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Diversity and relative abundance of insect pests associated with rainfed, tubewell and canal irrigated chickpea crop in hot arid region of Rajasthan

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Abstract

A study was done to find out the diversity and comparative abundance of insect pests of Chick pea (*Cicer arietinum* L.) in hot arid Rajasthan; a total of 10 locations of chick pea were surveyed from rainfed, tubewell and canal irrigated area in Jaisalmer district during Rabi 2019-20 and 2020-21. Different insects i.e., pod borer (*Helicoverpa armigera* Hubner), aphid (*Aphis craccivora* Koch), cutworm (*Agrotis ipsilon* Hufnagel) and termite (*Odontotermes obesus* Rambur) were recorded. Of these, *H. armigera* and *O. obesus* were recorded as the key pests; It is evident that *H. armigera* was first appeared in the First fortnight of November (45th - 46th SW) (0.49 larvae per plant) and peak attained in the First fortnight of February (6th - 7th SW) and density was maximum (1.90 larvae per plant) in rainfed as compared to Canal (1.28 larvae per plant) and tubewell irrigated (1.50 larvae per plant) crop. Termite Infestation was maximum in rainfed grown chickpea as compared to tubewell irrigated and canal irrigated. The *Helicoverpa* showed positive correlation with mean maximum temperature and mean rainfall and significant positive correlation with sunshine hours and significant negative correlation with mean minimum and maximum Relative Humidity.

Keywords: Arid Rajasthan, *Cicer arietinum* L., insect-pests, *Helicoverpa armigera*

1. Introduction

Chickpea (*Cicer arietinum* L.), is the important pulse crop under the Fabaceae mainly grown as rainfed crop (68% area). It accounts about 46% of national pulses production (23.95 MT). Rajasthan state contributes 1.22 MT in 14.0% (1.49 mha) of the national acreage under chickpea with 818 kg ha⁻¹ average productivity (Anonymous, 2021) [1]. Chickpea is one of the major crops grown in Jaisalmer. In the irrigated area, availability of water for irrigation has completely changed crop patterns during *kharif* and *rabi* seasons as groundnut, mustard, chick pea, cumin and wheat has become equally important as much as traditional crops such as moong, moth, *guar* and *bajra*. The climatic changes like high temperature, relative humidity and rainfall patterns influence the population and diversity of pests (Macfadyen *et al.*, 2018) [2]. The conditions of high and low temperature favor the pest outbreaks and results in increased pest damage to crops (Lehmann *et al.*, 2020) [3]. Recently, Meena *et al.* (2023) [4] have reported the outbreak and migration of *Catopsilia pyranthe* L. on senna (*Cassia angustifolia* Vahl) and migration in western arid region. Biotic stresses have great impact on chick pea growth and lead to low productivity, among them, damage of insect pests is an important factor. An annual loss due to insect-pests is estimated to be 15% in chick pea (Chandrashekar *et al.*, 2014) [5].

Pod borer, termite, aphid and cutworm are considered major pests of chickpea. The pod borer is causing average 70–95% damage in Indian conditions (Prakash *et al.*, 2007) [6]. Recent changes in the arid region have influenced the agro ecology in different ways. Knowledge of diversity, behavior and seasonal population dynamics are very important for development of integrated pest management. Therefore, this study was undertaken to find out the changes taking place in the diversity and comparative abundance insect pests.

2. Materials and Methods

2.1 Study locations and sampling: The study was undertaken in the Jaisalmer which falls under western dry region agro climatic zone of India (<http://mowr.gov.in/agro-climaticzones>). A total of 9 locations selected from rainfed, tubewell and canal irrigated area in Jaisalmer

district and fields of rainfed, tubewell and canal irrigated area had a distance of about 50-80 km while three field within each area had a distance of 2-4 km. The selected plots were farmers owned; therefore, mixture of crop varieties and staggered sowing dates was observed in chickpea crop. Fixed plot survey approach was adopted and observations were taken at fortnightly intervals from five spots of each field. From each spot, 3 plants in 1 sqm were randomly examined for the incidence of different insect pests.

