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Study on seasonal incidence of Stem girdler [*Obereopsis Brevis* (Swedenbord)] on soybean

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Abstract

An investigation was carried out to “Study on seasonal incidence of Stem girdler [*Obereopsis brevis* (Swedenbord)] on soybean” at Agricultural Research Station (ARS), Adilabad, Professor Jayashankar Telangana State Agricultural University during *kharif*, 2017 and 2018. The pooled results indicated that among different sowing dates *viz.*, 15th-18th of June (sowing I), 25th-28th of June (sowing II), 5th-7th of July (sowing III), 15th -17th of July (sowing IV) and 25th-27th of July (sowing V), sowing I recorded minimum incidence of plant infestation and stem tunnelling by stem girdler (10.00% and 12.46%) and maximum incidence in sowing III (12.52% and 14.18%), similarly sowing I recorded minimum incidence (23.1% and 13.13%) and maximum incidence in sowing II (25.08% and 14.39%) during *kharif*, 2017 and 2018, respectively.

Keywords: *Kharif*, seasonal incidence, sowing dates, stem girdler

Introduction

Soybean is native to East Asia, where it appears to have been cultivated from a wild species known as '*Glycine soja*' starting about 5000 years ago. Soybean [*Glycine max* (L.) Merrill] commonly known as soya is mostly grown for its protein (40%) and oil (20%) around the world. It also contains 35% carbohydrates, 6-7% total mineral, 5-6% crude fiber, 5% ash (Chauhan *et al.*, 2002) ^[1]. Soybean is a rich source of vegetable oil and ranks first with 56.753 million metric tonnes of oil production globally (SOPA, 2019) ^[11]. The other sources of vegetable oils that follow soybean are canola, sunflower, corn, palm, coconut, and others (Global Vegetable Oils Industry, 2019). India is the sixth largest soybean oil producing country in the world with 1.440 million metric tonnes of oil production (SOPA, 2019) ^[11].

In India, soybean is cultivated in an area of 113.98 lakh ha during 2019-20. Among the states, Madhya Pradesh stands first with 55.16 lakh ha. Followed by Maharashtra (40.11 lakh ha.), Rajasthan (10.60 lakh ha), Karnataka (3.30 lakh ha.) and Telangana (1.77 lakh ha.) (SOPA, 2020) ^[12]. Nearly 48% of soybean cultivated area is contributed by Madhya Pradesh and is called as 'Soya-state'. Madhya Pradesh, Maharashtra and Rajasthan together contribute about 97% to the total area and 96% production of soybean in the country. In Telangana, soybean occupies an area of 1.77 lakh ha. With a production potential of 2655 tonnes and productivity of 1500 kg/ha.

Among the dozen major pests, stem girdler (*Obereopsis brevis* Swedenbord) was found to cause extensive damage to soybean crop in Adilabad district of Telangana. The grub of stem girdler feeds on the internal content of the stem resulting in the formation of tunnels inside the stem. Due to tunnelling of stem, the supply of nutrients gets blocked to rest parts of the plant and eventually plant gets dried up. At later stages, the dried plant will be broken at about 15-25 cm above the ground. Girdle formation by the adult female resulted in significant reduction in number of pods, number of seeds and seed weight. Losses caused by girdle beetle were also influenced by crop stage and different infestation levels. Up to 10% infestation level by girdle beetle did not seem to have much yield reduction at all the crop stages but the crop between 37 and 44 days after germination appeared to be most vulnerable to girdle beetle infestation.

Insect-pests population dynamics, distribution and period of infestation on crops are highly dependent on weather variables. The understanding of congenial pre-disposing weather conditions for multiplication and spread of insect are essential for timely, efficient and cost-effective management.

Hence, it is of paramount importance to assess the crucial weather factors responsible for the prevalence of girdle beetle. Temperature, relative humidity and rainfall were among the key abiotic factors which have influenced the girdle beetle infestation. Thus, it was hypothesized to determine the crop growth stage (standard meteorological week) of occurrence of girdle beetle infestation and influencing weather parameters through prediction model so as implementation of best management strategies with a view to maximize soybean productivity and reduce the sprays required.

