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Safflower aphid, *Uroleucon compositae* (Theobald) a major pest of safflower crop in Chhattisgarh and its correlation with abiotic and biotic parameters

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Abstract
The experiment was conducted under All India Coordinated Research Project (AICRP) during *Rabi* 2020–2021 and 2021–2022 at the College of Agriculture, IGKV, Raipur (C.G.). In Chhattisgarh, the major pest of safflower is aphid, *Uroleucon compositae* (Theobald) was found active from stem elongation stage to the maturity stage of crop during both years *Rabi* 2020-21 and 2021-22. The observations were recorded during the early morning hours in a weekly basis on IGKV Kusum variety of safflower. The *U. compositae* were counted on 5 cm of the apical shoot length. The peak activity of *U. compositae* found during last week of Februrary to first week of March. Natural enemies like coccinellid beetles and praying mantids were counted as numbers of insects/plant. The correlations of *U. compositae* with different abiotic *viz.,* minimum temperature and relative humidity II was found significant and negative (r = -0.499*) and (r = -0.417*), while with sun shine hours it was found positive significant (r = 0.516*). The correlation of biotic parameters such as coccinellid beetles with *U. compositae* was found highly significant and positive (r = 0.920*, r = 0.896* and r = 0.891*), while with praying mantis it was found negative non-significant in both the years.

Keywords: Population dynamics, aphid, coccinellid beetles, praying mantis and safflower

1. Introduction
Safflower (*Carthamus tinctorius* L.) is an oldest oilseed crop. It is native to parts of Asia and Africa (Central India through the Middle East to the upper reaches of the Nile River and into Ethiopia). Safflower is known to be attacked by 101 different pests at various growth and development phases of the crop (Singh *et al*., 1996) [11]. The area, production, and productivity of India was 56,042 ha, 35,890 tonnes, and 640 kg/ha in the years 2020–21. In the years 2020–21, Karnataka ranked first with an average area of 29,000 ha, a production of 19,285 tonnes, and a productivity of 665 kg/ha, followed by Maharashtra with 21,400 ha, a production of 12,177 tonnes, and a productivity of 569 kg/ha. The production of safflower during the cropping year 2021-22 was 45000 tonnes in an area of 64000 hectares, with a productivity of 694 kg per hectare in India. (Directorate report 2021-22, IIOR, Hyderabad) [3].
In Chhatisgarh, *Rabi* safflower sowing is always delayed due to late rice crop harvesting and land preparation. The AICRP trials conducted in Chhattisgarh from 2010 to 2013 showed higher productivity than the national average, and the percentage oil content was also two percent higher than the national average, despite the crop's limited area, production, and productivity in the state (600 hectares, 200 tonnes of production, and 333 kg/ha productivity). Safflower was grown on 69 ha area in Chhattisgarh in the years 2020–21 with a production of 28 tonnes and a productivity of 408 kg/ hectare (Anonymous 2021) [1].
Safflower aphid, *Uroleucon compositae* Theobald significantly reduce crop growth and productivity. It is the major pest of safflower and can be detected after the rosette stage which continues upto the maturity stage of crop. Late-sown safflower is more vulnerable to aphid infestation in Chhattisgarh, and the degree of the infestation is extreme. The coccinellid beetles are the important predator of aphid, while praying mantis feeds on the varied range of pests like sucking pests and defoliators. Hence, the present study was conducted to study the correlation of aphid population with weather parameters and with biotic parameters *viz.*, coccinellid beetles and praying mantis populations.

2. Material and Methods

The experiment was carried out in the safflower variety, IGKV Kusum at the College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, C.G. during *Rabi* 2020–2021 and 2021–2022. The observations were recorded on weekly basis, from 15 days after sowing till the harvesting of the crop during morning hours. The populations of aphid, *U. compositae* were counted on 5 cm of the apical shoot length from randomly selected five plants. Natural enemies like coccinellid beetles and praying mantids were counted as average numbers of insects per plant.

3. Results and Discussion

3.1 Population dynamics of aphid (*Uroleucon compositae,* Theobald)

Safflower aphid, *U. compositae* is the major pest of safflower in Chhattisgarh due to late sown condition after rice harvest. This insect appeared after the rosette stage and continued up to the maturity stage of the crop. The initial mean population of *U. compositae* during 2020–2021 was 3.5 nymphs and adults/5 cm of apical shoot at 48th SMW, which corresponds to the fourth week of November, and peak population was 149.7 nymphs and adults/5 cm of apical shoot during the 10th SMW, which corresponds to the first week of March. During 2021–2022, the initial population was 2.6 nymphs and adults/5 cm of apical shoot during the 48th SMW, *i.e.,* the fourth week of November, and reached its peak 169.4 nymphs and adults/5 cm of apical shoot during the 11th SMW, *i.e.,* the second week of March. The pest infestation was found active from Nov. to April. Seasonal means of *Rabi* 2020–2021 and 2021–2022 was 61.71 and 61.33 nymphs and adults/5 cm of apical shoot length, respectively (mentioned in table 1 and fig 2). Similar results also reported by Kulkarni and Byadgi (2004) [8] who stated that the population started increasing with delay in sowing and reached maximum levels (149.82 aphids/10cm twig) on crop sown on 7th November.

