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Population Dynamics of Major Insect-pest and Natural Enemies on Maize Crop

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A B S T R A C T

An field experiment was conducted in two consecutive year (Spring 2015 and 2016) at NawabGanj Farm of C. S. Azad University of Agriculture and Technology, Kanpur 208002 (U.P.). The Shoot fly (egg/plants) on maize appeared in both year (Spring 2015 and 2016) from 7th to 13th standard week and the highest egg laying was found in 11th S.W. (2.83egg/plant) in above years. Stem borer, *Chilo partellus* (Swinhoe) dead heart was observed from 8th to 16th standard week after this period there was no newly dead heart was found till the crop harvested. Three species of coccinellids *viz., Coccinella septempunctata* (Linnaeus), *Cheilomenes sexmaculata* (Fab.), *Coccinella tranversalis* (Fab.) and *Brumoides suturalis* (Fab.) were found commonly associated with sucking pests of maize crop. The population was recorded from 7th to 19th S.W. Spiders are the predominant generalised predators found feeding on variety of sucking as well as lepidopteron pests in maize ecosystem. It was observed that the spiders were abundant between 8th to 20th S.W., its peak population observed during 15th and 16th standard week that coincided to follow with high prey population *i.e.* stem borer and aphids.

Introduction

Maize or corn (*Zea mays*) belongs to the family Poaceae. It is the third most important cereal crop in India after rice and wheat. It has dual importance as food and fodder in addition to industrial uses as raw material for manufacture of many industrial products. The products include corn starch, maltodextrins, corn oil, corn syrup and products of fermentation and distillation industries. It is also being recently used as bio fuel. The maize contributes 36% (712MT) of the global grain production. The global productivity of maize is 4.92 tons/ha and productivity in USA is 10 tons/ha. In India area, production and productivity of maize was 0.87 million hectares, 2.22 million tonnes and 2556Kg/hectare, respectively. In Uttar Pradesh it is grown in an area of 0.74 million hectare, with production 1.24 million tonnes and productivity 1671 kg/ha (Anonymous, 2013-14). The high yield in maize could not be acquired due to attack of large number of insect pest. More than 150 insect species damage the crop from sowing to harvest. The continuous cropping of maize during the *'kharif', 'rabi'* and *'spring'* seasons has led to a change in the insect-pest complex with the occurrence of shoot fly (*Atherigona soccata*) in '*spring*', Maize stem borer (*Chilo partillus*) in kharif and Pink stem borer (*Sesamia inference*) in rabi sown maize. Among them shoot fly, *Atherigona soccata* causes maximum yield losses of 75.6% in grain and 68.6% in fodder (Pawar *et al.*, 1984). There are two types of factors influencing the population dynamics of insects: endogenous factors, which generate the first and second order feedback structure, and exogenous factors, e.g. climate. In populations where fluctuations are affected by trophic interactions such as predator-prey or host-parasitoid systems, the correlated climatic effects either operate via density-dependent mechanisms, whereby strong density dependence would enhance the synchrony, or more directly on population abundance, moving the populations towards a synchronous phase (Bjornstad & Bascompte 2001; Lima *et al.*, 2002; Stenseth *et al.*, 2002; Cattadori *et al.*, 2005), which means that correlated population fluctuates over localized or wide-scaled geographical areas (Ranta*et al.*, 1995; Hudson &Cattadori 1999).Furthermore, dispersal or the mobility of the host and parasitoid determine the synchrony of the population (Bjornstad *et al.*, 1999).

Materials and Methods

The present investigation was carried out at NawabGanj Farm of C. S. Azad University of Agriculture and Technology, Kanpur 208002 (U.P.) during both the *Spring* season of 2015 and 2016. Pest complex and predators associated with maize crop were recorded right from germination till the harvest of the crop at weekly interval from a separate 10sq. meter plot. Observations were taken randomly at five spots. The insect-pests and predators were collected and reared up to adult stage wherever necessary. The nature and extent of damage caused by various insect-pests were also recorded to assess the economic status of the pest.

