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Effect of Meteorological Parameters on Population Dynamics of Sucking Pest and its Natural Enemy in Brinjal

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Abstract: To assess the effect of meteorological parameters on seasonal population dynamics of whitefly, jassid and LBB on brinjal, experiments were conducted at College of Agriculture, Ganjbasoda during winter season (2016-2018) and rainy season (2018-2020) with NS302 variety. The activity of these insects were initiated in 44th standard meteorological week (SMW) with 30.16, 19.12 and 3.40individuals / plant and peak population of whitefly with 37.84 individuals / plant on 12th SMW, jassid found maximum with 25.36individuals / plant with 11th SMW however population of LBB get maximum (5.14 / plant) in 10th SMW respectively and remained active up to 13rdSMWduring winter season although seasonal activity of these insects were commencement from 27th SMW with 2.5, 1.29 and 3.40 individuals / plant and reached at maximum with 36.17 and 5.78 of whitefly as well as LBB on 42nd SMW whereas population of jassid was found higher (14.99) in 41st SWM and its ended up to 46thSMW during rainy season. The correlation coefficient between whitefly, jassid and LBB with population and meteorological parameters *viz.* maximum temperature (r=0.786*,r=0.782*,r=0.4738) minimum temperature (r=0.85*,r=0.852*, r=0.528*), wind speed (r=0.691*,r=0.451*) and BSS (r=0.801*,r=0.801*,r=0.433*) were strongly significant positive impact except wind speed in case of jassid whereas significant negative correlation with relative humidity (RH) in white fly and jassid (r=-0.512*, r=-0.509*). The Correlation analysis between whitefly, jassid and LBB population and weather parameters revealed that significant positive correlation with maximum temperature(r=0.569*, r=0.540) except jassid (r=0.256) and significant negative correlation with minimum temperature(r=-0.831*) only white fly however rainfall(r=-0.643*r=-0.569*) and BSS (r=-0.656*, r=-0.479*) excluding jassid.

Keywords: Brinjal, Meteorological parameters, Whitefly, Jassid, Lady Bird Beetle

The brinjal or eggplant (*Solanum melongena* L.) is one of the most common and key vegetable crops grown in India and other parts of the world. It is originated from India and second largest producer of brinjal after china. In India, it is cultivated mainly in West Bengal, Orissa, Bihar, Gujarat and Madhya Pradesh states (Garg et al 2018). In Madhya Pradesh, it is cultivated in 0.40 lakh hectare an annual production of 1.016 lakh tones and a productivity of 24.97 MT (Metric Tonn) per hectare(Shaikh and Patel 2012). The fruits contain approximately, 92.0 per cent moisture, 6.0 per cent carbohydrate, 1.0 per cent proteins, 0.3 per cent fats and some minerals. They are fairly good source of calcium, phosphorus, iron and vitamin B. Brinjal crop suffers severely due to infestation of various insect pests, which reduces its fruit yield and quality. In India, the crop is damaged by more than 30 insect pests' right from germination to harvesting (Raghupaty et al 1997). Shoot and fruit borer is most destructive and ubiquitous but whitefly, *Bemisia tabaci* Gennadius and Jassid, *Amrasca biguttula biguttulla*(Ishida) are also an important sucking pest that causes a considerable damage to the brinjal plants (Garg et al 2018). The losses caused by these pests were estimated to range from, 70-92 per cent in the fruit yield (Rosaiah, 2001). Weather plays an important role for determining the geographical distribution and periodic abundance of the insect pests. Among the weather factors; temperature, rainfall, relative humidity plays the crucial role in insect life (Seni and Naik 2018). For this purpose, an attempt was made to know the role of abiotic factors on the population buildup of sucking pest (White fly & Jassid and natural enemy (lady bird beetle (C*occinella septumpuntata*) on brinjal during winter (2016-2018) and rain*y* season (2018-2020), respectively.

