EFFECT OF METEOROLOGICAL FACTORS OVER THE INCIDENCE OF SUCKING PESTS IN *RABI* CASTOR, *RICINUS COMMUNIS L.*

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Abstract: Field experiments were conducted to study the effect of meteorological factors over the incidence of sucking pests *viz.*, leafhopper (*Empoasca flavescens* F.) and thrips (*Retithrips syriacus* Mayet) with eight genotypes having different morphological characters. The incidence of leafhopper was low during 43rd standard week and their intensity increased gradually till the 7th standard week. Incidence of thrips was low during 52nd standard week, and their intensity increased gradually till the 12th standard week. Among the eight genotypes DCH-177 and DPC-9 were more preferred by the pests, while GCH-4 and PCH-111 was least preferred. The genotypes with zero and single bloom were susceptible to leafhopper and thrips. None of the genotypes with double and triple bloom character recorded high infestation of leafhopper and thrips. The castor genotypes reacted differently to similar leafhopper infestations showing different foliage drying symptoms. Correlation co-efficient studies revealed significant negative influence of all the weather parameters except evaporation and maximum temperature. Minimum temperature did not show significant influence on leafhopper incidence in all the genotypes except in PCH-111. Weather based pest forewarning models developed for eight genotypes of castor for leafhopper explained the variation in hopper population by 33 to 52 per cent and thrips population by 34 to 57 per cent with linear models as compared to 38 to 71 per cent and 44 to 68 per cent obtained with non linear models. Prediction models developed indicated that non linear regression equations predicted the pest incidence with higher precision than linear regression.

Introduction: Castor (*Ricinus communis* L.) is an industrially important non-edible oilseed crop widely cultivated in the arid and semi arid regions of the world (Govaerts *et al.,* 2000). It is attacked by more than 107 insect pests. Defoliators cause substantial loss to the rainfed castor, while irrigated castor is more prone to sucking pests (Vijay singh *et al.,* 1993). Among the sucking pests, the leafhopper (*Empoasca flavescens* F.) is the most important one which could cause hopper burn followed by thrips (*Retithrips syriacus* Mayet). Whitefly (*Trialeurodes ricini* Misra) infests the castor during the hotter months (April-May), but the crop does not express damage symptoms unlike leaf hoppers and thrips. The leafhopper is more prevalent in Southern India and its peak infestation occurs during September to December. The activity and multiplication of the pest is enhanced in the cold and humid weather of the winter season (Lakshminarayana and Raoof, 2005; AICRP, 2005). The nymphs and adults suck sap from leaves and characteristic symptoms of hopper burn appear owing to the toxigenic nature of leafhopper (Jayaraj, 1967), while thrips cause distortion and characteristic wrinkling of leaves. Among the different morphological attributes, bloom character has been reported to be the most important in imparting resistance against the sucking pests (Lakshminarayana, 2003), hence eight different genotypes with different bloom nature were selected for the study. Though information on the seasonal incidence and management of sucking pests, physical, biochemical and chemical parameters influencing the castor plant resistance to the leafhopper and thrips (Rani *et al.,* 2006) is available to certain extent, very little work has been done on the effect of weather parameters on the incidence of the pest. Hence the present study was taken up to study the effect of meteorological factors and development of weather based forewarning models against sucking pests in selected castor genotypes.

Materials and Methods: The field experiments were conducted during the *Rabi* season for five years from 2008 to 2013 to study the seasonal incidence and development of weather based forewarning models for leafhopper, *E. flavescens* and thrips, *R. syriacus* in eight commercially grown popular genotypes of castor *viz.,* Haritha, Kranthi, Kiran, DPC-9, PCH-111, PCH-222, GCH-4 and DCH-177. The genotypes had different morphological characters with respect to bloom (zero, single, double and triple). The experiments were conducted in a randomized complete block design at research farm of Regional Agricultural Research Station, Palem and each treatment (genotype) was replicated thrice. Each entry was sown in 5 rows of 6m length adopting a spacing of 90x60 cm. Normal agronomic practices were followed from time to time except the plant protection measures.

