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Population Dynamics of Mite (Polyphagotarsonemus Latus Bank) and Correlation with Weather Parameters on Processing Varieties of Potato

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Abstract

Pests are the major constraints in achieving full yield potential in food crops. Amongst them, mite (Polyphagotarsonemus latus Banks) causes severe damage to early planted potato crop. The field experiments were carried out at Central Potato Research Institute Campus, Modipuram during 2003-04 and 2004-05 to record the population of mite (Polyphagotarsonemus latus Banks) on processing varieties of potato and its correlation with weather parameters. Early crop of potato planted in September was affected the most whereas the main crop planted in October and spring crop planted in December did not show any mite symptom. A distinct varietal difference was observed in appearance and buildup of mite. Multiple regression equation based on temperature, relative humidity, wind velocity and sunshine period could explain mite population ranging from 98-99 per cent.

Keywords: *Polyphagotarsonemus latus, mite, potato, weather parameters, buildup.*

Introduction

Potato is a major non-cereal food crop consumed by more than a billion people in the World. Potato tuber constitutes an ideal food rich in carbohydrate, vitamins, minerals, and dietary fibres, In India, Potato can play a major role in crop diversification, rural poverty alleviation, and food and nutritional security. But potato crop is damaged by variety of insect species. Among them, mite (*Polyphagotarsonemus latus* Banks) causes major havoc to the crop, reducing both quality and quantity of tubers (Rajendran and Chandla, 1986; Raj, 2003). Yield losses due to mite in early planted potato crop in the western Gangetic plains have been reported 11 – 60 per cent (Raj,1997; Raj, 2000; Raj and Gupta, 2000; Misra *et al*., 2003). Nymphs and adults of mite suck the plant sap from apical leaves which roll and bend with consequent arrest of growth (Mahopatra, 1996).

Polyphagotarsonemus latus Banks commonly known as broad mite, tarsonemid mite, tropical mite and yellow tea mite (Raj and Saxena, 1987) has a cosmopolitan distribution. The broad mite was first described by Banks (1904) in Washington, D.C as *Tarsonemus latus* from the terminal buds of mango in a greenhouse. Mites are not insects as they have four pairs of legs and belong to the class Arachnida. They are extremely minute with variable colours. Raj (2003) reported that damaging stages of mite are adults and nymphs.

This has been reported throughout the tropics (Jeppson *et al.,* 1975), United Kingdom (Bassett, 1981), Spain (Abad-Martin, 1983), California (Badii and McMurty, 1984), Australia (Gough and Qayyum, 1987), Cuba (Martinez and Mendez, 1994), Florida (Pena and Baranowski, 1989), France (Trottin-Caudal *et al.,* 1989), South Africa (Fourie, 1989), Pakistan (Zia and Chaudhary, 1994), Taiwan (Liu *et al.,* 1991), China (Zhi, 2002), Korea (Lee *et al.,* 1992), Madeira Island (Carmona, 1992), Turky (Bulut and Gocmen, 2000). The activities of this pest have also been reported from Japan (Mizobe and Tamura, 2004), Indonesia (Ihsan and Yusof, 2004), Thailand (Uraisakul, 2003), Brazil (Vieira and Chiavegato, 1998; Vieira, 2001), Sri Lanka (Dharmasena, 1998), Italy (Siviero *et al.,* 2002), Mexico (de-Coss-Romero and Pena, 1998), West Africa (Ochou *et al.,* 1998), USA (Fan and Petitt, 1998), Vietnam (Duong *et al.,*1998), Argentina (Costilla, 1980), Hungary (Kerenyine-Nemestothy *et al.*,1981), Yugoslavia (Petanovic, 1998) and Poland (Labanowski and Soika, 2002). This pest is also distributed in several parts of India (Sudharma and Nair, 1999). Raj and Saxena (1987) stated that the broad mite was a serious pest of potato crop in the plateau region of Maharashtra. Whereas Mohaptra (1996) opined that the yellow mite, *Polyphagotarsonemus latus* a major pest of tossa jute, is widely distributed in the jute growing regions in north east India. According to Misra *et al.* (2003) mite is a serious pest of potato in western Gangetic plains, and is widely distributed in Punjab, Gwalior (MP), Kangra valley (HP), Karnataka and Maharashtra.