MATERIAL AND METHODS

The experiment was laid out at instructional farm of College of Agriculture, Ganjbasoda district Vidisha (MP) India during winter season of 2016-17 & 2017-18 and rain*y* season 2018-19 & 2019-20. The College is situated at 23^{0}85' N latitude, 77^{0}92' E longitude in Ganjbasoda block of Vidisha district at an altitude of 416 m above MSL. The NS302 variety was transplanted during winter and rain*y* season in a plot size 4.5 m x6 m with 60x45 cm plant spacing. All cultural practices were followed from time to time to raise the crop successfully as per package of practices prescribed for the region except plant protection. The crop was regularly monitored after transplanting till final harvest for the seasonal population dynamics of whitefly and Jassid. The observations of the population of whitefly, and Jassid were be recorded on six compound leaves (3 middle + 3 lower) of ten randomly selected tagged plants. Numbers of insects (nymph and adult) were recorded in the morning time and cumulative population of whitefly and Jassid per plant was calculated. The observation of predator population of insect pest, lady bird beetle (LBB) recorded on whole plant basis. Theses populations were converted in mean population by averaging them. Weekly weather data on temperature, relative humidity (RH), rainfall, wind speed (km/h) and bright sunshine hours (BSS) were obtained from college of Agriculture, GanjBabsoda. The mean population data obtained from various Standard Meteorological Week (SMW) were subjected to simple correlation analysis with meteorological parameters maximum and minimum temperature, relative humidity (RH), rainfall, wind speed (km/h) and bright sunshine hours (BSS). Data was analyzed statistically by SPSS software and simple correlation and linear regression was worked out between population of sucking pest and natural enemy and weather parameters (maximum and minimum RH, rainfall, wind speed and BSS) by Karl Pearson's Coefficient of correlation and regression at 5% level of significance.

RESULTS AND DISCUSSION

Seasonal Population Dynamics of Sucking Pest and Natural Enemy

Winter season: The seasonal population dynamics of whitefly, Jassid and LBB on brinjal crop during winter season of was initiated in 44th SMW with 30.16, 19.12 and 3.40 individuals / plant, respectively. Thereafter the activity of whitefly population was gradually increase and reached at peak with 37.84 individuals / plant on 12th SMW however population of jassid found maximum with 25.36 individuals / plant with 11th SMW and the population of LBB get maximum in number with 5.14 per plant during 10th SMW respectively. When the favourable weather parameters were occurred, during these periods maximum temperatures, minimum temperatures, rainfall, wind speeds, relative humidity and BSS were 35.72^{0}C, 19.57^{0}C, 0.00mm, 5.57km/h, 22.64% & 12.09 respectively, 33.22^{0}C, 16.58^{0}C, 0.00mm, 6.22km/h, 19.93% and 11.76, 32.00^{0}C, 17.36^{0}C, 0.00mm, 6.86, 25.50 and 11.49 respectively. After that it was gradually declined as increased age of crop and remained active up to 13rd SMW with 30.17, 20.03 and 2.71 individuals/plant (Fig. 1 and 2). The present finding are more or less supported with result reported by Kumar et al (2016) found that maximum population of White fly, jassid and LLB was recorded during 10th, 12th and 11thSMW.

Rainy season: The seasonal activity of whitefly, Jassid and LBB on brinjal crop during rainy season was commencement from 27th SMW with 2.5, 1.29 and 3.40 individuals / plant. and reached at maximum with 36.17 and 5.78 of whitefly as well as LBB on 42nd SMW whereas population of jassid was found higher with 14.99individuals / plan in 41st SWM, during these period favorable parameters *i.e.* maximum temperatures, minimum temperatures, rainfalls, wind speeds, relative humidity and BSS were 31.78^{0}C, 19.93^{0}C, 1.00mm, 14.86km/h, 49% and 11.33 respectively and 32.50^{0}C, 20.14^{0}C, 11mm, 12.35km/h, 59.64% and 11.43 respectively. After that it was gradually declined and ended up to 46thSMW with 3.21, 1.19 and 1.2 individuals per plant (Fig. 2 and 4). The almost similar finding had reported by Mohapatra (2008) he indicated that peak whitefly population recorded in44th SMW whereas peak Jassid population was observed in 41st SMW

Correlation and regression analysis: Effect of weather parameters on seasonal population dynamics of whitefly, jassid and LBB was analyzed in term of correlation and regression in winter and rainy season pooled data and presented in Table 1 and 2.