The counts on leafhopper nymphs were recorded on 4 plants in each row and in total on 20 plants from each treatment. In each plant 3 leaves (lower, middle and top) were examined for leaf hopper nymphs from 70 days after germination. The hopper burn (foliage drying) caused due to leaf hopper was estimated on whole plant basis and expressed as percentage on 0 to 4 scale. The absolute population of thrips was recorded on the tender most and not fully opened leaf in each genotype on 20 plants starting from 120 days after germination. The observations were recorded at weekly interval and the average population per leaf for each genotype was calculated. The data on leafhopper was transformed to square root values and subjected to RBD analysis while that on thrips was subjected to simple RBD analysis. For studying the relationship between weather parameters and pest incidence, the data on weather parameters such as rainfall (mm), morning relative humidity (RHM), evening relative humidity (RHE), maximum temperature (Tmax), minimum temperature (Tmin), mean temperature (Tmean), evaporation (mm) and wind speed (km/hr) were recorded from the agro meteorological observatory located at RARS, Palem for five years *i.e.* 2008-13 and correlation coefficients were worked out between weekly weather data of preceding one week and the pest incidence. The data were further subjected to step down multiple linear regression and non-linear techniques using Indostat and excel stat software.

Results and Discussion: The perusal of the data obtained from different seasons indicated that the incidence of the leaf hoppers was low during the 43rd standard week (22-28 Oct) and their intensity was increased gradually till the 7th standard week (12-18 Feb) irrespective of the genotypes. Sudden increase was noticed in the incidence of leafhopper population during 51st standard week (17-23 Dec), while the incidence was less after 8th standard week (19-25 Feb). These results are in accordance with Suganthy (2007, 2011), she reported that leafhopper incidence was observed in all the locations with average population of 37.9 – 180.4 hoppers/3leaves/plant with the damage grade of 0.1 - 2.0 on 0 to 4 scale in all the fields during 2nd fortnight of December. Incidence of thrips was low during 52nd standard week (24-31 Dec), and their intensity increased gradually till the 12th standard week (19-25 March). Sudden increase in thrips population was noticed during 9th standard week (26-04 March).

The varietal preference of leaf hoppers and thrips observed during 2008-2013 (Tables 1 and 2) indicated that among the eight genotypes, DCH-177 was highly susceptible to both the pests with a mean population of 102.5 hoppers/ 3 leaves/ plant and 25.2 thrips/leaf respectively, followed by DPC-9 with 85.3 hoppers/ 3 leaves/ plant and 21.0 thrips/leaf. GCH-4 and PCH-111 were least preferred by these pests with 24.9 and 37.0 hoppers/ 3 leaves/ plant and 11.6 and 11.4 thrips/leaf respectively. While, Haritha and Kiran exhibited intermediate preference to these pests. Lakshminarayana (2003) reported that among the different morphological attributes, bloom character was the most important in imparting resistance against the sucking pests. GCH-4 had a waxy coating in all parts of the plant (triple bloom), whereas DCH-177 had a waxy coating only on the stem (single bloom). Jayaraj (1967) indicated that the role of antibiosis component in castor against leafhopper was remarkable and the varieties affected significantly the biology of the insect. Moreover, Jayaraj (1966), showed that in the bloomed varieties, the incidence of leafhopper increased with the intensity of bloom. But the present investigation revealed that the susceptibility of castor to leafhopper decreased with the increase in bloom. The bloom character of castor was found to play a major role in determining the resistance or susceptibility to leafhopper. Similar observations were made by Dorairaj, 1963. However, Jayaraj (1967) positively correlated the leafhopper incidence with the intensity of bloom. The infestation of thrips decreased with the increase in the intensity of bloom which is similar to that of leafhopper resistance (Lakshminarayana, 2003).

Prediction models developed for leafhopper by subjecting the pooled data of five years to correlation and multiple regression analysis. The correlation coefficients were worked out between leafhopper incidence and weather parameters of one week lag. The results showed the significant negative influence of various weather parameters except evaporation which recorded significant positive influence on leafhopper incidence. Minimum temperature did not show significant influence on leafhopper incidence in all the genotypes except in PCH-111 (Table 3). These results are in accordance with Mortale *et al.,* (2007), who reported that the leafhopper population was significantly negatively correlated only with maximum temperature of the same fortnight.

Prediction models for thrips shows that, there was significant negative influence of various weather parameters, except maximum temperature, which recorded positive influence on thrips incidence (Table 4). These results are in accordance with Lakshminarayana, 2003, who reported that, with the increase in temperature, the population of thrips also increases and expressed the damage symptoms. Akashe *et al.,* (2015) studied the effect of climatic factors on the development of *Retithrips syriacus* in castor and stated that damage level was increased with the increase in temperature.

The weather based forewarning models of *E. flavescens* and *R. syriacus* were developed for each variety by subjecting the data to linear and non-linear regression analysis. The step down linear regression models explained the variation in leaf hopper incidence to an extent of 33 to 52% and thrips incidence to an extent of 34 to 57% in different varieties (Table 5 and 6).

