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Efficacy Test of Bio-pesticides against Tobacco Whitefly *Bemisia tabaci* (Gennadius, 1889) on Tomato Plants in Nepal

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ABSTRACT

The efficacy test of bio-pesticides (Lastraw, Racer™ Pacer™, Mealikil™, Nimbecidine, Servo, Biocide Manic, Bio Power, Nico Neem, Uchit, Mighty-Cure, and Bio Magic) was experimented in tomato plants to control Tobacco whitefly *Bemisia tabaci* population. The results showed that biopesticides *viz*. Bio Magic (92.67%), Racer (91.90%), Pacer (91.50%), Mealikil (90.84%) were highly effective following Bio Power (87.53%) and Biocide Manic (85.8%) in reducing the population of whitefly over control after third spray. All biopesticides containing insect pathogen *Beauveria bassiana*, *Verticillium lecanii* and *Metarhizium anisopliae* were found effective in reducing the pest population. But the organic products and mineral oil were comparatively less effective.

Keywords: Tomato, pathogens, whitefly, pest, bio-pesticides, organic product, biorationals

INTRODUCTION

Tomato is one of the major commercial vegetable crops (Ghimire *et al.* 2000/2001) and widely grown in different seasons both in the plains and hills of Nepal (i.e. winter in Tarai and inner Tarai, spring and rainy in the low and mid hills). Tomato production during rainy season in open field condition is very difficult and the production during the season is very low (Pandey *et al.* 2006) however the difficulty is overcome by the new and modest technology of tomato production inside the plastic house and arrival of hybrid varieties (Chapagain *et al.* 2011). The annual production of tomatoes in Nepal is 317,657 metric tonnes in an area of 19,724 hectares (CBS 2010). There are several factors limiting the tomato production. The pests and diseases are major factors causing significant loss in crop yield. There are number of serious arthropod pests (Lange & Bronson 1981) such as aphid, whitefly, spider mite, fruit borer. Whitefly is one of the serious pests in tomato field (Muñiz & Nombela 2009).

Whiteflies are minute insects generally characterized by having wings covered with wax (Hodges & Evans 2005, Liburd & Nyoike 2012). It is a phloem feeding insect that lives predominantly on herbaceous plant (De Barro *et al.* 2011). It is broadly polyphagous feeding on estimated 600 plant species (Oliveira *et al.* 2001). Since the early 1980s, it has caused severe problem to agriculture crops and ornamental plants (OEPP/EPPO 2004). Whitefly was reported as pest of cotton in 1998 in Nepal and now becoming the burning pest, especially in vegetables both in hills and Tarai of Nepal (NARC 2011) and farmers are using chemical pesticides (Bhandari 2012, Karmacharya 2012). The chemical pesticides belonging to synthetic pyrethroids and organophosphate were applied at initial stage of infestation with increased dose and frequency over the year in vegetables (Rijal *et al.* 2006). More than one-sixth pesticides used by the farmers were extremely hazardous and which were banned for general agriculture use (Shrestha *et al.* 2010). Farmers were found using pesticides in pest management and they had little or no knowledge on alternative pest management and IPM (Awino 2008) but FFS' farmers were aware found adopting IPM technology (Adhakari *et al.* 2007). The sharp increase in the use of pesticides resulted in the development of resistance in key pest species so alternative to the chemicals such as microbial and plant products were studied (Rao *et al.* 2007). Unavailability of biopesticides on time and lack of awareness among farmers are the major constraints of adoption of biopesticides however, IPM FFS farmers are marginally ahead of using biopesticides in Nepal (Jha 2010).

Whitefly infestations can easily go unnoticed until they reach high numbers. It is important to minimize potential infestations by employing all possible control tactics, but present study is mainly focused on the management of whitefly using bio-pesticides especially Neem and Insect pathogens (*Beauveria bassiana, Metarhizium anisopliae* and *Verticillium lecanii*)

MATERIAL AND METHODS

A field experiment was conducted to evaluate the efficacy of biopesticides against whitefly *B. tabaci* on tomato

under poly-house condition. The field was laid out at the experimental farm of Entomology Division NARC, Khumaltar; Lalitpur under Complete Randomized Block Design during 2012-13. Three replications and twelve treatments with two controls were experimented to evaluate the efficacy different bio-pesticides against *B. tabaci*. Cuttings of tomato (Variety Srijhana) branches about 15 cm heights were collected from farmers' field containing eggs mass and nymphs. The branches were then dipped in the Rootex (Root developing hormone) and then planted in the experimental plot of area 1.75×1 square meter with row to row distance of 55 cm and plant to plant distance of 30 cm (Fig. 1).

