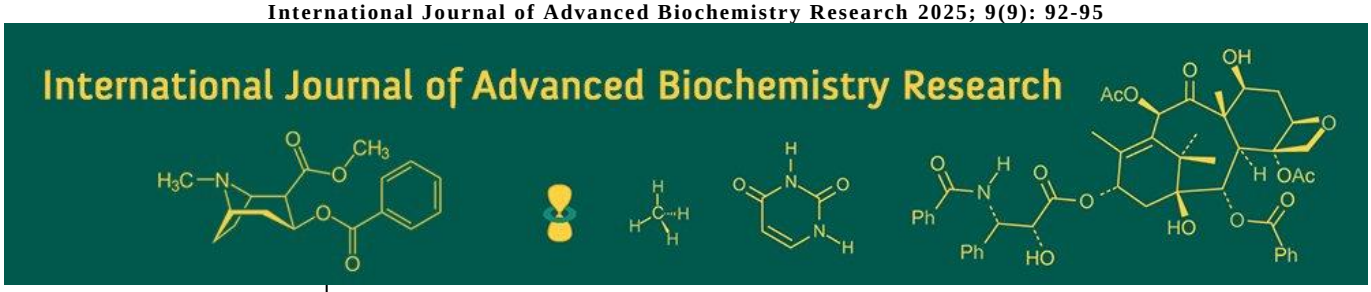

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Population dynamics of major arthropods on soybean [*Glycine max* (L.) Merrill]

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Abstract
An experimental trial was conducted to study the population dynamic of major arthropods of soybean at College of Agriculture, JNKVV, Jabalpur (MP) during *Kharif* season 2024-25. The result revealed that the incidence of whitefly and jassid was first observed on the crop during 29th SW and attained its peak population during 36th and 37th SW, respectively. The first incidence of stem fly infestation was recorded during 30th SW which attained its peak during 40th SW. The first appearance of green semilooper and bihar hairy caterpillar was observed during 31st and 32nd SW, respectively, and reached its peak point at 38th SW. Correlation studies between weather parameters and insect pests was revealed that whitefly and Jassids population was exhibited significantly negative correlation with evaporation whereas, the infestation of stem fly was exhibited significantly positive correlation with maximum temperature and sunshine hours while, significant negative correlation with morning and evening RH, evening vapour pressure and rainy days.

Keywords: Insect pests, population dynamics, whitefly, soybean, correlation, weather parameter

Introduction
Soybean [*Glycine max* (L.) Merrill], a member of the Leguminaceae family and Papilionaceae sub-family, is a major oilseed cash crop in India. Known for its high nutritional value, it is often referred to as the "Miracle bean," "Golden bean," and the "Crop of the planet" (Chauhan and Joshi, 2005) [7]. Soybean is an exceptionally nutritious crop, boasting a remarkable composition of 40% protein, 20% edible oil, and essential minerals and vitamins (Sasvihalli *et al*., 2017) [17]. India is the 5th largest producer of soybean in the world after the Brazil, United States of America, Argentina and China (Baig *et al*., 2017) [3]. In India, during the same period, the crop covered around 12.08 mha, producing 12.3 MT with a productivity rate of 1.01 tons per hectare (Anonymous, 2024a) [1, 2]. Madhya Pradesh led the country in soybean cultivation, with an area of 5.26 mha, a production of 5.49 MT, and a productivity of 1.04 tons per hectare. In Jabalpur district specifically, soybean was grown on about 0.018 mha, resulting in a production of 0.024 MT and a higher productivity of 1.33 tons per hectare during 2023-24 (Anonymous, 2024b) [1, 2]. In Madhya Pradesh, 20 insect species are classified as major soybean pests. However, a dozen notable pests, including girdle beetle, tobacco caterpillar, green semilooper, bihar hairy caterpillar, stem fly, aphids, jassids, and whitefly, are responsible for significant economic damage (Patel and Rahul, 2020) [14]. During the kharif season, significant damage to soybean crops is caused by four major pests: tobacco caterpillar (30-50%), semilooper (50-60%), girdle beetle (60-80%), and stem fly (16-20%) Naik *et al*., (2021) [12]. Around a dozen insect species commonly infest soybean crops, and they are of significant economic importance, with each species causing yield losses ranging from 20 to 100 percent (Sharma *et al*., 2014) [18]. Other hand, abiotic factors are also plays an important role for fluctuation of population of arthropods encompasses insect pests and their natural enemies. Thus, the present study was aimed to study the population dynamics of arthropods and correlation with weather parameters which highlight their impact on soybean crop.

