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Comparative efficacy of conventional vs new chemistry insecticides against mango thrips, *scirtothrips dorsalis* hood (Thripidae: Thysanoptera)

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ABSTRACT

Thirteen insecticides- Stake 40WV (triazophos), Polo 500SC (diafenthiuron), Actara 25WG (thiamethoxam), Chlorfenapyr 36SC (chlorfenapyr), Maximal 60WG (nitenpyram + pymetrozine), Crown 20SL, Lescenta 80WG (fipronil + imidacloprid), Fyfanon 57EC (malathion), Talstar 10EC (bifenthrin) Momentum 50WG (nitenpyram + chlorfenapyr), Jozer 202SL (imidacloprid + acetamaprid), Tresta 20SC (clothianidin) and Closer 240SC (sulfoxaflor)- were evaluated for efficacy in a controlled mango nursery experiment against an active infestation of *Scirtothrips dorsalis* at the Mango Research Institute, Multan during 2018 and 2019. The data was recorded before the treatments were applied, then 24, 72, 168 h after treatment. Treatments with percent mortality greater than 70 % were considered to be effective controls. Percent mortality was 74.14 % for chlorfenapyr, 70.58 % for Momentum, and 70.51 % for Crown at post-treatment on an cumulative average of 24, 72 and 168 h of both the study years. Medium percent mortality was; 69.52 % for Jazor; 59.59 % for Maximal; 57.38 % for Actara; and 45.11 for Lescenta. All other treatments had percent mortality estimates of less than 30 %. It is concluded that chlorfenapyr, Momentum and Crown are suggested to be used on mango nursery against *S. dorsalis* for better management since among the treatments in the trial efficacious control was found at 24, 72 and 168 h post-treatment.

1. Introduction

Mangifera indica L. is a fruit crop of tropical and subtropical areas of the world an allopolyploid species from family Anacardiaceae (Yamanaka et al., 2019). Mango fruit is known as "King of fruits" globally (Usman et al., 2003). It is recorded that more than 75 % of this fruit is produced in Pakistan, China, India, Mexico, Thailand and Indonesia (Mitra, 2016), but our country Pakistan ranked 5th (Baloch and Bibi, 2012) among mango producing countries. Mango fruit is native to South East Asia and have many vari-

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eties with beautiful color, sweet aroma and delightful taste. Mango is also known for its balanced nutritive value as it contains 10–20 % sugar as well as good source of fiber and vitamins (Amin and Hanif, 2002). It is also suggested that by the consumption of every 100 g of mango fruit a man got more than 80 calories of energy (Rathore et al., 2007). Insect pests infesting to mango fruits were reported to be more than 300 species (Peña et al., 1998). Among these thrips is found to be an emerging threat to mango nursery which caused severe losses on leaves and young fruits. To overcome these losses the growers apply an insecticide which causes serious threats to atmosphere and have consequences like insecticide resistance and outbreak of secondary pests (Desneux et al., 2007). It is estimated that approximately 6000 species of thrips are documented which infesting many fruit crops as well as vegetables (Mirabbalou, 2013; Grimaldi et al., 2004) worldwide. Due to wide host range this pest mango is one of the consistent hosts of thrips (Aliakbarpour and Salmah, 2011) but *Scirtothrips dorsalis* Hood is key pest to many fruits as reported by Hood in 1919 (Patel et al., 1997). It is not only dangerous for leaves and fruits but also reported that this species is also responsible for the transmission of certain viruses in plants (Jones, 2005). Thrips causing substantial losses to the leaves by rubbing their mouthparts and produces whitish or silvery speaks on leaves as well as fruit causing economic damage. Primarily reduce the overall production by sucking the cell sap of the leaves and attacks the underside areas along the veins of the young leaves (Akram et al., 2002; Akram et al., 2003). Both larvae and adult preferred to attack on young leaves and inflorescence of the mango plant (Venette and Davis, 2004). So for the better production of mango nursery and to avoid such kind of economic damage to young fruit, it is obligatory to maintain its population under economic threshold level.

The prime objective of current research, reported herein to evaluate the comparative efficacies of selected chemicals against mango thrips, *S. dorsalis* on mango nursery for making superior management strategies and successful nursery production.

