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Insect Pests Dynamics and Their Weather-based Population Fluctuation in Mungbean Crop in Hot Arid Region of Western Rajasthan

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ABSTRACT

Background: Mungbean is one of the important major pulse crops of the country. The Indira Gandhi Canal and groundwater irrigation have brought about significant ecological changes in the hot, dry region. Crop patterns have drastically shifted due to the availability of water for irrigation. Since the insects are, poikilothermic creatures, also prone to climate change. Therefore, it aimed to study the insect pest scenario in changing crop and climate of this region.

Methods: Survey and surveillance was done at fortnightly intervals. A total of 10 locations of mungbean were selected in Jaisalmer covering distance about 100-120 km while each filed/village had a distance of 5-7 km. Fixed plot survey approach was adopted and observations were taken at fortnightly interval from five spots in a field. From each spot, 3 plants were randomly examined. Weather data recorded at agro-meteorology unit of experimental area chandan (located 40 km from Jaisalmer) of regional research station Jaisalmer of ICAR-Central Arid Zone Research Institute was used for the study.

Result: Insects *i.e.*, Spotted pod borer, pod borer, blister beetle, looper, sphinx moth caterpillar, leaf folder, whitefly, thrips, leaf miner were found on mungbean, of these major were thrips, pod borer and spotted pod borer. Blister beetle was also observed as voracious and devastating but sporadic. Shannon's diversity index recorded in this study was 1.45 altogether. Spotted pod borer and American pod borer appeared in second fortnight of July (0.05 and 0.06 larvae) and reached to peak (1.02 and 1.01 larvae) in first fortnight of Sept. Thrips seen (0.51 thrips) in second fortnight of July and maximum (4.3 thrips) in first fortnight of September. Mean maximum temperature exhibited mild effect on the decrease of spotted pod borer and increase of *Helicoverpa* and thrips population while minimum had moderate effect. Mean Maximum and minimum Relative humidity demonstrated strong significant positive effect.

Key words: Arid region, *Helicoverpa armigera*, Insect pests, *Maruca testulalis*, Mungbean, Thrips.

INTRODUCTION

Mung bean, also known as green gram, is one of the important pulse crops of the country, besides dietary value, importance of mungbean in arid region lies due to its short duration nature, fixing soil nitrogen content, adaptation to low water requirement, makes it suitable to water stress area. Aridity, frequent droughts, moisture stress, low soil organic carbon and desert settlement are the characteristics of this area. In Rajasthan, Crop is grown in around 2560671-hectare area with production of 905713 M.T. Jaisalmer district produces the lowest yield of mungbean (merely 0.51 q/ha) as compared to average productivity of the state (5.50 q/ha) (Anonymous, 2021). This low productivity is attributed to many factors like, poor fertile soils, long drought spells and insect pests. About 99 species of insect pests under 68 genera enlisted as pests of mungbean, among which *Attactogaster orientalis*, *Myllocerus lactivirens* and *Poophilus costalis* were reported as new records (Verma and Saxena, 1987). Aphid, flea beetle and pod borer were also recorded as pests (Nimchang *et al.*, 2018; Khan *et al.*, 2018).

The Indira Gandhi Canal and groundwater irrigation have brought about significant ecological changes in the hot, dry region of India in recent decades. As a consequence of canal irrigation, many minor insects have assumed significance in the last two decades and damage to several crops has increased (Vyas, 1996). Due to strip cultivation of forage with legumes, *Clovia pucta* exclusive pest of grasses has established on legumes as well (Verma, 1979). *Cydia ptychora* is a less known pod borer of mungbean, but 45% pod with 73% grain damage was

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observed when grown as companion crop with *Cenchrus* sp. grass strips (Verma, 1986). Crop patterns have drastically shifted due to the availability of water for irrigation. Since the insect pests being the Poekilothermic creatures are also prone to the changes in response to the changing ecology and climatic conditions. Therefore, this study was aimed to study the insect pest scenario in the developing new crop and climatic patterns of this region.

