UNIVERSITY OF SINDH JOURNAL OF ANIMAL SCIENCES
DOI: https://doi.org/10.57038/usjas.v8i2.6350
Uni. Sindh. J. Anim. Sci., vol. 7(2); 50-58, 2023
Email: editors.usjas@usindh.edu.pk
ISSN (P): 2521-8328
ISSN (E): 2523-6067
Published by University of Sindh, Jamshoro.

EXPLORING THE IMPACT OF WEATHER FACTORS ON THE POPULATION TREND OF OXYCARENUS LAETUS KIRBY (DUSKY COTTON BUG) AND NATURAL ENEMIES IN DIFFERENT AGRO-ECOLOGICAL ZONES OF SINDH, PAKISTAN

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ARTICLE INFORMATION

Article History:
Received: 11th April 2023
Accepted: 15th June 2023
Published online: 30th June 2023

Authors contribution
MMR planned the research study, collected and analyzed the data and writing of manuscript, and HAS supervised whole process.

Key words:
Dusky cotton bug, population, weather, cotton, natural enemies

ABSTRACT

The research work was carried out in different agro-eco-zones of Sindh, Pakistan at the experimental field area of Cotton Agriculture Research Station at Tandojam, Sakrand, Kotdiji and Sarhad, 2019. The peak population of the Dusky cotton bug (DCB) was recorded at Tandojam. The high population of natural enemies like Chrysoperla, Orius, and Mirid bug was observed from July to September. The peak pest of pest observed averagely at Tandojam and Sakrand (49 to 23%). The abiotic factors like temperature and humidity averagely at Tandojam and Sakrand (32 to 50%) followed by Kotdiji and Sarhad (41 to 18%) recorded ideal for Chrysoperla, Orius, and Mirid bug. The abiotic factors were recorded as favorable for natural population multiplication like temperature and respectively. The weather factors noted optimum for spider population at Tandojam. It was concluded that the peak population of the pest was observed in different agro-eco-zones from September and October.

1. INTRODUCTION

The fiber of cotton is considered the best in the globe. The cotton-based textile industries are the world's biggest and are spread all over the world. It has been a yearly minimum of $600 of an economic impact overall across the globe. It is a major crop and significant role in Pakistan's economy and enjoyed the position of "king of fibers" (Ashraf *et al*., 2018). It has high-quality fiber and is cultivated in more than fifty countries of the world. (Azad *et al*., 2011). It is a profitable fiber throughout the globe. Cotton is a perennial crop that is grown in the warm temperate region. The seeds are produced by cotton with different products like lint, oil, hulls, and animal food. (Ozyigit *et al*., 2007).

The Dusky cotton bug has been observed on various plants throughout the year and survived on various alternate host plants and no cotton varieties were found resistant to this pest (Rind *et al*., 2021). The *Oxycarenus laetus* is considered a critical pest of cotton and feeds on seeds of host plants (Sarmad *et al*., 2020).

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The cotton was infested by various insect pests which affected the yield and export quality. The DCB was firstly considered a minor pest and reached the status of a major insect (Henry, 1983). The Oxycarenus species was recorded as a major insect pest of cotton and caused an emerging threat to transgenic cotton. No cotton variety was recorded free from this pest. (Iqbal *et al*., 2017). The DCB caused damage to the unripened seeds. The systemic insecticides were more used on Bt. cotton and the application of contact insecticides were reduced. As a result, the DCB population reached the major insect pest status of the cotton crop. Cottonseed weight, germination, and oil content were reduced by the Dusky cotton bug (Henry, 1983).

The lint quality of the cotton crop was declined by DCB and losses occurred from 10 to 40% in the production of the crop (Gahukar, 2006). Lint quality was Discoloration during the process. The cotton quality, as well as quantity both, were affected due to the *O. laetus* attack. (Srinivas *et al*., 2004; Ahmed *et al, 2015*). When sever attacked by DCB, its adults produced an unpleasant odor and also reduced the quality of the seed (Srinivas *et al*.,

2004; Thangavlu, 2007). It was considered that *O. laetus* disturbed the lint as a result of discoloration during the ginning process. When heavy attacks happened by DCB; as a result, a reduction occurred in seed germination; oil content, and lint quality. When DCB caused a severe attack on the cotton crop, the adults of DCB were given an unpleasant smell during feeding on cotton seeds (Nakache, 1992; Thangavelu, 2007).

