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Management of thrips on carnation (*Dianthus caryophyllus* L.) by using biorationals

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ABSTRACT
Studies on evaluation of efficacy of biorationals against thrips on carnation were conducted during 2013 in an naturally ventilated polyhouse at Hi-tech horticulture unit, Saidapur Farm, MARS, UAS, Dharwad. L. lecanii @ 2 g/l emerged as the best treatment by providing the highest percent protection over control followed by B. bassiana @ 2 g/l and NSKE @ 5%. Lowest per cent protection was seen in P. lilacinus @ 2 g/l treated crop. L. lecanii @ 2 g/l recorded maximum yield, highest net return and cost- benefit ratio followed by NSKE @ 5%.
Key words: Biorationals, efficacy, thrips, carnation

I. INTRODUCTION

Carnation (*Dianthus caryophyllus* L.) being native of southern Europe is one of the most important commercial flowers of the world belonging to the family caryophyllaceae. The common name, Carnation, is likely derived from '*coronation'*, as the Greeks wove Dianthus flowers into crowns for their athletes. It is genetically a quantitative long day plant (Blake, 1955). Himachal Pradesh, Punjab, West Bengal, Jammu and Kashmir and Karnataka are the major states producing carnation. Carnations are grown commercially in India in places having mild climate such as Solan, Shimla, Kalimpong, Kodaikanal, Mandi, Kullu, Srinagar, Ooty. In Pune and Bangalore, it is grown under controlled condition (Shiragur *et al*., 2004).

Thrips (*Thrips tabaci* (Linderman) are one of the most common pests of carnation which are severely responsible for decreasing plant growth, crop quality, yield, vase life.. Thrips suck the sap from the leaves, causing them to turn yellow and patchy often with black streaks and slight crinkling. A severe attack adversely affects the growth. They also cause streaks in the flowers making them unmarketable.

Keeping in view the economic value of carnation, present investigation was taken up to evaluate the efficacy of biorationals against thrips on flowers and leaves.

II. MATERIALS AND METHODS

For the evaluation of biorationals (botanicals and entomopathogens) against the thrips on carnation, the experiments were conducted in naturally ventilated polyhouse at Saidapur Farm, Department of Horticulture, UAS, Dharwad.

For these experiments, the variety Lisa was selected which was planted on a bed with 1m width and 25m length. The bed was divided into 12 plots of $1m^2$. $1m^2$ size consisting of 33 plants per plot with a spacing of 15x20cm. The experiment was laid out with 12 treatments comprising of different botanicals and entomopathogens along with an untreated control and two popular chemical pesticides against thrips as check. The treatments were randomized completely following random number tables and each treatment was replicated thrice.

Entomopathogens like *Lecanicillium lecanii* (Zimmerman) viegas , *Beauveria bassiana (Bals.-criv)* and *Paecilomyces lilacinus* (Thom) samson were obtained from the Institute of Organic Farming and the vermiwash and cow urine were from the Biofarm, MARS, UAS, Dharwad. The botanicals; nimbecidine 0.03% and turmeric powder@ 2% were purchased from the market and the botanical extracts such as NSKE @ 5%, garlic chilli kerosene extract @ 0.5% were prepared.

2.1. Preparation of botanical extracts

Neem seed kernel extract

Fresh neem seed kernels of 50 g were dried and ground to coarse powder then soaked in water overnight and filtered by using muslin cloth. Volume of the solution was adjusted to one litre to get 5% concentration.

Garlic chilli kerosene extract

To prepare kerosene extracts of garlic and chilli, fifty grams of each dried garlic bulb and green chilli fruits were thoroughly ground separately with the help of pestle and mortar by adding little quantity of distilled water. The ground materials were soaked in kerosene (20 ml each) overnight, separately. Next day the extracts were squeezed with a thin muslin cloth and the volume was made upto one liter to obtain 5 per cent garlic and chilli extracts, which served as standard solution. Later the required concentrations were obtained by diluting it with water.

The treatments were imposed by using a hand sprayer after taking the pre-treatment counts of both mites and thrips. Subsequent second spray was given at 15 days intervals. For recording observations three plants were randomly selected from each plot and observations on thrips and mite population was recorded at 1 day before and 1, 3, 7, and 15 days after each spray. The flower yield was recorded after first spray. The data were subjected to statistical analysis.

