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BIO-EFFICACY OF INDOXACARB 10% + THIAMETHOXAM 10% WG AGAINST TOMATO FRUIT BORER AND THEIR EFFECT ON NATURAL ENEMIES

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ABSTRACT

The present investigation on bio-efficacy of indoxacarb 10% + thiamethoxam 10% WG at different doses along with other insecticides against fruit borer was carried out at Horticulture Farm, Rajasthan College of Agriculture, MPUAT, Udaipur during the two consecutive years. Tomato seedlings of variety Dev were transplanted on 25th September and 20th September during 2016 and 2017, respectively.Among nine insecticides, indoxacarb 10% + thiamethoxam 10% WG at 1500 ml/ha was found most effective against fruit borer followed by indoxacarb 10% + thiamethoxam 10% WG at 750 ml/ha. The treatment indoxacarb 10% + thiamethoxam 10% WG at 250 ml/ ha proved least effect. All the insecticides significantly increased the yield of marketable fruits over control. The maximum yield (241.82 q; in the year 2016 and 250.70 qha-1 in the year 2017) was recorded in indoxacarb 10% + thiamethoxam 10% WG at 1500 ml/ha followed by indoxacarb 10% + thiamethoxam 10% WG at 750 ml/ha (232.50 q ha-1 in the year 2016 and 238.45 q ha-1 in the year 2017). At all doses of indoxacarb 10% + thiamethoxam 10% WG *viz.*, 250, 400, 500, 750 and 1500 ml/ha did not cause any adverse effect on common natural enemies present in tomato ecosystem.

Key words: Tomato fruit borer, indoxacarb 10% + thiamethoxam 10%WG, natural enemies

INTRODUCTION

Tomato is most popular and extensively consumed vegetable crops in the world among various vegetables (Grandillo *et al.*, 1999). Various factors have been attributed for the production of tomato like low yield, poor quality seeds, incidence of pests and adverse climate. Among various factors, insect pests are of prime importance (Oerke, 2006). The tomato fruit borer, *Helicoverpa armigera* (Hubner) is a key pest of tomato as it attacks the cashable part of the plant (fruits) and makes them unfit for consumption causing considerable crop losses leading up to 55 per cent (Selvanarayanan, 2003). It has been estimated that the tomato crop worth Rs. of 1000 crore is lost by this pest annually (Jayraj *et al.*, 1994). Chemical insecticides are generally preferred for the control of this pest due to their easy availability and quick applicability, but their excessive and indiscriminate use has resulted in plethora of problems e.g. resurgence of minor insect pests, insecticidal resistance in insects, mortality of natural enemies and non-target species and pesticide residue in harvested produce leading to various health hazards, besides the increased cost of cultivation per unit area. To overcome these problems, it has now become imperative to select safer insecticides that should protect the crop, keep the pest population below injury leveland also safer for natural enemies in tomato ecosystem. Hence, the present attempts were made to evaluate the Bio-efficacy of newer combination of insecticide indoxacarb 10% + thiamethoxam 10% WG for the sustainable management of *H. armigera* on tomato.

MATERIALS AND METHODS

Bio-efficacy against tomato fruit borer. The experiment on the Bio-efficacy of indoxacarb 10% + thiamethoxam 10% WG at 250, 400, 500, 750 and 1500 ml/ha along with indoxacarb 14.5 % SC at 400 ml/ha, thiamethoxam 25% WG at 200 ml/ha, novaluron 5.25% + indoxacarb 4.5 % SC at 825 ml/ha (Table 1) against tomato fruit borer was conducted in Randomized Block Design with three replications at Horticulture Farm, Rajasthan College of Agriculture, MPUAT, Udaipur during two consecutive years of *Kharif* 2016 and *Kharif* 2017.Tomato seedlings of variety Dev were transplanted on 25th September and 20th September during 2016 and 2017, respectively.

Transplanting was done in plots each measuring 6 m x 3.60 m at row to row and plant to plant spacing of 60 cm x 45 cm. Each treatment was sprayed three times initiating first spray as soon as a pest infestation starts and subsequent spray was given at 15 days interval. The observations on the population of tomato fruit borer was recorded on tomato fruit on five randomly selected and tagged plants. The observations were recorded one day before and at 1, 3, 5, 7, and 10 days after each spray and mean reduction in population was calculated at 1, 3, 5, 7and 10 days after each spray.

