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IPM strategies for management of insect transmitted viral diseases in rice fallow blackgram in farmer's fields of Krishna district of Andhra Pradesh

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Abstract
On farm trials in ten locations were conducted to evaluate efficacy of IPM strategies with emphasis on use of seed treatment and cultural practices for management of vector borne viral diseases in blackgram and to create awareness among the farming community during rabi, 2017-18 to 2019-20 in the farmer's fields in Krishna District of Andhra Pradesh. By adoption of IPM practices in all the three years, the incidence of the MYVM was reduced to 1.03 per cent compared to 2.77 in farmers practice and leaf curl viral disease was reduced to 1.06 compared to 3.47 percent in farmers practice; while leaf curl and bud necrosis was not notice in all the years. This has resulted in reduction in the average cost of cultivation by Rs. 3504.00 per hectare and the average net income was improved by Rs. 12752 per hectare compared to the farmers practice. The average yield levels (1652 kg/ha) improved by 11.55 per cent compared to farmers practice (1479 kg/ha) giving a clear indication that adoption of IPM practices with emphasis on seed treatment and cultural practices helped in reducing the sucking pest population and viral diseases damage and improving yield, helps in improving the net income levels to the resource poor farmers.

Keywords: Blackgram, sucking pests, IPM, viral diseases, yield and net income

Introduction
Blackgram (*Vigna mungo* L.) is of special significance in Andhra Pradesh as it fits well in rice–pulse cropping system as a relay crop under low input management particularly in Krishna–Godavari and North Coastal zones. Photo-insensitive high yielding varieties suitable for rice fallow conditions were developed so that the rabi rice fallow blackgram cultivation is profitable and helps in promoting sustainable cereal-pulse based cropping system enriching even the soil fertility. In Andhra Pradesh it is cultivated in 12.5 lakh acres with a production of 3.29 lakh tonnes and with a productivity of 263 kg/acre (Vyavasaya Panchagam 2018) [1]. Blackgram along with other pulse crops are severely affected by many viral diseases causing severe loss to yield. Of which whitefly (*Bemisia tabaci* (Gennadius) transmitted *Mungbean yellow mosaic virus* (MYMV), thrips (*Thrip tabaci* Lindeman) transmitted Groundnut bud necrosis virus (GBNV) and uncharacterized urdbean leaf crinkle virus complex (ULCD) are most important (Biswas and Varma, 2000; 2001; Kumari *et al*., 2003; Varma and Malathi, 2003; Kumar *et al*., 2006) [2, 3, 4, 5].
Mungbean yellow mosaic disease (MYMD) initially appear as yellow specks or spots and later leaf exhibits irregular yellow and green patches, puckering and reduced leaf size. The yellow patches coalesce to form larger patches that develop into a yellow mottle, eventually the entire leaf turns yellow. Maturity is delayed, flower and pod production are severely reduced, and develop immature undersized seeds (Nariani, 1960; Nene, 1968; Singh *et al*., 1998) [6, 7, 8]. Weed serves as reservoir of the virus, and are a source of primary inoculums. It is not seed or soil borne or sap transmissible. Due to significant positive correlation between YMV incidence and whitefly population (Kumar *et al.*, 2004) [9], management of *MYMV* through chemical control of vector was attempted by several workers (Ganapathy and Karuppiah, 2004; Konar and Paul, 2005; Salam *et al*., 2009) [10, 11, 12].
Leaf crinkle disease caused by *urdbean leaf crinkle virus* (ULCV) is another serious diseases with reported loss to grain yield by 35-81% (Bashir *et al*., 1991) [13], complete yield loss during the epidemic years (Kanimozhi *et al.*, 2009) [14]. There exists a direct relation between the stage of plant growth at which infection occurred and yield loss. The reduction in tryptophan, increase in IAA and higher sugar content have been reported in urdbean leaves infected by leaf crinkle virus (Brar and Rataul, 1990) [15]. The disease is characterized by crinkling, curling, puckering, rugosity of leaves, enlargement of leaf lamina, stunting of plants

and malformation of floral organs (Kanimozhi *et al.,* 2009) [14]. Infected plants produce sterile flowers and few pods (Bashir *et al.,* 1991) [16]. Seed borne nature of the virus is well established (Sharma *et al.,* 2014) [17], however aphids are important vectors (Dhingra, 1975) [18].

Leaf curl and bud necrosis of mungbean cause yield loss as high as 40 per cent (Makkouk *et al.,* 2003) [19]. Ghanekar (1979) [20] reported that infected mungbean leaves shows downward curling, venial necrosis, chlorotic area developed on leaf lamina and over all stunting of the plants and finally death of affected plants due to apical necrosis. Even late infection reduced number of pods which either produced smaller or larger seeds or no seeds at all. The mungbean leaf curl virus is transmitted by thrips (Ananthakrishnan, 1980) [21].

