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Effect of nitrogenous fertilizer on yellow mite infestation in *Corchorus* spp.

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Abstract

The pest status of yellow mite, *Polyphagotarsonemus latus* (Banks) has enhanced jute causing regular infestation. Improper crop management, particulary imbalanced fertilizer application encourages population build-up and outbreak of mite and other sucking pests.Field experiments were conducted to study the effect of different levels of nitrogenous fertilizer (40, 60, 80, 100 and 120 kg ha^{-1}) on infestation of *P. latus* in jute (*cv.* JRO-8432) in two subsequent cropping seasons. Results revealed there was significant variation on infestation of *P. latus* in jute crop treated with different levels of nitrogenous fertilizers. Moderate infestation (96.73 mites cm^{-2} leaf) of yellow mite during peak period at 55 days after sowing (DAS) was recorded in the recommended dose (80:40:40 kg ha^{-1}) as compared to higher doses *i.e.,* 120: 40: 40 kg ha^{-1} (138.52 mites cm^{-2} leaf). Although, positive correlation exists between N-fertilization and mite population, yield was maximum with highest N dose *i.e.,* 120: 40: 40 and incremental dose of nitrogen on yield was clearly manifested on the benefit cost ratio (BCR) of different NPK dosages, which was highest (1.58) at 120: 40:40 level. It is evident from the study that although NPK had favorable effect on population establishment and it may also replenish the damage as fibre yield was maintained at higher doses instead of higher mite population. These study clearly suggested that slight manipulation in recommended doses of N fertilizer can contribute substantially in regulating the abundance of yellow mite with non-significant effect on yield enhancement in jute.

Key words

Corchorus spp., Fibre yield, Jute, Nitrogen doses, *Polyphagotarsonemus latus*

Introduction

Yellow mite, *Polyphagotarsonemus latus* (Banks) (Acari : Tarsonemidae) is an important pest with high polyphagous feeding behavior reported to infest more than 100 different plant species including jute and its damage can adversely affect plant morphology and physiology (Hath, 2000; Grinberg *et al*., 2005). Jute, *Corchorus* spp. (Malvaceae) is one of the important bast fibre crops grown mostly in India and other South East Asian countries. Yellow mite is a regular and destructive pest of jute, prevalent almost throughout the crop growth stage particularly from 25- 85 days after sowing (DAS). Both nymphs, as well as, adults suck cell sap from the undersurface of young leaves, which curls ventrally in due course of time. The infested jute leaves do not grow to their full size and turn to coppery-brown often drop prematurely.

Their attack is mostly confined to new growth resulting in curling of leaf margins, firmness of infested leaves, necrosis of growing points and growth inhibition, which arrests the internode length and produces suppressed side branches resulting in significant yield loss and reduction in fibre strength (Ramasubramanian *et al*., 2009; Karmakar and Mazumdar, 2010). The *tossa* jute (*C. olitorius*) suffers more due to *P. latus* infestation as compared to jute (*C. capsularis*). As a result, yield loss has been estimated to the extent of 42% in jute plants (Pandit *et al.,* 2002).

Improper crop management practices is one of the reason for persistent damage and infestation of yellow mite on different crops. No doubt, fertilizers are important inputs to increase productivity through improved crop growth and yield potential. There are evidences that inorganic fertilizers reduce resistance to insect pests which tend to increase in insect survivorship and population warranting repeated need for insecticide application (Yardim and Edwards, 2003). During the recent years, introduction of new jute varieties for cultivation has witnessed enhanced fertilization over marginally grown crop for increasing jute fibre production. Eventually, to obtain higher fibre yield in jute, recommended dose of fertilizers has been enhanced over the previous recommended doses of 60:30:30 kg NPK ha^{-1} (Anonymous, 1999). However, studies on the effect of nitrogenous fertilizer on infestation of yellow mite in jute is meagre. In light of the above, the present investigation was carried out to study infestation of yellow mites under variable regimes of nitrogenous fertilizers, which may be useful for framing the management options for yellow mite in jute.