3.2 Population dynamics of coccinellid beetles

Coccinellid beetles are the voracious feeders of plant-harming insect pests like aphids, mealybugs, thrips, jassids, whiteflies, and scale insects. The primary predator of safflower aphids was coccinellid beetles. Its activity was recorded during stem elongation stage to maturity of the crop which coincides with the aphid appearance. Six species of coccinellid beetles *viz., Menochilus sexmaculatus, Coccinella transversalis* (transverse ladybird), *Coccinella septempunctata* (seven spotted ladybird), *Adalia bipunctata* (two spotted ladybird), *Olla v. nigrum* (ashy grey ladybird), and *Micraspis vincta,* were found during both years. The initial population was recorded (0.2 grubs and adults/plant) during the 48th SMW, *i.e.,* the 4th week of November, and reached its peak (3.0 grubs and adults/plant) during the 10th SMW, *i.e.,* the 1st week of March, during 2020-2021. In 2021–2022, the initial population of coccinellid beetles was recorded during 49th SMW, *i.e.,* the 1st week of December (0.2 grubs and adults/plant), and reached its peak (1.8 grubs and adults/plant) during the 9th SMW, *i.e.,* the 4th week of February (depicted in table 1 and fig2). The seasonal mean of coccinellid beetles was 1.22 and 0.66 grubs and adults/plant during 2020–2021 and 2021–2022. The present findings is partially supported by Kashyap *et al.* (2018) [6] who reported the population ranged from 0.28 to 4.8 lady bird beetle per plant.

3.3 Population dynamics of praying mantis

Praying mantis, *Mantis religiosa,* is a highly predatory and carnivorous insect that feeds on a variety of insects. Its activity was recorded from stem elongation stage to the branching stage of the crop. The initial population recorded (0.2 adults/plant) during 52 SMW *i.e.,* 4th week of December and peak population (0.8 adults/plant) were recorded during second week of January *i.e.,* 2nd SMW during 2020-21, whereas in 2021-22 initial population was 0.2 adults/plant during 51 SMW *i.e.,* 3rd week of December and peak population (0.6 adults/plant) was recorded during 1st week of January *i.e.,* 1st SMW (presented in table 1 and illustrated in fig 3).

3.4 Correlation of *U. compositae* with abiotic and biotic parameters

The correlation of *U. compositae* with abiotic *i.e.* weather parameters and biotic *i.e.* natural enemies are presented in table 2. The correlation of mean population of *U. compositae* with minimum temperature was found significant and negative (r = -0.499*) during 2020–2021. Similar findings also reported by Bade and Kadan (1993) [2], Painkra *et al.* (2003) [10] and Jemimah *et al.* (2013) [4] who also found a negative significant correlation between aphid population and minimum temperature. During 2021–2022, relative humidity II showed significant negative correlation (r = -0.417*). Similar results also reported by Mane *et al.* (2002) [9] and Painkra *et al.* (2003) [10] who also reported the negative correlation of aphid and relative humidty, while sun shine hours showed significant positive correlation (r = 0.516*) with the mean population of *U. compositae* population (illustrated in figures 4,5 and 6).

The correlations of coccinellid beetles with *U. compositae* (depicted in table 2 & figure 7 and 8) revealed a highly significant and positive correlation (r = 0.920* and r = 0.896*) during 2020-2021 and 2021-2022. The present findings are in accordance with Singh (2002) [12], Painkra *et al.* (2003) [10], Khating *et al.* (2016) [7], Karane *et al.* (2019) [5] also reported that coccinellid populations were highly significant and positively correlated with aphid populations. The correlation of *M. religiosa* with *U. compositae* population was found negative non-significant during 2020–2021 and 2021–2022.

