

## STUDY ON IMPACT OF SOWING DATES ON RICE LEAF FOLDER *Cnaphalocrocis medinalis* (Guenee) IN DIRECT SEEDED RICE

A field experiment to study the impact of sowing dates on Rice leaf folder in direct seeded rice was conducted at Agricultural College Farm, Bapatla during *kharif*, 2021. Early planted rice crop had lower pest than later transplanted rice. Various dates have a significant impact on the occurrence of biotic stress, particularly insect pests. To identify suitable plating dates to minimize the leaf folder infestation in paddy the following experiment was conducted. Sowing was done at four different dates with 10 days interval which were taken as treatments each replicated with five times and the data has also been correlated with light trap data. The mean per cent damage ranged from 9.44 to 16.64 %. Highest infestation (16.64 %) was observed in last date of sowing and least damage (9.44 %) was observed in first date of sowing. Correlation analysis of light trap catch data shown a positive correlation with morning ( $r = 0.373$ ) and evening ( $r = 0.186$ ) relative humidity while a negative correlation with maximum ( $r = - 0.182$ ), and minimum ( $r = - 0.017$ ) temperatures and rainfall ( $r = - 0.154$ ). Multiple Linear Regression (MLR) of trapped adult number and climatic conditions at different sowing dates revealed that weather parameters contributed to the variation in moth number trapped in light trap by 35.4 per cent in first date of sowing, 42.2 per cent in second date of sowing, 59.6 per cent in third date of sowing, and 50.7 per cent in fourth date of sowing. Yield ranged from 3632 kg ha<sup>-1</sup> in last date of sowing to 5156 kg ha<sup>-1</sup> in first date of sowing.

**Keywords:** Rice leaf folder, Dates of sowing (DOS), Light trap, Yield

### Introduction

Rice is the world's third most produced agricultural commodity, behind Sugarcane and Maize (FAO, 2017). With 148.5 million metric tonnes produced, India is the second largest producer behind China (Statista, 2021). Andhra Pradesh comes in third place in terms of rice production, with 128.95 lakh tonnes production and 22 lakh hectares area in India.

A total of 52 per cent of global rice production is lost each year due to biotic causes. The attack of insect pest accounts for 21 per cent of the total losses. Pests alone limit rice output by roughly 30% in Asia. Among insect pests the rice leaf folder (*Cnaphalocrocis medinalis*) was once considered as a minor pest, but it is now a major problem throughout the country. Under epidemic conditions, rice leaf folder can result from 30 to 80 per cent yield losses. The rate of establishment of rice seedlings is also influenced by the sowing date (Tashiro *et al.*, 1999). Various dates have a significant impact on the occurrence

of biotic stress, particularly insect pests. Planting at the right time helps to minimize pest damage. By keeping this in view, the present study is planned to find out correct time to manage leaf folder in direct seeded rice.

## **Materials and methods**

The rice variety BPT 2782 (Bhavathi) developed at Agricultural Research Station (ARS), Bapatla under ANGRAU was evaluated to study the impact of sowing dates on rice leaf folder in direct seeded rice against leaf folder during *kharif*, 2021 at Agricultural College Farm, Bapatla.

The experiment was laid out in a simple Randomized Block Design (RBD). Four dates of sowing at ten days interval were taken as treatments each replicated five times. The seeds were directly sown on four different dates *i.e.*, 02-08-2021, 12-08-2021, 22-08-2021, 02-09-2021. The plot size of 5m× 5m was taken and seed was sown in lines at spacing of 20×15 cm

Recommended fertilizer dose @ 120:60:40 NPK ha<sup>-1</sup> was applied in the form of urea, single super phosphate and murate of potash. No plant protection measures were provided to create optimum conditions for pest multiplication.