Effect on natural enemies: The effect of the insecticides indoxacarb 10% + thiamethoxam 10% WG at 250, 400, 500, 750 and 1500 ml/ha along with other treatments on natural enemies was studied by counting the population of common predatory fauna *viz.;* population of spiders and *Coccinella* spp. at one day before and at 1, 3, 5, 7, and 10 days after each spray during both the season.

Table 1. Treatment details

T1	Indoxacarb 10% + Thiamethoxam 10% WG @250 ml/ha
T2	Indoxacarb 10% + Thiamethoxam 10% WG @ 400 ml/ha
T3	Indoxacarb 10% + Thiamethoxam 10% WG @ 500 ml/ha
T4	Indoxacarb 10% + Thiamethoxam 10% WG @ 750 ml/ha
T5	Indoxacarb 10% + Thiamethoxam 10% WG @ 1500 ml/ ha
T6	Indoxacarb 14.5 % SC @ 400 ml/ha
T7	Thiamethoxam 25% WG @ 200 ml/ha
T8	Novaluron 5.25%+ Indoxacarb 4.5 % SC@ 825 ml/ha
T9	Untreated

Yield of tomato: The weight of tomato fruits for each treatment at each picking was recorded and yield per hectare was calculated for each treatment separately.

RESULTS AND DISCUSSION

Bio-efficacy against tomato fruit borer: The result on bio-efficacy of the insecticides against tomato fruit borer is presented in Table 2 and 3. The resultant data revealed that all the treatments were found significantly superior over untreated control. The highest per cent mean reduction in the population of fruit borer was recorded in case of first spray (2016) of indoxacarb 10% thiamethoxam 10% WG @ 1500 ml/ha which resulted 58.95, 70.05, 73.50, 82.73 and 77.94 per cent and 2nd spray, (2016) of the same dose as 63.53, 78.39, 86.97, 93.05 and 87.92 per cent; 67.11, 81.97, 90.55, 96.63and 91.50 per cent (3rd spray,2016) whereas 70.18, 72.30, 75.71, 88.94 and 87.99 per cent (1st spray, 2017) and in 2nd spray, 2017 resulted 72.96, 80.25, 86.89, 96.79 and 96.30 per cent; 74.96, 82.25, 88.89, 98.79 and 97.30 per cent (3rd spray, 2017)reduction in tomato fruit borer population at 1, 3, 5, 7 and 10 days after spray. It was followed by indoxacarb 10% + thiamethoxam 10% WG @ 750 ml/ha which caused 55.29, 62.59, 69.90, 74.83 and 71.74 per cent (1st spray, 2016); 60.72, 70.43, 79.31, 85.82 and 80.57 per cent (2nd spray, 2016) and 64.30, 74.01, 82.89, 89.40 and 84.15 per cent (3rd spray, 2016); 58.85, 68.36, 72.12, 79.68 and 78.22 per cent (1st spray, 2017) ; 67.88, 76.26, 78.88, 89.14 and 88.23 per cent (2nd spray, 2017) and 69.98, 78.36, 80.98, 91.24 and 90.33 per cent (3rd spray, 2017) reduction in tomato fruit borer population at 1, 3, 5, 7 and 10 days during *Kharif* 2016 and 2017, respectively. Other treatments were also found superior over control.The present results are in accordance with the findingsof Murray *et al.* (2005), Singh *et al.*(2005), Patil *et al.* (2007), Kuttalam *et al.* (2008) and Dhaka *et al.* (2010) who reported indoxacarb as most effective insecticides against tomato fruit borer.

