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Studies on Population Dynamics of Yellow Stem Borer, *Scirpophaga incertulas* walker (Lepidoptera: Pyralidae)

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ABSTRACT: The yellow stem borer (YSB) is monophagous and closely associated with the crop throughout the cropping period, better understanding of its adult activity pattern studies is considerable. This study was conducted on paddy crop at Agriculture Research Station, Gangavathi during 2021-22. Ten locations monitored using pheromone traps revealed clear patterns in the flight period. Moths burst on scene only during the expected times, with a clear rise, fall and an in-between peak. Each flight period occurred at exactly the time of transition between two generations and there was a distinct definiteness with the higher period. Each flight period preceded and followed by zero moth activity. Further there was a distinct occurrence of definite life stages for the period of observations. The first peak trap catches ranged from 11.33 to 121.67 moths/trap/week, the second peak trap catches ranged from 10.67 to 126.67 moths/trap/week and third peak trap catches ranged from14 to108.67 moths/trap/week. Negligible to no moths were recorded during 28th and 39th SMW across all the locations during the study period.

Keywords: Population dynamics, flight period, peak moth activity, trap catches.

INTRODUCTON

The yellow stem borer (YSB) infests rice plant throughout the cropping period. At tillering stage, the stem borer larva enters in the tiller and feeds inside resulting in “dead heart”. Whereas, in the central leaf whorl does not unfold, turns brownish and dries out although the lower leaves remain green and healthy. The affected tillers do not bear panicles. At reproductive stage, the damage is characterized by conspicuous whitish empty panicles which are called “white ear head” (Dutta and Roy 2018). YSB causes 1 to 19 per cent yield loss in early planted and 38 to 80 per cent in late transplanted rice crops (Choudhary *et al*., 2017). Being associated closely with paddy due to its monophagous nature, reported to cause 20-70 per cent yield loss (Sharma *et al*., 2018).

In Karnataka, the incidence and damage level of yellow stem borer varies from region to region. Mysuru, Mandya and Chamrajanagara districts of Karnataka recorded 5-40 per cent damage (AICRP, 2019). In Shivamogga the per cent dead heart and white ear head ranges from 5.70-32.20 and 11.40-38.50, respectively during *kharif* and per cent dead heart and white ear head ranges from 3.12-36.50 and 12.20-22.80, respectively during summer (Shilpa *et al*., 2018). In Tungabhadra project area, reported that 1.20 per cent dead heart during vegetative stage and 1.00 per cent white ears at harvest was recorded. Whereas, in Gangavathi <2 per cent dead heart and <5 per cent white ear head damage was recorded due to yellow stem borer (ICAR-IIRR, Progress Report, 2019).

Current management practices are mainly aimed at chemical approaches, resulting in indiscriminate application with often unsatisfactory results. One of the reasons could be attributed to non-availability of susceptible stages in the infested field at the time of application.

Though the pest is monophagous and closely associated with the crop throughout the cropping period, the available management strategy seems to be inadequate. Better understanding of its generation population dynamics of adult moths could lead to its effective management.

MATERIAL AND METHODS

The present investigation was carried out in rice growing Tungabhadra command regions of Karnataka during 2021-2022.

Investigations on population dynamics of yellow stem borer, *Scirpophaga incertulas* Walker (Lepidoptera:

Pyralidae) was conducted during 2021-22 on paddy crop at Agriculture Research Station (ARS), Gangavathi, surrounding villages of Gangavathi (Ayodhya, Vidyanagar, Hosalli, Basapatna, Arhal, Herur, Kesarahatti and Gonal) and ARS, Dhadhesugur, Karnataka, India.

Monitoring the population dynamics of rice yellow stem borer through pheromone trap. Population dynamics of YSB was studied from February 2021 to May 2022 in rice field at ARS, Gangavathi, surrounding villages of Gangavathi (Ayodhya, Vidyanagar, Hosalli, Basapatna, Arhal, Herur, Kesarahatti and Gonal) and ARS, Dhadesugur. In each of the location, three sleeve traps were installed to monitor the moth activity of YSB. The count of male moths trapped in three sleeve traps (Male) were made at weekly interval during the study period.

