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## Insect pests complex associated with rapeseed mustard crop in western Uttar Pradesh

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### Abstract

The present investigation was carried out on insect pests complex associate with rapeseed mustard during Rabi, 2020-21 and 2021-22 at Crop Research Center, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U. P.) 250110. The occurrence of four major insects viz. mustard sawfly (*Athalia proxima*), mustard aphid (*Lipaphis erysimi*), cabbage butterfly (*Pieris brassicae*) and painted bug (*Bagrada hilaris*) caused more damage at different crop growth stage. The maximum incidence of sawfly was recorded during 1<sup>st</sup> SMW (4.90 grubs/plant), when the crop at vegetative stage, whereas, the aphid population was highest at 7<sup>th</sup> MSW (101.90 aphid/10 cm terminal twig/plant). The maximum intensity of cabbage butterfly was recorded in 8<sup>th</sup> SMV (4.60 larvae/plant) and the highest incidence of the painted bug was noticed in the 11<sup>th</sup> SMV (4.25 bugs/plant). The two predators viz. ladybird beetle and syrphid fly was recorded during the crop period with maximum population of 6.20 grubs/plants and 3.90 grubs/plant at 7<sup>th</sup> and 8<sup>th</sup> MSW, respectively.

**Keywords:** Insect pests complex, sawfly, painted bug, syrphid fly and incidence

### Introduction

The mustard is an important oilseed crop belongs to the family *cruciferae*. The oilseed crop plays an important role in agricultural economy of India. Rapeseed mustard is a major winter (Rabi) season oilseed crop grown mainly in Northern parts of India. Mustard seed is the third biggest source of vegetable oil in the world after soybean oil and palm oil. The green leaves and stems of mustard are good source of green vegetable and fodder are rich in protein, minerals, vitamin A and C. The oil content varies from 37% to 49% and serves as a very good cooking medium and dietary fat on the majority of the population in Northern, North-Western, Central, Eastern and North-Eastern states.

It is the most common medium of pickling and food preserving. The seed and oil are used as condiment in the preparation of pickles and for flavouring curries and vegetables. It is also used in preparation of hair oils, medicines, soap making, in mixtures with mineral oils for lubrication and manufacture of grease. The oil cake is used as feed for cattle and manures besides oil, the leaves of young plants are used as green vegetable and whole plant as green fodder as they supply enough sulphur and minerals in the diet. In the tanning industry, mustard oil is used for softening leather (Singh *et al.*, 2012) [13].

Total oilseed was grown over an area of 28.79 million hectare with a production of 36.10 million tones and productivity of 1254 kg/ha during 2020-21. Rapeseed-mustard was grown over an area of 6.69 million hectare with a production of 10.11 million tones and productivity of 1511 kg/ha during 2020-21 in India, However, in Uttar Pradesh during the year 2020-21 the area of rapeseed-mustard was 0.70 million hectare and production 0.99 million tones with low productivity 1412 kg/ha. In world, during 2017-2018, Rapeseed-mustard occupied almost 36.68 million ha area with total production was 70.42 million tones and 1920 kg/ha productivity (Anonymous, 2021) [1].

Among various constraints in the productivity of rapeseed mustard, such as abiotic and biotic factor, abiotic factor in which rain fall, temperature, light humidity and biotic factors of insect pests is one of the most important limiting factors for its low yield. More than 43 species of insect pests have been recorded to infest rapeseed mustard crops in India under biotic stress. However, the maximum damage to the crop is done at flowering stage. During the period of present investigation, a total number of four insect pests from four different families viz. mustard aphid, *Lipaphis erysimi* (Kalt.); mustard sawfly, *Athalia lugens proxima* (Klug); Flea beetle, *Phyllotreta Cruciferae* (Goeze); cabbage butterfly, *Pieris brassicae* (Linn.) were recorded at different stages of mustard crop (Pradhan *et al.*, 2020) [10-11].