Effects on natural enemies: The data presented in the Table 4, 5 and 6 reveals that no significant difference was recorded in the population of Spiders and *Coccinella* spp. among different treatments of indoxacarb 10% + thiamethoxam 10% WG at 250, 400, 500, 750 and 1500 ml/ ha along with indoxacarb 14.5 % SC at 400 ml/ha, thiamethoxam 25% WG at 200 ml/ha, novaluron 5.25% + indoxacarb 4.5 % SC at 825 ml/ha and untreated control. Thus, the data indicated that indoxacarb 10% + thiamethoxam 10% WG at 750 and 1500 ml/ ha did not cause adverse effect on the common natural enemies (predators) presented in tomato ecosystem. Similar combination of insecticides was used by Abhijit Ghosal *et al.* (2016) that both novaluron and indoxacarb were found to be safer to non-target organisms and quickly degraded to non-toxic products, so it can be assumed that their pre-mix formulated product Plethora (novaluron 5.25+ indoxacarb 4.5 SC) also could be safe towards the non-targets.

Marketable yield: The yield data presented in Table 7 revealed that all the treatments yielded significantly higher marketable yield over untreated control. The tomato fruit yield among different treatments ranged from 146.75 to 241.82 and 148.98 to 250.70 q/ha against 120.45 and 123.72 q/ha in untreated control during *Kharif 2016* and 2017, respectively. The highest marketable yield of tomato 241.82 and 250.70 q/ha was recorded in case of spray of indoxacarb 10% – thiamethoxam 10% WG at 1500 ml/ha during *Kharif* 2016 and 2017, respectively. It was followed by spray of indoxacarb 10% + thiamethoxam 10% WGat 750 ml/ha which yielded 232.50 and 238.45 q/ha during *Kharif* 2016 and 2017, respectively. Indoxacarb 10% + thiamethoxam 10% WG at 500 ml/ha and indoxacarb 10% + thiamethoxam 10% WG at 400 ml/ha recorded 208.95 and 211.65; 195.38 and 198.25 q/ha during *Kharif* 2016 and

Table 2. Efficacy of Indoxacarb 10 % + Thiamethoxam 10% WG against fruit borer on tomato during *Kharif* 2016

S.No	Treatment	Dose (ml/ha)	PTP	Mean reduction (%) in fruit borer population, days after spray															
				1st spray					2nd spray					3rd spray					
				1 day	3 day	5 day	7 day	10 day	1 day	3 day	5 day	7 day	10 day	1 day	3 day	5 day	7 day	10 day
