Seasonal incidence of spotted pod borer (*Maruca vitrata*F.) in Indian bean and correlation with meteorological aspects

ABSTRACT

Aim: To study the population dynamics of spotted pod borer infesting Indian bean in relation to weather parameters
Study design: Field trail; Randomized Block Design
Place and Duration of Study: The study was conducted at College farm at Navsari Agricultural University during *Rabi* of 2022-23 and 2023-24
Methodology:50 plants were randomly selected from the net plot area. The observations on the number of larvae per plant and per cent pod damage were counted.
Results: The larval population, in year 2022-23 started from 51st SMW. The peak activity was observed in 4th SMW when 6.46 larvae/plant population was recorded which coincided with the peak flowering stage. During the second season (year 2023-24) also, the pest population started from 51st SMW with pest population of 0.8 larvae/plant. The peak pest population was observed on 4th SMW with 6.84 larvae/plant. The pod damage started from 2nd SMW with 10.05 per cent and gradually increased. The peak was recorded in 12th SMW, highest pod damage was observed with 55.89 per cent. Similar to previous year, the pod damage was recorded from 2nd SMW with 11.67 per cent and peak was seen in 8th SMW with 56.63 per cent damage. The correlation of number of larvae per plant with maximum (r=-0.63), minimum (r=-0.62), average temperature (r=-0.74) and average vapour pressure (r=-0.59) showed significantly negative correlation. During year 2023-24, minimum (r=-0.637) and average temperature (r=-0.610) showed significant negative correlation. In case ofpod damage, it was revealed that maximum temperature (r=0.58) and bright sunshine hours (BSSH) (r=0.59) exhibited significant positive correlation with pod damage per cent, in year 2022-23. A similar trend was seen in year 2023-24 where, maximum temperature (r=0.692) and BSSH (r=0.787) showed significant positive correlation.
Conclusion: Temperature and to some extent vapour pressure plays a significant role in the population fluctuation of spotted pod borer in Indian bean

Keywords: spotted pod borer, Maruca vitrata, Indian bean, population, dynamics

1. INTRODUCTION

Indian bean or field bean is one of the most popular and ancient perennial vegetable crops. It is a multi-purpose crop that is primarily grown for its green pods. It is consumed as vegetables pulse and asforage (Anon., 2018)[1]. Normal area of field bean is 7.45 L ha, producing 9.10 L tonne with a productivity of 1222 kg/ha. In total field bean contributes 5% in area and 6% in production[12-15]. The ever highest area and production was 11 L ha and 10 Lt. for both during 2016-17 and productivity of 986 kg/ha during 2020-21 (Anon., 2022)[2]. The poor yield of this crop is mainly attributed to the attack of a wide range of insect pests.Among them spotted pod borer, *Maruca vitrata* (Fabricius) (Crambidae, Lepidoptera) is a serious polyphagous pest attacking various legumes *viz.,* cowpea, green gram, black gram, red gram, yam bean, field bean, *etc.*(Bharathi *et al.*, 2019)[3].The larvae, which are photo-negative, emerge early in the evening and feed on the plant throughout the night. Losses in grain yield of 20 to 60% due to *Maruca* damage in grain legumes have been estimated (Sharma *et. al.,* 1999)[4].

The indiscriminate use of chemical pesticides by legume growersnecessitates the exploration of alternative, sustainable pest management strategies. To develop such strategies it is inevitable to understand the pest population and its dynamics. This study is an attempt to understand the population dynamics of Spotted pod borer in Indian bean

2. METHODOLOGY

Field investigations took place at College farm of N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat. It is situated between 20º 57' N latitudeand 72 º 54' E longitudes, the location boasted an altitude of approximately 11.98 m above sea level andfell under the 'South Gujarat Heavy Rainfall Zone AES-III'. The crops was sown during *Rabi* in the years 2022-23 and 2023-24.The GNIB-22 variety of Indian bean was raised on the experimental plot of 20.4 × 20.1 m^2size, with the spacing of 60 × 30 cm^2. The crop was sown in fourth week of November. The plot was kept insecticide free for pest development. Around50 plants were randomly selected from the net plot area. The observations on the number of larvae per plant were counted from the selected plants. Observations were taken regularly at weekly intervals from the first week after germination until harvest.The infested pods and total pod were also counted at the time of picking. The per cent pod damage was computed as per the given formula(Mallikarjuna, 2009)[5].