Materials and Methods

A field experiment was conducted in Randomized Block Design (RBD) with three replications in the Research Farm of ICAR-Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpore, West Bengal during 2012 and 2013 cropping seasons. The experiment, including control (no additional application), was laid out in a plot with available N, P and K of 270, 35 and 220 kg ha^{-1} respectively. Soil was coarse textured (6.5-7.5 pH and 0.5 % organic carbon). Seeds of jute (*cv*. JRO-8432) were sown in (4 m x 3 m) plots in lines at 30 cm spacing with 10 cm between the plants. For proper sampling, 10 plants were randomly selected from inner rows.

Varying doses of nitrogen was applied in the experimental plot as basal application during land preparation to record its effect on yellow mite infestation. All the standard agronomic practices were followed for raising the jute crop. No plant protection measures were adopted. There were eight treatments with varying level of N P K (40: 30: 30; 60:30:30; 80:30:30; 100:30:30; 120:30:30; 80: 40: 40 and 120:40:40).The following sources of NPK were used: N, Urea (CH_4N_2O-46% N); P_2O_5, single super phosphate (SSP-16% P); K_2O, muriate of potash (MOP- 60% K). Yellow mite population (number cm^{-2} on 2nd unfolded leaf) was recorded at 55 DAS, 70 DAS and 85 DAS on ten randomly selected plants per plot using 1 cm x 1cm white hard paper quadrate with 10x magnifying lens. Data on yellow mite population, thus obtained were square root transformed prior to statistical analysis. The mean number of mites and fibre yield for each fertilizer treatment were calculated and compared with one-way analysis of variance (ANOVA). Duncan's multiple range test was used to determine significant difference ($P<0.05$) between the treatments (means of numbers for each fertilization treatment). Economic parameters such as cost of production, net return and benefit cost ratio (BCR) were calculated by considering all inputs and outputs. Simple correlation between mite population and fibre yield at different crop stages, as well as, different levels of nitrogen were computed.

Results and Discussion

The population of mite on jute crop, with variable doses of nitrogen at different physiological stages of the plant, clearly indicates favorable effect of N-fertilization on yellow mite infestation and further population establishment. A significant ($P<0.05$) difference in mite population was recorded on jute crops treated with variable fertilizer regimes (Table 1). Among the three crop stages (55, 70 and 85 DAS) at which the mite population was recorded, maximum infestation was observed at 55 DAS during both the cropping seasons. Least yellow mite population of 45.1 and 38.4 mites cm^{-2} leaf area was recorded at 55 DAS in untreated plants during two successive seasons. Whereas, treatment which received maximum nitrogen dose (120 kg ha^{-1}) was found to be more vulnerable to mite infestation with 160.3-185.2 to 91.8-100.2 mites cm^{-2} leaf during peak infestation stage at 55 DAS in 2012 and 2013 cropping season, respectively. Subsequently, the mite population reduced (> 50 %) as crop age advanced irrespective of nitrogen level both at 70 and 85 DAS as compared to 55 DAS during both the cropping seasons. During the later crop growth period also, significantly ($P<0.05$) maximum mite infestation was observed in 120:40:40 kg ha^{-1} fertilizer treatment, which was 48.73 mites cm^{-2} and 42.90 mites cm^{-2} at 70 DAS during 2012 and 2013 cropping season, respectively. Similar trend of relative mite infestation was also observed at 85 DAS. Nitrogen fertilizer treatments significantly ($P<0.05$) increased *Tetranychus urticae* population density on six common bean cultivars. Increasing N from 0-69 kg ha^{-1} resulted in enhanced mite population (Najafabadi and Shoushtari, 2011). Increasing population density with higher doses of N-fertilizer enhance higher foliar nitrogen content that typically increase the fecundity, sex ratio and subsequent population built up of mite (Rodriguez *et al*., 1970; Rather and Lavdari, 2006; Sharma *et al.,* 2010). Similarly, fibre yield results revealed that the plots without nitrogen (control) application produced the lowest fibre yield of 15.11 and 14.54 q ha^{-1} as compared to 26.45 and 27.45 q ha^{-1} in 2012 and 2013 cropping season, respectively with increase in nitrogen application up to 120 kg ha^{-1} (Table 1).