Sex pheromone trap: Rice yellow stem borer sex pheromone trap with scirpolure, (Z)-11 hexadecenal + (Z)-9 hexadecenal in 3:1 ratio. Traps were fixed to the supporting pole at a height of one foot above the plant canopy. Trap catches were taken throughout the year and lures were changed at every 20 days interval after first installation.

RESULTS AND DISCUSSION

Monitoring the population dynamics of rice yellow stem borer through pheromone trap. Adult activity of YSB was monitored through pheromone traps in ten locations spread across Tungabhadra command area over two years (2021-22). The results pertaining to the adult activity is presented and discussed hereunder.

Population dynamics observed through pheromone trap. Three peaks of moth activity were observed at ARS, Gangavathi during the study period from February 2021 to May 2022, of which two peaks trap catches were recorded during *rabi* and one peak during *kharif*. The population during the 31st and 17th SMW of 2021 varied from 0.00 to 121.67 (Table 1). Pheromone trap catches were recorded 19 moths/week during 6th SMW and gradually increased and attained its first peak (121.67 moths/trap/week) during 17th SMW and drastically declined by 37th SMW. Negligible to no moths were recorded during 28th and 39th SMW. However, moth catches started again during 40th SMW and increased gradually and reached to its second peak during 48th SMW (65.67 moths) and gradually declined and attained its third peak (108.67 moths/trap/week) during 18th SMW of 2022.

Two peaks of moth activity were observed at Dhadesugur during the study period from February 2021 to November 2021, of which one peak was recorded each during *rabi* and *kharif*. Population ranged from 0.00 to 45.67 during 30th and 17th SMW of 2021, respectively (Table 1). Pheromone trap catches were recorded 11.67 moths/week during 6th SMW and attained its first peak during 17th SMW (45.67 moths/trap/week) and drastically declined up to 34th SMW. Negligible to no moths were recorded during 26th and 35th SMW. Moth population again started during 36th SMW, increased gradually and reached to its second peak during 39th SMW (34 moths/trap/week) and gradually declined.

In Ayodhya, observed three peaks of moth activity during the study period from February 2021 to May 2022, of which two peaks trap catches were recorded during *rabi* and one peak during *kharif*. Population ranged from 0.00 to 126.67 during 30th and 51st SMW of 2021, respectively (Table 1). Pheromone trap catches were recorded 0.67 moths/week during 6th SMW and gradually increased and attained its first peak during 17th SMW (116.67 moths/trap/week) and drastically declined up to 31st SMW. Negligible to no moths were recorded during 29th and 32nd SMW. Moth population again started during 33rd SMW and increased gradually and reached to its second peak during 51st SMW (126.67 moths/trap/week) and gradually declined. Moth activity attained its third peak during 10th SMW (109 moths/trap/week) of 2022.

In Vidyanagar, observed three peaks of moth activity during the study period from February 2021 to April 2022, of which two peaks trap catches were achieved during *rabi* and one peak during *kharif*. YSB moth catches (male) in pheromone trap ranged from 0 to 27.67 on 30th and 11th SMW, respectively. Pheromone trap catches were 18.67 moths/week during 6th SMW and gradually increased and attained its first peak (27.67 moths/trap/week) during 11th SMW and drastically declined up to 38th SMW. Negligible to no moths were recorded during 28th and 40th SMW. The moth population again started during 41st SMW, increased gradually to reach its second peak (13 moths/trap/week) during 1st SMW of 2022 and gradually declined. Moth activity attained its third peak (14 moths/trap/week) during 15th SMW of 2022.

