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Laboratory evaluation of anthocorid bug, *Blaptostethus pallescens* Poppius (Heteroptera: Anthocoridae) against European red mite, *Panonychus ulmi* (Koch) and two spotted spider mite, *Tetranychus urticae* Koch infesting apple in Kashmir

M Jamal Ahmad, Sajad Mohiudin, ABU Manzar and Asma Sherwani

Abstract

A single 8 day's old nymph, mature female and mature male of anthocorid bug *B. pallescens* Poppius consumed an average of 9.2 10.0 and 10.0 eggs of two spotted spider mite, *Tetranychus urticae* Koch respectively, whereas similar stage of bugs consumed an average of 7.2, 9.8 and 9.4 eggs of European red mite, *Panonychus ulmi* (Koch) during a period of three days at 1:10 predator- prey ratio. Rate of consumption increased gradually in relation to increased predator- prey ratio up to 1:30. Data on consumption rate when denoted in terms of per cent host egg mortality was found declining gradually in relation to predator- prey ratio, both for two spotted spider mite and European red mite which was due to increasing chance of escape of host eggs from predation. Although potential feeding by all the stages of the bug used was positively correlated with prey density however result on was found varying at different predator- prey used. % host egg mortality by 8 day's old nymph, mature female and mature male when compared for the two hosts, through Student's t- test, statistically significant differences were obtained, except between mature female and mature male. A regression model Y = a+bx (where Y= Consumption of host eggs in three days; a= constant, x= Number of predator) has also been established to predict potentials of all predatory stages of bug against both TSSM and ERM.

Keywords: *Blaptostethus pallescens*, 8 day old nymph, mature male, mature female, two spotted spider mite, european red mite, predatory potential,% host egg mortality

1. Introduction

European Red Mite (*Panonychus ulmi* Koch) is native to Europe which was first introduced into the Pacific Northwest in the early 1900s. Since then, it spread and established throughout the apple growing countries of the world [6]. Apart from apple, it is also known to attack pear, almond, peach, apricot and walnut in temperate areas including Kashmir [18, 24, 26]. Its preference to Red Delicious cultivar of apple however [12, 26] is of much economical concern because of large scale production of 'Red delicious apple' in Kashmir. Next to European red mite, two spotted spider mite, *Tetranychus urticae* Koch also attacks apple in Kashmir, besides its common occurrence on other pome fruits, vegetables, roses and carnation [19] etc. The two mites together cause considerable effect on apple, both qualitatively and quantitatively [21]. The severity of incidence is observed during June- July each year because of their increased population build up influenced by temperature and humidity. Excessive de sapping by all the stages of mites disrupts the normal transport of food and fluid from leaves to twigs and fruits which ultimately affects the size and marketable quality of apple. During severe infestation browning or bronzing of leaves occur resulting defoliation mostly in non irrigated orchards [2, 4, 26]. Population of 30-55 European red mite / leaf has been observed to show negative influence on apple yield Hardman [12]. Decline in yield due to considerable leaf infestation has also been reported from Kashmir [26]. Besides adverse effects on apple, European red mite and two spotted spider mite have also been linked to development of allergy such as asthma and rhinitis in apple farmers [27].

Although management of European red mite and two spotted spider mite are done chemically but development of resistance in mites to chemicals including a number of insecticides and

acaricides [5, 8, 13, 23, 20, 25] and their non target effects on natural enemies of mites [14, 17, 28] pose unlimited challenges for control of mites. Presence of a wide variety of bio control agents nevertheless occurring throughout world [22, 9, 12] offer biological control as better option for the management of these mites. Barring scanty information on this aspect from Kashmir in particular [16, 21] no large scale effort has however been made so far, which indeed is need of the hour.
In view of the present scenario, anthocorid bug, *Blaptostethus pallescens* Poppius (Heteroptera: Anthocoridae) received from ICAR- National Beaureau of Agricultural insect Resources (NBAIR), Bengaluru- India was evaluated for the first time against eggs of *P. ulmi* and *T. urticae* on apple. Potential role of *B. pallescens* though well documented against *T. urticae* infesting vegetables, roses and stored grains [1, 15, 2, 3, 10] its role against European red mite and two spotted spider mite on apple is yet to be ascertained which is of utmost importance in view of noticeable damage caused by these pests to apple in Kashmir.