The pooled mean data revealed that, there was a wide variation in *P. latus* infestation across the stage of crop and various doses of nitrogen application (Table 2). Among

different stages of crop, maximum mite population was observed at 55 DAS as compared to 70 and 85 DAS. Higher dosage of NPK favoured yellow mite infestation as evidenced by the treatment of 120: 40: 40 which supported significantly highest mite population (138.52 mites cm^{-2}) which was at par with the infestation level of 130.16 mite cm^{-2} at 120: 30: 30 treatment. Favorable effect on mite infestation was witnessed with increase in P and K level at same N level With enhancement of P and K both at 80 and 120 kg N_2 level, there was significant ($P<0.05$) increase in mite population to the extent of 96.73 and 138.52 mites cm^{-2} over 130.26 and 67.52 mites cm^{-2}, respectively. *P. latus* population decreased with decreasing level of nitrogen and was in the range of 96.73-47.13 mites cm^{-2} on 2nd unfolded leaf with nitrogen level of 80-40 kg ha^{-1}. Treatment without fertilizer application harbored least mite population of 41.79 mites cm^{-2} leaf. Similar trend in mite infestation was recorded at 70 and 85 DAS. During later stage, crop (70 and 80 DAS) showed comparatively less mite population in the range of 10.06-46.49 and 6.39-23.18 mites cm^{-2} leaf at 70 and 85 DAS, respectively. It is evident from previous studies that besides N, the impact of P and K was also positive on mite infestation across many mite species and host plants. Higher spider mite population on cowpea was due to enhanced application of phosphorous and potassic fertilizers (Rather and Lavdari, 2006). Increased population of mite at higher N level might be due to improved physiological status of host plant. Plant nitrogen fertilization has been found to modify the dietary nitrogen concentration of plants for insects to affect their population growth, fecundity and sex ratio of mite (Jansson and Ekbom, 2002; Mattsson and Wallen, 2003; Patil and Nandihalli, 2008). At all the stages of crop, the mite population maximum N level was 3-4 times more than control plants. Fibre yield also varied according to nitrogen dose. Treatment with highest dose (120 kg ha^{-1}) of nitrogen showed better yield of 25.42 and 26.94 q ha^{-1} as compared to control (14.82 q ha^{-1}). Among

Table 1 : Effect of different doses of nitrogen fertilizer on yellow mite, *Polyphagotarsonemus latus* population in jute crop

Treatments	Mite population during 2012			Yield	Mite population during 2013			Yield
(N:P:K kg ha^{-1})	55 DAS*	70 DAS	85 DAS	(Q ha^{-1})	55 DAS	70 DAS	85 DAS	(Q ha^{-1})
T_1 (40:30:30)	58.4 (7.68)^{c}	11.20 (3.42)^{c}	9.6 (3.18)^{cd}	19.78	35.9 (6.03)^{d}	14.0 (3.81)^{bc}	10.5 (3.32)^{bc}	20.37
T_2 (60:30:30)	77.5 (8.83)^{bc}	15.67 (4.02)^{bc}	10.2 (3.27)^{cd}	21.74	44.8 (6.73)^{cd}	14.9 (3.92)^{bc}	12.2 (3.56)^{bc}	22.31
T_3 (80:30:30)	87.5 (9.38)^{bc}	14.40 (3.86)^{bc}	11.3 (3.44)^{c}	22.42	47.5 (6.93)^{cd}	15.6 (4.01)^{bc}	12.0 (3.54)^{bc}	23.15
T_4 (100:30:30)	91.5 (9.59)^{bc}	17.33 (4.22)^{bc}	13.3 (3.71)^{bc}	24.72	51.6 (7.22)^{cd}	22.8 (4.82)^{b}	10.0 (3.23)^{bc}	25.07
T_5 (120:30:30)	160.3 (12.68)^{a}	25.67 (5.12)^{b}	16.2 (4.09)^{bc}	25.10	100.2 (10.03)^{a}	45.2 (6.76)^{a}	15.0 (3.93)^{abc}	26.75
T_6 (80:40:40)	126.7 (11.28)^{ab}	45.17 (6.76)^{a}	21.4 (4.68)^{ab}	23.31	66.8 (8.20)^{bc}	47.8 (6.95)^{a}	24.9 (5.04)^{a}	24.42
T_7 (120:40:40)	185.2 (13.63)^{a}	48.73 (7.02)a	28.0 (5.34)^{a}	26.45	91.8 (9.61)^{ab}	42.9 (6.58)^{a}	18.0 (4.30)^{ab}	27.45
T_8 (Control)	45.1 (6.76)^{c}	8.93 (3.07)^{c}	5.4 (2.44)^{d}	15.11	38.4 (6.24)^{d}	11.2 (3.42)^{c}	7.4 (2.80)^{c}	14.54
SEm (±)	2.02	1.08	0.71	1.87	1.23	1.11	0.58	3.01
LSD (P=0.05)	6.12	3.29	2.16	5.66	3.72	3.36	1.75	9.12

