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Integrated disease management of blackgram yellow mosaic

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Abstract
Comparative potential IDM packages was evaluated and validated in three successive years to have dependable technology for field level management of yellow mosaic viral disease (YMD) of Black gram by integrating botanicals and insecticides. The basic theme behind such experiments was to come out deliverables which is not only capable to effectively check the disease but vis-a-vis residue free and sustainable. Here our proposed modules were sown the promise over prevailing farmer's practices and build-up of veruliferous pest population was tends to be kept under check since initial stages of plant growth. This is what needed to manage the viral diseases like yellow mosaic of Uradbean. The safe consumable produce was insured by deploying insecticides in initial stage and before flowering where as botanicals and antifeedents were chosen for later stages of plant growth. The deliverable 4 which envisages seed treatment with Thiomethaxame followed by imidachloprid spraying at 20 DAS then one foliar spray of NSKE at 40DAS showed significantly lowest incidence of YMD (9.07 per cent) and white fly population (1.67 / three terminal leaves) with highest number of pods / plants (42.2/ plant), number seeds / pod(4.53 / pod); thousand seed weight (39.99 g), yield (716.67 kg ha) and it was cost effective, as it provide the highest benefit cost ratio(2.56:1). This is obvious observation with our experimentation that if initial population of vectors remain minimal level by insecticides in that case the botanicals and antifeedents efficacy used to be enhanced substantially. The package having seed treatment with Thiomethaxam -75 WG and one foliar spray of Imidachloprid at 20 DAS was rendered second best.

Keywords: Integrated management, YMD, Blackgram, White fly, NSKE

Introduction
Blackgram (*Vigna mungo* L.) also known as Urdbean is one of the Indian origins, high prized, short duration pulse crop. India ranks first in world with 5.6 million hectare acreage and 3.6 million tonnes of production (Project Coordinators Report - 2018) [11]. Blackgram has received important place in Indian diets as dal, idlli, vada, dosa, papad etc., it contains high quality digestible protein (25-26%), Carbohydrate (25-26%), minerals (4.5-5.5%), fat (1.5%), iron (40-70ppm), at dry weight basis and also rich phosphoric acid, making its an decisive alternatives of balance diet. The major blackgram producing states are Andhra Pradesh, Bihar, Karnataka, Maharashtra, Madhya Pradesh, Odhisa, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal (Archana *et al.*, 2018) [2].

In Madhya Pradesh, blackgram has acreage of 1.82 million hectare with 1.73 million tones production and 739 kg / ha productivity (Anonymous, 2018) [1].

The yield potential of Blackgram is much higher than the actual yield the farmers are still realizing because much damage occurs by different biotic and abiotic factors. Among the different biotic factors, the Yellow Mosaic Disease (YMD) caused by *Mungbean yellow mosaic virus* (MYMV), is a most destructive disease and causes 5-100 per cent yield losses in blackgram (Nene, 1972 and Rathi, 2020) [10, 12]. Initially small yellow patches or spots appear on green lamina of young leaves. Soon it changes into characteristic bright yellow patches. Yellow discoloration slowly increases and leaves turn completely yellow. Infected plants mature later and bear few flowers and pods. The pods remain small and distorted (Thilagavathi and Chandrasekaran, 2020) [13].

Although, techniques for management of yellow mosaic disease comprises use of resistant varieties, vector management, management of collateral hosts of viruses and alteration in cultural practices are not found sufficient individually to manage the disease significantly. So, far there is no management strategies directly aimed at virus, use of insecticides is the only option remain left to combat with disease through vector management. But some time because of susceptible varieties, vector populations, presence of collateral hosts and other extraneous

factors like rain fall, weather condition and stage of the crop, insecticide fail to deliver its expected action. That to injudicious use may create resistance in vector, health risk and environmental hazards. Now a day's every one's focus has been shifted towards comparatively safer alternatives of insecticides. In the recent era integrated management practices had got importance in modern agriculture to minimize the hazards of intensive use of insecticides for vector management. Therefore Integrated Disease Management (IDM) that envisages the botanicals and judicious use insecticides and other means would reduce the quantum of toxicant used per season in addition to mitigate disease in an economically viable and sustainable manner.