The net return per hectare was worked out for all the treatments by subtracting the cost of cultivation from the gross returns. The return per rupee invested (B:C ratio) was also calculated as follows.

$$\text{B:C ratio} = \frac{\text{Gross returns}}{\text{Total cost of cultivation (plant protection + cost of cultivation)}}$$

III. RESULTS AND DISCUSSION

Effect of biorationals on thrips population infesting carnation flowers

Results on efficacy of biorationals on the thrips population infesing flowers is presented in table 1,which indicates that at 1 DAS, all the treatments recorded similar percent reduction except the standard check (9.62 thrips per flower). *L. lecanii* @ 2 g/l (9.89 thrips/flower) proved to be significantly superior over other treatments on 3 DAS followed by *B. bassiana* @ 2 g/l (10 thrips/flower) and NSKE @ 5% *(10.6* thrips/flower). Same trend was followed at 7 DAS also.Significantly lowest thrips population was observed on the crop treated with *L. lecanii* @ 2 g/l at 15 DAS which reduced the thrips population to 9.18 thrips per flower. *B. bassiana* @ *2* g/l (15.24 thrips/flower) and NSKE @ 5% (15.15 thrips/flower) were the other promising treatments found to be significantly superior over the untreated control which recorded highest population of thrips (22.59 thrips/flower). Among the treatments imposed highest population of thrips was recorded in crop treated with *P. lilacinus* @ *2* g/l with 17.81 thrips per flower respectively.

Similar trend of treatment efficacy was observed at 1, 3, 7 DAS of second spray also. At 15 DAS, significantly lowest thrips population was observed on the crop treated with *L. lecanii* @ 2 g/l which reduced the thrips population to 5.62 thrips per flower (Table 1). *B. bassiana* @ *2* g/l (8.20

thrips per flower) and NSKE @ 5% (12.62 thrips/flower) were the other promising treatments, found to be significantly superior over the untreated control (28.98 thrips/flower). Highest population of thrips was recorded in crop treated with *P. lilacinus* @ *2* g/l (23.30 thrips/flower) and turmeric poedwr @ 2% (22.21 thrips/flower).

L. lecanii @ *2* g/l emerged as the best treatment by providing the highest percent protection over control (80.60%) followed by *B. bassiana* @ *2* g/l and NSKE @ 5% which resulted in to protection of 71.70 and 56.42 per cent respectively over control. Lowest per cent protection was seen in *P. lilacinus* @ *2* g/l (19.59%) treated crop.