MATERIALS AND METHODS

Study locations and sampling

The study was undertaken in the Jaisalmer which falls under western dry region of agro climatic zone of India (http://mowr.gov.in/agro-climaticzones). Nine field locations were selected from different areas of Jaisalmer district and covering a distance of about 100-120 km while three fields within each area had a distance of 2-4 km. The mungbean crop was observed using fixed plot survey approach and observations were taken at fortnightly intervals from five spots of each field during kharif season of 2020 and 2021. From each spot, 3 plants in 1 sq m were randomly examined for the incidence of different insect pests.

Data analysis

Mean density (MD), Relative density (RD %) and Diversity [Shannon-Weiner index (H')] index of insect species between the habitats surveyed was worked out with the help of below mentioned formulae. For working out the correlation of pod borer with weather parameters, data on incidence of pod borer collected from one field adjacent to the Agro-meteorology unit of the Experimental Area Chandan of Regional Research Station Jaisalmer of ICAR-Central Arid Zone Research Institute was utilized.

$$\text{Shannon diversity index (H)} = H = \sum_{i=1}^{S} - (Pi * 1n\ Pi)$$

Where,

H - Shannon diversity index.

pi - Proportion of individuals of i-th species in a whole community.

pi = n / N,

Where,

n - Individuals of a given species.

N - Total number of individuals in a community.

RESULTS AND DISCUSSION

Insect diversity and abundance

For assessing the diversity of different insect pests of mungbean, survey in Jaisalmer revealed that mungbean crop received the infestation of Spotted pod borer (*Maruca testulalis*), pod borer (*Helicoverpa armigera*), blister beetle (*Lydomorphus angusticollis*), looper (*Chrysodexis* sp.), sphinx moth caterpillar, leaf folder, whitefly (*Bemicia tabaci*), thrips (*Megalurothrips usitatus*) and leaf miner, of these major pests were thrips, pod borer and spotted pod borer (Fig 1). Spotted pod borer was initially found to feed on the growing shoots later infested the pods. *Helicoverpa* was first seen on the leaves of mungbean then on the developing pods. Blister beetle was also observed as voracious and devastating pest but was sporadic in nature; In mungbean, spotted pod borer and American pod borer appeared in the second fortnight of July (0.05 and 0.06 larvae) and reached peak (1.02 and 1.01 larvae) in the first fortnight of September. Mean pod damage was observed to be 20.93 per cent which ranged from 12.8 to 41.90 per cent at various locations. Thrips was seen (0.51 thrips) in the second fortnight of July and recorded maximum (4.3 thrips) in the first fortnight of September (Table 1 and 2).

Verma and Saxena (1987) reviewed the insect-pests of mung and enlisted about 99 species of insect pests under 68 genera. *Atactogaster orientalis*, *M. lactivirens* and *P. costalis* were reported as new records. Nimchang *et al.* (2018) recorded 23 insect-pests in mungbean. Duraimurugan and Tyagi (2014) recorded the pest spectra on mungbean comprising of 35 species during *kharif* season. Broad mite (*Polyphagotarsonemus latus*), blister beetle *(Mylabris pustulata*), spotted pod borer (*Maruca vitrata*) and Bean flower thrips (*M. usitatus*) recorded as the pests of major status during *kharif* season at Kanpur location. Khan *et al.* (2018) observed richness of aphid, flea beetle and pod borer on mungbean. Grey weevil (*Myllocerus maculosus*), black weevil (*Cyrtozemia cognata*), jassid (*Empoaska kerri*) pod borer (*Lampides boeticus*) and white fly (*Bemisia tabaci*) were reported as pests in arid region (Verma and Henry, 1988). They observed mean percent pods damage varying from 2.66 to 29.33 by *L. boeticus* with mean damage of 6.94 per cent at different locations. Soundararajan and Chitra (2017) recorded legume pod borer larva during *kharif* (0.33-3.75/plant) season. As a consequence of canal irrigation, many minor insects have assumed significance in the last two decades and damage to several crops has increased (Vyas, 1996). Due to strip cultivation of forage with legumes, *C. pucta* exclusive pest of grasses has established on legumes as well (Verma, 1979). *Cydia ptychora* is a less known pod borer of mungbean, but 45% pod with 73% grain damage was observed when grown as companion crop with *Cenchrus* sp. grass strips (Verma, 1986). Yadav *et al.* (2020) recorded the spotted borer, *M. vitrata*, chickpea pod borer, *H. armigera*, Bihar hairy caterpillar, *Spilosoma obliqua* and leafhopper, *E. kerri* as major pests in Western U.P.

