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In vivo appraisal of Phytoextracts, essential oils and insecticides against Tomato fruit borer (*Helicoverpa armigera* Hubner)

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ABSTRACT

Tomato is one of the most popular solanaceous vegetable crops grown all over the world. Tomato fruit borer (*Helicoverpa armigera*) is one of the major key pests of tomato. The effectiveness of eleven treatments were determined based on the population of fruit borer recorded one day before spray as pre-treatment observation, while post treatment observations were taken at 1, 3 and 7 days after spray (DAS). In 1st spray the most effective treatment was with indoxacarb14.5 SC 1.37 larval population reductions while ginger rhizome extract@ 5% showed least effective with 3.61 larval population reductions. In 2nd spray again the most effective treatment was indoxacarb14.5 SC with 1.21 larval population reductions while ginger rhizome extract 5% showed least effective with 3.83 larval population reductions. After both the spray, the maximum per cent reduction of damage of tomato fruits was obtained by the application of indoxacarb14.5 SC with 12.92% and lowest per cent reduction in damage was recorded in ginger rhizome extract with 38.80%. All the treatments were found effective in increasing fruit yield of tomato with 0.51 Kg/plot to 0.70 Kg/plot tomato yield over control.

1. Introduction

Tomato (*Solanum lycopersicum* L.) is the one of the worlds most important and consumed vegetable crop. The cultivated tomato is a member of the genus Solanum within the family Solanaceae. Tomato is used mostly as vegetable but it also tops the list of canned vegetables. It is an important condiment in most diets and a good source of vitamins A, C and E, fibers and minerals (Olaniyi, 2010). Tomato is also rich in medicinal value, have an antiseptic property against intestinal infection and acts as blood purifier. Lycopene is the important constituent present in tomato, which is a powerful antioxidant and helpful to reducing the risk of prostate cancer (Raiola *et al.*, 2014). It is useful against prostate cancer, cancer of the mouth, sore mouth, night blindness and intestinal disorders etc. After China, India is the 2nd largest producer of tomatoes in the world. In India, it occupies an area of 778,000 ha with an annual production of 193, 970, 00 MT in the year 2018-2019 (Anonymous, 2018). Andhra Pradesh, Odisha, Telangana, Madhya Pradesh, Karnataka, West Bengal, Chhatishgarh, Maharashtra, Bihar, Gujarat and Rajasthan are the tomatoes growing state. In Uttarakhand, tomato is cultivated over an area of 4509.28 ha with an annual production of 64141.09 MT in the year 2019-20 (Anonymous, 2019). The use of natural compounds in place of synthetic insecticides can lower environmental pollution, and they are safe for crop production and highly effective to control insect pests (Liao *et al.*, 2017). Management of pests using plant-based products was practised over time until technology took over and synthetic pesticides were developed (Mehmood *et al.,* 2016). Many researchers have found botanicals having pesticidal properties and are effective against insect pest management. It would help to avoid environmental pollution caused by chemicals. Plant extracted oils are volatile and many oils serve as chemical messengers for insects. Citronella oil has insecticidal properties as repellent as well as antifeedent agent *against H. armigera* (Papulwar *et al.*, 2018). *Azadirachta indica* has, substantially, been used in pest management nowadays worldwide (Hussain *et al.*, 2015). Green leaf extracts of walnut and ginger rhizome extract are

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used against *Helicoverpa armigera* on oats crop (Kumar *et al*., 2018). Solvent extract of *Artemisia* spp. was effective against third instar caterpillar of *Pieris brassicae* (Sharma, 2016). Insecticidal control is one of the common methods against the fruit borer; many of the insecticides applied are effective for the satisfactory control of this pest. Number of synthetic organo phosphates has been recommended from different parts of country for effective control of *H. armigera* (Mote *et al.* 1975, Murray *et al.* 2005, Patil *et al.*2007, and Dhaka *et al*., 2010) recorded indoxacarb as most effective insecticides against tomato fruit borer. The application of novaluron was effective against *H. armigera* (Saini *et al*., 2013). Profenofos is also effective against tomato fruit borer (Patil *et al*., 2018).