The mustard aphid, *Lipaphis erysimi* (Kalt.) belongs to the family Aphididae of order Hemiptera and sub order Homoptera. Both nymph and adult stages of this pest cause quantitative and qualitative losses in the mustard crop is the major pest of rapeseed mustard and damage to the crop ranged from 9 to 96% in different agro-climatic conditions of India. Both the adults and nymphs cause damage to mustard plant at vegetative, flowering and pod formation stages by sucking sap from the plant. In case of severe infestation leaves become curled, plant fails to develop pods, the young pods when developed do not mature and cannot produce seed. The pest also secretes the honeydew, which provides suitable medium for the development of sooty mould, which ultimately hampers the process of photosynthesis. On the basis of economic importance, mustard aphid is considered as a key pest (Bakhetia and Sechan, 1989) [2].

The judicious application of fertilizers is known to be effective in controlling the sucking insect pests. Fertilizer applications change the proportion of nutrient composition in plant tissues and consequently their nutritive value helps in the management of sucking pests (Pandey, 2010) [8].

### Material and Method

The present investigation was conducted under field condition at Crop Research Center (CRC) Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India during Rabi, 2020-22 on rapeseed mustard variety of Varuna. The quantification of the insect pests population was done under field conditions in the plot size kept 5 m × 4 m and replicated thrice with a field border of 1m and row to row spacing of 45 cm and plant to plant spacing of 15 cm. The observation was recorded at weekly interval started from soon after appearance of the aphid till the maturity of crop. To find out the population of mustard aphid from 10 cm terminal shoot of five plants were randomly selected in untreated plot. The daily metrological data pertaining to temperature, relative humidity and rain fall during experimental period was obtained from meteorological observatory of soil Science, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. The data on abiotic factors viz., temperature (°c), relative humidity (%) and rainfall (mm) were correlated to mean infestation caused by mustard aphid. Relationship between per cent infestation and metrological variables was worked out using simple correlation analysis.

### Incidence of Mustard Sawfly (*Athalia proxima*)

The incidence of mustard sawfly recorded at weekly intervals during crop season revealed that the insect appeared at early growth stage of crop. During Rabi, 2020-21, the initial population of this insect (0.40 grubs/plant) was recorded in 50<sup>th</sup> standard week (2<sup>nd</sup> week of December) and increased up to peak 4.70 grubs/plant in 1<sup>st</sup> standard week (1<sup>st</sup> week of January). Thereafter, the population of mustard sawfly declined and it was not observed at the 4<sup>th</sup> standard week (Table 1).

During Rabi, 2021-22, the initial population of mustard sawfly (0.20 grubs/plant) was observed in 49<sup>th</sup> standard week (2<sup>nd</sup> week of December) and reach its peak 5.10 grubs/pant in 1<sup>st</sup> standard week (1<sup>st</sup> week of January). Thereafter, the population of mustard sawfly declined and it was not observed at the 4<sup>th</sup> standard week (Table 2).

During Rabi, 2020-21 & 2021-22 (Pooled), the initial

population of mustard sawfly (0.10 grubs/plant) was observed in 49<sup>th</sup> standard week (2<sup>nd</sup> week of December) and reach its peak 4.90 grubs/pant in 1<sup>st</sup> standard week (1<sup>st</sup> week of January). Thereafter, the population of mustard sawfly declined and it was not observed at the 4<sup>th</sup> standard week (Table 3).

The present results on seasonal incidence of mustard sawfly are close agreement with the result of Pal *et al.* (2020) [6] who observed mustard sawfly, *Athalia lugens proxima* (Klug.) at seedling stage. The minimum population (0.30) was found in 48<sup>th</sup> standard meteorological week and maximum population (3.60) in 46<sup>th</sup> standard meteorological week. The similar result has been also reported by Gour and Pakeer (2003) [5] who observed the mustard sawfly grub population first time in fourth week of October, reaching its maximum (1.8 and 1.2 bug/plant) in the third week of November and persisted up to the third week of January.

Pal and Debnath (2020) [7] reported that maximum intensity of mustard sawfly was observed in middle of January, when the crop was flower bud formation stage. Pradhan *et al.* (2020) [10-11] revealed that mustard sawfly (*A. lugens proxima*) was appeared during 51<sup>st</sup> SMW i.e., 3<sup>rd</sup> week of December. Similar work had been reported by Pradhan *et al.* (2020) [10-11] the infestation of mustard sawfly began in third week of December and lasted until the last fortnight of February.