The precision of prediction was greatly improved when the same data was subjected to non-linear regression analysis. The non-linear models in *E. flavescens* population explained the variation to an extent of 38 to 71%, while in *R. syriacus* population the co-efficient of determination ranged from 44 to 68%.

These models will help to predict the population of sucking pests like leafhopper and thrips, one week in advance and this information can be utilised by the farmers to take timely control measures there by reducing the cost of plant protection incurred in indiscriminate spraying of insecticides.

References:

1. **AICRP 2005.** Annual Progress Report: Castor. Directorate of Oilseeds Research, Hyderabad, India.
2. Akashe V B, Indi D V, Patil S R, Jadhav J D and Pawar P B 2015. Incidence of insect pest damage in castor in relation to meteorological parameters in the scarcity zone of Maharashtra. Journal of Agrometeorology. 17(1): 139-141.
3. Dorairaj M S, Savithri A and Aiyadurai S G 1963. Population density as a criterion for evaluating varietal resistance of castor (*Ricinus communis* L.) to jassid infestation. Madras Agricultural Journal 50 : 100.
4. Govaerts R, Frodin D G and Radcliffe-Smith A 2000. World checklist and bibliography of Euphorbiaceae (with Pandaceae). Trowbridge, Redwood Books, Ltd.
5. Jayaraj S 1966. The influence of the feeding by the leafhopper, *Empoasca flavescens* (F.) on transpiration and moisture content of certain varieties of *Ricinus communis* L. Phytopathologische Zeitschriff 57 : 121-126.
6. Jayaraj S 1967. Studies on the resistance of castor plant (*Ricinus communis* L.) to the leafhopper, *Empoasca flavescens* (F.) (Homiptera, Jassidae). Zeitschriff fur angewandte entomologie 59 : 112-126.
7. Lakshminarayana M 2003. Host plant resistance in castor against leaf hopper, *Empoasca flavescens* (F.) and thrips, *Retithrips syriacus* Mayet. *Indian Journal of Plant Protection* 31(2) : 13-16.
8. Lakshminarayana M and Raoof M A 2005. Insect pests and diseases of castor and their management. Directorate of Oilseeds Research, Hyderabad Pp.78.
9. Mortale H T, Narayanaswamy T K, Jagadish K S and Venugopal R 2007. Screening of castor (*Ricinus communis* L.) genotypes against foliage pests. *Bulletin of Indian Academy of Sericulture* 11(2) : 57-59.
10. Rani P U, Sudheer S D, Padmini G and Lavanya C 2006. Nutrient-allelochemical interactions of castor, *Ricinus communis* (L.) plants, resistant and susceptible to infestation of green leaf hopper, *Empoasca flavescens* (Fabr.). *Journal of Applied Zoological Researches* 17(1) : 1-8.
11. Suganthy M 2007. Survey and monitoring the incidence of pests of castor. *Madras Agricultural Journal* 94 : 133-135.
12. Suganthy M 2011. Field screening of promising castor cultures against capsule borer, *Conogethes punctiferalis* and leaf hopper, *Empoasca flavescens*. *Madras Agricultural Journal* 98(4/6) : 178-179.
13. Vijay Singh, Lakshminarayana M and Ranga Rao V 1993. Changing scenario of insect pest problem in annual oilseed crops. (In) Pests and pest management in India : The changing scenario. 78-87. Edited by Sharma S C and Veerabhadra Rao M. Plant Protection Association of India, national Plant Protection Training Institute, Hyderabad.

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Table 1. Incidence of leafhoppers in different genotypes of castor during 2008-2013

Genotype	Leafhoppers/3 leaves/Plant					Mean
	2008-09	2009-10	2010-11	2011-12	2012-13	
Haritha	26.3	39.8	54.6	42.8	40.9	40.9
Kranthi	52.8	60.4	49.1	72.4	39.8	54.9
Kiran	60.4	52.8	42.5	60.4	24.2	48.1
DPC-9	80.2	85.8	70.9	110.4	79.2	85.3
PCH-111	29.5	39.2	40.8	20.8	54.5	37.0
PCH-222	33.5	42.5	62.5	56.9	58.4	50.8
GCH-4	14.8	22.5	30.2	26.4	30.4	24.9
DCH-177	98.4	88.6	105.6	99.2	120.5	102.5