Materials and Methods
The field experiment was conducted during *Kharif* 2024 at Experimental Field of Bio-

Control Research & Production Centre, Department of Entomology, College of Agriculture, JNKVV, Jabalpur, MP. To study the population dynamics of major arthropods on soybean. The experiment was carried out in a single plot and the plot size was 3 x 3 m ($9m^2$). JS 20-116 variety was used with spacing of 50 x 15 cm. Observations of major insect pests associated with soybean was recorded twice in a standard week on randomly ten plants. Methodology of sucking pest, adult whitefly and nymph and adult jassid using the cage, defoliators, larvae of green semilooper, tobacco caterpillar, leaf folder and bihar hairy caterpillar and also observed natural enemies like lady bird beetle and spider per meter row length, bean leaf beetle per plant and stem borer, stem fly infestation (%). The correlation and regression were worked out using the OPSTAT software.

Results and Discussion

Whitefly, *Bemisia tabaci* (Gennediuas)

The adult whitefly population was first observed during the 29th SW with 0.81 adults/cage/plant and remained present on the crop till the 41st SW, reaching 1.95 adult/cage/plant. The highest population of whiteflies was recorded in the 1st week of September (i.e., 36th SW) with 5.02 adults/cage/plant (Table 1). Similar finding was also reported by Sapekar *et al*. (2020) [16]. Correlation studies as given in Table 2 revealed that whitefly population showed significant negative correction with evaporation (r =-0.62) and regression equation $\hat{Y}$ = 6.30-1.34x, (R^2 = 0.45). The regression equation suggests that with each unit increasing of evaporation, there was a decrease of 1.34 adult whiteflies per cage per plant on the soybean crop. The present finding contradicts with the findings of Marabi *et al*. (2017) [10] who reported that evaporation exhibited significant positive correlation on the influence of whitefly population in soybean crop.

Jassid, *Empoasca kerri* (Pruthi)

The first appearance of Jassid was recorded during the 29th SW with 0.19 Jassid (nymph and adult)/cage/plant and remained present on the crop till the 41st SW, reaching 0.81 Jassid (nymph and adult)/cage/plant. The peak population of Jassid was observed at 37th SW with 3.83 Jassid (nymph and adult)/cage/plant (Table 1). Present finding is corroborated with the findings of Panwar *et al*. (2021) [13]. Correlation studies revealed that jassid population showed significant negative correction with evaporation (r =-0.63) (Table 2). The regression equation was expressing as $\hat{Y}$ = 3.44-0.41x (R^2 = 0.46). The regression equation suggests that with every unit increase of evaporation, there was a decrease of 0.41 jassids per plant in the soybean crop. Similarly, Biradar *et al*. (2023) [5] also reported that evaporation had exhibited significant negative correlation on the jassid population on soybean.