### Incidence of Mustard Aphid (*Lipaphis erysimi*)

The mustard aphid was appeared from 2<sup>nd</sup> standard week (2<sup>nd</sup> week of January) to 11<sup>th</sup> standard week (2<sup>nd</sup> week of March) with the population ranging from 14.20 to 123.50 aphids/10 cm terminal twig/plant in different standard weeks. The maximum population of mustard aphid (123.50 aphids/10 cm terminal twig/plant) was observed in the 7<sup>th</sup> standard week (2<sup>nd</sup> week of February). The minimum population 14.20 aphids/10 cm terminal twig/ plant were recorded at 11<sup>th</sup> standard week (2<sup>nd</sup> week of March) during Rabi, 2020-21 (Table 1).

During Rabi, 2021-22, mustard aphid was appeared from 1<sup>st</sup> standard week (1<sup>st</sup> week of January) to 10<sup>th</sup> standard week (2<sup>nd</sup> week of March) with the population ranging from 4.90 to 130.00 aphids/10 cm terminal twig/plant in different standard weeks. The maximum population of mustard aphid (130.00 aphids/10 cm terminal twig/plant) was observed in the 6<sup>th</sup> standard week (2<sup>nd</sup> week of February). The minimum population 4.90 aphids/10 cm terminal twig/plant was recorded at 10<sup>th</sup> standard week (2<sup>nd</sup> week of March) (Table 2). During Rabi, 2020-21 & 2021-22 (Pooled), mustard aphid was appeared from 1<sup>st</sup> standard week (1<sup>st</sup> week of January) to 11<sup>th</sup> standard week (2<sup>nd</sup> week of March) with the population ranging from 5.20 to 101.90 aphids/10 cm terminal twig/plant in different standard weeks. The maximum population of mustard aphid (101.90 aphids/10 cm terminal twig/plant) was observed in the 7<sup>th</sup> standard week (3<sup>rd</sup> week of February). The minimum population 5.20 aphids/10 cm terminal twig/plant was recorded at 1<sup>st</sup> standard week (1<sup>st</sup> week of January) (Table 3).

The present findings are partial agreement with the finding of Tomar and Yadav (2009) [15] who reported that mustard aphid infestation increased gradually from December and attained peak in the last week of January during 2002-03 when the temperature ranged from 8.4 to 20.20% and the relative humidity was 78.5 percent. During 2003-04 the aphid infestation began in the fourth week of December and reached its peak in the 3<sup>rd</sup> week of February when the temperature

ranged from 10.5 to 25.70 °C and the relative humidity was 68 percent. During 2004- 05, the infestation began in the first week of December and reached its peak in the 3<sup>rd</sup> week of January when the temperature from 6.6 to 15.90 °C and the relative humidity was 77.5 percent. Sahoo (2012) [12] also reported that mustard aphid is the most serious insect pest of mustard and responsible for causing the yield losses ranging from 35.4 to 96 per cent depending upon weather condition. The natural appearances of the aphid on the yellow sarson variety, Binooy (B-9) was observed from the 52<sup>nd</sup> standard week, with the peak population on 6<sup>th</sup> standard week and the aphid disappeared after 10<sup>th</sup> standard week.

The present findings are similar to the finding of Venkateswarlu *et al.* (2011) [16] found that major insect pests, which caused maximum yield losses in cabbage, caused by mustard aphid, *L. erysimi*, peak incidence of mustard aphid (169.9 aphids/plant) was recorded during 2<sup>nd</sup> week of March, 1<sup>st</sup> week of March, and 2<sup>nd</sup> week of March, respectively. Singh and Lal (2012) [13] also reported that mustard aphid, *Lipaphis erysimi* (Kalt.) was appearance from the 2<sup>nd</sup> week of January during both years and reached its peak in 8<sup>th</sup> standard week with a 219.07/10 cm terminal shoot and 199.10/10 cm terminal shoot during 2009-2010 and 2010-2011. These studies indicated that mustard aphid incidence was higher when maximum and minimum temperature ranged between 9.30 to 25.90 °C and 8.20 to 25.20 °C, relative humidity during hours 64.75 and 67.6 percent, rainfall 0.4 and 1.4 mm and sunshine hours 7.50 and 7.20 during 2009-2010 and 2010-2011, respectively.