The Dusky cotton bug has attained the position of major insect pest of cotton because of its high growth rate which affected the rate and quality of the cotton crop. It also damaged the growth of the buds and flowers and the cash crop was badly affected by this pest. Sometimes it caused problems for cotton pickers due to itching. This pest should be controlled during these peak months and might cause considerable losses in the lint of cotton (Jawaid *et al*., 2019).

The Dusky cotton bug has been reached major pest of the cotton crop which effected the value of lint and also seed. (Abbas *et al*., 2015). It was considered cotton insect-like as the Dusky cotton bug was a new emerging pest and threatened the cotton crop in Pakistan. (Saleem *et al.,* (2018). The pest has reached the status of major and the Dusky cotton bug affected the lint and seed quality of cotton (Abbas *et al.,* 2015). *Oxycarenus laetus* has become recorded as an economic insect pest of cotton throughout the globe (Henry, 1983).

The main factors which kept the pest population below the economic threshold level by the natural enemies (Evans, 1998). The meaning of natural enemies is "natural balance" and the natural regulation effect on all insect populations to either smaller or larger levels. The natural enemies up setting the insect pest's population density out breaks forecasting. (Solangi *et al*., 2005).

The outcomes revealed that the optimum temperature (20-36^{0C}) and humidity (24-32%) were recorded as ideal for DCB multiplication on transgenic and non-transgenic cotton varieties (Rind, *et al*., 2021). The pest numbers increased at the time of maturing of the crop. The temperature was noted positive correlation, whereas, rainfall and humidity were shown negative correlation with the Dusky cotton bug population (Qayyoum *et al.,* 2014). The temperature has importantly affected the infestation caused by this pest (Patil *et al.,* 1992). However, the temperature positively and rainfall negatively correlated with pest infestation (Chaudhary *et al*., 1999).

Natural enemies such as the Spider, *Dictyna* species were recorded in the cotton crop. The high numbers of pests and their natural enemies were noted from June to October. (Ashfaq *et al*., 2011). The population fluctuation of natural enemies such as *Chrysoperla carnea* population was recorded in range (0.0 – 1.07/ plant) and touched the highest pest population on seventh 7th July population on 7th July with the low population on ninth June and twelfth August respectively. The population of Orius was observed in a range of (0 – 0.21/ plant) and the highest population was observed on 28th July and low on third and ninth September respectively. It touched the highest significant correlation between environmental factors and a positive correlation of temperature and humidity with natural enemies (Bhutto *et al*, 2012).

Keeping in view the importance of the crop and the losses caused by different insect pests to it, the present research was aimed at studying the population dynamics of insect pests and their natural enemies on cotton. Dictyna sp. was observed on 10th July and a high population was noted from 19 to 29, September (Ashfaq, et al., 2011).

2. MATERIALS AND METHODS

The research work was carried out at the experimental field area of Cotton Agriculture Research Station in different agro-eco-zones of Sindh, Pakistan Tandojam, Sakrand, Kotdiji, and Sarhad in 2019. The cotton variety (Sindh-1) was sown in April at (Tandojam, Sakrand) and in May at (Kotdiji and Sarhad) respectively. All possible agronomic practices were conducted as per routine. There was no application of insecticide practiced during the overall cropping period. The seed rate was used at 20 kg per hectare along with row to row and plant to plant distance of 2.5ft. X 1.0 ft. was maintained. The crop was raised under canal irrigation conditions. The data were taken in each district from one acre land for the cotton crop.

Sampling method

The observations were taken at fortnightly intervals from the first appearance of the pest till the harvesting of the crop. (Qayyoum, *et al*., 2014). Thirty plants were selected randomly from different locations six plants

from each corner, and six plants from the center. The adults and nymphs were counted from the bottom, middle, and top bolls of the cotton crop early in the morning (Sanghi, *et al.*, 2014). The natural enemies were counted from the whole cotton plant. The weather data were taken from Accu weather mobile software.

Statistical analysis of the collected data

The data of the insect pest population was analyzed by using analysis of variance for significant difference and least significant difference (LSD) were tested and applied to compare the mean through statistical software student package Statistics-8.1 the USA.

