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Effect of trap design and weather factors on relative efficiency of yellow sticky traps for sampling aphids in groundnut

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ABSTRACT

The present investigations were carried to evaluate the trapping efficiency of three different yellow sticky traps for monitoring of aphid population in groundnut with relation to weather factors. The aphid population was found comparatively higher during January to March every year. The number of aphid (alates) caught was significantly higher on inverted dust bin traps followed by round plate traps and rectangular tray trap.

Key words: Aphid, Groundnut, Monitoring, Traps, Weather factors.

INTRODUCTION

Groundnut crop is attacked by more than 100 insect-pests right from planting stage to till its storage (Nandagopal, 1992). Cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae) is considered as one of the most notorious insect-pest of groundnut in India, causing pod loss up to 40% (Jena and Kuila, 1997). Sreenivasulu *et al.,* (1991) reported it is responsible for transmitting about 23 viral diseases also. To develop appropriate forecasting systems accurate information on the population dynamics of aphids is essential that can predict the timing and extent of epidemics of pest and its related diseases (Thresh, 1986). Therefore, insect monitoring and surveillance on regular basis is highly advised to know the status of the pests in a particular area. For the monitoring aphid population several different types of insect traps are commercially available in market. The yellow traps are commonly used for aphid monitoring in fields and in greenhouses (Straw *et al.*, 2011). According to Southwood (1978) sticky traps measure aphid populations more readily than other labor-intensive absolute monitoring methods, as traps continuously catch and retain specimens without constant human management. Moreover traps are rapid, simple to install, cost effective and provides systematic, continuous information on pest population build-up. They can provide excellent long-term fore-warning of the need for chemical control and short-term warning of control timing. The few studies have shown that the main factors that affect the efficiency of a trap for catching an insect are its shape and placement in the field (Gillespie and Vernon, 1990) besides, the abiotic factors greatly impact insect population built-up. Highland *et al.* (1981) suggested that a yellow sticky trap should be positioned for each 1200 sq. m. of ground space in peanut crop. Keeping the above perspective in view, the present study was planned to determine the trapping efficiency of three different types of traps (dust bins, round plates and rectangular trays) which can be prepared easily by using locally available materials and also to study the impact of weather factors on aphid population in groundnut crop.

MATERIALS AND METHODS

The experiments were conducted with groundnut variety, GG-2 at ICAR-Directorate of Groundnut Research, Junagadh, India during 2010 to 2014 in plots size 5 m X 2 m for monitoring of *A. craccivora* population. Plant to plant and row to-row distance was kept as 10 cm and 45 cm, respectively. The crop was maintained throughout the year by following recommended package of practices except chemical spray which could have negative influence on population of aphid.

Three different designs of traps were used in the study were prepared by using locally available plastic material in different designs *viz.*, dust bins, round plates and rectangular trays. The traps were prepared by painting the yellow colour and then were allowed to dry and later coated with sticky material (castor oil). The size of each trap was measured before installing them in the experimental plots. The cost of each trap type was also calculated based on the material used in their preparation. The traps were installed in individual replicated plots (n=3) and weekly alate population of *A. craccivora* trapped in each trap was recorded throughout the cropping season from 2010 to 2014. All types of traps were placed on the ground at an approximate height of 10-15 cm from the ground level. The aphid population per trap was recorded at weekly intervals. After taking observations, the trapped insects and sticky material were cleaned and the same traps were again placed in the experimental plots along with a fresh sticky material. The

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daily weather data pertaining to maximum and minimum temperature (°C), morning and evening relative humidity (%), duration of sunshine (hrs) and amount of rainfall (mm) were gathered from the meteorological observatory.

