Article

Impact of organic-inorganic nutrients combination in rice on the occurrence of *Steneotarsonemus spinki* Smiley (Acari: Tarsonemidae) in West Bengal, India

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Abstract

Rice sheath mite, Steneotarsonemus spinki Smiley (Acari: Tarsonemidae), was observed to pose a serious threat to the rice cultivation under Bengal Basin of West Bengal, India during wet season. The mite appeared during tillering to panicle emergence with a maximum population encountered during early ripening stage of the crop causing characteristic brownish specks on the leaf sheath and on the grains resulting poor yield particularly in case of susceptible rice cultivars, IET-4786, IR-36, IET-4094 and many others high yielding varieties. Field experiment was carried out in a randomized complete block design with 11 treatments, comprising different organicinorganic nutrients combination. The result of the experiment reveals that the mite population significantly varied among different treatments with a maximum mite population colonized (930 mites/ leaf sheath) in chemical fertilized plots and a minimum recorded (108 mites/leaf sheath) in leaf manure of *Gliricidia sepium* (Jacq.) treated plots. However, maximum seed yield (fresh rough grain) was obtained from chemical fertilizer treated plots (8.23 t/ha) followed by combined application of mustard cake, Gliricidia leaf manure and chemical fertilizers (7.37 t/ha) treated plots and the minimum yield was recorded from control plots (4.60 t/ha).

Key words: Chemical fertilizers, fertilizers management, *Gliricidia sepium*, organic manures, rice sheath mite.

Introduction

The cultivation of rice is of immense importance to food security of Asia, where more than 90% of the global rice is produced and consumed. India is the largest rice growing country with the production of 105.24 million ton from 42.53 million ha and average productivity of 2.462 t/ha, where the state West Bengal is the rice producing bowl of the country covering an area of 6.18 million hectare with the annual production of 15.024 million tons (Anonymous 2014). The rice sheath mite, *Steneotarsonemus spinki* Smiley, was observed as a serious pest of rice in West Bengal affecting *Kharif* paddy (Karmakar 2008).

It has been reported that the efficiency of chemical fertilizers increased significant-

ly in crop production and probably pest suppression as well when sufficient organic nutrient is added to the soil. Though impact of organic manure over chemical fertilizers against the sheath mite is not explored much and literature regarding this is very scanty. Although, it is evident that proper fertilizer management could change the nutrient composition in plant tissue and consequently this favorable change in plant physiology may help in management of sucking pests (Wooldridge and Harrison 1968). Markkula and Tiittanen (1969) also demonstrated that host plant nutrition may have a positive effect on the reduction of the mite population by varying the fertilizer regime applied to the crops. Considering the importance of the crop and severity of mite infestation in regular basis, the present experiment was conducted with the objectives to find out the influence of organic nutrients on the occurrence of rice sheath mite and their impact on seed yield under Gangetic plains of West Bengal.

Materials and methods

The field experiment was conducted during wet season (Kharif) of 2012 in the District Seed Farm (located at 22° 58' 52" N latitude, 88° 26' 30" E longitude with an elevation of 9.75 m above Mean Sea Level) of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal, India. The nutrient sources viz., Cow dung at 5 t/ha, mustard cake at 2.5 t/ha, neem cake at 2.5 t/ha, Gliricidia leaf manure at 2.5 t/ha, recommended dose of chemical fertilizer (N:P:K at 100:50:50) and an untreated control treatment were considered. Field experiment was carried out in a randomized complete block design with eleven treatments, comprising different organic-inorganic nutrients combination to find out their impact on mite population. A lay out of the experimental plots have been shown in (Table 1). Different nutrients and their combinations considered as treatments have been shown in Table 2. The 25 day old seedlings of rice cultivar, IET-4786 were transplanted in a randomized complete block design in $5m \times 4m$ plots (20 m²) with four replications for each of the treatments covering a total uniformly plain experimental land of 880 m². For recording data on mite population, 10 tillers along the diagonal line from each of the plots were considered. The mite population per leaf sheath was counted under stereo zoom binocular microscope at regular 10 days interval and the mean mite population of 40 leaf sheaths has been presented in Table 4. The mite population per leaf sheath has been counted taking 10 leaves from each of the hill along the diagonal line of each plot. So, mean mite population per leaf sheath of 40 observations has been considered. Each of the leaf sheaths was cut into four pieces and was taken into a glass tube containing 25 ml 70% alcohol which was then shake vigorously to dislodged the mite into alcohol. The total mite population per sheath was then counted under stereo zoom binocular microscope after pouring them into counting disc. All the post embryonic stages of the mite viz., larvae, guiscents (pharate nymphal stages) and adult (males and females) were counted. The mean percent tiller infested/hill showing damage symptoms was counted taking 10 hill/plot along the diagonal line of each plot and the rough grain yield (t/ha) was recorded after harvesting threshing and drying of the crop (Table 5). The data on mite populations were subjected to square root transformation while the percent tillers infested by mite showing damage symptoms were transformed by using arc sin transformation to make the data normal before statistical analysis. The design was analyzed using analysis of variance (ANOVA) techniques and the treatment significance was tested using Fisher's "F" test (Table 3).

