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Original Research Article

Evaluation and Economics of Various Insecticide against Whitefly *Bemisia tabaci* on Tomato

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Keywords

Tomato, whitefly, insecticide

A B S T R A C T

A field trial was conducted at Vegetable Research Farm of Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar during Rabi season of 2016-17 on tomato crop variety Avinash 2 to evaluate the efficacy and economics of different insecticidal treatments against whitefly, Bemisia tabaci. Three sprays at ten days interval of ten treatments with three replications were applied in the field. The obtained after each spray revealed that all the insecticidal treatments were significantly superior over control in reducing whitefly population and efficacy was maximum in imidacloprid followed by profenophos 40% + cypermethrin 4% and it was minimum in tobacco decoction while efficacy of other insecticides were in between these insecticides. Total weight of fruits was also recorded after each picking per plot. The benefit – cost ratio was calculated by dividing the additional income over control to the additional cost incurred for pest control. The benefit cost ratio was highest in imidaclorpid followed by cypermethrin

Introduction

Tomato, *Solanum lycopersicum* is an important and remunerative vegetable crop grown as commercial and kitchen garden in India. It belongs to the nightshade family Solanaceae. It is often described as "poor man orange" or "Love apple". It is a rich source of minerals, vitamins and organic. It is mainly a warm season vegetable but extensively grown in cold season also. It is the second most grown vegetable in world after potato**.** In India, tomato is grown across the length and breadth of the country**.** In 2015-16 total area under cultivation is7.74 lakh ha with annual production 188 lakh tonnes and productivity 24 tonnes per ha (NHB). The whitefly is one of the most economically important pests of tomato in many tropical and sub-tropical regions (Block, 1982). Currently its host range has crossed 600 plant species including cotton, vegetable, ornamental plants and several other agriculture crop (Oliveira *et al.*, 2001). Tomato plant is one of the major vegetable hosts of the *Bemisia tabaci* and act as an important pest of the plant (Butter *et al.*, 1978).

Damage is caused by both nymph and adults in three ways viz; the vitality of the plant is lowered through the loss of cell sap, normal photosynthesis is interfered due to the growth of sooty mould on the honey dew excreted by the insect and transmits a number of viral diseases including leaf curl virus. Thus, it not only suck the plant sap while feeding but also transmit tomato leaf curl virus (TLCV), which results in curling of tomato leaves (Atwal and Dhaliwal, 2005).

The damage is caused by whitefly, adult and nymph directly or as a vector of TLCV leads to heavy loss in tomato production. Therefore, management of whitefly is very essential. Various methods of whitefly management on tomato have been recommended. However, chemical based management strategies are common feature of Asian vegetable production because it gives rapid result in comparison to other control measures. Profenophos @ 500 g a.i. ha^{-1} reduced whitefly population by 86.25 per cent (Sharma *et al.*, 2002). Polytrin (profenophos 40 % + cypermethrin 4%) were found effective against whitefly on okra (Sinha and Nath, 2009). Imidacloprid @ 5 g per kg significantly reduced whitefly population as compared to untreated control (Hossain *et al.*, 2013). Control of whitefly by profenophos was most effective followed by indoxacarb and NSKE (Meena and Ranju, 2014). Further, plant products are natural eco-friendly insecticides and are cheaper and safe as compared to synthetic insecticides and they are not very persistent. Neem product such as NSKE, neem oil reduced nymph and adult population of whitely significantly (Ahirwar *et al.*, 2009). Yam bean seed has great value as botanical insecticides to insect pests (Yongkhamcha and Indrapichate, 2012). Neem oil, neem seed extract and tobacco reduced whitefly population in cotton ecosystem by 59.78, 59.38 and 40.61 %, respectively (Noonari *et al.*, 2016). Against whitefly first spray of neem extract, tobacco extract and datura extract showed 82.60, 75.95 and 73.99 per cent mortality, respectively while in the second spray it was 676.53, 56.43 and 42.25 per cent, respectively (Ali *et al.*, 2017). However, chemical based management strategies are common feature of Asian vegetable production because it gives rapid result in comparison to other control measures.

Materials and Methods

The field experiment was conducted at Vegetable Research Farm of Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar during *Rabi* season of 2016-17. Tomato variety 'Avinash - 2' seedling (25 days old) of 8-10 cm in length were transplanted from nursery to the main field and crop was grown without application of any insecticide either in soil or as seed treatment. This was done to allow natural population of whitefly on crop. The chemical insecticides and plant products (profenophos @ 500 g a.i. ha^{-1}, imidacloprid @ 20 g a.i. ha^{-1}, cypermethrin @ 25 g a.i. ha^{-1}, indoxacarb @ 50 g a.i. ha^{-1}, profenophos 40% + cypermethrin 4% @ 440 g a.i. ha^{-1}, neem seed kernel extract 5%, neem oil 2%. tobacco decoction 5%, yam bean seed extract 5% and control (water spray) were sprayed three times during crop season at 10 days interval immediately after crossing the ETL. Observation pertaining to population of whitefly was recorded on five randomly selected plants, by observing three leaves (upper, middle and lower) randomly during early morning hours in each plot when it remains on leaves with the help of a hand lens of 10X magnification one day before first spraying and after 1^{st}, 5^{th} and 7^{th} day of each spray.