Table 1: Evaluation of biorationals against thrips infesting carnation flowers

Treatments	Number of thrips / flower bud 1st spray					Number of thrips / flower bud 2nd spray				Per cent protection
	1DBS	1DAS	3DAS	7DAS	15DAS	1DAS	3DAS	7DAS	15DAS	
T_1 - *Lecanicillium lecanii* @ 2 g/l	16.38 (4.11)^{a}	15.07 (3.94)^{b}	9.89 (3.22)^{b}	8.56 (3.01)^{a}	9.18 (3.11)^{a}	8.43 (2.99)^{a}	5.36 (2.42)^{b}	2.33 (1.68)^{b}	5.62 (2.47)^{b}	80.60
T_2 - *B. bassiana* @ 2 g/l	16.53 (4.13)^{a}	15.67 (4.02)^{b}	10 (3.23)^{b}	12.26 (3.57)^{cd}	15.24 (3.97)^{c}	14.69 (3.90)^{c}	6.91 (2.72)^{c}	4.69 (2.28)^{c}	8.20 (2.95)^{c}	71.70
T_3 - *Paecilomyces lilacinus* @ 2 g/l	16.30 (4.10)^{a}	15.54 (4.00)^{b}	12.45 (3.60)$^{c-e}$	14.03 (3.81)^{e}	17.81 (4.28)^{e}	15.96 (4.06)^{c}	12.87 (3.66)^{fg}	17.27 (4.22)^{i}	23.30 (4.88)^{i}	19.59
T_4 - NSKE @ 5%	16.59 (4.13)^{a}	14.15 (3.82)^{b}	10.6 (3.33)^{bc}	11.49 (3.46)^{c}	15.15 (3.95)^{c}	11.22 (3.42)^{b}	8.54 (3.01)^{d}	8.13 (2.94)^{d}	12.62 (3.62)^{d}	56.42
T_5 - Nimbecidine 0.03% @ 5 ml/l	17.48 (4.24)^{a}	14.63 (3.88)^{b}	11.11 (3.41)$^{b-d}$	13.22 (3.70)^{de}	15.99 (4.06)^{cd}	15.03 (3.94)^{c}	11.75 (3.50)^{f}	13.25 (3.71)^{f}	14.84 (3.91)^{e}	48.79
T_6 - Turmeric powder @ 2%	17.08 (4.19)^{a}	16.08 (4.07)^{b}	13.43 (3.73)^{de}	14.54 (3.88)^{ef}	15.37 (3.98)^{c}	14.61 (3.88)^{c}	12.86 (3.65)^{fg}	16.41 (4.11)^{hi}	22.21 (4.77)^{hi}	23.36
T_7 - Vermiwash + water @ 1:1 proportion	17.23 (4.21)^{a}	15.54 (4.00)^{b}	13.96 (3.80)^{e}	15.62 (4.01)^{f}	16.31 (4.10)^{cd}	15.29 (3.97)^{c}	15.24 (3.97)^{h}	17.19 (4.21)^{i}	20.92 (4.63)^{gh}	27.81
T_8 - Garlic chilly kerosene extract @ 0.5% + cow urine @ 5%	17.31 (4.22)^{a}	14.67 (3.89)^{b}	13.09 (3.69)^{de}	13.21 (3.70)^{de}	15.38 (3.98)^{c}	11.30 (3.43)^{b}	10.06 (3.25)^{e}	9.70 (3.19)^{e}	15.43 (3.99)^{e}	46.75
T_9 - Vermiwash + Cow urine + water @ 1:1:8 proportion	16.83 (4.16)^{a}	14.7 (3.91)^{b}	12.31 (3.58)$^{c-e}$	13.74 (3.77)^{e}	16.77 (4.16)^{de}	11.92 (3.52)^{b}	12.44 (3.59)^{f}	14.95 (3.93)^{g}	16.71 (4.15)^{f}	42.33
T_{10} - Dicofol 18.5 EC @ 2.5 ml/l (check)	17.39 (4.23)^{a}	15.64 (4.01)^{b}	12.18 (3.56)$^{c-e}$	13.93 (3.80)^{e}	17.25 (4.21)^{de}	15.27 (3.97)^{c}	13.99 (3.81)^{gh}	16.05 (4.07)^{h}	20.27 (4.56)^{g}	42.96
T_{11} - Fipronil 5 EC @ 2 ml/l (check)	16.52 (4.13)^{a}	9.62 (3.17)^{a}	7.14 (2.76)^{a}	10.08 (3.25)^{b}	12.21e (3.56)^{b}	8.61 (3.02)^{a}	3.21 (1.93)^{a}	1.72 (1.49)^{a}	3.04 (1.88)^{a}	85.32
T_{12} - Control	16.35 (4.10)^{a}	16.52 (4.13)^{b}	17.57 (4.25)^{f}	20.40 (4.57)^{g}	22.59 (4.81)^{f}	23.9 (4.95)^{d}	24.19 (4.97)^{i}	25.52 (5.10)^{j}	28.98 (5.43)^{j}	-
S.Em.±	NS	0.104	0.10	0.06	0.05	0.06	0.06	0.04	0.05	-
C.D. at 5%	NS	0.31	0.30	0.18	0.14	0.18	0.18	0.13	0.15	-

DAS- Days after spray, DBS- Days before spraying, Figures in parentheses are square root transformations, NS-Non-significant, Means followed by same letter in a column do not differ significantly by DMRT (p=0.05)