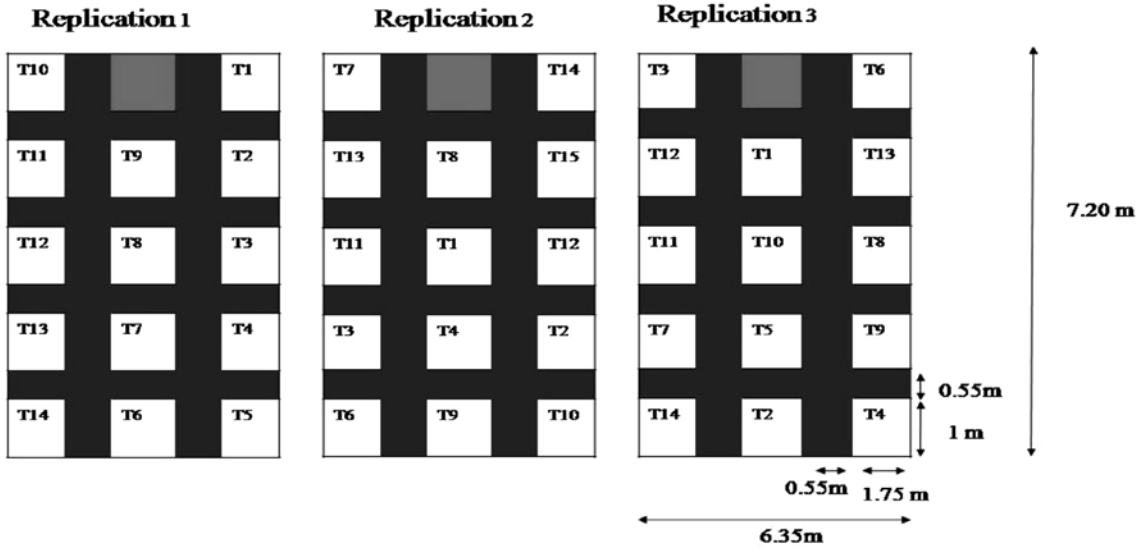

Fig. 1. Layout of the experiment design

Altogether nine tomato plants were planted in each plot. The distance between two plots was 0.55m. The field was maintained weeds free and irrigation were applied frequently as needed. Following different bio-pesticides (Table 1) were tested to evaluate the efficacy against whitefly.

Table 1. Treatments used in the experiment

Treatment	Trade name	Common/Scientific name	a.i.	Dosage
1	Lastraw	Organic salt		5 ml/l
2	Racer™	*Beauveria bassiana*	1.15% wp	2gm.l
3	Pacer™	*Metarhizium anisopliae*	1.15% wp	2gm/l
4	Mealikil™	*Verticillium lecanii*	1.15% wp	2gm/l
5	Nimbecidine	*Azadirachtin*	0.03% EC	5ml/l
6	Servo	Mineral oil		15ml/l
7	Biocide Manic	*Metarhizium anisopliae*	1% wp	5ml/l
8	Bio Power	*Beauveria bassiana*	1.15% wp	5ml/l
9	Nico Neem	*Azadirachtin*	0.15% EC	5ml/l
10	Uchit	Organic product		3ml/l
11	Mighty-Cure	Organic product		3ml/l
12	Bio Magic	*Metarhizium anisopliae*		5 gm/l

There were three foliar sprays for all treatments. The first spray was started after 65 days of transplanting and repeated at 12 days interval. The pre-treatment and post-treatment observations were recorded on randomly selected and tagged four plants from each plot. The pre-treatment observation was made 24 hrs before spray. The post observation was done on eleventh day. The population of whitefly nymphs, and adults were counted from three leaves viz. one in each upper, middle and lower leaf of each tagged plant with the help of hand lens

(20X). The density of nymphs was counted as described by Ohnesorge and Rapp (1986) at the 11th day after spray for succeeding spray.

The percentage of the population reduction due to different treatments over control was calculated using the modified Abbots formula given by Fleming and Retnakaran (1985) as below:

Population reduction over control (%) = {1- (Ta×Cb) / (Tb×Ca) }×100

Where, Ta = Population in treatment after spray
Tb = population in treatment before spray
Ca= Population in control after spray
Cb= Population in control before spray

RESULTS

Effect of Different Treatments on the Population of Whitefly Nymphs

Lastraw (41.75%) was found the best effect on reducing the population of nymphs after first spray followed by Mealikil (25.98%), Bio Power (25.28%), Racer (23.70%) and Pacer (22.51%). The other treatments included were Biocide Manic (19.16%), Bio Magic (17.44%), Servo (9.94%), Nimbecidine (13.72%), Nico Neem (13.65%), Mighty-Cure (8.22%) and Uchit (12.26%) (Table 2).