3. RESULTS AND DISCUSSION

The results of the present research work (Table-1) showed that the first appearance of the pest was recorded on 13th July (0.47DCB/plant) in the Agro-eco zone of Hyderabad (Tandojam). The peak population of the pest was recorded on 19th October (31.30 DCB/ plant. The high population of natural enemies like Chrysoperla (24th August, 0.73/ plant), Orius (13th July, 1.17/ plant), Mirid bug (24th August, 1.30/ plant), and Spider (7th September, 0.79/ plant). The ideal weather factors like temperature (34.50 to 27^{0C}) and humidity (49 to 26%) were observed for pest multiplication. Likewise, the favorable abiotic factors were noted as favorable for natural enemies population like (Chrysoperla, Orius, and Mirid bug) such as temperature (33.50 to 35^{0C}) and humidity (58 to 39$^{\%}$). The weather factors were recorded as ideal for the spider population at Tandojam Temperature (34.50 to 26^{0C}) and humidity (49 to 26%). The data were statistically analyzed (table-1) and have shown significant effects on the Dusky cotton bug and natural enemies (F=8/233; P1.12E-05). Whereas, the pest was significantly correlated with temperature and humidity (F=18.125; P=1.6E-05).

The results of the research work (Table-2) have shown that the first appearance of the pest (0.23/ plant) was noted on 26th July with an average temperature (36.00^{0}C) and humidity (47.00%). The high pest population was observed on 20th September (30.80 DCB/ plant). The natural enemies were present throughout the crop period and high numbers were observed like Chrysoperla (23rd August, 30.80 DCB/ plant), Orius (23rd August, 1.43 DCB/ Mirid bug (23rd August, 0.97DCB/ plant), and Spider (15th November, 0.95 DCB/ plant). The favorable abiotic factors for pest multiplication were temperature (33.50^{0C}) and humidity (32.00%). The ideal abiotic factors for natural enemies (Chrysoperla, Orius, and Mirid bug) were noted as temperature (33 to 36^{0C}) and humidity (50 to 32%) and for spiders (19.50 to 30^{0C}; 20 to 28%) respectively. The analysis data (Table 4.2) revealed that the natural enemies were a significant effect on pests (F=11.88; P>0.0001). However, weather factors such as Temperature and humidity were significantly effective with the Dusky cotton bug (F=9.85; P=0.00075).

The results of the present research work (Table 3) indicated that the first appearance of the pest was recorded on (22nd August, 0.50 DCB/plant) and the peak population was noted on (17th October, 29.07 DCB/plant). Whereas, natural enemies were present overall crop period. A high population of natural enemies were recorded like Chrysoperla (22nd August 0.60/ plant), Orius (22nd August 1.13/ plant), and Spider (17th October 0.93/ plant). The abiotic factors like temperature ((34 to 27^{0C}), and humidity ((28 to 21%) have remained suitable for pest multiplication. The weather factors noted optimum for spider population averagely temperature and humidity at Kotdiji (37 to 29.50^{0C}; 41 to 19%), and for spiders (20.50 to 29.50$^{0C;}$ 19 to 41%). The analyzed data (Table-3) depicted that the natural enemies were significantly (F=16.63; P>0.0004) effective with the Dusky cotton bug. While abiotic components like temperature and humidity were significantly (F=6.19; P>0.0147) effective with pests.

The research work results (Table-4) showed that the first emergence of pests (0.43 DCB/ plant) was observed on 21st August with an average temperature (35.50^{0}C) and humidity (40%). The high Pest (27.50 DCB/ plant) population was observed on 16th October followed by 2nd October (21.17 DCB/ plant), and 30th October (18.37 DCB/ plant) respectively. The natural enemies overall population and the high numbers were recorded like Chrysoperla (4th September 0.63/plant), Orius bug (18th September 1.20/ plant), Mirid bug (18th September 0.90/plant), and Spider (27th November 0.89/plant) on with average temperature (33.00^{0}C) and humidity (26.00%). The pest's overall seasonal average population (13.41/ plant) with temperature (29.44^{0}C) and humidity (26.50%) were recorded. The weather factors noted optimum for spider population averagely temperature and humidity at Sarhad Sarhad (35.50 to 31^{0C}; 40 to 18 %) and for spiders ((20 to 31$^{0C;}$ 21 to 23%)

The analysis data (table4) were revealed that abiotic factors like as temperature and humidity (F=9.82; P=0.0009) significantly effective on the Dusky bug population and natural enemies were also effective with pest numbers (F=15.03; P>0.00001) were also

