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Seasonal incidence of melon thrips (*Thrips palmi* Karny) and watermelon bud necrosis virus (WBNV) in watermelon (*Citrullus lanatus*)

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Abstract
Watermelon bud necrosis virus (Buniyaviridae; Tospovirus) is the major production constrains in watermelon and it is transmitted by *Thrips palmi* Karny. A study was conducted during summer 2019 in Tamil Nadu, India to understand the influence of weather parameters (temperature, RH and rainfall) on the vector population and the disease incidence. The result showed thrips population ranged from 0.5 to 18.1/plant and WBNV incidence ranged from 0 to 60 per cent. The thrips incidence started at 10 DAS and reached maximum on 30 DAS likewise the symptomatic expression of disease incidence started at 15 DAS and attained maximum at 70 DAS. The maximum incidence of thrips population was correlated with the temperature of 35.6ºC and 58% of RH. The maximum incidence of WBNV was correlated with the temperature of 35.7 C and 65% RH. Temperature was positively correlated with WBNV incidence (r = 0.7) and thrips population/plant. Relative humidity (r=-0.5) and rainfall (r=-0.5) were negatively correlated with the incidences of thrips population and positively correlated with WBNV incidence (r=0.34 and 0.41) in watermelon.

Keywords: *Thrips palmi*, Watermelon, WBNV, Tospovirus *Watermelon bud necrosis virus*, weather parameters

Introduction
The melon thrips *Thrips palmi* Karny (Family: Thripidae; Order: Thysanoptera) is a serious pest of fruits, vegetables, fibre crops, legumes and flower plants in tropical countries [2]. It act as a direct pest [1] as well as indirect pest [9] by transmitting tospoviruses [16, 22, 23]. Tospoviruses are transmitted by the thrips in a persistent circulative and propagative manner [4, 21]. The first instar larvae can acquire the virus efficiently by feeding on the infected plants and the virus can be retained in its larval and pupal molts and transmitted by the adults after the latent period [10]. Adults can only transfer the virus when the larval thrips acquired the virus.
Watermelon bud necrosis virus (Buniyaviridae; Tospovirus) in watermelon [9] is an emerging viral disease in India which causes 40 to 100 per cent yield loss [22]. The infected plant shows leaf mottling, yellowing, necrotic streaks on veins, necrotic spot on leaves with yellowing, shortened internodes, Stunded growth, dieback of buds, no flower or fruit formation [9]. Changes in the weather conditions especially temperature, RH and rainfall drastically influence the survival and multiplication of sucking pests [24], specifically thrips [5, 15] which would inturn influence the epidemiology of the vector transmitted diseases. With this view, a study was conducted to understand the influence of weather parameters on the population of thrips and the incidence of WBNV in watermelon.

Materials and Methods
Observations were taken during summer-2019 at the Department of Vegetables, TNAU Coimbatore. Fifteen randomly selected plants in the field were observed for the number of adult / nymphal thrips present in the plant where each plant was gently tapped against black clothed foam sheet. A 10 x hand lens was used for the observation at weekly interval starting from 10 days after sowing**.** Simulteneously, the occurrence of WBNV was observed visually and the percent disease incidence was worked out [18].

$$Percent\ disease\ incidence = \frac{No.of\ plants\ infected}{Total\ no.of\ plants\ observed} \times 100$$

Both the thrips and WBNV incidences were correlated with weather parameters *viz*., maximum temperature (T_{max}), minimum temperature (T_{min}), relative humidity (RH) and rainfall obtained from the automatic weather station of Tamil Nadu Agricultural University, Coimbatore**.** Correlation and regression analysis of weather parameters with pest and virus incidence were carried out with the help of SPSS statistics [7].

Results

The incidence of thrips population on watermelon starts to occur from 9th standard week which was 10 days after sowing (0.5 thrips/ plant). Maximum population of thrips obtained from 12th standard week (18.1thrips/ plant). At maximum population of thrips (no/plant), the temperature was 35.6ºC, RH was 58% and precipitation was absent.