After second spray, Biocide Manic (68.81%), Nico Neem (64.57%), Nimbecidine (64%) and Bio Power (63.51%) were found to be effective in reducing the population of nymphs.

Table 2. Effect of different treatments against whitefly's nymphs (Mean±S.E, % control)

Treatments	Before spray	1st spray	%	2nd spray	% l	3rd spray	%
Lastraw	112.83±69.28	159.08±71.79	41.75	81.75±12.0	38.65	15.833±4.44	78.10
Racer	119.67±43.47	221.0±73.32	23.70	82.41±34.83	55.47	6.08±1.30	91.65
Pacer	176.0±89.13	330.08±137.46	22.51	128.67±34.27	53.46	9.75±1.28	91.43
Control	118.50±81.16	286.83±156.30		240.25±39.09		212.5±71.22	
Mealikil	175.50±85.47	314.42±51.54	25.98	108.25±34.18	58.89	6.17±2.59	93.55
Nimbicidine	188.58±60.51	393.83±140.23	13.72	118.75±41.34	64.0	40.83±6.52	61.12
Servo	85.25±48.47	185.83±114.17	9.94	68.0±25.49	56.31	32.17±1.92	46.52
Biocide Manic	161.42±74.51	315.83±108.70	19.16	82.50±17.17	68.81	7.91±1.17	89.15
Bio Power	161.50±51.40	292.08±66.08	25.28	89.25±29.62	63.51	8.75±0.38	88.91
Nico Neem	170.25±69.01	355.83±183.92	13.65	105.58±54.18	64.57	37.41±7.98	59.93
Uchit	151.75±38.94	332.25±84.65	12.26	126.67±59.93	53.07	54.75±10.07	51.13
Mighty-Cure	164.08±51.57	364.50±119.34	8.22	180.58±76.56	40.85	49.41±12.67	69.06
Bio Magic	144.33±73.77	288.42±129.37	17.44	104.75±49.91	56.64	7.75±1.52	91.64

Mealikil (58.89%), Bio Magic (56.64%), Servo (56.31%), Racer (55.47%), Pacer (53.46%) and Uchit (53.07%) were moderate in reducing the population of nymphs while Mighty-Cure (40.85%) and Lastraw (38.65%) were comparatively less effective in reducing the population (Table 2).

After third spray, Mealikil, Racer, Bio Magic, Pacer, Biocide Manic and Bio Power were found effective in reducing the population of nymphs by 93.55, 91.65, 91.64, 91.43, 89.15 and 88.91 percent respectively. Mighty-Cure (69.06%), Nimbecidine (61.12%), Nico Neem (59.93%) Uchit (51.13%) and Servo (46.52%) were comparatively less effective than above bio-pesticides.

Effect of Different Treatments on the Population of Whitefly Adults

Nico Neem (83.33%), Mealikil (80.24%), Racer (75.95%), Bio Power (75.17%), Nimbecidine (74.03%), Lastraw (71.39%) and Bio Magic (70.34%) were the most effective in controlling population of whitefly adults whereas Uchit (67.74%), Biocide Manic (67.13%), Pacer (67.73%) and Mighty-Cure (67.17%) were moderate and Servo (58.43%) was found comparatively less effective in reducing the population (Table 3) after the first spray.

Bio Magic (81.61%), Bio Power (78.79%), Pacer (77.18%), Racer (76.63%), Mealikil (73.67%), Biocide Manic (74.16%) and Servo (72.08 %) were the most effective in reducing the population of adult over control after the second spray. The moderate impacts were included Lastraw (64.15%), Nimbecidine (63.48%) and Nico Neem (53%) and Uchit (50.30%) and Mighty-Cure (47.90%) were less effective in reducing the population of whitefly over the control (Table 3).

Bio Magic (92.67%), Racer (91.90%), Pacer (91.50%), Mealikil (90.84%), Bio Power (87.53%) and Biocide Manic (85.8%) were highly effective in reducing the population of whitefly over control after third spray, Nimbecidine (76.96%), Nico Neem (61.28%) Lastraw, (59.42%) and Mighty-Cure (58.59%) were moderate and Uchit (51.61%) and Servo (38.01%) were found less effective against adult whitefly control (Table 3).