Materials and Methods

The present experiment was carried out at Agriculture research station, Adilabad, in order to Study on seasonal incidence of Stem girdler [*Obereopsis brevis* (Swedenbord)] on soybean based on different sowing dates and to find out the effect of sowing dates on incidence of Stem girdler [*Obereopsis brevis* (Swedenbord)] on soybean crop.

The layout was laid out at Agricultural Research Station (ARS), Adilabad during *khariif*, 2017 and 2018. Adilabad is situated in Northern zone of Telangana state at a latitude of 19° 40' 12.00" North and longitude of 78° 31' 48.00" East with an altitude of 264 m from Mean Sea Level (MSL). The experimental field represented medium black soil with good drainage and possessed low to medium organic matter as well as potash contents. The pH and soluble salts were normal. Fertilizers were applied at the time of sowing as basal dose of 30 kg N, 60 kg P₂O₅ and 40 kg K₂O/ha in the form of Urea, Diammonium phosphate and Murate of potash, respectively.

Soybean, variety JS 335 was sown in an area of 1250 sq. m with a plot size of 50 x 5 m. Five such sowings were taken up on different dates during *khariif*, 2017 viz., on 18.06.2017, 28.06.2017, 07.07.2017, 17.07.2017 and 27.07.2017 and similar sowing were taken up during *khariif*, 2018 on 15.06.2018, 25.06. 2018, 05.07.2018, 15.07. 2018 and 25.07.2018. Spacing of 45 x 5 cm was followed between rows and plants of soybean. The experiment was conducted under unprotected conditions.

Stem girdler

The data was recorded from vegetative stage of the crop till harvesting stage of the crop at weekly interval. The percent damage of stem girdler was estimated by counting the number of girdled plants damaged by the beetle and total number of plants in a meter row length. Three such meter row length spots were randomly selected per plot. The data on percent tunneling was recorded by measuring the plant height and tunnel length in randomly selected five plants at physiological maturity.

$$\text{Per cent damage (\%)} = \frac{\text{No. of plants infested}}{\text{Total no. of Plants}} \times 100$$

$$\text{Tunneling per cent damage (\%)} = \frac{\text{Length of tunnel (cm)}}{\text{Length of total stem (cm)}} \times 100$$

Correlation coefficient between insect pests and weather parameters

The incidence of insect pests was correlated with the corresponding weekly record of the meteorological data (Appendices) viz., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall by using the following formula

$$\text{Correlation coefficient "r"} = \frac{\sum xy - \frac{\sum x \sum y}{n}}{\sqrt{(\sum x^2 - \frac{(\sum x)^2}{n})(\sum y^2 - \frac{(\sum y)^2}{n})}}$$

Where

r = Simple correlation coefficient

x = Independent variable i.e., abiotic component

y = Dependent variable i.e., mean number of insect pests

n = Number of observations

Test of significance of correlation coefficient

$$t = \frac{r}{\sqrt{(1-r^2)}} \times \sqrt{(n-2)}$$

Where

The value of 't' is based on (n-2) degrees of freedom

n = the number of sets of observations

r = Correlation coefficient

Besides, correlation, simple and multiple linear regressions were also fitted for the insect pests of soybean and preceding one week weather parameters.

Results and Discussion

The observations recorded on population dynamics of Stem girdler of soybean at five different dates of sowings i.e., 18.06.17 (sowing I), 28.06.17 (sowing II), 07.07.17 (sowing III), 17.07.17 (sowing IV) and 27.07.17 (sowing V) during *khariif*, 2017 and at 15.06.18 (sowing I), 25.06.18 (sowing II), 05.07.18 (sowing III), 15.07.18 (sowing IV) and 25.07.18 (sowing V) during *khariif*, 2018 are presented in tables 1 and 2, respectively.

Seasonal incidence of Stem girdler [*Obereopsis brevis* (Swedenbord)] on soybean

Stem girdler, *O. Brevis*

(A) Number of damaged plants

The incidence of *O. brevis* at initial stages of crop growth was observed in terms of number of damaged plants per *mrl* that were girdled on stem. The number of damaged plants/*mrl* ranged from 0.40 to 4.20, 1.50 to 4.40, 1.82 to 4.62, 1.49 to 4.40 and 1.24 to 3.00 in sowings I, II, III, IV and V, respectively during *khariif*, 2017. Similarly, during *khariif*, 2018 *O. brevis* incidence ranged from 2.00 to 7.00, 1.80 to 7.00, 1.96 to 7.56, 2.00 to 7.90 and 1.90 to 6.50 number of damaged plants/*mrl* in sowings I, II, III, IV and V, respectively. (Tables 1 and 2).