All these viral diseases in blackgram are transmitted by sucking pests, efforts were made for development of resistant varieties but success was achieved only in case of YMV tolerant varieties. Since, there is no proven technology to management viral disease directly, management of the vectors is the appropriate strategy adopted for containing the incidence and spread of the viral diseases. Farmers use systemic insecticides to manage these sucking pests with variable results. However, continual use of only insecticides leads to quick development of resistance in the sucking pests and become ineffective. Moreover, very low population of vectors also transmits viral diseases; effective method is the adoption of resistant or tolerant varieties to the viral disease to which ever disease available along with other cultural methods to suppress the pest population. Promotion of such integrated adoptable strategies against viral diseases is the need of the hour to for achieving higher yields with less cost of cultivation.

Thus, an attempt was made to evaluate IPM modules for effective management of sucking pests for control of vector transmitted viral diseases in rice fallow rabi blackgram in the farmers' fields.

Materials and methods

The present investigation was carried out in ten locations in farmers' fields of adopted villages of KVK, Ghantasala in Movva mandal of Krishna district for four years from 2017-18 to 2019-20, where farmers cultivate blackgram in large area during *rabi* season. On farm trials were conducted in selected farmers' fields with an objective to evaluate the performance of 'integrated pest management practices' so that the same package may be popularized among the farming community for better management of the sucking pests and viral diseases in blackgram.

T1 – Integrated Pest Management Practices (IPM)

- Cultivation of MYMV resistant variety - LBG 752 or TBG 104 or PU 31 or LBG 787
- Seed treatment with imidacloprid 600 FS @ 5 ml or thiomethaxam 70 WS 5 g per kg of seed
- Growing of 4-6 rows of maize/jowar as border crop
- Removal and destruction of weeds and infected plants
- Installation of blue and yellow sticky traps @ 20 per acre.
- Spraying of neem oil @ 5 ml/lt 15-20 DAS

Need based application of insecticides - For thrips – acephate 1.0 g/lt or fipronil 1.5 ml / spinosad 0.3 ml per lt of water; For aphids and whitefly – alternate spray of acetamipride @ 0.2 g/lt or thiomethaxam 0.2 g/lt or imidaclopride 0.2 ml/l or triazophos @ 1.5 ml per liter of water.

T2: Farmers practices (Non IPM)

- Spraying different insecticides for vector management (imidaclopride, monocrotophos, acephate)

Each treatment was imposed in 0.4 Ha with blackgram "LBG 752" variety, which is MYMV tolerant variety. Recommended package of practices were followed for raising the crop. Weather conditions during the period of investigation is characterized by temperature range of maximum 26.5 to 32.5 and minimum 10.5 to 20.5 ºC with no rainfall during the crop growth period. Seed treatment was done with imidacloprid 600 FS (Goucho) @ 5.0 ml/kg. of seed. At the time of sowing itself jowar was sown in 4 rows as boarder crop around the field. Neem oil @ 5.0 ml/lt was sprayed 20 days after sowing of crop. Yellow and blue sticky traps were installed in the field @20 each per acre to monitor and mass trap whiteflies and thrips simultaneously. Regular roughing of infected plants and weeds was done to remove virus load in the field. The spraying of insecticides was done when infected plants was observed and after their removal to control the vectors. All the sprayings were done by using Taiwan sprayer. Data were recorded from ten randomly selected plants from each field leaving border rows for each virus disease separately. The observations were recorded to assess the percentage of virus affected plants. The seed yield, cost of cultivation, net benefit and cost benefit ratios were calculated.

$$\text{Per cent damage} = \frac{\text{Number of infected plants in one sq. meter}}{\text{Total number of plants in one sq. meter}} \times 100$$

Results and discussion

The results indicate (Table No. 1 & 2) that adoption of IPM module with emphasis on seed treatment and cultural practices helped in reduction of viral diseases incidence and thereby the damage. In 2017-18 in the IPM plot, the per cent incidence of MYMV was 5.36 per cent while, in the farmers practice it was 10.11 per cent wherein only chemical insecticides were sprayed indiscriminately, while it is 4.75 and 11.29 in case of leaf crinkle respectively. Leaf curl and bud necrosis was not noticed in all the three years of study. In IPM plot, the yield was 1642 kg/ha with a 12.31 per cent increase over farmers practices (1462 kg/ha). In 2018-19 in the IPM plot, the per cent incidence of MYMV was 0.89 per cent while, in the farmers practice it was 10.71 per cent, wherein only chemical insecticides were sprayed indiscriminately, while it is 2.5 and 20.0 in case of leaf crinkle respectively. In IPM plot, the yield was 1417 kg/ha with a 10.02 per cent increase over farmers practices (1288 kg/ha). In 2019-20 in the IPM plot, the per cent incidence of MYMV was 4.75 per cent while, in the farmers practice it was 8.93 per cent, wherein only chemical insecticides were sprayed indiscriminately, while it is 4.14 and 9.50 in case of leaf crinkle respectively. In IPM plot, the yield was 1896 kg/ha with a 12.32 per cent increase over farmers practices (1688 kg/ha).

