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Role of Neem cake in management of chilli mite, *Polyphagotarsonemus latus* (Banks)

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Abstract
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. The chilli crop is attack by more than 293 insects and mite species. Among these, yellow/broad mite *Polyphagotarsonemus latus* (Banks) is consider as major pest of chilli. *P. latus* belongs to the group of acarines known as Acariformes, in the suborder Prostigmata and the family Tarsonemidae. It is known to cause leaf curling and yield leading to huge economic losses. To study the role of Neem cake (2t/ha) on the activity of chilli mite, *P. latus;* chilli hybrids were raised during the year 2014 with standard agronomic practices. The present study showed reduced mite population (9.25 mite/leaf) on chilli plants after adding neem cake manure (2t/ha) as soil amendment when compare to control (10.78 mite/leaf). Neem cake treatment @ 2 t/ha reduced 16.18 percent fecundity and 4.59 percent mobile population of *P. latus* on chilli plants. During study period the recommended dose of NPK treatment was not found to be effective in reducing the *P. latus* population. Neem cake is eco-friendly and also safer to predatory mites, *Amblyseius* spp. It contains good amount of organic nitrogen and other nutrients. The use of organic manure (neem cake) is considered as a suitable pest management practice.

Keywords: chilli hybrids, neem cake, NPK, *Polyphagotarsonemus latus*

Introduction
Chilli (*Capsicum annuum* L.) is an important spice crop grown for its fruits, which are used in green as well as ripe dried form for its pungency. Chilli belongs to the genus *Capsicum* family Solanaceae. Chilli has two important commercial qualities. Some varieties are famous for red colour because of the capsanthin, others are known for biting pungency attributed by capsaicin. India is the only country rich in many varieties with different quality factors (Raju, 2010). Green chilli contains a good amount of vitamin C and is also a good source of vitamin A and B. It contains small quantities of protein, fats, carbohydrates and minerals like phosphorus, iron and calcium. Among the plethora of constraints in chilli cultivation, they attack by a multitude of pests at different crop stages is of utmost concern. The pest spectrum of chilli crop is complex with more than 293 insects and mite species debilitating the crop in field as well as in storage (Dey *et al.*, 2001). The major insect pests that attack chilli are aphids, mites and thrips. India is the largest producer of chilli in the world. The broad mite, *P. latus* was first recorded in Europe (Italy) in 1961 (Navajas *et al*., 2010) as a pest which spread to numerous crops in many parts of the world, including the tropical and subtropical climates of Australia, Asia, Africa, America, the Pacific Islands (Gerson, 1992).
Farmers use chemical pesticides for the control of these pests. Though the recommended schedules of pesticides sprays are 3-4, the farmers are spraying different pesticides more than ten times for the crop protection against these pests. This ultimately lead to high cost of production, low net returns, heavy debts and finally into a crisis situation and pesticide residues being left in the environment polluting air, water and soil. Hence it is necessary to overcome this problem by use of organic manure; is one of the best alternatives, presently attracting a lot of attention. The organic manure (Neem cake) starts decomposing after soil application and liberates nitrogen gradually in the form of ammonia for the use of crops and inhibits soil borne pathogens (Thimma Naik, 2006).
It involves making best use of natural resources locally available and takes best advantage of the natural processes. The concept to management of pests of using of organic manure can reduce human and environmental hazardous and lower the cost of cultivation.

Materials and Methods
Seeds of chilli (*Capcicum annum* L.) hybrids were grown under natural conditions from June, 2013 to November, 2013 following recommended agronomical practices. The experiments were laid out in randomized block design with three replications having a plot size of 3.0 m × 2.7 m at a spacing of 60 cm × 45 cm. Neem cake (2t/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 analysed 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 analysed 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	Neem cake	2t/ha
2	T_2	NPK (Recommended dose)	(25:12:12 kg/ha)
3	T_3	Control	No fertilizer

Statistical Analysis

Field experiments were laid in randomized block design with three replicates. From each replicate observation was recorded from ten plants.

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 Neem Cake (NC)

The effect of neem cake (2 t/ha) treatment on fecundity of *P. latus* on chilli leaves is presented in Table 1. Statistical analysis on the effect of neem cake on the fecundity of *P. latus* depicted a significant difference (CD= 0.64, p= 0.05) with control treatment. The highest number of eggs (6.18 eggs/leaf) was recorded in no fertilizer treatment while the lowest was obtained in neem cake application (5.18 eggs/leaf). Neem cake treatment @ 2 t/ha reduced 16.18 percent yellow mite fecundity on chilli plants.