The Dusky cotton bug was found all over the year and survived in different host plants. Now, it attained the status of a major pest of the cotton crop. Iqbal *et al*., (2017) reported that *Oxycarenus* species were noted as the key pest of cotton in Pakistan. Sarmad *et al*., (2020) reported that *Oxycarenus laetus* has become an important pest of fiber crops. It also feeds on seeds, leaves, and stems of host plants. Henry (1983) evaluated that *Oxycarenus* species has reached the major pest position. Past time this pest appeared on cotton once when most of the cotton bolls were opened. The current results indicated that the peak population of the Dusky cotton bug was recorded at different Agro-eco-zones of Sindh like Tandojam (19, October, 31.30 DCB/plant) followed by Sakrand (20th September, 30.80 DCB/plant), Kotdiji (17th October, 29.07DCB/plant), Sarhad (16th October, 27.50 DCB/plant) respectively. The results were supported by Rind *et al*., (2021) reported that the first appearance of the Dusky cotton bug was recorded on the cotton crop during the first week of September, and high numbers were recorded in October. The outcomes were also supported by Khan *et al*., (2017) found that the peak population of the bug was observed in October. Shah *et al*., (2016) investigated the Dusky cotton bug huge numbers were observed in September and October months. The pest population trend increased from September up to November months. Ashfaq *et al*., (2011) evaluated that the maximum population of insect pests and natural enemies was recorded from June to October.

The natural enemies peak population were recorded in different agro-eco-zones of Sindh like Tandojam (Chrysoperla 24th August 0.73/plant, Orius13th July 1.17/plant, Mirid bug 8th July 0.73/plant) followed by Sakrand (Chrysoperla 9th August 0.73/plant, Orius 23rd August 1.43/plant, Mirid bug23rd August 0.97/plant), Kotdiji (Chrysoperla 22nd August 0.60/ plant, Orius 22th August, 1.13/plant, Mirid bug 5th September, 0.80/plant), Sarhad (Chrysoperla 4th September, 0.63/plant, Orius 18th September 1.20/plant, Mirid bug 4th September, 0.97/plant) respectively.

Whereas, a high spider population was recorded in different agro-eco-zones of Sindh like Tandojam (7th September 0.79/plant), Sakrand (15th November 0.95/plant), Kotdiji (14th November, 0.93/plant), Sarhad (Spider 27th November 0.89/plant). The findings were supported by Evans, (1998) said that the natural enemies maintained the pest population below the economic threshold level. Dhaka *et al*., (2007) reported that natural enemies such as Chrysoperla sp., and the spider were observed in the cotton crop and played important role in the cotton agro eco-system (Dhaka *et al*, 2007). Wang, *et al*., (1996) observed that beneficial insects like Green lacewing insect, and Orius have been checked in the insect pests population in cotton crop. Ashfaq *et al*., (2011) evaluated that the maximum population of insect pests and natural enemies was recorded from June to October. Dhaken *et al*., (2007) described that *Chrysoperla carnea* Stephens and spiders were noted as natural enemies of major insect pests of the cotton crop and played a vital role in the cotton ecosystem.

The weather factors in different Agro-eco-zones of Sindh were recorded as ideal for the Dusky cotton bug multiplication like the temperature at Tandojam (34.50 to 27^{0C}), Sakrand (34 to 29.50^{0C}), Kotdiji (34 to 27^{0C}), Sarhad (33 to 21.50^{0C}). Whereas, humidity like Tandojam humidity (26 t0 49%), Sakrand (47 to 23%), Kotdiji (28 to 21%), and Sarhad (26 to 23 %.) respectively. The findings were supported by Rind *et al*., (2021) who observed that the favorable temperature (20-36^{0C}) and humidity (24-32%) for the reproduction of the Dusky cotton bug was observed both on non-Bt. and Bt. cotton. Qayyoum *et al*., (2014) reported that humidity negatively correlated with the Dusky cotton bug and temperature positively correlated with it. Ashfaq et al., (2011) reported that *Dictyna* sp was observed on 10th July and a high population was noted from 19 to 29, September. (Ashfaq, *et al*., 2011)

The abiotic factors in different agro-eco-zones of Sindh recorded favorable for natural enemies population multiplication like temperature and humidity at Tandojam (32 to 36^{0C}; 49 to 58%), Sakrand (36 to 33^{0C}, 50 to 32%), Kotdiji (37 to 29.50^{0C}; 41 to 19%), and Sarhad (35.50 to 31^{0C}; 40 to 18 %) respectively. The findings were supported by the weather factors noted optimum for spider population averagely temperature and humidity at Tandojam (34.5 to 26$^{0C;}$ 49 to 26%) followed by Sakrand (19.50 to 30^{0C}; 20 to 28%), Kotdiji

(20.50 to 29.50$^{0C;}$ 19 to 41%), and Sarhad (20 to 31$^{0C;}$ 21 to 23%) respectively.