Observations were recorded from 45 days after sowing at 15 days interval randomly from 10 hills in each replication. To calculate per cent leaf folder damage total number of leaves and total number of infested leaves per hill were counted. The per cent leaf folder damage was calculated using the formula

$$\text{Leaf folder per cent damage} = \left( \frac{\text{Number of damaged leaves per hill}}{\text{Total number of leaves per hill}} \right) \times 100$$

The data obtained from various treatments were statistically analysed using Analysis of Variance (ANOVA). The per cent leaf folder damage in each observation was transformed to the corresponding Arc sine values and subjected to ANOVA. The yield data at different planting dates was collected separately and subjected to statistical analysis (Gomez and Gomez, 1984) to test the significance of mean yield in different treatments

## **Light trap for monitoring of leaf folder adults**

Light trap was arranged and the data on number of adult moths has been collected at weekly intervals. The data regarding the weather parameters has also been collected at weekly intervals from IMD located at Agricultural College Farm, Bapatla.

The data obtained from various treatments were statistically analysed using Analysis of Variance (ANOVA). The per cent leaf folder damage in each observation was transformed to the corresponding Square root transformation values and subjected to ANOVA. The moth number data has been correlated with the maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall data. Multiple Linear Regression (MLR) of moths trapped in the crop period of four different sowings with climatic factors had been done. The yield data at different planting dates was collected separately and subjected to statistical analysis (Gomez and Gomez, 1984) to test the significance of mean yield in different treatments.

## **Results and discussion**

### **Mean per cent damage by leaf folder at 45 DAS**

Mean per cent damage caused by leaf folder at 45 DAS ranged from 2.48 to 3.92 %. Lowest per cent damage of 2.48 % was observed in first date of sowing (DOS) followed by 2.66 % in second DOS and 3.15 % in third DOS and 3.92 % in fourth DOS.

### **Mean per cent damage by leaf folder at 60 DAS**

The infestation was increased from 45 DAS to 105 DAS. The mean per cent damage ranged from 5.72 to 11.13 % at 60 DAS. Lowest per cent damage was observed in first date of sowing *i.e.* 5.72 % followed by 6.63 % in second DOS, 9.52 % in third DOS and 11.13 % in fourth DOS.

### **Table 1. Impact of sowing dates on rice leaf folder damage in DSR under field conditions during *kharif*, 2021**

\*Figures in paranthesis are square root transformed values

## Mean per cent damage by leaf folder at 75 DAS

Treatments	*Damage per cent at					
	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	MEAN
1 <sup>st</sup> Date of Sowing (02/08/2021)	2.48 (1.57)	5.72 (2.39)	9.33 (3.05)	13.32 (3.65)	16.34 (4.04)	9.44 (3.07)
2 <sup>nd</sup> Date of Sowing (12/08/2021)	2.66 (1.63)	6.63 (2.57)	10.79 (3.28)	15.99 (3.99)	20.27 (4.50)	11.27 (3.35)
3 <sup>rd</sup> Date of Sowing (22/08/2021)	3.15 (1.77)	9.52 (3.08)	15.32 (3.91)	22.60 (4.75)	23.73 (4.87)	14.86 (3.85)
4 <sup>th</sup> Date of Sowing (02/09/2021)	3.92 (1.98)	11.13 (3.33)	18.23 (4.27)	24.04 (4.90)	25.89 (5.08)	16.64 (4.08)
SEm±	0.08	0.12	0.19	0.16	0.17	0.08
Fcal	Sig	Sig	Sig	Sig	Sig	Sig
CD (P= 0.05)	0.25	0.38	0.61	0.50	0.55	0.25

Data indicated that at 75 DAS the per cent damage ranged from 9.33 to 18.23. Lowest per cent of damage was observed as 9.33 in first date of sowing followed by 10.79 in second DOS, 18.23 in third DOS and 15.32 in the fourth DOS.

CV(%)	10.43	9.81	12.23	8.47	8.69	5.18
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### **Mean per cent damage by leaf folder at 90 DAS**

At 90 DAS the data indicated that per cent damage ranged from 13.32 to 24.04. Lowest per cent damage was observed as 13.32 in first date of sowing followed by 15.99 in second DOS, 22.60 in third DOS and 24.04 observed in fourth DOS.

