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Field efficacy of some selected insecticides against whitefly, *Bemisia tabaci*, a vector of yellow mosaic disease in greengram

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ABSTRACT

Yellow mosaic disease (YMD) is one of the most destructive diseases of greengram popularly known as the yellow plague of *Kharif* pulses. The present study was conducted to know the effect of some selected insecticides on vector whitefly, *Bemisia tabaci* and the incidence of YMD. Two years of pooled data revealed that thiamethoxam 25 WG and imidacloprid 17.8 SL recorded lowest population of whiteflies (0.80 and 1.16) per trifoliate leaf and lowest per cent disease incidence 2.28 and 2.48, respectively. Similarly, these insecticide-treated plots recorded higher grain yield (9.81 and 9.20 q/ha) and C: B ratio (1:3.01 and 1:2.99), respectively. Overall, the study indicated that insecticides were efficient in reducing the whitefly population there by reducing YMD incidence in greengram.

***Key words**: Greengram, Imidacloprid, Thiamethoxam*

Green gram (*Vigna radiata* L.) Wilczek) generally known as mungbean, is native to India or the Indo Burma region (Vavilov, 1951). It is well adapted to different cropping pattern/systems and creates an important source of cereal-based diet worldwide (Anonymous, 2018). The major reason for the low yield is the sensitivity of the crop to weeds, insects and diseases caused by fungi, virus and bacteria (Anonymous, 2012). Among those, the viruses are the most crucial group of plant pathogens, which substantially decreases the yield (Kang *et al,* 2005). Different species of insect pests attack greengram, but sucking insect pests such as aphids and whitefly are of the major importance (Islam *et al*, 2008). These insect pests not only reduce the vigour of the plant by sucking the sap but also transmit the viral diseases and affect photosynthesis as well (Sachan *et al*, 1994). Among the different viral diseases infecting greengram, yellow mosaic is the most destructive in the Indian subcontinent. This disease is caused by at least three different species of begomoviruses (Mungbean yellow mosaic virus, Mungbean yellow mosaic virus and Horsegram yellow mosaic virus) and are transmitted through plant-to-plant by whitefly, *Bemisia tabaci* (Chhabra and Kooner, 1981; Selvi *et al.*, 2006; Mantesh *et al,* 2019). This virus cannot be transmitted through sap, seed and soil or mechanically but Thailand strain of this virus is reported to be transmitted by mechanical inoculation (Boss, 1999; Shad *et al,* 2006).

Insecticides are used as the frontline defense sources against disease vectoring insects in India. Effective management of insect vectors of plant pathogens is of crucial importance to minimizing vector-borne diseases in greengram. Insecticides play an important role in managing vector populations by reducing the number of individuals that can acquire and transmit a virus, thereby potentially lowering disease incidence. Hence, experiments were conducted to evaluate different insecticides against whitefly, *B. tabaci* and YMD incidence.

MATERIALS AND METHODS

The field experiment was conducted at AHRS, Bhavikere, University of Agricultural and Horticultural Sciences, Shivamogga during two seasons, *i.e., Kharif* 2018 and 2019. The experiment was laid out in a Randomized Block Design (RBD) with eight treatments and replicated in thrice. The widely grown greengram variety KKM-3 was used. The crop was raised according to the package of practices of UAHS, Shivamogga except for plant protection measures. The treatments were imposed at 30 and 45 days after sowing of the crop. The spraying was done by using hand-operated knapsack sprayer with a standard volume of water. Sufficient care was taken to avoid the drift problem to neighboring treatments.

Observation of the whitefly population was made on five randomly selected tagged plants in each treatment. The adult whitefly count was taken at early morning by slowly lifting the top, middle and bottom trifoliate leaf in each plant at a day before, seventh and fifteen days after imposition of treatments. The data were subjected to square root transformation before statistical analysis. Both the years of 2018 and 2019 yield data were recorded on each treatment and computed to hectare basis. Further, the data of both the seasons were pooled and analysed to bring out valuable conclusions.