#### **Incidence of Cabbage Butter Fly (*Pieris brassicae*)**

The cabbage butter fly population was appeared from 6<sup>th</sup> to 13<sup>th</sup> standard week with population ranging from 0.20-5.10 larvae/plant. The maximum population 5.10 larvae/plant was observed in 9<sup>th</sup> standard week and minimum population 0.20 larvae/plant was recorded in 8<sup>th</sup> standard week during *Rabi*, 2020-21 (Table 1).

During *Rabi*, 2021-22, cabbage butter fly population was appeared from 5<sup>th</sup> standard week to 11<sup>th</sup> standard week with populations ranging from 0.10-5.00 larvae/plant. The maximum population 5.00 larvae/plant was observed in 8<sup>th</sup> standard week and minimum population 0.10 larvae/plant was recorded in 11<sup>th</sup> standard week (Table 2).

During *Rabi*, 2020-21 & 2021-22 (Pooled), cabbage butter fly population was appeared from 5<sup>th</sup> to 12<sup>th</sup> standard week with populations ranging from 0.10-4.60 larvae/plant. The maximum population 4.60 larvae/plant was observed in 8<sup>th</sup> standard week and minimum population 0.10 larvae/plant was recorded in 12<sup>th</sup> standard week (Table 3).

The present findings are close agreement with the result of Patel *et al.* (2019) [9] who noticed the cabbage butterfly, *Pieris brassicae* irregular occurrence with low abundance. Bhati *et al.* (2015) [4] who also observed that, cabbage butterfly (*P. brassicae*) was found attacking at different growth stages of the rapeseed-mustard crop. In addition, to crop stage, the different *Brassica* species and weather conditions played a major role in the occurrence of insect-pests on Brassica species. The similar result has been reported by Venkateswarlu *et al.* (2011) [16] was observed that, the incidence of cabbage butterfly appeared during 2<sup>nd</sup> week of January.

#### **Incidence of Painted Bug (*Bagrada hilaris*)**

The painted bug population was appeared from 8<sup>th</sup> standard week (Third week of February) to 13<sup>th</sup> standard week (Fourth week of March) with populations ranging from 0.80- 4.80

bugs/plant. The highest population 4.80 bugs/plant was observed in 12<sup>th</sup> standard week. The lowest population 0.80 bug/plant was recorded in 8<sup>th</sup> standard week during *Rabi*, 2020-21 (Table 1).

During *Rabi*, 2021-22, painted bug population was appeared from 7<sup>th</sup> standard week (2<sup>nd</sup> week of February) to 13<sup>th</sup> standard week (Fourth week of March) with populations ranging from 0.60-4.30 bugs/plant. The maximum population, 4.30 bugs/plant was observed in 12<sup>th</sup> standard week and minimum population 0.60 bugs/plant was recorded in 7<sup>th</sup> standard week. During *Rabi*, 2020-21 & 2021-22 (Pooled), painted bug population was appeared from 7<sup>th</sup> standard week (2<sup>nd</sup> week of February) to 13<sup>th</sup> standard week (Fourth week of March) with populations ranging from 0.30-4.25 bugs/plant. The maximum population, 4.25 bugs/plant was observed in 11<sup>th</sup> standard week and minimum population 0.30 bugs/plant was recorded in 7<sup>th</sup> standard week (Table 3).

The present results are accordance with the result of Pal *et al.* (2020) [6] who found that, the incidence of painted bug, *Bagrada cruciferarum* (Kirk.) was observed at two different crop stages firstly, at seedling stage and secondly at maturity stage of crop. Patel *et al.* (2019) [9] was found the incidence of painted bug, *Bagrada cruciferarum* during seedling to maturity stage at a low level of population causing negligible damage. Lal *et al.* (2018) found that the appearance of painted bug was began during the 47<sup>th</sup> SMW and reached its peaks during 8<sup>th</sup> SMW. Bhati *et al.* (2015) [4] was found that, the painted bug appears at different growth stages of the rapeseed-mustard crop. In addition, to crop stage, the different *Brassica* species.