(B) Percent damage

The incidence of *O. Brevis* was observed in the crop sown during all the dates of sowings during *khariif*, 2017. The percent damage by *O. Brevis* ranged from 2.0 to 21.0 percent/*mrl* during sowing I. Infestation of stem girdler started from 28th SMW (7.0 percent/*mrl*). Thereafter, infestation increased gradually and reached peak during 31st SMW (21.0 percent/*mrl*). Similarly, during sowing II, the percent damage ranged from 7.50 to 22 percent/*mrl*. Maximum infestation of 22.0 percent damage was recorded during 35th SMW. Likewise in the sowings III, IV and V the percent damage ranged between 9.10 to 23.1, 7.45 to 22.0 and 6.20 to 15.0 percent/*mrl* with highest percent damage of 23.1 percent/*mrl* during 36th SMW, 22.0 percent/*mrl* at 37th SMW and 15.0 percent/*mrl* at 38th SMW, respectively.

During *kharif*, 2018 incidence of *O. Brevis* ranged between 10.0 to 35.0, 9.00 to 35.0, 9.80 to 37.8, 10.0 to 39.5 and 9.50 to 32.5 percent/*mrl*. Highest being during 38th SMW (35.0 percent/*mrl*), 39th SMW (35.0 percent/*mrl*), 40th SMW (37.8 percent/*mrl*), 41st SMW (39.5 percent/*mrl*) and 42nd SMW (32.5 percent/*mrl*) during sowings I, II, III, IV and V, respectively. (Tables 1 and 2).

(C) Percent tunneling

During *kharif*, 2017 the mean percent tunneling of *O. brevis* during sowings I, II, III, IV and V was recorded as 12.46, 13.38, 14.18, 13.92 and 13.09 percent/*mrl*, respectively. The maximum mean percent tunneling of *O. brevis* was recorded during sowing III (14.18 percent/*mrl*) followed by IV (13.92 percent/*mrl*), II (13.38 percent/*mrl*), V (13.09%/mrl) and sowing I (12.46 percent/*mrl*).

During *kharif*, 2018 the percent tunneling of *O. brevis* during sowings I, II, III, IV and V were recorded as 13.13, 13.42, 14.39, 12.40 and 12.15%/mrl, respectively. The percent tunneling of *O. Brevis* has gradually increased from the sowing I to sowing III *i.e.*, 13.13 to 14.39%/mrl and later on decreased in sowings IV and V *i.e.*, 12.40 and 12.15%/mrl (Tables 1 and 2).

The mean plant infestation and stem tunneling by stem girdler were recorded as 10.0 and 12.46%, 13.46 and 13.38%, 12.52 and 14.18%, 13.73 and 13.92% and 10.9 and 13.09%, respectively during sowings I, II, III, IV and V. Among different dates of sowings during *kharif*, 2017 sowing I has recorded lower plant infestation and stem tunneling and gradually incidence increased in sowings II and III. Thereafter, its incidence decreased in sowings IV and V. However, during *kharif*, 2018 sowing I has recorded 23.1 and 13.13% plant damage and stem tunneling, respectively followed by decrease in sowing II (23.64 and 13.42%/mrl) and then again increased in sowing III (25.08 and 14.39%/mrl). The infestation decreased in IV (22.77 and 12.40%/mrl) and sowing V (19.68 and 12.15%/mrl), respectively. (Table 3).

The present findings are in partial agreement with those of Rai and Patel (1990) who reported the incidence of the cerambycid, *O. Brevis* in plots sown with the soybean variety JS 72-44 on 15th July, 1988 in India. The pest first appeared on 10th August 1988 and activity continued until 12th October, 1988. It was concluded that the low infestation level (0.86 to

12.09%) during the period of activity might be due to the late planting of soybean crop. Kundu and Trimohan (1986) [6] reported that girdle beetle infestation on soybean was negligible during 1983. However higher infestation was noticed in (24.87%) crop sown on 1st July, 1985, but it was reduced to 10.2% in crop sown on 1st August, 1985.

