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Studies on efficacy of vermicompost for the management of *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae) infesting chilli (*Capsicum annuum* L.) in Haryana

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Abstract
Chilli (*Capsicum annuum* L.) (Family: Solanaceae) is one of the important spice crops of India and is being widely cultivated throughout warm temperate, tropical and subtropical countries. Chilli hybrids were raised during the year 2013 with standard agronomic practices to study the effect of Vermicompost (5t/ha) on the activity of chilli mite, *Polyphagotarsonemus latus.* The present investigation reported that the *P. latus* population was decreased the number of eggs laid by *P. latus* significantly (5.05 eggs/leaf) in comparison to control (no fertilizer; 6.18 eggs/leaf). Statistically significant control was recorded in the vermicompost treatment @ 5t/ha which reduced 18.28 percent egg laying and 21.16 percent mobile stages of *P. latus* population on chilli plants. Recommended dose of NPK treatment was not found to be effective in reducing the *P. latus* population during the present investigation. The organic sources of nitrogen, especially vermicompost, contain major and minor plant nutrients in available from that makes the plant system defensive against pest infestation.

Keywords: Chilli hybrids, NPK, *Polyphagotarsonemus Latus,* vermicompost

Introduction
Chilli (*Capsicum annuum* L.) belonging to family Solanaceae is one of the important vegetable and commercial spice crops grown throughout the world and is also used in making beverages and medicines (Tiwari *et al*., 2005) [17]. India is the largest producer and consumer of chilli in the world. Chillies constitute about 20 per cent of Indian spice exports in quantity and about 14 per cent in value (Sujay and Giraddi, 2015) [16]. It is grown in almost all the states throughout the country.

Chilli cultivation is attack by a crowd of pests during crop is of the furthermost concern. Among these pests, the yellow mite, *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae), is a serious one of greenhouse crops including pepper, cucumber and egg plants (Mannan *et al*., 2010) [11] in temperate and subtropical areas (Luypaert *et al*., 2015) [10] and causing severe damage to reproductive buds resulting in substantial yield loss. Numbers of sprays have enlarged over the years, however in vein and on the contrary, the value of cultivation has increased enormously making cultivation of chilli extremely risky and non-profitable. In addition to this, these pesticidal sprays became a threat to chilli ecosystem causing resurgence of pests and menace to natural enemy fauna. Pesticide residues in chilli are of nice concern from the purpose of domestic consumption and exports too. It's thus imperative to resort to different non-chemical pest management strategies like use of organic fertilizers, which are eco-friendly and utterly safe to the consumers. With this opinion, study was planned to evaluate the power of vermicomposting against chilli mite, *P. latus.*

Materials and methods
Seeds of chilli hybrids were grown under natural conditions from June to November, 2013 following recommended agronomical practices. The experiments were laid out in randomized block design (RBD) with three replications having a plot size of 3.0 m × 2.7 m at a spacing of 60 cm × 45 cm. Vermicompost (5t/ha), NPK (25:12:12 kg/ha) and no fertilizer were applied in separate plots before transplanting following standard practices. The treatment in which no fertilizer was applied acted as corresponding control. After the appearance of natural mite infestation, two leaves each from top, middle and bottom were selected from ten plants per plot per week randomly to count the number of eggs and mobile stages per leaf under Stereo

Zoom Binocular Microscope. The observations were continued till the crop was terminated.

For assessing the effectiveness of the treatments, mean numbers of *P. latus* were pooled and analyzed using standard statistical tools. The percent reduction in mite count as compared to count in control treatment was calculated by the formula:

$$\text{Percent Reduction} = \frac{\text{(Average number of mites in control- Average number of mites in treatment)}}{\text{Average number of mites in control}} \times 100$$

The treatments were analyzed statistically, doses recommended in chilli/ other vegetable crops were taken to evaluate their effectiveness in reducing *P. latus* population. These were compared with control.

Table 1: Treatment description to evaluate its effect on *P. latus* incidence in chilli crop

S. No.	Treatment No.	Organic Manure/ Fertilizer	Fertilizer Dose
1	T_1	Vermicompost	5t/ha
2	T_2	NPK	recommended dose (25:12:12 kg/ha)
3	T_3	Control	No fertilizer

Critical difference (CD) was calculated between the organic manures/inorganic fertilizer treatments by using two factorial CRD. This was done to know the efficacy of the treatments in reducing the *P. latus* population in chilli plants. The Software 'OPSTAT', developed at the Computer Centre, College of Basic Sciences and Humanities, CCS Haryana Agricultural University, Hisar was used for the analysis.