Relative density and diversity index

RD of major insect pests *i.e.* spotted pod borer, American pod borer and thrips recorded to be 10.77, 13.26 and 48.32 percent, respectively. Minor insects were also recorded in numerous proportions (Table 1). A diversity index is a quantitative measure that reflects how many different types (such as species) there are in a dataset (a community). Shannon's diversity index recorded in this study was 1.45 altogether. It is irrefutable that insects significantly contribute to ecological prosperity and play a crucial role in

agroecosystems (Vijayababu *et al.*, 2016). Studies have shown that the populations of insects population profile are governed by vegetation, abiotic factors and other meteorological factors (Pinheiro *et al.*, 2002). Vegetation is a major factor in the diversity and composition of insects and any changes to the environment are likely to affect the distribution and relative abundance of insects (Kerchev *el al.*, 2012; Patil *et al.*, 2016). The type of vegetation in a

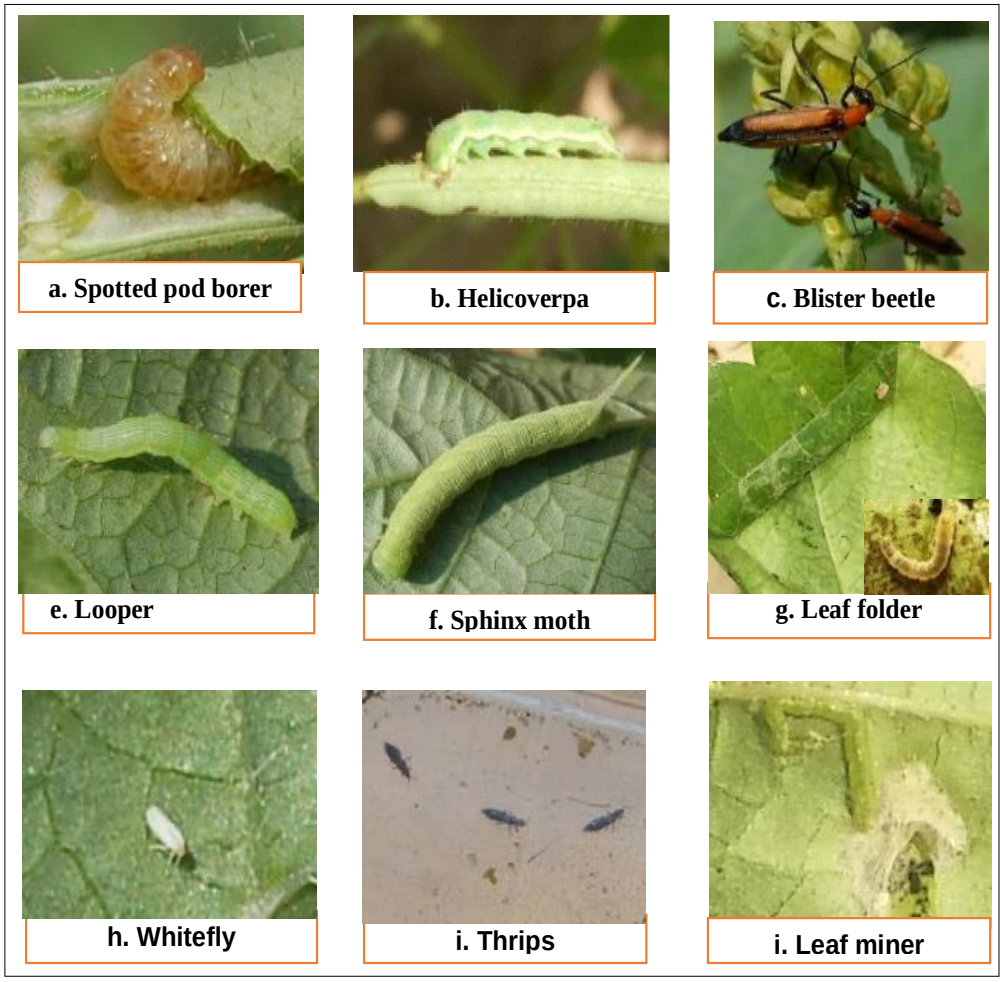

Fig 1: Insect pests on mungbean (a-j).

Table 1: Diversity and relative density of insect-pests on mungbean at Jaisalmer.

Date	(Mean/plant/location)								
	Spotted pod borer	Pod borer	Thrips	Whitefly	Looper (Chrysodexis)	Blister beetle	Leaf folder	Sphinx moth	Lm
Jul I - Fortnight	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Jul II - Fortnight	0.05	0.06	0.51	0.37	0.00	0.00	0.00	0.10	0.00
Aug I- Fortnight	0.30	0.52	1.71	2.10	0.00	0.00	0.00	0.00	0.05
Aug II - Fortnight	0.66	0.84	4.24	3.55	0.00	0.00	0.40	0.10	0.20
Sept I - Fortnight	1.02	1.01	4.30	5.85	0.15	0.54	0.80	0.20	0.00
Sept II - Fortnight	0.56	0.54	1.37	3.46	0.00	0.21	0.95	0.10	0.00
Oct I - Fortnight	0.05	0.00	0.00	0.91	0.00	0.00	0.40	0.00	0.00
Oct II - Fortnight	-	-	-	-	-	-	-	-	-
R D %	10.77	13.26	48.32	49.87	0.26	1.31	4.48	0.88	0.44
Mean density	0.38	0.43	1.74	2.32	0.02	0.11	0.36	0.07	0.04
Shannon-Weiner index (H')					1.45				