Table 1: Mean populations of safflower aphid and its predators

Month and week	SMW	Aphid/5cm apical shoot length			Coccinellid beetles/plant			Praying mantis/plant		
		2020-2021	2021-2022	Pooled mean	2020-2021	2021-2022	Pooled mean	2020-2021	2021-2022	Pooled mean
November	47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	48	3.5	2.6	3.05	0.2	0.0	0.1	0.0	0.0	0.0
December	49	19.2	16.4	17.8	0.0	0.2	0.1	0.0	0.0	0.0
	50	39.8	28.2	34.0	0.6	0.6	0.6	0.0	0.0	0.0
	51	47.1	45.5	46.3	0.8	0.4	0.6	0.0	0.2	0.1
	52	55.4	20.2	37.8	1.0	0.2	0.6	0.2	0.0	0.1
January	1	64.9	34.8	49.85	1.2	0.4	0.8	0.2	0.6	0.4
	2	88.1	27.6	57.85	1.2	0.0	0.6	0.8	0.0	0.4
	3	97.0	37.3	67.15	1.4	0.2	0.8	0.4	0.0	0.2
	4	125.3	55.2	90.25	2.6	0.8	1.7	0.0	0.0	0.0
	5	138.2	108.5	123.35	2.4	1.4	1.9	0.0	0.0	0.0
February	6	106.5	86.8	96.65	2.0	0.4	1.2	0.0	0.0	0.0
	7	105.6	109.7	107.65	2.2	1.2	1.7	0.0	0.0	0.0
	8	100.1	117.1	108.6	2.2	1.4	1.8	0.0	0.0	0.0
	9	120.9	120.9	128.9	2.8	1.8	2.3	0.0	0.0	0.0
March	10	149.7	160.6	155.15	3.0	1.6	2.3	0.0	0.0	0.0
	11	75.3	169.4	122.35	0.8	1.2	1.0	0.0	0.0	0.0
	12	20.7	130.9	75.8	1.4	1.2	1.3	0.0	0.0	0.0
	13	33.8	85.2	59.5	1.2	1.0	1.0	0.0	0.0	0.0
April	14	19.4	39.5	29.45	1.0	0.8	1.3	0.0	0.0	0.0
	15	8.9	14.4	11.65	0.2	0.4	0.9	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Average	61.71	61.33	61.87	1.22	0.66	0.98	0.4	0.4	0.3