2. Materials and Methods

Present experiment was conducted at Vegetable Research and Demonstration Block, College of Horticulture, VCSG UUHF, Bharsar during 2021 at an altitude of 1900m above the sea level lies between latitude 30.056˚ North and longitude 78.99˚ East (IMD, 2015). It falls under the foot hills of Himalayas, the mid-hill zone of Uttarakhand and falls under sub-humid and sub-tropic climate. Climate of the area is generally sub-temperate and sub-humid characterized by cold winters. The climatic condition existing throughout the cropping season was favorable for crop growth.The efficacy of various phytoextracts, essential oils and insecticides during *Kharif* season, with eleven treatments and three replications in RCBD (Randomized Complete Block Design). The insecticides of required concentration were prepared in water just before spraying and applied after proper stirring with care to cover the entire plant during morning hours and sunny day. First spray was done at dawn and dusk time. Five plants were labeled and examined per plot, from each plant number of larvae, the damage and healthy fruits before and after 1st, 3rd and 7th day of application was counted to know the effect of insecticides, phyto extracts and essential oils. Same method was adopted for second spray. Then per cent reduction of insect population was calculated by using Henderson and Tilton-equation (1955) formula as under:

$$\text{Per cent Reduction in Larval Population}=100\left[1-\frac{Ta\times Cb}{Tb\times Ca}\right]$$

Where, T_a is number of insects after treatment, T_b is number of insects before treatment, C_a is number of insects in untreated check after treatment and C_b number of insects in untreated check before treatment. After this infested fruits percentage was calculated by following formula:

$$\text{Per cent Fruit Damage}=\frac{\text{Number of damaged fruits}}{\text{Total number of fruits}}\times 100$$

Finally total yield was calculated. The data recorded after management of *H. armigera* population, decreased damaged fruit and increase yield were statistically analyzed with the help of OPSTAT.

3. Results and Discussion

Effect of different treatments against population of (*H. armigera)* on tomato

The efficacy of lemon grass oil, profenofos, novaluron, imidacloprid, neem oil, fipronil, garlic extract, indoxacarb, ginger rhizome extract and artemisia leaf were studied against the tomato fruit borer. The result of effectiveness of phytoextracts, essential oils and insecticides treatments against tomato fruit borer, *H. armigera* showed that all the treatments were significantly superior over control in terms of mean reduction of tomato fruit borer larvae. The minimum population of *H. armigera* was recorded in indoxacarb 14.5 SC with the percent reduction over control of 72.26 per cent after 1st, 3rd, 7th day after first spray. Indoxacarb 14.5SC (0.014 %) was found superior to all the treatments and it was statistically at par with fipronil 50SC (0.005%). The maximum population of *H. armigera* was recorded in ginger rhizome 5% extract with the per cent reduction over control of 25.70%. Ginger rhizome extract@5% was less effective among all the treatments. The minimum population at second spray was recorded in indoxacarb 14.5SC treated plots with percent reduction of 77.34 %. In second spray indoxacarb 14.5SC (0.014 %) was found superior to all the treatments and statistically at par with fipronil 50 SC (0.005%) and ginger rhizome extract @5% showed least effective (Table 1). The present findings is agreement with the result of Singh and Gupta (2017) who reported that indoxacarb 14.5 SC (0.01%) was found most effective against fruit borer and novaluron was also effective at 10 EC (0.01%) among nine insecticides. The data recorded on per cent damaged fruits by *H. armigera* on tomato during *Kharif* season are presented in (Table 2).

Effect of different treatments against fruit damage caused by *H.armigera* on tomato

Effect of phytoextract, essential oils and insecticides against fruit damage (on weight basis) caused by *H. armigera* on tomato revealed that per cent reduction in fruit damage reduction on weight basis on first, third and seventh day after treatments. The average per cent fruit damage reduction of all pickings was 28.70, 31.98, 19.93, 21.86, 24.72, 29.40, 17.71, 35.22, 13.40, 46.17 and 28.70 per cent, respectively and per cent fruit damage in control was 38.80 per cent. Minimum per cent fruit damage was recorded in indoxacarb 14.5 SC (13.40 per cent) followed by fipronil 50 SC (17.02 per cent) and maximum percent fruit damage recorded in control (42.43 %).The present findings supported with the result of Kamble*et al.* (2005) where 41.44 percent fruit damage was found due to the pest in total six picking,

Faqiri and Kumar (2016) reported the lowest infestation of fruit borer were recorded in treatments profenofos 50%EC (4.350) (Table 3).