Stem fly (*Melanagromyza sojae*) infestation

The first appearance of stem fly infestation was recorded during the 30th SW which was caused 10% infestation and continued on the crop till the 40th SW, reaching 100% infestation attained its peak point (Table 1). The present finding is accordance with findings of Suyal *et al*. (2018) [19]. Correlation studies as given in Table 2 revealed that significant positive correlation with maximum temperature and sunshine hours (r = 0.68 and 0.72, respectively) and regression equation analyzed were $\hat{Y}$ =-380.61 + 14.16x, (R^2 = 0.57), and 21.2 + 10.41x, (R^2 = 0.60) the regression equations, it is expressed that with every unit increase of maximum temperature and sunshine hours there was an increase of 14.16 and 10.41% stem fly infestation, on soybean crop respectively. Similar finding was also reported by Dudy (2022) [8] on soybean crop. Further, Correlation studies as given in Table 2 clearly depicted that stemfly infestation was exhibited significant negative correlation with morning and evening RH, evening vapour pressure and rainy days (r =-0.83,-0.84,-0.62 and-0.68, respectively) and regression equation were expressed as $\hat{Y}$ = 1029.2-10.52x, (R^2 = 0.74), 269.94-2.91x, (R^2 = 0.78), 499.8-18.96x, (R^2 = 0.49) and 89.21-12.77x, (R^2 = 0.59), the regression equations indicate that with each unit increase in morning and evening RH, evening vapour pressure and rainy days, there was a decrease of 10.52, 2.91, 18.96 and 12.77 mean stem fly infestation, respectively. Such type of similar findings were also reported on soybean crop by Raghuwanshi (2024) [15].

Green semilooper, *Chrysodeixis acuta* (Walker)

The larval population of *C. acuta* was first detected on the crop during 31st SW with a population of 0.43 larvae/mrl, and remained present till the 41st SW, with a population of 1.10 larvae/mrl. The peak population was occurred during the 38th SW with 6.21 larvae/mrl (Table 1). Similarly, Chaudhari *et al*. (2020) [6] also reported same result on soybean crop. Correlation studies of green semilooper with all taken weather parameters exhibited statistically non-significant (Table 2). Similarly, Sapekar *et al*. (2020) [16] also reported that the population of green semilooper had exhibited non-significant correlation with all weather parameter on soybean crop.

Tobacco caterpillar, *Spodoptera litura* (Fabricius)

The larval stage of *S. litura* was first observed during the 32nd SW, with 0.81 larvae per meter row length (mrl) and continued present on the crop until the 41st SW, reaching 1.05 larvae/mrl. The highest larval population was recorded during the 37th SW with 6.19 larvae/mrl (Table 1). The same result was also found by Bangale *et al*. (2019) [4]. The population of tobacco caterpillar was exhibited non-significant correlation with all taken weather parameters (Table 2). Similarly, Suyal *et al*. (2018) [19] also reported that the population of tobacco caterpillar had exhibited non-significant correlation with all weather parameter.

Bihar hairy caterpillar, *Spilarctia obliqua*(Walker)

The infestation of larval population of *S. obliqua* was first observed during the 32nd SW with 1.48 larvae/mrl and remained on the crop until the 41st SW, reaching 3.10 larvae/mrl. The highest larval population was recorded during the 38th SW, with 8.95 larvae/mrl (Table 1). Similar finding was also reported by Raghuwanshi (2024) [15]. The larval population of bihar hairy caterpillar expressed non-significant correlation with all taken weather parameters (Table 2). Similarly, Suyal *et al*. (2018) [19] also reported that the population of bihar hairy caterpillar had exhibited non-significant correlation with all weather parameters.

Leaf folder, *Omiodes indicata* (Fabricius)

The larval stage of the leaf folder was first observed during the 31st SW, with 0.26 larvae/mrl and continued to be present on the crop till the 41st SW, reaching 0.63

larvae/mrl. The highest population of larvae was recorded during the 37th SW with 1.73 larvae/mrl (Table 1) found similar finding Meena *et al*. (2018) [11]. Correlation studies as given in Table 2 revealed that the population of leaf folder larvae had exhibited non-significant correlation with all weather parameter. Similarly, Meena *et al*. (2018) [11] also reported that the population of leaf folder had exhibited non-significant correlation with all weather parameters.