$$\text{Per cent pod damage} = \frac{\text{Total number of damaged pods}}{\text{Total number of pods}} X\ 100$$

The data on weather parameters were collected from meteorological observatory of College farm, N. M. College of Agriculture, Navsari Agricultural University for the investigation.The relationship between meteorological variables *viz.,* maximum and minimum temperature, morning and evening relative humidity, wind speed, sunshine hours, evaporation and morning and evening vapour pressure and pest population was studied. The weekly mean observation made on insect pests was subjected to Pearson's correlation co-efficient analysis.Also, correlation analysis was conducted for the data of per cent pod damage with weather parameters.

3. RESULTS AND DISCUSSION

3.1. Number of larvae per plant

The data presented in the Table 1, reveals that the pest population started from 3rd WAS, *i.e.,* 51st SMW. The pest population of *M. vitrata* fluctuated from 0.02 to 6.46 larvae/plant. The pest activity gradually increased from the 51st SMW to 5th SMW, then a slight decline was seen the following week *i.e.*, on 6th SMW. After that, the population gradually increased till the peak pest population was observed. The peak activity was seen in4th SMW when highest number of larvae per plant *i.e.*, 6.46 larvae/plant was recorded which coincided with the peak flowering stage. After that, it gradually declined till the harvest. The pest population remained above the economic threshold level (ETL) till 9th SMW. In the last week before harvesting *i.e.*, 12th SMW, 0.02 larvae/plant was recorded.

The data recorded in the year 2023-24(Fig.2), was found to be similar to the data of the previous season. The pest population started from 3rd WAS, *i.e.*, 51st SMW when the pest population observed was 0.8 larvae/plant. The pest population of *M. vitrata*fluctuated from 0.2 to 6.84 larvae/plant. A gradual increase in pest activity was observed from 51st SMW to 5th SMW, and then a slight decline was seen in the next week. After that, the population gradually increased till the peak pest population was observed on 4th SMW when highest number of larvae per plant *i.e.*, 6.84 larvae/plant was recorded which coincided with the peak flowering stage. After that, it gradually declined till the harvest. The pest population remained above ETL till 11th SMW. In the last week before harvesting *i.e.*, 12th SMW, 0.2 larvae/plant was recorded.

3.2. Pod Damage (%)

Based on the data, the pod damage incidence due to spotted pod borer ranged from 10.05 to 55.86 per cent during the year 2022-23. The pod damage started from 2nd SMW *i.e.,* with 10.05 per cent damage and gradually increased, except for the

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11th SMW (54.28%) when a slight reduction was noticed. In the 12th SMW highest pod damage per cent was observed at 55.89 per cent.As presented in Table 1, the data of per cent pod damage of the year 2023-24 ranged from 11.67 to 56.63 per cent. Similar to previous year, the pod damage (11.67%) was recorded from 2nd SMW, then gradually increased till 9th SMW, when, highest pod damage per cent (56.63%) was recorded. In the consequent period, the damage started decreasing. At the time of harvest, 53.21 per cent pod damage was recorded.

Table 1: Population dynamics of *M. vitrata*on Indian bean in *Rabi* 2022-23 and 2023-24

SMW	WAS	Year 2022-23		Year 2023-24	
		No. of larvae/plant	Pod damage (%)	No. of larvae/plant	Pod damage (%)
49	1	0	0.00	0	0.00
50	2	0	0.00	0	0.00
51	3	0.4	0.00	0.8	0.00
52	4	1.44	0.00	1.12	0.00
1	5	3.75	0.00	3.98	0.00
2	6	3.64	10.05	3.08	11.67
3	7	4.02	20.38	4.22	20.64
4	8	6.46	25.56	6.84	35.11
5	9	5.6	30.46	5.4	38.90
6	10	3.45	41.56	4.82	44.77
7	11	2.8	48.00	4.3	45.62
8	12	1.01	50.43	3.48	46.08
9	13	0.92	52.67	2.7	56.63
10	14	0.65	55.72	2.24	54.77
11	15	0.32	54.28	1.2	54.93
12	16	0.02	55.89	0.2	53.21