Meena and Sharma (2006) [7] reported that the lowest mean girdle beetle infestation was observed within 25th July sowing, Meena (2005) [8], Rajpoot and Choudhary (2015) [10], Yeotikar *et al.* (2015) [13] and Kalyan and Ameta (2017) [5] reported single peaks depending on the time of sowing.

Reported five insects' species, *viz.*, girdle beetle, *O. Brevis*, tobacco caterpillar, *S. Litura*, green semilooper, *C. Acuta*, leafhopper, *E. Kerri* and whitefly, *B. tabaci* as the major pests of soybean variety, JS 93-05 causing damage at various stages of the crop. All these insects made their first appearance on the crop to a greater or lesser extent in the last week of July.

Correlation coefficients between stem girdler of soybean and weather parameters

A significant negative correlation was obtained between stem girdler% damage and minimum temperature during total crop growth period, but it was significant positive correlation with maximum temperature at 83 DAS ($r = 0.783^*$). While, stem girdler% damage showed significant positive correlation with morning relative humidity at 34 DAS ($r = 0.730^*$) and 48 DAS ($r = 0.732^*$) and also with evening relative humidity at 48 DAS ($r = 0.670^*$). (Table 4). Yeotikar (2015) [13] reported that stem girdler% damage exhibited positive correlation with maximum temperature, morning relative humidity. Hiwarale (1995) [4] concluded that morning and evening relative humidity affects positively on stem girdler% damage.

Simple and multiple linear regressions for Stem girdler of soybean with preceding one week weather parameters

In case of stem girdler% damage, multiple linear regression indicated that morning relative humidity and evening relative humidity accounted for 66.1% ($R^2 = 0.661$) of pest incidence at 48 DAS. However, in simple linear regression stem girdler% damage showed that morning, evening relative humidity and maximum temperature influenced for 8.3% ($R^2 = 0.083$), 19.5% ($R^2 = 0.195$) and 32.3% ($R^2 = 0.323$) of pest incidence at 34, 41 and 83 DAS, respectively (Table 5).

Table 1: Seasonal incidence of Stem girdler [*Obereopsis brevis* (Swedenbord)] on soybean during *kharif*, 2017

SMW	Sowing I			SMW	Sowing II			SMW	Sowing III		
	Stem girdler				Stem girdler				Stem girdler		
	No. of damaged plants/ <i>mrl</i>	Percent damage / <i>mrl</i> (%)	% Tunneling / <i>mrl</i> (%)		No. of damaged plants/ <i>mrl</i>	Percent damage/ <i>mrl</i> (%)	Percent tunneling/ <i>mrl</i> (%)		No. of damaged plants/ <i>mrl</i>	Percent damage / <i>mrl</i> (%)	Percent tunneling/ <i>mrl</i> (%)
28	1.40	7.00	-	29	1.52	7.60	-	30	1.82	9.10	-
29	3.20	16.0	-	30	2.21	11.05	-	31	2.26	11.3	-
30	3.00	15.0	-	31	2.50	12.5	-	32	2.22	11.1	-
31	4.20	21.0	-	32	3.12	15.6	-	33	3.29	16.45	-
32	3.80	19.0	-	33	3.50	17.5	-	34	3.78	18.9	-
33	2.60	13.0	-	34	4.00	20.0	-	35	4.20	21.0	-
34	1.60	8.00	-	35	4.40	22.0	-	36	4.62	23.1	-
35	0.80	4.00	-	36	3.25	16.25	-	37	3.18	15.9	-
36	0.60	3.00	-	37	2.02	10.1	-	38	2.60	13.0	-
37	0.42	2.00	12.41	38	1.60	8.00	13.31	39	1.90	9.50	14.13
38	0.40	2.00	12.51	39	1.50	7.50	13.46	40	1.84	9.20	14.23
Mean	2.00	10.00	12.46	Mean	2.69	13.46	13.38	Mean	2.88	12.52	14.18