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Block	Block	Block	Block
R1	R2	R3	R4
T1	Т9	Т6	Т3
Τ4	T11	Τ7	Т8 м
Т3	Т6	Т9	T10
Τ2	Т8	Т5	T11
Т6	Т3	T10	Τ7
Τ8	Τ7	T1	T2
T10	T2	Т8	T5
T5	T1	T11	Τ4
Т9	T10	Т2	Τ6
Τ7	T4	Т3	T1
T11	Т5	T4	Т9

Table 1. Experimental layout showing replicated blocks and treatment arrangement in the field.

 Table 2. List of different treatment combinations of nutrient and dosage.

Treatment	Type of fertilizers	Dosage (t/ha)
T1	Full dose of Cow dung manure	5.0
T2	Full dose of Mustard cake	2.5
T3	Full dose of Neem cake	2.5
T4	Full dose of <i>Gliricidia</i> leaf manure	2.5
Т5	Full dose of Chemical fertilizer	N:P:K @ 0.1:0.05:0.05
T6	Half dose of Cow dung manure plus Half dose of Mustard	2.5 plus 1.25
T7	cake Half dose of Mustard cake plus Half dose of <i>Gliricidia</i> leaf manure	2.5 plus 1.25
Т8	One third of Cow dung manure plus One third of mustard cake plus One third of <i>Gliricidia</i> leaf manure	1.65 plus 0.85 plus 0.85
Т9	One third of Mustard cake plus One third of <i>Gliricidia</i> leaf manure plus One third of Chemical fertilizer	0.85 plus 0.85 plus (N:P:K @ 0.03:0.015:0.015)
T10	One fourth of Cow dung manure plus One fourth of	1.25 plus 0.62 plus 0.62
	mustard cake plus One fourth of <i>Gliricidia</i> leaf manure	plus (N:P:K @ 0.025:
	plus One fourth of Chemical fertilizer	0.012 : 0.012)
T11	Control treatment	Without application of
		fertilizers

Results and discussion

In the present study rice panicle mite or sheath mite was found to infest inner side of rice leaf sheath and developing grain causing chaffy grain and brownish patches on the affected sites during (*kharif*) wet season rice crop all over the state of West Bengal. The perusal of available literature found that the mite cause panicle sterility and deteriorated grain quality by producing chaffy or partially filled grain. The occurrence and damage of mite in rice has been reported from Madagascar (Gutierrez 1967), China (Ou *et al.* 1977), Taiwan (Lo and Ho 1977; Chen *et al.* 1979), Philippines (Hsieh *et al.* 1977), Kenya (Sogawa 1977), Japan (Shikata *et al.* 1984), Cuba (Ramos and Rodriguez 1998), Korea (Cheng and Chiu 1999), Thailand (Cho *et al.* 1999), Caribbean islands (Almaguel *et al.* 2004), Sri Lanka (Cabrera *et al.* 2002), Colombia (Instituto Colombiano Agropecuario 2005), Guatemala, Honduras (Castro *et al.* 2006), The United States of America (Texas Department of Agriculture 2007; Hummel *et al.* 2007; UCDavis 2009), Nicaragua, and Venezuela (Aguilar and Murillo 2008). In other states of India, the

occurrence of rice sheath mite was first reported from Orissa (Rao and Das 1977; Rao and Prakash 1992) and from East and West Godavari districts of Andhra Pradesh (Rao *et al.* 2000; Anonymous, 2001). Ou *et al.* (1977) reported that the Japonica varieties are more susceptible to spinki mite than the Indica varieties. Economic losses of crop were reported due to infestations of rice sheath mite from China (30 to 90%), Cuba (70%) and it has been predicted up to 30–70% in Brazil (Xu *et al.* 2001; Ramos and Rodriguez 2000; Navia *et al.* 2005).

SOURCE	DF	SS	MSS	Fcal	F tab	Significance
REP	3	SS r	SS r/3	MSS r/MSS e	2.922	Cal > tab f*
TREAT	10	SS t	SS t/10	MSS t/MSS e	2.165	Cal > tab f*
ERROR	30	SS e	SS e/30			

 Table 3. Model table of ANOVA.