#### **The occurrence of major predators**

##### **Incidence of Ladybird beetle (*Coccinella* spp.)**

Ladybird beetle was observed from 2<sup>nd</sup> standard week to 11<sup>th</sup> standard week during *Rabi*, 2020-21 (Table 1). The population of *Coccinella* spp. ranged from 0.50 to 6.20 (grubs/plant) during the whole observation period. The population of the predator was initially low (0.50 grubs/plant) in the 2<sup>nd</sup> standard week and increased gradually to reached its peak, 6.20 grubs/plant in the 7<sup>th</sup> standard week.

During *Rabi*, 2021-22 (Table 2), ladybird beetle was observed from 2<sup>nd</sup> standard week to 11<sup>th</sup> standard week. The population of *Coccinella* spp. ranged from 0.40 to 6.00 (grubs/plant) during the whole observation period. The population of the predator was initially low (0.40 grubs/plant) in the 11<sup>th</sup> standard week and its peak, 6.20 grubs/plant in the 7<sup>th</sup> standard week.

During *Rabi*, 2020-21 & 2021-22 (Pooled), ladybird beetle was observed from 2<sup>nd</sup> standard week to 11<sup>th</sup> standard week. The population of *Coccinella* spp. ranged from 0.65 to 6.10 (grubs/plant) during the whole observation period. The population of the predator was initially low (0.65 grubs/plant) in the 2<sup>nd</sup> standard week and its peak, 6.20 grubs/plant in the 7<sup>th</sup> standard week (Table 3).

Similar work has been also reported by Begam *et al.* (2016) [3] who revealed that *Coccinella transversalis* was the most dominant predator species observed throughout the cropping season. Singh *et al.* (2000) to record the *Coccinellid* predators associated with mustard aphid, *L. erysimi* infesting mustard crop revealed that four species of coccinellids viz, *C. septempunctata*, *C. transversalis*, *C. sexmaculata* and *B. suturalis* were present. Among these, *C. septempunctata* and *C. transversalis* were important aphidiphagous *Coccinellid* predators of the mustard aphid.

**Table 1:** Succession of insect pest complex on rapeseed mustard crop during *Rabi*, 2020-21

SMW	Date	Abiotic factors					Natural enemies			Incidence of Insect Pests			
		Temperature (°C)		Relative Humidity (%)		Total rainfall (mm)	Mean No. of <i>Coccinella</i> spp. (adults/grubs) /plant	Mean No. of <i>Syrphid</i> spp. grubs/plant	Mean No. of Sawfly larvae/plant	Mean No. of aphids/10cm central twig/plant	Mean No. of Cabbage butter fly larvae/plant	Mean No. of Painted Bugs/plant	
		Max.	Min.	Max.	Min.								
49	30 Nov.-06 Dec.	26.30	7.90	85.00	45.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
50	07 Dec.-13 Dec.	22.90	6.40	85.60	49.90	5.90	0.00	0.00	0.40	0.00	0.00	0.00	
51	14 Dec.-20 Dec.	20.30	6.00	87.40	51.30	0.00	0.00	0.00	1.80	0.00	0.00	0.00	
52	21 Dec.-27 Dec.	18.70	4.90	92.10	54.40	0.20	0.00	0.00	3.80	0.00	0.00	0.00	
1	28 Dec.-03 Jan.	19.00	6.20	94.10	66.10	24.00	0.00	0.00	4.70	0.00	0.00	0.00	
2	04 Jan.-10 Jan.	18.80	5.70	94.90	63.60	0.00	0.50	0.10	1.10	25.40	0.00	0.00	
3	11 Jan.-17 Jan.	18.10	7.20	93.30	62.30	0.00	1.20	0.80	0.20	57.00	0.00	0.00	
4	18 Jan.-24 Jan.	18.80	6.50	90.00	57.30	0.00	1.60	1.10	0.00	70.20	0.00	0.00	
5	25 Jan.-31 Jan.	21.60	7.10	85.70	56.00	1.10	2.30	1.30	0.00	83.50	0.00	0.00	
6	01 Feb.-07 Feb.	23.90	7.70	86.00	53.30	5.60	3.50	2.50	0.00	65.20	1.10	0.00	
7	08 Feb.-14 Feb.	26.60	9.80	84.30	43.00	0.00	6.20	3.20	0.00	123.50	3.80	0.00	
8	15 Feb.-21 Feb.	29.40	12.00	83.30	40.40	0.00	5.00	4.20	0.00	95.00	4.20	0.80	
9	22 Feb.-28 Feb.	30.50	14.10	76.60	41.30	0.20	4.20	3.80	0.00	60.30	5.10	1.30	
10	01 Mar.-07 Mar.	32.30	14.50	72.60	35.40	0.00	3.80	1.00	0.00	26.00	2.80	3.10	
11	08 Mar.-14 Mar.	31.70	15.70	71.00	32.90	0.10	1.00	0.00	0.00	14.20	0.70	4.20	
12	15 Mar.-21 Mar.	33.00	16.60	75.60	38.00	0.00	0.00	0.00	0.00	0.00	0.20	4.80	
13	22 Mar.-28 Mar.	34.00	16.90	71.90	35.10	0.00	0.00	0.00	0.00	0.00	0.00	2.10	