Winter season: The correlation coefficient between whitefly population and meteorological parameters *viz.* maximum, (r=0.786*) minimum temperature (r=0.85*), windspeed (r=0.691*) and BSS (r=0.801*) were strongly significant positive impact on population of whitefly. The rainfall (r=-0.1) was non-significant negative impact on population fluctuation while relative humidity (r=-0.512*) was significantly negative correlation with population of whitefly. Step wise regression analysis showed that the maximum and minimum temperature, BSS, relative humidity and wind speed hours were significantly contributed 61.78%, 73.06%, 62.44% 26.25% and 13.13%, variation of whitefly population fluctuation. The present finding are in concordance with the results of Horowitz et al (1984) and Horowitz (1986) also reported that the atmospheric humidity, temperature and rainfall influence the population dynamics of whitefly. Gerling et al (1986) stated that extreme relative humidity, both high and low, were unfavorable conditions for survivable of immature stages of whitefly. They were spatio-temporal (factors influence the population such as natural enemies, climatic and habitats) variations in the area. Echlkraut and Cardona (1989) found that dry conditions were more favourable for whitefly than high precipitation. Similarly, study by Rafiq et al (2008) reported that whiteflies developed rapidly in warm weather and population cane buildup quickly in situations where natural enemies are destroyed and

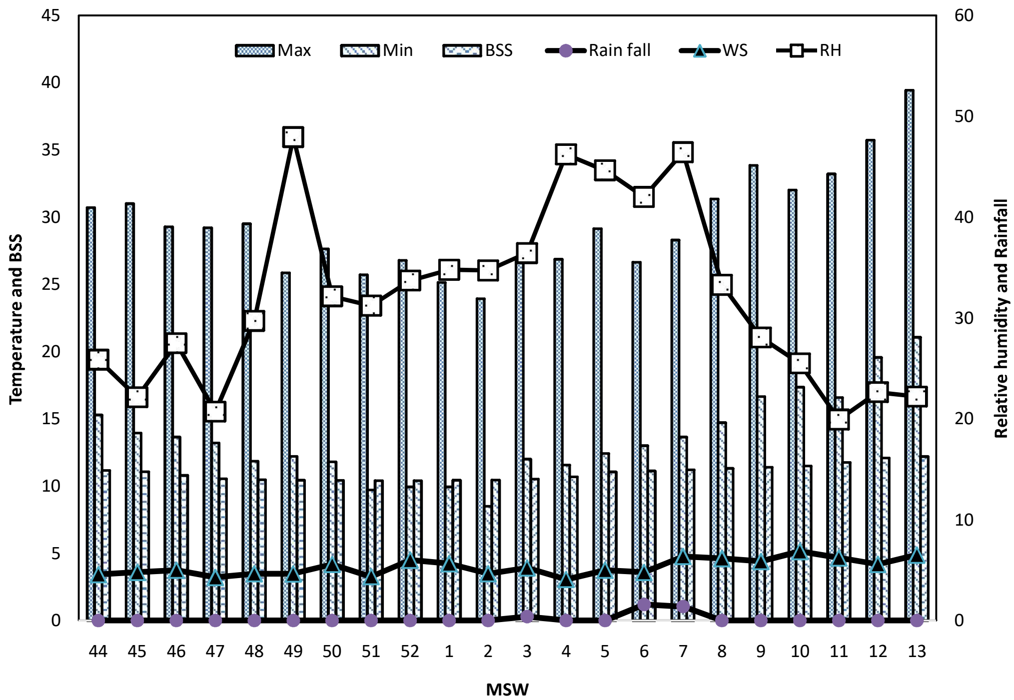

Fig. 1. Weather conditions during winter season brinjal crop study period and their effect on avearge population of sucking pest and their natural enemy during crop growing period 2018-2020