* Significant at 5% level (DF=degrees of freedom; SS=sum of square; MSS=mean sum of square)

No mite population was observed at the early vegetative stage of the crop; however, they began to develop their population during booting stage and gradually attained a peak during end of September at the ripening stage of the crop. The maximum mite population was encountered in the plots treated with chemical fertilizers followed by neem cake treated plots and the lowest population was recorded from *Gliricidia* leaf manure and $1/3^{rd}$ each of cow dung manure at 5 t/ha, mustard cake at 2.5 t/ha and *Gliricidia* leaf manure at 2.5 t/ha treated plots (Table 2).

The result of the experiment revealed that the maximum mean mite population was recorded in chemical fertilizers treated plots (930 mite/sheath) and lowest was found in *Gliricidia* (108 mite/sheath) treated plots on 10^{th} October, 2012. The maximum percent of damage symptoms was expressed in chemical fertilizer treated plots (92%) whereas, the minimum damage symptoms were expressed in *Gliricidia* (15%) treated plots.

The mite population began to establish at the late tillering to boot stage and attained maximum at ripening stage. Application of mustard cake and Gliricidia leaf manure at 2.5 t/ha respectively are very promising for maintenance of low mite population and securing satisfactory seed yield which were evidenced by the work of researchers. Ferret et al. (2008) evaluated the effect of the application of foliar fertilizers and plant growth regulators on S. spinki populations in commercial rice cultivars, Perta de Cuba and J-104. The panicle mite population was differentiated for each treatment and the application of triacontanol and foliar fertilizer with nutrients as well as the mixtures triacontanol plus foliar fertilizer without nutrients, analogues of brasinoesteroids plus foliar fertilizer with nutrients and analogues of brasinoesteroids plus microalgae caused increase in mature mite populations. Patil and Nandihalli (2008) observed significantly low population of spider mite in brinjal applied with sole vermicompost, neem cake and high K and low N whereas, higher population of mites was recorded in combinations like 50% of recommended doses of fertilizer plus pongamia cake, high N+P+K, low N + low P + low K. These findings are in confirmation of the present study which showing maximum mite population in the plots treated with chemical fertilizers. On the other hand, low mite population and higher yield was observed in the plots treated with organic manures viz. Gliricidia leaf manure and mustard cake. Similarly, in the present study the highest mite population observed in chemical fertilizer treated plots though the yield recorded from the chemical fertilizers treated plots also high. This was because of early and timely transplanting of rice seedling where the infestation of mite began at the late tillering stage of the crop and hence, there was a little chance for the mite to develop and appearance of destructive population during milking to ripening stage of the crop to cause economic loss as compared to late transplanted crop where the destructive population of mite get a prolong span of time to cause sufficient loss which is evidenced by earlier publication of Karmakar and Gupta (2011). Therefore, though the chemical fertilizer treated plots have been recorded higher incidence of mite there was less yield loss only due to early ripening and harvesting of crop which can be explained as the de-synchronization of mite incidence with crop maturity.

Table 4. Population density of rice sheath mite, *Steneotarsonemus spinki* Smiley during wet season (Kharif) 2012 in rice cultivar IET 4786 as influenced by organic and chemical fertilizers at Distict Seed Farm, BCKV, West Bengal.