2.2 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.

$$H = - \sum_{i=1}^s (P_i * \ln P_i)$$

Shannon diversity index (H) =

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; and

N - Total number of individuals in a community,

3. Results and Discussion

3.1 Diversity and abundance: Study in rainfed, tubewell and canal irrigated area revealed the presence of gram pod borer

(*Helicoverpa armigera* Hubner), aphid (*Aphis* sp), cut worm (*Agrotis ipsilon* Hufnagel) and termite (*Odontotermes obesus* Rambur). *H. armigera* and *O. obesus* were recorded as the key pests. *H. armigera* (table 1) was first appeared in the first fortnight of November (45th-46th SW) (0.49 larvae per plant) and peak attained in the first fortnight of February (6th-7th SW) and was maximum (1.90 larvae per plant) in rainfed chickpea as compared to canal (1.28 larvae per plant) and tubewell irrigated (1.50 larvae per plant) crop. In regard to aphid (table 2) first appeared in the second fortnight (49th SW-50th SW) of December (0.02 aphids per plant) and maximum were recorded during first fortnight of February (6th-7th SW) (2.18 aphids per plant) as compared to canal (0.50 aphids per plant) and tubewell irrigated (0.44), however in tubewell irrigated maximum population recorded in second fortnight of February (8th-9th SW). Infestation of cutworm (*Agrotis* sp.) was also observed during 2019 and 2020, however its population was in negligible numbers which may be due to its negatively phototaxic habit. Shannon wiener diversity index remained 0.67, 0.49 and 0.28 for the chickpea grown in the rainfed, tubewell and canal area, respectively.

Singh *et al.* (2018) [7] recorded *H. armigera*, *A. ipsilon*, *S. litura* and *O. obesus* as pests of chickpea and recorded gradual increase in pod borer population upto 9th SW. Pod borer larval population is positively correlated with temperature, whereas relative humidity and rainfall inhibit the population (Kumar and Bisht 2013; Shinde *et al.*, 2013) [8, 9]. Heavy rains negatively influence the insect population by washing away (Shrestha 2019) [10]. Overhead sprinkler compared to drip irrigation can result in increased relative humidity (RH) and decreased temperature within the plant canopy. Rendon and Walton (2019) [11] recorded higher RH in plant canopy in overhead sprinkler compared to drip irrigation treatments. Precipitation also increases air RH and Soil water content. Saturated soil water content results in a lower emergence of *H. armigera* pupae. Exposure to heavy precipitation results in the death of *H. armigera* (Ge *et al.*, 2003) [12].

Table 1: Mean population of gram pod borer at different locations in rainfed, canal and tubewell irrigated chick pea crop.

| Observation period | Rainfed (mean of 2019 and 2020) | | | | Canal (mean of 2019 and 2020) | | | | Tubewell (mean of 2019 and 2020) | | | |
|----------------------------|------------------------------------|------------|--------|------------|----------------------------------|-------------------|------------|------------|-------------------------------------|----------------|-----------|------------|
| | Basan peer | Bhagu gaon | Jhabra | Grand Mean | Mohan Garh 1 | Mathar khan house | Dalle khan | Grand Mean | Karmo ki dhani 1 | Chutar dhani 2 | Soda Kaur | Grand Mean |
| Nov I st Fort | 0.53 | 1.27 | 0.43 | 0.74 | 0.50 | 0.00 | 0.43 | 0.31 | 0.60 | 0.20 | 0.27 | 0.36 |
| Nov II nd Fort | 0.60 | 1.10 | 0.93 | 0.88 | 0.43 | 0.23 | 0.47 | 0.38 | 0.60 | 0.27 | 0.47 | 0.44 |
| Dec I st Fort | 0.67 | 0.77 | 0.53 | 0.66 | 0.37 | 0.80 | 0.80 | 0.66 | 0.43 | 0.67 | 0.43 | 0.51 |
| Dec II nd Fort | 0.90 | 1.13 | 0.37 | 0.80 | 0.43 | 0.40 | 0.57 | 0.47 | 0.50 | 0.43 | 0.33 | 0.42 |
| Jan I st Fort | 0.50 | 0.50 | 0.53 | 0.51 | 0.27 | 0.73 | 0.47 | 0.49 | 0.37 | 0.37 | 0.37 | 0.37 |
| Jan II nd Fort | 0.83 | 1.00 | 0.57 | 0.80 | 0.40 | 0.80 | 0.67 | 0.62 | 0.97 | 0.73 | 0.77 | 0.82 |
| Feb Ist Fort | 1.83 | 1.67 | 2.20 | 1.90 | 1.43 | 1.23 | 1.17 | 1.28 | 1.53 | 1.53 | 1.43 | 1.50 |
| Feb II nd Fort | 0.90 | 0.87 | 1.43 | 1.07 | 0.93 | 0.70 | 0.43 | 0.69 | 0.70 | 1.17 | 0.67 | 0.84 |
| March I st Fort | 0.07 | 0.60 | 0.80 | 0.49 | 0.93 | 0.27 | 0.33 | 0.51 | 0.63 | 0.40 | 0.10 | 0.38 |
| R D % | 29.04 | 37.82 | 33.14 | 41.53 | 35.19 | 31.89 | 32.92 | 28.59 | 37.40 | 34.06 | 28.54 | 29.88 |
| Mean Density | 0.76 | 0.99 | 0.87 | 0.87 | 0.63 | 0.57 | 0.59 | 0.60 | 0.70 | 0.64 | 0.54 | 0.63 |