2. Materials and methods

A research trail was conducted at Mango Research Institute, Multan-Punjab Pakistan (30°09 N Latitude and 71°26 E Longitude with an elevation of 126 m above sea level) on tukhmi young nursery plants that were used for grafting of different mango varieties in the month of July 2018 and 2019. There were three replication under Randomized Complete Block Design (RCBD) with 13 insecticides viz., Stake 40WV (triazophos) @150 ml, Polo 500SC (diafenthiuron) (Syngenta Pakistan Limited) @50 ml, Actara 25WG (thiamethoxam) (Syngenta Pakistan Limited) @ 12 g, Chlorfenapyr 36SC (chlorfenapyr) (Jaffar Agro Services (Pvt.) ltd.) @100 ml, Maximal 60WG (nitenpyram + pymetrozine) @ 50 g, Crown 20SL (Pak China Chemicals (Pvt.) ltd.) @ 100 ml, Lescenta 80WG (fipronil + i midacloprid) (Bayer Crop Sciences) @ 30 g, Fyfanon 57EC (malathion) (Jaffar Agro Services (Pvt.) ltd) @ 100 ml, Talstar 10EC (bifenthrin) (FMC United Pvt. ltd.) @ 50 ml, Momentum 50WG (nitenpyram + chlorfenapyr) (Evyol Group) @ 150 g, Jozer 202SL (imidacloprid + acetamaprid) (Agrow Limited) @ 240 ml, Tresta 20SC (clothianidin) (FMC United Pvt. ltd.) @ 50 ml and Closer 240SC (sulfoxaflor) (Dow AgroSciences) @ 50 ml per 100 L of water. The nursery was regularly observed to measure the thrips abundance. When the thrips population reached at ETL the nursery was subjected to pesticides applications. Thrips population was recorded from thirty leaves selected at random from each treatment of hundred plants. The data was recorded before spray and then after 24 h, 72 h and 168 h post treatment. To determine quantity of water for each treatment, calibration was done by spraying water on untreated treatment. Spraying was done manually operated knapsack sprayer (Jecto ®). All the insecticides were sprayed early in the morning for better results. Before application of insecticides the spray machine was thoroughly washed and cleaned to avoid intermixing of insecticides. Percent mortality was calculated as mention below by using the formula:

$$\%M = 100 \times (N_{bs} - N_{as}) \div N_{bs}$$

where %M = Percent Mortality; N_{bs} = Insect abundance before spray and N_{as} = insect abundance after spray.

2.1. Statistical analysis

The data was subjected to analysis of variance (ANOVA) using Statistix version 9 (www.statistix.com/free trial.html) (Lawes Agricultural Trust Rothamsted Experimental Station, Rothamsted, UK). The means were separated by Tukey HSD.

3. Results

3.1. Percent mortality of S. dorsalis Hood during 2018

3.1.1. Percent mortality 24 h after spraying

The data on the effectiveness of insecticides for the control of *S. dorsalis* Hood after 24 h of the spray revealed a significant differences ($p < 0.05$, SE for comparison 3.06, DF 24, Critical Q value 5.17 and CV 13.209) between treatments. The maximum mortality was observed in those treatments where Chlorfenapyr, momentum and crown were applied with percent mortalities of 76.72 %, 72.65 % and 72.27 % recorded. Stake, Polo, Talstar and Closer proved very less effective with very low mortalities of 18.49 %, 29.75 %, 15.70 % and 29.49 % were recorded. Maximal, Lescenta, Jozer, Actara and Tresta showed relatively mortality less than 70 %. Very low mortality was observed with treatment of Fyfanon with mortality of 11.97 % (Fig. 1).

3.1.2. Percent mortality 72 h after spray

The data on the effectiveness of insecticides for the control of *S. dorsalis* Hood after 72 h of spray revealed significant differences ($p < 0.05$, SE for comparison 3.35, DF 24, Critical Q value 5.17 and CV 12.29) between treatments. The maximum mortalities were observed in treatments where Crown, Chlorfenapyr, Momentum, Jozer and Actara applied with mortalities of 79.93 %, 77.91 %, 74.83 %, 73.85 % and 71.74 % respectively. Stake, Maximal, Lescenta, Tresta and Closer showed mortalities of 26.14 %, 68.28 %, 49.79 %, 29.49 % and 24.38 % respectively. Very less mortality was recorded where Talstar and polo were applied with mortalities of 14.74 % and 18.62 % respectively.