Treatments	Occurr	Occurrence of rice sheath mite/sheath at different dates of observations in 2012							
Treatments	05 Nov.	10 Nov.	15 Nov.	20 Nov.	25 Nov.	30 Nov.	05 Oct.	10 Oct.	
T1	0.10	0.50	3.00	10.67	14.67	50.00	122.67	190.67	
	(0.77)*	(1.00)	(1.87)	(3.34)	(3.89)	(7.11)	(11.10)	(13.83)	
Т2	0.00	0.20	2.00	8.00	12.00	71.67	151.33	214.67	
	(0.71)	(0.84)	(1.58)	(2.92)	(3.54)	(8.50)	(12.32)	(14.67)	
Т3	0.10	0.20	5.00	20.33	19.33	93.33	200.33	352.67	
	(0.77)	(0.84)	(2.35)	(4.56)	(4.45)	(9.69)	(14.17)	(18.79)	
T4	0.00	0.00	1.00	3.33	11.00	20.67	70.67	108.33	
	(0.71)	(0.71)	(1.22)	(1.96)	(3.39)	(4.60)	(8.44)	(10.43)	
Т5	0.20	0.60	10.00	40.67	108.67	151.67	498.67	929.67	
	(0.84)	(1.05)	(3.24)	(6.42)	(10.45)	(12.34)	(22.34)	(30.50)	
T6	0.00	0.10	1.00	10.33	20.67	80.33	150.67	324.33	
	(0.71)	(0.77)	(1.22)	(3.29)	(4.60)	(8.99)	(12.29)	(18.02)	
Τ7	0.00	0.00	1.50	6.33	12.00	50.33	111.67	122.67	
	(0.71)	(0.71)	(1.41)	(2.61)	(3.54)	(7.13)	(10.59)	(11.10)	
T8	0.00	0.00	1.20	5.00	15.33	55.00	88.33	114.67	
	(0.71)	(0.71)	(1.30)	(2.35)	(3.98)	(7.45)	(9.43)	(10.73)	
Т9	0.10	0.20	1.30	8.33	14.67	84.33	131.67	232.00	
	(0.77)	(0.84)	(1.34)	(2.97)	(3.89)	(9.21)	(11.50)	(15.25)	
T10	0.10	0.20	1.50	6.00	12.00	79.33	150.67	251.67	
	(0.77)	(0.84)	(1.41)	(2.55)	(3.54)	(8.93)	(12.29)	(15.88)	
T11	0.10	0.30	3.00	14.33	41.33	110.67	347.67	547.67	
	(0.77)	(0.89)	(1.87)	(3.85)	(6.47)	(10.54)	(18.66)	(23.41)	
F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	
Sem ±	0.027	0.026	0.133	0.095	0.107	0.127	0.113	0.204	
CD at 5%	0.081	0.077	0.391	0.281	0.316	0.376	0.335	0.600	

*Values in parentheses are square root transformed; Sig. = Significant; CD= Critical Difference, probability at 5% level.

In general, the organic matter is a continuous source of plant nutrients and amino acids that improves the soil physical, chemical and biological environment for plants (Awad *et al.* 1993). Patriquin *et al.* (1995) indicated that various forms of organic matter applied to soils, may be able to decrease populations of arthropod pests and

resultant crop damage. Rao et al. (2001) and Rao (2002) have reported that vermicomposts suppressed numbers of jassids, aphids and spider mites. Asami et al. (2003) reported that total amounts of phenolic substances were much higher in strawberries and corn grown organically than in those grown with inorganic fertilizers. Simmonds (1998) reviewed the modification of insect feeding behavior by phenolics and non-protein amino acids and general inhibition of insect pest feeding. In a study, Banhawy et al. (1997) demonstrated that presence of organic manure increases the population of predatory mite fauna. The predatory mite species, Lasioseius parberlesei Bhattacharyya, Neoseiulus imbricatus (Corpuz-Raros and Rimando), Neoseiulus pranadae Karmakar and Gupta and a predatory Thrips sp. those were encountered in this study were not quantified though their presence were encountered more in organic plots rather than the chemical fertilizer treated plots. It is also assumed that application of organic nutrients enrich the soil texture and structure favourable for growth, development and vigour of rice plants which might be the cause to prevent mite attack. All these might be the cause for reduced mite attack in organic manure treated rice plots in present study.

Table 5. Percent tillers infested by rice sheath mite, *Steneotarsonemus spinki* Smiley during wet season (Kharif) 2012 in rice cultivar IET 4786 with typical symptoms of damage at different dates of observation at Distict Seed Farm, BCKV, West Bengal.