Therefore, an attempt was made to assess the effect of IDM modules with botanicals and chemicals on yellow mosaic disease incidence and yield of blackgram in comparison with farmer's practices. In order to assess the efficacy of four different treatments including farmer's practice for management of yellow mosaic disease of blackgram, a three year on farm trials were conducted by KVK Singrauli in two adopted villages (Chitarwai kalan and Naugai) during crop season 2017-18, 2018-19 and 2019-20.

Materials and Methods

Field Experiment

The field experiment were conducted during Kharif season of three consecutive years (2017-18, 2018-19 and 2019-20) at 15 farmer's fields of Chitarwai kalan, and Naugai Villages of Singrauli District by Krishi Vigyan Kendra, Singrauli (MP). Here our aim was to found out efficacious integrated disease management modules, against Yellow mosaic disease of blackgram under the On Farm Trial (OFT) programme of KVK. The trials were laid out in randomized block design having four treatments including control (farmers practice) maintaining 5 replications. Each treatment was laid out in 2000 m^2 area. To exclude the effect of cultivar variability high yielding area suitable blackgram variety PU-31 was chosen for this entire trial. Blackgram was sown in second week of July every year at 45 X 15 cm spacing dimensions. Standard agronomic practices were followed to grow the crop which was validated in Madhya Pradesh by Rai *et al.,* (2021), Singh *et al.,* (2021) and Tripathi *et al.,* (2019) [16, 19, 14] Singh.

Table 1: Details of different Integrated Disease Management Modules (IDMs) in Blackgram

Treatments	Detail
T_0	Control (water spray at 20 and 40 DAS)
T_1	Seed treatment with Thiomethaxam-75WG@ 3g/ kg seed + one foliar Spray of NSKE@ 5% at 20DAS
T_2	Seed treatment with Thiomethaxam-75WP@3g/ kg seed + one foliar Spray of Imidachloprid-17.8% SL@ 0.5ml/ lit at 20DAS
T_3	Seed treatment with Thiomethaxam-75WP@3g / kg seed + One foliar Spray of Imidachloprid-17.8% SL@ 0.5 ml/ lit.% at 20 DAS + one foliar Spray of NSKE@ 5% at 40DAS

Incidence of the disease was recorded at 10 days interval by counting total and diseased plants in five middle rows in each plot leaving the borders after 7 days of foliar spray. Percent disease incidence and reduction in disease incidence were calculated by following formulae suggested by Nene (1972) [10].

Percent Disease incidence (PDI) = (Number of infected Plant in plot/ Total number of plant in plot) x 100

Vector populations were monitored by the methods given by Bhattiprolu and Rahman, (2006) [3]. The white fly population was recorded one day before spray and then at each 10 days interval on randomly selected 25 plants in each treatment subjected for statistical analysis. The Observations were also recorded on reduction of disease incidence, no. of pod per plant, number of seeds per plant and seed yield per hectare for each treatment in this trial.

Estimation of Benefit - Cost Ratio

Grain yield of each plot was taken from whole population separately and yield of each module was calculated by cumulating the successive plucking from respective field and computing to killogram per hectare .The data were tabulated, pooled and ranked on the basis of their yield performance. The benefit cost ratio (CBR) of different modules was calculated by estimating different cost of cultivation and return from yield after converting them to one hectare land. Benefit -cost ratio of Blackgram was calculated from Minimum support price of Blackgram in the respective years.