The observation on YMD incidence was recorded at 15 days interval by counting the number of plants infected, and the total number of plants in an experimental plot (for each treatment) and Per cent Disease Incidence (PDI) was worked out using the formula given below.

Percent Disease Incidence (PDI) =

$$\frac{\text{Number of diseased plants}}{\text{Total number of plants examined}} \times 100$$

Further, data were transformed to arcsine values and subjected to statistical analysis. The data of both the seasons (*Kharif* 2018 and 2019) are pooled and analysed.

RESULTS AND DISCUSSION

Effect of insecticides on whitefly population

In 2018, the pre-treatment population of the whiteflies ranged from 4.8 to 5.93 per trifoliate leaf in all the treatments. Whitefly population was found to be statistically non-significant in pre-treatment plots. At seven days after spraying, a significant difference was found among the treatments. The lowest number of whitefly population per trifoliate leaf was recorded in the thiamethoxam 25 WG (1.2) followed by imidacloprid 17.8 SL (2.07). But the higher population of whiteflies was recorded in the control plot (6.40). At 15 days after spraying of insecticides, the same trend was noticed. The lowest population of whiteflies per trifoliate leaf was recorded in the thiamethoxam 25 WG application plot (1.73), which was followed by imidacloprid 17.8 SL (2.33). In untreated control, the whitefly population was 6.60 and significantly differed from the other insecticides tested (Table 1).

The lowest number of whiteflies per trifoliate leaf was recorded in the thiamethoxam 25 WG treated pot (1.43) which was followed by imidacloprid 17.8 SL (1.80) at seven days after spraying of insecticides. The highest number of whiteflies was noticed in the untreated plot (6.53), which is significantly differed from other insecticides evaluated. Observations recorded at 15 days after the second spray indicated that the lowest number of whiteflies were recorded in thiamethoxam 25 WG (1.0), followed by imidacloprid 17.8 SL (1.4) per trifoliate leaf. The higher number of whiteflies were recorded in the control plot (5.40) and found to significantly differ from all the insecticides evaluated (Table 1).

In 2019, the observations recorded at seven days after treatment imposition indicated that thiamethoxam 25 WG was found to be most effective in reducing whitefly population. It recorded 1.13 per trifoliate leaf and was followed by imidacloprid 17.8 SL 1.47 with per trifoliate leaf. The higher number of whiteflies were recorded in the control plot (6.07) and found to be significantly differed from all the insecticides tested. Observations at 15 days after treatment imposition showed the lowest whitefly population per trifoliate leaf was recorded in thiamethoxam 25 WG (1.47), followed by 1.8 per trifoliate leaf in imidacloprid 17.8 SL. The higher number of whiteflies were recorded in the control plot (6.33) and found to be significantly different from all the insecticides evaluated (Table 2).

The lowest number of whiteflies per trifoliate leaf was recorded in the thiamethoxam 25 WG treated pot (0.80) which was followed by imidacloprid 17.8 SL (1.13) at seven days after spraying of insecticides. The highest number of whiteflies was noticed in the untreated plot (6.67), which is significantly differed from other insecticides. Observations recorded at 15 days after the second spray indicated that the lowest number of whiteflies was recorded in thiamethoxam 25 WG (0.6), followed by imidacloprid 17.8 SL 0.93 per trifoliate leaf. The higher number of whiteflies was recorded in the control plot (6.87) and found to significantly differ from all the insecticides evaluated (Table 2). The similar trend was observed in pooled data also (Table 3).

Effect of insecticides on YMD

Per cent disease incidence of YMD at 15 and 30 days after sowing indicated that there was no significant difference among the treatments. However, at 45 days after sowing, the lowest disease incidence was recorded in the thiamethoxam 25 WG treated plot (1.82 %), and it was found to be on par with the imidacloprid 17.8 SL (1.98 %). The highest disease incidence (8.23 %) was documented in the control plot. At 60 days after sowing, the lowest disease incidence

Table 1. Evaluation of selected insecticides against whitefly, *B. tabaci* on greengram during *Kharif* 2018.