This pest has been found infesting on a variety of economic crops like chilli (Sudharama and Nair, 1999), jute (Khodawe and Taley, 1978), cotton (Vieira and Chiavegato, 1998), tea (Fourie, 1989), coffee, castor (Hill, 1983), rubber, tobacco (Jeppson *et al.,* 1994), pepper (Amin, 1979), sesame (Mahto, 1987), fruit trees like citrus (Vieira, 2001), mango (Ochoa *et al.,* 1990), papaya (Aubert *et al.,* 1981), pear, guava, datura (Liu *et al.,* 1991), grapes (Nemaura *et al.,* 2001), mulberry (Zhang *et al.,* 1990), vegetables like potato (Raj and Saxena, 1987; Masoud Arbabi *et al.,* 2001; Raj, 2003), tomato (Tunc and Gocmen, 1995), cucumber (Grinberg *et al.,* 2004), brinjal (Gui *et al.,* 2001), French bean (Puttaswamy-Reddy, 1981) and ornamental plants (Bose and Yadav, 1989).

Karuppuchamy and Mohanasundaram (1987) while working on chilli in Tamil Nadu observed that the population of mites steadily increased from January onwards. The population reached its maximum during February and started declining thereafter. In western Uttar Pradesh, the population of mite was highest on potato crop planted during middle of September whereas the crop planted during middle of November remained free from mite attack (Raj, 1999). The peak period of activity of mite in western Gangetic plains was reported from October - December (Raj, 2003). Misra *et al.*(2003) also reported that the mite generally appeared in the 3rd week of October on potato crops planted at around 15th September in western Gangetic plains and was hyperactive during November and early December. However, it caused little damage on main crop (planted after 15th October) and spring crop (planted during the last week of December). In penisular India, the mite generally appeared in early August on kharif crop, and was active during August - September. In Maharashtra and Karnataka, it attacked on rabi potato crop and was generally seen towards crop maturity i.e. during February - March.

The incidence of mite was found to be influenced by abiotic factors (Ahuja, 2000). The studies carried out by Jeppson *et al.* (1994) revealed that optimum environmental conditions for various species of mites involved a combination of warm temperature, high humidity and low light intensity. Chatterji *et al.* (1978) reported that higher temperature both air and soil was congenial for the proliferation of mite on jute. The adult stage of tarsonemus mites was observed surviving through prolonged exposure to freezing temperatures, but seemed sensitive to temperature above 35^{o} C (Jeppson *et al.*, 1994). On chilli also mite population was favoured by higher temperature (Lingeri *et al.*, 1998). Ahuja (2000) while working on sesame in Rajasthan observed that maximum temperatures showed negative and significant correlation with the population of mite. But correlation between minimum temperature and the number of mite was non-significant. Peak population of mite (28.7 per leaf) was recorded during mid September in 1994 when the maximum and minimum temperature ranged from 30.1 - 33.0° C and 22.6 - 25.2° C, respectively. Misra *et al.* (2003) reported that moderate temperatures were quite conducive for the multiplication of mite. Besides temperature, relative humidity also influences the mite population. Karuppuchamy and Mohanasundaram (1987) noted that the mite incidence increased after continuous humid and cloudy weather during the second fortnight of January and was severe during 1st and 2nd fortnight of February. Relative humidity was positively correlated with the incidence of mite on potato in Orissa (Sontakke *et al*., 1989). Similar results were obtained by Ahuja (2000). Misra *et al.* (2003) also stated that high humidity has been quite conductive for the proliferation of mite while Chatterji *et al.* (1978) reported that low afternoon humidity is favorable for the multiplication of mite on jute. Just opposite to this, Lingeri *et al.* (1998) established that lower humidity was positively associated with population of mite. Effect of rainfall followed the trend of relative humidity (Ghosh, 1983).

Keeping in view the economic growth, changing trade scenario following liberalization, rising incomes, changing food habits and life styles are likely to increase the demand of processed potato products, the present study was therefore taken up to find out the build up of mite on processing varieties of potato. The scenario of insect pests also keeps on changing due to changing weather conditions, so the correlation with weather parameters was also studied.

Materials and Methods

Studies were undertaken to record the population of mite (*Polyphagotarsonemus latus* Banks) on processing varieties in early, main and spring crop season of potato. The experiments were conducted at Central Potato Research Institute Campus, Modipuram during 2003-04 and 2004-05. Five processing varieties *viz.*, Kufri Chipsona-1, Kufri Chipsona-2, Kufri Jyoti, Kufri Lauvkar, Kufri Surya and along with one table potato variety Kufri Anand were planted in plots of size 3.6 m x 2.4 m with row to row and plant to plant spacing of 60 cm and 20 cm, respectively in randomized block design with four replications in early (September-December), main (October-February) and spring (December-April) season. All recommended agronomical practices were followed from time to time to raise the crop successfully.