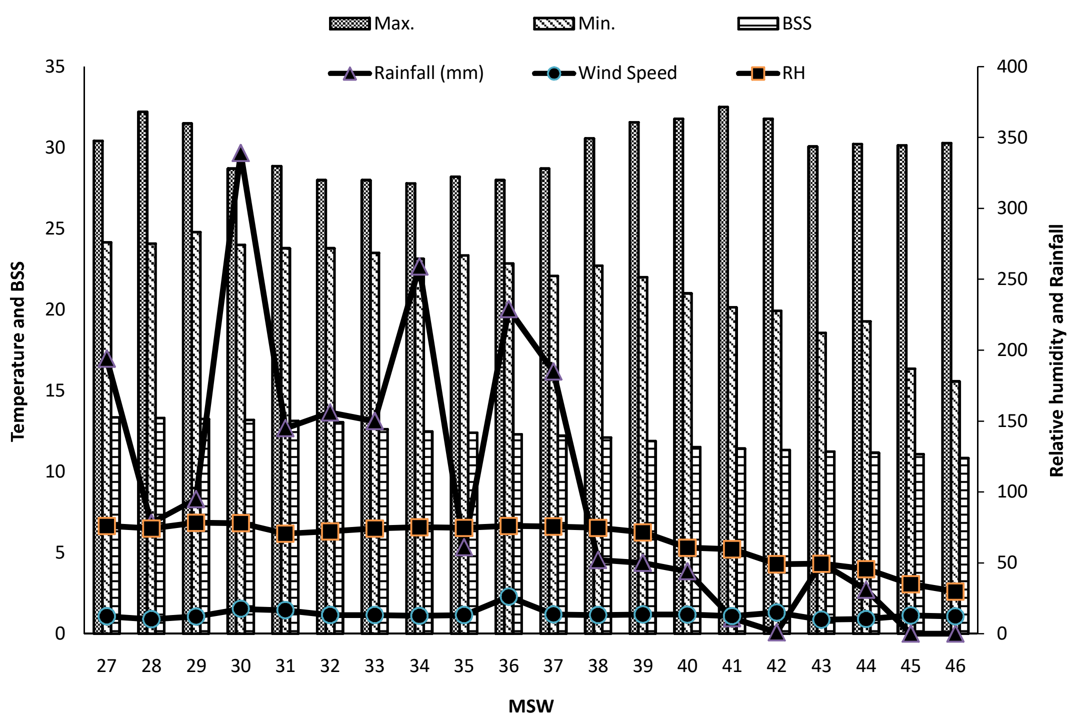

Fig. 2. Weather conditions during rainy season brinjal crop study period and their eggect on average population of sucking pest and their natural enemy during crop period of 2016-2018

weather is favourable. Heavy and prolonged periods of rain can substantially reduce population of whiteflies. Khan (2019) reported that a strong positive and linear relationship was observed between population of whitefly with average temperature and average relative humidity but he contradicted and present result reported that negative correlation with relative humidity. The present results are lineup with result reported by Kumar et al (2016) found that correlation coefficient between white fly population and other abiotic parameters like temperature, relative humidity, rainfall and wind speed was non-significant. The relative humidity (maximum and minimum), rainfall and wind speed have got negative impact on population flare-up of white fly while the temperature (maximum and minimum) has got non-significantly positive impact on the population fluctuation.

A significant positive and linear relationship between jassid population and meteorological parameters like maximum (r=0.782*), minimum temperature(r=0.852*) and BSS (r=0.801*). The other abiotic factors *i.e.* wind speed (r=0.392) showed positive impact on jassid population whereas rainfall (r=-0.047) was non-significant negative impression on population fluctuation while relative humidity(r=-0.509*) was significant negative correlation with population of leafhopper. The regression analysis exhibited that the maximum and minimum temperature, BSS and relative humidity were significantly contributed 61.27%,

Table 1. Correlation between sucking pest and natural enemy population in brinjal with meteorological parameters

Meteorological parameters	Correlation coefficient (r)					
	Winter season (2016-2018)			Rainy season (2018-2020)		
	Whitefly	Jassid	Lady Bird Beetle	Whitefly	Jassid	Lady Bird Beetle
Maximum temperature	0.786*	0.782*	0.473*	0.569*	0.256	0.540*
Minimum temperature	0.85*	0.852*	0.528*	-0.831*	0.015	-0.278
Rainfall (mm)	-0.1	-0.047	-0.030	-0.643*	-0.385	-0.569*
Wind Speed (km/hrs)	0.695*	0.392	0.451*	-0.240	0.010	-0.149
Relative humidity (%)	-0.512*	-0.509*	-0.352	-0.384	0.117	0.310
Sun Shine (hrs)	0.790*	0.801*	0.433*	-0.656*	-0.322	-0.479*

*Significant (p<0.05)