2. Material and Methods

The present work was conducted in the Biological Control laboratory of the Division of Entomology of Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir, (Jammu & Kashmir), India, under All India Coordinated Research Project during 2017. The two spotted spider mites, *Tetranychus urticae* Koch and European red mite, *Panonychus ulmi* (Koch) infesting High density apple orchards of Shalimar campus of the University were collected during June-July and evaluated *in vitro* against the predatory anthocorid bug, *Blaptostethus pallescens* Poppius (Heteroptera: Anthocoridae) supplied by ICAR- National Bureau of Agricultural Insect Resources, Bangalore, Karnataka, India.
Apple leaves infested with two spotted spider mites and European red mites were collected during morning hours. Fresh and succulent leaves containing eggs of mites were preferred for evaluation. This was mainly due to presence of higher egg density and ensuring survivability of host eggs for 3-4 days in laboratory condition. The leaves were examined under stereoscopic binocular and two sets of leaves were isolated. One set with only healthy eggs of two spotted spider mite and other set with only healthy eggs of European red mite. In each case, interfering host eggs, their motile stages, predatory mites *Amblysieus* sp., and their eggs as apparent from their creamy colour were removed with the help of fine needle or brush. Predatory potential of 8 days' old nymphs, mature female and mature male of anthocorid bugs was evaluated separately at 1:10, 1:15, 1:20, 1:25 and 1:30 predator: prey ratio. In order to observe the effect of density of predator i.e. 1, 2, 3, 4 and 5 individuals at varying prey density i.e. 10, 30, 60, 100 and 150 eggs. The peduncle of each apple leaf was covered with moist cotton to keep leaves fresh enabling survival of eggs at least for 4-5 days. Leaves containing 10, 30, 60, 100 and 150 eggs were kept separately on moist cotton pad on top of 3.0 cm. thick moist sponge in a ventilated rectangular plastic box (10.0x 8.0x 3.0 cm.). From the stock culture of anthocorid bugs, reared on eggs of *Corcyra cephalonica*, fixed number of predatory bugs i.e. 1,2,3,4 and 5 were introduced in corresponding boxes and kept in BOD maintained at 27±1°C, 60±5 per cent relative humidity and 14:10 photoperiod (L:D). The experiment was replicated five times for each observation of anthocorid bugs i.e. 8 days' old nymphs, mature female and mature male, both for two spotted spider mite and European red mite. An untreated control, of both the mite species was also set up along with the main experiment, in order to observe the failure of egg hatch in natural condition, for the purpose of calculating correct mortality of the host eggs under different treatments. The host eggs on leaves were exposed to anthocorid bugs for three days after which the predators were removed from all the samples, and examined on fifth day for the failure of egg hatch which indicated host egg mortality caused by feeding of bugs. Number of eggs that failed to hatch on fifth day was considered as consumed by the host and indicated its predatory potential/ three days, at a given predator: prey ratio. Rate of consumption of a single bug^{-day} for a definite predator: prey ratio was calculated by dividing total eggs consumed by the number of predator used and subsequently dividing by 3.

3. Statistical analysis

Per cent mortality of host eggs of each sample was determined by dividing number of unhatched eggs from total number of eggs offered, and multiplied by 100. Correct mortality was determined by the formula: T-C/100-C X100 (where T= per cent mortality in treated condition; C= per cent mortality in untreated control condition).In untreated control condition, an average of 11.5 and 18.0 per cent mortality of eggs of two spotted spider mite and European red mite were recorded respectively which were used to obtain corrected mortality for corresponding host. Corrected mortality was transformed to arc sin for statistical analysis through Minitab Version 11.12.