1	Indoxacarb 10 % + Thiamethoxam 10% WG	250	12.55	34.32 (35.86)	40.05 (39.26)	46.78 (43.15)	57.01 (49.03)	56.40 (48.68)	38.94 (38.61)	48.41 (44.09)	59.14 (50.27)	64.44 (53.39)	61.39 (51.58)	42.52 (40.70)	51.99 (46.14)	62.72 (52.37)	68.02 (55.56)	64.97 (53.71)
2	Indoxacarb 10 % + Thiamethoxam 10% WG	400	12.50	44.21 (41.68)	50.49 (45.28)	62.14 (52.03)	70.39 (57.03)	68.15 (55.64)	47.44 (43.53)	62.35 (52.15)	72.08 (58.10)	77.71 (61.83)	73.70 (59.15)	51.02 (45.58)	65.93 (54.29)	75.66 (60.44)	81.29 (64.37)	77.28 (61.53)
3	Indoxacarb 10 % + Thiamethoxam 10% WG	500	11.95	54.42 (47.54)	59.99 (50.76)	65.13 (53.81)	71.99 (58.05)	70.69 (57.22)	56.40 (48.68)	67.93 (55.51)	77.71 (61.83)	82.90 (65.57)	77.25 (61.51)	59.98 (50.76)	71.51 (57.74)	81.29 (64.37)	86.48 (68.43)	80.83 (64.03)
4	Indoxacarb 10 % + Thiamethoxam 10% WG	750	13.05	55.29 (48.04)	62.59 (52.29)	69.90 (56.73)	74.83 (59.89)	71.74 (57.89)	60.72 (51.19)	70.43 (57.06)	79.31 (62.94)	85.82 (67.88)	80.57 (63.85)	64.30 (53.31)	74.01 (59.35)	82.89 (65.57)	89.40 (71.00)	84.15 (66.54)
5	Indoxacarb 10 % + Thiamethoxam 10% WG	1500	12.85	58.95 (50.16)	70.05 (56.82)	73.50 (59.02)	82.73 (65.44)	77.94 (61.99)	63.53 (52.85)	78.39 (62.30)	86.97 (68.84)	93.05 (74.71)	87.92 (69.66)	67.11 (55.01)	81.97 (64.87)	90.55 (72.10)	96.63 (79.42)	91.50 (73.05)
6	Indoxacarb 14.5 % SC	400	13.00	40.07 (39.27)	46.77 (43.15)	54.83 (47.77)	65.49 (54.02)	61.62 (51.72)	43.27 (41.13)	59.67 (50.58)	64.03 (53.15)	71.07 (57.46)	66.05 (54.36)	46.85 (43.19)	63.25 (52.68)	67.61 (55.31)	74.65 (59.77)	69.63 (56.56)
7	Thiamethoxam 25% WG	200	12.35	37.59 (37.81)	42.95 (40.95)	48.42 (44.09)	61.71 (51.77)	60.74 (51.20)	39.63 (39.01)	49.93 (44.96)	60.18 (50.87)	67.27 (55.10)	62.38 (52.17)	43.21 (41.10)	53.51 (47.01)	63.76 (52.99)	70.85 (57.32)	65.96 (54.31)
8	Novaluron 5.25% + Indoxacarb 4.5 % SC	825	12.70	38.55 (38.38)	45.67 (42.52)	53.48 (47.00)	61.72 (51.78)	60.75 (51.21)	41.50 (40.11)	55.39 (48.09)	60.79 (51.23)	67.92 (55.50)	62.96 (52.51)	45.08 (42.18)	58.97 (50.17)	64.37 (53.35)	71.50 (57.73)	66.54 (54.66)
9	Untreated control		12.95	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
	S. Em. +			0.75	0.82	0.74	0.80	0.80	0.92	0.83	0.88	0.94	0.89	0.95	1.04	0.81	0.50	0.52
	C.D. at 5%			2.24	2.46	2.23	2.38	2.41	2.77	2.50	2.63	2.82	2.67	2.86	3.10	2.43	1.52	1.57