Table 3. Effect of different treatments against whitefly's adults (Mean±S.E, % control)

Treatments	Before spray	1st spray	%	2nd spray	%	3rd spray	%
Lastraw	26.83±3.66	12.50±4.26	71.39	20.0±4.64	64.15	6.92±0.73	59.42
Racer	29.58±9.98	11.58±4.91	75.95	12.08±1.72	76.63	0.83±0.08	91.90
Pacer	34.42±12.79	18.08±3.04	67.73	18.41±0.98	77.18	1.33±0.36	91.50
Mealikil	31.08±6.77	10.0±2.78	80.24	11.75±3.59	73.67	0.91±0.22	90.84
Nimbecidine	39.41±19.56	16.66±7.20	74.03	27.16±7.39	63.48	5.33±1.08	76.96
Servo	24.50±5.64	16.58±8.48	58.43	20.66±6.78	72.08	10.91±0.82	38.01
Biocide Manic	21.33±6.83	11.42±6.54	67.13	13.16±0.30	74.16	1.58±0.50	85.8
Bio Power	34.833±7.44	14.08±4.50	75.17	13.33±1.10	78.79	1.41±0.36	87.53
Nico Neem	43.92±33.17	11.91±1.80	83.33	25.0±8.04	53.00	8.25±1.08	61.28
Uchit	42.83±10.91	22.50±10.71	67.74	49.91±3.53	50.30	20.58±6.16	51.61
Mighty-Cure	46.91±14.46	25.08±8.97	67.16	58.33±13.66	47.90	20.58±4.83	58.59
Bio Magic	26.91±10.74	13.00±0.76	70.34	10.66±1.59	81.61	0.66±0.17	92.67

DISCUSSION

The efficacy of different treatments was observed on the basis of reduction of number of nymphs and adults. The nymphs and adults population of whitefly were reduced by 91.65 and 91.90 percent respectively by Racer and 88.91 and 87.53 percent by Bio Power after the third successive spray in comparison to control. Both Racer and Bio Power belong to insect pathogen *Beauveria bassiana*. According to Faria and Wraight (2001) *B. bassiana* provides good control of whitefly both in green house and field crops. This was supported by the study of Liu and Stansly (2009) where treatment with BotaniGuard™ (*B. bassiana*) killed 76.7-91.6% of whitefly *B. tabaci* nymphs. Application of *B. bassiana* at the dose of 1 $mgml^{-1}$ killed 100% of *B. tabaci* adults (Zaki 1998). Bioassay method using *B. bassiana* on melon leaves as substrate for egg and nymphs of the *Bemisia tabaci* biotype B shows that average nymphal mortality at day seven post spray reached a maximum value of 25.7% and average mortality at day 14 post sprays varied from 6.1% to 92.3% (Vicentini *et al.* 2001). Different isolates of *B. bassiana* at the concentration of 10^7 on the fourth instar nymphs gave 3-85% mortality (Quesada-Moraga *et al.* 2006). All these results are in support with the present study where population reduction by *B. bassiana* was found between 18 percent which was lowest in case of eggs to over 90 in case of nymphs and adults.

Efficacy of *Verticillium lecanii* (Mealikil) was found similar to *B. bassiana*. It reduced the number of nymphs and adults population by 93.55 and 90.84 percent respectively after the third successive spray. It was found effective in reducing the population of whitefly in tomato crops (NARC 2011). Andrew *et al.* (2008) found mortality of *B. tabaci* was significantly different between different isolate varying from 87-56%. Wang *et al.* (2007) showed that nymph was the most susceptible stage and adult being the second, this result supports the present study. The result was supported by (Cuthbertson *et al.* 2005) where nymphs were found to be the most susceptible. Concentration of 0.25 of *V. lecanii* caused 100% mortality of *B. tabaci* (Karthikeyan & Selvanarayanan 2011) and concentration of 3.2×10^6 conidia per ml of *V. lecanii* under in vitro condition was 92 to 100 percent of the nymphal mortality (Nier *et al.* 1993).

Three different products of *Metarhizium* tested were Pacer, Biocide Manic and Bio Magic. Effectiveness in reducing the population of nymphs and adults by Pacer, Biocide Manic and Bio Magic was 91.43 and 91.50; 89.15 and 85.8; and 91.64 and 92.67 percent respectively after third spray. *M. anisopliae* (Daman) was found effective in reducing the population of whiteflies where the numbers of nymphs were very few (NARC 2011). Batta (2003) when tested the fungus *M. anisopliae* under field condition the mortality of whitefly ranged from 30-92.2% which was comparatively low than the results of this study. When the formulated and non-formulated forms of *Metarhizium* were tested against immature stage of *B. tabaci* the mortality percent was 92.26 and 27.94 (Zaid 2002). *M. anisopliae* ($2x10^5$ spores l^{-1}) proved to be least effective whereas Nimbecidine 0.03 EC (5 ml l^{-1}) and Neem seed kernel extract (NSKE) 5 percent were found in the middle order of effectiveness (Bairwa *et al.* 2006).