Table 2: Mean population of aphid at different locations in rainfed, canal and tubewell irrigated chick pea crop.

| Observation period | Rainfed (mean of 2019 and 2020) | | | Grand Mean | Canal (mean of 2019 and 2020) | | | Grand Mean | Tubewell (mean of 2019 and 2020) | | | Grand Mean |
|----------------------------|------------------------------------|------------|--------|------------|----------------------------------|-------------------|------------|------------|-------------------------------------|----------------|-----------|------------|
| | Basan peer | Bhagu gaon | Jhabra | | Mohan garh1 | Mathar khan house | Dalle khan | | Karmo ki dhani 1 | Chutar dhani 2 | Soda kaur | |
| Nov I st Fort | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Nov II nd Fort | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Dec I st Fort | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0.00 |
| Dec II nd Fort | 0.00 | 0.00 | 0.07 | 0.02 | 0.00 | 0.17 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.00 |
| Jan I st Fort | 0.13 | 0.07 | 0.60 | 0.27 | 0.07 | 0.00 | 0.00 | 0.02 | 0.07 | 0.03 | 0.00 | 0.03 |
| Jan II nd Fort | 0.00 | 0.17 | 1.33 | 0.50 | 0.07 | 0.07 | 0.10 | 0.08 | 0.07 | 0.23 | 0.13 | 0.14 |
| Feb I st Fort | 0.63 | 0.90 | 5.00 | 2.18 | 0.70 | 0.50 | 0.10 | 0.43 | 0.10 | 0.53 | 0.57 | 0.40 |
| Feb II nd Fort | 0.70 | 1.63 | 2.83 | 1.72 | 0.13 | 0.00 | 0.17 | 0.10 | 0.97 | 0.37 | 0.00 | 0.44 |
| March I st Fort | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.57 | 0.30 | 0.13 | 0.33 |
| R D % | 10.43 | 19.67 | 69.91 | 69.52 | 47.62 | 34.92 | 17.46 | 10.38 | 43.44 | 36.07 | 20.49 | 20.10 |
| Mean Density | 0.16 | 0.31 | 1.09 | 0.52 | 0.11 | 0.08 | 0.04 | 0.08 | 0.20 | 0.16 | 0.09 | 0.15 |

3.2 Percent pod damage

Percent chick pea pod damage was varying at different locations (table 3) and recorded with mean of 20.00 percent and 21.37 percent during 2019-20 and 2020-21, respectively. The highest mean pod damage was (23.69%) in rainfed crop as compared to canal (18.39%) and tubewell irrigated (17.91%) chickpea during 2019-2020. While it was higher in canal irrigated with 24.32% than rainfed (20.19%) and tubewell irrigated (19.60%) crop.

Patel (1979) ^[13] reported yield losses by *H. armigera* from 10–60%. Vyas (1996) ^[14] recorded 3.56 to 46.40 percent pod damage during 1977-78 to 1988-89 in hot arid region. Rajput *et al.* (2003) ^[15] observed 1 to 50 larvae/ plant, with 8 to 90 percent pod damage. Pod borer positively correlated with temperature, whereas relative humidity and rainfall inhibit the population (Kumar and Bisht 2013; Shinde *et al.*, 2013) ^[8, 9] which may be one of the reasons of lower pest incidence in irrigated because the humidity remains higher in irrigated area. Besides this, sprinkler irrigation may also influence

negatively because the insect eggs, larvae and small bodied pests are washed away with heavy rains (Shrestha 2019) ^[10].

