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RK Bagri
Associate Professor, RARI, Durgapura, Jaipur, Rajasthan, India

SK Goyal
Assistant Professor, RARI, Durgapura, Jaipur, Rajasthan, India

J Singh
Assistant Professor, College of Agriculture, Bharatpur, Rajasthan, India

Vipen Kumar
Associate Professor, RARI, Durgapura, Jaipur, Rajasthan, India

RS Sharma
Assistant Professor, RARI, Durgapura, Jaipur, Rajasthan, India

Pryanka
Ph.D., Scholar, RARI, Durgapura, Jaipur, Rajasthan, India

Corresponding Author:
RK Bagri
Associate Professor, RARI, Durgapura, Jaipur, Rajasthan, India

Management of mosaic disease of Bottle Gourd (*Lagenaria siceraria* (Mol.) Stand) through integrated methods

RK Bagri, SK Goyal, J Singh, Vipen Kumar, RS Sharma and Pryanka

Abstract
Mosaic disease of bottle guard [*Lagenaria siceraria* (Mol.) Standl] is one of the most important foliar diseases, causing significant loss in India. The pathogen has wide geographical distribution and has been reported in over 100 countries, including environments ranging from semi arid to tropical. It is the most widely distributed and important virus disease of cucurbits The field trial was conducted during *Kharif* season of 2015 to 2018 at RARI, Durgapura for the integrated disease management of mosaic disease in bottle gourd through different means and combinations among seven treatments. The minimum disease incidence (6.56%) and maximum yield (338.5 q/ha) were observed in treatment T_5(T_0+ Seed treatment with carbendazim 12%+ mancozeb 63% @ 3 g/kg and drenching of Captan 70% + Hexaconazole 5% WP @ 0.1% 15 days after germination followed by spraying of Tebuconazole 50% + Trifloxystrobin 25% @1g/l + spray with (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @ 0.1% followed by spraying of Tebuconazole 50% + Trifloxystrobin 25% @1g/l + spray with (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @ 0.1% at 10 days interval) while maximum disease incidence (40.13%)and minimum yield (225.7 q/ha)were observed in treatment T_7(Control). Natural products such as herbal extracts may provide alternatives to synthetic fungicides.

Keywords: Bottle gourd, mosaic virus, integrated management

Introduction
Bottle gourd [*Lagenaria siceraria* (Mol.) Standl] is a commonly grown vegetable crop in India, which is also grown in Ethiopia, Africa, Central America and other warmer regions of the world. It is widely grown on open fields as well as in river beds throughout the year. It is also suitable for cultivation in hot dry areas. The fruits can be used as a vegetable or for making sweets. As a vegetable, it is easily digestible, even by patients (Thamburaj and Singh, 2000) [12]. It is gaining importance due to its high yield potential, steady market price throughout the season. The fruits contain 0.2% protein, 2.9% carbohydrates, 0.5% fat and 11 mg of vitamin C per 100 g fresh weight (Aykroyd, 1963) [2]. It also has wide medicinal properties such as laxative, digestive and to prevent constipation. The crop is attacked by a number of diseases such as, *Cercospora* leaf spot, *Alternaria* leaf blight, powdery mildew, downy mildew anthracnose and virus, amongst which *mosaic virus* is found to cause serious losses throughout Rajasthan and other states. Mosaic virus is important virus disease of cucurbits. On bottlegourd the first symptoms appear on young leaves that exhibit mottled mosaic leaf pattern of alternate light green and dark green patches with edges and curled downward. The characteristic symptoms are yellow colored mottling, leaf destoration and stunted plant growth due to shortening of stem internodes. Dead leaf either fall off or droops; wilting of the petioles occur leaving the older vine mostly bare (MacNab *et al*., 1983) [8]. This virus transmitted through aphid vector and also through seed and several weed hosts. It can be transmitted through sap adhered on the hand and cloths of workers harvesting fruits. Agrios 1978 [1] has reported that the entire field of cucurbits sometimes turns yellow due to CMV immediately after the first harvest. Keeping in view, the present study was undertaken to aware the management of mosaic virus of bottle gourd in under semi arid conditions in Rajasthan.

Materials and Methods
The field trials were conducted during rainy season of 2015 to 2018 at Rajasthan Agricultural Research Institute, Durgapura, Jaipur in vegetable block.