given area or habitat has a direct impact on the distribution of insects (Selvi and Dayana, 2015). The diversity of the entomofauna is highly influenced by weather factors. Temperature, precipitation and relative humidity influence the seasonal activities of insects (Danks and Key, 2006). There is a strong correlation between rainfall and insect abundance, which may have an impact on the insects numbers (Selvi and Dayana, 2015).

Relationship of mungbean insect pests with weather parameters

Incidence of *Maruca* (0.17 larvae /plant), *Helicoverpa* borer (0.63 larvae /plant) and thrips (2.43 thrips) started in the first fortnight of August. Population increased gradually with peak period of incidence of spotted pod borer and thrips coincided with the second fortnight of August while *Helicoverpa* attained peak in first fortnight of September (Table 3). Verma and Saxena (1987) reviewed the insect-pest of mung and enlisted about 99 species of insect including *A. orientalis*, *M lactivirens* and *P. costalis* as new records from 68 genera. *Mylocerus maculosus*, black weevil (*C. cognata*), jassids, pod borer *L. boeticus* and *B. tabaci* were reported as pests in arid region (Verma and Henry, 1988).

Mean maximum temperature exhibited mild effect on the decrease of spotted pod borer and increase of *Helicoverpa* and thrips population while mean minimum had moderate effect. Mean Maximum and mean minimum relative humidity demonstrated strong significant positive effect on the population of these pests. Sunshine hours demonstrated significant negative relationship of relative humidity with the spotted pod borer as well as thrips population and negative relationship with *Helicoverpa*. Duraimurugan and Tyagi (2014) in mungbean recorded strong negative correlation of flower thrips with mean relative humidity (r= - 0.66) and positive correlation with maximum (r= 0.39 in mungbean) and minimum temperature which are in agreement with the present study. Rainfall recorded a strong negative correlation with the incidence of bean flower thrips (r = -0.78) and spotted pod borer (r = -0.83). There was positive correlation with

Table 2: Pod damage in mungbean crop.