SMW = Standard Meteorological Week

**Table 2:** Succession of insect pest complex on rapeseed mustard crop during *Rabi*, 2021-22

SMW	Date	Abiotic factors					Natural enemies			Incidence of Insect Pests			
		Temperature (°C)		Relative Humidity (%)		Total rainfall (mm)	Mean No. of <i>Coccinella</i> spp. (adults/grubs) /plant	Mean No. of <i>Syrphid</i> spp. grubs/plant	Mean No. of Sawfly larvae/plant	Mean No. of aphids/10cm central twig/plant	Mean No. of Cabbage butter fly larvae/plant	Mean No. of Painted Bugs/plant	
		Max.	Min.	Max.	Min.								
49	06 Dec.-12 Dec.	23.07	11.64	84.29	48.14	0.90	0.00	0.00	0.20	0.00	0.00	0.00	
50	13 Dec.-19 Dec.	22.40	9.36	83.43	39.43	0.00	0.00	0.00	0.80	0.00	0.00	0.00	
51	20 Dec.-26 Dec.	20.74	7.17	82.43	38.43	0.00	0.00	0.00	2.00	0.00	0.00	0.00	
52	27 Dec.-02 Jan.	20.00	6.49	88.63	59.50	2.50	0.00	0.00	4.50	0.00	0.00	0.00	
1	03 Jan.-09 Jan.	20.60	7.50	84.60	61.10	9.90	0.00	0.00	5.10	10.40	0.00	0.00	
2	10 Jan.-16 Jan.	17.70	5.30	91.90	80.60	67.50	0.80	0.20	1.80	25.30	0.00	0.00	
3	17 Jan.-23 Jan.	16.20	4.70	92.60	71.10	3.70	1.00	0.90	0.30	53.20	0.00	0.00	
4	24 Jan.-30 Jan.	16.60	5.30	91.60	67.90	33.90	1.60	1.10	0.00	68.80	0.00	0.00	



5	31 Jan.-06 Feb.	20.10	6.00	88.60	67.00	18.43	1.90	2.30	0.00	90.20	0.50	0.00
6	07 Feb.-13 Feb.	20.50	7.30	85.90	64.10	4.50	2.80	2.80	0.00	130.00	1.90	0.00
7	14 Feb.-20 Feb.	24.30	8.30	82.60	57.40	0.00	6.00	3.10	0.00	80.30	3.20	0.60
8	21 Feb.-27 Feb.	25.90	9.90	82.70	50.30	0.70	4.80	3.60	0.00	35.10	5.00	1.40
9	28 Feb.-06 Mar.	26.00	10.50	88.60	53.10	31.50	3.20	2.50	0.00	10.20	2.20	3.50
10	07 Mar.-13 Mar.	30.30	13.40	76.00	47.00	0.00	2.60	0.60	0.00	4.90	0.40	4.00
11	14 Mar.-20 Mar.	34.20	17.10	71.10	39.60	0.00	0.40	0.00	0.00	0.00	0.10	4.30
12	21 Mar.-27 Mar.	37.50	20.10	67.40	34.30	0.00	0.00	0.00	0.00	0.00	0.00	2.10
13	28 Mar.-03 Apr.	38.70	20.30	58.90	28.40	0.00	0.00	0.00	0.00	0.00	0.00	1.00