3.1.3. Percent mortality 168 h after spray

The data on the effectiveness of the insecticides for the control of *S. drsalis* Hood after 168 h of spray revealed significant difference ($p < 0.05$, SE for comparison 3.12, DF 24, Critical Q value 5.17 and CV 11.44) between treatments. The maximum mortalities were observed in treatments where Jozer, Momentum and crown was applied with mortalities of 77.51 %, 76.32 % and 75.1 % recorded. Chlorfenapyr, Maximal and Actara showed mortality up to 68.31 %, 66.37 % and 64.89 % respectively. Very low mortality was observed as 10.38 % recorded.

3.2. Percent mortality of S. dorsalis Hood during 2019

3.2.1. Percent mortality 24 h after spraying

The data on the effectiveness of insecticides for the control of *S. dorsalis* Hood after 24 h of the spray revealed a significant differences ($p < 0.05$, SE for comparison varies, DF 24, Critical Q value

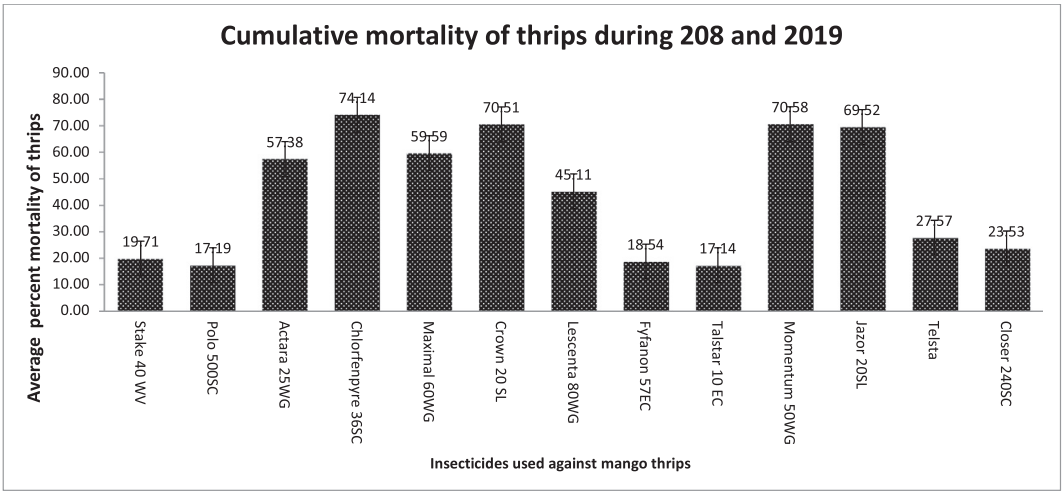

Fig. 1. Showing the average percent mortality of *S. dorsalis* Hood.

4.97 and CV varies) between the treatments. The maximum mortality of 77.02 % was recorded where Chlorfenapyr sprayed followed by 65.73 %, 64.95 % and 64.81 % recorded where Crown, Momentum and Jozer applied respectively. Maximal and Lescenta showed mortalities up to 59.95 % and 49.03 % respectively. Stake, Polo, and Fyfanon showed very mortalities as 15.94 %, 20.01 % and10.88 % recorded respectively (Table 1).

3.2.2. Percent mortality 72 h after spraying

The data on the effectiveness of the insecticides for the control of *S. dorsalis* Hood after 72 h of the spray revealed that a significant differences are present among treatments($p < 0.05$, SE for comparison varies, DF 24, Critical Q value 4.94 and CV varies). Maximum mortalities were recorded to those treatments where Chlorfenapyr and Jozer applied as 73.41 % and 71.17 % respectively. Momentum, Crown and Actara showed mortalities up to 68.50 %, 65.85 % and 53.03 % respectively. Very low mortalities were recorded where Polo, Closer and Fyfanon were applied as 16.30 %, 19.23 % and 17.32 % respectively (Table 2).