Three peaks of moth activity observed at Hosalli during the study period from February 2021 to May 2022, of which two peaks trap catches were achieved during *rabi* and one peak during *kharif*. Population of YSB moth catches (male) in pheromone trap ranged from 0 to 73.67 on 27th and 20th SMW, respectively. Pheromone trap catches were recorded 2.33 moths/week during 6th SMW and gradually increased and attained its first peak (73.67 moths/trap/week) during 20th SMW and drastically declined up to 31st SMW. However, negligible to no moth activity was observed during 29th and 32nd SMW. Moth population again started during 33rd SMW and increased gradually and reached to its second peak (46 moths/trap/week) during 48th SMW and drastically declined and attained its third peak (43.67 moths/trap/week) during 18th SMW of 2022.

Three peaks of moth activity were observed at Basapatna during the study period from February 2021 to May 2022, of which two peaks trap catches were achieved during *rabi* and one during *kharif*. Population of YSB moth catches (male) in pheromone trap ranged from 0 to 26.67 on 27th and 17th SMW, respectively. Pheromone trap catches were 2.00 moths/week during 6th SMW and gradually increased and attained its first peak (26.67 moths/trap/week) during 17th SMW and drastically declined up to 32nd SMW. Negligible to no moth recorded during 27th and 32nd SMW. Moth population again started during 33rd SMW and

increased gradually and reached to its second peak (10.67 moths/trap/week) during 51st SMW and gradually declined. Moth activity attained its third peak (18.67 moths/trap/week) during 15th SMW of 2022.

Three peaks of moth activity were observed at Arhal during the study period from February 2021 to May 2022, of which two peaks trap catches were recorded during *rabi* and one during *kharif*. Population of YSB moth catches (male) in pheromone trap ranged from 0 to 52.67 during 36th SMW of 2021 and 17th SMW of 2022, respectively (Table 2). Pheromone trap catches were recorded 4 moths/week during 6th SMW and gradually increased and attained its first peak (39.67 moths/trap/week) during 16th SMW and drastically declined during 27th SMW. Negligible to no moth recorded during 28th and 32nd SMW. Moth population again started during 33rd SMW and increased gradually and reached to its second peak (31.33 moths/trap/week) during 51st SMW and gradually declined. Moth activity attained its third peak (52.67 moths/trap/week) during 17th SMW of 2022.

Three peaks of moth activity were observed at Herur during the study period from February 2021 to May 2022, of which two peaks trap catches were achieved during *rabi* and one peak during *kharif*. Population of YSB moth catches (male) in pheromone trap ranged from 0 to 99.33 during 28th SMW of 2021 and 17th SMW of 2022, respectively (Table 2). Pheromone trap catches were recorded 0.67 moths/week during 6th SMW and gradually increased and attained its first peak (11.33 moths/trap/week) during 17th SMW and drastically declined up to 26th SMW. Negligible to no moth recorded during 27th and 32nd SMW. Moth population again started during 33rd SMW and increased gradually and reached to its second peak (87.00 moths/trap/week) during 51st SMW and gradually declined. Moth activity attained its third peak (99.33 moths/trap/week) during 17th SMW of 2022.

Three peaks of moth activity were observed at Kesarahatti during the study period from February 2021 to May 2022, of which two peaks trap catches were achieved during *rabi* and one during *kharif*. Population of YSB moth catches (male) in pheromone trap ranged from 0.00 to 160.00 during 29th SMW of 2021 and 17th SMW, respectively (Table 2). Pheromone trap catches were recorded 2.67 moths/week during 6th SMW and gradually increased and attained its first peak (160 moths/trap/week) during 17th SMW and drastically declined up to 27th SMW. Negligible to no moth recorded during 28th and 32nd SMW. Moth population again started during 33rd SMW and increased gradually and reached to its second peak (73.67 moths/trap/week) during 51st SMW and gradually declined. Moth activity attained its third peak (55.33 moths/trap/week) during18th SMW of 2022.

Three peaks of moth activity were observed at Gonal during the study period from February 2021 to May 2022, of which two peaks trap catches were achieved during *rabi* and one during *kharif*.