4. CONCLUSION

It was concluded that the Dusky cotton bug population was recorded during July on cotton crop in agro-eco-zones of Sindh like Tandojam and Sakrand with low population due to high temperature and humidity. The peak population of the pest was observed during September and October. The Dusky cotton bug was negatively correlated with weather factors like temperature and humidity. The high population of natural enemies was observed in different agro-eco-zones of Sindh from July to September. Whereas, Spider's maximum population was noted from September to November. The natural enemies were positively correlated with weather factors like temperature and humidity except for the spider which showed a negative correlation.

5. CONFLICT OF INTERESTS

All authors have declared that the there is no conflict of interest regarding this publication.

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Figure 1. Map of Sindh province showed the different agro-eco zones of Sindh.

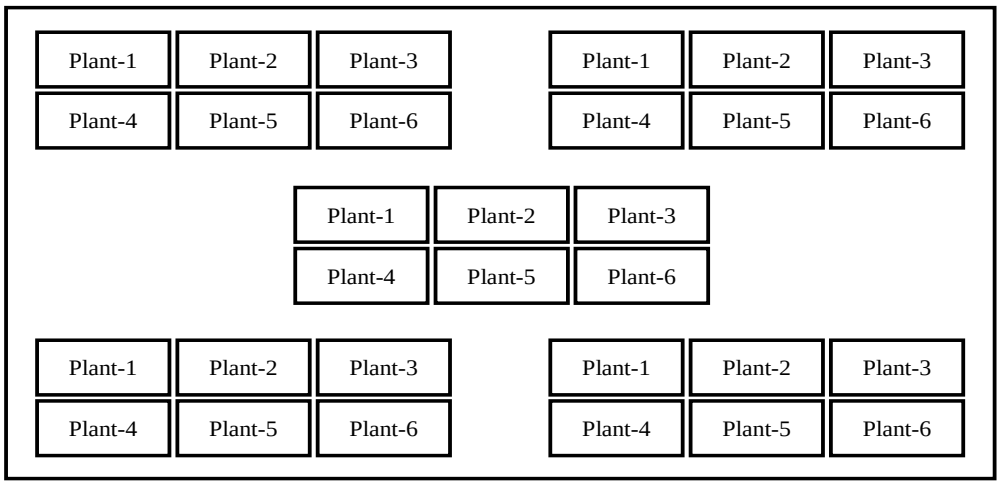

Figure 2. Mario method used for DCB sampling described by (Carolyn *et al*., 2004)
Statistical analysis of the collected data

Table 1. Population dynamics of dusky cotton bug and effect of bio-ecological factors on its population in Agro-eco zone of Hyderabad (Tandojam)

Dated	No. of DCB/ plant	Natural enemies/plant				Overall Natural enemies		Abiotic factors
		Chrysopa	Orius	Mirid bug	Spider	Mean±S.E	Av. Temp.	Humidity%
13.7.2019	0.47	0.53	1.17	0.87	0.40	0.81±0.02	35.50	50.00
27-07-2019	0.60	0.43	0.90	0.60	0.90	0.81±0.06	36.00	58.00
08-07-20`9	1.00	0.67	1.07	0.73	0.40	0.81±0.03	32.00	57.oo
24-08-2019	2.63	0.73	0.87	0.6	0.50	0.8±o.o2	33.00	54.00
07-09-2019	13.48	0.72	0.92	0.65	0.79	0.74±0.03	34.50	49.00
21-09-2019	27.67	0.49	0.65	0.47	0.41	0.54±0.03	33.00	39.00
05-10-2019	29.07	0.30	0.6	0.37	0.67	0.54±0.27	30.00	33.00
19-10-2019	31.30	0.35	0.68	0.51	0.68	0.61±0.02	27.00	26.00
02-11-2019	12.77	0.36	0.51	0.49	0.83	0.6±0.02	26.00	26.00
Mean±S.E	13.22±4.36	0.51±0.05	0.82±0.07	0.59±0.05	0.64±0.07	0.71±0.04	31.89±1.19	43.56±4.28

