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# MONITORING OF CITRUS PSYLLA POPULATION DYNAMICS IN SHADANANDA AND BHOJPUR MUNICIPALITY OF KOSHI PROVINCE, NEPAL

**Usha Karki[1] and Krishna Dahal[1*]**
[1]G.P. Koirala College of Agriculture and Research Centre, Morang, Purbanchal University, Nepal
[*]Corresponding author: dahalitahari@gmail.com
Krishna Dahal: 0000-0002-3330-7397
Usha Karki: 0000-0002-8418-9765

## ABSTRACT

The study on monitoring of Asian citrus psylla (*Diaphorina citri*) population at different altitude of Bhojpur district was carried out in the elevation of 733 meter above sea level (masl) to 1473 masl. A total of nine sites were monitored using yellow sticky trap glued with acetic acid from 14th March, 2024 to 3rd July, 2024. The spatial and temporal variations in citrus psylla population was detected at Shadananda-8, Semeng (733 and 855 masl), Bhojpur-4, Badahare tol (1298 masl) and Bhojpur-5, Damsing (1473 masl). Psyllid population was not found on yellow sticky trap at Shadananda-2, Tallo tabu (952 masl), Shadananda-11, Jhaupokhari (1081 masl), Shadananda-10 (1200 masl), Bhojpur-3, Gupteswor and Dawa bichbazar (1320 and 1556 masl). High psyllid population was detected in the month of April and May in low altitude area (<1000 masl), where temperature was from 27.6 - 29.5°C. Similarly, in high altitude sites (>1000 masl) the psyllid population was the highest in the month of June, where temperature was from 26.3 - 28.7°C. The results from the findings can be helpful to launch the management strategies for the control of citrus psylla in different altitude of Bhojpur district and similar agro-climatic zones in eastern Nepal.

**Key words:** *Altitude, citrus, population dynamics, yellow sticky trap*

## INTRODUCTION

Citrus (*Citrus reticulata* Blanco) is a genus of flowering trees and shrubs of subfamily Aurantioideae of Rutaceae family. It is native to sub-tropical regions of Asia, Australia, Melanesia and Polynesia and believed to be originated from southeast Asia (Dahal et al*.,* 2020). Most of the citrus fruits grow on either side of the belt around the equator covering tropical and sub-tropical areas of the world 35°N and 35°S latitudes with cultivation and production concentrated in major regions in the Northern hemisphere (Liu et al., 2012). Citrus is cultivated at the range of an altitude of 650 m to 1400 m above sea level and is the important cash crop to the hill farmers. The mid hill region of Nepal (1000 m to 1500 m altitude) has a comparative advantage in the cultivation of citrus fruits (Ghimire et al., 2024). Poudel et al. (2022) also reported that mid-hill region of Nepal has a comparative advantage in citrus cultivation due to affirmative climate. Mandarin is a sub-tropical fruit which is grown in wide range of soil of pH between 5.5 and 6.5, site receiving an annual rainfall of 1250 mm-1800mm, and having mild(frost-free) winter (Acharya et al., 2019). Economically citrus is 4-5 times more profitable than cereals in hills terraces and slopes (Gauchan,2000).

Despite many diseases reported to attack citrus crop, huanglongbing (greening) disease is the number one threat followed by Phytophthora inducing diseases in Nepal (Prasad & Chandra, 2019). Insects like citrus psylla, fruit fly, scale insect, stem borer, and leaf minor are serious threats to citrus cultivation (Nath and Sikha, 2019). The Asian citrus psylla (*Diaphorina citri* Kuwayama*)* is an important pest of citrus as it is a vector of serious bacterial disease of citrus called citrus greening or huanglongbing, belonging to Psyllidae family of the order Hemiptera. The most common species of the bacteria found in Nepal is *Candidatus Liberibacter asiaticus* which is transmitted by an insect vector, Asian citrus