Results and Discussion

Population dynamics of *Atherigona soccata* (Rondani)

Population dynamics of *Atherigona soccata* (Rondani) in *Spring* 2015

Shoot fly (egg/plants) on maize appeared at seventh standard week (S.W.) (Table-1) with the intensity 0.26 egg/leaf. The shoot fly intensity increased upto 9th S.W., when number of egg increased (1.87egg/leaf). The highest intensity of shoot fly 2.73 egg/plants was found with maximum temperature (26.6^{0}C), medium level of minimum temperature (14.6^{0}C), morning (92%) and evening (63%) relative humidity and with rainfall of 95.0 mm. The crop stage which found highest shoot fly intensity was in 10th and 11th standard week. During these weeks, maximum temperature remained 26.9 and 26.6^{0}C, minimum temperature 12.7^{0}C and 14.6^{0}C, morning relative humidity 92% and 84% and evening relative humidity 63% and 55% and rainfall of 0.0 and 95 mm, respectively. The egg/plant decreased just from 13thS.W. and not found in14th S.W. to till the crop was harvested (Table-1).The correlation values with regard to egg per plant there was negative correlation with maximum temperature with significant values (Table-3). The minimum temperature had also significantly negative correlation with egg per plant. Per cent relative humidity minimum and maximum was found to be positively correlated with respect to egg per plant. Rainfall increases the egg/plant of shoot fly.

Population dynamics of *Atherigona soccata* (Rodani) in *Spring* 2016

Shoot fly eggs on maize plant appeared during seventh standard week (Table-2) with the intensity 0.22egg/plants. The intensity of pest increased upto 9th S.W. to 11th S.W., when eggs (1.81 and 2.83/plant) was recorded maximum in at 30.6^{0}C and 30.4^{0}C (maximum), 14.4^{0}C and 16.6^{0}C (minimum) temperatures, with 91 and 75 per cent relative humidity in morning and 44 and 41 per cent in evening and rain fall of 3.7 and 5.8 mm, respectively. The highest egg laying was found in 11th standard week (2.83egg/plant) and recorded with 30.4 and 16.6 maximum and minimum temperature, the relative humidity 75 per cent and 41 per cent of morning and evening respectively with 3.7 mm rainfall. The eggs decreased from 13th S.W. and not found in14th S.W. to till the crop was harvested. The correlation values with regard to egg per plant there was negative correlation with maximum temperature with significant values (Table-3). The minimum temperature had also significantly negative correlation with egg per plant. Per cent relative humidity minimum and maximum was found to be positively correlated with respect egg per plant. Rainfall negatively correlated with the egg/plant of shoot fly.

The above finding supported by Sable *et al.,* (2009) who reported that shoot fly dead hearts were 73.23% during the 32nd-37th meteorological week, where maximum and minimum temperature and relative humidity in the morning and evening were 30.00 and 21.80 ^{0}C and 86 and 67%, respectively with 244 mm rainfall. Overall shoot fly infestation increased consistently in crops sown from 1 July to 16 August and declined from 16 August to 1 September. Aghav (2007) also reported that the population dynamics showed significant positive correlation with meteorological parameters studied while dead hearts formation was not correlated. Whereas, Kandalkar *et al.,* (1996) reported peak period of shoot fly infestation occurred 13-41 days after sowing. Similarly, Shekhar (1995) reported that correlation between percentage dead hearts and the maximum temperature was significant and positive, whereas the correlation was negative between percentage dead hearts and relative humidity.

Population dynamics of *Chilo partellus* (Swinhoe)

Population dynamics of *Chilo partellus* (Swinhoe) in *Spring* 2015

The data on population fluctuations of *Chilo partellus* during spring 2015 have been furnished in the Table-1. It is evident from table that maximum (32.19%) dead heart was observed in12th standard week.