Mite population (no. cm^{-2} leaf area; *DAS-Days after sowing; Figures in the parentheses are square root transformed values.In columns, means followed by same superscripts are not significantly different ($P<0.05$) by DMRT

Table 2 : Effect of different doses of nitrogen fertilizers on yellow mite, *Polyphagotarsonemus latus* infestation in jute crop (Pooled mean data of 2012 and 2013)

Treatments (N:P:K kg ha^{-1})	Mite population (no. cm^{-2} leaf area on pooled mean data of 2012 and 2013 cropping season			Yield (Q ha^{-1})
	55 DAS*	70 DAS	85 DAS	
T_1 (40:30:30)	47.13 (6.67)^{dc}	12.61 (3.61)^{bc}	10.06 (3.22)^{cb}	20.07
T_2 (60:30:30)	61.18 (7.74)^{cde}	15.26 (3.95)^{bc}	11.17 (3.39)^{b}	22.02
T_3 (80:30:30)	67.52 (8.07)^{cde}	14.99 (3.93)^{bc}	11.67 (3.48)^{b}	22.78
T_4 (100:30:30)	71.53 (8.40)^{cd}	20.05 (4.52)^{b}	11.59 (3.46)^{b}	24.89
T_5 (120:30:30)	130.26 (11.42)^{ab}	35.46 (5.97)^{a}	15.58 (3.98)^{b}	25.42
T_6 (80:40:40)	96.73 (9.76)^{bc}	46.49 (6.67)^{a}	23.18 (4.77)^{a}	23.86
T_7 (120:40:40)	138.52 (11.79)^{a}	45.79 (6.67)^{a}	22.99 (4.79)^{a}	26.94
T_8 (Control)	41.79 (6.29)^{c}	10.06 (3.20)^{c}	6.39 (2.57)^{c}	14.82
SEm (±)	1.58	1.07	0.59	2.56
LSD (P=0.05)	4.79	3.24	1.80	7.78

*DAS-Days after sowing. Figures in the parentheses are square root transformed values. In columns, means followed by same superscripts are not significantly different ($P<0.05$) by DMRT

nutritional factors, influence of N has been considered critical for both plants and consumers (Nansen and Ridsdill-Smith, 2013).

The recommended dose of fertilizer (N: P_2O_5: K_2O) for *Olitorius* jute is 80:40:40 kg ha^{-1} and inorganic fertilizers elevates plant nitrate and amino acid level (Mengel *et al*., 2001) but inadvertently increase nutritional quality and attractiveness of plants to phytophagous insects (Bentz and Larew, 1992). Inorganic fertilizers need to be judiciously applied as excessive and imbalance application of inorganic fertilizers especially nitrogen, triggers insect herbivore occurrence and outbreak especially sucking pests and crop damage by reducing host plant resistance (Sudoi *et al.,* 2001; Altieri and Nicholls, 2003; Ge *et al.,* 2003). The level of nitrogen fertilizers play an important role in infestation, development, fecundity and distribution of sucking insect pests including mite and physiological susceptibility of crop to pests (Habibullah *et al.,* 2007; Sharma *et al*., 2010). The present study showed complex interaction between nitrogen doses and development of mite population. During 2012 cropping season, there was a high positive correlation of *P. latus* population and various doses of nitrogen level at 55 DAS (R^2 = 0.92), 70 DAS (R^2 = 0.90), 85 DAS (R^2 = 0.95)