psyllid (*Diaphorina citri*) (Pokhrel et al., 2021). Adult Asian citrus psylla are 2.7-3.3 mm long, have brown mottled wings and relatively three distinct colors of abdomen: orange/ yellow, blue/green, grey/brown (Pandey & Shrestha, 2023). *Diaphorina citri* (Asian citrus pysllid) and *Trioza erytreae* (African citrus psyllid) are the only known vectors of the etiological agent of citrus greening disease and are the only economically important psyllid species on citrus in the world. Psylla adult and nymph consume the cell sap of leaves, buds and young shoots which cause the leaves to curl, distort and shed all their leaves (Singh et al., 2018). *D. citri* prefers lower altitude of hot and dry condition (Hall, 2008). But due to the climate change and other various factors psylla has been reported above 1000m altitude in recent days. Therefore, it is necessary to monitor the insect population in different altitude of citrus growing region. Bhojpur is a district that lies in eastern hilly region of Koshi province of Nepal. The cultivation and production of mandarin orange is well flourished in this region. The favorable climatic conditions and suitable terrain in Bhojpur make it an ideal location for mandarin cultivation. In fiscal year 2021/22 mandarin was cultivated in 900 ha with the production of 5,440 Mt in Bhojpur district (MoALD,2023). In past, citrus psylla used to be found at lower elevation (below 1000 masl), however, in recent years it's presence has been observed at above 1000 masl in many districts of Nepal. Symptoms of citrus decline and citrus greening has been observed in Bhojpur district in recent years, but presence or absence of citrus psylla has not been studied yet. It is essential to develop integrated management methods for citrus psylla in developing country that is efficient, economic and has simple monitoring (Ramirez et al., 2018). Thus, the monitoring and analysis of population dynamics of citrus psylla is necessary to develop the recommendation of effective management of pest and thereby increase the production and productivity of mandarin in Bhojpur district.

## MATERIALS AND METHODS

### Site selection

The research was carried out both in Bhojpur and Shadananda municipality of Bhojpur district. Geographically, Bhojpur is situated at 27° 56' 8.34''North latitude and 81°46'31.98''East longitude. The annual temperature range of Bhojpur district is 29.12°C which is 7.12% higher than Nepal's averages annul temperature.

### Sample tree selection

At least 20 bearing fruit trees were selected for psylla monitoring through yellow sticky trap from the orchard. The selection of locations was primarily based on variation in altitude and area suspected of greening disease. Preference was also given to those orchards where insecticides had not been applied in recent years. The graph of temperature and rainfall data have been shown in Figure 3 and Figure 4 respectively.

**Table 1: Selection of research sites for monitoring**

| Location | Altitude (masl) |
|---|---|
| Shadananda-8, Semeng | 733 |
| Shadananda-8, Semeng | 855 |
| Shadananda-2, Tallo tabu | 952 |
| Shadananda-11, Jhaupokahari | 1081 |
| Sadananda-10, Majhuwa | 1200 |
| Bhojpur-4, Badahare tol | 1298 |
| Bhojpur-3, Gupteswor | 1320 |
| Bhojpur-3, Dawa bich bazar | 1556 |
| Bhojpur-5, Damsing | 1473 |

**Experimental period**

The monitoring was carried out from 14th March,2024 to 3rd July, 2024. First trap was installed in 14th of March at Bhojpur municipality and in 15th of March at Shadananda municipality.

**Installation of yellow sticky trap**

Yellow sticky traps were hung on citrus tree at 1.5 m from the ground. Cotton dipped in aqueous acetic acid was glued on the four corners of the trap, with two pieces placed at alternate corner on one side and other two at alternate corner on the opposite side. Four trees were selected at each orchard randomly at distance from one another and each yellow sticky trap was installed on branches of each four trees. Yellow sticky trap of size 24.7*19.5 cm was used to trap the psyllid population during the experiment. Four traps per orchard was used. A total of thirty-six traps were installed initially which was changed at each 10 days' interval till the end of study period. It is recommended to use four traps per hectare, which is enough to observe Asian citrus psyllid movement activity, subject to the specific edaphic and climatic conditions of each region (Leong & Beattie, 2022).