Treatments	Dosage	DBS	Mean number of whiteflies per trifoliate leaf			
			First spray		Second spray	
			7 DAS	15 DAS	7 DAS	15 DAS
T_1 - Imidacloprid 17.8 SL	0.3 ml	5.33 (2.41)	2.07 $(1.59)^{e}$	2.33 $(1.67)^{de}$	1.80 $(1.51)^{ef}$	1.40 $(1.37)^{d}$
T_2- Acetamiprid 20 SP	0.3 g	4.80 (2.30)	2.67 $(1.78)^{de}$	2.73 $(1.77)^{cd}$	2.53 $(1.74)^{de}$	2.53 $(1.74)^{c}$
T_3- Acephate 75 SP	1.0 g	5.27 (2.40)	3.13 $(1.90)^{cd}$	3.60 $(2.02)^{bc}$	3.00 $(1.87)^{cd}$	3.07 $(1.89)^{c}$
T_4- Thiamethoxam 25 WG	0.5 g	5.93 (2.53)	1.20 $(1.28)^{f}$	1.73 $(1.49)^{e}$	1.43 $(1.47)^{f}$	1.00 $(1.22)^{d}$
T_5 -Dinotefuron 20 SG	0.3 g	5.47 (2.44)	3.60 $(2.01)^{bcd}$	4.00 $(2.12)^{b}$	3.60 $(2.02)^{bc}$	3.20 $(1.92)^{c}$
T_6- NSKE 5%	-	5.07 (2.36)	4.60 $(2.25)^{b}$	4.80 $(2.29)^{b}$	4.00 $(2.12)^{b}$	4.20 $(2.17)^{b}$
T_7- Dimethoate 30 EC (standard check)	1.7 ml	4.87 (2.31)	3.93 $(2.10)^{bc}$	4.13 $(2.14)^{b}$	3.27 $(1.94)^{bcd}$	3.40 $(1.97)^{bc}$
T_8- Control	-	4.93 (2.33)	6.40 $(2.62)^{a}$	6.60 $(2.66)^{a}$	6.53 $(2.65)^{a}$	5.40 $(2.43)^{a}$
F value		NS	*	*	*	*
SEM±		0.09	0.09	0.10	0.08	0.07
CD @ 0.05		-	0.27	0.29	0.24	0.21
CV (%)		6.66	8.05	8.47	7.07	7.46

Numbers in the parenthesis are $\sqrt{(x+0.5}$ transformed values; * -Significant at (P≤0.05); NS- Non-significant; DBS-Day before spray; DAS- days after spraying; Means followed by the same letter do not differ significantly by DMRT (P=0.05)

Table 2. Evaluation of selected insecticides against whitefly, *B. tabaci* on greengram during *Kharif* 2019.