Table 3. Efficacy of Indoxacarb 10 % + Thiamethoxam 10% WG against fruit borer on tomato during *Kharif* 2017

S.No	Treatment	Dose (ml/ha)	PTP	Mean reduction (%) in fruit borer population, days after spray															
				1st spray					2nd spray					3rd spray					
				1 day	3 day	5 day	7 day	10 day	1 day	3 day	5 day	7 day	10 day	1 day	3 day	5 day	7 day	10 day	
1	Indoxacarb 10 % + Thiamethoxam 10% WG	250	13.25	38.52 (38.36)	42.49 (40.68)	48.77 (44.30)	58.80 (50.07)	56.28 (48.61)	47.62 (43.64)	55.10 (47.93)	59.48 (50.46)	65.55 (54.06)	63.49 (52.83)	49.72 (44.84)	57.20 (49.14)	61.58 (51.70)	67.65 (55.34)	65.59 (54.08)	
2	Indoxacarb 10 % + Thiamethoxam 10% WG	400	12.90	47.38 (43.50)	56.66 (48.83)	61.56 (51.68)	73.15 (58.79)	71.32 (57.62)	58.75 (50.04)	61.15 (51.44)	69.94 (56.75)	72.72 (58.51)	71.01 (57.42)	60.85 (51.27)	63.25 (52.68)	72.04 (58.08)	74.82 (59.88)	73.11 (58.76)	
3	Indoxacarb 10 % + Thiamethoxam 10% WG	500	13.05	56.85 (48.94)	61.64 (51.73)	66.05 (54.36)	75.13 (60.09)	72.12 (58.13)	64.35 (53.34)	74.76 (59.84)	74.07 (59.39)	85.64 (67.73)	86.63 (68.55)	66.45 (54.60)	76.86 (61.25)	76.17 (60.78)	87.74 (69.50)	88.73 (70.38)	
4	Indoxacarb 10 % + Thiamethoxam 10% WG	750	12.80	58.85 (50.10)	68.36 (55.77)	72.12 (58.13)	79.63 (63.17)	78.22 (62.18)	67.88 (55.48)	76.26 (60.84)	78.88 (62.64)	89.14 (70.76)	88.23 (69.94)	69.98 (56.78)	78.36 (62.28)	80.98 (64.14)	91.24 (72.78)	90.33 (71.88)	
5	Indoxacarb 10 % + Thiamethoxam 10% WG	1500	13.00	70.18 (56.90)	72.30 (58.24)	75.71 (60.47)	88.94 (70.58)	87.99 (69.72)	72.96 (58.67)	80.25 (63.51)	86.89 (68.77)	96.79 (79.68)	96.30 (78.91)	74.96 (59.97)	82.25 (65.08)	88.89 (70.53)	98.79 (83.68)	97.30 (80.54)	
6	Indoxacarb 14.5 % SC	400	12.85	42.89 (40.91)	54.48 (47.57)	59.58 (50.52)	71.30 (57.61)	69.44 (56.44)	51.77 (46.01)	58.81 (50.07)	67.46 (55.22)	70.80 (57.29)	69.01 (56.17)	53.87 (47.22)	60.70 (51.18)	69.56 (56.51)	72.90 (58.63)	71.11 (57.49)	
7	Thiamethoxam 25% WG	200	13.35	40.49 (39.52)	50.81 (45.46)	51.77 (46.01)	64.32 (53.32)	62.10 (52.00)	49.82 (44.90)	57.39 (49.25)	61.59 (51.70)	68.12 (55.62)	66.18 (54.44)	51.92 (46.10)	59.49 (50.47)	63.69 (52.95)	70.22 (56.93)	68.28 (55.72)	
8	Novaluron 5.25% + Indoxacarb 4.5 % SC	825	12.75	42.05 (40.43)	52.90 (46.66)	58.15 (49.69)	65.99 (54.33)	63.81 (53.02)	50.16 (45.09)	58.50 (49.95)	62.68 (52.35)	70.61 (57.17)	68.84 (56.07)	52.26 (46.30)	60.91 (51.30)	64.78 (53.60)	72.71 (58.51)	70.94 (57.38)	
9	Untreated control		12.90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
	S. Em. +			0.95	0.88	0.87	0.79	0.97	0.95	0.90	0.87	0.98	0.97	0.92	1.02	0.91	0.75	0.60	
	C.D. at 5%			2.84	2.64	2.6	2.36	2.92	2.84	2.69	2.59	2.93	2.91	2.75	3.05	2.92	2.27	1.82	

Table 4. Natural Enemy population in different treated plots of tomato after 1st round of spray (Pooled data of 2 years) (*Kharif* 2016 and 2017)