**Monitoring of psyllid population and record keeping**

Monitoring the Asian citrus psylla (ACP) population is an essential component of ACP management, both for application of economic thresholds as well as assessing effectiveness of control action (Monzo & Stansly, 2017). The number of psyllids trapped per trap was recorded at every ten days interval. Adult psyllids were observed using a hand magnifier and a microscope for further identification. The psyllid nymphs were counted during each monitoring period and records were maintained accordingly. The number of psyllid nymphs captured on four traps were averaged, and a graph of mean number of psyllids was plotted.

**Statistical analysis of data**

The recorded data was entered in MS-Excel and the analysis of data was done in IBM SPSS Statistics 25. Graph of population dynamics of citrus psylla was plotted with mean values of psyllid nymphs collected at four trees.

## RESULTS AND DISCUSSION

### Distribution of psyllids population at 733 masl

The presence of citrus psylla was recorded with fluctuation trends during the monitoring period at Shadanada-8, Semeng. The highest peak of psyllid population was observed in mid-April at temperature of 29 °C, after which the population declined as temperature decreases. However, Psyllid population start to rise as temperature increased from 12$^{th}$ of May, as shown in the Figure 1. This might be due to positive correlation in which psyllid population increases with temperature and vice versa. Sharma and Khokhar (2019) reported that psyllid population was lowest or absent from February to November with the first peak occurring during April-May and the second pick in August. The high population during April-May could be due to new flush emergence as well as conducive environmental condition (Devi & Sharma, 2014). Bibi et al. (2021) also reported that availability of flush growth and optimum meteorological conditions leads to large infestations of Asian citrus psylla on citrus plants.

### Distribution of psyllids population at 855 masl

The considerable numbers of psyllid population were detected during the middle of March which accelerated last week of April (30 nymph/trap) at temperature 28 °C, as shown in the Figure 1. Arora et al. (1997) also reported the first peak of the nymphal population in April and the second peak at the first fortnight of September in kinnow mandarin. The psyllid population was recorded lowest in the month of June when temperature start to decline (<25 °C). Piehua et al. (1988) reported that psyllid is stedious and found surviving in a wide range of extreme temperature which ranges from 45 °C to -7 to -8 °C.

### Distribution of psyllids population at 1298 masl

Bhojpur-4, showed psyllid population from the first monitoring. The recorded data showed a rise in psyllid population from the beginning to the end of study period, as temperature of (17 °C -24 °C) was recorded. There was not fluctuation in temperature as of altitude mentioned in 733 masl and 855 masl. The psyllid population was least in early spring and increase as temperature rises with commencement of rainy season. Wankhede et al. (2015) reported that psyllid population was peak during August- September and decrease in population abundance with low temperature and non-availability of new shoot flush. Manandhar et al. (2004) also found that highest number of psyllids population after rainfall at high altitude (>1000 masl) and in spring season at low altitude (<1000 masl).

### Distribution of psyllids population at 1473 masl

Bhojpur-5, Damsing, is the highest altitude range where the psylla was detected. However, it was recorded in a very low number (1.25 nymphs/trap). The psyllids were not detected during the month of March, April, May and middle of June. The first psylla was detected during last week of June when temperature was above 25 °C. This might be due to fluctuation in temperature as commencement of rainfall and exceed in temperature (> 20 °C) from the first week of May as shown in Figure 3. Manandhar et al. (2004) also reported high psyllid population 1000 masl during rainy season in day temperature of ≥ 20 °C. Wang et al. (2019) reported that extremely low temperature limits the development and dispersal of *Diaphorina citri*. This might be the reason for low population of Psyllids in rest of season.