The population of nymphs and adults of mite was counted at five days interval on six test varieties on five randomly selected plants in each replication in early, main and spring crop season. One central leaflet of one leaf each from the top, middle and bottom of a plant was plucked, and observations were recorded on the population of mite visually with a hand lens 10X (Mohapatra, 1996). The observations were continued till maturity of the crop

The weather conditions are known to have a direct influence on the appearance and population buildup of the pests. Keeping this in view, data were collected daily from first week of October up to end of March on five weather parameters i.e. maximum and minimum temperatures (^{o}C) at 2 pm and 8 am, per cent relative humidity at 8 am and 2 pm, wind velocity (km / hr) at 8 am and at 2 pm and sunshine hours (from sun rise to sun set) The information collected on above weather parameters was subsequently utilized to correlate with the status of the pest population on test varieties during early crop season for two consecutive years 2003-04 and 2004-05.

The statistical analysis of experimental data was performed using computer software programme 'IRRISTAT'(http://www.biometrics@IRRI.cgiar.org) for randomized block design. Correlation and Regression equation was developed for weather parameters with the help of Microsoft Excel Software.

Results and Discussion

Population dynamics

Data on population buildup of mite in early planted crop during 2003 revealed that its population increased gradually from 5th November onwards and reaching at the peak at different times on different varieties. For example, highest population of mite was recorded on 25th November on Kufri Chipsona-2 (771.8 mites per 15 leaflets), Kufri Lauvkar (539.8 mites per 15 leaflets), Kufri Surya (817.8 mites per 15 leaflets) and Kufri Anand (736.5 mites per 15 leaflets). Whereas peak mite population on Kufri Chipsona-1 (429.3 mites per 15 leaflets) and Kufri Jyoti (790.5 mites per 15 leaflets) was recorded on 15th November and 30th November, respectively (**Table 1**). Highest mite population was recorded on Kufri Surya (817.8 mites per 15 leaflets) followed by Kufri Jyoti (790.5 mites per 15 leaflets), Kufri Chipsona-2 (771.8 mites per 15 leaflets), Kufri Anand (736.5 mites per 15 leaflets), Kufri Lauvkar (539.8 mites per 15 leaflets) and Kufri Chipsona-1 (429.3 mites per 15 leaflets). However, mean population buildup did not follow the same trend. Highest mean population of mites was recorded on variety Kufri Anand (452.1 mites per 15 leaflets) followed by Kufri Surya (410.9 mites per 15 leaflets) and Kufri Jyoti (400.7 mites per 15 leaflets). The population buildup on remaining three varieties was almost similar.

During 2004 overall population buildup of mites was comparatively less as compared to 2003 (**Table 3**). Like 2003, mite population also increased gradually from 5th November and peaking between 10th November to 10th December depending on the varieties (**Table 2**). Highest peak population of mites was supported by variety Kufri Surya in both the years. Similarly, Kufri Jyoti was next in order in both the years. Ranking of Kufri Anand with regard to highest mite population also remained unchanged. But, Kufri Chipsona-1, Kufri Chipsona-2 and Kufri Lauvkar did not follow any definite trend (**Table 3**). Mean

Table 1. Population buildup of mite (*Polyphagotarsonemus latus* Banks) in early potato crop during 2003

Variety	Number of mite per 15 leaflets								Mean
	5 NOV	10 NOV	15 NOV	20 NOV	25 NOV	30 NOV	5 DEC	10 DEC	
Kufri Chipsona-1	59.50 (7.76)	192.50 (13.82)	429.25 20.56	413.75 (20.26)	239.75 (15.49)	303.00 (17.37)	183.00 (13.50)	47.00 (6.74)	233.47 (14.44)
Kufri Chipsona-2	52.75 (7.27)	116.00 (10.72)	330.25 18.18	215.75 (14.69)	771.75 (27.75)	574.75 (23.98)	233.00 (15.22)	55.75 (7.48)	293.75 (15.66)
Kufri Jyoti	79.25 (8.94)	124.25 (11.14)	292.25 17.03	537.00 (23.15)	532.50 (23.06)	790.50 (28.07)	602.25 (24.54)	247.50 (15.70)	400.69 (18.95)
Kufri Lauvkar	17.25 (4.24)	100.50 (10.03)	161.00 12.60	289.75 (17.00)	539.75 (23.23)	313.50 (17.72)	306.75 (17.53)	272.00 (16.48)	250.06 (14.85)
Kufri Surya	75.50 (8.74)	97.75 (9.92)	388.25 19.66	367.75 (19.15)	817.75 (28.60)	666.50 (25.81)	500.75 (22.36)	373.54 (19.28)	410.97 (19.19)
Kufri Anand	38.00 (6.20)	102.75 (10.15)	398.25 19.85	635.75 (25.14)	736.50 (27.09)	531.75 (23.02)	555.75 (23.53)	618.25 (24.85)	452.13 (19.98)
S.Em. ±	(0.34)	(0.64)	1.05	(0.87)	(0.78)	(0.74)	(0.56)	(0.59)	(0.20)
CD (0.05)	(1.02)**	(1.92)**	(3.19)**	(2.64)**	(2.36)**	(2.24)**	(1.70)**	(1.78)**	(0.62)**