3.2.3. Percent mortality 168 h after spraying

The data on the effectiveness of the insecticides for the controle of the *S. dorsalis* Hood after 168 h of the spray showed a significant difference among the treatments is present($p < 0.05$,SE for the comparison varies, DF 24, Critical Q value 4.94 and CV varies). Maximum mortalities were recorded where Chlorfenapyr, Crown, Momentum and Jozer were applied as Percent mortalities were recorded as 71.49 %, 64.18 %, 66.24 % and 66.11 % respectively. Maximal and Actara showed mortalities up to 47.86 % and 43.81 % respectively. Polo showed very power result as only 8.07 % mortality was recorded (Table 3).

3.2.4. Cumulative average percent mortality of Scirtothrips dorsalis

The data on the effectiveness of various insecticides for the control of *S. dorsalis* on cumulative basis 24 h after spray revealed a highly significant differences ($F = 187.50$; $df = 12, 38$; $P < 0.01$) (Table 4) between treatments. The maximum mortality of the pest was observed in those treatments where Chlorfenapyr was sprayed statistically similar to Crown and Momentum having 69.00 and

Table 1
Information of insecticides with different mode of action used against *Scirtothrips dorsalis.*

Insecticides		Formulation	Group	WHO hazard classification	IRAC group	Dose (ml/ per 100 L water)	Mode of Action
Trade Name	Common Name						
Stake 40 WV	triazophos	40 WV	Organophosphate	Class Ib	1B	150 g	AChE Inhibitors
Polo 500SC	diafenthiuron	500 SC	Thiourea	Class II	12 A	50 ml	Inhibitors of mitochondrial ATPsynthase
Actara 25WG	thiamethoxam	25 WG	Neonicotinoids	Class IV	4A	12 g	nAchR agonists
Chlorfenapyr 36SC	chlorfenapyr	36 SC	Pyrolle	Class III	13	100 g	Uncouplers of oxidative Phosphorylation
Maximal 60WG	nitenpyram + pymetrozine	60 WG	Neonicotinoids + Pyridine azomethine derivatives	Class IV/III	4A/ 9B	50 g	nAchR agonists/Feeding inhibitors
Crown 20SL	imidacloprid	20 SL	Neonicotinoids	Class II	4A	100 ml	nAchR agonists
Lescenta80 WG	fipronil + imidacloprid	80 WG	Phenylepyrazoles + Neonicotinoids	Class II/II	2B/ 4A	30 g	GABA/ nAchR agonists
Fyfanon 57 EC	malathion	57 EC	Organophosphate	Class IV	1B	100 ml	AChE Inhibitors
Talstar 10EC	bifenthrin	10 EC	Pyrethroids	Class II	3A	50 ml	Sodium Channel modulator
Momentum 50WG	nitenpyram + chlorfenapyr	50 WG	Neonicotinoids + Pyrolle	Class II	4A/ 13	150 g	nAchR agonists/ Uncouplers of oxidative Phosphorylation
Jozer 202SL	imidacloprid + acetamaprid	202 SL	Neonicotinoids	Class II/IV	4A	240 ml	nAchR agonists
Tresta 20 SC	clothianidin	20 SC	Neonicotinoids	Class II	4A	50 ml	nAchR agonists
Closer 240SC	sulfoxaflor	240 SC	Neonicotinoids	Class III	4C	50 ml	nAchR agonists

Table 2
Mean Comparison of Percent mortality of mango thrips *S. dorsalis* Hood after spray during 2018.