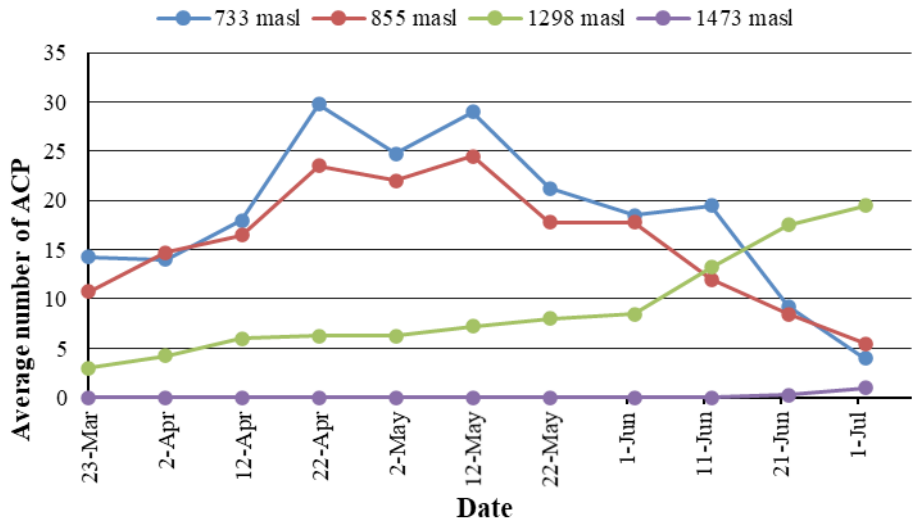


**Figure 1: The average population dynamics of citrus psylla trapped on yellow sticky trap at different altitudes in Shadananda and Bhojpur municipality ,2024**

**Detection of citrus psylla at different altitude**

The average number of Citrus psylla nymph found at two altitudes of Shadananda-8, Semeng are (202.25, 173.5); Bhojpur-4, badahare tol (99.75) and Bhojpur-5, Damsing (1.25); and it was not found at Shadananda-2, Shadananda-11, Shadananda-10, as well as both altitude of Bhojpur-3. ACP monitoring is considered as an indispensable tool for management of vector and disease (Monzo et al., 2015). Ghimire et al. (2024) also reported that the average number of aphids was significantly difference in different altitudes ($P \leq 0.01$).

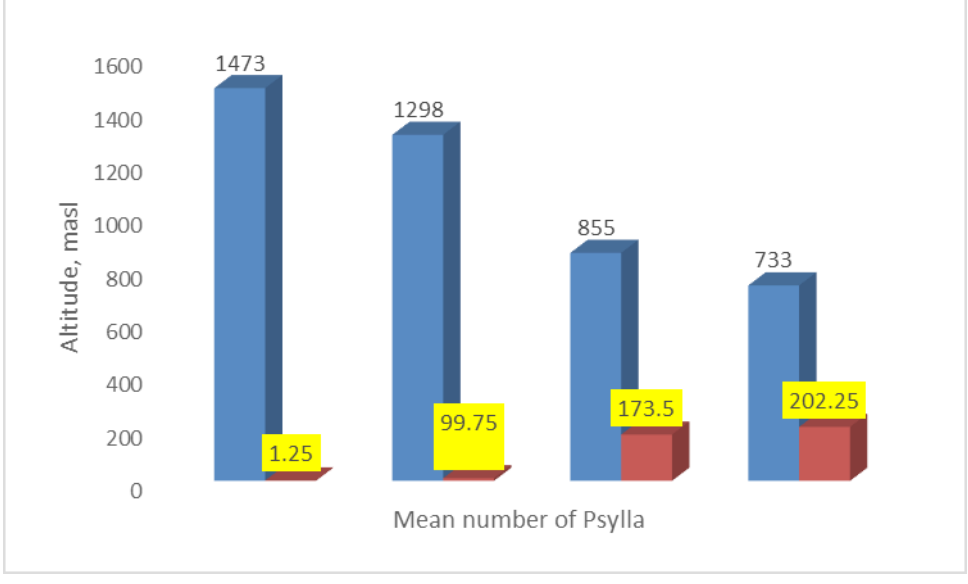


**Figure 2: Population dynamics of Asian Citrus Psylla at different altitude range (733-1556) masl**

**Meteorological data of Research site**

Average temperatures of the location tended to decrease with the increase in the altitude as per the data recorded as shown in Figure 3.