Results and Discussion

Effect of Vermicompost (VC) on *P. latus*

Among various sources of organic matter, vermicompost have been recognized as having considerable potential as soil amendments (Arancon *et al.*, 2005) [1]. This one is a creation of non-thermophilic biodegradation of organic material by collective action of earthworms and associated microbes (Pathma and Sakthivel, 2013) [15]. It is a extremely fertile, finely divided peat-like material with high porosity, aeration, water-holding capacity and low C:N ratios (Dominguez and Edwards, 2004) [3]. It is primarily made up of carbon (C), hydrogen (H) and oxygen (O) and possesses remarkable plant growth-promoting properties due to the presence of nutrients in plant-available forms such as nitrates, calcium, phosphorus and potassium (Edwards and Burrows, 1988) [4]. It also acts as a soil conditioner and has been evolving as a potential matter for maintaining soil productivity (Narkhede *et al.*, 2011) [14] in addition to pest control. Several studies also report that application of vermicompost suppresses infection by insect pests, repel crop pests and induce biological resistance in plants against pests and diseases due the presence of antibiotics and actinomycetes (Munroe, 2007) [13].

The present investigation reported that the vermicompost treatment @ 5t/ha decreased the number of eggs laid by *P. latus* significantly (5.05 eggs/leaf) in comparison to control (no fertilizer; 6.18 eggs/leaf) (CD= 0.55; p= 0.05) Table 1. Statistically significant control was recorded in the vermicompost treatment which reduced 18.28 percent egg laying by yellow mite. Number of eggs recorded during the months of July (3.44 eggs/leaf), August (3.59 eggs/leaf), September (7.55 eggs/leaf), October (11.44 eggs/leaf) and November (4.88 eggs/leaf) in no fertilizer (control) treatment.

Table 1: Effect of Vermicompost on fecundity of *Polyphagotarsonemus latus* on chilli hybrid leaves

Observation Periods	Average number of eggs/ leaf of chilli (Mean ± S.E.)						Mean (OP)		Pooled Mean (OP)
	Top leaf		Middle leaf		Bottom leaf				
	NF	VC	NF	VC	NF	VC	NF	VC	
July	3.14± 0.58	2.93± 0.33	3.87±0.67	2.73± 0.33	3.33±0.67	2.87± 0.33	3.44	2.84	3.14[a]
August	3.33±0.88	2.93± 0.33	4.13± 0.58	3.27±0.88	3.33±0.67	3.33±0.88	3.59	3.17	3.38[a,b]
September	7.20±0.67	6.20± 0.33	8.13±0.88	5.93± 0.33	7.33± 0.58	6.80±0.88	7.55	6.31	6.93
October	13.40± 0.58	10.67± 0.58	10.47±1.20	8.60± 0.58	10.47±1.15	9.33± 0.58	11.44	9.53	10.49
November	5.26±0.88	3.07±0.88	5.00±0.33	3.47±0.88	4.40± 0.58	3.66±0.88	4.88	3.40	4.14[b]
Mean							6.18	5.05 (18.28%)	

NF=No fertilizer, VC = Vermicompost (5t/ha) Figure in parenthesis is percent reduction in mite eggs over NF
C.D. for Observation Period (OP) = 0.87, SE (m) =0.29 Values with the same superscript do not differ significantly
C.D. for Treatment (T) =0.55, SE (m) = 0.19 C.D. for Interaction OP×T= NS, SE (m)=0.41