Location	Pod damage (%) during 2020	Pod damage (%) during 2021	Mean damage
Hameera	27.18	16.81	22.00
Mohangarh (Dwarkaram)	24.15	13.7	18.93
Mohangarh (Uparsingh)	15	10.54	12.77
Mohangarh (Mukhtar)	52.57	31.25	41.91
Mohangarh (Mathar)	19.21	10.98	15.10
Mohangarh (Mathar)	31.39	27.27	29.33
Chandan	23.45	16.78	20.12
Karmo ki dhani	18.05	16.93	17.49
Chutar dhani	17.79	20.02	18.91
Sodakaur	15.11	10.47	12.79
Mean	24.39	17.475	20.93

Table 3: Influence of weather parameter on major insect-pests of mungbean crop.

Period of observation	Mean max temp (°C)	Mean min temp (°C)	Mean max RH(%)	Mean min RH	Sunshine (Hrs/Day)	Rainfall (mm)	Mean population/plant		
							Spotted pod borer	Pod borer	Thrips
Jul I - Fortnight	41.1	26.5	69.2	37.3	7.4	2.1	0	0	0
Jul II -Fortnight	39.5	27.7	75.3	48.6	6.4	0.9	0.00	0.00	0.00
Aug I - Fortnight	38.5	27.2	77.5	46.5	7.3	0.2	0.17	0.63	2.43
Aug II - Fortnight	38.6	27.0	76.8	47.5	6.2	0.3	0.98	0.77	4.27
Sept I - Fortnight	39.5	26.6	77.0	47.1	6.6	0.9	0.93	1.43	2.93
Sept II -Fortnight	36.9	25.3	76.9	49.6	6.9	1.6	0.70	0.73	2.07
Oct I - Fortnight	36.6	21.2	67.5	35.2	8.1	0.4	0.00	0.00	0.00
Oct II - Fortnight	37.3	17.2	62.9	32.2	8.0	0.0	0.00	0.00	0.00
Mean	38.14	24.59	73.42	43.82	0.59	7.08	0.40	0.51	1.67
Coefficient of correlation (r) for population and mean max temperature							-0.02	0.06	0.01
Coefficient of correlation (r) for population and mean min temperature							0.38	0.43	0.48
Coefficient of correlation (r) for population and mean max RH							0.65*	0.71*	0.74*
Coefficient of correlation (r) for population and mean min RH							0.63*	0.64*	0.66*
Coefficient of correlation (r) for population and Sunshine (Hrs)							-0.67*	-0.55	-0.62*
Coefficient of correlation (r) for population and rainfall							0.02	-0.01	0.09

maximum (r= 0.39) and minimum temperature (r= 0.83) supporting the present study. The present findings outcome are supported by Kurly and Singh, (2021) who recorded that RH and temperature had positive and rainfall had negative influence on defoliators. In contrast to the present investigation, Sujatha and Bharpoda, (2017) reported a significant positive association with bright sunshine hours on thrips (r = 0.69*). Gehlot and Prajapat, (2021) recorded negative correlation of sucking insect pests with rainfall.

CONCLUSION

The Indira Gandhi Canal and groundwater irrigation have brought about significant ecological changes in the hot, dry region of India in recent decades. As a consequence of canal irrigation, many minor insects have assumed significance in the last two decades and damage to several crops has increased. Crop patterns have drastically shifted due to the availability of water for irrigation. Since the insect pests being the Poikilothermic creatures are also prone to the changes in response to the changing ecology and climatic conditions. In the scenario of climate change, the present study gives information on the changing pest complex, sequence of appearance during the season and effect of weather parameters on their population fluctuation. This study would serve as base data for further research in the hot arid region of Rajasthan.

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Conflict of interest

The authors declare that there is no conflict of interest.

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