Results and Discussion

Percent Disease Incidence: The pooled results of the three years Table 2 (2018-19, 2019-20 and 2020-21) indicated that all the treatments were found comparatively effective in reducing yellow mosaic disease incidence than control (T_0). Results are presented in table-03 showed that the highest disease incidence (40.2% 5) was observed in control plot (T_0). Among the all four treatments tested, treatment (T_3) having Seed treatment with Thiomethaxam-75WP + One foliar Spray of Imidachloprid-17.8% SL@ 0.5ml/ lit. at 20 DAS) +one foliar Spray of NSKE@ 5% at 40DAS found significantly superior by recording lowest per cent of yellow mosaic disease incidence (9.07%) followed by T_2 where Seed treatment with Thiomethaxam-75WP@3g/ kg seed+ one foliar Spray of Imidachloprid-17.8% SL@ 0.5ml/ lit. at 20 DAS) Our finding clearly indicating that the individual protection measures tested were performing up to some extent but when they were integrated in a suitable manner and spray schedule followed at an early stage of disease occurrence. Then it turns out to be incredible. The above findings are in accordance with Ghosh *et al.*,(2009) [7] who evidenced that Imidachloprid and Thiomethaxam were more effective in reducing yellow mosaic disease incidence and white fly population as compared to other conventional insecticides. Saravanan (2006) [18] found that two spray of 5 per cent neem seed karnal extract at 25 and 50 DAS and recorded lowest incidence of YMD in blackgram.

White fly populations

White fly population was recorded (Table 2) directly on the

leaves early in the morning when they were less active. The average number of white populations at three terminal leaves of each randomly selected plant revealed that lowest average white fly population of 1.67 per three terminal leaves of plant with the per cent population reduction of 64.08 per cent were observed in forth module tested i.e.T_3. The highest average no. of whiteflies per plant (6.27/ three terminal leaves of plant) was recorded in T_0 (Control) which received two sprays of sterilized distilled water at 20 and 40DAS. The results are in consonance with Ganapathy and Karuppaiah (2004) [6]; Radhika *et al.,* (2018) [15] and Ghosh *et al.*,(2009) [7] who reported that Thiomethaxam and Imidachlprid are highly effective in reducing the vector (White fly) population of YMD in Blackgram. Archana *et al.,* (2018) [2] also reported that 2 sprays of Imidacloprid 17.8 SL (@ 0.5 ml/l, 30 and 45 DAS had significantly effective in the management of whitefly population (1.86/plant). Similarly Dubey and Singh (2010) [4] evidenced that Imidachloprid and Thiomethaxam were significantly superior in efficacy against vector of YMD. The systemic nature of Thiomethaxam and Imidachloprid on white fly populations at initial stage might be the reason for low incidence of YMD (Rao *et al.,* 2021). Singh *et al.,* (2011) [17, 20] evidenced that prevention of the nymphal stage from developing adult with the application of NSKE and foliar application of Neem oil.

Yield and yield attributes

The effect of different evaluated integrated yellow mosaic disease management treatments in the present investigation on yield and yield attributes *viz*., no. of seeds / pod, no. of pods / plant, yield / plant and yield / ha were recorded (Table-3). It is apparent from the results that the treatments having lowest per cent disease incidence and white fly population have showed a significant positive impact on all yield attributing characters.

Number of seeds/pod

It is clearly expressed from table-3, there was no significance difference among various treatments with respect to number of seeds / pod. However, Average maximum number (4.53) of seeds / pod was observed in T_3 followed by T2 (4.33 seeds / pod) and T_1(4.07 seeds/ pod). The least no. of seeds / pod (3.67) was recorded in control (T_0).

Number of pods plant

The pooled data of three years in table -3 indicated that the minimum average number of pods / plant (32.93) was recorded in control plot (T_0) whereas the maximum average number of pods / plant (.42.20) was observed in module-T3 with 28.15 per cent increase over the control (T_0).

Yield

In the present study, (Table 3) the treatment T_3 and T_2 proved effective in managing the disease and at the same time increasing yield. The Maximum per cent increase in yield (43.08) was observed with forth package i.e. treatment T_3 followed by T_2 (36.02). The lowest yield among the all treatments was recorded in control plot. However, all the treatments are significantly superior control plot.