The corresponding values in vermicompost treatment were 2.84, 3.17, 6.31, 9.53 and 3.40 eggs/leaf which were less than the former treatment although the decrease was non-significant. This showed that the interaction between observation period and treatments was non-significant. Irrespective of treatment, significantly higher number of eggs (10.49 eggs/leaf) was recorded in the month of October which significantly decreased to 6.93 eggs/leaf in September, followed by 4.14, 3.38 and 3.14 eggs/ leaf in the months of November, August and July (CD=0.87; p=0.05). The latter three values were statistically comparable with each other. The organic sources of nitrogen, especially vermicompost, contain major and minor plant nutrients in available form besides enzymes, antibiotics, vitamins and growth hormones. This makes the plant system defensive against pest infestation and plant might exhibit tolerance mechanism for the leaf curl (Meerabai and Asha, 2001) [12]. Giraddi *et al.*, (2003) [9] observed significantly lower leaf curl of chilli applied with vermiwash (soil drench 30 DAT, foliar spray 60 and 75 DAT) and higher yields vis-à-vis untreated crop. However, it was inferior to soil application of combinations like vermicompost (2.5 t ha^{-1}) and vermiwash in the ratio of 1:1, 1:2 and 1:4 which reduced the leaf curl by 0.64, 0.85 and 0.96, respectively.

The effect of vermicompost treatment on mobile stages of *P. latus* on chilli leaves is presented in Table 2. Statistical analysis of no fertilizer and vermicompost treatment showed a significant effect of observation period (CD=0.45; p=0.05) on *P. latus* incidence on chilli leaves. Average population as depicted in pooled mean showed significantly higher

population in the month of October (9.39 mites/leaf) followed by 6.20 and 3.72 mites/leaf in September and November. Lowest mite count was recorded in the month of July (2.85 mites/leaf) and August (3.18 mites/ leaf); both the counts were at par with each other. In both the treatments natural mite infestation increased at each observation period till October, thereafter, it declined. It was 3.51, 3.57, 6.75, 10.11 and 4.39 mites/leaf and 2.20, 2.80, 5.64, 8.66 and 3.04 mites/leaf in control (no fertilizer) and vermicompost treatment at each observation period, respectively. Irrespective of observation periods, treatments showed a significant difference in *P. latus* count on chilli leaves (CD=0.29; p=0.05). A fall in mite count (4.47 mites/leaf) was recorded subjected to vermicompost treatment in experimental units as compared to count (5.67 mites/leaf) in control units. Vermicompost treatment @ 5t/ha reduced 21.16 percent yellow mite population on chilli plants. Data presented in Table 2 however, revealed that interaction between treatment and observation period was not significant which meant that population count in both the treatments did not differ significantly at observation period.

Table 2: Effect of Vermicompost on mobile stages of *Polyphagotarsonemus latus* on chilli hybrid leaves

Observation Periods	Average number of mobile stages/ leaf of chilli (Mean ± S.E.)						Mean (OP)		Pooled Mean (OP)
	Top leaf		Middle leaf		Bottom leaf				
	NF	VC	NF	VC	NF	VC	NF	VC	
July	3.93 ± 0.58	2.60± 0.33	3.47±0.67	1.67± 0.33	3.13±0.67	2.33± 0.33	3.51	2.20	2.85[a]
August	3.53±0.67	2.33± 0.33	3.53± 0.58	2.80± 0.33	3.67±0.67	3.27± 0.33	3.57	2.80	3.18[a]
September	6.27±0.88	5.67±0.67	7.07± 0.58	5.60±0.88	6.93± 0.58	5.67±0.67	6.75	5.64	6.20
October	10.33 ±1.20	9.33±0.67	10.00±1.15	8.54±0.67	10.01±0.88	8.13±0.88	10.11	8.66	9.39
November	4.86±0.88	2.93± 0.33	4.40±0.33	3.27± 0.33	3.93±0.67	2.93± 0.33	4.39	3.04	3.72
Mean							5.67	4.47 (21.16%)	

NF = No fertilizer, VC = Vermicompost (5t/ha) Figure in parenthesis is percent reduction in mite population over NF
C.D. for Observation Period (OP) = 0.45, SE (m) = 0.16 Values with the same superscript do not differ significantly
C.D. for Treatment (T) = 0.29, SE (m) = 0.09 C.D. for Interaction OP×T=NS, SE (m) = 0.22

A reduction in sucking pests and severity of murda disease was also reported by Giraddi and Verghese (2007) [8] after application of vermicompost (2.5 t/ha). Application of vermicompost (2.5 t/ha) with six sprays of vermiwash in the ratio of 1:1 registered significantly lower mite population (0.64 per leaf), being at par with the standard check (0.42 mites/leaf) (George *et al.*, 2007) [5, 6]. It also reduced the leaf curl index significantly.