4. Results and Discussion

A single 8 day's old nymph of *B. pallescens* consumed an average of 9.2 and 7.2 eggs of two spotted spider mite and European red mite respectively during a period of three days at 1: 10 predator- prey ratio. Similarly, mature female and male consumed an average of 10.0 eggs of two spotted spider mite and 9.8 and 9.4 eggs of European red mite respectively at similar predator: prey ratio during similar period of time. Rate of consumption of host eggs by immature bug, female and male individuals increased gradually both in two spotted spider mite and European red mite in relation to increased predator prey ratio (Figs 1-3). Difference in consumption rate when compared through one way ANOVA for different predator: prey ratio was found statistically significant for 8 days old nymph (F= 1507**, d.f.= 4,16, p= < 0.001), female (F= 291.64**, d.f.= 4,16, p= < 0.001), and male (F= 4661.82**, d.f.= 4,16, p= < 0.001) for two spotted spider mite and European red mite also by 8 day's old nymph (F= 310.99**, d.f.= 4,16, p= < 0.001), female (F= 711.68**, d.f.= 4,16, p= < 0.001) and male (F= 863.29**, d.f.= 4,16, p= < 0.001) (Table 1). Rate of consumption on daily basis by 8 day's old nymph, female and male corresponded to 3.06 to 6.4, 3.33 to 8.85 and 3.33 to 7.41 eggs of TSSM (Fig. 2) and 2.4 to 4.41, 3.26 to 5.98 and 3.13 to 4.97 eggs of European red mite (Fig. 3) at 1:10 to 1:30 predator: prey ratio respectively. Mature females were observed to feed comparatively more eggs of two spotted spider mite and European red mite than 8 day's old nymphs and mature males. Rate of consumption at given predator: prey ratio when denoted in terms of% host eggs' mortality, it was found maximum at 1:10 predator- prey ratio which declined gradually in relation to predator : prey both for two spotted spider mite and European red mite (Table 2).% host egg mortality caused by 8 day's old nymph, female and male individuals declined from 90.96 to 59.32, 100.0 to 70.78 and 100.0 to 67.60 against two spotted spider mite and similarly for European red mite by 65.85 to 31.86, 97.56 to 51.05 and 92.68 to 38.69 at predator: prey ratio of 1:10 to 1:30 respectively. Difference in% host eggs' mortality when compared through one way ANOVA for different predator: prey ratio was found statistically significant for 8 days old nymph (F= 160.27**, d.f.= 4,16, p= < 0.001), mature female (F= 111.08**, d.f.= 4,16, p= < 0.001), and mature male (F= 168.48**, d.f.= 4,16, p= < 0.001) for two spotted spider mite and European red mite also by 8 day's old nymph (F= 25.28**, d.f.= 4,16, p= < 0.001), mature female (F= 50.79**, d.f.= 4,16, p= < 0.001) and mature male (F= 46.45**, d.f.= 4,16, p= < 0.001). Although potential feeding by 8 day's old, mature female and mature male was found positively correlated with prey density (Table 3), however, in terms of % host egg mortality 8 day's old bug displayed statistically identical mortality beyond 1:20 predator: prey ratio in both the hosts. Whereas mature females caused significantly different% host egg mortality at all predator: prey ratio in two spotted spider mite, males however indicated statistically similar mortality beyond 1:25 predator: prey ratio. Against European red mite, mature female predator showed statistically similar host mortality beyond 1:25 predator: prey ratio, whereas mature male predator caused statistically similar host mortality beyond 1:20 predator: prey ratio (Table 2). Performance of all the stages of predatory bugs against two spotted spider mite and European red mite when compared through Student's t- test, for% host egg mortality, statistically significant differences were obtained, except between mature female and mature male (Table 4). A regression model Y = a+bx (where Y= Consumption of host eggs in three days; a= constant, x= Number of predator) has also been established to predict potentials of all predatory stages of bug against both two spotted spider mite and European red mite (Table 3).