S. No	Insecticides		Dose/100 L of water	Abundance of thrips before spray	Percent mortality of thrips after		
	Trade Name	Common Name			24 h Mean ± SE	72 h Mean ± SE	168 h Mean ± SE
1	Stake 40 WV	triazophos	150 ml	27.33	18.49 ± 0.92 ef	26.14 ± 0.73 cd	20.58 ± 0.68 def
2	Polo 500SC	diafenthiuron	50 ml	40.65	29.75 ± 0.82de	18.62 ± 0.74cd	10.38 ± 0.32f
3	Actara 25WG	thiamethoxam	12 g	74.83	60.44 ± 1.43bc	71.74 ± 1.10a	64.89 ± 1.33b
4	Chlorfenapyr 36SC	chlorfenapyr	100 ml	36.61	76.72 ± 1.43a	77.91 ± 0.75a	68.31 ± 1.01ab
5	Maximal 60WG	nitenpyram + pymetrozine	50 g	16.87	69.85 ± 1.32ab	68.28 ± 0.85a	66.37 ± 1.26ab
6	Crown 20SL	imidacloprid	100 ml	50.22	72.27 ± 2.65ab	79.93 ± 3.02a	75.1 ± 1.41ab
7	Lescenta80 WG	fipronil + imidacloprid	30 g	28.11	55.60 ± 1.71c	49.79 ± 0.89b	42.77 ± 2.12c
8	Fyfanon 57 EC	malathion	100 ml	66.33	11.97 ± 0.60f	19.76 ± 1.03cd	28.14 ± 0.98d
9	Talstar 10EC	bifenthrin	50 ml	24.14	15.70 ± 1.29f	14.74 ± 0.47d	15.9 ± 0.50ef
10	Momentum 50WG	nitenpyram + chlorfenapyr	150 g	10.83	72.65 ± 0.68ab	74.83 ± 0.29a	76.32 ± 1.12ab
11	Jozer 202SL	imidacloprid + acetamaprid	240 ml	6.93	63.65 ± 0.82abc	73.85 ± 0.80a	77.51 ± 1.56a
12	Tresta 20 SC	clothiandin	50 ml	99.00	35.35 ± 1.36d	29.49 ± 2.02c	22.2 ± 0.93ef
13	Closer 240SC	sulfoxaflor	50 ml	80.84	29.49 ± 0.91de	24.38 ± 1.45cd	24.04 ± 2.03de
Tukey HSD Value @ 5 %					13.21	12.29	11.45
F-Value					89.51	124.51	140.19

Means sharing similar letters are not significantly different by Tukey Test at $P < 0.05$ HSD = Honestly Significant Difference.

Table 3
Mean Comparison of Percent mortality of mango thrips *S. dorsalis* Hood after spray during 2019.

S. No	Insecticides		Dose/100 L of water	Abundance of thrips before spray	Percent mortality of thrips after		
	Trade Name	Common Name			24 h Mean ± SE	72 h Mean ± SE	168 h Mean ± SE
1	Stake 40 WV	triazophos	150 ml	36.54	15.94 ± 0.43f	24.09 ± 0.58de	13.00 ± 0.15ef
2	Polo 500SC	diafenthiuron	50 ml	33.23	20.01 ± 0.22ef	16.30 ± 0.53e	8.07 ± 0.08f
3	Actara 25WG	thiamethoxam	12 g	41.29	50.34 ± 1.48c	53.03 ± 0.88bc	43.81 ± 0.30bc
4	Chlorfenapyr 36SC	chlorfenapyr	100 ml	46.58	77.02 ± 0.95a	73.41 ± 0.70a	71.49 ± 0.74a
5	Maximal 60WG	nitenpyram + pymetrozine	50 g	25.21	59.95 ± 0.70b	45.22 ± 0.98cd	47.86 ± 1.05c
6	Crown 20SL	imidacloprid	100 ml	42.39	65.73 ± 1.12ab	65.85 ± 2.04b	64.18 ± 1.25b
7	Lescenta80 WG	fipronil + imidacloprid	30 g	35.48	49.03 ± 0.78c	41.83 ± 0.33cd	31.66 ± 0.77cd
8	Fyfanon 57 EC	malathion	100 ml	49.77	10.88 ± 0.22f	17.32 ± 0.64e	23.17 ± 0.54de
9	Talstar 10EC	bifenthrin	50 ml	37.30	19.49 ± 0.97ef	19.00 ± 0.54e	18.02 ± 0.40def
10	Momentum 50WG	nitenpyram + chlorfenapyr	150 g	22.89	64.95 ± 1.70ab	68.50 ± 1.68b	66.24 ± 1.12ab
11	Jozer 202SL	imidacloprid + acetamaprid	240 ml	19.29	64.81 ± 1.17ab	71.17 ± 1.34ab	66.11 ± 1.05ab
12	Tresta 20 SC	clothiandin	50 ml	46.58	36.93 ± 0.27d	24.27 ± 1.47de	17.17 ± 0.67ef
13	Closer 240SC	sulfoxaflor	50 ml	53.29	25.96 ± 0.81e	19.23 ± 0.98e	18.07 ± 0.91def
Tukey HSD Value @ 5 %					9.51	10.76	7.24
F-Value					152.47	119.50	277.77

Means sharing similar letters are not significantly different by Tukey Test at $P < 0.05$ HSD = Honestly Significant Difference.