When thrips population reached maximum, the incidence of WBNV got increased slightly (33%). After attaining the maximum population, the population density of thrips decreased, but the incidence of WBNV increased gradually and reached a maximum level of 60 percent at 18th standard week. At maximum incidence of WBNV, temperature was increased to the maximum of 36ºC ad relative humidity ranged from 65 to 67 percent. Occurrence of precipitation was recorded as 23.6mm at 18th standard week (Table. 1).

The statistical analysis showed that the temperature (r=0.2) was positively correlated with the incidence of *Thrips palmi* and relative humidity(r=-0.5) and rainfall (r=-0.5) were negatively correlated (Table.2). Incidence of WBNV was positively correlated with temperature (r=0.7), relative humidity (r=0.3) and rainfall (r=0.4) (Table.2). The percent incidence of WBNV ranged from 0 to 60 per cent (Table. 1). According to the linear regression equation, the incidence of *T. palmi* (R^2 =0.9) and WBNV (R^2=0.7) was influenced by the weather parameters up to 86.6 and 70 percent respectively (Table. 3).

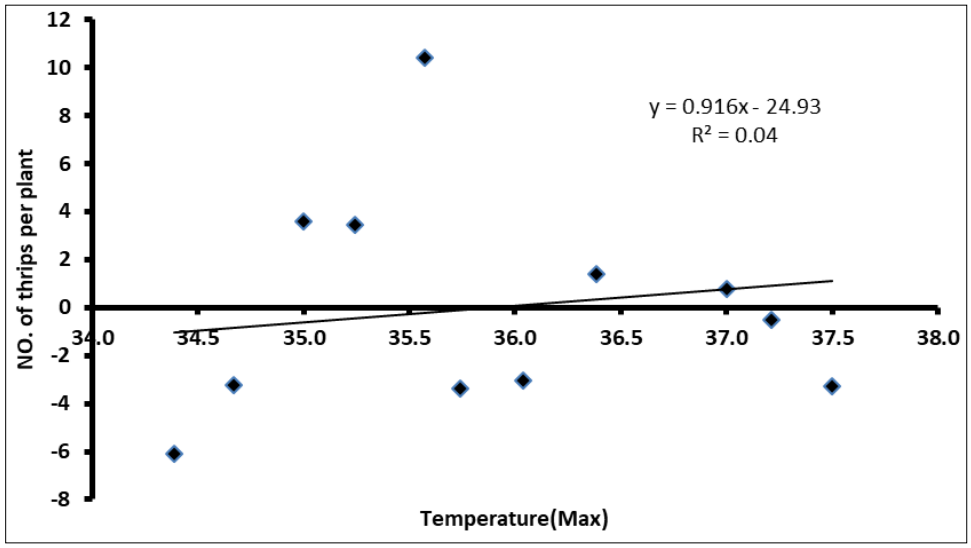

Fig 1: Influence of Temperature (Max) on population density of *Thrips palmi* on watermelon