Bean leaf beetle, *Cerotoma trifurcata* (Forster)

Bean leaf beetle was first observed on the crop during the 30th SW with a population of 0.21 per plant, and continued present till the 41st SW, reaching 0.95 per plant. The peak population of bean leaf beetle was recorded in the 37th SW, with 4.10 per plant (Table 1). Correlation studies as given in Table 2 revealed that non significant with all weather parameter.

Ladybird beetle complex

The first appearance of the ladybird beetle complex (both grubs and adults) comprising two species *i.e*., seven-spotted ladybird beetle (*Coccinella septempunctata*) and zig-zag ladybird beetle (*C. transversalis*) was recorded during the 30th SW, with 0.12 ladybird beetles per meter row length (LBB/mrl). They remained on the crop until the 41st SW, reaching 0.21 LBB/mrl. The highest population of ladybird beetles was observed during the 36th SW, with 2.24 LBB/mrl (Table 1). This finding is corroborated with the finding of Hemlata *et al*. (2022) [9]. Correlation studies as given in Table 2 revealed that non significant with all weather parameter. Similarly, Suyal *et al*. (2018) [19] also reported that the population of lady bird beetle had exhibited non-significant correlation with all weather parameter.

Spider, *Oxyopes satticus* (Hentz)

The first appearance of spiders was recorded during the 31st SW with 0.57 spiders/mrl which were remained on the crop until the 41st SW, reaching 0.43 spider/mrl. The population was gradually increased and reached its peak at 36th SW with population of 3.19 spiders/mrl (Table 1). Similarly, Hemlata *et al*. (2022) [9] also reported the same result on soybean crop. Further, spider population had exhibited non-significant correlation with all taken weather parameters (Table 2). Similarly, Birader *et al*. (2023) [5] also reported that the population of spider had exhibited non-significant correlation with all weather parameters.

Table 1: Mean population of major arthropods on soybean at Jabalpur during *Kharif* 2024

SW	Period From-To	Crop age (DOC)	Insect pests								Natural enemies /mrl	
			Per cage per plant		Infestation (%)	Larvae/mrl				Per plant		
			Whitefly (Adult)	Jassid (Nymph+ Adult)	Stem fly	*C. acuta*	*S. litura*	*S. obliqua*	Leaf folder	Bean leaf beetle (Adult)	LBB complex (Grub + Adult)	Spider (Adult)
29	16-22 July 24	17	0.81	0.19	0	0.00	0.00	0.00	0	0.00	0.00	0.00
30	23-29 Jul 2024	24	1.01	0.26	10	0.00	0.00	0.00	0	0.21	0.12	0.00
31	30Jul-5Aug. 24	31	1.37	0.88	20	0.43	0.00	0.00	0.26	1.12	0.26	0.57
32	6-12 Aug. 24	38	1.69	1.36	30	1.14	0.81	1.48	0.48	1.62	0.55	0.64
33	13-19 Aug. 24	45	2.93	1.76	40	2.19	1.55	2.71	0.74	2.02	0.86	0.93
34	20-26 Aug. 24	52	3.36	2.40	50	3.38	3.38	3.93	0.79	2.60	1.33	1.05
35	27Aug.-02 Sept. 24	59	4.29	2.93	50	4.10	4.19	6.31	0.89	3.31	1.86	2.83
36	3-9 Sept.24	66	5.02	3.24	60	5.14	5.31	6.55	1.25	3.64	2.24	3.19
37	10-16 Sept. 24	73	4.79	3.83	70	5.40	6.19	8.36	1.73	4.10	2.02	2.64
38	17-23 Sept.24	80	3.26	2.74	80	6.21	4.33	8.95	1.02	2.93	0.93	1.95
39	24-30 Sept.24	87	2.45	1.86	90	4.38	2.90	5.95	0.91	2.10	0.71	1.14
40	1-7 Oct.24	94	2.07	1.21	100	2.17	2.02	4.21	0.71	1.50	0.29	0.79
41	8-14 Oct.24	101	1.95	0.81	100	1.10	1.05	3.10	0.63	0.95	0.21	0.43