The maximum temperature 31.2°C, minimum temperature 15.9°C morning and evening relative humidity 82 and 48 per cent respectively, were recorded during this period with no rainfall. It is also evident from the table that minimum percent of dead heart (1.21) were recorded during observational period of 16th S.W. with maximum temperature of 38.4°C along with minimum temperature of 22.1°C, morning and evening relative humidity 70 and 48 per cent and no rainfall was observed during this period. Stem borer dead heart was observed from 8th S.W. to 16th S.W., after this period there was no newly dead heart was found till the crop harvested. It is evident from the data in table-3 that maximum and minimum temperature was negatively correlated to the dead heart percentage of stem borer. Rainfall was positively correlated to the dead heart percentage. Relative humidity was also positively correlated to the dead heart percentage of stem borer.

Population dynamics of *Chilo partellus* (Swinhoe) in *Spring* 2016

The data on population fluctuations of *Chilo partellus* during *Spring* 2016 have been furnished in the Table-2. It is evident from table that maximum (31.21%) dead heart was observedin 12th standard week. The maximum temperature (33.9°C), minimum temperature (16.9°C), morning and evening relative humidity 70 and 33 per cent respectively, were recorded during this period with no record of rainfall followed by 26.25% dead heart was observed in 11th S.W. with maximum and minimum temperature 30.4°C and 16.6°C in this period morning and evening R.H. was 41% and 58% with 3.7 mm rainfall counted. It is also evident from the table that minimum percent of dead heart (1.01 per cent) were recorded during observational period of 16th S.W. with maximum temperature of 41.3°C along with minimum temperature of 24.1°C, morning and evening relative humidity 49 and 32 per cent and no rainfall was observed during this period. Stem borer dead heart was observed from 8th S.W. to 16th S.W. after this period there was no newly dead heart was found till the crop harvested. It is evident from the data (Table-3) that maximum and minimum temperature was negatively correlated to the dead heart, percentage of stem borer. Maximum relative humidity was also positively correlated to the dead heart percentage of stem borer but on the other hand minimum relative humidity negatively correlated was observed. Rainfall was negatively correlated to the dead heart percentage.

The above finding on population dynamics of *Chilo Partellus* is supported by Zulfiquar *et al.*, (2010) who reported that the infestation of *Chilo partelous* was found highest at the temperature of 32.5°C with relative humidity of 68% and lowest infestation of *chilo partellous* found at the temperature of 32.5°C with relative humidity of 50%. Similarly, Kandalkar *et al.*, (1996) reported peak infestation of *C. partellus* occurred 31-68 days after sowing. Moreover, Kumar (2016) noticed that correlation analysis showed that among the weather factors, maximum and minimum temperature showed a positive correlation with stem borer incidence while, morning, evening relative humidity and rainfall had negative correlation

Population dynamics of Coccinellids

Three species of coccinellids *viz.*, *Coccinella septempunctata*, *Cheilomenes sexmaculata* and *Brumoides suturalis* were found commonly associated with sucking pests of maize crop. They were observed at very low densities during the last stages (0.93 coccinellids/5plant in 19th S.W.) of the crop in *Spring* 2015. The population trend of coccinellids presented in Table-1 shows that the population of coccinellids appeared on the maize crop from 7th S.W. with an initial density of 1.10 coccinellids per five plants. The abundance of these predators increased with the crop age along with corresponding increase in the pest population to attain their peak population of 15.31 coccinellids per five plants on 14th S.W., the maximum temperature (33.0°C), minimum temperature (17.7°C), morning and evening relative humidity 74 and 48 per cent respectively, were recorded during 2015. Thereafter, the population started decreasing with lower population densities of these predators observed towards the crop maturity stages. During *spring* 2016, the coccinellids were observed on the crop between 8th S.W. to 19th S.W. (Table-2) with population ranging from 1.31 to 14.75 coccinellids per five plants. The peak population was recorded (14.75/5plant) on 12th S.W. corresponded with the peak density of aphids and other hosts and thereafter the population declined with no coccinellids were observed at crop maturity stages.