68.80 % mortality of the pest followed by Maximal and Jazor. Actara and Lescenta caused 55.39 and 52.32 % mortality of the pest. The least morality of the pest at 36.14, 27.73, 24.88, 17.60, 17.21 and 11.43 % were observed in the Tresta, Closer, Polo, Talstar, Stake and Fyfanon treatments.

Significant differences ($F = 152.91$; $df = 12, 38$; $P < 0.01$) (Table 4) was recorded between treatments after 72 h post treatment. The maximum mortality of the pest was observed in those treatments where Cholfenpyr and Crown were sprayed having 75.66 % and 72.89 % mortality of the pest statistically similar to Jazor and Momentum having 72.51 and 71.67 % mortality of the pest followed by Actara at 62.38 % mortality and is statistically similar to Lescenta had 45.81 % mortality. The lowest morality of the pest at 26.88, 25.12, 21.81, 18.55, 17.46 and 16.88 % were observed in the Tresta, Stake, Closer, Fyfanon, polo and Talstar treatments.

Significant differences were found between treatments at 168 h post-treatment ($F = 30.5.30$; $df = 12,38$) (Table 4). The maximum mortality of *S. dorsalis was* observed in those treatments where Jazor, Momentum, Chlofenpyr and Crown were sprayed having 71.81, 71.28, 69.90 and 69.64 percent mortality of the pest followed by Maximal and Actara having 57.12 and 54.35 percent mortality of the pest. The least mortality of the pest was recorded in Lescenta, Fyfanon, Closer, Tresta, Talstar,Stake and Polo having 37.22, 25.65, 21.06, 19.69, 19.96, 16.79 and 9.23 percent mortality.

4. Discussions

Thrips cause substantial loss as they feed on the leaves and inflorescence, which significantly harmful to the plant health at early stages (Pena et al., 2002). The cosmetic loss is definitely reduced its marketability both in nursery as well as in fruits (Nault et al., 2003). However insecticides proved the most suited management practice in nursery (Morse and Hoddle, 2006). So the use of suited insecticides will overcome the populations of this species. The most common use for controlling this pest is chemical control (Lewis, 1997). However different eradication campaign was

Table 4
Overall average Percent mortality of mango thrips *S. dorsalis* Hood after spray during 2018–2019.

S. No	Insecticides		Dose/ 100 L of water	Abundance of thrips before spray	Percent mortality of thrips after		
	Trade Name	Common Name			24 h Mean ± SE	72 h Mean ± SE	168 h Mean ± SE
1	Stake 40 WV	triazophos	150 ml	31.94	17.21 ± 0.43 fg	25.12 ± 0.58e	16.79 ± 0.15e
2	Polo 500SC	diafenthiuron	50 ml	36.94	24.88 ± 0.22ef	17.46 ± 0.53e	9.22 ± 0.08f
3	Actara 25WG	thiamethoxam	12 g	58.06	55.39 ± 1.48c	62.38 ± 0.88bc	54.35 ± 0.30b
4	Chlorfenapyr 36SC	chlorfenapyr	100 ml	41.59	76.87 ± 0.95a	75.66 ± 0.70a	69.90 ± 0.74a
5	Maximal 60WG	nitenpyram + pymetrozine	50 g	21.04	64.90 ± 0.70b	56.75 ± 0.98c	57.12 ± 1.05b
6	Crown 20SL	imidacloprid	100 ml	46.30	69.00 ± 1.12ab	72.89 ± 2.04a	69.64 ± 1.25a
7	Lescenta80 WG	fipronil + imidacloprid	30 g	31.80	52.31 ± 0.78c	45.81 ± 0.33d	37.22 ± 0.77c
8	Fyfanon 57 EC	malathion	100 ml	58.05	11.43 ± 0.22g	18.54 ± 0.64e	25.65 ± 0.54d
9	Talstar 10EC	bifenthrin	50 ml	30.72	17.60 ± 0.97fg	16.87 ± 0.54e	16.96 ± 0.40e
10	Momentum 50WG	nitenpyram + chlorfenapyr	150 g	16.86	68.80 ± 1.70ab	71.67 ± 1.68ab	71.28 ± 1.12a
11	Jozer 202SL	imidacloprid + acetamaprid	240 ml	13.11	64.23 ± 1.17b	72.51 ± 1.34ab	71.81 ± 1.05a
12	Tresta 20 SC	clothiandin	50 ml	72.79	36.14 ± 0.27d	26.88 ± 1.47e	19.69 ± 0.67de
13	Closer 240SC	sulfoxaflor	50 ml	67.07	27.72 ± 0.81de	21.80 ± 0.98e	21.05 ± 0.91de
Tukey HSD Value @ 5 %					8.81	10.21	7.27
F-Value					187.50	152.91	305.30