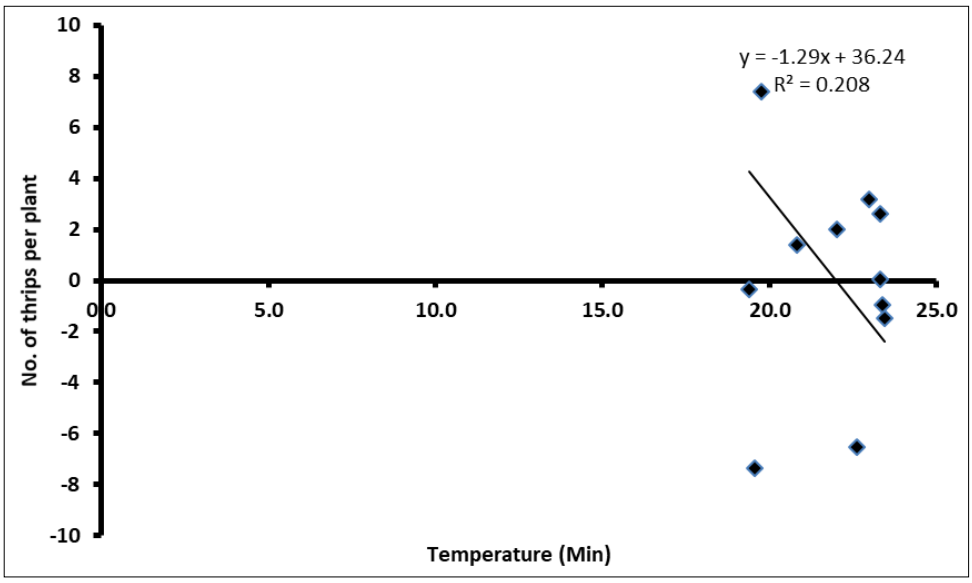

Fig 2: Influence of Temperature (Min) on population density of *Thrips palmi* on watermelon

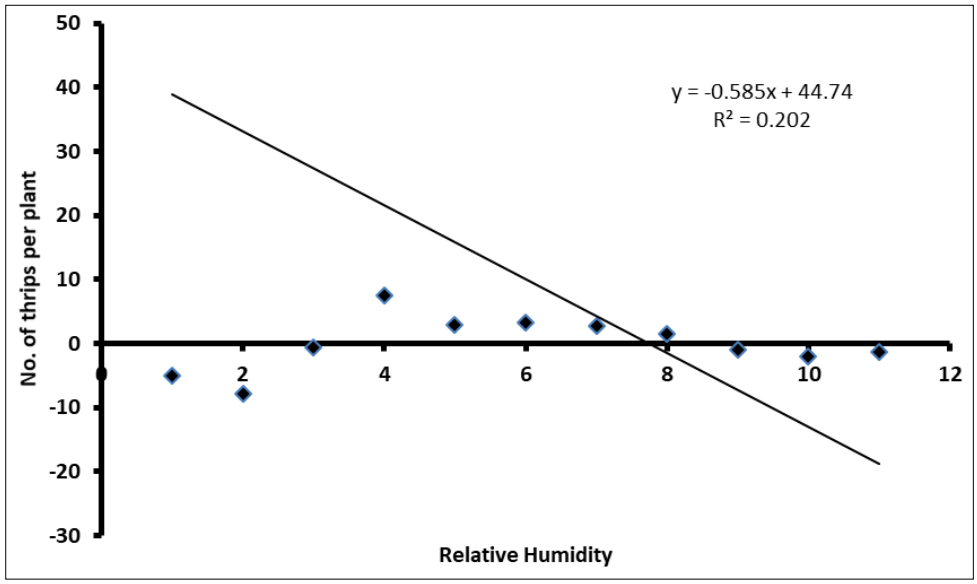

Fig 3: Influence of Relative Humidity on population density of *Thrips palmi* on watermelon