Total weight of fruits was recorded after each picking per plot. The cumulative yield data of each treatment was worked out and analysed statistically. Economics of the each insecticidal application was calculated in context of the applicability and suitability of individual insecticidal treatment. The net income was deduced by taking the difference between the gross income obtained by selling the produce at the market price and cost of insecticidal application. The benefit – cost ratio was calculated by dividing the additional income over control to the additional cost incurred for pest control.

Results and Discussion

The different treatments at different days after application varied in suppression of whitefly population. All the insecticidal treatments, including plant products were significantly effective than untreated control in reducing the whitefly *Bemisia tabaci* population (Table 1). Imidacloprid provide the best suppression of population, followed by mixture of profenophos and cypermethrin. This finding is in partial agreement with the results of Meena and Ranju (2014) who reported that control of whitefly by prophenophos was most effective insecticides followed by indoxacarb > NSKE 5%. Balakrishnan *et al.,* (2009) reported that indoxacarb 14.5 SC (500 ml ha^{-1}) against whitefly reduced population by (79.01%).

Akbar *et al.,* (2011) reported that prophenophos used against whitefly on okra reduces population upto 73 per cent. Pardeshi *et al.,* (2011) tested insecticides profenophos+ cypermethrin (0.044 %), cypermethrin 0.066 % and profenophos 0.05% on okra against *Earias vitella* were found to be most effective in reducing fruit infestation from 6.47 to 10.52 % against 43.5 % in the control. The highest yield of healthy fruit was recorded in the treatment of profenophos+ cypermethrin (0.044 %) while highest benefit cost ratio was obtained in the treatment of cypermethrin 0.006%. Smith and Giurcanu (2014) reported the effect of insecticides on transmission of Tomato yellow leaf curl virus (TYLCV) by the *Bemisia tabaci* and found that cypermethrin effective at 3 and 7 days after treatment in combination with the 14 days after treatment. Singh *et al.,* (2006) reported that all plant extract molecule gave superior control of whitefly over the untreated check. Noonari *et al.,* (2016) evaluated neem oil, neem seed extract and tobacco and reported that on cotton ecosystem whitefly population reduced by 59.78, 59.38 and 40.61 %, respectively.

The data on the effect of different insecticide and their doses on the marketable yield of tomato fruits are presented in the Table 2. Over all efficacy of various insecticidal treatments was finally assessed and compared on the basis of benefits realized in monitory terms and the data pertaining to this economical parameters are presented in Table 2. The result showed that increased yield and added benefit over control (Rs ha^{-1}) varied in respect of the average yield obtained in various treatments.

All treatments proved profitable over control and increase in yield varied from the maximum of 90 q ha^{-1} in imidacloprid to the minimum of 48 q ha^{-1} tobacco decoction 5 % showing a corresponding increase of 25.71 and 13.71 per cent. The gross income incurred due to the different treatments was the highest (Rs. 72000) in case of imidacloprid while it was the lowest (Rs 38400) in tobacco decoction 5 %. Remaining treatments occupied intermediate position yet with wide difference in respect of gross income. The net profit derived out of different treatments got affected since the cost involved in the these treatments ranged from a minimum of Rs. 3172 ha^{-1} in case of imidacloprid to the maximum of Rs. 26100 ha^{-1} in case of YBSE 5 %. Consequently the net profit derived out of different treatments was the highest Rs. 68828 to the lowest Rs. 13900 in imidacloprid and tobacco decoction 5 %, respectively.

Table.1 Effect of synthetic insecticides and plant products against whitefly, *Bemisia tabaci* population on tomato after spray under field condition