Population of YSB moth catches (male) in pheromone trap ranged from 0.33 to 52.33 during 29th SMW of 2021 and 50th SMW, respectively (Table 2). Pheromone trap catches were recorded 1.00 moths/week during 6th SMW and gradually increased and attained its first peak (25 moths moths/trap/week) during 17th SMW and drastically declined up to 27th SMW. Negligible to no moth recorded during 28th and 31st SMW. Moth population again started during 32nd SMW and increased gradually and reached to its second peak (52.33 moths/trap/week) during 50th SMW and gradually declined. Moth activity attained its third peak (35.33 moths/trap/week) during 11th SMW of 2022

Pheromone traps set up throughout the year to observe adult activity pattern. Each flight period occurred at exactly the time of transition between two generations and there was a distinct definiteness with the higher period. Each flight period preceded and followed by zero moth activity (Fig. 1a and 1b). Further there was a distinct occurrence of definite life stages for the period of observations. The results were in consistent with previous reports by Shilpa *et al.* (2017) observed two peaks, during summer month, moth activity were recorded from 9th - 28th SW (Feb 4th to July 2nd week), peak at 17 SW (April 3rd week) and during *kharif*, the moth activity were recorded from 29-44th SW (July 3rd to Oct 4th week), peak at 38th SW (Sep 3rd week) and there was negligible or no trap collection during June and July month. It has also been shown by Wagan *et al*. (1999) that the first moth appeared during first week of March. The moth activity reached to its peak during October and no moth was captured during December.

A distinct moth trap catches of YSB on pheromone trap was also reported from Asia, China, Pakistan and Philippines. Pallavi *et al.* (2018) reported that the peak moth catches of 44.40 moths was recorded during fourth week of April. During *Kharif*, Peak catches of 35.20 moths was recorded during third week of September. The similar observation was made by Hussain *et al.* (2018) who recorded that the YSB moth population through light trap recorded higher number from mid-March to 1st week of May and then it escalated again from 2nd week of August to a maximum in September. Further, it has also been shown by Bhutto *et al.* (2015) who reported that the over-wintering generation started during the 4th week of March reaches to first peak during the 2nd week of April and drastically decline up to the end of May and no moth was captured during June and July. Second peak observed during the 1st week of October and then moth population gradually decline. No moth was captured during last week of November, December, January and February. Interestingly it could be noted the peak trap catches over other parts of India and Asia coincides with the present study. It is quite fascinating to know that even though the cropping period varies considerable across wide paddy growing nations, moth activity period remains more or less same.

Table 1: Activity of yellow stem borer moth at different research stations through pheromone trap during 2021-22.

Month	SMW	Moths/trap/week	
		ARS, Gangavathi	Dhadesugur
February	6	19.00	11.67
	7	18.33	15.00
	8	22.33	20.00
	9	25.33	10.00
March	10	25.00	13.33
	11	29.33	9.67
	12	34.33	5.67
	13	34.33	18.00
April	14	42.00	18.00
	15	52.33	26.00
	16	50.67	31.67
	17	121.67	45.67
	18	110.00	18.33
May	19	105.33	17.33
	20	47.00	11.33
	21	25.00	10.00
	22	21.67	9.00
June	23	20.67	5.00
	24	14.33	4.33
	25	2.33	1.00
	26	1.67	0.67
July	27	1.00	0.33
	28	0.67	0.33
	29	0.33	0.33
	30	0.33	0.00
	31	0.00	0.00
August	32	0.00	0.00
	33	0.33	0.00
	34	0.00	0.00
	35	0.00	0.33
September	36	0.00	8.67
	37	0.00	14.67
	38	0.33	25.67
	39	0.67	34.00
October	40	2.33	5.00
	41	1.67	7.00
	42	1.67	8.67
	43	13.67	8.67
	44	15.67	6.67
November	45	13.33	6.00
	46	29.00	7.67
	47	57.00	7.67
	48	65.67	4.67
December	49	31.33	
	50	51.33	
	51	37.67	
	52	20.00	
January	1	19.67	
	2	11.00	
	3	10.00	
	4	9.67	
	5	10.67	
February	6	18.00	
	7	16.00	
	8	17.33	
	9	19.00	
March	10	14.33	
	11	15.00	
	12	32.33	
	13	36.33	
April	14	40.00	
	15	40.33	
	16	42.67	
	17	44.33	
	18	108.67	
May	19	51.33	
	20	59.67	
	21	33.67	
	22	21.00	
Mean		**26.63**	**10.41**
SD		**27.56**	**10.29**

Table 2: Activity of yellow stem borer moth at different villages through pheromone trap during 2021-22.