The anthocorid bug *B. pallescens* being an oophagus of *Corcyra cephalonica* [1] was found to cause egg mortality of two spotted spider mite and European red mite by inserting and sucking the egg contents through its long proboscis. Predatory potential of mature female of the predatory bug was higher than 8 day's old nymphs and mature male because of comparatively higher energy requirement for egg laying. Increased consumption rate in all the stages of predatory bug in response to higher predator- prey ratio was on account of host density dependent reaction, greater chances of encounter with prey and also due to food competition in relation to increased number of predators. Nevertheless, observed decline in% host egg mortality was due to relatively slower rate of egg handling by predators in relation to increase in number of prey which enabled a good proportion of host eggs escape from predatory attack. This resulted increase in egg hatching causing decline in% host egg mortality. Since food requirement in 8 day's old nymphs of *B. pallescens* was comparatively less it did not induce host egg mortality significantly beyond 1:20 predator- prey ratio both in two spotted spider mite and European red mite whereas mature female and mature male by and large displayed this ratio as 1:25. Significantly higher egg mortality induced in two spotted spider mite than European red mite by all the stages of bugs, as also revealed through Student's t- test is presumably due to thin and soft egg chorium in former than latter.

The present work however fails to make any corroborative evidences of related findings as no work has been done on this aspect so far. However almost similar rate of egg consumption by 8 day's old nymphs and adults of *B. pallescens* in case of *Corcyra cephalonica* is documented by Ballal *et al.* [2] but contrary to our findings, 8 day's old nymphs were found more potential than adults. They made similar observations against nymphs of *Tetranychus urticae* and *Aphis gosypii* however correlated% host mortality with advancing age of predatory bug (*loc. cit*.). Different observations regarding age of predator vs. host have been made by different workers. Duso & Girolami [7] reported higher feeding potential for immature stages of *Orius vicinus* on *Panonychus ulmi* whereas Zhang *et al.* [29] showed adults of *Orius minutus* as more potential on *Tetranychus viennensis* Zacher. Despite varying observations, the present work however indicates both immature as well as adults of *B. pallescens* as potential bio control agents of two spotted spider mite as well as European red mite infesting apple and hold wide scope for their future exploitation after field evaluation.

Table 1: Feeding potential of anthocorid bug on eggs of two spotted spider mite and European red mite on apple

Predator: prey	No. of Predator used	No. of prey used	No. of eggs consumed by anthocorid bugs in three days					
			Two spotted spider mite			European red mite		
			8 days old nymph	Mature female	Mature male	8 days old nymph	Mature female	Mature male
1:10	1	10	9.2 (3.03)a	10.0 (3.16)a	10.0 (3.16)a	7.2 (2.67)a	9.8 (3.12)a	9.4 (3.06)a
1:15	2	30	25.2 (5.01)b	29.6 (5.44)b	29.0 (5.38)b	20.8 (4.55)b	27.2 (5.21)b	26.2 (5.11)b
1:20	3	60	47.6 (6.89)c	57.6 (7.58)c	55.0 (7.41)c	34.0 (5.83)c	48.4 (6.95)c	43.0 (6.55)c
1:25	4	100	68.2 (8.25)d	95.4 (9.76)d	82.6 (9.08)d	49.8 (7.04)d	69.8 (8.35)d	60.6 (7.78)d
1:30	5	150	96.0 (9.79)e	132.8 (11.49)e	111.2 (10.54)e	66.2 (8.13)e	89.8 (9.46)e	74.6 (8.63)e
CD (0.01)			0.28	0.71	0 .15	0.44	0.35	0.27
CV (%)			63.92	70.88	64.43	60.34	60.20	56.02

Figures in column 4-9 represent mean of 5 observations; figures in parentheses represent √N; figures outside parentheses represent average feeding; similar superscripts in each column indicate the values statistically on par

Table 2: Per cent mortality of eggs of spider mite and European red mite caused by feeding of *B. pallescens* in 3 days