Regarding observation period, maximum number of eggs were laid in the month of October (10.12 eggs/leaf) which was significantly higher than other observation periods (CD= 1.01, p= 0.05). In the month of July and August, eggs recorded were 3.27 and 3.46 eggs/leaf, which was found to be statistically comparable to each other. Likewise, eggs laid during the months of August (3.46 eggs/leaf) and November (4.28 eggs/leaf) were at par with each other but were significantly lower than the eggs observed in the month of September (7.27 eggs/leaf). The interaction between observation periods and treatments were found to be statistically insignificant revealing that number of eggs laid in neem cake at different observation periods do not differ significantly with corresponding eggs recorded in control treatment.

The effect of neem cake treatment on mobile stages of *P. latus* on chilli leaves is presented in Table 2. Statistical analysis of no fertilizer and neem cake treatment showed a significant effect of observation period (CD= 0.71; 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 (9.91 mites/leaf) followed by 6.64 and 4.10 mites/leaf in September and November. Lowest mite count was recorded in the months of July (3.28 mites/leaf) and August (3.76 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 3.06, 3.95, 6.53, 9.71 and 3.82 mites/leaf in control (no fertilizer) and neem cake treatment at each observation period, respectively.

Irrespective of observation periods, treatments showed a statistically no significant difference in *P. latus* count on chilli leaves (CD= NS; p= 0.05). A meager fall in mite count (5.41 mites/leaf) was recorded subjected to neem cake treatment in experimental units as compared to count (5.67 mites/leaf) in control units. Neem cake treatment @ 2 t/ha reduced 4.59 percent yellow mite population on chilli plants. Data presented in Table 2 also, 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.

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 showed 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 (12.03 mite/ top leaf) which was statistically higher than the mite density on middle leaves (11.32 mite/middle leaf). Least number of mites was recorded on the older (bottom) leaves of the plants (10.99 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 treatments and control (10.78 mites/ leaf) where no fertilizer was applied.

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). In neem cake (2t/ha) treatment the mite population percent reduction was 14.19 over control. The data on the effect of three treatments (neem cake 2t/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 (18.44 eggs/leaf) than mobile stages (17.90 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.

Discussion

Organic fertilizers

The organically manure treatments like farm yard manure, neem cake, vermicompost recorded lowest pest population compared to straight fertilized treatments (Rajasekhara Rao, 2002).

Neem cake

The use of organic manure is considered a suitable pest management practice. Thimma Naik (2006) reported that neem cake start decomposing after soil application and liberates nitrogen gradually in the form of ammonia for the use of crops and inhibits soil borne pathogens. Neem cake contains good amount of organic nitrogen (2.0 to 2.5 %) and other nutrients (George and Giraddi, 2007). Application of neem cake @ 500 kg ha^{-1}, seedling dip with 1 per cent neem oil, followed by neem oil spray at weekly intervals reduced the thrips population to lower levels (Rao and Ahmed, 1986).

The efficacy of neem cake in reducing *P. latus* mite population on chilli crop was reported by Smitha (2002). She reported that neem cake @ 2 q ha^{-1} + 50% RDF and *in situ* greenmanuring with sunhemp @ 5 t ha^{-1} + 50% RDF recorded significantly less mite population and leaf curl index compared to 100% RDF alone and these treatments were comparable withstandard check, dicofol + 100% RDF.

Present study showed reduced mite population (9.25mite/leaf) on chilli plants after adding neem cake manure (2tha^{-1}) as soil amendment when compare to control (10.78mite/leaf). This concord the earlier observations made by Giraddi and Verghese (2007) that application of neem cake (1 t/ha) results in reduction in activity of chilli sucking pests and severity of murda disease.

Effects of neem cake at varied dosages and sun hemp in reducing the chilli sucking pest activity were also recorded by many workers (Shashidhar, 2000; Varghese, 2003). George (2006) applied neem cake @ 0.5 t ha^{-1} followed by with neem seed kernel extract (5%) and Neemazal at 2, 5, 7 and 11 weeks after transplanting and recorded significantly less population of thrips, mites and leaf curl index. Application of neem cake @ 2500 kg ha^{-1} + 50% NPK recorded significantly reduced population of thrips and mites with leaf curl index of 0.43 (Lingappa *et al.*, 2002).