3.3 Percent termite infestation

Maximum infestation of termite was in rainfed grown chickpea accounting 17.27 percent as compared to tubewell irrigated (13.35%) and canal irrigated (10.98%). However during 2020-21 the maximum infestation was recorded in canal irrigated crops with a 17.35 percent as compared to rainfed (16.53 percent) and tubewell irrigated (15.09 percent) which might be a reason of closure of IGNP during the crop growing period. Mean termite infestation was maximum in case of rainfed grown crop (table 3).

Vyas (1996) ^[14] cited percent termite damage from 1.5–16.6 percent between 1975 to 1988. Present study gets the support from Sharma *et al.* (2009) ^[16] who reported the infestation of termites greater in rainfed than irrigated crops and was 20–25 and 10 percent in rainfed and irrigated fields, respectively.

Table 3: Percent pod damage of gram pod borer and percent plant infestation of termite in chick pea crop

| Area | Location | Pod borer (% pod damage) | | | | | Termite (% infestation) | | | | | |
|----------|-----------------------|--------------------------|-------|---------|-------|------------|-------------------------|--------|---------|--------|------------|--------|
| | | 2019-20 | Mean | 2020-21 | Mean | Grand mean | 2019-20 | Mean | 2020-21 | Mean | Grand mean | |
| Rainfed | Basanpeer | 23.85 | 23.69 | 19.14 | 20.19 | 21.94 | 17.78 | 17.27 | 13.16 | 16.53 | 16.90 | |
| | Bhagu gaon | 20.26 | | 22.98 | | | 20.83 | | 15.38 | | | |
| | Jhabra | 26.94 | | 18.47 | | | 13.21 | | 21.05 | | | |
| Canal | Mohangarh petrol pump | 18.06 | 18.39 | 23.02 | 24.32 | 21.36 | 10.00 | 10.98 | 25.00 | 17.35 | 14.17 | |
| | Matharkhan house | 17.73 | | 26.92 | | | 11.48 | | 13.85 | | | |
| | Dalle khan | 19.39 | | 23.02 | | | 11.48 | | 13.21 | | | |
| Tubewell | Karmo ki dhani1 | 15.94 | 17.91 | 15.92 | 19.60 | 18.76 | 14.75 | 13.35 | 12.50 | 15.09 | 14.22 | |
| | Chutar dhani2 | 24.72 | | 22.47 | | | 8.33 | | 19.57 | | | |
| | Sodakaur/lathi | 13.06 | | 20.41 | | | 16.95 | | 13.21 | | | |
| | Total | 179.96 | | 192.36 | | 186.16 | | 124.81 | | 146.92 | | 135.86 |
| | Mean | 20.00 | | 21.37 | | 20.68 | | 13.87 | | 16.32 | | 15.10 |