Effect of biorationals on thrips population infesting carnation leaves

Results on efficacy of biorationals on the thrips population in leaves presented in table 2 indicates that, at 1 DAS of first spray, NSKE @ 5% recorded the lowest population of mites among the treatments (1.06 thrips/leaf). NSKE @ 5% (0.47 thrips/leaf) maintained its superiority at 3 DAS also followed by *L. lecanii* @ *2* g/l (0.78 thrips/leaf) and nimbecidine 0.03% (0.87 thrips/leaf). At 7 DAS *L. lecanii* @ *2* g/l (0.26 thrips/leaf) proved to be significantly superior over the other treatments followed by *B. bassiana* @ *2* g/l (0.40 thrips/leaf) and NSKE @ 5% (0.60 thrips/leaf). At 15 DAS, *L. lecanii* @ *2* g/l (1.26 thrips/leaf), *B. bassiana* @ *2* g/l (1.39 thrips/leaf), NSKE @ 5% (1.33 thrips/leaf) and nimbecidine 0.03% (1.32 thrips/leaf) were superior over the other treatments. *P. lilacinus* @ 2 g/l and turmeric powder @ 2% recorded highest thrips population with 1.70 1nd 1.74 thrips per leaf respectively.

Table 2: Evaluation of biorationals against thrips infesting carnation leaves

Treatments	Number of thrips / leaves 1st spray					Number of thrips / leaves 2nd spray				Per cent protection
	1DBS	1DAS	3DAS	7DAS	15DAS	1DAS	3DAS	7DAS	15DAS	
T_1 - *Lecanicillium lecanii* @ 2 g/l	1.61 (1.45)^{a}	1.56 (1.43)^{bc}	0.78 (1.13)^{b}	0.26 (0.87)^{a}	1.26 (1.33)^{a}	1.22 (1.31)^{a}	0.44 (0.97)^{b}	0.09 (0.77)^{a}	0.78 (1.13)^{a}	75.47
T_2 - *B. bassiana* @ 2 g/l	1.64 (1.46)^{a}	1.54 (1.46)^{bc}	0.89 (1.18)^{b}	0.40 (0.94)^{ab}	1.39 (1.38)^{a}	1.26 (1.32)^{a}	0.58 (1.04)^{b}	0.17 (0.82)^{a}	0.96 (1.21)^{b}	69.81
T_3 - *Paecilomyces lilacinus* @ 2 g/l	1.51 (1.41)^{a}	1.48 (1.40)^{bc}	1.34a (1.36)^{de}	1.25 (1.32)^{d}	1.70 (1.48)^{c}	1.62 (1.46)^{bc}	1.54 (1.43)^{bc}	1.74 (1.50)^{c}	2.74 (1.80)^{f}	13.83
T_4 - NSKE @ 5%	1.48 (1.40)^{a}	1.06 (1.25)^{ab}	0.47 (0.99)^{a}	0.60 (1.05)^{bc}	1.33 (1.35)^{a}	0.93 (1.19)^{a}	0.59 (1.04)^{b}	0.79 (1.13)^{b}	1.09 (1.26)^{b}	65.72
T_5 - Nimbecidine 0.03% @ 5 ml/l	1.58 (1.44)^{a}	1.13 (1.28)$^{b-d}$	0.87 (1.17)^{a}	0.65 (1.07)^{c}	1.32 (1.35)^{a}	1.09 (1.26)^{a}	0.66 (1.08)^{b}	0.86 (1.16)^{b}	1.63 (1.46)^{c}	48.74
T_6 - Turmeric powder @ 2%	1.78 (1.51)^{a}	1.56 (1.43)^{bc}	1.43 (1.39)^{de}	1.49 (1.41)^{de}	1.74 (1.50)^{c}	1.57 (1.44)^{c}	1.47 (1.40)^{bc}	1.56 (1.44)^{c}	2.53 (1.74)^{de}	20.44
T_7 - Vermiwash + water @ 1:1 proportion	1.49 (1.41)^{a}	1.32 (1.35)^{bc}	1.21 (1.31)^{cd}	1.36 (1.36)^{de}	1.66 (1.47)^{b}	1.46 (1.40)^{b}	1.26 (1.32)^{c}	1.38 (1.37)^{c}	2.39 (1.70)^{d}	24.84
T_8 - Garlic chilly kerosene extract @ 0.5% + cow urine @ 5%	1.59 (1.44)^{a}	1.50 (1.41)^{bc}	0.89 (1.18)^{b}	1.17 (1.29)^{d}	1.64 (1.46)^{b}	1.61 (1.45)^{bc}	1.29 (1.34)^{c}	1.39 (1.38)^{c}	1.56 (1.44)^{c}	50.94
T_9 - Vermiwash + Cow urine + water @ 1:1:8 proportion	1.73 (1.49)^{a}	1.39 (1.37)^{bc}	0.97 (1.21)^{bc}	1.37 (1.37)^{de}	1.64 (1.46)^{b}	1.37 (1.37)^{b}	1.22 (1.31)^{c}	1.34 (1.36)^{c}	2.46 (1.72)^{d}	22.64
T_{10} - Dicofol 18.5 EC @ 2.5 ml/l (check)	1.69 (1.47)^{a}	1.42 (1.38)^{bc}	1.31 (1.34)^{de}	1.41 (1.38)^{de}	1.73 (1.49)^{b}	1.49 (1.41)^{bc}	1.35 (1.36)^{c}	1.55 (1.43)^{c}	2.69 (1.79)^{e}	15.40
T_{11} - Fipronil 5 EC @ 2 ml/l (check)	1.65 (1.46)^{a}	0.76 (1.10)^{a}	0.46 (0.98)^{a}	0.52 (1.01)^{bc}	1.21 (1.31)^{a}	0.56 (1.02)^{a}	0.07 (0.76)^{a}	0.14 (0.80)^{a}	0.67 (1.08)^{a}	78.93
T_{12} - Control	1.51 (1.40)^{a}	1.52 (1.41)^{bc}	1.54 (1.43)^{e}	1.62 1.45^{e}	1.76 (1.50)^{b}	1.76 (1.50)^{bc}	1.79 (1.51)^{d}	2.03 (1.59)^{d}	3.18 (1.92)^{g}	-
S.Em.±	NS	0.06	0.03	0.04	0.02	0.04	0.04	0.05	0.02	-
C.D. at 5%	NS	0.18	0.10	0.11	0.07	0.13	0.12	0.15	0.06	-