Table.1 Population dynamics of major insect-pest and natural enemies in maize crop (*spring* 2015)

S. No.	S.W.	Date	Temperature			Relative Humidity%			Rainfall (mm)	Shoot Fly (Eggs/plant)	Stem borer Dead heart %	Coccinellids/ five plants	Spider/ Five plants
			Max.	Min.	Mean	Mor.	Even.	Mean					
1.	6	Feb.,5-11	25.2	11.3	18.25	86	52	69	00	0	0	0	0
1.	7	Feb., 12-18	26.4	12.7	19.55	89	56	73	00	0.26	0	1.1	0
2.	8	Feb., 19-25	29.6	15.1	22.35	95	60	78	00	0.95	7.36	3.65	2.43
3.	9	Feb., 26-Mar.,04	25.3	12.2	18.75	95	67	81	71.5	1.87	15.87	7.53	4.26
4.	10	Mar.,5-11	26.9	12.7	19.80	84	55	70	00	2.12	21.12	10.32	5.32
5.	11	Mar.,12-18	26.6	14.6	20.60	92	63	78	95	2.73	26.75	12.54	5.87
6.	12	Mar.,19-25	31.2	15.9	23.55	82	48	65	00	1.54	32.19	14.75	6.45
7.	13	Mar.,26-April 01	33.7	18.4	26.05	82	49	66	4.6	0.52	23.54	13.32	7.64
8.	14	April, 02-08	33.0	17.7	25.35	74	48	61	00	0	12.34	15.31	8.43
9.	15	April, 09-15	32.1	18.8	25.45	76	61	69	4.8	0	5.89	12.32	10.32
10.	16	April,16-22	38.4	22.1	30.25	70	48	59	00	0	1.21	10.32	8.43
11.	17	April, 23-29	36.1	21.5	28.80	78	61	70	3.5	0	0	5.33	6.54
12.	18	April, 30-May,6	40.0	21.5	30.75	70	47	59	00	0	0	2.81	3.86
13.	19	May, 7-13	40.4	23.6	32.00	67	39	53	6.5	0	0	0.93	1.21
14.	20	May, 14-20	38.4	23.5	30.95	59	32	46	20.4	0	0	0	0.87
15.	21	May, 21-27	44.4	25.5	34.95	46	18	32	00	0	0	0	0

Table.2 Population dynamics of major insect-pest and natural enemies in maize crop (*Spring*2016)

S. No.	S.W.	Date	Temperature			Relative Humidity%			Rainfall (mm)	Shoot Fly (Eggs/plant)	Stem borer Dead heart %	Coccinellids/ five plants	Spider/ Five plants
			Max.	Min.	Mean	Mor.	Even.	Mean					
1.	6	Feb.,5-11	26.8	11.3	19.05	87	51	69	0	0	0	0	0
1.	7	Feb., 12-18	27.6	11.9	19.75	88	52	70	0	0.22	0	1.31	0
2.	8	Feb., 19-25	28.2	14.6	21.40	79	41	60	5	0.99	7.86	3.85	2.23
3.	9	Feb., 26-Mar.,04	30.6	14.4	22.50	91	44	68	0	1.81	15.17	6.43	4.45
4.	10	Mar.,5-11	31.3	17	24.15	80	46	63	5.8	2.22	21.31	11.12	5.46
5.	11	Mar.,12-18	30.4	16.6	23.50	75	41	58	3.7	2.83	26.25	12.24	5.47
6.	12	Mar.,19-25	33.9	16.9	25.40	70	33	52	0	1.34	31.21	14.75	6.85
7.	13	Mar.,26-April 01	35.6	17.7	26.65	79	42	61	0.6	0.62	22.57	14.12	7.84
8.	14	April, 02-08	38.6	22.1	30.35	62	48	55	0	0	13.01	13.91	9.23
9.	15	April, 09-15	39.9	22.1	31.00	44	27	36	0	0	4.91	13.12	10.12
10.	16	April,16-22	41.3	24.1	32.70	49	32	41	0	0	1.01	10.62	8.43
11.	17	April, 23-29	40.7	21.2	30.95	55	43	49	0	0	0	5.63	6.14
12.	18	April, 30-May,6	39.1	23.2	31.15	62	45	54	9	0	0	2.61	2.86
13.	19	May, 7-13	38.8	25.3	32.05	69	47.1	58	0.2	0	0	0.83	1.51
14.	20	May, 14-20	42.6	28	35.30	55	26	41	0	0	0	0	0.82
15.	21	May, 21-27	37.3	25.1	31.20	65	42	54	37.4	0	0	0	0