### **Mean per cent damage by leaf folder at 105 DAS**

Data indicated that at 105 DAS the per cent damage ranged from 16.34 to 25.89. Lowest per cent of damage was observed as 16.34 in first DOS followed by 20.27 in second DOS, 23.73 in third DOS and 25.89 in fourth DOS.

### **Cumulative mean per cent damage by leaf folder**

Cumulative mean per cent damage caused by leaf folder ranged from 9.44 to 16.64 per cent (Table 1). The lowest per cent damage of 9.44 was observed in 1<sup>st</sup> DOS followed by 11.27 in 2<sup>nd</sup> DOS, 14.86 in 3<sup>rd</sup> DOS and 16.64 in 4<sup>th</sup> DOS. Results indicated that the delay in sowing recorded more infestation levels compared to the early sowing in Direct Seeded Rice (DSR). In the case of late transplanting, the surrounding crop may have reached the end of their vulnerable growth stages, and the entire pest will be feeding or confined to the late transplanted crop (Rani and Pillai *et al.* 2013). This might be the reason for the higher incidence of leaf folder in the late sown crop. The results are in accordance with Moniperumal (1989) who reported that a lower incidence of rice leaf folder in early transplanted crops. The higher insect pests attack in late planted rice has also been reported by Bambhro *et al.* (2000) and Hassan *et al.* (2003). These results are in concurrence with Aziz Khakwani *et al.* (2006) whereby rice seedlings transplanted early were little infested by the attack of leaf folder. Singh *et al.* (2013) also reported that the most damage to leaf folder occurred in late transplanting and the least damage occurred in early transplanting. According to Magumnder *et al.* (2013), early planted rice crops had fewer pest and natural enemies than later transplanted rice (after August 30<sup>th</sup>). Leaf folder damage was reduced by early sowing. Vimal *et al.* (2015) also reported that leaf folder activity was observed maximum in late planted rice followed by normal and early planted rice. Rautaray *et al.* (2019), Prasad,

R.(2020) and Kumari, A and Prasad, R. (2021) also confirmed that minimum infestation of leaf folder was recorded in early planted crop than late planted crop.

### **Leaf folder adult collection through light trap**

The data was recorded from 31<sup>st</sup> Standard Meteorological Week (SMW) to 4<sup>th</sup> SMW (Table 2). During this period, the average maximum and minimum temperatures were 31.24<sup>o</sup>C and 22.36<sup>o</sup>C, respectively, with an average morning relative humidity of 85.65 per cent, evening relative humidity of 73.48 per cent, and rainfall of 6.24mm. In the light trap, the average number of moths caught was 4.25. With 13.56 adults per trap, 45<sup>th</sup> SMW had the highest number of moths. The average maximum and minimum temperatures observed during this time were 28.60<sup>o</sup>C and 21.89<sup>o</sup>C, respectively, while the average morning relative humidity, evening relative humidity, and rainfall were 87.14 per cent, 73.29 per cent, and 1.15mm, respectively. Udayababu *et al.* (2021) also reported that adult moths were peaked during the 42<sup>nd</sup> SMW and 43<sup>rd</sup>SMW. During October, November, and December adult moth caught was highest.

During the 1<sup>st</sup>DOS, sowing the average moth number trapped was about 4.45 and during this period from 32<sup>nd</sup> SMW to 1<sup>st</sup> SMW average climatic conditions recorded were 31.71<sup>o</sup>C maximum temperature, 22.91<sup>o</sup>C minimum temperature, 84.64 per cent morning relative humidity, 72.94 per cent evening relative humidity and 6.41mm of rainfall. During crop period of 2<sup>nd</sup> sowing from 33<sup>rd</sup> SMW to 2<sup>nd</sup> SMW the average number of moths trapped were 4.50 and average climatic conditions recorded were 31.41<sup>o</sup>C maximum temperature, 22.61<sup>o</sup>C minimum temperature, 85.66 per cent morning relative humidity, 74.38 per cent evening relative humidity and 6.78 mm rainfall. During crop period of 3<sup>rd</sup> date of sowing from 35<sup>rd</sup> SMW to 3<sup>rd</sup> SMW the average number of moths trapped were 4.53 and average climatic conditions recorded were 30.86<sup>o</sup>C maximum temperature, 22.25<sup>o</sup>C minimum temperature, 86.21 per cent morning relative humidity, 74.81 per cent evening relative humidity and 6.07 mm rainfall. During crop period of 4<sup>th</sup> date of sowing from 36<sup>th</sup> SMW to 4<sup>th</sup> SMW the average number of moths trapped were 4.54 and average climatic conditions recorded were 30.95<sup>o</sup>C maximum temperature, 22.01<sup>o</sup>C minimum temperature, 86.16 per cent morning relative humidity, 73.95 per cent evening relative humidity and 5.54 mm rainfall.