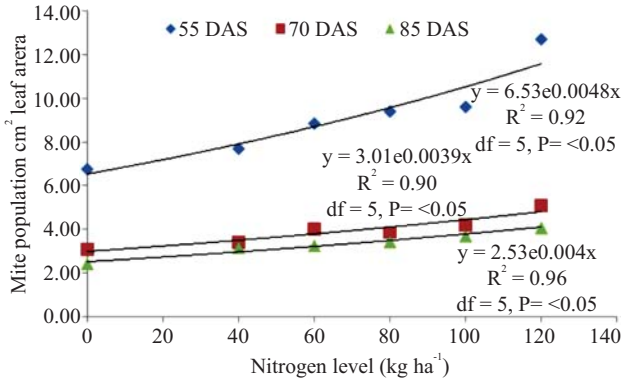

Fig. 1 : Correlation of different nitrogen levels on yellow mite population at different days after sowing during 2012 cropping season

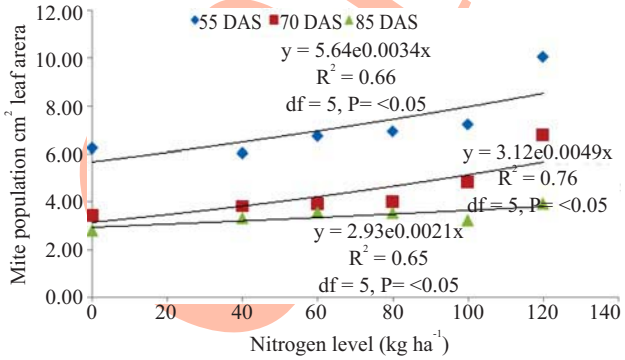

Fig. 2 : Correlation of different nitrogen levels on yellow mite population at different days after sowing during 2013 cropping season