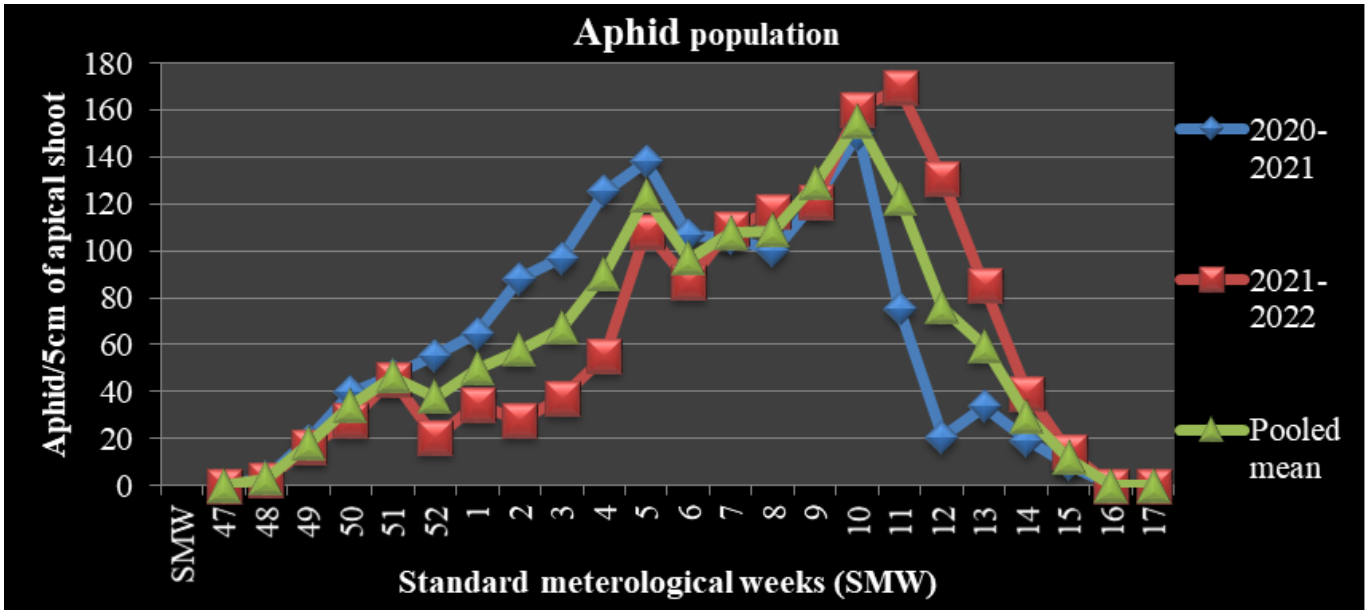

Fig 1: Mean aphid population

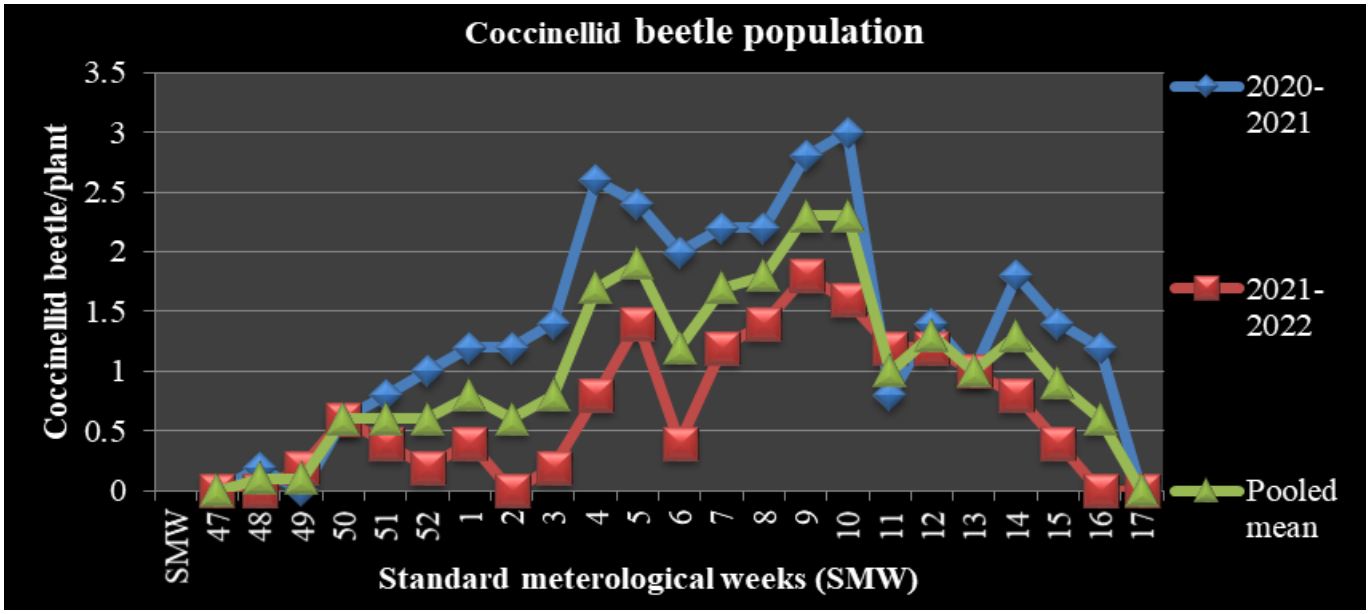

Fig 2: Mean coccinellid beetle population

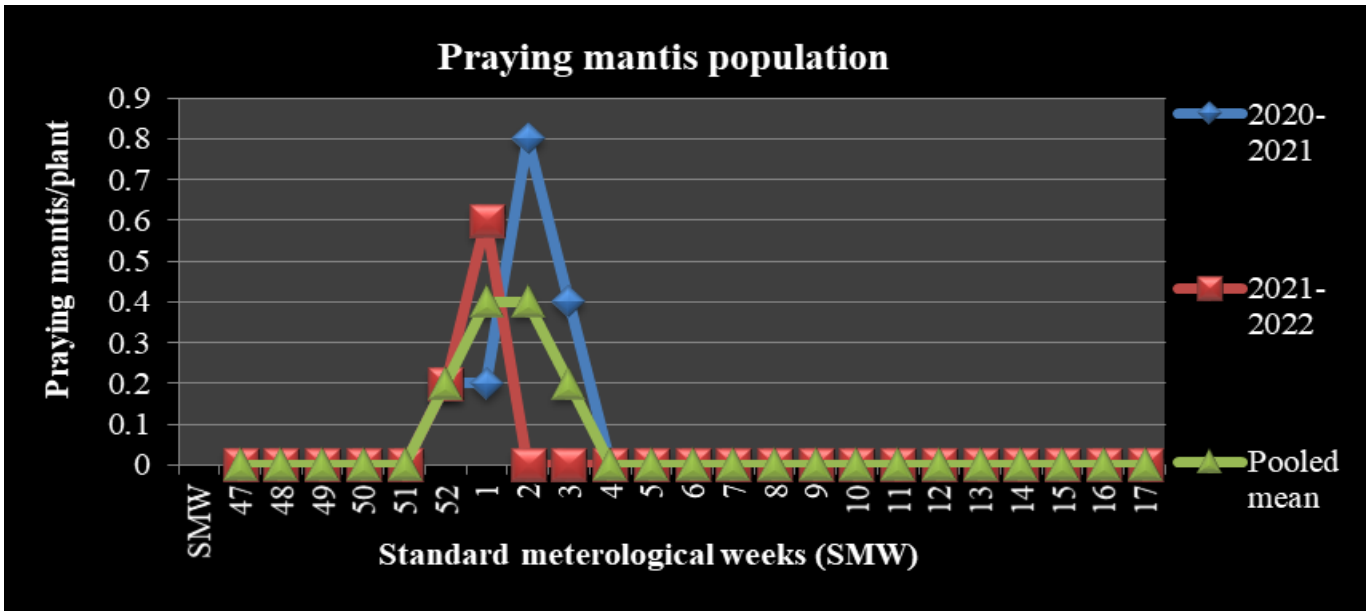

Fig 3: Mean praying mantis population

Table 2: Correlation of aphid with abiotic and biotic parameters

Abiotic parameters	Aphid/5cm apical shoot		
	2020-2021	2021-2022	Pooled mean
Maximum Temp. (˚C)	-0.324	0.069	-0.178
Minimum Temp. (˚C)	**-0.499***	-0.219	-0.382
Rainfall (mm)	0.241	-0.285	-0.199
Relative Humidity I (%)	0.288	0.009	0.185
Relative Humidity II (%)	0.033	**-0.417***	-0.175
Wind Velocity (kmph)	-0.388	-0.266	-0.228
Sun Shine (hrs.)	0.062	**0.516***	0.337
Biotic parameters			
Coccinellid beetle	0.830*	0.912*	0.870*
Praying mantis	-0.222	-0.089	-0.280
* Significant at 5% level of significance (r=0.413) at 21 df			