S.No	Treatment	Dose (g/ml ha^{-1})	Mean reduction (%) in natural enemies population, days after spray											
			Spiders						Coccinellids					
			PTP	1 day	3 day	5 day	7 day	10 day	PTP	1 day	3 day	5 day	7 day	10 day
1	Indoxacarb 10 % + Thiamethoxam 10% WG	250	1.84 (1.53)	1.78 (1.51)	1.82 (1.52)	1.94 (1.56)	2.10 (1.61)	1.90 (1.55)	1.85 (1.53)	1.90 (1.55)	1.92 (1.56)	1.94 (1.56)	1.90 (1.55)	1.96 (1.57)
2	Indoxacarb 10 % + Thiamethoxam 10% WG	400	2.02 (1.59)	1.88 (1.54)	1.84 (1.53)	1.96 (1.57)	2.12 (1.62)	2.2 (1.59)	1.96 (1.57)	1.97 (1.57)	1.93 (1.56)	1.91 (1.55)	1.94 (1.56)	1.95 (1.57)
3	Indoxacarb 10 % + Thiamethoxam 10% WG	500	1.96 (1.57)	1.82 (1.52)	2.20 (1.59)	2.00 (1.58)	1.90 (1.55)	1.94 (1.56)	1.92 (1.56)	1.99 (1.58)	1.88 (1.54)	1.87 (1.54)	2.10 (1.58)	2.00 (1.58)
4	Indoxacarb 10 % + Thiamethoxam 10% WG	750	1.80 (1.52)	1.63 (1.46)	1.94 (1.56)	1.98 (1.57)	1.92 (1.56)	1.88 (1.54)	1.87 (1.54)	1.66 (1.47)	1.73 (1.49)	1.71 (1.49)	1.91 (1.55)	1.92 (1.56)
5	Indoxacarb 10 % + Thiamethoxam 10% WG	1500	2.02 (1.59)	2.00 (1.58)	1.98 (1.57)	2.00 (1.58)	2.20 (1.64)	1.90 (1.55)	1.94 (1.56)	1.92 (1.56)	1.82 (1.52)	1.72 (1.49)	1.82 (1.52)	1.85 (1.53)
6	Indoxacarb 14.5 % SC	400	2.10 (1.61)	1.98 (1.57)	1.84 (1.53)	2.3 (1.59)	2.13 (1.62)	1.98 (1.57)	1.82 (1.52)	1.93 (1.56)	1.99 (1.58)	2.30 (1.59)	2.20 (1.59)	1.96 (1.57)
7	Thiamethoxam 25% WG	200	1.82 (1.52)	1.9 (1.55)	1.84 (1.53)	1.88 (1.54)	2.00 (1.58)	2.40 (1.59)	1.77 (1.51)	1.97 (1.57)	1.95 (1.57)	1.92 (1.56)	1.97 (1.57)	1.94 (1.56)
8	Novaluron 5.25% + Indoxacarb 4.5 % SC	825	1.88 (1.54)	1.82 (1.52)	1.74 (1.5)	1.92 (1.56)	2.20 (1.59)	2.00 (1.58)	1.79 (1.51)	1.71 (1.49)	1.81 (1.52)	1.84 (1.53)	1.90 (1.55)	1.87 (1.54)
9	Untreated control		1.90 (1.55)	1.88 (1.54)	2.00 (1.58)	1.97 (1.57)	1.88 (1.54)	1.96 (1.57)	1.80 (1.52)	2.00 (1.58)	1.99 (1.58)	2.50 (1.6)	1.95 (1.57)	1.97 (1.57)
	S. Em. +		0.08	0.06	0.04	0.02	0.05	0.04	0.11	0.05	0.06	0.05	0.04	0.11
	C.D. at 5%		0.26	0.19	0.13	0.06	0.16	0.14	0.34	0.16	0.22	0.16	0.14	0.33

Table 5. Natural Enemy population in different treated plots of tomato after 2nd round of spray (Pooled data of 2 years) (*Kharif* 2016 and 2017)