Note: SMW = Standard meteorological week; WAS = Week after sowing

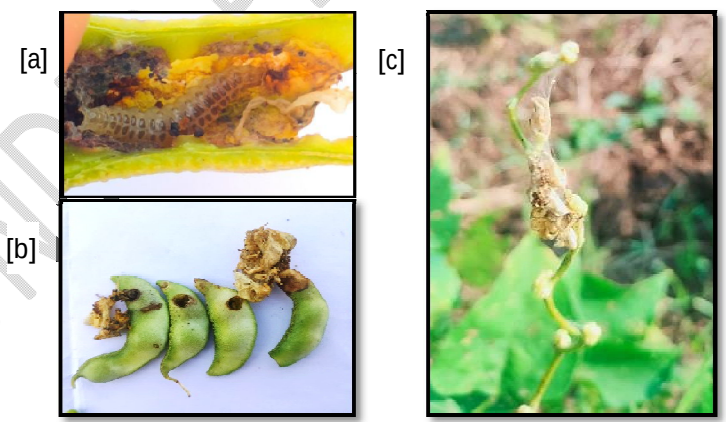

Image1: a) Larvae of spotted pod borer inside Indian bean pod
b) Pod damaged by spotted pod borer
c) Webbed flowers by spotted pod borer

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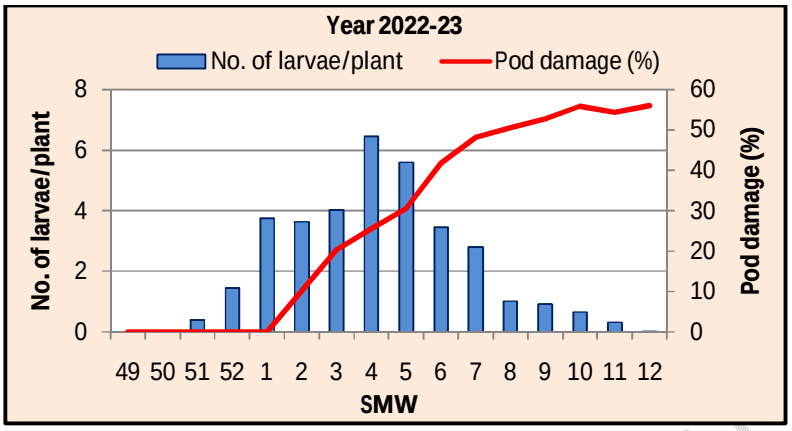

Fig. 1:Seasonal incidence of *M. vitrata* and its effect on per cent pod damage in Indian bean during *Rabi*, 2022-23

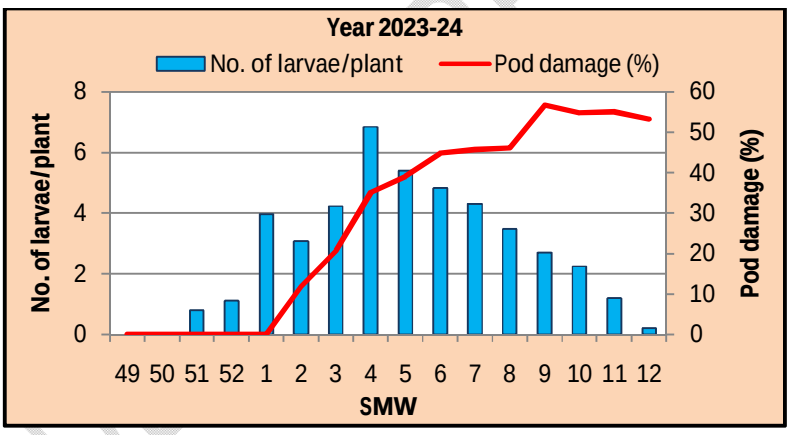

Fig. 2:Seasonal incidence of *M. vitrata* and its effect on per cent pod damage in Indian bean during *Rabi*, 2023-24