Figures in parenthesis are transformed value = √ x + 1, ** Significant at 1 %

	Variety	Date	Variety x Date
S.Em. ±	0.27	(0.31)	(0.77)
CD(0.05)	(0.76)**	(0.88) **	(2.16) **

Table 2. Population buildup of mite (Polyphagotarsonemus latus Banks) in early potato crop during 2004

Variety	Number of mite per 15 leaflets								Mean
	5 NOV	10 NOV	15 NOV	20 NOV	25 NOV	30 NOV	5 DEC	10 DEC	
Kufri Chipsona-1	25.50 (5.11)	73.75 (8.61)	168.75 12.98	109.75 (10.47)	151.25 (12.30)	130.00 (11.42)	174.00 (13.13)	288.50 (16.95)	140.19 (11.37)
Kufri Chipsona-2	80.75 (9.00)	141.75 (11.89)	96.75 9.86	139.00 (11.77)	122.50 (11.05)	57.50 (7.59)	104.00 (10.20)	172.25 (13.05)	114.31 (10.55)
Kufri Jyoti	70.50 (8.36)	292.50 (15.22)	194.75 13.95	187.75 (13.66)	227.50 (15.03)	139.25 (11.67)	175.00 (13.17)	152.75 (12.35)	180.00 (12.93)
Kufri Lauvkar	13.00 (3.70)	55.25 (7.42)	54.25 7.38	69.25 (8.32)	115.50 (10.78)	47.75 (6.94)	66.25 (8.04)	57.25 (7.54)	59.81 (7.52)
Kufri Surya	33.50 (5.84)	124.50 (11.17)	126.00 11.22	175.75 (13.26)	290.00 (17.01)	326.75 (18.09)	200.50 (14.05)	204.75 (14.32)	185.22 (13.12)
Kufri Anand	24.00 (4.96)	57.75 (7.63)	132.50 11.50	156.75 (12.50)	185.00 (13.62)	200.00 (14.15)	150.00 (12.17)	187.25 (13.59)	136.66 (11.27)
S.Em. ±	(0.43)	(1.78)	0.59	(0.53)	(0.64)	(0.59)	(0.84)	(0.78)	(0.26)
CD (0.05)	(1.30)**	(5.38)*	(1.80)**	(1.60)**	(1.95)**	(1.79)**	(2.55)**	(2.35)**	(0.80)**

Figures in parenthesis are transformed value = √ x + 1, ** Significant at 1 %, * Significant at 5 %

	Variety	Date	Variety x Date
S.Em. ±	0.32	(0.37)	(0.92)
CD (0.05)	(0.91)**	(1.05) **	(2.59)**

population buildup of mites during 2004 was altogether different as compared to 2003. For example, highest population during 2004 was recorded on Kufri Surya whereas during 2003 it was recorded on Kufri Anand. Similarly, the least population of mite during 2004 was recorded on Kufri Lauvkar as against Kufri Chipsona-1 during 2003. On overall basis highest mean population buildup was recorded on variety Kufri Surya (298.1 mites per 15 leaflets) followed by Kufri Anand (294.4 mites per 15 leaflets), Kufri Jyoti (290.3 mites per 15 leaflets), Kufri Chipsona-2 (204.0 mites per 15 leaflets), Kufri Chipsona-1 (186.8 mites per 15 leaflets) and Kufri Lauvkar (154.9 mites per 15 leaflets) (**Table 3**).