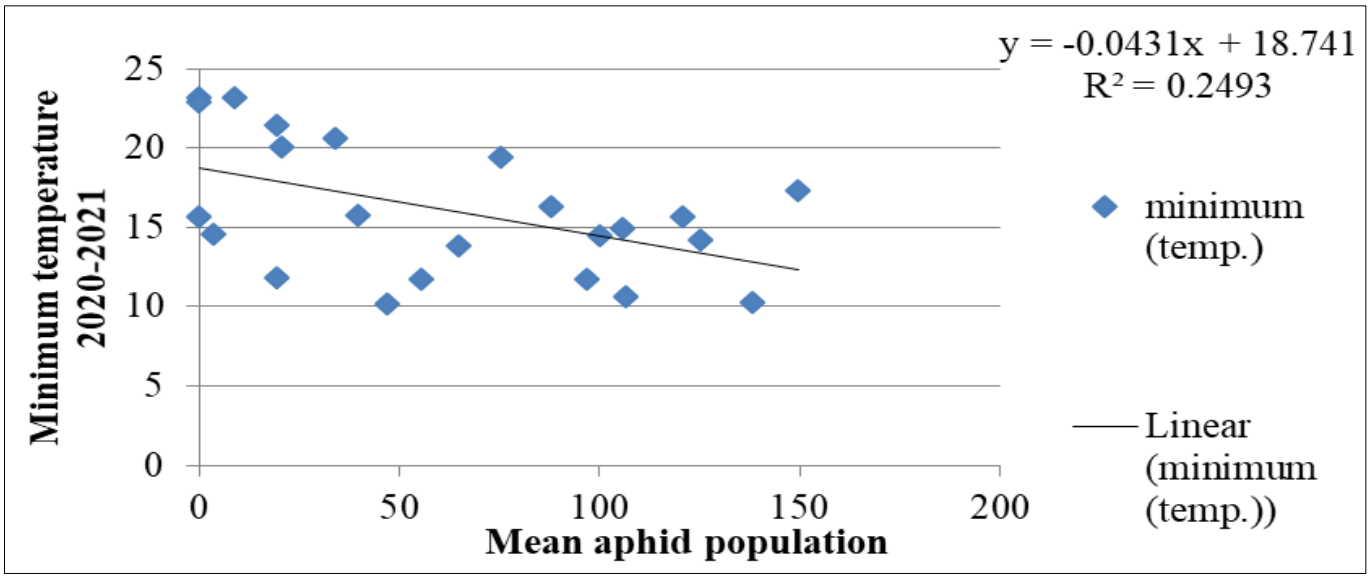

Fig 4: Regression line between aphid and minimum temperature during 2020-2021

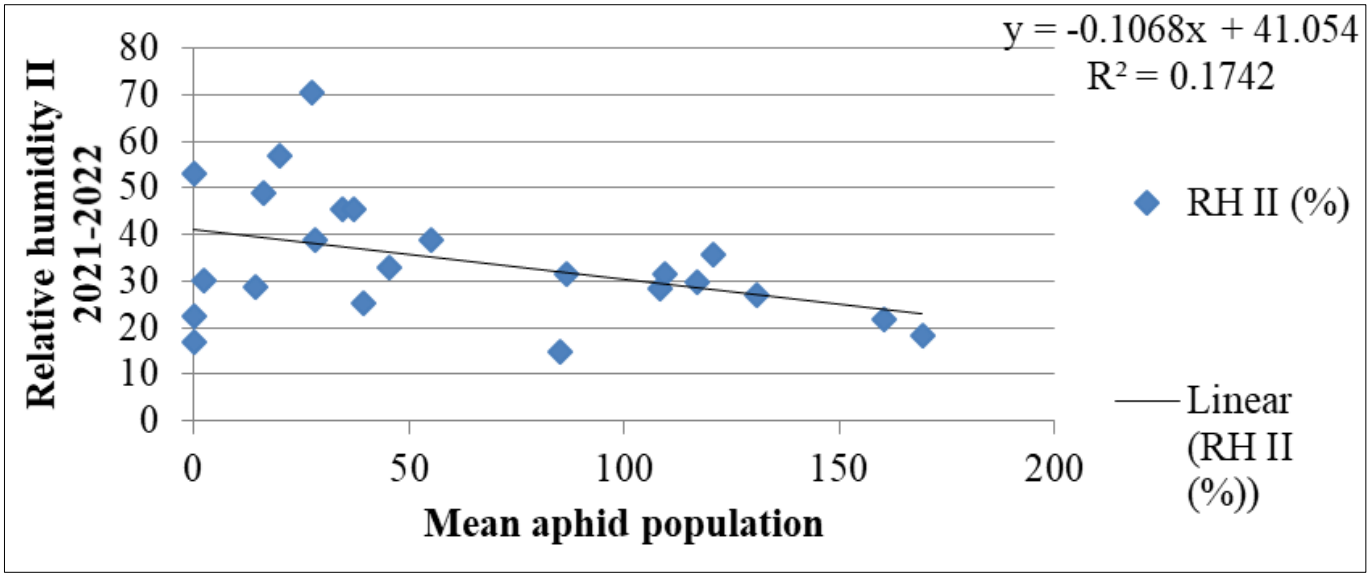

Fig 5: Regression line between aphid and relative humidity II during 2021-2022

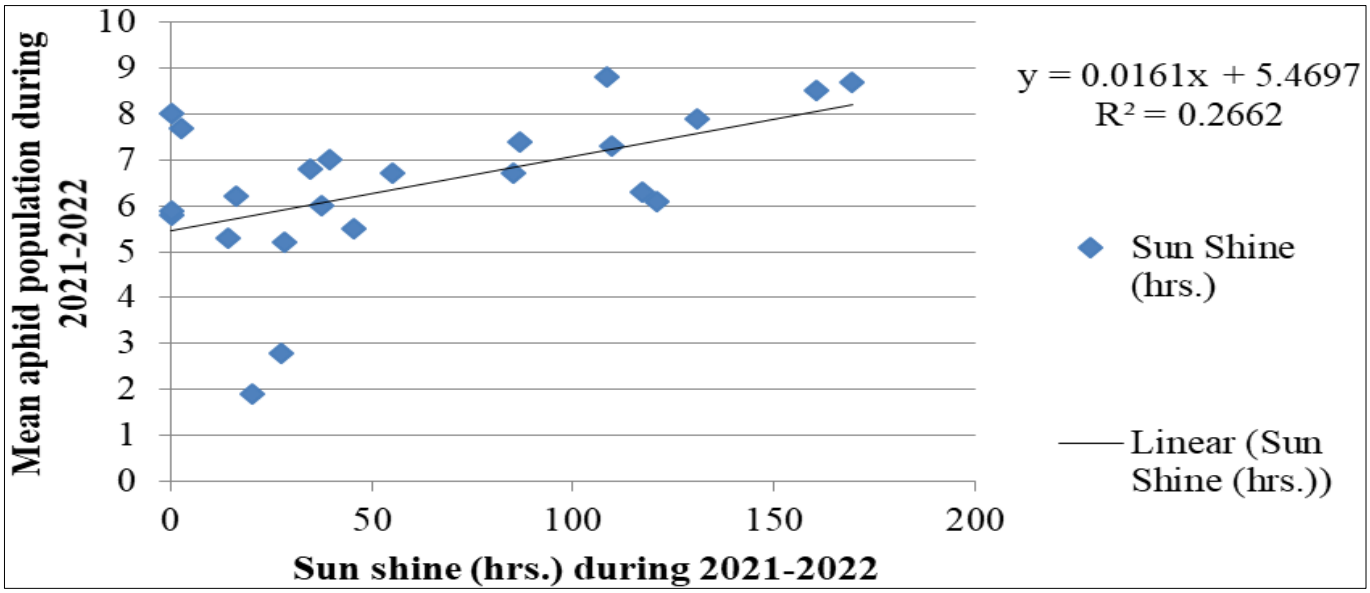

Fig 6: Regression line between aphid and sun shine (hrs.) during 2021-2022

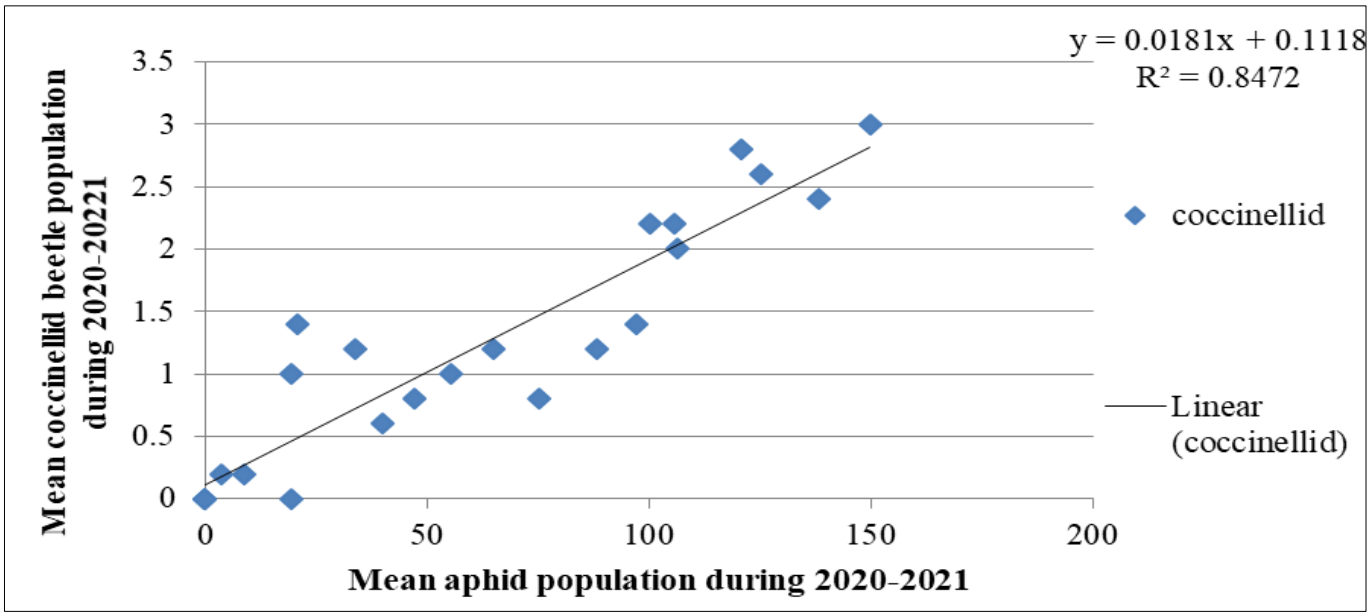

Fig 7: Regression line between aphid and coccinellid beetle during 2020-2021

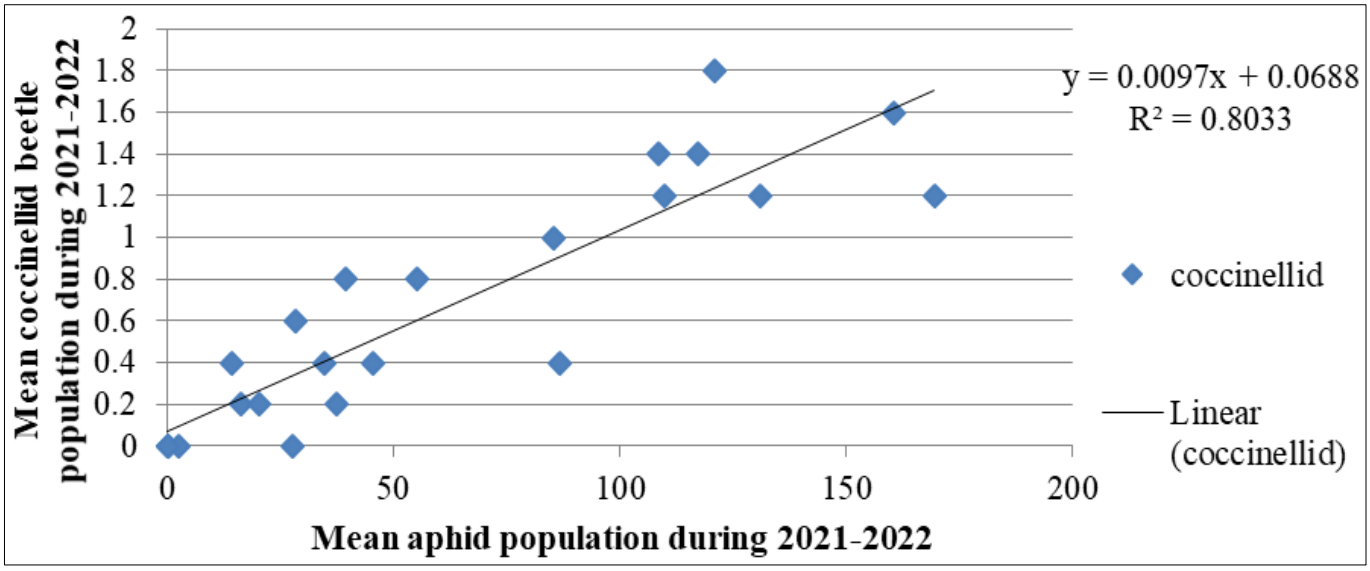

Fig 8: Regression line between aphid and coccinellid beetle during 2021-2022

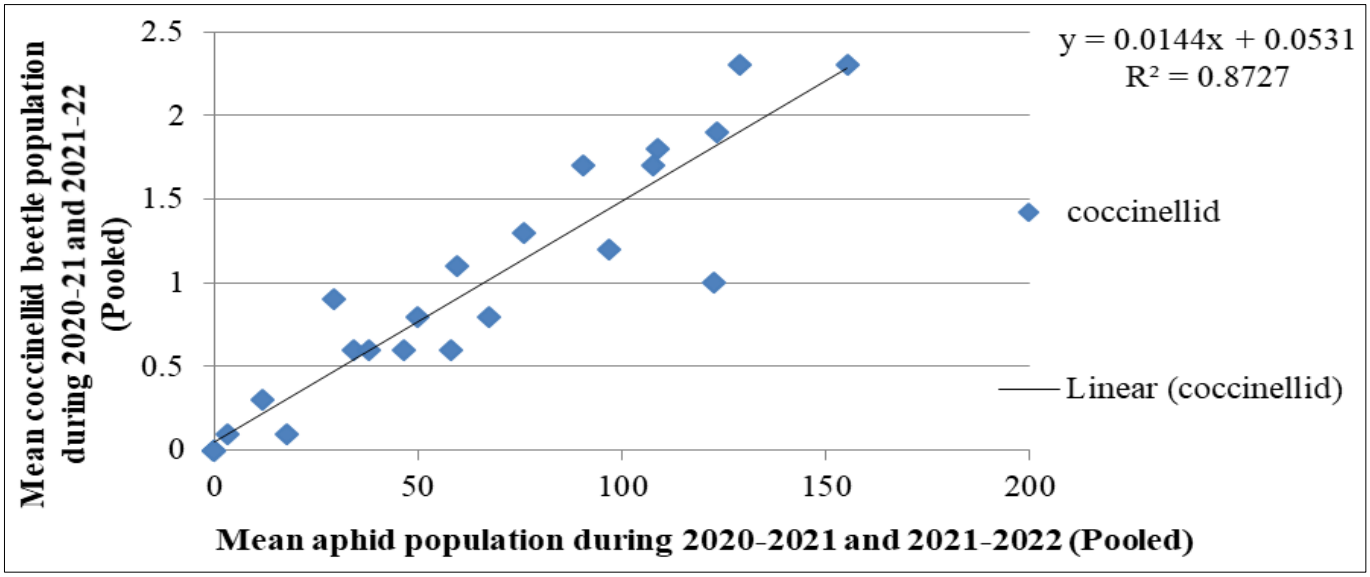

Fig 9: Regression line between aphid and coccinellid beetle during 2020-2021 and 2021-2022 (Pooled)