	Percen	Percent tillers infested by rice sheath mite at different dates of observations							Mean
Treatments	05	10	15	20 Nov	25 Nov	20 Nov	05 Oct	10 Oct	yield
	Nov.	Nov.	Nov.	20 1107.	23 NOV.	30 NOV.	05 001.	10 001.	in t/ha
T1	0.0	0.1	1.0	2.5	5.5	15.2	16.2	25.1	5.60
	(4.1)*	(4.4)	(7.0)	(9.9)	(14.2)	(23.3)	(24.1)	(30.4)	
Τ2	0.0	0.0	1.0	2.0	5.7	12.4	14.3	22.8	7.50
	(4.1)	(4.2)	(7.0)	(9.2)	(14.5)	(21.0)	(22.6)	(28.8)	
Т3	0.0	0.1	1.5	4.8	8.6	16.2	20.4	30.1	5.40
	(4.2)	(4.4)	(8.1)	(13.3)	(17.6)	(24.1)	(27.2)	(33.6)	
T4	0.0	0.0	0.5	1.4	4.7	5.2	10.2	15.2	6.6.
	(4.1)	(4.1)	(5.7)	(7.9)	(13.2)	(13.8)	(19.1)	(23.3)	
Т5	0.0	0.1	3.0	10.6	20.9	25.3	50.3	91.9	8.23
	(4.2)	(4.4)	(10.8)	(19.5)	(27.6)	(30.5)	(45.5)	(74.0)	
T6	0.0	0.0	0.9	2.7	8.7	10.3	15.0	33.1	5.93
	(4.1)	(4.1)	(6.8)	(10.3)	(17.6)	(19.2)	(23.2)	(35.4)	
Τ7	0.0	0.0	0.9	2.4	5.7	8.4	17.1	20.5	7.20
	(4.1)	(4.1)	(6.8)	(9.7)	(14.5)	(17.4)	(24.8)	(27.3)	
Т8	0.0	0.0	0.8	1.5	6.6	9.3	16.1	29.0	6.00
	(4.1)	(4.1)	(6.5)	(8.1)	(15.5)	(18.3)	(24.1)	(32.9)	
Т9	0.0	0.0	0.7	2.0	8.0	10.2	20.2	40.6	7.37
	(4.1)	(4.1)	(6.3)	(9.1)	(17.0)	(19.1)	(27.1)	(39.9)	
T10	0.0	0.0	0.7	1.7	5.3	10.6	20.2	41.8	6.80
	(4.1)	(4.1)	(6.3)	(8.5)	(13.9)	(19.5)	(27.1)	(40.6)	
T11	0.0	0.1	1.5	5.2	10.8	15.7	25.1	64.2	4.60
	(4.2)	(4.3)	(8.1)	(13.8)	(19.6)	(23.7)	(30.4)	(53.5)	
F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	
Sem ±	0.02	0.02	0.52	0.79	0.52	0.70	0.43	1.62	
CD at 5%	0.07	0.06	1.52	2.32	1.55	2.06	1.26	4.76	

*Values in parentheses are arc sin transformed; Sig. = Significant; CD= Critical Difference, probability at 5% level

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As a conclusion, the result confirmed that the mites grow easily in rice plant treated with chemical fertilizers than organic manures. Application of higher amount organic manures improves soil which in turn results better yield and sustainability of agroecosystems. So, it can be recommended to apply organic manures i.e. mustard cake and *Gliricidia* leaf manure in farmer's field. Further studies are necessary to confirm the ratios of different organic manures and chemical fertilizers that would give cost effective best yield in different rice growing zones of the world.

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کریشنا کارمکار یو پراناب دبناث

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چکیدہ

کنهٔ غلاف برنج، (Steneotarsonemus spinki Smiley (Acari: Tarsonemidae) ، به عنوان تهدیدی جدی برای کشت برنج در حوزهٔ روخانه بنگال در فصل مرطوب در بنگال غربی به حساب میآید. کنه در طی جوانهزنی تا ظهور ستبله ظاهر شده و بیشینه جمعیت را در اوایل پر شده خوشه ایجاد و لکههای قهوهای روی غلاف برگ و دانههای حاصل از محصول ضعیف به ویژه روی ارقام حساس، IET-4094 ، IR-36 ، IET-4094 و بسیاری دیگر از ارقام پرمحصول به وجود میآیند. آزمون صحرایی در قالب طرح بلوکهای کاملاً تصادفی با ۱۱ تیمار متشکل از مخلوط مواد غذایی مختلف متفاوت است با بیشینه جمعیت کنه به طور معنیداری بین تیمارهای مختلف متفاوت است با بیشینه جمعیت کنه (۹۳۰ کنه/غلاف برگ) در کرتهای دارای کود شیمیایی و کمینه (۱۰۸ کنه/غلاف برگ) در کود برگی (Jacq) در کرتهای دارای کود شیمیایی و کمینه (۱۰۸ کنه/غلاف برگ) در کود برگی (Jacq) و رو در گی *و گو*دهای شیمیایی(۱۰۹ تن در هکتار) به دست آمد که برابر کرتهای تیمار شده با کود شیمیایی بود و کمترین محصول از کرتهای شاهد به دست آمد (۲۰۸ تن در هکتار). کود شیمیایی بود و کمترین محصول از کرتهای شاهد به دست آمد (۲۰۸۶ تن در هکتار). کود شیمیایی بود و کمترین محصول از کرتهای شاهد به دست آمد (۲۰۸۶ تن در هکتار). کود شیمیایی بود و کمترین محصول از کرتهای شاهد به دست آمد (۲۰۸۶ تن در هکتار). کود شیمیایی بود و کمترین محصول از کرتهای شاهد به دست آمد (۲۰۸۶ تن در هکتار). کودهای آلی، کنهٔ غلاف

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