S.No	Treatment	Dose (g/ml ha^{-1})	Mean reduction (%) in natural enemies population, days after spray											
			Spiders						Coccinellids					
			PTP	1 day	3 day	5 day	7 day	10 day	PTP	1 day	3 day	5 day	7 day	10 day
1	Indoxacarb 10 % + Thiamethoxam 10% WG	250	1.88 (1.54)	1.94 (1.56)	1.97 (1.57)	1.99 (1.58)	2.03 (1.59)	2.01 (1.58)	1.74 (1.50)	1.73 (1.49)	1.76 (1.50)	1.71 (1.49)	1.74 (1.50)	1.71 (1.49)
2	Indoxacarb 10 % + Thiamethoxam 10% WG	400	1.84 (1.53)	1.90 (1.55)	2.00 (1.58)	1.88 (1.54)	1.92 (1.56)	1.90 (1.55)	1.64 (1.46)	1.72 (1.49)	2.00 (1.58)	1.92 (1.56)	1.64 (1.46)	1.92 (1.56)
3	Indoxacarb 10 % + Thiamethoxam 10% WG	500	1.78 (1.51)	1.79 (1.51)	1.90 (1.55)	1.83 (1.53)	1.86 (1.54)	1.86 (1.54)	1.85 (1.53)	1.87 (1.54)	2.00 (1.58)	1.92 (1.56)	1.85 (1.53)	1.92 (1.56)
4	Indoxacarb 10 % + Thiamethoxam 10% WG	750	1.86 (1.54)	1.89 (1.55)	2.06 (1.60)	1.91 (1.55)	1.90 (1.55)	2.00 (1.58)	1.79 (1.51)	1.87 (1.54)	2.04 (1.59)	1.99 (1.58)	1.79 (1.51)	1.99 (1.58)
5	Indoxacarb 10 % + Thiamethoxam 10% WG	1500	1.67 (1.47)	1.70 (1.48)	1.85 (1.53)	1.80 (1.52)	1.90 (1.55)	1.93 (1.56)	1.78 (1.51)	1.63 (1.46)	1.86 (1.54)	1.66 (1.47)	1.78 (1.51)	1.66 (1.47)
6	Indoxacarb 14.5 % SC	400	1.77 (1.51)	1.79 (1.51)	1.87 (1.54)	1.82 (1.52)	1.97 (1.57)	1.85 (1.53)	1.83 (1.53)	1.80 (1.52)	2.01 (1.58)	1.97 (1.57)	1.83 (1.53)	1.97 (1.57)
7	Thiamethoxam 25% WG	200	1.74 (1.50)	1.72 (1.49)	1.74 (1.50)	1.67 (1.47)	1.64 (1.46)	1.59 (1.45)	1.77 (1.51)	1.76 (1.50)	1.87 (1.54)	1.82 (1.52)	1.77 (1.51)	1.82 (1.52)
8	Novaluron 5.25% + Indoxacarb 4.5 % SC	825	1.78 (1.51)	1.80 (1.52)	1.88 (1.54)	1.83 (1.53)	1.98 (1.57)	1.86 (1.54)	1.85 (1.53)	1.84 (1.53)	1.97 (1.57)	1.89 (1.55)	1.85 (1.53)	1.89 (1.55)
9	Untreated control		2.06 (1.60)	2.12 (1.62)	2.13 (1.62)	2.09 (1.61)	2.03 (1.59)	1.97 (1.57)	1.88 (1.54)	1.88 (1.54)	2.00 (1.58)	1.90 (1.55)	1.88 (1.54)	1.90 (1.55)
	S. Em. +		0.04	0.02	0.05	0.05	0.04	0.06	0.06	0.04	0.01	0.03	0.04	0.09
	C.D. at 5%		0.14	0.06	0.15	0.16	0.12	0.19	0.19	0.13	0.15	0.19	0.14	0.29

Table 6. Natural Enemy population in different treated plots of tomato after 3rd round of spray (Pooled data of 2 years) (*Kharif* 2016 and 2017)