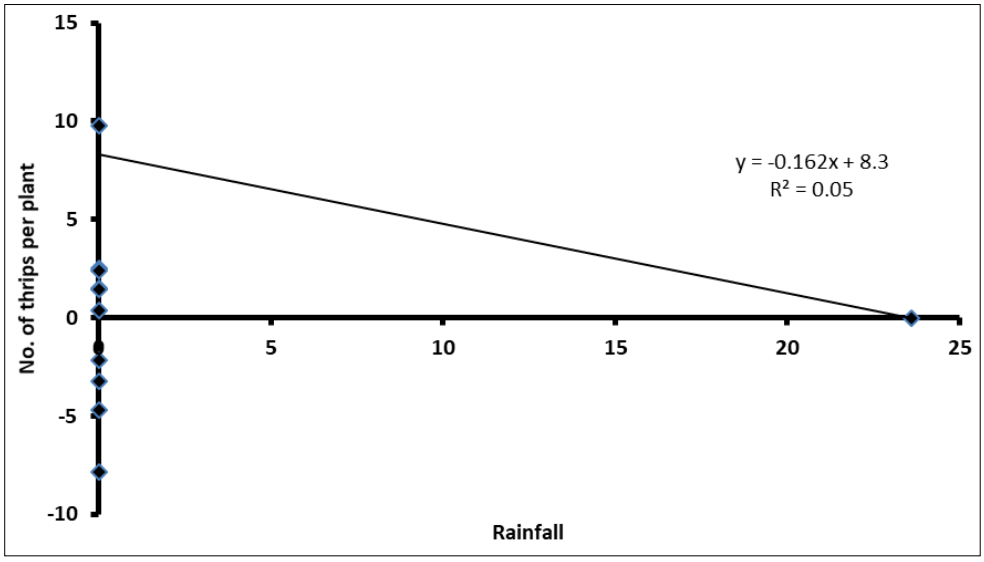

Fig 4: Influence of Rainfall on population density of *Thrips palmi* on watermelon

Table 1: Seasonal incidence of *Thrips palmi* in watermelon and cucumber and incidence of WBNV in watermelon

SMW	Temperature (Max) ºC	Temperature (Min) ºC	RH (%)	Rainfall (mm)	Mean number of thrips per plant	% Incidence of WBNV
9	34.4	22.6	67	0	0.5	0
10	34.7	19.5	57	0	3.6	13
11	35.2	19.4	57	0	10.8	26
12	35.6	19.8	58	0	18.1	33
13	35.0	20.8	63	0	10.7	33
14	36.4	22.0	65	0	9.8	40
15	37.0	23.0	64	0	9.7	40
16	37.2	23.3	64	0	8.7	46
17	37.5	23.3	64	0	6.1	53
18	35.7	23.4	65	23.6	4.5	60
19	36.0	23.4	66	0	5.1	60

SMW – Standard Meteorological Week

Table 2: Weather correlation with *Thrips palmi* and WBNV incidences in Watermelon.

S. No	Factors	Temperature (ºC)		Rainfall (mm)	Relative Humidity (%)
		Maximum	Minimum		
1.	*Thrips palmi*	0.2	-0.5	-0.5	-0.5
2.	WBNV	0.7	0.6	0.3	0.4

Total number of observations = 15, t_{tab} = 2.262

Table 3: Linear Regression Equation for incidence of *Thrips palmi* and WBNV with weather parameters.

Particulars	Regression Equation	R^2 Value
No. of thrips/ plant	$Y = 14.306\ X_1 - 2.247\ X_2 + 0.874\ X_3 + 1.274\ X_4 + 0.00\ X_5 + 14.553 - 485.06$	0.9
WBNV incidence	$Y = 5.454\ X_1 - 6.173 X_2 + 1.347\ X_3 + 0.180\ X_4 + 0.000\ X_5 + 3.944 - 137.617$	0.7

Y=Incidence of thrips (Number per top bud leaves)/ Incidence of WBNV; X1 = Maximum temperature (°C); X2 = Minimum temperature (°C); X3 =RH morning (%); X4 =RH evening (%); X5 = Rainfall (mm).

Discussion

In the initial stage of the crop the population of thrips are more and the disease incidence is less where the noninfected plant would have attracted the viruliferous thrips as evidenced from earlier works on aphid-PLRV-potato [17, 20] and whitefly–MYMV-Mungbean pathosystems [19] where the vector preference is influenced by the virus in order to spread the disease and also the preference varies with stage of inoculation [18]. This might be the reason for increased population at earlier stage. The increase in temperature has also correlated with increased number of thrips - per plant and the incidence of WBNV which confirm the earlier report who showed that the major factors affecting the population dynamics of thrips are temperature and rainfall [3, 14]. Both factors influence the multiplication rate of the thrips population with negative correlation [6, 13]. By affecting the growth rate of thrips, temperature has a direct effect on the population [11, 12, 26]. Increased activity of thrips was found during increased temperature [8, 25, 26]. Incidence of thrips was higher during dry weather condition [12]. The incidence of WBNV was greater at the later stage of the crop this may be due to time interval between virus inoculation and disease expression. The incidence of WBNV has linear progression with increased temperature.

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