*Means sharing similar letters are not significantly different by Tukey Test at $P < 0.05$ HSD = Honestly Significant Difference.

studied earlier (MacLeod et al., 2004). In our experiment thirteen different insecticides were tested against *S. dorsalis* Hood under field conditions during 2018 and 2019. Among all chemicals few were proved very effective against this pest. Among these during the year 2018, Crown (Imidacloprid), Momentum (nitenpyrm + c hlorfenapyr), chlorfenapyr and Jozer (imidacloprid + acetamaprid) showed maximum average percent mortality as 75.77 %, 74.60 %, 74.31 % and 71.67 % respectively. During 2019, Chlorfenapyr showed maximum average percent mortality up to 73.97 %. Chlorfenapyr was proved effective in reducing adult populations and Imidacloprid controlling larvae of thrips (Seal et al., 2006). Similarly Imidacloprid proved effective against adult of thrips population reducing 68.7 % population and 80.7 % larval population (Aliakbarpour et al., 2011). Among Neonicotinoids, Imidacloprid has very less toxic to humans (Tomizawa and Casida, 2005) and have highly effective against *S. dorsalis* Hood on different crops (Shibao et al., 2006).

5. Conclusion

It was concluded from this study that Chlorfenapyr is very effective in controlling *S. dorsalis* Hood on mango nursery plants followed by Crown and Jozer. If the nursery is infested with *S. dorsalis* Hood and is to be managed for further propagation and plantations, these insecticides can be recommended to control the pest populations for up to 168 h after application. While spraying at inflorescence against *S. dorsalis* Hood, application of insecticides should be done at evening time to avoid exposure of pollinators at morning hours.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Akram, W., Oh, S.W., Lee, J.J., 2002. Taxonomic review of the genus Mycterothrips (Terebrantia: Thysanoptera) and its species from Pakistan. Entomol. Res. 32 (4), 251–254.
Akram, W., Koh, J.B., Lee, J.J., 2003. Genus Thrips (Thysanoptera: Thripidae) from Pakistan with most commonly recorded species. Entomol. Res. 33 (4), 277–286.
Aliakbarpour, H., Salmah, M.C., Dzolkhifli, O., 2011. Efficacy of neem oil against thrips (Thysanoptera) on mango panicles and its compatibility with mango pollinators. J. Pest. Sci. 84 (4), 503–512.
Aliakbarpour, H., Salmah, M.R.C., 2011. Seasonal abundance and spatial distribution of larval and adult thrips (Thysanoptera) on weed host plants in mango orchards in Penang, Malaysia. Appl. Entomol. Zool. 46 (2), 185–194.
Amin, M., Hanif, M., 2002. Cultivation of Mango in Dera Ismail khan. Agric. Research Institute, Ratta Kulachi, DI Khan, p. 1.
Baloch, M.K., Bibi, F., 2012. Effect of harvesting and storage conditions on the post harvest quality and shelf life of mango (Mangifera indica L.) fruit. S. Afr. J. Bot. 83, 109–116.
Desneux, N., Decourtye, A., Delpuech, J.-M., 2007. The sublethal effects of pesticides on beneficial arthropods. Annu. Rev. Entomol. 52 (1), 81–106.