Predator : prey	No. of Predator used	No. of prey used	Per cent corrected mortality					
			Two spotted spider mite			European red mite		
			8 days old nymph	Mature female	Mature male	8 days old nymph	Mature female	Mature male
1:10	1	10	90.96 (76.46)[c]	100.00 (90.00)[e]	100.00 (90.00)[d]	65.85 (54.41)[c]	97.56 (85.91)[d]	92.68 (77.73)[d]
1:15	2	30	81.92 (65.00)[b]	96.23 (80.09)[d]	90.20 (72.15)[c]	62.60 (52.31)[c]	88.61 (70.65)[c]	84.55 (66.88)[c]
1:20	3	60	76.64 (61.13)[ab]	90.58 (72.16)[c]	83.05 (65.72)[b]	47.15 (43.36)[ab]	76.42 (61.04)[b]	65.44 (54.03)[ab]
1:25	4	100	64.06 (53.20)[a]	80.33 (63.72)[b]	72.20 (58.21)[a]	38.78 (38.46)[a]	63.17 (52.65)[a]	51.95 (46.11)[a]
1:30	5	150	59.32 (50.38)[a]	70.78 (57.28)[a]	67.60 (55.34)[a]	31.86 (34.32)[a]	51.05 (45.61)[a]	38.69 (38.44)[a]
CD (0.01)			9.36	4.48	3.87	6.29	8.08	8.45
CV (%)			17.17	12.67	14.95	29.52	23.56	31.19

Figures in column 4-9 represent mean of 5 observations; figures in parentheses represent arc sin values; figures outside parentheses represent corrected values of actual mortality; similar superscripts in each column indicate the values statistically on par

Table 3: Coefficient of correlation and Regression equation of predatory potential of anthocorid bugs at different predator : prey ratio

Anthocorid bug	Spider mite			European red mite		
	r=	R^2	Y= a+bx	r=	R^2	Y= a+bx
8 days' old	0.99**	0.98	-15.74+21.66x	0.98**	0.97	-8.5+14.7x
Mature female	0.97**	0.95	-28.34+31.14x	0.98**	0.96	-10.004+19.372x
Mature male	0.99**	0.99	-19.24+25.6x	0.99**	0.98	-6.68+16.48x

Where, r= Coefficient of correlation; R^2= Coefficient of determination; Y= Consumption of mites' eggs in three days; a= constant, x= Number of predator; **= significant at 0.01

Table 4: Comparison between performance of *B. pallescens* against eggs of two spotted spider mite, *Tetranychus urticae* and European red mite, *Panonychus ulmi*

Nymph and adults of *B. pallescens*	t- value (0.01)	d.f.	P=
8 days' old nymphs	5.97**	45	<0.001
Females	2.44**	45	0.019
Males	2.92**	46	0.0054
Female vs. male (against spider mite)	1.24 NS	47	0.22
Female vs. male (against European red mite)	1.52 NS	47	0.14