Efficacy of neem formulations was less than insect pathogens used against the population of whitefly. Among the neem products, Nico Neem reduced the population of whitefly nymphs and adults by 59.93 and 61.28 percent respectively after the third successive spray while the

Nimbecidine reduced the population by 61.12 and 76.96 percent respectively. The reduction in the population of *B. tabaci* in all concentration of neem derivatives was 50-60% (Jat and Jeyakumar 2006) which was quite similar to the present study while Jayaraj *et al.* (1986) found NSKE at 5% and neem oil @ 5% caused 93.7 and 90.3 percent mortality of nymphal stage of *B. tabaci* respectively. Nimbalkar (1993) also found that NSKE @ 5% and neem oil @ 2% gave considerable reduction in adult and nymphal population of *B. tabaci.* Spraying of neem oil @ 0.5% and NSKE 5% were found superior over chemical check moncorotophos (Rosaiah 2001). The neem based insecticides viz., NSKE (3%), Achook (0.3%), Neem gold (0.3%) and Nimbecidine (0.3%) were found comparable to moncorotophos and dimethoate in all respects (Rajnish *et al.* 2006). Neem Azal-T/S (NA, at 20g. a.i. ha-1) reduced the population of *B. tabaci* by 61% when conducted in three similar field experiments in egg plant (EL Shafie and Basedow 2003) which is similar to the result of the present study where Nico Neem reduced the population by 61%. The reduction in the population of the whitefly is due to the anti-feedant and deterrent effect of neem which had forced the test insects to leave the locality or chronic effect of the neem compounds (Khattak *et al.* 2006). At dose-rate of 7 and 10 ml Neem Azal (-T/S(1%) *Azadirachtin* induced an immature mortality of 32 and 44% respectively whereas seven days post application under greenhouse conditions, mortality declined to 5 and 7% respectively (Kumar & Poehling 2006). Kumar (2008) using a commercial neem product (Neem Azal-U 17%) against *B. tabaci* on tomatoes found that the fresh neem residue had the strongest effect in all parameters which decreases gradually over time. The bio efficacy was recorded from 1-7days where the immature mortality was reduced from 88.20%-45.01%. Among the eight neem based formulations tested against whitefly causing leaf curl disease in tomato, Nimbecidine proved most promising in minimizing the leaf curl incidence (08.33 and 08.73 %) in both years followed by Neemazal, Neemgold, RD-9-Repelin, Bioneem, Neemark, Neemta-2100 and Achook (Kuldeep *et al.* 2009).

Lastraw (composition of Potassium salt) reduced the population of whitefly nymphs and adults by 78.10, and 59.42 percent respectively where the population reduction by Servo (petroleum oil) was 46.52 and 38.01 percent respectively. Certis spraying oil (Petroleum oil 1ml/100ml water, Certis UK) resulted in high second instar larval mortality (93%). Certis spraying oil resulted in a high efficacy against adult *B. tabaci* with 100% mortality on *Poinsettia* plants (Cuthbertson *et al.* 2009). The result of the Cuthbertson *et al.* (2009) is not in support of the present study. Agricultural spray oil is effective against whiteflies however in combination with these insecticides was observed to be more effective (Mote 1978).

Mighty-Cure, one of the organic products reduced the population of whitefly nymphs and adults by 69.06 and 58.59 percent where Uchit which is tested for the repellent activity of whitefly reduced the population of whitefly nymphs and adults by 51.13 and 51.61 percent respectively. Similar result was found in NARC (2011) where the organic product Mighty-Cure, Margosome and Jibatu were found less effective than *V. lecanii* and *M. anisopliae* but effective over control.

CONCLUSION

Among the different biorationals used, insect pathogens were found to be effective in reducing the population. Among the insects pathogens *Beauveria bassiana* (Racer and Bio Power), *Verticillium lecanii* (Mealikil) and *Metarhizium anisopliae* (Pacer, Biocide Manic and Bio Magic) were comparatively effective in reducing the pest population. Although during the period of first and second spray the percent reduction over control was quite less, but after the third spray their effectiveness was impressive. Treatments belonging to the neem products (Nico Neem and Nimbecidine) were moderate in their effectiveness while Lastraw was found quite similar in their effectiveness with the neem products. Among the organic products Mighty-Cure and Uchit were less effective than above mentioned products but effective than Servo (Petroleum oil).

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