Table 2. Regression analysis of sucking pest and their natural enemy population with different weather factors on brinjal

Insects	Variables*	R^2	
		Winter season (2016-2018)	Rainy season (2018-2020)
Bemisia tabaci	Maximum temperature	0.6178 (61.78%)	0.3242 (32.42%)
	Minimum temperature	0.7306 (73.06%)	0.1726 (17.26%)
	Rainfall (mm)	0.0074 (0.74%)	0.4132 (41.32%)
	Wind Speed (km/hrs)	0.1313 (13.13%)	0.0747 (7.47%)
	Relative humidity (%)	0.2625(26.25%)	0.1475 (14.75%)
	Bright sun shine (hrs)	0.6244 (62.44%)	0.4304 .04%)
A. biguttulla bituttulla	Maximum temperature	0.6127 (61.27%)	0.0654 (6.54%)
	Minimum temperature	0.726 (72.60%)	0.0002 (0.02%)
	Rainfall (mm)	0.0023 (0.23%)	0.1478 (14.78)
	Wind speed (km/hrs)	0.1539 (15.39%)	0.0003 (0.03%)
	Relative humidity (%)	0.2594 (25.94%)	0.0138 (1.38%)
	Bright sun shine (hrs)	0.6421 (64.21%)	0.1039 (10.39%)
Coccinellaseptum punctata	Maximum temperature	0.2788 (27.88%)	0.2908 (29.08%)
	Minimum temperature	0.2233 (22.33%)	0.0773 (7.73%)
	Rainfall (mm)	0.001 (0.10%)	0.3233 (32.33%)
	Wind speed (km/hrs)	0.1255 (12.55%)	0.0221 (2.21%)
	Relative humidity (%)	0.1239(12.39%)	0.0963 (9.63%)
	Bright sun shine (hrs)	0.1877(18.77%)	0.2292 (22.92%)

72.60%, 64.21 and 25.94% Jassid population variability. The present results are conformity with Mahamood et al (1990) also observed that among the various environmental factors, the only significant factors that influence the density of Jassid was maximum and minimum temperature. The present findings are accordance with Kumar et al (2016) indicated that correlation coefficient between Jassid and temperature (maximum and minimum) alongwith relative humidity (maximum and minimum) was significant. The temperature (maximum and minimum) has got significantly positive impact on the fluctuating population of jassid.

The significant positive correlation was found between LBB population and maximum (r=0.473*), minimum temperature (r=0.528*), wind speed (r=0.451*) and BSS (r=0.433*). Neither relative humidity (r=-0.352) nor rainfall (r=-0.030) had significant influence on LBB population. This indicates that activity of LBB population increase with the rise of temperature, wind speed and BSS and decrease with the rise of relative humidity and rainfall during winter season.The regression coefficient revealed that the maximum and minimum temperature, BSS and wind speed were contributed 27.88%, 22.33%, 18.77% and 12.55% significantly variation in LBB population fluctuation. The present observations are conformity with findings of Khan (2019).

Rainy season*:* Correlation coefficient between whitefly population and weather parameters revealed that whitefly population had significant positive correlation with maximum temperature(r=0.569*) and significant negative correlation with minimum temperature(r=-0.831*), rainfall(r=-0.643*), and BSS (r=-0.656*) while wind speed (r=-0.240) and relative humidity (r=-0.384) has non-significant negative correlation. The significant contribution of regression coefficient discovered that the BSS, rainfall, maximum, minimum temperature and relative humidity were 43.04%, 41.32%, 32.42%, 17.26% and 14.75% variation in whitefly population fluctuation, On the other hand wind speed showed non-significant deviation in whitefly population buildup. The present findings are supported by Zia *etal*.(2013) they found that whitefly population showed that rainfall and relative humidity were negatively correlated while temperature was positively correlated with whitefly population.