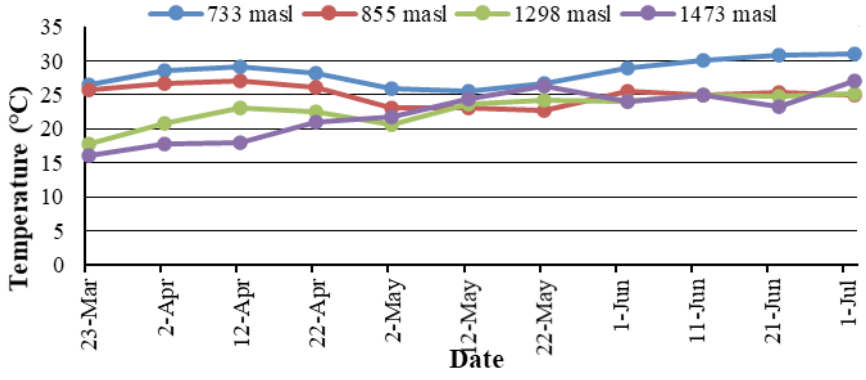


**Figure 3: Temperature at different altitudes in Bhojpur and Shadananda municipality, Nepal, 2024**

The highest average temperatures were recorded in the month of April and May at the study sites which ranged between 29.5°C and 27.6°C at 733masl and 855masl respectively. And at high altitude, highest average temperature ranged between 26.9°C and 26.3°C at 1298masl and 1473masl was recorded respectively. The increase in temperature and intensity of rainfall has positive effect in population of citrus psylla at different altitude of study site.

Rainfall was recorded highest in June (160.64mm) and July (128.31mm) and also there was considerable rainfall recorded in the month of May as shown in the Figure 4. The accumulated rainfall of the district was collected from the Department of Hydrology and Meteorology Station, Dingla.

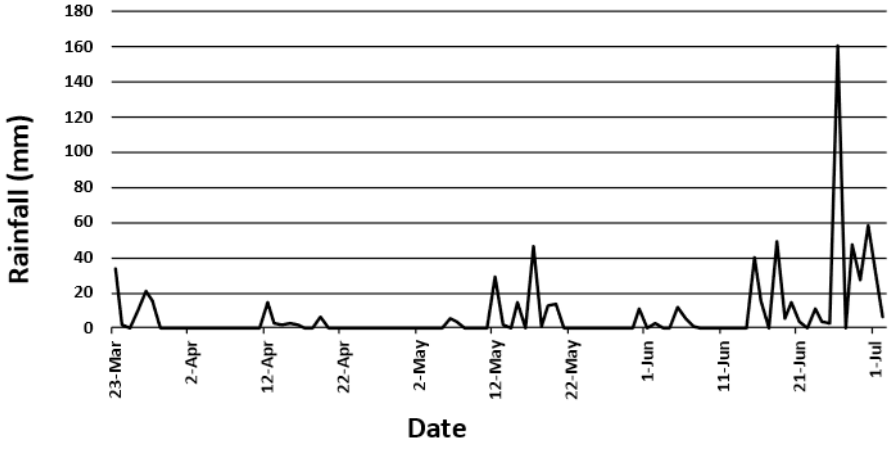


**Figure 4: Accumulated rainfall of the Bhojpur district, Nepal, 2024**

## CONCLUSION

Citrus is one of the pre-dominant crops in Bhojpur district, Nepal, with the majority of citrus grown as mandarins (*Citrus reticulata* Blanco). Monitoring and evaluation of psyllid

population is a cost-effective approach for initiating timely and effectively management of *D. citri*. The result showed the presence of citrus psylla at altitude of 733masl, 855masl, 1298masl and 1473masl, confirming its distribution across Bhojpur district. A decrease in psyllid population was observed when both maximum and minimum temperature declined, while relative humidity remained moderate. Spatial and temporal variations in psyllid population were evident in the monitored areas, and the seasonal fluctuation were also observed. Therefore, psyllid monitoring should be conducted throughout the year to understand its population dynamic in citrus growing-region and to support effective control measure.

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