Field-efficacy of treatments against tomato fruit yield and increase fruit yield over control

All the treatments gave significantly higher yield over control (33.44 q/ha – 23.25 q/ha) and increase yield over control (43.81 % – 3.85 %). The higher yield was found in indoxacarb 14.5 SC (33.44 q/ha) with 43.81 per cent increase in yield over control followed by fipronil 50 SC (30.66 q/ ha) with 31.84 per cent increase in yield over control (Table 4). The results of present investigations are in confirmatory with findings of Ravi *et al.* (2008).indoxacarb 14.5 SC (33.44 q/ha) with 43.81 per cent increase in yield over control followed by fipronil 50 SC (30.66 q/ ha) with 31.84 per cent increase in yield over control (Table 4). The results of present investigations are in confirmatory with findings of Ravi *et al.* (2008).

Table 1. Efficacy of different treatments on the larval population and per cent reduction of tomato fruit borer (*H. armigera*) after 1st spray

Treatments	1st Spray (Tomato fruit borer larvae/5 Plants)						
	Dose (%)	1st DBT	1st DAT	3rd DAT	7th DAT	Pooled mean	Per cent reduction of larvae
Control (Water Spray)	-	4.43	4.73	5.03	5.06	4.94	-
Lemon grass oil	1	4.06*	3.50*	3.39*	3.58*	3.49*	29.35
Profenofos 50 EC	0.05	3.86*	2.63*	2.46*	3.21*	2.76*	43.92
Novaluron 10% EC	0.01	3.83*	3.13*	3.07*	3.18*	3.13*	36.63
Imidacloprid 17.8 SL	0.03	3.26*	3.20*	3.27*	3.29*	3.25*	34.21
Neem oil	1	3.66*	3.33*	3.26*	3.20*	3.27*	33.80
Fipronil 50 SC	0.005	3.93*	1.63*	1.49*	2.08*	1.73*	64.97
Garlic bulb extract	5	4.03*	3.50*	3.53*	3.52*	3.52*	28.74
Indoxacarb 14.5 SC	0.014	3.83*	1.26*	1.23*	1.63*	1.37*	72.26
Ginger Rhizome extract	5	4.03*	3.76*	3.56*	3.70*	3.67*	25.70
Artemisia Leaf Extract	5	4.13*	3.60*	3.63*	3.56*	3.61*	26.92
SE(d)	-	0.101	0.109	0.081	0.092	0.129	-
C.D.(p=0.05)	-	0.213	0.228	0.170	0.193	0.272	-

DBT- Day before treatment; DAT- Day after treatment

Table 2. Efficacy of treatments on the larval population and per cent reduction of tomato fruit borer (*H. armigera)* on 2nd spray

Treatments	2nd Spray (Tomato fruit borer larvae/5 Plants)					
	Dose (%)	1st DAT	3rd DAT	7th DAT	Pooled Mean	Per cent reduction of Larvae
Control	-	5.16	5.33	5.61	5.37	-
Lemon grass oil	1	3.80*	3.66*	3.55*	3.67*	31.60
Profenofos 50 EC	0.05	2.53*	2.51*	2.64*	2.56*	52.21
Novaluron 10% EC	0.01	3.40*	3.01*	2.94*	3.12*	41.89
Imidacloprid 17.8 SL	0.03	3.44*	3.41*	3.50*	3.45*	35.71
Neem oil	1	3.66*	3.53*	3.44*	3.54*	33.91
Fipronil 50SC	0.005	1.53*	1.42*	1.43*	1.46*	72.75
Garlic bulb extract	5	3.73*	3.70*	3.71*	3.71*	30.81
Indoxacarb 14.5 SC	0.014	1.26*	1.06*	1.31*	1.21*	77.34
Ginger Rhizome extract	5	3.86*	3.83*	3.81*	3.83*	28.54
Artemisia Leaf Extract	5	3.83*	3.70*	3.91*	3.81*	28.95
SE(d)	-	0.06	0.07	0.03	0.10	-
C.D. (p=0.05)	-	0.13	0.15	0.07	0.21	-

Table 3. Efficacy of treatments on per cent reduction of damaged tomato fruit yield on weight basis