Table 2. Incidence of thrips in different genotypes of castor during 2008-2013

Genotype	No. of thrips/Leaf					Mean
	2008-09	2009-10	2010-11	2011-12	2012-13	
Haritha	18.8	18.4	8.9	6.4	12.8	13.1
Kranthi	11.4	18.6	15.5	12.4	12.4	14.1
Kiran	15.4	22.4	9.9	10.4	8.9	13.4
DPC-9	24.6	18.4	26.8	20.8	14.6	21.0
PCH-111	11.8	12.6	12.4	9.8	10.4	11.4
PCH-222	15.6	20.4	14.2	14.8	18.4	16.7
GCH-4	12.8	16.8	8.5	9.8	9.9	11.6
DCH-177	28.8	26.8	25.4	24.2	20.8	25.2

Table 3. Influence of weather parameters on leafhopper population in different genotypes of castor (Pooled data of 2008-13)

Weather parameters	Correlation coefficient							
	Haritha	Kranthi	Kiran	DPC-9	PCH-111	PCH-222	GCH-4	DCH-177
Rain fall	0.00	-0.01	0.28*	-0.21*	-0.18	-0.00	0.01	0.00
RHM	0.17	0.20*	-0.37*	-0.48**	0.28*	-0.37*	0.14	0.42**
RHE	-0.18	-0.33	-0.28	-0.18	-0.37*	-0.41*	-0.24	-0.31*
T max	0.27	0.27	-0.36*	0.40*	0.34	0.28	0.25	-0.32*
T min	0.16	0.00	0.30	0.18	0.39*	0.07	-0.02	0.27
Evaporation	0.14	0.32	0.44*	0.43*	0.47**	0.33	0.41*	0.52**
Wind speed (Km/hr)	-0.42*	0.07	0.48**	0.20	0.51**	0.22	-0.07	0.38

*Significant at P = 0.05; ** Significant at P = 0.01

Table 4. Influence of weather parameters on thrips population in different genotypes of castor (Pooled data of 2008-13)

Weather parameters	Correlation coefficient							
	Haritha	Kranthi	Kiran	DPC-9	PCH-111	PCH-222	GCH-4	DCH-177
Rain fall	-0.013**	-0.06*	-0.104	-0.32**	-0.14	0.01	-0.34*	0.02
RHM	-0.17	-0.08	-0.21	-0.08	-0.28*	-0.09	-0.18	-0.28*
RHE	-0.32*	-0.28*	-0.25**	-0.17	-0.43**	-0.42**	-0.48**	0.12
T max	-0.38**	+0.41**	-0.30*	+0.41**	-0.26*	-0.40	-0.31*	+0.42*
T min	-0.70**	-0.69**	-0.59**	-0.61**	-0.68**	-0.77**	-0.75**	-0.42
Evaporation	-0.02	-0.30*	0.02	-0.18	-0.04	-0.32**	-0.43**	-0.59*
Wind speed (Km/hr)	-0.49**	-0.47**	-0.36**	-0.50**	-0.41**	-0.45**	-0.46**	-0.18

Table 5. Regression equations developed for castor leafhopper, *Empoasca flavescens* in different genotypes of castor (pooled data of 2008-2013)

Genotype	Multiple regression	Equation	Co-efficient of Determination (R^2)
Haritha	Linear	Y=42.18+2.39*RF-4.2*WS+0.48T.Mean	0.38
	Non linear	Y=5.70-9.23*RHE-6.11*WS+8.80*Epan+0.77*TMin^2+1.25*-0.67*Epan^2	0.46
Kranthi	Linear	Y=40.10-3.19*T.Min+0.37*RHM+0.59*WS	0.35
	Non linear	Y=99.19-9.42*T.Min+1.15*RHE-11.78*Epan+14.87*T.Mean+0.08*Tmin^2-0.01RHM^2+T.Mean^2	0.38
Kiran	Linear	Y=70.30+10.6*T.Min-1.34*RHE+1.48*RF+7.55*Epan+5.99*T.Mean	0.40
	Non linear	Y=57.31-3.89*T.Max-5.54*T.Min+5.38*T.Mean-0.02*T.Max^2-0.003*T.Min^2+0.09*T.Mean^2	0.45
DPC-9	Linear	Y=67.54+10.6*T.Max -11.29*T.Min+7.92*T.Mean	0.33
	Non linear	Y=143.51+1.89*T.Max-1.51*T.Mean-0.37*T.Max^2-0.28*T.Min^2+0.79*T.Mean^2	0.49
PCH-111	Linear	Y=47.78+3.79*T.Mean+4.3*Epan+0.12RHE	0.42
	Non linear	Y=855.04-21.66*Tmax-7.33*RHM-55.19*Epan+7.15*Tmean-0.19*Tmax^2+0.03*RHM^2+5.41*Epan^2+0.53Tmean^2	0.49
PCH-222	Linear	Y=40.10-3.19*Tmin+0.37*RHM+0.59*WS	0.40
	Non linear	Y=-41.32+6.48*Tmin+1.07*RHM-0.76*RHE-4.42*RF(mm)+3.76*Epan-	0.52