Table.3 Correlation of insect-pests and their natural enemies with abiotic factors during *spring*2015 and 2016 in maize crop

Serial No.	Insects-pest and predators	Weather Parameters									
		Temperature ^{0}C				Relative Humidity				Rainfall (mm)	
		Min.		Max.		R.H. Morning		R.H. Evening			
		2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
1.	Shoot Fly (Eggs/plant)	-0.613**	-0.538*	-0.593**	-0.473*	0.605**	0.494*	0.476*	0.056	0.680***	-0.076
2.	*C. partellus* (Dead heart percentage)	-0.468	-0.325	-0.461	-0.369	0.475*	0.327	0.334	-0.071	0.402	-0.179
3.	Coccinellids per five plants	-0.280	0.084	-0.239	-0.095	0.320	-0.177	0.404	-0.290	0.185	-0.326
4.	Spider per five plants	-0.061	0.357	0.007	0.124	0.168	-0.445	0.424	-0.382	0.049	-0.373

Significant at 5% level *
Significant at 1 % level **
Significant at 0.1 % level ***

Among the different weather parameters, maximum and minimum temperature had negative effect on the abundance of coccinellids during all the two years except maximum temperature of *Spring* 2016 positively correlated with coccinellids population. Relative humidity (Morning and evening) and rainfall had a significant positive correlation with coccinellids population during 2015 butall these parameters was negatively correlated during 2016 (Table -3).

Tha above finding supported by Megha *et. al* (2015) who found population had negative correlation with rainfall (r =-0.324*) and positive correlation with relative humidity in maize (r = 0.343). Minimum temperature had negative correlation and maximum temperature had positive correlation with coccinellids in maize crop. Sahito *et al.*, (2012) also recorded the population of seven spotted ladybird beetle (0.44), Zigzag beetle (0.69), eleven spotted beetle (0.07), *Brumus* (0.50), Green lacewing (0.78) /plant, respectively.

Population dynamics of spiders

Spiders are the predominant predators found feeding on variety of sucking as well as lepidopteron pests in maize ecosystem. They were present throughout the cropping period with varying densities. The data presented in Table-1 represents the population trend of spiders on maize crop during *Spring* 2015. It was observed that the spiders were abundant between 8th S.W. to 20th S.W., its peak population i.e. 10.32 and 8.43 spiders per five plants observed during 15th and 16th S.W. that coincided to follow with high prey population *i.e.* stem borer and aphids. During *spring*2016, the population of spiders was quite low during early crop growth stages, which increased gradually corresponding with increase in prey population and attained a peak population of (10.12 and 9.23 spiders/5 plants) on 15th and 16th standard week. The spider population did not affected by maximum and minimum temperature during both years of study (Table-3) except maximum temperature of *Spring* 2015 had negative correlation with spider population. However, significant positive correlation was observed with rainfall and maximum and minimum relative humidity during 2015, respectively but these parameters were found negatively correlated with spider population in 2016.

The above finding is as alignment with Patra *et al.*, (2013) who reported thirteen spider species in maize crop.