SMW = Standard Meteorological Week

**Table 3:** Succession of insect pest complex on rapeseed mustard crop during *Rabi*, 2020-21 & 2021-22 (Pooled)

SMW	Date	Abiotic factors					Natural enemies		Incidence of Insect Pests			
		Temperature (°C)		Relative Humidity (%)		Total rainfall (mm)	Mean No. of <i>Coccinella</i> spp. (adults/grubs) /plant	Mean No. of <i>Syrphid</i> spp. grubs/plant	Mean No. of Sawfly larvae/plant	Mean No. of aphids/10cm central twig/plant	Mean No. of Cabbage butterfly larvae/plant	Mean No. of Painted Bugs/plant
		Max.	Min.	Max.	Min.							
49	06 Dec.-12 Dec.	24.69	9.77	84.65	46.57	0.45	0.00	0.00	0.10	0.00	0.00	0.00
50	13 Dec.-19 Dec.	22.65	7.88	84.52	44.67	2.95	0.00	0.00	0.60	0.00	0.00	0.00
51	20 Dec.-26 Dec.	20.52	6.59	84.92	44.87	0.00	0.00	0.00	1.90	0.00	0.00	0.00
52	27 Dec.-02 Jan.	19.35	5.70	90.37	56.95	1.35	0.00	0.00	4.15	0.00	0.00	0.00
1	03 Jan.-09 Jan.	19.80	6.85	89.35	63.60	16.95	0.00	0.00	4.90	5.20	0.00	0.00
2	10 Jan.-16 Jan.	18.25	5.50	93.40	72.10	33.75	0.65	0.15	1.45	25.35	0.00	0.00
3	17 Jan.-23 Jan.	17.15	5.95	92.95	66.70	1.85	1.10	0.85	0.25	55.10	0.00	0.00
4	24 Jan.-30 Jan.	17.70	5.90	90.80	62.60	16.95	1.60	1.10	0.00	69.50	0.00	0.00
5	31 Jan.-06 Feb.	20.85	6.55	87.15	61.50	9.77	2.10	1.80	0.00	86.85	0.25	0.00
6	07 Feb.-13 Feb.	22.20	7.50	85.95	58.70	5.05	3.15	2.65	0.00	97.60	1.50	0.00
7	14 Feb.-20 Feb.	25.45	9.05	83.45	50.20	0.00	6.10	3.15	0.00	101.90	3.50	0.30
8	21 Feb.-27 Feb.	27.65	10.95	83.00	45.35	0.35	4.90	3.90	0.00	65.05	4.60	1.10
9	28 Feb.-06 Mar.	28.25	12.30	82.60	47.20	15.85	3.70	3.15	0.00	35.25	3.65	2.40
10	07 Mar.-13 Mar.	31.30	13.95	74.30	41.20	0.00	3.20	0.80	0.00	15.45	1.60	3.55
11	14 Mar.-20 Mar.	32.95	16.40	71.05	36.25	0.05	0.70	0.00	0.00	7.10	0.40	4.25
12	21 Mar.-27 Mar.	35.25	18.35	71.50	36.15	0.00	0.00	0.00	0.00	0.00	0.10	3.45
13	28 Mar.-03 Apr.	36.35	18.60	65.40	31.75	0.00	0.00	0.00	0.00	0.00	0.00	1.55