Vaidik and Patel (2023)[6] and Rashmi *et al.* (2019)[7], found that *M. vitrata* population started in December and peak population was observed in January. Patel (2014)[8] found that infestation of spotted pod borer started from 4th WAS coinciding with flower initiation. The peak population was found during 7th WAS and the population declined thereafter. These results were in corroboration with the results of the present investigation. The findings of Bhagora (2019)[9] were somewhat relatable with the present results. According to them, an infestation of spotted pod borer started in 44th SMW (0.20 larva/plant) and persisted till 4th SMW. The peak population was observed during 52nd SMW *i.e.*, 4.42 larvae per plant. Rekha (2005)[10] recorded 9.14 per cent pod damage on a 45-day-old crop increasing to 34.95 per cent pod damage on a 108-day-old crop. Thereafter, the pod damage declined and reached 14.00 per cent at 136 days. These results are in good agreement with the present data on per cent pod damage.

3.3. Correlation of population with weather parameters

3.3.1.Correlation of number of larvae per plant with weather parameters

The correlation analysis between number of larvae per plant and weather parameters of the year 2022-23 is presented in Table 2. The correlation of maximum, minimum and average temperature with number of larvae per plant was r = -0.63*, -0.62* and -0.74*, respectively. Maximum, minimum and average temperature showed a significantly negative correlation. While relative humidity (RH) was non-significant, morning RH (r=0.04) was positively correlated but, evening RH (r=-0.13) was negatively correlated. Wind speed (r=0.38) was positively correlated while, bright sunshine hours (BSSH) (r=-0.11) and evaporation rate (r=-0.51) was negatively correlated, but the results were non-significant. The morning vapour pressure (r=-0.57*), evening vapour pressure (r=-0.57*) and average vapour pressure (r=-0.59*) was significantly negatively correlated.

During the year 2023-24, the correlation between number of larvae per plant and weather parameters revealed that minimum temperature (r=-0.64*) and average temperature (r=-0.61*) showed significant negative correlation. While maximum temperature (r=-0.25) was also negatively correlated, but the results was non-significant. Even though, morning RH (r=-0.08), evening RH (r=-0.15) and average RH (r=-0.17) along with evaporation rate (r=-0.16), morning vapour pressure (r=-0.36), evening vapour pressure (r=-0.44) and average vapour pressure (r=-0.43) were negatively correlated, results were non-significant. Similarly, wind speed (r=0.17) and BSSH (r=0.25) showed non-significant positive correlation with number of larvae per plant.

3.3.2. Correlation of per cent pod damage with weather parameters

Based on the data of the year 2022-23, it was reported that maximum temperature (r=-0.58*) showed significant positive correlation with per cent pod damage, while minimum temperature (r=0.14) and average temperature (r=0.42) showed positive, but, non-significant correlation. While BSSH (r=-0.59*) exhibited significant positive correlation. Also, even though, morning RH (r=-0.27), evening RH (r=-0.32), average RH (r=-0.36) and evening vapour pressure (r=-0.07) showed negative correlation, the results were non-significant. Wind speed (r=0.07), evaporation rate (r=-0.36), morning vapour pressure (r=-0.09) and average vapour pressure (r=-0.01) had positive non-significant correlation with per cent pod damage.Similar trends in correlation with pod damage in the year 2023-24. Maximum temperature (r=-0.69*) and BSSH (r=-0.79**) showed significant positive correlation. While other weather parameter such as morning RH (r=-0.12), evening RH (r=-0.45), average RH (r=-0.42), evening vapour pressure (r=-0.08), morning vapour pressure (r=-0.38) and average vapour pressure (r=-0.25) displayed negative, but, non-significant correlation. Correlation between per cent pod damage with wind speed (r=0.19) and evaporation rate (r=0.1) was also non-significant but positive correlation.