** Significant at 0.01; NS= Non significant; d.f.= degree of freedom; p= probability; t= Student's t- test

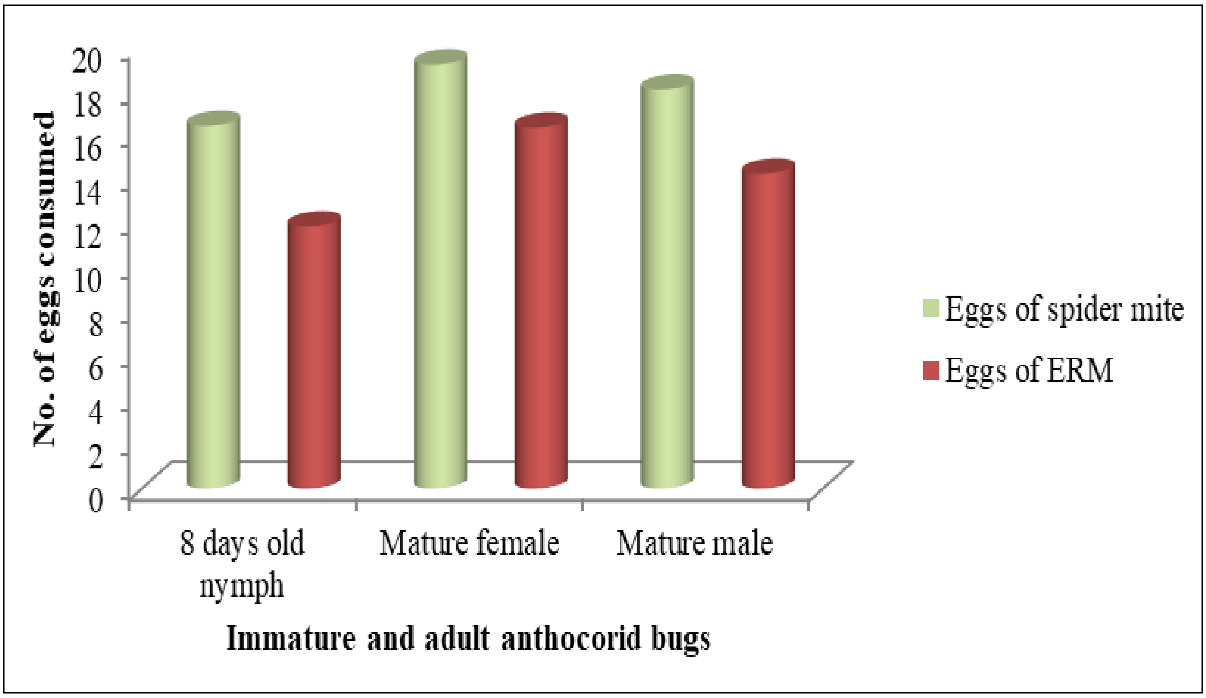

Fig 1: Average consumption of eggs of two spotted spider mite and European red mite by anthocorid bug, *Blaptostethus pallescens* in three days