A bottle gourd variety Pusa Naveen was sown on *Kharif* in all years in the field in Randomized Block Design with three replications for integrated management of mosaic disease of bottle gourd through botanical, fungicides, insecticide and their different combinations. Seven treatments such as T_0: Growing of two rows of maize as border crops and use of agri silver mulch sheet. T_1: T_0 + Seed treatment with Seed Pro @ 25 g/kg and soil drenching of Seed Pro @ 5% at 1st true leaf stage after germination followed by 5-6 spray of Seed Pro (1%) at 10 day interval in rotation with Neem oil (0.2%) alternatively after 15 days after drenching, T_2: T_0 + Seed treatment with carbendazim 12%+ mancozeb 63% @ 3 g/kg and drenching of Captan 70% + Hexaconazole 5% WP @ 0.1% at 1st true leaf stage after germination followed by 5-6 spraying of Seed Pro (1%) at 10 day interval in rotation with Neem oil (0.2%) alternatively after 15 days after drenching' T_3: T_0 + Seed treatment with Seed Pro @ 25 g/kg and soil drenching of Seed Pro @ 5% 1st true leaf stage after germination followed by spraying of Captan 70% + Hexaconazole 5% WP @ 0.1% followed by spraying of (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @ 0.1% followed by Captan 70% + Hexaconazole 5% WP @ 0.1% followed by spraying of (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @ 0.1% at 10 days interval,T_4: T_0 + Seed treatment with Seed Pro @ 25 g/kg and soil drenching of Seed Pro @ 5% at1st true leaf stage after germination followed by spray of (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by spray of Tebuconazole 50%+Trifloxystrobin 25% @1g/l followed by Fosetyl-Al @ 0.1%, followed by spray of Tebuconazole 50%+Trifloxystrobin 25% @1g/l followed by spray of (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @ 0.1% at 10 days interval T_5: T_0 + Seed treatment with carbendazim 12%+ mancozeb 63% @ 3 g/kg and drenching of Captan 70% +Hexaconazole 5% WP @ 0.1% 15 days after germination followed by spraying of Tebuconazole 50% + Trifloxystrobin 25% @1g/l + spray with (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @ 0.1% followed by spraying of Tebuconazole 50% + Trifloxystrobin 25% @1g/l + spray with (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @ 0.1% at 10 days interval,T_6: T_0 + Seed treatment with carbendazim 12%+ mancozeb 63% @ 3 g/kg and drenching of Captan 70% + Hexaconazole 5% WP @ 0.1% 15 days after germination followed by spray with (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%)%) followed by spraying of Captan 70% + Hexaconazole 5% WP @ 0.1% followed by Fosetyl-Al @0.1% followed by spraying of Captan 70% + Hexaconazole 5% WP @ 0.1% + spray with (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%)%) followed by Fosetyl-Al @ 0.1% at 30 days after drenching andT_7: Control were taken for this study. Seed treatment (ST) was done before sowing of bottle gourd crop. Mosaic disease was observed in the field during both the years. The per cent data were angular transformed and statistically analyzed in RBD.

Per cent disease incidence was recorded by using the formula:

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

Different insecticides, seed dresser, plant products and fungicides *viz*.; Seed pro, Carbendazim, mancozeb, Captan, Hexaconazole, Tebuconazole, Trifloxystrobin, Imidacloprid, Neem oil, Fosetyl-Al, Trifloxystrobin were used to check the spread of the disease under field conditions. Cultural method like, Growing of two rows of maize as border crops and use of agri silver mulch sheet. First spray at the time of true leaf stage and six successive sprays at 10 days interval. The percent incidence was calculated by using standard formula (Mckinney, 1923) [7]. The experimental data was analysed by using standard methods to test of the significance (Gomez and Gomez, 1984) [5].

Results and Discussion

Data on disease incidence of mosaic disease are presented in table 1. All the treatments were found superior than control in case of disease incidence. Mosaic disease was found with ranging from 6.54 to 40.13 per cent disease incidence. Among 7 treatments, minimum disease incidence was observed in treatment T_5 (6.54 PDI) i.e. (T_0 + Seed treatment with carbendazim 12%+ mancozeb 63% @ 3 g/kg and drenching of Captan 70% +Hexaconazole 5% WP @ 0.1% 15 days after germination followed by spraying of Tebuconazole 50% + Trifloxystrobin 25% @1g/l + spray with (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @ 0.1% followed by spraying of Tebuconazole 50% + Trifloxystrobin 25% @1g/l + spray with (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @ 0.1% at 10 days intervals) with maximum yield (338.5 Q/ha). Treatment T_5 and T_6 are Statistically at per each other.

The next best treatments was observed T_6 (8.22 PDI) i.e. (T_0 + Seed treatment with carbendazim 12%+ mancozeb 63% @ 3 g/kg and drenching of Captan 70% +Hexaconazole 5% WP @ 0.1% 15 days after germination followed by spraying of Tebuconazole 50% + Trifloxystrobin 25% @1g/l + spray with (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @ 0.1% followed by spraying of Tebuconazole 50% + Trifloxystrobin 25% @1g/l + spray with (Imidacloprid 17.8 SL @ 7.5 ml/ 15 l + Neem oil 0.2%) followed by Fosetyl-Al @ 0.1% at 10 days interval.) with yield(324.8 Q/ha) and maximum disease intensity was observed in treatment T_7(28.54) with minimum Yield(225.7 Q/ha). Baruah *et al*., (2016) [4] reported that seed treatment with Imidacloprid @0.25ml /lit + nursery net + foliar spray with imidacloprid @2ml/l was proved to be most effective in reduction in disease incidence. Isman *et al*., (1990) [6] also reported that application of neem seed and neem seed kernel extract was also found to be effective for the ecofriendly management of aphids which is the major vector of chilli mosaic. Stapleton and summers (2002) [11] reported that use of superreflective plastic mulch *deters* vectors aphids from landing and thus limits the spread of virus and floating row covers or reflective mulches may help exclude or repel aphids

Table 1: Integrated Disease Management of mosaic virus Disease in Bottle Gourd (Pooled 2015-2018).

Treatments	PDI (Mosaic disease)	Yield Q/ha
T_1	17.30(24.53)*	276.2
T_2	14.84(22.57)	285.5
T_3	9.03(17.29)	310.4
T_4	12.18(20.38)	301.3
T_5	6.56(14.76)	338.5
T_6	8.22(16.61)	324.8
T_7	40.13(39.29)	225.7
SEM ±	0.49	11.29
CD 5%	1.39	32.16

Figures in parentheses are angular transformed value

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