Table 2: Correlation of number of larvae of *M. vitrata* per plant with weather parameters on Indian bean

Weather parameters	Correlation co-effecient			
	Rabi 2022-23		*Rabi*2023-24	
	Larval Population (mean no./plant)	Pod Damage(%)	Larval Population (mean no./plant)	Pod Damage(%)
Maximum Temperature (°C)	-0.63*	0.58*	-0.25	0.69*
Minimum Temperature (°C)	-0.62*	0.14	-0.64*	-0.28
Morning Relative Humidity (%)	0.04	-0.27	-0.08	-0.12
Evening Relative Humidity (%)	-0.13	-0.32	-0.15	-0.45
Wind Speed (km/hrs)	0.38	0.07	0.17	0.19

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Bright Sunshine Hours (hrs)	-0.11	0.59*	0.25	0.79**
Evaporation (mm/day)	-0.51	0.36	-0.16	0.19
Morning Vapour Pressure (mmHg)	-0.57*	0.09	-0.36	-0.08
Evening Vapour Pressure (mmHg)	-0.57*	-0.07	-0.44	-0.38

Note: * Significant at 5% level and **Significant at 1% level

Patel (2014)[8] observed minimum temperature (r=-0.205) and average temperature (r=-0.125) to be non-significant negative correlation. BSSH (r=0.254) showed non-significant positive correlation, while, morning RH (r=-0.082), evening RH (r=-0.479), average RH (r=-0.281) and wind velocity (r=-0.244) showed non-significant negative correlation. Reddy *et al.* (2017)[11] significant negative correlation was observed with maximum temperature (r=-0.351), minimum temperature (r=-0.575), and evaporation (r=-0.581). Bhagora (2019)[9] also found a highly significant negative correlation with the minimum temperature (r=-0.690). The remaining factors like maximum temperature (r=-0.553), morning RH (r=-0.558), morning vapour pressure (r=-0.630) and evening vapour pressure (r=-614) showed significantly negative correlation. BSSH (r=-0.176) showed non- significant negative correlation while, wind speed (r=0.265) showed non-significant positive correlation. Vaidik and Patel (2023)[6] also indicated that maximum, minimum temperatures and morning RH and morning RH showed a significant negative influence on the incidence. Wind speed (r=0.288) was positively correlated. Also, morning vapour pressure (r=-0.593) showed significant positive correlation. Thus, above mentioned findings have shown similarities with the results obtained from present investigations.

Table 3: Multiple regression line of correlation association of *M. vitrata*

	Particulars	Multiple regression line	Coefficient of determination (R^2)
Year 2022-23 (*Rabi*)	No. of Larvae/Plant	$Y = 29.98 – 0.38X_1 – 1.03X_2 – 0.05X_3 – 0.17X_4 + 0.83X_5 – 0.50X_6 + 0.44X_7 + 0.93X_8 – 0.06X_9$	0.879
	Pod Damage (%)	$Y = 76.76 + 14.75X_1 – 41.55X_2 – 4.8X_3 + 1.23X_4 + 8.69X_5 – 4.84X_6 + 1.85X_7 + 40.23X_8 – 1.93X_9$	0.931
Year 2023-24 (*Rabi*)	No. of Larvae/Plant	$Y = –74.62 + 1.93X_1 + 0.90X_2 + 0.47X_3 + 0.66X_4 + 0.84X_5 – 0.74X_6 – 0.92X_7 – 1.72X_8 – 2.67X_9$	0.796
	Pod Damage (%)	$Y = –527.24 + 5.98X_1 + 9.28X_2 + 3.52X_3 – 1.03X_4 + 19.26X_5 + 5.29X_6 + 10.45X_7 – 16.01X_8 + 2.81X_9$	0.986

Note: X_1= Temp. Max.; X_2= Temp. Min.; X_3= Mor. RH; X_4=Eve. RH; X_5=Wind speed; X_6= BSSH; X_7= Evaporation; X_8= Mor. Vapour Pressure; X_9= Eve. Vapour Pressure

4. CONCLUSION

With the reference of the above results of population dynamics of *M. vitrata* on Indian bean for both the years, it can be concluded that the pest population highly synchronize with the flowering stages of the plant in early stages. The population starts from 51st SMW when flower buds grow. The peak activity of pest is realized at peak flowering stages. Thereafter, the population remains high till the pod formation stage, then gradually decline. The correlation with the weather parameters states that maximum and minimum temperature plays a significant negative role in dynamics of the population. Hence, with higher temperature the larval population decreases. Upto some extent vapour pressure also exhibited significant negative correlation, while other parameters

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were non-significant. The correlation of per cent pod damage to the weather parameters suggested that maximum temperature had a significant negative effect, while, bright sunshine hours had significant positive effect. This knowledge will enable the farmers to keep track of the said pest according to the changing climate.