For comparison of trapping efficiency of three types of traps, the whole sampling area was divided the two sampling periods *i.e.*, January to March and October to December keeping in view that aphid population was comparatively higher in these two periods. This was done to avoid periods with no aphid or low aphid counts for determining trap efficiency which could have led to misleading conclusions. The area of each trap type was measured and aphid population caught on each trap was standardized using calculated trap area and aphid count was then represented in 100 cm^2 for each trap to avoid any biased conclusion based on the size of the trap. The calculated area of inverted dust bin, round plate and rectangular tray was 1974, 531, 3622 cm^2, respectively. The weekly population of aphids trapped on each trap (100 cm^2) recorded during these periods was averaged and then tested using a one-way analysis of variance (ANOVA) and further separation of means was subjected to Tukey's honestly significant difference test (Steel and Torrie, 1960) using JUMP software. The relationship of weather parameters *viz.*, mean temperature (°C), morning and evening relative humidity (%), duration of sunshine (hrs) and amount of rainfall (mm) with aphid population per trap was determined by correlation and regression analyses using SAS software (SAS, 2005). The periods where the aphid population was zero or quite low were not included in these analyses. All tests were performed at the 0.05 significance level.

RESULTS AND DISCUSSION

Trap efficiency: The population of aphid, *A. craccivora* followed a rhythmic trend during the year and two major periods of activity *i.e.*, January to March and October to December were observed when the population was substantially higher for making comparison of trap efficiency. During the period of study (2010-2014), the population of aphids was comparatively higher during January-March period in all the three types of traps than October to December period (Figure 1a and 1b). The population during January-March period ranged from 2.2 to 41.5 aphids/100 cm^2 being maximum in inverted dust bin trap during year 2013 and minimum in rectangular tray trap during year 2014 (Figure 1a).The highest population (13.9 aphids/100 cm^2) during October to December period was observed in inverted dust bin trap during year 2013 whereas lowest (0.2 aphids/ 100 cm^2) was observed in rectangular tray trap during year 2012 (Figure 1b). During the five-year period, the inverted dust bin traps caught significantly higher number of aphid alates followed by round plate traps in both peak periods. Rectangular tray traps caught least number of aphid alates (Figure 1a and 1b). The cost incurred for the preparation of inverted dust bin, round plate and rectangular tray traps is around Rs. 70.0, 60.0 and 75.0 per trap, respectively.

The size and shape of a sampling trap and its placement height in the field play a major role in determining its trapping efficiency (Gillespie and Vernon, 1990). In present study, inverted dust bin trap caught maximum number of aphids than other two tested traps. The probable reason could be its shape and height. Since its shape was like a round cylinder and therefore it was catching alate aphids from all the directions within the crop canopy as well as