DAS- Days after spray, DBS- Days before spraying, Figures in parentheses are square root transformations, NS-Non- significant, Means followed by same letter in a column do not differ significantly by DMRT (p=0.05)

At 1 DAS of second spray, NSKE @ 5% (0.93 thrips/leaf), nimbecidine 0.03% (1.09 thrips/leaf), *L. lecanii* @ 2 g/l (1.22 thrips/leaf), and *B. bassiana* @ 2 g/l (1.26 thrips/leaf) were superior over other treatments and were on par with the standard check (0.56 thrips/leaf).All the three treatments maintained their superiority at 3 DAS also. At 7 DAS, *L. lecanii* @ 2 g/l (0.09 thrips/leaf), and *B. bassiana* @ 2 g/l (0.17 thrips/leaf) were significantly superior over other treatments. Other promising treatments were, NSKE @ 5% (0.79 thrips/leaf), nimbecidine 0.03% (0.86 thrips/leaf).Treatment *L. lecanii* @ 2 g/l excelled over other treatments at 15 DAS by reducing the thrips population to 0.78 thrips per leaf and which was on par with the standard check (0.67 thrips/leaf). *B. bassiana* @ 2 g/l (0.96 thrips/leaf) and NSKE @ 5% (1.09 thrips/leaf) also were notable which suppressed their efficacy in suppressing thrips population till 15 DAS and being superior over untreated control which recorded highest thrips population (3.18 thrips per leaf). *P. lilacinus* @ 2 g/l (2.74 thrips/leaf), turmeric powder @ 2% (2.53 thrips/leaf) exhibited poor efficacy in suppressing the thrips population.

Among the biorationals imposed, highest percent protection of 75.47 % was given by by *L. lecanii* @ 2 g/l followed by *B. bassiana* @ 2 g/l (69.81%) and NSKE @ 5% (65.72%) while *P. lilacinus* @ 2 g/l (13.83%) showed the lowest per cent protection.