S.No	Treatment	Dose (g/ml ha^{-1})	Mean reduction (%) in natural enemies population, days after spray											
			Spiders						Coccinellids					
			PTP	1 day	3 day	5 day	7 day	10 day	PTP	1 day	3 day	5 day	7 day	10 day
1	Indoxacarb 10 % + Thiamethoxam 10% WG	250	1.81 (1.52)	1.88 (1.54)	2.00 (1.58)	1.88 (1.54)	1.93 (1.56)	1.93 (1.56)	1.91 (1.55)	1.98 (1.57)	2.02 (1.59)	1.74 (1.49)	1.74 (1.49)	1.73 (1.49)
2	Indoxacarb 10 % + Thiamethoxam 10% WG	400	1.95 (1.57)	1.9 (1.55)	2.16 (1.63)	1.97 (1.57)	1.92 (1.56)	1.95 (1.56)	1.87 (1.54)	1.94 (1.56)	1.91 (1.55)	1.68 (1.48)	1.96 (1.57)	1.78 (1.51)
3	Indoxacarb 10 % + Thiamethoxam 10% WG	500	1.89 (1.55)	2.1 (1.61)	1.92 (1.56)	1.96 (1.57)	1.88 (1.54)	2.5 (1.6)	1.79 (1.51)	1.87 (1.54)	1.86 (1.54)	1.86 (1.54)	1.96 (1.57)	1.89 (1.54)
4	Indoxacarb 10 % + Thiamethoxam 10% WG	750	1.72 (1.49)	1.96 (1.57)	1.90 (1.55)	1.77 (1.5)	1.72 (1.49)	1.92 (1.55)	1.88 (1.54)	1.99 (1.58)	1.95 (1.57)	1.83 (1.53)	2.02 (1.59)	1.89 (1.55)
5	Indoxacarb 10 % + Thiamethoxam 10% WG	1500	2.10 (1.58)	1.99 (1.58)	2.50 (1.6)	1.93 (1.56)	1.77 (1.51)	1.84 (1.53)	1.69 (1.48)	1.83 (1.52)	1.92 (1.55)	1.71 (1.48)	1.76 (1.50)	1.72 (1.49)
6	Indoxacarb 14.5 % SC	400	2.4 (1.59)	2.70 (1.6)	2.60 (1.6)	1.88 (1.54)	2.15 (1.63)	2.80 (1.61)	1.78 (1.51)	1.85 (1.53)	1.91 (1.55)	1.82 (1.52)	1.99 (1.58)	1.90 (1.55)
7	Thiamethoxam 25% WG	200	1.86 (1.54)	1.86 (1.54)	2.20 (1.64)	1.87 (1.54)	1.94 (1.56)	1.96 (1.57)	1.73 (1.49)	1.71 (1.48)	1.62 (1.45)	1.77 (1.50)	1.85 (1.53)	1.80 (1.51)
8	Novaluron 5.25% + Indoxacarb 4.5 % SC	825	1.85 (1.53)	1.83 (1.53)	2.10 (1.61)	1.75 (1.50)	1.83 (1.52)	1.89 (1.54)	1.79 (1.51)	1.86 (1.53)	1.92 (01.56)	1.85 (1.53)	1.93 (1.56)	1.87 (1.54)
9	Untreated control		1.89 (1.55)	1.99 (1.58)	1.92 (1.56)	1.90 (1.55)	2.25 (1.66)	1.96 (1.57)	2.09 (1.61)	2.11 (1.62)	2.00 (1.58)	1.88 (1.54)	1.95 (1.57)	1.89 (1.55)
	S. Em. +		0.02	0.04	0.01	0.02	0.02	0.03	0.04	0.04	0.03	0.01	0.04	0.05
	C.D. at 5%		0.16	0.21	0.25	0.26	0.26	0.29	0.25	0.29	0.29	0.25	0.21	0.16

Table 7. Effect of Indoxacarb 10% + Thiamethoxam 10% WG on yield of Tomato (*Kharif* 2016 and 2017)

S. No.	Treatments	Dose (g/ml ha $^{-1}$)	2016 q/ha	2017 q/ha
1	Indoxacarb 10% + Thiamethoxam 10% WG	250	146.75	148.98
2	Indoxacarb 10% + Thiamethoxam 10% WG	400	195.38	198.25
3	Indoxacarb 10% +Thiamethoxam 10% WG	500	208.95	211.65
4	Indoxacarb 10% + Thiamethoxam 10% WG	750	232.50	238.45
5	Indoxacarb 10% +Thiamethoxam 10% WG	1500	241.82	250.70
6	Indoxacarb 14.5 % SC	400	188.81	190.85
7	Thiamethoxam 25% WG	200	153.87	156.67
8	Novaluron 5.25% + Indoxacarb 4.5 % SC	825	168.27	169.56
9	Untreated control		120.45	123.72
	CD		35.12	38.35
	SEm±		11.71	12.78

2017, respectively. Novaluron 5.25% − indoxacarb 4.5 % SC at 825 ml/ha, Indoxacarb 14.5 % SCat 400 ml/ha, Thiamethoxam 25% WG at 200ml/ha and Indoxacarb 10% Thiamethoxam 10% WG at 250 ml/ha were also found superior to untreated control.The yield ranging from 18.31 q ha-1 to 602.78 q ha-1 with the indoxacarb was achieved (Patil *et al.* 2007, Dhaka *et al.* 2010 and Singh *et al.* 2005) earlier which support the present findings.

CONCLUSION

The present experiment on bio-efficacy of indoxacarb 10% + thiamethoxam 10% WG at different doses revealed that indoxacarb 10% − thiamethoxam 10% WG at 500-750 ml/ha is optimum and most effective against tomato fruit borer and resulted higher yield. The treatments of indoxacarb 10% + thiamethoxam 10% WG at the doses of 250-1500 ml/ha did not cause any adverse effect on common natural enemies present in tomato ecosystem.

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