Table 1: Details of the percent incidence of different viral diseases in blackgram

Year	Viral disease	IPM		Farmer's practice	
		No. of infected plants/m^2	Percentage	No. of infected plants/m^2	Percentage
2017-18	YMV	1.5	5.36	2.83	10.11
	Leaf crinkle	1.33	4.75	3.16	11.29
	Leaf curl	-	-	-	-
2018-19	YMV	0.25	0.89	3	10.71
	Leaf crinkle	0.7	2.50	5.6	20.00
	Leaf curl	-	-	-	-
2019-20	YMV	1.33	4.75	2.5	8.93
	Leaf crinkle	1.16	4.14	2.66	9.50
	Leaf curl	-	-	-	-

Table 2: Details of the blackgram crop yields obtained during different years

Year	Variety	No. of Farmers	Yield (q/ha)		Increase in yield
			Demo	Check	(%)
2017-18	LBG 752	10	1642	1462	12.31
2018-19	LBG 752	10	1417	1288	10.02
2019-20	LBG 752	10	1896	1688	12.32

The cost of cultivation, average gross returns, average net returns and benefit cost ratios calculated in each year were presented in table no. 3 indicates that adoption of IPM practices with special emphasis on seed treatment and cultural practices resulted in reduction of number of sprays of insecticides, thus reducing the cost of cultivation and improving the net income levels.

In 2017-18, through adoption of IPM practice, the cost of cultivation was reduced by Rs. 2396.00 with an increase of Rs. 10660.00 in net returns compared to the farmers practice; the benefit cost ratio was 2.27 compared to 1.89 in farmers practice. In 2018-19, the cost of cultivation was reduced by Rs. 2492.00 with an increase of Rs. 8950.00 in net returns in IPM plots compared to farmers practice. The benefit cost ration was 2.23 compared to 1.88 in farmers practice. In 2019-20, the cost of cultivation was reduced by Rs. 5625.00 and an increase of Rs. 18646 in net returns in IPM plots compared to farmers practice. The benefit cost ration was 3.58 compared to 2.72 in farmers practice.

Table 3: Details of cost of cultivation, average gross and net income levels

Year	Average Cost of cultivation (Rs./ha)		Average Gross Return (Rs./ha)		Average Net Return (Rs./ha)		BC ratio	
	Demo	Local Check	Demo	Local Check	Demo	Local Check	Demo	Local Check
2017-18	33229	35625	75539	67275	42310	31650	2.27	1.89
2018-19	31708	34200	70833	64375	39125	30175	2.23	1.88
2019-20	33125	38750	118490	105469	85365	66719	3.58	2.72

The data indicates that by adoption of IPM practices with emphasis on seed treatment and cultural practices, the sucking pest population was effectively managed there by the viral diseases. Sunil Kulkarni *et al.,* (2019) [22] reported that the IPM module with components *viz.,* seed treatment with imidacloprid 60 FS @ 5 ml/kg yellow sticky trap, need based insecticides spray showed significantly less YMD incidence and higher yield which is in agreement with the present findings.

Among the IPM practices, use of resistant variety is a vital practice (Sandhu *et al*., 1996 [23]), since it will combat the disease without employing any other practice. But, in Andhra Pradesh, the released varieties are resistant or tolerance to only yellow mosaic virus disease. In the previous 10 year, MYMV is the only serious disease and is responsible for crop shift in rabi from pulses to maize and jowar. But with advent of the resistant varieties to MYMV, farmers again started cultivating blackgram overcoming MYMV. In 2016 leaf curl and bud necrosis appeared in a sudden and severe form due to congenial climatic conditions causing huge losses, however this particular disease did not appear again in the period of investigation. In the later years other viral diseases *viz.,* leaf crinkle started to appear and causing losses, for both of these diseases, no resistant variety is available.

For managing the viral diseases transmitted by vectors, it is most important to avoid the incidence of whiteflies, aphids and thrips from the beginning of crop growth itself. Hence, seed treatment is most adoptable technique to protect the crop from the moment of sowing to early establishment stages of the crop. Seed treatment is the most targeted, effective and eco-friendly method for controlling the sucking pests. In the preset investigation also, seed treatment with imidaclopride @ 5 ml/kg seed is effective in controlling sucking pests and there by the viral diseases in general and leaf curl disease in particular. This is in agreement with the work of several authors (Mote *et al*. (1993) [24]; Sreelatha and Divakar (1997) [25]; Abbas (1999) [26]; Dhandapani *et al*., (2002) [27] and Sireesha, 2012) [28] who reported that seed treatment in different crops is effective in reducing the sucking pests for an extended period after sowing of the crop. For reducing the population load, cultural practices viz., growing of boarder crop is vital along with sticky traps.

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