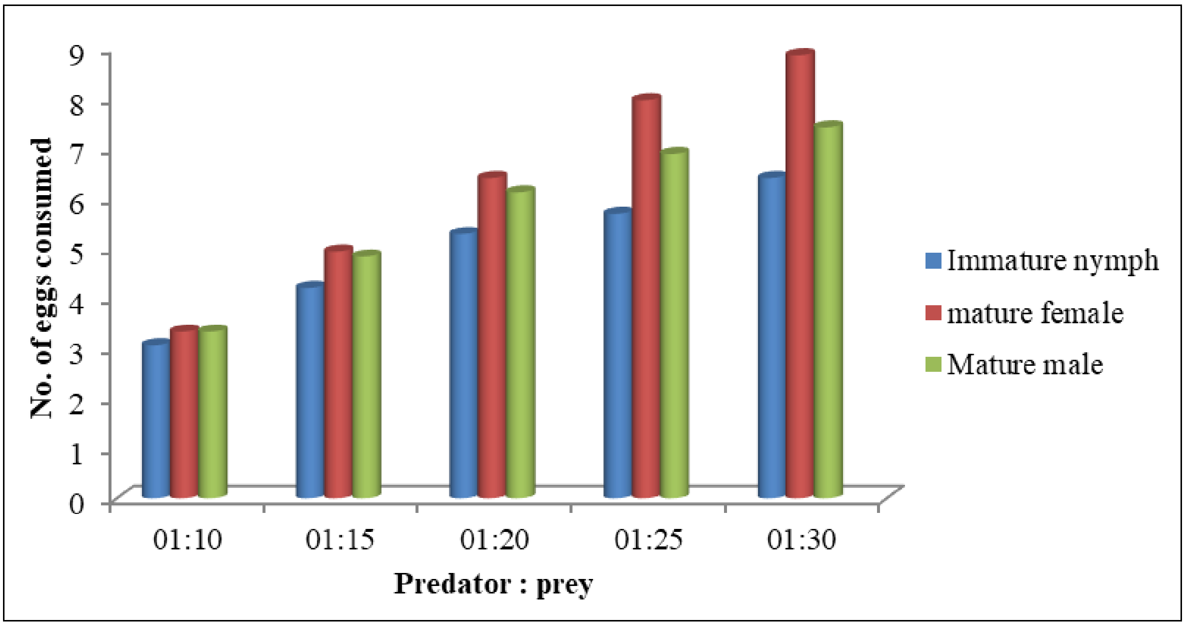

Fig 2: Rate of consumption of eggs of spider mites^{-day} by anthocorid bug, *Blaptostethus pallescens*

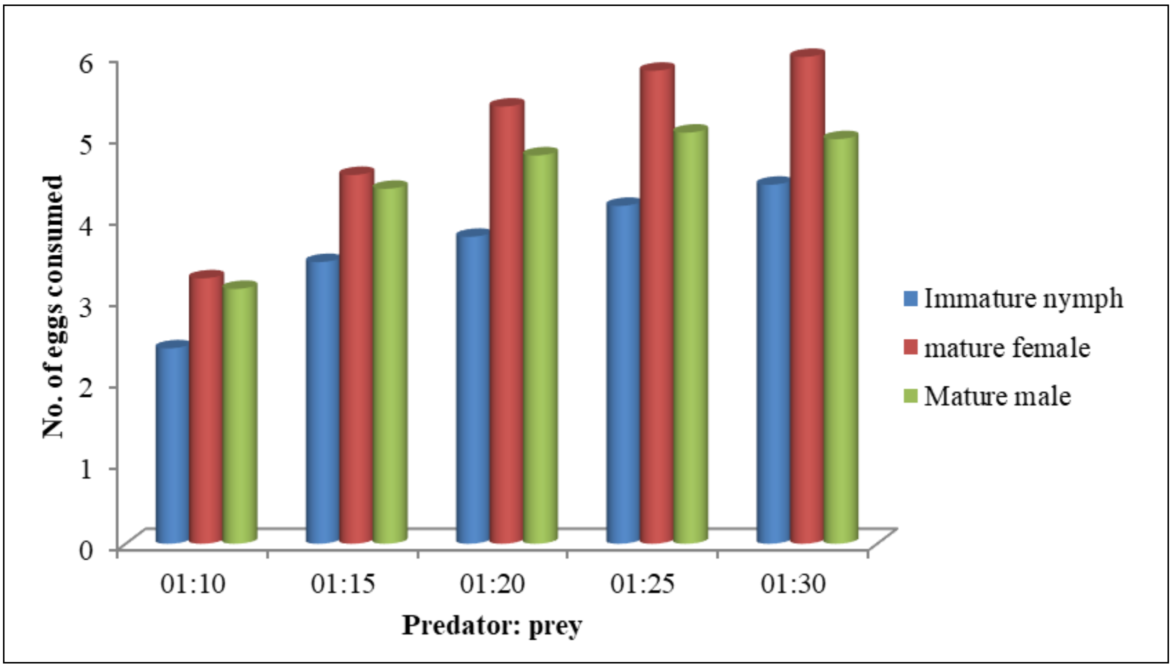

Fig 3: Rate of consumption of eggs of European red mites^{-day} by anthocorid bug, *Blaptostethus pallescens*

5. Conclusion

The above investigation regarding potential of anthocorid bug, *Blaptostethus pallescens* against two spotted spider mite and European red mite infesting apple necessitates its elaborate study in field condition against the said mites. Since the bug also feeds on nymphs of *Tetranychus urticae* [2] its dual effect both on eggs as well nymphs will result in considerable reduction in two spotted spider mites. Field trials together with assessment of bugs against nymphs of European red mite, if positive, will certainly open new vistas for organic management of mites, thereby curtailing chemical loads on apple in Kashmir.

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