Grimaldi, D., Shmakov, A., Fraser, N., 2004. Mesozoic thrips and early evolution of the order Thysanoptera (Insecta). J. Paleontol. 78 (5), 941–952.
Jones, D.R., 2005. Plant viruses transmitted by thrips. Eur. J. Plant Pathol. 113 (2), 119–157.
Lewis T, ed. 1997.Thrips as Crop Pests. Wallingford, UK: CABI. 349 pp.
MacLeod, A., Head, J., Gaunt, A., 2004. An assessment of the potential economic impact of Thrips palmi on horticulture in England and the significance of a successful eradication campaign. Crop Prot. 23 (7), 601–610.
Mirabbalou, M., 2013. A checklist of Iranian thrips (Insecta: Thysanoptera). Far East. Entomol. 267, 1–27.
Mitra, S. K. (2014, August). Mango production in the world–present situation and future prospect. In *XXIX International Horticultural Congress on Horticulture: Sustaining Lives, Livelihoods and Landscapes (IHC2014): IV 1111* (pp. 287-296).
Morse, J.G., Hoddle, M.S., 2006. Invasion biology of thrips. Annu. Rev. Entomol. 51 (1), 67–89.
Nault, B.A., Speese Iii, J., Jolly, D., Groves, R.L., 2003. Seasonal patterns of adult thrips dispersal and implications for management in eastern Virginia tomato fields. Crop Prot. 22 (3), 505–512.
Patel, J.R., Patel, M.B., Radadia, G.C., Shah, A.A., Pandya, H.V., 1997. Insect pest management in mango nursery. J. Appl. Horticult. Navsari 3, 125–128.
Peña, J.E., Mohyuddin, A.I., Wysoki, M., 1998. A review of the pest management situation in mango agroecosystems. Phytoparasitica 26 (2), 129–148.
Pena, J.E., Sharp, J.L., Wysoki, M., 2002. Tropical Fruit Pests and Pollinators: Biology, Economic Importance, Natural Enemies and Control. CAB Publishing, New York, NY.
Rathore, H.A., Masud, T., Sammi, S., Soomro, A.H., 2007. Effect of storage on physico-chemical composition and sensory properties of mango (Mangifera indica L.) variety Dosehari. Pak. J. Nutr. 6 (2), 143–148.
Seal, D.R., Ciomperlik, M., Richards, M.L., Klassen, W., 2006. Comparative effectiveness of chemical insecticides against the chilli thrips, Scirtothrips dorsalis Hood (Thysanoptera: Thripidae), on pepper and their compatibility with natural enemies. Crop Prot. 25 (9), 949–955.

Shibao, M., Ehara, S., Hosomi, A., Tanaka, H., 2006. Effect of insecticide application on the population density of yellow tea thrips, Scirtothrips dorsalis Hood (Thysanoptera: Thripidae). Jpn. J. Appl. Entomol. Zool. 50 (3), 247–252.
Tomizawa, M., Casida, J.E., 2005. Neonicotinoid insecticide toxicology: mechanisms of selective action. Annu. Rev. Pharmacol. Toxicol. 45 (1), 247–268.
Usman, M., Fatima, B., Khan, M.M., Chaudhry, M.I., 2003. Mango in Pakistan: A chronological review. Pak. J. Agric. Sci. 40, 151–154.
Venette, R.C., Davis, E.E., 2004. Chilli Thrips/Yellow Thrips, Scirtothrips dorsalis Hood (Thysanoptera: Thripidae) Mini Pest Risk Assessment. Univ. of Minnesota, St. Paul, MN, USA, p. 31.
Yamanaka, S., Hosaka, F., Matsumura, M., Onoue-Makishi, Y., Nashima, K., Urasaki, N., Ogata, T., Shoda, M., Yamamoto, T., 2019. Genetic diversity and relatedness of mango cultivars assessed by SSR markers. Breed. Sci. 69 (2), 332–344.