Safflower Aphid, *Uroleucon compositae*

Praying mantis, *Mantis religiosa*

Menochilus sexmaculatus

Olla-v-nigrum

Adalia bipunctata

Micraspis vincta

Coccinella septempunctata

Coccinella transversalis

Plate 1: Different species of coccinellid beetles in safflower field

4. Conclusion

In the average result of two years, the initial mean population of *U. compositae* (3.05 nymphs and adults/5 cm apical shoot) was recorded during 48th SMW, *i.e.,* the 4th week of November, and reached its peak (155.15 nymphs and adults/5 cm apical shoot) during the 10th SMW, *i.e.,* the 1st week of March. Thus, the peak activity of *U. compositae* found between the last week of February to first weeks of March. The coccinellid beetle population initially recorded (0.1 grubs and adults/plant) during the 48th SMW, *i.e.,* the 4th week of November, and reached its peak (2.3 grubs and adults/plant) during the 9th and 10th SMW, *i.e.,* the 4th week of February to 1st week of March. The correlation of coccinellid beetles with *U. compositae* was found a highly significant and positive (r = 0.891*) (illustrated in fig 9). *M. religiosa* population was initially recorded (0.1 adults/plant) during 51 SMW *i.e.,* 3rd week of December and peak population (0.4 adults/plant) was recorded during first and second week of January *i.e.,* 1st and 2nd SMW. The correlation of *M. religiosa* with *U. compositae* was found negative non-significant.

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