Among the organic amendments; neem cake @ 500 kg ha^{-1} with 50% RDF resulted in significantly lower number of thrips, mites and leaf curl resulting in higher fruit yield (Giraddi and Smitha, 2004). In chilli ecosystem, neem cake (2qha^{-1}) was safer to coccinellid beetles, predatory mites, mirid bug and spiders (Babu *et al.*, 1998; Chakraborti, 2000). Chinniah and Mohanasundaram (1999) suggested that neemcake extract (10%) is eco-friendly and safer to predatory mites, *Amblyseius* spp.in cotton ecosystem.

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

Observation Period	Average number of Eggs/ Leaf of chilli (Mean ± S.E.)						Mean (OP)		Pooled Mean (OP)
	Top leaf		Middle leaf		Bottom leaf				
	NF	NC	NF	NC	NF	NC	NF	NC	
July	3.14± 0.58	2.93± 0.58	3.87±0.67	3.60± 0.58	3.33±0.67	2.80±0.88	3.44	3.11	3.27[a]
August	3.33±0.88	3.03± 0.58	4.13± 0.58	3.67±0.33	3.33±0.67	3.27±0.33	3.59	3.32	3.46[a,b]
September	7.20±0.67	6.20± 0.58	8.13±0.88	7.80±0.88	7.33± 0.58	7.00± 0.58	7.55	7.00	7.27
October	13.40± 0.58	7.06±0.88	10.47±1.20	9.66±0.88	10.47±1.15	9.67±0.33	11.44	8.79	10.12
November	5.26±0.88	3.80± 0.58	5.00±0.33	3.86±0.33	4.40± 0.58	3.40±0.33	4.88	3.68	4.28[b]
Mean							6.18	5.18 (16.18%)	

NF=No fertilizer, NC = Neem Cake (2t/ha) Figure in parenthesis is percent reduction in mite eggs over NF
C.D. for Observation Period (OP) = 1.01, SE(m) =0.34 C.D. for Treatment (T) =0.64, SE(m)=0.22 C.D.for Interaction OP × T= NS, SE(m)=0.49 Values with the same superscript do not differ significantly

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

Observation Period	Average number of mobile Stages/ Leaf of chilli (Mean ± S.E.)						Mean (OP)		Pooled Mean (OP)
	Top leaf		Middle leaf		Bottom leaf				
	NF	NC	NF	NC	NF	NC	NF	NC	
July	3.93 ± 0.58	3.20±0.33	3.47±0.67	3.20±0.33	3.13±0.67	2.80±0.33	3.51	3.06	3.28[a]
August	3.53±0.67	3.40±0.33	3.53± 0.58	3.47± 0.58	3.67±0.67	5.00±0.33	3.57	3.95	3.76[a,b]
September	6.27 ±0.88	5.80± 0.58	7.07± 0.58	6.53±0.88	6.93± 0.58	7.27±0.88	6.75	6.53	6.64
October	10.33 ±1.20	8.53±0.33	10.00±1.15	10.27±0.88	10.01±0.88	10.33±0.88	10.11	9.71	9.91
November	4.86 ±0.88	3.13± 0.58	4.40±0.33	4.00± 0.58	3.93±0.67	4.33± 0.58	4.39	3.82	4.10[b]
Mean							5.67	5.41 (4.59%)	

NF=No fertilizer, NC = Neem Cake (2t/ha) Figure in parenthesis is percent reduction in mite population over NF
C.D. for Observation Period (OP) = 0.71, SE(m) =0.24 C.D. for Treatment (T) = NS, SE(m)=0.15 C.D. for Interaction OP × T= NS, SE(m)=0.34 Values with the same superscript do not differ significantly

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

Treatments	Number of Mites/Leaf			
	Top leaf	Middle leaf	Bottom leaf	Mean
Neem cake (2t/ha)	9.96	9.79	10.00	9.25 (14.19)
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	12.03	11.32[a]	10.99[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

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

Treatments (A)	Number of mite stages/leaf (B)		Mean
	Egg	Mobile Stages	
Neem cake (2t/ha)	15.55	16.25	15.90
NPK (25:12:12 kg/ha)	21.21	20.44	20.82
Control (No fertilizer)	18.55	17.01	17.78
Mean	18.44[a]	17.90[a]	

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

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