SMW = Standard Meteorological Week

**Table 4:** Succession of insect pest complex on rapeseed mustard crop during *Rabi*, 2020-21 & 2021-22 (Pooled)

SMW	Date	Abiotic factors					Natural enemies		Incidence of Insect Pests			
		Temperature (°C)		Relative Humidity (%)		Total rainfall (mm)	Mean No. of <i>Coccinella</i> spp. (adults/grubs) /plant	Mean No. of <i>Syrphid</i> spp. grubs/plant	Mean No. of Sawfly larvae/plant	Mean No. of aphids/10cm central twig/plant	Mean No. of Cabbage butterfly larvae/plant	Mean No. of Painted Bugs/plant
		Max.	Min.	Max.	Min.							
49	06 Dec.-12 Dec.	24.69	9.77	84.65	46.57	0.45	0.00	0.00	0.10	0.00	0.00	0.00
50	13 Dec.-19 Dec.	22.65	7.88	84.52	44.67	2.95	0.00	0.00	0.60	0.00	0.00	0.00
51	20 Dec.-26 Dec.	20.52	6.59	84.92	44.87	0.00	0.00	0.00	1.90	0.00	0.00	0.00
52	27 Dec.-02 Jan.	19.35	5.70	90.37	56.95	1.35	0.00	0.00	4.15	0.00	0.00	0.00
1	03 Jan.-09 Jan.	19.80	6.85	89.35	63.60	16.95	0.00	0.00	4.90	5.20	0.00	0.00
2	10 Jan.-16 Jan.	18.25	5.50	93.40	72.10	33.75	0.65	0.15	1.45	25.35	0.00	0.00
3	17 Jan.-23 Jan.	17.15	5.95	92.95	66.70	1.85	1.10	0.85	0.25	55.10	0.00	0.00
4	24 Jan.-30 Jan.	17.70	5.90	90.80	62.60	16.95	1.60	1.10	0.00	69.50	0.00	0.00
5	31 Jan.-06 Feb.	20.85	6.55	87.15	61.50	9.77	2.10	1.80	0.00	86.85	0.25	0.00
6	07 Feb.-13 Feb.	22.20	7.50	85.95	58.70	5.05	3.15	2.65	0.00	97.60	1.50	0.00
7	14 Feb.-20 Feb.	25.45	9.05	83.45	50.20	0.00	6.10	3.15	0.00	101.90	3.50	0.30
8	21 Feb.-27 Feb.	27.65	10.95	83.00	45.35	0.35	4.90	3.90	0.00	65.05	4.60	1.10
9	28 Feb.-06 Mar.	28.25	12.30	82.60	47.20	15.85	3.70	3.15	0.00	35.25	3.65	2.40
10	07 Mar.-13 Mar.	31.30	13.95	74.30	41.20	0.00	3.20	0.80	0.00	15.45	1.60	3.55
11	14 Mar.-20 Mar.	32.95	16.40	71.05	36.25	0.05	0.70	0.00	0.00	7.10	0.40	4.25
12	21 Mar.-27 Mar.	35.25	18.35	71.50	36.15	0.00	0.00	0.00	0.00	0.00	0.10	3.45
13	28 Mar.-03 Apr.	36.35	18.60	65.40	31.75	0.00	0.00	0.00	0.00	0.00	0.00	1.55

### Incidence of Syrphid fly

The population of syrphid fly was observed from 2<sup>nd</sup> standard week to 10<sup>th</sup> standard week during *Rabi*, 2020-21. The syrphid fly population ranged from 0.10 to 4.20 (grubs/plant) during the whole observation period. The population of the predator was initially low (0.10 grubs/plant) in 2<sup>nd</sup> standard week. The population of predator increased gradually and reached its peak, 4.20 grubs/plant in 8<sup>th</sup> standard week (Table 1).

During *Rabi*, 2021-22, syrphid fly was observed from 2<sup>nd</sup> standard week to 10<sup>th</sup> standard week. The population of syrphid fly ranged from 0.20 to 3.60 (grubs/plant) during the whole observation period. The population of the predator was initially low (0.20 grubs/plant) in 2<sup>nd</sup> standard week. The population of predator increased gradually and reached its peak, 3.60 grubs/plant in 8<sup>th</sup> standard week (Table 2).

During *Rabi*, 2020-21 & 2021-22 (Pooled), syrphid fly was observed from 2<sup>nd</sup> standard week to 10<sup>th</sup> standard week. The population of syrphid fly ranged from 0.15 to 3.90 (grubs/plant) during the whole observation period. The population of the predator was initially low (0.15 grubs/plant) in 2<sup>nd</sup> standard week. The population of predator increased gradually and reached its peak, 3.90 grubs/plant in 8<sup>th</sup> standard week (Table 3).

The present findings are in accordance with the finding of Pradhan *et al.* (2020) <sup>[10-11]</sup> reported that, the syrphid fly, *Xanthogrammas cutellaris* was major predator of aphid.

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