Month	SMW	Moths/trap/week							
		Ayodhya	Vidyanagar	Hosalli	Basapatna	Arhal	Herur	Kesarahatti	Gonal
February	6	0.67	18.67	2.33	2.00	4.00	0.67	2.67	1.00
	7	1.00	3.33	1.00	1.67	2.00	1.33	2.67	10.00
	8	5.00	1.67	2.00	2.00	2.33	7.33	4.00	12.00
	9	12.00	4.33	6.00	1.67	0.67	5.00	8.00	5.33
March	10	36.33	11.67	14.33	0.67	2.33	6.00	21.00	12.00
	11	70.00	27.67	14.00	1.33	2.00	4.67	35.33	5.67
	12	4.00	1.33	1.33	0.33	4.33	1.67	3.67	0.00
	13	3.67	1.67	1.00	2.67	2.33	2.00	2.33	1.00
April	14	8.00	3.67	2.67	8.67	10.33	2.33	3.00	1.00
	15	6.33	8.33	3.33	17.00	23.33	1.33	9.33	2.67
	16	38.00	6.33	25.67	26.33	39.67	6.67	92.00	14.00
	17	116.67	15.33	71.33	26.67	20.67	11.33	160.00	25.00
	18	100.33	14.67	65.00	25.00	16.00	8.67	115.00	10.33
May	19	94.00	16.33	60.00	25.00	14.33	6.67	100.00	3.33
	20	38.00	12.00	73.67	19.00	10.00	11.33	85.00	16.00
	21	37.00	5.67	70.67	16.00	12.33	9.33	64.33	5.00
	22	39.33	6.67	45.67	16.33	11.67	9.33	33.67	2.67
June	23	18.33	4.33	33.00	6.33	7.00	8.67	18.33	1.33
	24	28.33	3.67	22.00	7.00	2.00	5.67	12.00	1.33
	25	18.00	2.33	18.00	6.00	2.00	1.33	8.00	1.67
	26	1.33	1.33	9.33	1.33	3.00	1.00	5.67	0.67
July	27	1.00	1.67	0.33	0.33	1.00	0.00	1.00	1.00
	28	1.33	0.67	1.33	0.67	0.67	0.33	0.00	0.33
	29	0.67	1.67	0.67	0.00	0.67	0.33	0.33	0.33
	30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
August	32	0.67	0.00	0.33	0.00	0.00	0.00	0.00	5.67
	33	7.00	0.00	1.33	1.00	0.67	2.00	1.67	20.00
	34	9.67	0.33	1.67	3.00	2.67	5.33	9.67	6.00
	35	3.67	0.33	2.33	0.67	1.67	1.67	2.67	1.33
September	36	0.33	0.67	1.67	0.33	0.33	0.33	0.33	0.33
	37	0.67	0.67	2.33	0.67	1.00	0.00	0.00	0.00
	38	3.00	0.00	3.67	1.00	0.67	1.67	1.00	0.00
	39	2.00	0.33	9.33	2.33	1.33	5.33	1.67	1.33
October	40	3.00	0.33	2.33	2.00	2.67	3.33	1.67	1.00
	41	3.00	1.00	1.67	4.00	3.00	5.00	4.33	0.67