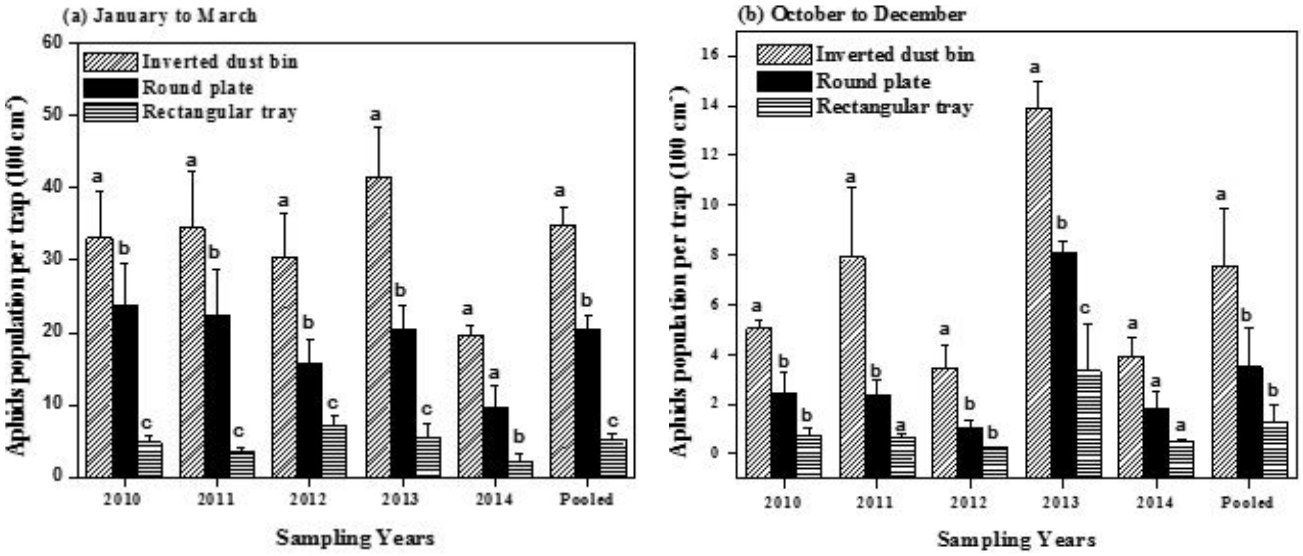

Fig 1: Comparative efficiency of three different types of traps in two peak periods; (a) January-March and (b) October-December during years 2010 to 2014. (Means indicated by the same letters are not significantly different from each other (ANOVA; Tukey's HSD; $P > 0.05$). Standard error of means indicated by error bars)

above the canopy as compared to round and rectangular traps which were laid down on the ground at around 10 cm height.

Population trends of *A. craccivora*: The mean aphid population of five-year indicated that the pattern of aphid occurrence was almost similar in all the tested traps (Figure 2). The first appearance of aphids was recorded during September or October when temperature comes below 30 °C. Small peaks were observed in all the years during December between standard weeks 48th to 52nd. During period from late April to late August, there was low population or no population of aphid was observed during all the years. In inverted dust bin traps, the peak populations of 87.9 and 102.2 aphids per 100 cm² were recorded during 1st and 5th standard weeks (January – Ist week of February) of 2010 and 2011, respectively while during year 2012 and 2013, peak populations of 38.3 and 65.4 aphids per 100 cm² were observed during 7th standard week (3rd week of February) during both the years. In year 2014, the population was comparatively lower to previous years and a peak of 18.5 aphids per 100 cm² was observed during 9th standard week (Figure 2a). Similarly in round plate trap, the peak populations of 80.4, 61.0, 34.7, 75.0 and 39.9 aphids per 100 cm² were recorded during 4th (last week of January), 5th (Ist week of February), 7th, 7th (3rd week of February) and 9th (Ist week of March) standard weeks of years 2010, 2011, 2012, 2013 and 2014, respectively (Figure 2b). The lowest number of aphids was observed in rectangular tray traps which trapped only 10.6, 7.7, 17.4, 26. 6 and 14.7 aphids per 100 cm² during 5th (Ist week of February), 8th (4th week of February), 4th (last week of January), 7th (3rd week of February) and 9th (Ist week of March) standard weeks of years 2010, 2011, 2012, 2013 and 2014, respectively (Figure 2c).

In present study, we found that the population of *A. craccivora* on groundnut peaked around 5th to 7th standard weeks (February) in most of the observed years with few exceptions. However smaller peaks were observed around 49th standard week (Ist week of December). The high occurrence of aphids during January- March indicated that aphids were finding good quality vegetation for establishment. Shahzad *et al.* (2003) observed that *A. craccivora* appeared during the last week of December and established its population at peak during 3rd week of February. Similarly, Prasad *et al.* (2008) observed peak during August in *Kharif* season, while, in *rabi* recorded three peaks first during third week of November, second at second week of January and third in the first week of March.

Effect of weather factors on aphid population: The mean temperature recorded during five-year period ranged from 18.6-34.9, 18.6-33.6, 18.4-32.3, 18.7-33.5 and 18.5-33.0 in 2010, 2011, 2012, 2013 and 2014, respectively. Similarly, the total rainfall was 1689.7, 962.7, 425.0, 1520.3 and 1271.5 mm in 2010, 2011, 2012, 2013 and 2014, respectively