Treatments	Dosage	DBS	Mean number of whiteflies per trifoliate leaf			
			First spray		Second spray	
			7 DAS	15 DAS	7 DAS	15 DAS
T_1 - Imidacloprid 17.8 SL	0.3 ml	6.13 (2.57)	1.47 $(1.40)^{de}$	1.80 $(1.50)^{ef}$	1.13 $(1.27)^{de}$	0.93 $(1.18)^{f}$
T_2- Acetamiprid 20 SP	0.3 g	4.80 (2.30)	1.87 $(1.52)^{d}$	2.27 $(1.66)^{de}$	1.60 $(1.44)^{cd}$	2.00 $(1.58)^{e}$
T_3- Acephate 75 SP	1.0 g	5.40 (2.43)	2.67 $(1.78)^{c}$	3.00 $(1.87)^{cd}$	2.20 $(1.64)^{c}$	2.53 $(1.74)^{de}$
T_4- Thiamethoxam 25 WG	0.5 g	5.93 (2.53)	1.13 $(1.28)^{e}$	1.47 $(1.39)^{f}$	0.80 $(1.13)^{e}$	0.60 $(1.05)^{f}$
T_5 -Dinotefuron 20 SG	0.3 g	5.27 (2.40)	3.27 $(1.94)^{bc}$	3.60 $(2.02)^{bc}$	3.20 $(1.92)^{b}$	2.93 $(1.85)^{cd}$
T_6- NSKE 5%	-	5.07 (2.35)	4.00 $(2.12)^{b}$	4.27 $(2.18)^{b}$	3.60 $(2.02)^{b}$	3.80 $(2.07)^{b}$
T_7- Dimethoate 30 EC (standard check)	1.7 ml	5.13 (2.37)	3.73 $(2.06)^{b}$	4.20 $(2.17)^{b}$	3.20 $(1.92)^{b}$	3.27 $(1.94)^{bc}$
T_8- Control	-	4.80 (2.30)	6.07 $(2.56)^{a}$	6.33 $(2.61)^{a}$	6.67 $(2.67)^{a}$	6.87 $(2.71)^{a}$
F value		NS	*	*	*	*
SEM±		0.44	0.07	0.08	0.09	0.07
CD @ 0.05		-	0.20	0.24	0.26	0.21
CV (%)		14.25	6.39	6.53	8.54	8.54

Numbers in the parenthesis are $\sqrt{(x+0.5}$ transformed values; * -Significant at (P≤0.05); NS- Non-significant; DBS-Day before spray; DAS- Days after spraying; Means followed by the same letter do not differ significantly by DMRT (P=0.05)

Table 3. Evaluation of selected insecticides against whitefly, *B. tabaci* on greengram (pooled data of 2018 and 2019).

Treatments	Dosage	DBS	Mean number of whiteflies per trifoliate leaf			
			First spray		Second spray	
			7 DAS	15 DAS	7 DAS	15 DAS
T_1 - Imidacloprid 17.8 SL	0.3 ml	5.73 (2.49)	1.76 (1.49)^{e}	2.06 (1.58)^{de}	1.46 (1.39)^{ef}	1.16 (1.27)^{e}
T_2- Acetamiprid 20 SP	0.3 g	4.80 (2.30)	2.26 (1.65)^{e}	2.50 (1.72)^{d}	2.06 (1.60)^{de}	2.26 (1.66)^{d}
T_3- Acephate 75 SP	1.0 g	5.33 (2.41)	2.90 (1.83)^{d}	3.30 (1.94)^{c}	2.60 (1.76)^{cd}	2.80 (1.81)^{cd}
T_4- Thiamethoxam 25 WG	0.5 g	5.93 (2.53)	1.16 (1.28)^{f}	1.60 (1.44)^{e}	1.26 (1.32)^{f}	0.80 (1.13)^{e}
T_5 -Dinotefuron 20 SG	0.3 g	5.36 (2.42)	3.43 (1.97)^{cd}	3.80 (2.07)^{bc}	3.40 (1.97)^{bc}	3.06 (1.88)^{c}
T_6- NSKE 5%	-	5.06 (2.35)	4.30 (2.18)^{b}	4.53 (2.24)^{b}	3.80 (2.07)^{b}	4.00 (2.12)^{b}
T_7- Dimethoate 30 EC (standard check)	1.7 ml	5.00 (2.34)	3.83 (2.07)^{bc}	4.167 (2.15)^{b}	3.23 (1.92)^{bc}	3.33 (1.95)^{bc}
T_8- Control	-	4.86 (2.31)	6.23 (2.59)^{a}	6.46 (2.63)^{a}	6.60 (2.66)^{a}	6.13 (2.57)^{a}
F value		NS	*	*	*	*
SEM±		0.08	0.06	0.07	0.08	0.07
CD @ 0.05		-	0.16	0.19	0.22	0.20
CV (%)		5.27	5.08	5.68	6.90	6.37

Numbers in the parenthesis are $\sqrt{(x+0.5}$ transformed values; * -Significant at (P≤0.05); NS- Non-significant; DBS-Day before spray; DAS- Days after spraying; Means followed by the same letter do not differ significantly by DMRT (P=0.05)

was recorded in the thiamethoxam 25 WG (2.28 %), and it was on par with the treatment imidacloprid 17.8 SL (2.48 %). In control, records the 11.8 per cent virus disease incidence, and it was found to be highest among the treatments (Table 4).

