.78    | 5.61 |
|                                                 | (3.10)        | (2.93)  | (2.93)    | (36.42) | (35.34) |      |           |         |      |
| T4 2 rows of Sorghum after 15 rows of Mungbean | 7.81          | 7.03    | 7.42      | 32.13   | 29.61   | 30.87 | 6.61      | 6.88    | 6.75 |
|                                                 | (2.88)        | (2.74)  | (2.74)    | (34.51) | (32.89) |      |           |         |      |
| T5 1 row of Pearl millet after 10 rows of Mungbean | 8.48        | 8.31    | 8.40      | 37.58   | 35.58   | 36.58 | 5.17      | 5.70    | 5.44 |
|                                                 | (2.99)        | (2.97)  | (2.97)    | (37.80) | (36.59) |      |           |         |      |
| T6 2 rows of Pearl millet after 15 rows of Mungbean | 8.23        | 7.25    | 7.74      | 33.89   | 31.33   | 32.61 | 6.20      | 6.31    | 6.26 |
|                                                 | (2.96)        | (2.78)  | (2.78)    | (35.57) | (33.98) |      |           |         |      |
| T7 Control                                      | 10.47         | 10.05   | 10.26     | 41.25   | 40.58   | 40.92 | 4.33      | 4.27    | 4.30 |
|                                                 | (3.31)        | (3.25)  | (3.25)    | (39.93) | (39.53) |      |           |         |      |
| SEm±                                            | 0.10          | 0.09    | 0.07      | 1.26    | 1.63    | 1.03  | 0.60      | 0.44    | 0.37 |
| CD 5%                                           | 0.30          | 0.27    | 0.19      | 3.88    | 5.01    | 3.00  | 1.85      | 1.34    | 1.08 |
| CV %                                            | 5.62          | 5.19    | 5.42      | 6.03    | 8.06    | 7.09  | 7.52      | 5.32    | 6.49 |

**Figures in parentheses are square root transformed values, * Figures in parantheses are angular transformed values**
Table 2. Effect of intercropping on management of whitefly, *Bemisia tabaci* (*Gennadius*) which transmitted MYMV in Mungbean in Jharkhand, India

| Treatments                  | Whitefly population/plant | Per cent MYMV disease incidence | Yield (q/ha) |
|-----------------------------|---------------------------|---------------------------------|--------------|
|                             | 2018-19  | 2019-20  | Mean     | 2018-19  | 2019-20  | Mean     | 2018-19  | 2019-20  | Mean     |
| T1  | Mung bean + Pigeon pea (4:1) | 9.85 (3.21)** | 9.59 (3.17) | 9.72     | 35.46 (36.53)* | 33.46 (35.31) | 34.46     | 4.49     | 4.30     | 4.39     |
| T2  | Mung bean + Pigeon pea (4:2) | 6.97  (2.73) | 6.77 (2.70) | 6.87     | 29.78 (33.06) | 28.28 (31.12) | 29.03     | 6.61     | 6.29     | 6.45     |
| T3  | Mung bean + Maize (4:1)   | 7.39  (2.81) | 7.17 (2.76) | 7.28     | 30.51 (33.47) | 29.15 (32.60) | 29.83     | 6.17     | 6.51     | 6.34     |
| T4  | Mung bean + Maize (4:2)   | 4.88  (2.32) | 4.55 (2.24) | 4.71     | 25.77 (30.50) | 24.77 (29.82) | 25.27     | 8.18     | 8.60     | 8.39     |
| T5  | Mung bean + Sorghum (4:1) | 7.81  (2.88) | 8.01 (2.91) | 7.91     | 31.97 (34.42) | 30.44 (33.48) | 31.21     | 6.06     | 6.51     | 6.29     |
| T6  | Mung bean + Sorghum (4:2) | 5.59  (2.46) | 5.66 (2.48) | 5.63     | 26.55 (30.97) | 26.21 (30.76) | 26.38     | 7.54     | 7.48     | 7.51     |
| T7  | Mung bean + Pearl Millet (4:1) | 8.64 (3.02) | 7.78 (2.87) | 8.21     | 32.82 (34.91) | 31.26 (33.98) | 32.04     | 5.25     | 5.38     | 5.32     |
| T8  | Mungbean + Pearl Millet (4:2) | 6.10 (2.56) | 6.23 (2.59) | 6.17     | 27.43 (31.57) | 26.87 (31.21) | 27.15     | 6.85     | 6.22     | 6.54     |
| T9  | Control                    | 25.77 (5.12) | 21.10 (4.64) | 23.44 | 44.10 (41.61) | 43.77 (41.40) | 43.94     | 4.40     | 4.40     | 4.40     |

|                | SEM±   | CD 5%  | CV %   |
|----------------|-------|--------|--------|
| 2018-19        | 0.13  | 0.38   | 7.21   |
| 2019-20        | 0.09  | 0.27   | 5.39   |
| Mean           | 0.08  | 0.22   | 7.81   |
| Per cent MYMV disease incidence | 1.39 | 4.18 | 7.08 |
| Mean           | 1.38  | 4.14   | 7.16   |
| Yield (q/ha)   | 0.98  | 2.83   | 7.12   |
| Mean           | 0.50  | 1.50   | 6.07   |

**Figures in parentheses are square root transformed values, * Figures in parantheses are angular transformed values**
Spiroplasma kunelii disease in maize. [2] studied and reported patterns of spread of Tomato spotted wilt virus in field crops of lettuce in pepper with reference to Spatial dynamics and validation of control measures. In several instances, plants markedly taller than the primary crop have been chosen as barrier crop because of their likelyhood to intercept insect vector while in flight [5]. [12] however, reported that maize as border crop recorded a higher population of whitefly (6.20 whitefly/Plant) and 44.51 % MYM disease in mungbean and the treatment found ineffective in management of MYMV disease in mungbean.

4. CONCLUSION

From the present study, it is evident that, cultural practices like barrier and intercrop could be helpful in reducing the natural spread of MYMV disease. Tall barrier and intercrop appears to contribute towards reducing insect vector activity and consequent spread of the disease to the main crop. Maize, Sorghum and Pearl millet crops perhaps intercept whitefly vector activity and indirectly reduces MYMV disease spread to the main Mungbean crop. The formation of physical barrier between the vector and host plant could be the first line of defense and used in the integrated management of MYMV disease.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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