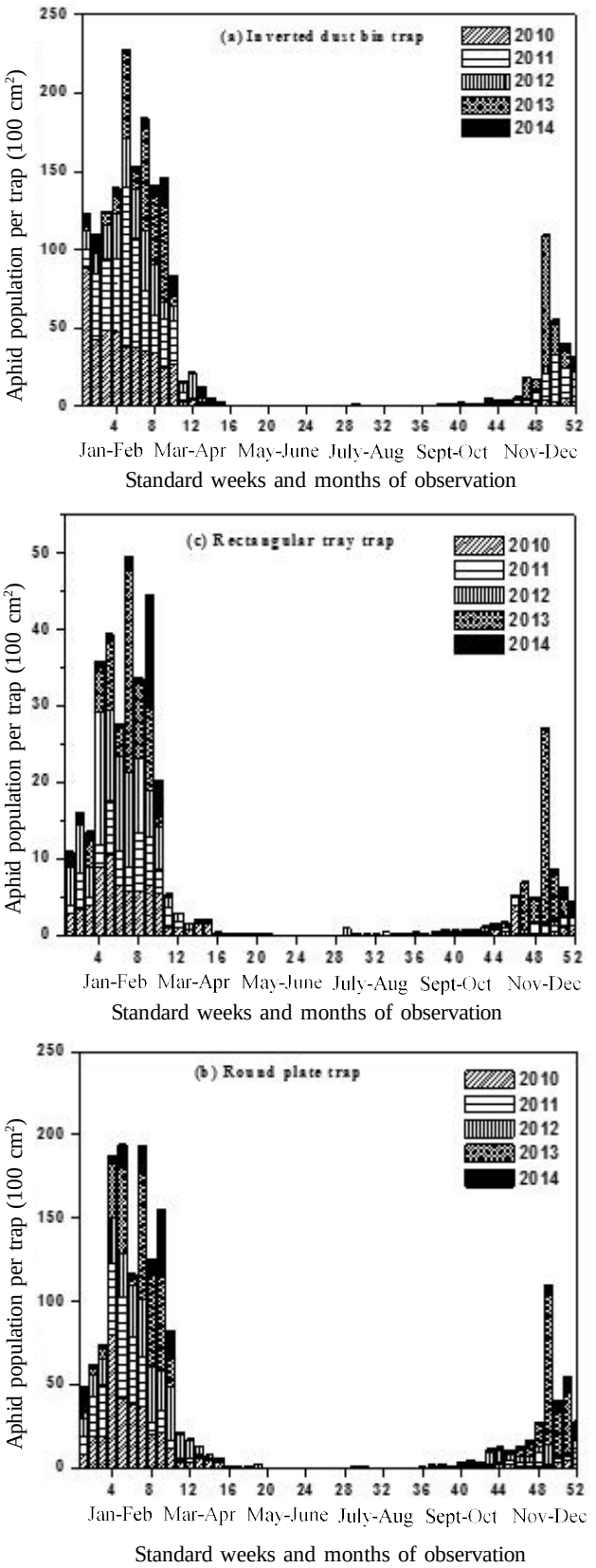

Fig 2: Population of *A. cracciovra* trapped on three different types of traps during years 2010 to 2014.