Table 2. Population dynamics of Dusky cotton bug and effect of bio-ecological factors on its population in Agro eco zone of Shaheed Benazirabad (Sakrand)

Dated	No. of DCB/plant	No. of Natural enemies/ plant				Overall Natural enemies	Abiotic factors	
		Chrysopa	Orius	Mirid bug	Spider	Mean±S.E	Av. Temp.	Humidity%
26/07/2019	0.23	0.60	1.23	0.77	0.40	0.90±0.02	36.00	47.00
09-08-2019	0.73	0.43	1.33	0.80	0.23	0.87±0.02	34.00	50.00
23-08-2019	1.60	0.57	1.43	0.97	0.33	0.93±0.03	33.00	44.00
06-09-2019	27.73	0.53	0.76	0.80	0.50	0.80±0.02	34.00	47.00
20-09-2018	30.80	0.43	0.70	0.80	0.37	0.71±0.03	33.50	32.00
04-10-2019	20.10	0.27	0.53	0.29	0.50	0.51±0.3	30.00	28.00
18-10-2019	22.86	0.34	0.62	0.34	0.62	0.61±0.02	29.50	20.00
01-11-2019	14.43	0.31	0.31	0.28	0.79	0.52±0.02	29.00	23.00
15-11-2019	10.37	0.47	0.63	0.63	0.95	0.72±0.06	19.50	20.00
Mean±S.E	14.32±3.94	0.44±0.04	0.84±0.13	0.63±0.09	0.52±0.08	0.73±0.06	30.94±1.64	34.56±4.16

Table 3. Population dynamics of Dusky cotton bug and effect of bio-ecological factors on its population in Agro-eco zone of Khairpur (Kotdiji)

Dated	No. of DCB/ plant	No. of Natural enemies/plant				Overall Natural enemies	Abiotic factors	
		Chrysopa	Orius	Mirid bug	Spider	Mean±S.E	Av. Temp.	Humidity%
22-8-2019	0.50	0.60	1.13	0.73	0.17	0.79±0.24	33.00	41.00
05-09-2019	3.93	0.40	0.77	0.80	0.40	0.69±0.13	37.00	40.00
19-09-2019	16.53	0.30	0.93	0.53	0.67	0.66±0.11	34.00	28.00
03-10-2019	24.77	0.33	0.87	0.73	0.60	0.70±0.11	31.00	27.00
17-10-2019	29.07	0.30	0.70	0.60	0.93	0.69±0.12	29.50	19.00
31-10-2019	26.30	0.27	0.57	0.50	0.90	0.63±0.12	27.00	21.00
14-11-2019	15.33	0.23	0.57	0.50	0.93	0.59±0.12	19.50	18.00
28-11-2019	10.17	0.20	0.47	0.40	0.79	0.48±0.10	20.50	22.00
Mean±S.E	15.83±3.72	0.31±0.03	0.75±0.08	0.60±0.05	0.67±0.10	0.65±0.02	28.94±2.22	27.00±3.20

Table 4. Population dynamics of Dusky cotton bug and effect of bio-ecological factors on its population in Agro-eco zone of Ghotki (Sarhad)

Dated	No.of DCB/ plant	No. of Natural enemies/plant				Overall Natural enemies	Abiotic factors	
		Chrysopa	Orius	Mirid bug	Spider	Mean±S.E	Av. Temp.	Humidity %
21-8-2019	0.43	0.50	1.07	0.67	0.17	0.70±0.03	35.50	40.00
04-09-2019	1.87	0.63	1.10	0.97	0.37	0.83±0.02	34.50	37.00
18-09-2019	10.43	0.47	1.20	0.90	0.47	0.79±0.03	33.00	26.00
02-10-2019	21.17	0.50	0.97	0.73	0.60	0.79±.04	32.00	24.00
16-10-2019	27.50	0.40	0.70	0.73	0.85	0.76±0.30	31.00	18.00
30-10-2019	18.37	0.27	0.47	0.43	0.77	0.52±0.25	28.00	23.00
13-11-2019	14.07	0.20	0.47	0.40	0.79	0.48±0.02	21.50	23.00
27-11-2019	12.83	0.25	0.56	0.54	0.89	0.63±0.02	20.00	21.00
Mean ±S.E	13.41±3.76	0.42±0.06	0.85±0.12	0.69±0.08	0.57±0.09	0.70±0.05	29.44±2.06	26.50±2.76