Insecticide	Dose	Number of whitefly per three leaves									
		Pre count	1st spray			2nd spray			3rd spray		
			1DAS	5DAS	7DAS	1DAS	5DAS	7DAS	1DAS	5DAS	7DAS
Profenophos	500 g a.i.ha^{-1}	30.20 (5.54)	23.00 (4.85)	19.20 (4.44)	16.00 (4.06)	10.80 (3.36)	9.60 (3.18)	8.80 (3.04)	6.80 (2.70)	5.40 (2.43)	4.80 (2.30)
Imidacloprid	20 g a.i. ha^{-1}	31.00 (5.61)	19.80 (4.51)	17.40 (4.23)	15.00 (3.94)	8.80 (3.05)	7.40 (2.81)	6.60 (2.66)	5.40 (2.43)	4.00 (2.12)	3.60 (2.02)
Cypermethrin	25 g a.i. ha^{-1}	29.20 (5.45)	23.60 (4.91)	19.60 (4.48)	16.60 (4.13)	12.20 (3.56)	10.60 (3.33)	9.80 (3.21)	8.60 (3.01)	6.60 (2.66)	5.80 (2.51)
Indoxacarb	50 g a.i. ha^{-1}	29.60 (5.48)	24.20 (4.96)	20.40 (4.57)	17.40 (4.23)	12.40 (3.59)	10.80 (3.36)	10.00 (3.24)	9.00 (3.08)	7.20 (2.77)	6.20 (2.59)
Profenophos 40 % + Cypermethrin 4%	440 g a.i. ha^{-1}	31.40 (5.64)	22.80 (4.83)	18.60 (4.37)	15.80 (4.04)	10.00 (3.24)	9.00 (3.08)	8.20 (2.95)	6.20 (2.56)	4.80 (2.30)	4.40 (2.21)
NSKE	5%	29.20 (5.45)	25.20 (5.07)	21.40 (4.68)	19.00 (4.415)	13.40 (3.73)	11.40 (3.45)	10.40 (3.30)	9.40 (3.15)	8.20 (2.95)	7.20 (2.77)
Neem oil	2%	29.80 (5.50)	24.80 (5.03)	21.20 (4.66)	18.40 (4.35)	13.20 (3.70)	11.00 (3.39)	10.20 (3.27)	9.00 (3.08)	7.40 (2.81)	6.60 (2.66)
Tobacco Decoction	5%	29.40 (5.47)	26.80 (5.22)	23.40 (4.89)	21.00 (4.64)	17.40 (4.17)	15.40 (3.99)	14.60 (3.88)	13.40 (3.73)	11.40 (3.45)	10.00 (3.24)
YBSE	5%	28.40 (5.38)	26.0 (5.15)	22.80 (4.83)	19.20 (4.44)	16.80 (4.16)	14.60 (3.89)	13.80 (3.78)	12.40 (3.59)	10.80 (3.36)	9.20 (3.11)
Control		29.60 (5.49)	30.20 (5.54)	34.60 (5.92)	35.80 (6.02)	39.40 (6.32)	42.40 (6.55)	38.60 (6.25)	39.20 (6.30)	36.60 (6.09)	33.20 (5.80)
SEm (±)			1.122	1.130	1.054	0.722	0.640	0.732	0.874	0.481	0.458
CD (p=0.05)		NS	3.358	3.382	3.155	2.162	1.918	2.193	2.616	1.441	1.372

Figures in parentheses are $(X+0.5)^{1/2}$ transformed values.

Table.2 Economics of different treatments against whitefly, *Bemisia tabaci* on tomato during *Rabi* 2016-17

Insecticide	Dose	Mean Yield (q ha^{-1})	Increased yield over control (q ha^{-1})	Added benefit over control* (Rs ha^{-1})	Treatment cost (Rs ha^{-1})	Net profit (Rs ha^{-1})	Benefit : cost ratio (BCR)
Profenophos	500 g a.i. ha^{-1}	429	79	63200	4800	58400	13.16:1
Imidacloprid	20 g a.i. ha^{-1}	440	90	72000	3172	68828	22.69:1
Cypermethrin	25 g a.i. ha^{-1}	421	71	56800	3300	53500	17.21:1
Indoxacarb	50 g a.i. ha^{-1}	416	66	52800	6838	45962	7.72:1
Profenophos 40 % + Cypermethrin 4%	440 g a.i. ha^{-1}	434	84	67200	4800	62400	14.00:1
NSKE	5%	404	54	43200	6225	36975	6.94:1
Neem oil	2%	413	63	50400	13200	37200	3.82:1
Tobacco Decoction	5%	398	48	38400	14850	23550	2.58:1
YBSE	5%	400	50	40000	26100	13900	1.53:1
Control		350					

Selling price of tomato Rs.800 per quintal

The descending order of benefit cost ratio was: imidacloprid (22.69:1) > cypermethrin (17.21:1) > profenophos 40% + cypermethrin 4% (14.00:1) > profenophos (13.16:1) > indoxacarb (7.72:1) > NSKE (6.94:1) > neem oil (3.82:1) > tobacco decoction (2.58:1) > YBSE (1.53:1).

This finding is in partial agreement with the results of Pardeshi *et al.,* (2011) who reported that profenophos + cypermethrin (0.044 %), cypermethrin (0.06 %) and profenophos (0.05 %) were found to be effective in reducing *Earias vitella* infestation on okra crop by 6.47 – 10.52 per cent against 43.5 % in control while highest cost benefit ratio was obtained in treatment of cypermethrin (0.006 %). Gupta (2013) reported that in brinjal yield was higher in indoxacarb treated plot than imidacloprid treated plot against shoot and fruit borer (*Leucinodes orbonalis*) but benefit cost ratio was higher in imidacloprid treated plot. Patil *et al.,* (2003) reported that yield was increased in neem seed extract and tobacco decoction treated plot as compare to untreated control plot and benefit cost ratio was higher in neem seed extract than tobacco decoction treatment.

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