	42	3.00	0.67	2.67	0.33	1.67	0.33	2.33	1.00
	43	4.00	1.00	6.33	0.33	1.00	0.67	1.00	0.33
	44	4.00	2.33	8.00	0.67	1.67	1.00	1.33	1.00
November	45	6.67	2.67	13.33	3.67	2.67	0.67	0.67	1.33
	46	20.33	1.33	19.33	1.00	3.33	1.00	0.67	0.67
	47	51.33	1.33	42.00	2.33	3.33	4.33	2.33	5.33
	48	57.67	3.67	46.00	0.67	4.33	6.67	10.33	38.00
December	49	68.00	1.00	23.33	3.33	2.33	2.33	18.33	38.33
	50	43.67	0.67	15.33	6.33	1.00	3.00	34.00	52.33
	51	126.67	7.00	15.00	10.67	31.33	87.00	73.67	21.67
	52	61.33	11.33	14.67	9.67	28.00	35.00	34.00	20.33
January	1	31.00	13.00	5.00	7.67	27.67	40.33	13.67	13.67
	2	5.67	3.33	5.33	2.67	8.67	10.33	6.67	6.33
	3	4.67	3.00	3.33	1.00	4.00	8.00	7.33	4.67
	4	5.00	1.33	2.33	1.33	2.33	0.67	10.00	10.33
	5	6.33	1.67	2.00	1.67	5.33	2.33	10.33	10.00
February	6	5.67	1.67	1.67	2.00	9.33	14.33	10.67	7.67
	7	8.33	9.33	2.00	3.67	26.00	31.67	13.00	10.00
	8	22.67	13.33	12.00	3.00	37.67	65.33	23.00	16.00
	9	48.00	4.67	19.33	4.33	7.67	9.67	38.00	5.67
March	10	109.00	2.33	38.33	10.33	7.33	12.67	21.67	24.67
	11	24.33	1.67	18.00	12.33	2.67	5.00	8.67	35.33
	12	6.67	1.00	7.00	10.67	2.33	3.00	3.33	0.67
	13	17.67	5.67	8.67	10.00	6.67	7.00	4.00	1.67
April	14	20.67	10.67	7.67	10.00	15.33	13.67	4.00	2.00
	15	32.67	14.00	15.67	18.67	28.00	28.00	14.67	10.33
	16	97.00	11.33	21.33	13.00	28.00	80.33	26.33	25.33
	17	88.33	8.67	35.67	9.33	52.67	99.33	36.00	33.67
	18	42.67		43.67	5.67	27.67	72.33	55.33	17.33
May	19	41.33		26.33	4.67	13.67	39.33	31.33	11.67
	20	21.00		28.33	3.33	2.33	18.67	20.67	5.00
	21	11.00		11.33	1.67	2.67	10.33	5.67	2.33
	22	4.67		4.00	1.67	1.00	8.33	6.67	1.67
Mean		**26.28**	**4.97**	**15.89**	**5.89**	**8.82**	**12.47**	**19.71**	**8.79**
SD		**32.38**	**5.72**	**19.21**	**7.01**	**11.45**	**21.46**	**30.65**	**11.20**