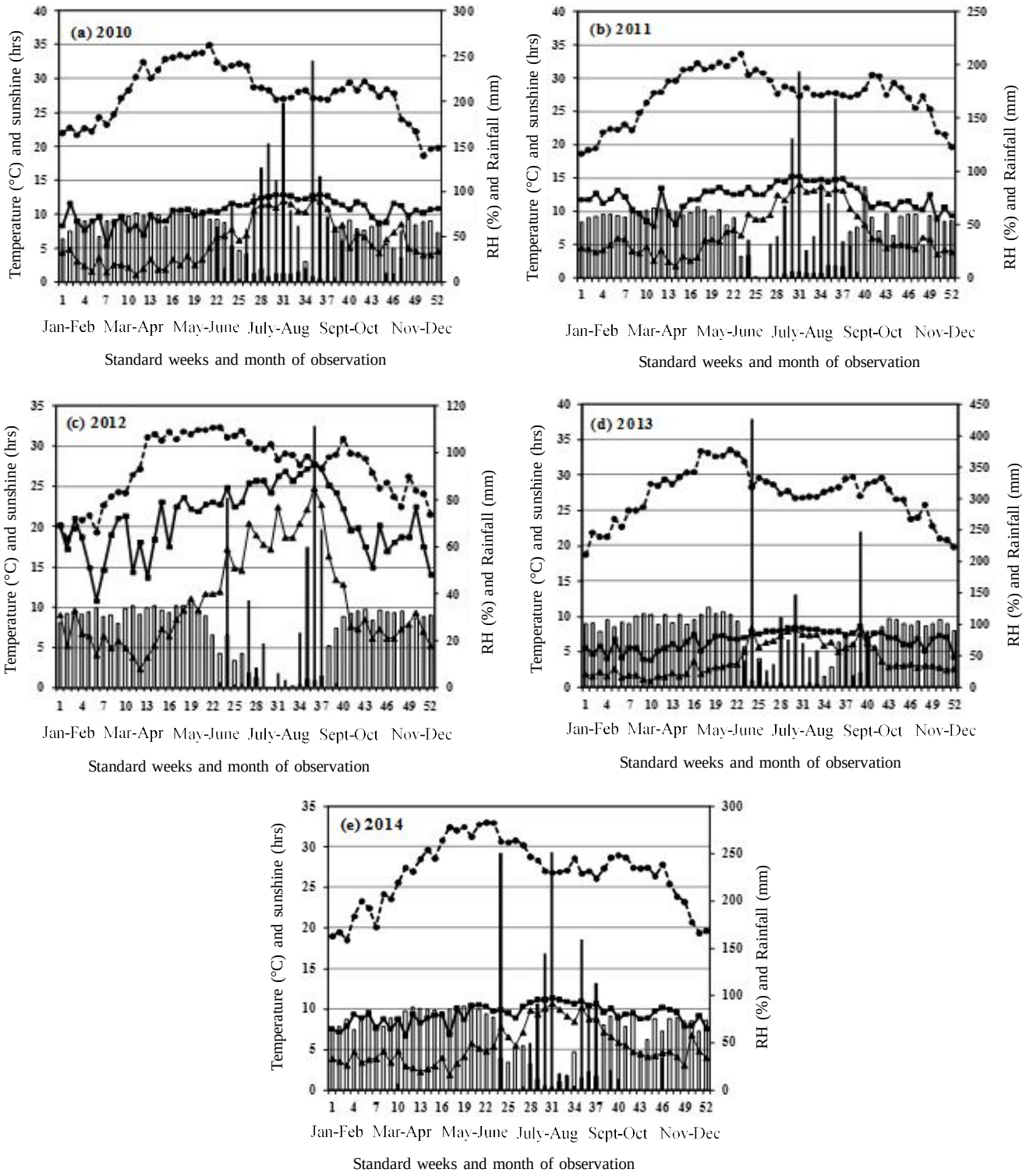

Fig 3: Weather parameters during study period (2010 to 2014)

(Figure 3). The correlation analyses revealed that the population of aphids had a strong relationship with weather parameters. Irrespective of trap type, the population was negatively affected by maximum and minimum temperature, morning and evening relative humidity and amount of rainfall, whereas sunshine had a positive effect on aphid population (Table 1). Multiple regression analyses performed between weather parameters and aphid population indicated that highest total variation of sixty one percent (R^2=0.61) in the aphid population was recorded in inverted dust bin traps

Table 1: Correlation between weather parameters and aphid population during study period (2010 to 2014)

Sampling period	Trap type	Mean weekly factors of five years (2010-2014)					
		Temperature (°C)		Relative humidity (%)		Rainfall	Sunshine
		Maximum	Minimum	Morning	Evening	(mm)	(hrs)
January-March	Inverted dust bin	-0.41**	-0.32*	-0.47**	-0.36**	0.00	0.28**
	Round plate	-0.35*	-0.20**	-0.36**	-0.38**	0.01	0.20**
	Rectangular tray	-0.18*	-0.17*	-0.36**	-0.25**	0.08	0.26**
October-December	Inverted dust bin	-0.25*	-0.20**	-0.38**	-0.26**	-0.27**	0.27**
	Round plate	-0.14*	-0.14*	-0.31**	-0.19*	-0.21**	0.22**
	Rectangular tray	-0.14*	-0.17*	-0.29**	-0.15*	-0.24**	0.18*

N= 130, *Significant at *P*=0.05 **Significant at *P*=0.01

followed by forty five percent (R^2=0.45) in round plate trap and lowest non-significant variation of twenty one (R^2=0.21) was observed in rectangular tray trap (Table 2).