Table 3. Mean population buildup of mite (*Polyphagotarsonemus latus* Banks) on potato in early crop season 2003 and 2004

Variety	Number of mite per 15 leaflets		Mean
	2003	2004	
Kufri Chipsona-1	233.47	140.19	186.83
Kufri Chipsona-2	293.75	114.31	204.03
Kufri Jyoti	400.69	180.00	290.34
Kufri Lauvkar	250.06	59.81	154.94
Kufri Surya	410.97	185.22	298.10
Kufri Anand	452.13	136.66	294.39

In other crop seasons *viz*., main and spring crop seasons mite was not observed right from the time of plant emergence to the maturity of crop of all the test varieties indicating that these two seasons did not favour the occurrence of mite. Potato kharif crop in southern India and early planted rabi crop in western Indo-Gangatic plains have been reported to be attacked by mite (Karuppuchamy and Mohanasundaram, 1987; Raj, 1999; Raj, 2000; Misra *et al.,* 2003). Similar observations have been made in the present study where early crop of potato planted in September was affected the most whereas the main crop planted in October and spring crop planted in December did not show any mite symptom.

Correlation between Weather Parameters and Population Buildup of Mite

Studies on correlation between weather parameters and mite population buildup revealed that both maximum and minimum temperatures were negatively correlated with mite population, whereas on the other hand, relative humidity and wind velocity were positively correlated in both the years of study (**Table 4**). Relationship of population with sunshine period did not follow any definite trend. To quantify the role of weather parameters in mite

Table 4. Correlation coefficient (r) values and Multiple regression equation between meteorological parameters and population dynamics of mite (*Polyphagotarsonemus latus* Banks) on potato in early crop during 2003 and 2004

Year	Correlation coefficient (r)						Multiple Regression equation	Multiple Regression coefficient *(R)*	R^2
	Temperature (°C)		Relative Humidity (%)		Wind Velocity	Sun Shine			
	Max (X_1)	Min (X_2)	Morning (X_3)	Evening (X_4)	(K / hr) (X_5)	(min) (X_6)			
2003	- 0.634	- 0.849**	+ 0.122	+ 0.189	+ 0.559	+ 0.241	$Y = -6713.13 + 165.87 X_1 - 176.68 X_2 + 7.55 X_3 + 72.04 X_4 - 85.44 X_5 + 2.13 X_6$	0.987	0.975
2004	- 0.635	- 0.189	+ 0.779**	+ 0.708*	+ 0.255	- 0.678	$Y = -4505.22 + 28.91 X_1 + 3.02 X_2 + 23.89 X_3 + 24.81 X_4 - 41.24 X_5 + 2.21 X_6$	0.999	0.997
Mean	- 0.629	- 0.599	+ 0.845**	+ 0.780*	+ 0.647	- 0.829**	$Y = 8193.50 + 37.221 X_1 - 127.68 X_2 - 32.91 X_3 - 58.05 X_4 + 166.46 X_5 - 6.75 X_6$	0.994	0.988

** Significant at 1 %   * Significant at 5 %

population buildup, multiple regression equations were developed which revealed that the mite population can be predicted to a satisfaction of more than 98 per cent with the help of maximum and minimum temperatures, relative humidity, wind velocity and sunshine period (**Table 4**).

Higher temperatures have been reported to favour mite development (Jeppson *et al.,* 1994; Lingeri *et al.,* 1998; Ahuja, 2000). Ahuja (2000) reported a significant negative correlation between mite population and maximum temperature. He further reported that mite activity was high when the maximum and minimum temperatures ranged from 30.1 – 33 °C and 22.6 – 25.2 °C, respectively. In the present study also negative correlation was found and similar relationship was observed in both the years of study with respect to maximum as well as minimum temperatures. In the present study the optimum maximum temperature range varied from 24.6 – 32.3 °C. High relative humidity has been reported to be associated with high mite population (Karuppuchamy and Mohanasundaram, 1987 and Misra *et al.,* 2003), although low humidity levels have also been reported in favour of mite development (Lingeri *et al*., 1998). Sontakke *et al.* (1989) and Ahuja (2000) reported positive relationship between relative humidity and mite population. Similar results were obtained in the present study, although extent of relationship varied from year to year. It was low in 2003 (r = 0.122) whereas it was significantly high in the year 2004 (r = 0.779). Wind velocity and mite population were found positively correlated whereas sunshine period was positively correlated in the year 2003 but reverse was true in the year 2004. No information is available in literature on relationship between wind velocity and mite population and sunshine period and mite population. While comparing the sunshine profile of two years (2003 and 2004) it was revealed that between 15th November and 20th November the sunshine period was severely reduced due to cloudy days during 2003 whereas in the year 2004 no such reduction was recorded up to 20th November. This could be one of the reasons for variation in population buildup in the two years of study.

Multiple regression equation based on temperature (maximum and minimum), relative humidity (morning and evening), wind velocity and sunshine period, could explain 98 – 99 per cent of the variation in the mite population buildup during the two years of study. Such regression models have not been worked out by any of the workers so far, and therefore these are the new dimensions to study the mite population dynamics in the country.

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