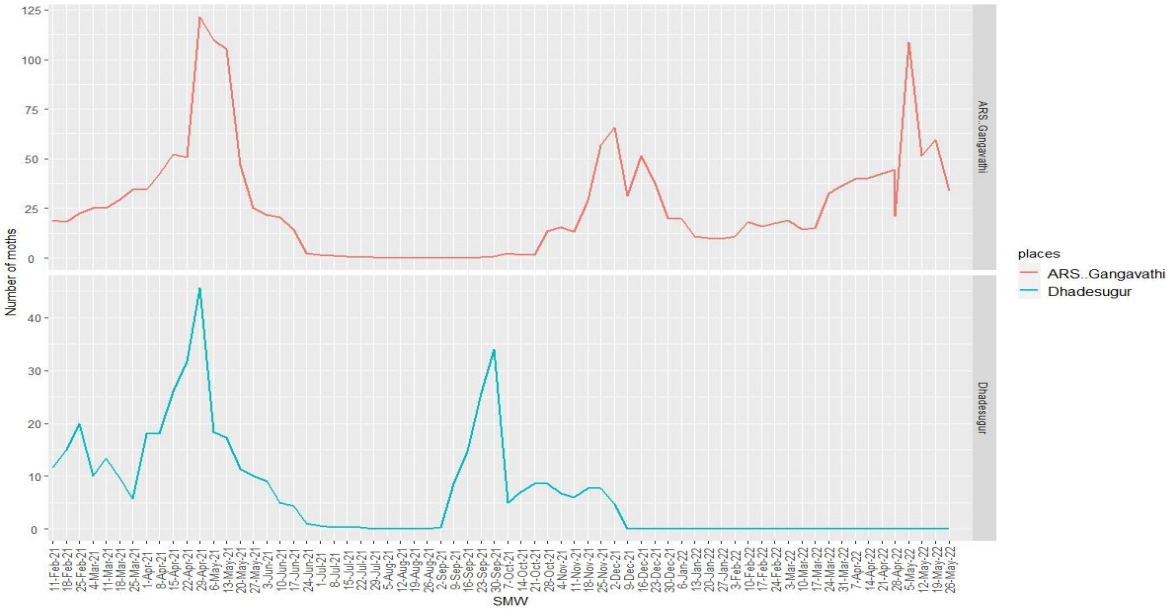

Fig. 1a. Adult activity of yellow stem borer recorded through sex pheromone traps from ARS, Gangavathi and Dhadesugur.

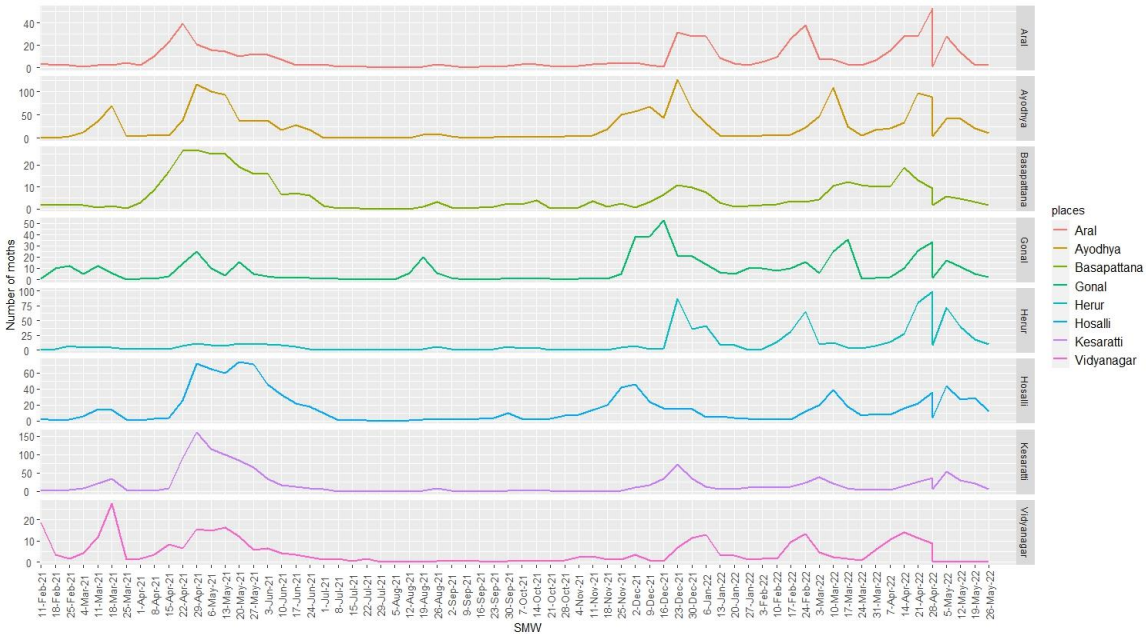

Fig. 1b. Adult activity of yellow stem borer recorded through sex pheromone traps from different locations.

CONCLUSIONS

It is quite fascinating to know that even though the cropping period varies considerable across wide paddy growing nations, moth activity period remains more or less same. Pheromone traps are now recommended against YSB. The current study shows that there are distinct flight periods when pheromone traps should be used; usage during other times will not only add to the cost, but also result in loss of farmers trust on the technology.

FUTURE SCOPE

— By knowing population dynamics, management practices will be taken at right time.
— Ecofriendly management.

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