The present findings clearly indicate that aphid build-up on groundnut crop was strongly impacted by abiotic factors prevailing during different seasons. However, its peak is dependent on upon the availability of choice food coupled with favourable climatic factors. Prasad *et al.* (2008) reported by analyzing seven years data (1999-2005) that there was marked intra and inter seasonal variations in the *A. craccivora* population on groundnut. Low temperature, morning and evening relative humidity during *rabi* favoured the population of aphids and was responsible for the multiplication of alate forms of aphids. High temperature during summer and high rainfall during *kharif* were key abiotic factors responsible for the decline of aphid population. On contrary, Jagadish *et al*. (2003) reported that maximum and average temperatures were significantly and positively correlated with the total aphid population. The other studies reported that aphid population was highly influenced by the amount of rainfall (Nandagopal 2004, Atsebeha *et al.*, 2009). The rainfall and relative humidity showed significant correlation with aphid population (Cividanes, 2002). Shahzad *et al*. (2003) observed that population of *A. craccivora* increased with the increase in morning relative humidity and decreased with the increase in evening relative humidity.

Table 2: Multiple regressions with population of *A. craccivora* and weather parameters during 2010-14

Weather parameters	Partial regression coefficients	Standard error	't' value	R^2
Inverted dust bin				
Intercept	2596.64	1008.19	2.58	0.61**
X_1=Maximum temperature (°C)	-68.88	46.59	-1.48	
X_2=Minimum temperature (°C)	-1.75	35.49	-0.05	
X_3=Morning relative humidity (%)	11.06	8.06	1.37	
X_4=Evening relative humidity (%)	-18.84	10.45	-1.80	
X_5=Rainfall	0.85	1.36	0.62	
X_6=Sunshine (hrs)	-12.39	23.68	-0.52	
Round plate				
Intercept	1541.82	612.20	2.52	0.45*
X_1=Maximum temperature (°C)	-40.27	28.29	-1.42	
X_2=Minimum temperature (°C)	-0.21	21.55	-3.01	
X_3=Morning relative humidity (%)	6.00	4.89	1.23	
X_4=Evening relative humidity (%)	-11.19	6.35	-1.76	
X_5=Rainfall (mm)	0.61	3.45	0.73	
X_6=Sunshine (hrs)	-6.63	14.38	-0.46	
Rectangular tray				
Intercept	977.21	242.30	1.58	0.21^{NS}
X_1=Maximum temperature (°C)	-25.27	18.46	-0.64	
X_2=Minimum temperature (°C)	-0.21	18.23	-0.01	
X_3=Morning relative humidity (%)	-3.25	0.58	-1.41	
X_4=Evening relative humidity (%)	-11.19	0.35	-0.76	
X_5=Rainfall (mm)	0.61	0.83	0.73	
X_6=Sunshine (hrs)	-2.20	9.99	-0.35	

N= 130, *Significant at *P*=0.05 **Significant at *P*=0.01 NS- Non Significant

CONCLUSION

All traps were found effective in trapping *A. craccivora*, however inverted dust bin traps caught maximum number of aphids, therefore, may be used for monitoring purpose. There was not much difference in the cost of installation of each trap. The population of *A. craccivora* on groundnut peaked around 5th standard week (February) however, the considerable pest activity was also observed during October to December. The weather parameters *viz.*, maximum and minimum temperature, morning and evening relative humidity and amount of rainfall were negatively correlated with aphid population, whereas sunshine had a positive effect on aphid population. The population of *A. craccivora* is highly influenced by weather parameters; however the rainfall had a significant impact by completely washing out aphids from plants.

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