Comparative Efficacy of Fertilizer Treatments

A comparison of fertilizer treatments against *P. latus* population on chilli leaves of different strata *viz.* top, middle and bottom is presented in Table 3. The results revealed that leaves of all three strata were susceptible to mite infestation but varied significantly with each other (CD=0.58; p=0.05). The distribution of *P. latus* was found to be more on top leaves (12.04 mite/top leaf) which was statistically higher than the mite density on middle leaves (10.91 mite/middle leaf). Least number of mites was recorded on the older (bottom) leaves of the plants (10.57 mite/bottom leaf).

Statistical analysis of *P. latus* incidence showed a significant effect of the fertilizer treatment (CD=0.82; p=0.05). Irrespective of leaf age, statistically higher number of mites was recorded on recommended dose of NPK (25:12:12 kg/ha) (13.64 mites/leaf) than the mites recorded at other treatment of vermicompost (9.10 mites/leaf) and control (10.78 mites/ leaf) where no fertilizer was applied.

Table 3: Comparative efficacy of fertilizer treatments against *Polyphagotarsonemus latus* population on various chilli leaves

Treatment	Number of mites/leaf			
	Top leaf	Middle leaf	Bottom leaf	Mean
Vermicompost (5t/ha)	10.00	8.57	8.73	9.10 (15.58)
NPK (25:12:12 kg/ha)	14.27	13.93	12.73	13.64 (-26.53)
Control (No fertilizer)	11.86	10.23	10.24	10.78
Mean	12.04	10.91[a]	10.57[a]	

CD for Treatment (A) = 0.82, SE (m) = 0.29 CD for leaf stages (B) = 0.58, SE(m) = 0.20 CD for Interaction A × B =1.42, SE(m) = 0.50
Values with the same superscript do not differ significantly Figure in parenthesis is percent reduction in mite population over control

The ANOVA revealed a significant interaction between fertilizer treatment and leaf stage of plants. Mites were significantly higher in number on the top leaves as compared to middle and bottom leaves at each treatment (CD=1.42; p=0.05). Percent reduction in mite population over control in vermicompost treatment (5t/ha) was 15.58. The data on the effect of three treatments (vermicompost 5t/ha, NPK 25:12:12 kg/ha and control) on *P. latus* mite stage *viz*. egg and mobile stages revealed that although the egg number was higher (18.58 eggs/leaf) than mobile stages (16.89 mobile/ leaf), both were statistically at par with each other (Table 4). This showed that both the stages were equally susceptible to treatment. Significantly higher number of mite (20.82 mites/leaf) infestation were recorded in NPK treatment (CD=1.61; p=0.05), followed by 17.78 mites/leaf in no fertilizer treatment. The number of mites was 14.60 mites/leaf in vermicompost. There was no significant interaction between treatment and mite stages.

Table 4: Comparative efficacy of fertilizer treatments against eggs and mobile stages of *Polyphagotarsonemus latus*

Treatment(A)	Number of mite stages/leaf (B)		Mean
	Egg	Mobile Stages	
Control (No fertilizer)	18.55	17.01	17.78
Vermicompost (5t/ha)	15.97	13.23	14.60
NPK (25:12:12 kg/ha)	21.21	20.44	20.82
Mean	18.58	16.89	

CD for Treatment (A) = 1.61, SE (m) = 0.57 CD for mite stages (B) = NS, SE (m) = 0.70 CD for Interaction A × B =NS, SE(m) = 4.15 Values with the same superscript do not differ significantly

The present results could be compared with the report in the form of preliminary findings of Devi *et al*., (2017) [2] who reported that seedlings raised with the application of vermicompost in the nursery were attracted less pests in the main field. Combination of Vermicompost (2.5 t/ha) with 50% reduced dose of NPK significantly lower the activity of thrips and mite in chilli (Varghese, 2003; Giraddi and Smitha, 2004) [18, 7] compared to 100 percent NPK alone. George and Giraddi (2007) [5, 6] applied vermicompost @ 2.5 t ha^{-1} followed by four sprays with neem seed kernel extract (5%) and Neemazal at 2, 5, 7 and 11 weeks after transplanting and recorded significantly less population of thrips (0.45 to 0.51 / leaf), mites (0.60 and 0.64/leaf) and leaf curl index in chilli plants.

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