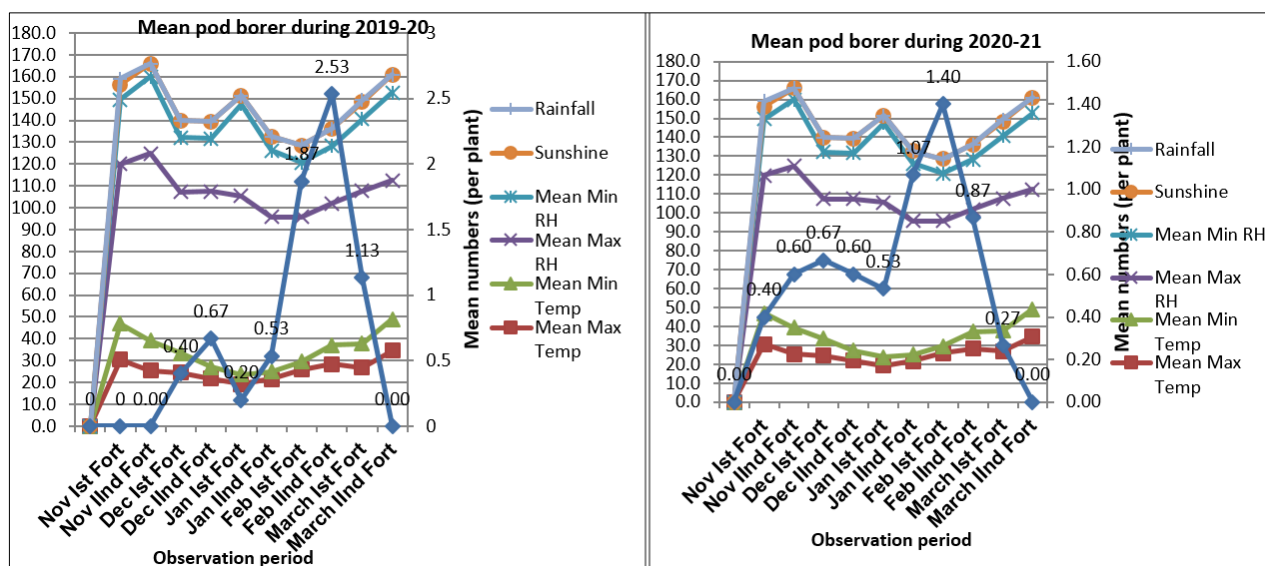


Fig 1: The different of mean pod borer during 2019-20 and 2020-21

3.4 Pod borer incidence and its association weather parameters- Incidence noted at different sites indicated that initial activity was occurred during the first fortnight of November (45th-46th SW) (0.49 larvae per plant) and peak attained in the first fortnight of February (6th-7th SW) and density was maximum (1.90 larvae per plant) in rainfed chickpea as compared to canal (1.28 larvae per plant) and tubewell irrigated (1.50 larvae per plant) crop. The *Helicoverpa* population showed positive correlation with mean maximum temperature and mean rainfall and significant positive correlation with sunshine hours and significant negative correlation with mean minimum and maximum RH (table 4).

Pod borer was positively correlated with temperature, whereas relative humidity and rainfall inhibit the larval population (Kumar and Bisht 2013; Shinde *et al.*, 2013)^[8, 9]. Heavy rains negatively influence the insect population by washing away their eggs, larvae and small bodied pests like aphids, mites, jassids, whiteflies etc (Shrestha 2019)^[10]. Findings of the present study are in conformity with Singh *et al.* (2018)^[7] who reported the first appearance of pod borer in the 51st SW (Standard Week) with intensity of 0.25 larvae m⁻¹ row to peak population of 13.00 larvae m⁻¹ row during 9th SW. They found positive correlation with respect to maximum temperature while negative correlation with minimum temperature, relative humidity and rainfall.

Table 4: Influence of weather parameters on chick pea pod borer population during 2019-20 and 2020-21.

| | 2019-20 | 2020-21 | Pooled |
|--|---------|---------|--------|
| Correlation Coefficient (r) for pod borer and mean max temperature | 0.14 | 0.19 | 0.20 |
| Correlation Coefficient (r) for pod borer and mean min temperature | -0.30 | -0.05 | -0.17 |
| Correlation Coefficient (r) for pod borer and mean max relative humidity | -0.55 | -0.32 | -0.50 |
| Correlation Coefficient (r) for pod borer and mean min relative humidity | -0.59 | -0.50 | -0.69 |
| Correlation Coefficient (r) for pod borer and Sunshine(Hrs) | 0.43 | 0.68 | 0.59 |
| Correlation Coefficient (r) for pod borer and rainfall | 0.14 | - | 0.15 |

4. Conclusion

In the last few decades, Jaisalmer has witnessed the rise in the sources of irrigation viz, tubewells, canal and fairly good harvested water in *khadins*. This is leading to change in the agroecology of desert ecosystem. These areas are having high humidity and low temperature which results extremes of weather events during that period. These events have adverse impact on the fauna available in the vicinity in different ways. Low temperature and high humidity during the winter results extreme weather events in irrigated area and have more adverse impact on the inset-pests of irrigated area as compared to rainfed areas. The climatic changes like high temperature, relative humidity and rainfall patterns influence the pests' population and diversity.

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6. Conflict of interest

Authors have no conflict of interest

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