DOC = Days old crop, SW = Standard week, LBB = Ladybird beetle

Table 2: Correlation of abiotic factors with insect pests and their natural enemies on soybean

Weather parameters	Correlation coefficient (r)									
	Per cage per plant		Stem fly infestation (%)	Larvae/mrl				Per plant	Per meter row length	
	Whitefly	Jassid		Green semilooper	Tobacco caterpillar	Bihar hairy caterpillar	Leaf folder	Bean leaf beetle	Lady bird beetle	Spider
n	13	13	12	11	10	10	11	12	12	11
Max. T (°C)	0.41^{NS}	0.26^{NS}	0.68^{*}	-0.12^{NS}	-0.51^{NS}	-0.55^{NS}	-0.10^{NS}	0.07^{NS}	0.13^{NS}	-0.01^{NS}
Min. T (°C)	0.31^{NS}	0.3^{NS}	-0.47^{NS}	0.39^{NS}	0.41^{NS}	0.21^{NS}	0.19^{NS}	0.44^{NS}	0.52^{NS}	0.52^{NS}
Morning RH (%)	0.23^{NS}	0.15^{NS}	-0.83^{**}	-0.05^{NS}	-0.24^{NS}	-0.07^{NS}	0.001^{NS}	-0.04^{NS}	-0.07^{NS}	0.009^{NS}
Evening RH (%)	-0.21^{NS}	-0.11^{NS}	-0.84^{**}	0.42^{NS}	0.58^{NS}	0.47^{NS}	0.57^{NS}	0.13^{NS}	0.06^{NS}	0.26^{NS}
Rainfall (mm)	-0.29^{NS}	-0.18^{NS}	-0.53^{NS}	0.26^{NS}	0.42^{NS}	0.36^{NS}	0.04^{NS}	0.03^{NS}	0.009^{NS}	0.12^{NS}
Sunshine (hrs)	-0.34^{NS}	-0.24^{NS}	0.72^{*}	0.09^{NS}	0.53^{NS}	0.29^{NS}	0.05^{NS}	0.04^{NS}	0.06^{NS}	0.08^{NS}
Wind speed (km/hr)	-0.12^{NS}	-0.06^{NS}	-0.44^{NS}	0.35^{NS}	0.66^{NS}	0.66^{NS}	0.54^{NS}	0.15^{NS}	0.04^{NS}	0.31^{NS}
Mor. vapour pressure (mm)	0.07^{NS}	0.03^{NS}	-0.52^{NS}	0.28^{NS}	0.24^{NS}	0.03^{NS}	0.04^{NS}	0.24^{NS}	0.35^{NS}	0.38^{NS}
Eve. vapour pressure (mm)	0.005^{NS}	-0.06^{NS}	-0.62^{*}	0.18^{NS}	0.23^{NS}	-0.05^{NS}	-0.004^{NS}	0.29^{NS}	0.44^{NS}	0.36^{NS}
Evaporation (mm)	-0.62^{*}	-0.63^{*}	-0.49^{NS}	-0.22^{NS}	-0.36^{NS}	-0.20^{NS}	-0.45^{NS}	-0.49^{NS}	-0.47^{NS}	-0.32^{NS}
Rainy days (nos.)	-0.26^{NS}	-0.20^{NS}	-0.68^{*}	0.43^{NS}	0.53^{NS}	0.28^{NS}	0.34^{NS}	0.13^{NS}	0.14^{NS}	0.23^{NS}

n = Number of observation, NS = Non-significant, * = Significant at 0.05%, ** = Significant at 0.01%

Conclusion

The present study on the population dynamics of arthropods i.e., insect pests and their natural enemies on soybean crop provides valuable information on the timing and dynamics of pests and their predator populations. Significant correlations and regression results indicate that pest densities are influenced by climatic factors. Understanding these patterns presents opportunities for designing of prediction forecasting models for targeted pest control strategies. These insights are useful in establishing pest surveillance systems and formulating ecologically sustainable integrated pest management (IPM) practices.

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