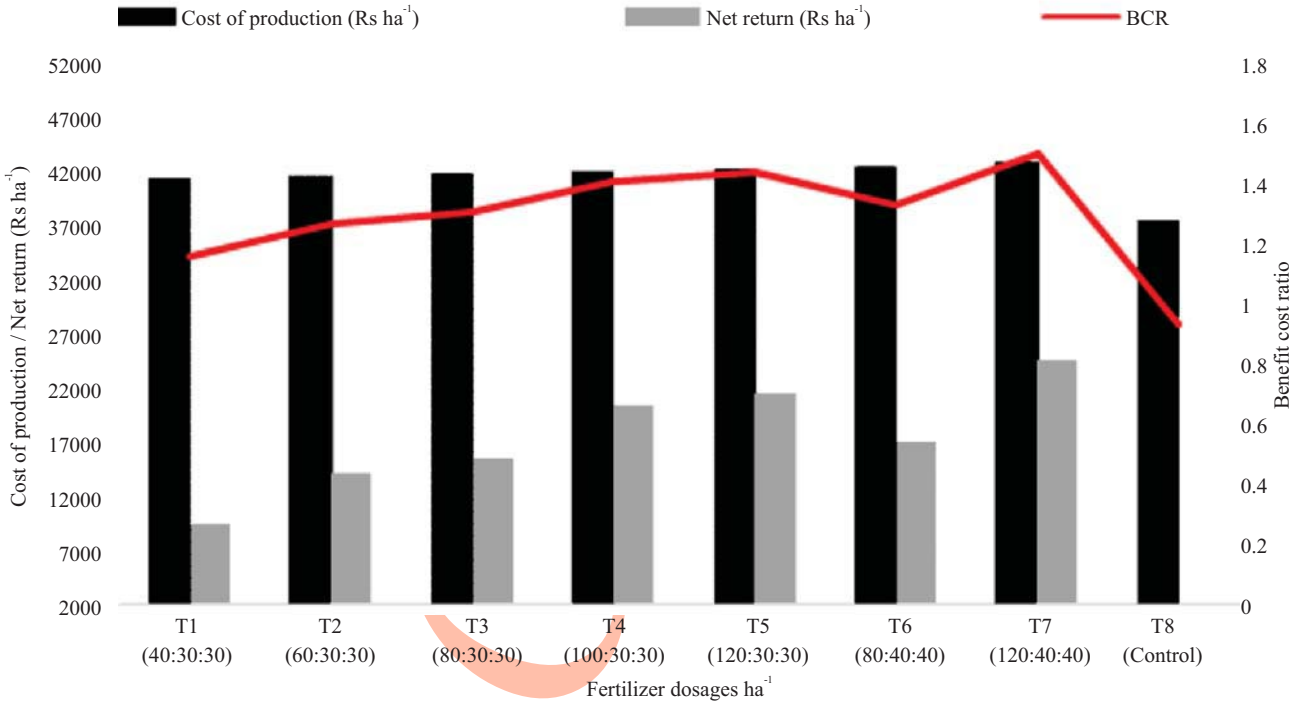

Fig. 3 : The net economical effect of mite infestation on different fertilizers treatment during both cropping seasons

(Fig. 1). In subsequent season (2013), the moderate trend of positive correlation between nitrogen level and mite infestation *i.e.* R^2=0.66, 0.76 and 0.65 at 55, 70 and 85 DAS, respectively was recorded (Fig.2). Wood and Reilly (2000) found a positive correlation between high soil nitrogen concentration and density of *Tetranychus* spp. Chen *et al.* (2007) reported positive correlation between nitrogen and phosphorous concentration in three foliage strata of ivy geranium, *Pelargonium peltatum* and within plant distribution of spider mites. A significant positive correlation between sex-ratio, fecundity of mite and leaf N content was observed in geranium and cowpea (Chow *et al.,* 2007; Rather and Lavdari, 2006; Najafabadi *et al.,* 2011). The insect-pest and disease complex in susceptible domain is directly correlated with use of N-fertilizers (Singh *et al.,* 2011). Recently, strong evidence of a positive developmental response by spider mites to nitrogen rich crops (West and Nansen (2014).

Soil fertility and fertilizer application may impact the physiological susceptibility of crop plants to insect pests either by affecting the resistance of individual plants to attack or by altering plant susceptibility to certain herbivores. Numerous studies have demonstrated that fertilizer regimes can affect crop susceptibility to mite. Increase in P and K level at same N (80 and 120 kg ha^{-1}) level also enhanced mite infestation, although it was not statistically significant. Increased nitrogen dose on yield is clearly manifested on the benefit cost ratio (BCR) of different NPK dosages which was highest (1.58) at 120: 40:40 level (Fig. 3). No doubt, at this nutrient level there was significant increase in mite infestation also, but the net economical effect of mite damage on yield was compensated through yield enhancement on higher N level as it is realized from higher BCR of 1.58. Compensatory effect on yield less at higher level of N is due to maintenance of good plant health through better nutrition negating the adverse effect of pest population (Pandey and Chandra, 2013). However, it is better that interaction among multiple nutrients be considered in efforts to explain the variation in mite responses to plant nutrients (Busch and Phelan, 1999).

In conclusion**,** the study showed moderate infestation of yellow mite during peak period at 55 DAS in the recommended dose as compared to higher doses of NPK. Although positive correlation exist between N-fertilization and mite population, the yield was maximum at highest N dose. Excessive dose of nitrogen fertilizer may produce lush green plants, which attracts mite infestation. Therefore, optimum dose of fertilizer should be applied for maximum yield with least mite population at proper time. So, appropriate level of N and K reduce the infestation of *P. latus* without affecting the plant growth, yield and quality parameters. This approach being ecofriendly would help in minimizing pesticide application for management of insect pests in jute crop.

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