References

Aghav, S. T., Tambe, A. B., Baheti, H. S. and Patil, A. J. (2007). Studies on seasonal incidence of sorghum shoot fly, (*Atherigona soccata* Rondani). *Asian Journal of Bio Science*; 2 (1/2): *pp* 36-38.

Anonymous (2013-2014). Directorate of Economics and Statistics, Department of Agriculture and Cooperation. www.dacnet.nic.in

Bjornstad O.N., Ims R.A. and Lambin, X. (1999). Spatial population dynamics analyzing patterns and processes of population synchrony. *Trends in Ecology and Evolution* 14: 427-433.

Bjornstand, O.N. and Bascompte, J. (2001). Synchrony and second-order spatial correlation in host-parasitiod system. *Journal of Animal Ecology* 70: 924-933.

Cattadori I.M., Haydon D.T., Hudson P.J. 2005. Parasites and climate synchronize red grouse poulations. *Nature* 433: 737-741.

Hudson P.J., Cattadori I.M. 1999. The Moran effect : a cause of population synchrony. *Trends in Ecology and*

Evolution 14: 1-2.

Kandalkar, H. G., Wanjari, U. B., Dhope, S. S., Narkhade, A. M., and Shekar, S. S. (1996). Effect of weather factors on population of shoot fly and stem borer. *PKV Research Journal*; 20 (1): 94-95.

Kumar, S. (2016). Studies on seasonal incidence and management of stem borer, *Chilo partellus* (Swinhoe) and shoot fly, *Atherigona soccata* (Rondani) in maize. Ph. D. Thesis, S.V.P.U.A&T., Meerut.

Lima, M., Stenseth, N.C. and Jaksic, F.M. (2002). Food web structure and climate effects on the dynamics of small mammals and owls in semiarid Chile.*Ecology Letters*. 5: 273-284.

Megha, R.R., Basavanagoud, K. and Kulkarni, N.S. (2015). Population Dynamics of Coccinellid Predators in Some Agricultural Crops at Dharwad Region. *Journal of Experimental Zoology India*. 18 (1): 299-303.

Patra, S., Rahman, Z., Bhumita, P., Saikia, K., and Thakur, N.S. A. (2013). Study on pest complex and crop damage in maize in medium altitude hill of Meghalaya, *The Bioscan* . 8(3): 825-828.

Pawar, V.M., Jadhav, G.D and Kadam, B.S. (1984). Compatibility of Incol 50 S.P. with different fungicides on Sorghum (CS-3541) against shoot fly (*Atherigona soccata Rondani*), *Pesticides*, 18:9-10.

Ranta E., Kaitala V., Lindström J., Lindén H. 1995. Synchrony in population dynamics. *Proceedings of the Royal Society of London B* 262: 113-118.

Sable, K. R., Kamble, S. K. Changule, R. B. and Dhutraj, D. N. (2009). Seasonal incidence and weather correlation of sorghum shootfly (*Atherigona soccata Rondani*). *Journal of Maharashtra Agricultural Universities*; 34 (2):243-244.

Sahito, H. A., Abro, G. H., Talpur, M. A., Mal, B. and Dhiloo, K. H. (2012). Population fluctuation of insect pests and predators in maize, *Zea may* l. *Wudpecker Journal of Agricultural Research*, 1(11): 466 – 473.

Shekhar, P. R. (1995). Seasonal incidence of sorghum shoot fly, *Atherigona soccata* Rondani (Diptera : Anthomyiidae). *Journal of Insect Science;* 8 (1):108-109.

Stenseth N.C., Mysterud A., Ottersen G., Hurrell J.W., Chan K.-S., Lima M. (2002). Ecological effects of climate fluctuations. *Science* 297: 1292-1296.

Zulfiqar, M. A., Sabri, M. A., Raza, M. A. ; Hamza, A., Hayat, A.and Khan, A. (2010). Effect of Temperature and Relative Humidity on the Population Dynamics of Some Insect Pests of Maize. *Pak. J. Life soc. Sci.* 8(1): 16-18.

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