From the above results, it was evident that the treatments had a differential effect in reducing the whitefly population at different intervals after the application of insecticides. The treatments such as thiamethoxam 25 WG @ 0.5 g/litre and imidacloprid 17.8 SL @ 0.3 ml/litre were found to be effective in reducing the whitefly population in greengram. Similarly, the lowest disease incidence was also recorded in these treatments. In other treatments also there is significantly reduced the whitefly population and YMD incidence to some extent when compared to the control. Thiamethoxam 25 WG and imidacloprid 17.8 SL are insecticide molecules belong to the neonicotinoid group. These insecticides are the broad-spectrum, systemic compounds exhibit activity against sap-sucking insect pests. Neonicotinoid compounds are used primarily as plant systemic, applied to seeds, soil or foliage, they move to the growing tip and afford long-term protection from piercing and sucking insect pests (Kundoo *et al,* 2017). They possess lower mammalian toxicity, less resurgence, environmental protection, pest management selectivity and low toxicity to natural enemies (Kunkel *et al,* 1999). Due to the mortality of the whitefly vector in insecticides treated plots, further spread of YMD was reduced. Hence insecticides play an essential role in reducing the disease incidence. These results are in accordance with the findings of Ganapathy and Karuppiah (2004); (Salam *et al,* 2009); Hossain *et al,* (2010); Mahalakshmi *et al*, (2015) who reported the effectiveness of thiamethoxam and imidacloprid in reducing the whitefly and YMD incidence in greengram.

Impact of insecticides on grain yield and cost economics in greengram

Pooled data revealed that thiamethoxam 25 WG was superior among all other treatments by documenting the highest yield of 9.81 q/ha. Next best treatments were imidacloprid 17.8 SL (9.2 q/ha), acetamiprid 20 SP (8.6 q/ha), acephate 75 SP (8.25 q/ha), dinotefuran 20 SG (7.82 q/ha), dimethoate 30 EC (7.69 q/ha) and NSKE 5% (7.02 q/ha). However, lower grain yield 6.31 q/ha was recorded in the untreated control. Thiamethoxam 25 WG documented the highest C: B ratio (1:3.01) and was superior when compared to

Table 4. YMD incidence in different selected insecticides treated plots of greengram (pooled data of 2018 and 2019).

Treatments	Dosage	Per cent disease incidence (%)			
		15 DAS	30 DAS	45 DAS	60 DAS
T_1 - Imidacloprid 17.8 SL	0.3 ml	0.81 (5.04)	1.23 (6.30)	1.98 (8.05)[e]	2.48 (9.03)[e]
T_2- Acetamiprid 20 SP	0.3 g	0.82 (5.14)	1.67 (7.35)	3.38 (10.59)[d]	4.15 (11.74)[d]
T_3- Acephate 75 SP	1.0 g	0.80 (5.07)	1.40 (6.75)	3.53 (10.82)[d]	4.50 (12.19)[d]
T_4- Thiamethoxam 25 WG	0.5 g	0.71 (4.76)	1.15 (6.13)	1.82 (7.72)[e]	2.28 (8.67)[e]
T_5 -Dinotefuron 20 SG	0.3 g	0.76 (4.92)	2.17 (8.39)	5.20 (13.16)[c]	6.22 (14.42)[c]
T_6- NSKE 5%	-	0.75 (4.94)	1.55 (7.13)	6.40 (14.63)[b]	7.70 (16.10)[b]
T_7- Dimethoate 30 EC (standard check)	1.7 ml	0.68 (4.66)	1.42 (6.79)	5.50 (13.56)[bc]	6.73 (15.01)[bc]
T_8- Control	-	0.86 (5.27)	1.57 (7.13)	8.23 (16.67)[a]	11.82 (20.09)[a]
F value		NS	NS	*	*
SEM±		0.18	0.50	0.41	0.50
CD @ 0.05		-	-	1.23	1.50
CV (%)		6.46	12.52	5.92	6.39