The results clearly indicate that treatment which recorded least disease incidence and white fly populations have significant positive impact on yield and yield attributing characters evaluated. Our results were corroborate with Archana *et al.,* (2018) [2]; Jayappa *et al.,* (2017) [9]. Gupta (2003) [8] who are also concluded that a strong negative correlation was recorded between incidences of YMD and yield attributes.

Economics

The economics was also calculated after the experimentation based on the expenditure incurred for different IDM modules under trial. Data presented in the table-4 express the average cost of production, gross return, net return and benefit cost ratio. While comparing the economics of all treatments the maximum net returns of Rs.25143.0 / ha was obtained from T-3 followed by T-2 (Rs. 23264.5 / ha) which is significantly higher than the usual practice done by the farmers of the area of experimentation. Highest benefit–cost ratio i.e. 2.56 in the treatment-3, followed by treatment-2 (2.45). Whereas the lowest number of benefit – cost ratio 1.95 was recorded in control plot (T_0). The effectiveness of the IPM module in the present study is in agreement with the findings of Gajendran *et al.,* (2006) [5] were they reported that cost: benefit ratio higher in IPM plots compared to farmers' practice.

Table 2: Effect of Integrated management modules on YVMV disease incidence of Blackgram

Treatment	Percent Disease incidence(PDI)	Reduction in PDI (%)	White flies population (No. / per Plant)	Reductions in White fly population (%)
T_0	40.20	-	6.27	-
T_1	26.87	33.15	4.65	25.83
T_2	16.73	58.38	2.55	45.16
T_3	9.07	77.43	1.67	64.08
CD at 5%	1.84	NA	0.37	NA

Note: Pooled data of Three years (2017-18, 2018-19 and 2019-20), NA = Not Analyzed

Table 3: Effect of Integrated YVMV Management Modules on Yield and Yield Attributes of Blackgram

Treatment	No. of Pods/Plant	% increase in No. pod/Plant	No. of seed/pod	% Increase in No. of seeds/pod	1000 seed weight (g.)	% Increase in 1000 seeds weight	Plant Yield (g/ Plant)	Increase Plant Yield (%)	Yield (kg/ha)	Increase in Yield (%)
T_0	32.93	-	3.67	-	39.85	-	15.81	-	500.87	-
T_1	38.67	17.43	4.07	10.89	39.91	0.15	17.23	8.98	634.67	26.71
T_2	40.60	23.29	4.33	17.98	39.98	0.32	18.53	17.20	681.33	36.02
T_3	42.20	28.15	4.53	23.43	39.99	0.35	19.17	21.25	716.67	43.08
CD at 5%	2.31	NA	0.93	NA	0.04	NA	0.33	NA	22.90	NA

Note: Pooled data of Three years (2017-18, 2018-19 and 2019-20); NS= Non significant and NA= Not analyzed.

Table 4: Economic of different IDM modules of YVMV management practices in Black gram

Treatments	Cost of Cultivation(Rs./ha)*	Grass return (Rs./ ha)*	Net return (Rs./ ha)*	B:C Ratio*
T_0	14955.16	29166.93	14211.77	1.95:1
T_1	15794.33	36766.33	21017.00	2.33:1
T_2	15995.16	39259.66	23264.50	2.45:1
T_3	16145.00	41288.33	25143.33	2.56:1

Note: * Average data of Three years (2017-18, 2018-19 and 2019-20).

Conclusions

The results of present investigation showed that considering the disease control potential, grain yield gain, and maximum protection due to disease losses and net return and favorable benefit cost ratio as well as sustainability, the moduleT_3 (Seed treatment with Thiomethaxam-75WP@3g/ kg seed+ One foliar Spray of Imidachloprid-17.8% SL@ 0.5ml/ lit. at 20 DAS) + one foliar Spray of NSKE@ 5% at 40DAS, would be recommended for the management of Yellow mosaic disease of Black gram.

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