The Correlation coefficient between jassid population and weather parameters expressed thatjassid population had non -significant positive correlation with maximum (r=0.256), minimum temperature(r=0.015), relative humidity(r=0.117) and wind speed (r=0.010) although rainfall (r=-0.385) and BSS (r=-0.322) had non-significant negative correlation. It suggested that the number of jassid population was less dependent on weather parameters except rainfall and BSS. The linear regression showed that the rainfall and BSS contributed 14.78% and 10.39% variation in jassid population. The other abiotic factors *viz*. Temperature, wind speed and relative humidity expressed very less impact on jassid population buildup. The present findings are refuted with result of Patel and Radadia (2018) found that jassid population showed significant positive correlation with maximum temperature, evaporation and sunshine hours whereas, significant negative correlation with wind speed and rainy days. In case of linear regression he indicated that upto 42.5 percent (R2= 0.425) on the population of jassid. Further, Prasad et al (2008) showed the multiple linear regression analysis indicated that the total influence of all the weather parameters was high and significant, it was upto 51.78 percent (R2=0.5178) on the population of leafhoppers.

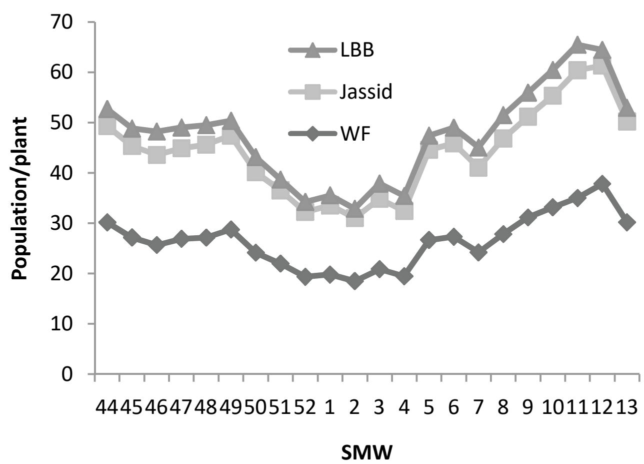

Fig. 3. Influence of weather parameters on sucking pest and their natural enemy during winter season

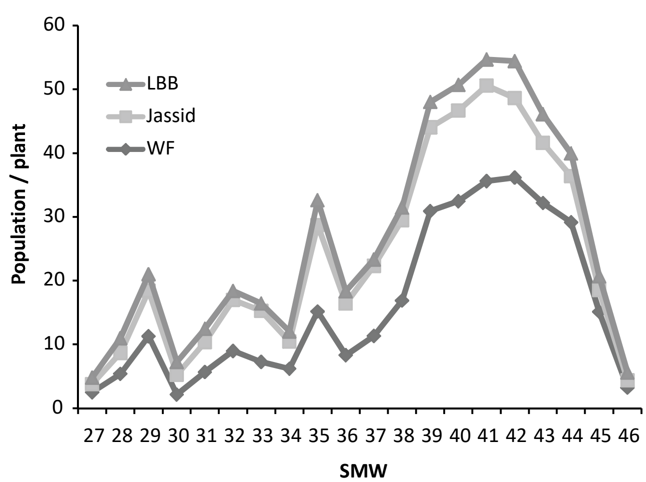

Fig. 4. Influence of weather parameters on population of sucking pest and their natural enemy during rainy season

Hameed et al (2014) noted the multi variable regression model along with coefficient of determination between weather factors and cotton insects clearly showed that highly significant linear relationship was observed between the maximum temperature and jassid population having 10.8 to 48.0 percent role and These results are less supported to present observations.

The correlation coefficient between LBB population and maximum temperature (r=0.540*) was found significantly positive whereas relative humidity was observed non-significant positive (r=0310).On the other hand the correlation coefficient between minimum temperature (r=-0.278) and wind speed (r=-0.149) was recorded non-significant negative correlation while bright BSS (r=-0.479*) and rainfall (r=-0.569*) were calculated significant negative correlation. This indicates that activity of LBB population increase with the rise of maximum temperature and decrease with the rise of rainfall and BSS. Neither the relative humidity nor minimum temperature with wind speed had significant influence on LBB population. The regression coefficient expressed that the rainfall, maximum temperature and BSS added 32.33%, 29.08% and 22.92% variation in LBB population instability. The similar results with meteorological parameters viz., wind speed and rainfall while temperature, relative humidity and BSS was disagree with results reported by Patel and Radadia (2018) he observed that the population of LBB showed highly significant negative association with minimum and average temperature, morning, evening and average relative humidity, wind speed, rainfall and rainy days while highly significant positive association with sunshine hours.

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