Halagatti (2006) on *Scirtothrips dorsalis* in rose and Van Der Schaaf *et al.* (1991) on *Frankliniella occidentalis* in chrysanthemum reported efficacy of *L. lecanii* in reducing the population of the thrips followed by *B. bassiana.* Murphy *et al. (*1998) and Ugine *et al.* (2007) also reported efficacy of *B. bassiana* on *F. occidentalis* in green house roses and bean respectively. Halagatti (2006) also reported efficacy of NSKE @ 5 per cent in reducing population of thrips, *S. dorsalis* under laboratory condition which is in close agreement with the present investigation .

Effect of biorationals on Yield and Cost economics

Among the biorationals, *L. lecanii* @ *2* g/l recorded maximum yield of 225.66 flowers /m^2 / year (Table 3) followed by NSKE @ 5% (217.33 flowers/m^2/year), garlic chilli kerosene extract @ 0.5% + cow urine @ 5% (214 flowers/m^2/year) and *B. bassiana* @ *2* g/l (213 flowers/m^2/ year) (Table 3). Significantly less yield was recorded from *P. lilacinus* @ *2* g/l (164.33 flowers/m^2/year), vermiwash + water @1:1 proportion (170 flowers/m^2/year) and vermiwash + cow urine + water (186.33 flowers/m^2/year). The untreated control recorded significantly lowest yield of 127.33 flowers /m^2/ year.

Table 3: Effect of Biorationals on yield of carnation

Treatments	Flowers/m^2/ year	Lakhs flowers /ha / year	Total cost of cultivation (`/ha)	Gross returns (`/ha)	Net returns (`/ha)	BCR
T_1 - *Lecanicillium lecanii* @ 2 g/l	225.66[a]	22.56	57,24,680	90,24,000	32,99,320	1.58
T_2 - *Beauveria bassiana* @ 2 g/l	213.00[d]	21.30	57,24,680	85,20,000	27,95,320	1.48
T_3 - *Paecilomyces lilacinus* @ 2 g/l	164.33[k]	16.43	57,24,680	65,60,000	8,35,320	1.14
T_4 - NSKE @ 5%	217.33[b]	21.73	57,29.080	86,92,000	29,62,920	1.51
T_5 - Nimbecidine 0.03% @ 5 ml/l	206.33[f]	20.63	57,20,480	82,52,000	25,31,520	1.44
T_6 - Turmeric powder @ 2%	193.00[g]	19.30	57,24,320	77,20,000	19,95,680	1.34
T_7 - Vermiwash + water @ 1:1 proportion	170.66[j]	17.06	57,25,480	68,24,000	10,98,520	1.19
T_8 - Garlic chilly kerosene extract @ 0.5% + cow urine @ 5%	214.00[c]	21.40	57,28,280	85,60,000	28,31,720	1.49
T_9 - Vermiwash + Cow urine + water @ 1:1:8 proportion	186.33[i]	18.63	58,33,280	74,75,000	16,41,720	1.27
T_{10}- Dicofol18.5EC @ 2.5 ml/l (check)	189.33[h]	18.93	57,50,480	75,72,000	18,21,520	1.31
T_{11} - Fipronil 5 EC @ 2 ml/l (check)	209.66[e]	20.96	57,34,400	83,84,000	26,49,600	1.46
T_{12} - Control	127.33[l]	12.73	57,13,280	50,92,000	-6,21,280	0.89
S.Em.±	7.18	-	-	-	-	-
C.D. at 5%	21.95	-	-	-	-	-

Means followed by same letter in a column do not differ significantly by DMRT (p=0.05)

Among the treatments *L. lecanii* @ *2* g/l recorded the highest net return of Rs. 32,99,320 followed by NSKE @ 5% (Rs. 29,62,920) and Garlic chilli kerosene extract @ 0.5% + cow urine @ 5% (Rs.28,31,720). Highest B:C ratio of 1.58 was recorded by *L. lecanii* @ *2* g/l followed by NSKE @ 5% (1.51) and garlic chilli kerosene extract @ 0.5% + cow urine @ 5% (1.49). Dhananjaya kumar (2007) reported *L. lecanii* tested against mite on rose recorded the highest yield. Roopa and Nandhihalli (2009) recorded highest yield of brinjal by NSKE @ 5% treatment which is in agreement with the present finding.

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