Sowing IV				Sowing V			
SMW	Stem girdler			SMW	Stem girdler		
	No. of damaged plants/mrl	Percent damage /mrl (%)	Percent tunneling/mrl (%)		No. of damaged plants/mrl	Percent damage /mrl (%)	Percent tunneling/mrl (%)
31	1.52	7.60	-	32	1.50	7.50	-
32	2.21	11.05	-	33	1.90	9.50	-
33	2.50	12.50	-	34	2.25	11.25	-
34	3.12	15.60	-	35	2.59	12.95	-
35	3.50	17.50	-	36	2.65	13.25	-
36	4.00	20.00	-	37	2.90	14.5	-
37	4.40	22.00	-	38	3.00	15.0	-
38	3.25	16.25	-	39	2.25	11.25	-
39	2.02	10.10	-	40	2.00	10.0	-
40	1.49	7.45	13.87	41	1.70	8.50	12.92
41	2.20	11.00	13.97	42	1.24	6.20	13.27
Mean	2.75	13.73	13.92	Mean	2.18	10.90	13.09

Table 2: Seasonal incidence of Stem girdler [*Obereopsis brevis* (Swedenbord)] on soybean during *kharif*, 2018

Sowing I				Sowing II				Sowing III			
SMW	Stem girdler			SMW	Stem girdler			SMW	Stem girdler		
	No. of damaged plants/mrl	% Damage /mrl (%)	Percent tunneling/mrl (%)		No. of damaged plants/mrl	Percent damage /mrl (%)	Percent tunneling/mrl (%)		No. of damaged plants/mrl	Percent damage /mrl (%)	Percent tunneling/mrl (%)
28	2.00	10.0	-	29	1.80	9.00	-	30	1.96	9.80	-
29	2.40	12.0	-	30	2.40	12.0	-	31	2.39	11.95	-
30	2.90	14.5	-	31	3.45	17.2	-	32	3.45	17.25	-
31	3.20	16.0	-	32	4.65	23.2	-	33	4.20	21.0	-
32	4.20	21.0	-	33	4.00	20.0	-	34	4.65	23.25	-
33	5.21	26.0	-	34	5.00	25.0	-	35	5.21	26.05	-
34	5.00	25.0	-	35	5.20	26.0	-	36	5.90	29.5	-
35	6.50	32.5	-	36	5.90	29.5	-	37	6.20	31.0	-
36	6.52	32.6	-	37	6.20	31.0	-	38	6.45	32.25	-
37	6.00	30.0	12.92	38	6.40	32.0	13.36	39	7.20	36.0	14.43
38	7.00	35.0	13.35	39	7.00	35.0	13.48	40	7.56	37.8	14.35
Mean	4.63	23.10	13.13	Mean	4.73	23.64	13.42	Mean	5.02	25.08	14.39

Sowing IV				Sowing V			
SMW	Stem girdler			SMW	Stem girdler		
	No. of damaged plants/mrl	Percent damage /mrl (%)	Percent tunneling/mrl (%)		No. of damaged plants/mrl	Percent damage /mrl (%)	Percent tunneling/mrl (%)
31	2.00	10.0	-	32	2.00	10.0	-
32	2.50	12.5	-	33	1.90	9.50	-
33	2.85	14.25	-	34	2.40	12.0	-
34	3.20	16.0	-	35	3.50	17.5	-
35	4.00	20.0	-	36	3.60	18.0	-
36	4.25	21.25	-	37	4.00	20.0	-
37	5.00	25.0	-	38	4.52	22.6	-
38	5.20	26.0	-	39	3.58	17.9	-
39	6.00	30.0	-	40	4.90	24.5	-
40	7.20	36.0	12.35	41	6.40	32.0	12.2
41	7.90	39.5	12.45	42	6.50	32.5	12.1
Mean	4.55	22.77	12.40	Mean	3.94	19.68	12.15

Table 3: Cumulative mean of Stem girdler [*Obereopsis brevis* (Swedenbord)] on soybean in different dates of sowings during *kharif*, 2017 and 2018