		0.86*Tmean-0.07*Tmin^2-0.004*RHM^2-0.007*RHE^2+0.48*RF(mm)^2+0.09*Tmean^2	
GCH-4	Linear	Y=16.81+1.59*Tmin+0.19*RHM-0.40*RHE+0.61*RF-1.24*WS	0.42
	Non linear	Y=-238.84-6.07*Tmin+7.68*RHM-0.08*WS+0.09*Tmin^2-0.04*RHM^2+0.02*WS^2	0.62
DCH-177	Linear	Y=20.30+16.9*Tmax+19.64*Tmin-9.11*RHE+8.77Epan-148.45*Tmean	0.52
	Non linear	Y=44.09-1.20*Tmin+5.36*RHM-21.84*Epan-6.96*Tmean-0.02*Tmin^2-0.03*RHM^2+1.88*Epan^2+0.15*Tmean^2	0.71

Table 6. Regression equations developed for castor thrips, *Retithrips syriacus* in different genotypes of castor (pooled data of 2008-2013)

Pest	Multiple regression	Equation	Co-efficient of Determination (R^2)
Haritha	Linear	Y=-84.678-0.507*RF+0.87RHM-0.079*RHE+3.935*Tmax-0.309Tmin+0.525Epan	0.34
	Non linear	Y=-165.875-0.551*T.max-0.10*T.min-15.63* T. mean-0.27*T.max^2-0.32*T.min^2+0.74* T.mean^2	0.61
Kranthi	Linear	Y=-15.059-6.018*T.min+0.49*RHE-1.80*Epan+5.14*T. mean	0.49
	Non linear	Y=-89.19-4.82* T.min+1.15*RHE-11.78*Epan+14.87* T.mean+0.08*T.min^2-0.01*RHM^2+0.98*Epan^2-0.18* T.mean^2	0.47
Kiran	Linear	Y = -58.843-0.28RF+0.559RHM+0.043RHE-1.374*TMax-1.121TMin-1.127EPan	0.46
	Non linear	Y =-58.918+0.579RHM-1.339*TMax-1.037TMin-1.082EPan+5.38* Tmean-0.02* T.max^2-0.003*T.min^2	0.45
DPC-9	Linear	Y=43.408-0.268*RF+0.066RHM-0.147RHE-0.229*TMax-0.742TMin-0.734EPan	0.38
	Non linear	Y=45.60+8.98*T.max-4.29*T.min+0.75*RHE-7.25*Epan-11.08*T.mean-0.34* T.max^2-0.28*T.min^2-0.02*RHM^2+0.97* Epan^2+0.73* T.mean^2	0.68
PCH-111	Linear	Y=17.543-0.366*RF-0.123RHM-0.294RHE+0.934Tmax-0.056Tmin-2.717Epan	0.47
	Non linear	Y=143.51+1.89*Tmax-8.93* T.min-1.51*T.mean-0.37*T.max^2-0.28*T.min^2+0.79* T.mean^2	0.66
PCH-222	Linear	Y=-9.477-0.0207RF+0.105RHM+0.0166RHE+0.261*TMax-0.257TMin-0.202EPan	0.57
	Non linear	Y=-57.31-3.89*T.max-5.54*T.min+5.38*T.mean-0.02*T.max^2-0.003*T.min^2+0.09*T.mean^2	0.59
GCH-4	Linear	Y=-29.198-0.58*RF+0.030RHM+0.084RHE+1.45TMax-0.743TMin+0.05EPan	0.46
	Non linear	Y=-44.09-1.20*t.min+5.36*RHM-21.84*Epan-6.96*Tmean-0.02*T.min^2-0.03*RHM^2+1.88*Epan^2+0.15*T.mean^2	0.64
DCH-177	Linear	Y=90.184-0.286*RF-0.98RHM-0.119RHE-0.072*Tmax+1.973Tmin-5.25Epan	0.46
	Non linear	Y=-218.84-6.07*T.min+7.68*RHM-0.08*WS+0.09*T.min^2-0.04*RHM^2+0.02*WS^2+0.87*Epan^2+0.73*T.mean^2	0.44

T.Mean = Mean temperature
T min = Minimum temperature
T max = Maximum temperature
RHM = Morning relative humidity
RHE = Evening relative humidity
E pan = Pan evaporation
WS = Wind speed
RF = Rainfall