Disclaimer (Artificial intelligence)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

APPENDICES

I. Standard week wise meteorological data of Navsari during year 2022-23

SMW	T. Max (°C)	T. Min (°C)	Morn. RH (%)	Eve. RH (%)	Wind Velocity (km/hrs)	BSSH (hrs)	Evaporation (mm/day)	Morn. VP (mmHg)	Eve. VP (mmHg)
49	32.8	17.6	85.2	43.1	2.5	5.3	3.5	13.7	15.4
50	33.1	20.1	85.4	44.0	2.7	6.0	3.6	16.5	16.4
51	33.2	17.8	81.4	35.5	2.5	8.3	4.1	13.8	12.7
52	30.0	11.7	94.1	39.9	1.8	7.9	2.8	10.4	12.5
1	29.1	15.2	80.1	40.7	5.3	5.9	2.6	11.5	12.5
2	29.8	12.8	82.9	34.9	2.8	7.4	3.0	10.2	10.1
3	29.3	10.9	88.1	38.4	2.1	8.6	3.3	9.3	11.8
4	27.5	12.7	82.9	35.9	3.8	5.3	3.0	10.6	10.0
5	30.8	16.7	85.7	43.0	4.6	4.2	3.5	13.7	13.4
6	33.6	13.6	86.5	29.5	2.4	9.4	3.2	11.1	11.2
7	35.1	13.5	75.0	19.9	3.1	10.0	3.1	9.6	8.5
8	36.1	13.7	87.4	24.5	2.2	9.4	4.4	11.1	10.5
9	35.9	15.4	87.8	26.8	2.0	9.1	3.9	12.6	11.7
10	36.3	18.6	66.1	31.5	3.6	5.9	3.7	12.4	12.8
11	36.1	20.0	71.5	39.3	3.7	4.2	4.1	14.6	15.5
12	30.9	19.0	94.1	56.0	3.7	7.3	3.1	18.0	17.7

Note: T. Max = maximum temperature; T. Min. = minimum temperature; Morn. = morning; Eve. = evening; RH = relative humidity; VP = vapour pressure; BSSH = bright sunshine hours

II. Standard week wise meteorological data of Navsari during year 2023-24

SMW	T. Max (°C)	T. Min (°C)	Morn. RH (%)	Eve. RH (%)	Wind Velocity (km/hrs)	BSSH (hrs)	Evaporation (mm/day)	Morn. VP (mmHg)	Eve. VP (mmHg)
49	31.1	19.9	96	61	2.6	5.7	2.7	17.8	20.1
50	31.7	16.7	86	40	1.3	7.7	4.3	13.9	13.7
51	29.4	17.8	67	37	3.9	4.1	4.2	11.3	10.8
52	32.2	13.6	95	39	1.0	7.7	3.6	13.6	13.5
1	29.2	15.5	93.7	57.2	2.2	4.8	4.2	14.0	16.4
2	31.3	17.7	94.8	47.7	2.3	4.6	4.4	15.9	15.9
3	29.4	11.8	93.5	42.2	1.7	7.9	3.7	10.5	12.7
4	30.7	11.6	82.0	25.2	2.5	9.1	3.9	9.7	7.9
5	31.5	14.1	95.3	38.7	1.4	8.5	3.8	12.3	12.8
6	33.2	14.8	87.8	35.2	1.9	8.9	4.2	12.2	12.3
7	32.7	15.5	59.5	60.3	15.2	7.8	2.6	19.5	13.8
8	31.6	13.9	92.4	31.7	2.4	9.8	3.8	12.7	10.5

9	34.0	17.1	86.2	39.2	2.6	8.8	4.0	13.7	14.5
10	32.0	12.2	84.6	24.8	2.3	10.0	4.2	10.2	9.0
11	34.3	16.4	89.9	36.0	1.9	9.2	4.4	14.3	13.8
12	34.7	17.1	92.2	37.1	2.3	8.5	5.0	15.9	14.6

Note: T. Max = maximum temperature; T. Min. = minimum temperature; Morn. = morning; Eve. = evening; RH = relative humidity; VP = vapour pressure; BSSH = bright sunshine hours

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