Treatments	Dose (%)	1st Spray			2nd Spray			Pooled mean of per cent reduction
		1st DAT	3rd DAT	7thDAT	1stDAT	3rd DAT	7thDAT	
Control	-	32.51 (34.74)	26.58 (31.02)	25.25 (30.15)	26.44 (30.93)	28.56 (32.29)	32.10 (34.50)	42.43 (39.58)
Lemon grass oil	1	19.26* (26.02)	19.37* (26.09)	17.50* (24.72)	18.13* (25.19)	19.23* (26.00)	19.93* (26.50)	28.57 (34.59)
Profenofos 50 EC	0.05	21.64* (27.71)	21.38* (27.51)	19.26* (26.02)	20.47* (26.89)	21.30* (27.47)	21.86* (27.86)	18.90 (30.48)
Novaluron 10% EC	0.01	24.21* (29.46)	22.86* (28.55)	21.42* (27.56)	22.40* (28.23)	23.25* (28.82)	24.72* (29.80)	20.99 (31.45)
Imidacloprid 17.8 SL	0.03	28.35* (32.16)	24.75* (29.82)	23.31* (28.86)	24.47* (29.63)	25.39* (30.24)	29.40* (32.82)	23.14 (32.40)
Neem oil	1	17.43* (24.66)	17.63* (24.79)	15.67* (23.31)	16.45* (23.91)	17.26* (24.53)	17.71* (24.88)	25.95 (33.56)
Fipronil 50 SC	0.005	34.08* (35.70)	28.99* (32.56)	27.58* (31.67)	29.19* (32.69)	32.98* (35.02)	35.22* (36.39)	17.02 (29.55)
Garlic bulb extract	5	13.21* (21.31)	13.50* (21.50)	11.69* (19.98)	12.32* (20.54)	13.38* (21.41)	13.40* (21.46)	31.34 (35.65)
Indoxacarb 14.5 SC	0.014	40.22 (39.34)	35.62* (36.62)	34.41* (35.90)	35.83* (36.75)	40.57* (39.53)	46.17 (42.79)	12.92 (27.28)
Ginger Rhizome extract	5	39.18* (38.73)	30.45* (33.47)	30.02* (33.21)	31.38* (34.05)	33.32* (35.24)	28.70* (32.38)	38.80 (38.32)
Artemisia Leaf Extract	5	32.51* (34.74)	26.58* (31.02)	25.25* (30.15)	26.44* (30.93)	28.56* (32.29)	32.10* (34.50)	32.18 (35.95)
SE(d)	-	**0.28 (0.18)**	**1.06 (0.76)**	**0.24 (0.17)**	**0.26 (0.17)**	**1.50 (0.94)**	**0.31 (0.21)**	**1.08 (0.38)**
C.D. (p=0.05)	-	**0.59 (0.38)**	**2.23 (1.61)**	**0.51 (0.36)**	**0.55 (0.37)**	**3.16 (1.97)**	**0.66 (0.44)**	**2.19 (0.77)**

( ) = Figures in the Parentheses are angular transformed values *Significant at 5% level of significance

Table 4. Efficacy of treatments on tomato fruit yield and increase fruit yield over control

Treatments	Dose (%)	Kg/plot	q/ha	Increase fruit yield overcontrol (%)
Control	5	0.49	23.25	-
Lemon grass oil	1	0.56*	26.50	13.99
Profenofos 50 EC	0.05	0.63*	30.09	29.41
Novaluron 10% EC	0.01	0.62*	29.62	27.38
Imidacloprid 17.8 SL	0.03	0.60*	28.67	23.32
Neem oil	1	0.59*	27.83	19.67
Fipronil 50 SC	0.005	0.65*	30.66	31.84
Garlic bulb extract	5	0.55*	26.22	12.77
Indoxacarb 14.5 SC	0.014	0.70*	33.44	43.81
Ginger Rhizome extract	5	0.51*	24.15	3.85
Artemisia Leaf Extract	-	0.53*	25.00	7.50
SE(d)	-	0.01	-	-
C.D. (p=0.05)	-	0.02	-	-

4. Conclusion

The effectiveness of treatments were determined based on population of fruit borer recorded one day before, while post treatments observation were taken at 1st, 3rd and 7th days after spray. Out of all treatments, indoxacarb followed by fipronil found most effective while ginger rhizome extract showed least effective for reducing the population of fruit borer, decrease in fruit damage and also found effective in increasing tomato fruit yield and increase fruit yield over untreated control.

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