Numbers in the parenthesis indicate arcsine transformed values; * -Significant at (P≤0.05); NS- Non-significant; DAS- Days after sowing; Means followed by the same letter do not differ significantly by DMRT (P=0.05)

Table 5. Effect of selected insecticides on grain yield and cost economics of greengram (pooled).

Treatments	Grain yield (q/ha)	Cost of production (Rs./ha)	Cost of treatments (Rs./ha)	Cost of cultivation (Rs./ha)	Gross income (Rs./ha)	Net income (Rs./ha)	C:B
T_1 - Imidacloprid 17.8 SL @ 0.3 ml	9.20[ab]	20489.32	1986.4	22475.72	67287.73	44812.01	1: 2.99
T_2- Acetamiprid 20 SP @ 0.3g	8.60[bc]	20489.32	2080	22569.32	62891.80	40322.48	1: 2.79
T_3- Acephate 75 SP @ 1.5 g	8.25[bc]	20489.32	2332	22821.32	60332.25	37510.93	1: 2.64
T_4- Thiamethoxam 25 WG @ 0.5 g	9.81[a]	20489.32	3340	23829.32	71732.40	47903.08	1: 3.01
T_5 - Dinotefuron 20 SG@ 0.3 g	7.82[cd]	20489.32	4254	24743.32	57212.04	32468.72	1: 2.31
T_6- NSKE 5%	7.02[de]	20489.32	2200	22689.32	51369.76	28680.44	1: 2.26
T_7- Dimethoate 30 EC (Standard check)	7.69[cd]	20489.32	1286	21775.32	56245.10	34469.78	1: 2.58
T_8- Control	6.31[e]	20489.32	0.0	20489.32	46908.83	26419.51	1: 2.25
F value	*	-	-	-	-	-	-
SEM±	0.36	-	-	-	-	-	-
CD @ 0.05	1.08	-	-	-	-	-	-
CV (%)	7.70	-	-	-	-	-	-

Market price of greengram= Rs. 7313/quintal; Variety-KKM-3
*Significant at (P≤0.05); Means followed by the same letter do not differ significantly by DMRT (P=0.05)

other treatments, followed by imidacloprid 17.8 SL (1:2.99), acetamiprid 20 SP (1: 2.79) and acephate 75 SP (1: 2.64), dimethoate 30 EC (1: 2.58), NSKE 5% (1: 2.26) and dinotefuran 20 SG (1:2.31). While the untreated control recorded C: B ratio (1:2.25) it was found to be lowest among the treatments. Due to the application of insecticides reduction in the whitefly and MYMV disease incidence, in addition to this, the other sucking insect pests also reduced. Hence, it leads to higher grain yield and C: B ratio. The influence of insecticides on virus incidence on greengram was also reported by Shah *et al*, (2007) who reported that thiamethoxam 25 WS @ 0.005 per cent recorded lowest whiteflies and disease incidence (10.7%). Similarly, Yadav *et al*, (2015) and Sujatha and Bharpoda (2017) reported that application of imidacloprid and thiamethoxam insecticides in greengram recorded the higher grain yield and C: B ratio (Table 5). There was a significant impact of insecticides on the incidence of whiteflies and YMD in greengram. Although insecticides did not completely eliminate disease incidence, they could reduce the incidence to greater extent. Hence, Thiamethoxam 25 WG @ 0.5 g/litre and imidacloprid 17.8 SL @ 0.3ml/litre insecticides may be utilized for the management of YMD and its vector whitefly in greengram.

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