Treatments	Stem girdler			Treatments	Stem girdler		
	No. of damaged plants/mrl	Percent damage /mrl (%)	% Tunneling/mrl (%)		No. of damaged plants/mrl	% damage/mrl (%)	% Tunneling/mrl (%)
(Sowing I) 18-06-17	2.00 (1.74)	10.00 (3.33)	12.46 (3.67)	(Sowing I) 15-06-18	4.63 (2.37)	23.1 (4.92)	13.13 (3.76)
(Sowing II) 28-06-17	2.69 (1.92)	13.46 (3.81)	13.38 (3.80)	(Sowing II) 25-06-18	4.73 (2.4)	23.64 (4.96)	13.42 (3.8)
(Sowing III) 07-07-17	2.88 (1.98)	12.52 (3.68)	14.18 (3.9)	(Sowing III) 05-07-18	5.02 (2.46)	25.08 (5.12)	14.39 (3.93)
(Sowing IV) 17-07-17	2.75 (1.94)	13.73 (3.84)	13.92 (3.87)	(Sowing IV) 15-07-18	4.55 (2.36)	22.77 (4.88)	12.4 (3.25)
(Sowing V) 27-07-17	2.18 (1.79)	10.9 (3.45)	13.09 (3.56)	(Sowing V) 25-07-18	3.94 (2.23)	19.68 (4.55)	12.15 (3.63)
SE m±	0.004	0.006	0.002	SE.M±	0.001	0.001	0.187
CD at 5%**	0.012	0.019	0.007	CD at 5%**	0.004	0.003	N/A
CV%	0.46	0.384	-	CV%	0.128	0.039	11.40

*Average of 3-meter row lengths **Significant at 5% Figures in parenthesis are angular transformed values *mrl* =meter row length

Table 4: Correlation coefficients between stem girdler, *O. brevis* % damage on soybean and preceding one week weather parameters: (Pooled data of *kharif*, 2017 and *kharif*, 2018)

Days after sowing (DAS)	Maximum temperature (°C)	Minimum temperature (°C)	Morning relative humidity (%)	Evening relative humidity (%)	Rainfall (mm)
20	-0.133	-0.865**	0.574	0.478	0.367
27	-0.070	-0.668*	0.535	0.304	0.002
34	-0.286	-0.776**	0.730*	0.610	0.271
41	-0.176	-0.852**	0.708*	0.331	0.279
48	-0.290	-0.847**	0.732*	0.670*	0.432
55	0.030	-0.849**	0.512	0.025	-0.280
62	0.324	-0.853**	0.420	0.066	-0.345
69	0.108	-0.780**	0.328	0.010	0.327
76	-0.121	-0.793**	0.490	0.051	-0.181
83	0.783**	-0.821**	-0.541	-0.833**	-0.462
90	0.430	-0.720*	-0.264	-0.556	0.338

*Significant at 5%, **Significant at 1%

Table 5: Simple and multiple linear regressions for Stem girdler of soybean with preceding one week weather parameters: (Pooled data of *kharif*, 2017 and *kharif*, 2018)

Days after sowing (DAS)	Insect pests	Regression equation	R ² value
34	Stem girdler	$Y = 3.453 + (0.132^*) X_3$	0.083
41	Stem girdler	$Y = 4.464 + (0.282^*) X_3$	0.195
48	Stem girdler	$Y = -13.670 + (0.163^*) X_3 + (0.270^*) X_4$	0.661
83	Stem girdler	$Y = -376.5 + (8.777^*) X_1$	0.139

Conclusion

Results on seasonal incidence of Stem girdler [*Obereopsis brevis* (Swedenbord)] on soybean made from seedling to harvest stage during five dates of sowing in *kharif*, 2017 and 2018 revealed that sowing I (18-06-17 and 15-06-18) recorded low incidence of plant infestation and stem tunnelling by stem girdler (10.00% and 12.46%; 23.1% and 13.13%) compared to the sowing III (07-07-17 and 05-07-18) which recorded maximum incidence (12.52% and 14.18%; 25.08% and 14.39%), respectively. Among different dates of sowings during *kharif*, 2017 and 2018, sowing I has recorded lower plant infestation and stem tunnelling and gradually incidence increased in sowings II and III. Thereafter, its incidence decreased in sowings IV and V. Sowings I (18-06-17 and 15-06-18), II (28-06-17 and 25-06-18) and III (07-07-17 and 05-07-18) were found to be suitable for soybean even under normal insect pest incidence compared to sowings IV (17-07-17 and 15-07-18) and V (27-07-17 and 25-07-18) which resulted in lowest yields even though the pest incidence was low during these two late sowing dates. Among different weather factors, Stem girdler showed significant positive correlation with maximum temperature at 83 DAS ($r = 0.783^*$), morning relative humidity at 34 DAS ($r = 0.730^*$) and 48 DAS ($r = 0.732^*$) and evening relative humidity at 48 DAS ($r = 0.670^*$).

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