Correlation studies between the adult population and abiotic factors were depicted in the Table 3. Correlation between maximum temperature, minimum temperature and adult number revealed a negative correlation. The adult number, morning and evening relative humidity have a positive correlation. A negative correlation was observed between the rainfall and adult number.

Due to the changes in the temperature, relative humidity, rainfall moth number also varied. The present findings are in accordance with Rai *et al.* (2000) who reported that maximum temperature, minimum temperature and rainfall were negatively correlated with adult number. Khan and Ramamurthy (2004) also reported that maximum and minimum temperatures had negative impact on population buildup, while the relative humidity at morning had a positive impact on rice leaf folder adults. Chhavi *et al.* (2016) & Haider *et al.* (2021) also confirmed that maximum and minimum temperature show a negative correlation while relative humidity is positively correlated with moth number. Chakraborty and Chandra Deb (2011) & Udayababu *et al.* (2021) reported that positive correlation with maximum temperature, minimum and maximum relative humidity and rainfall.

The data on the adult numbers and climatic conditions at different sowing dates was subjected to Multiple Linear Regression (MLR) and the data obtained was subjected in the table 4.

According to the results, the coefficient of determination ( $R^2$ ) for adult incidence on the first date of sowing was 0.354, indicating that weather parameters contributed to the variation in moth number in light trap by 35.4 per cent in first date of sowing, 42.2 per cent in second date, 59.6 per cent in third date of sowing, 50.7 per cent in fourth date of sowing.

**Table 2. Influence of abiotic factors on incidence of rice leaf folder during *khari* 2021**

Standard Meteorological week	Date and Month	Temperature (°C)		Relative Humidity (%)		Rain fall (mm)	No of adults per trap	Period of DOS-DOH
		Max	Min	Morning	Evening			
31	31 <sup>st</sup> -5 <sup>th</sup> Aug	36.16	26.37	62.43	12.14	0.00	0.14	1 <sup>st</sup> DOS
32	6 <sup>th</sup> - 12 <sup>th</sup> Aug	37.19	26.43	76.43	58.14	6.1	2.33	2 <sup>nd</sup> DOS

33	13 <sup>th</sup> - 19 <sup>th</sup> Aug	32.94	23.81	83.36	76.57	16.5	2.67	
34	20 <sup>th</sup> - 26 <sup>th</sup> Aug	28.07	24.57	86.00	75.43	11.68	1.67	3 <sup>rd</sup> DOS
35	27 <sup>th</sup> - 2 <sup>nd</sup> Sep	30.51	24.07	88.29	85.86	7.4	1	4 <sup>th</sup> DOS
36	3 <sup>rd</sup> - 9 <sup>th</sup> Sep	32.14	24.57	82.14	74.0	0.84	0.42	
37	10 <sup>th</sup> - 16 <sup>th</sup> Sep	34.23	25.71	81.00	62.57	0.14	2.28	
38	17 <sup>th</sup> - 23 <sup>rd</sup> Sep	34.76	25.39	83.57	74.00	9.03	1.28	
39	24 <sup>th</sup> - 30 <sup>th</sup> Sep	32.76	24.61	86.57	81.29	21.89	1.71	
40	1 <sup>st</sup> - 7 <sup>th</sup> Oct	33.29	24.24	87.14	80.86	8.3	2.33	
41	8 <sup>th</sup> - 14 <sup>th</sup> Oct	33.86	24.74	85.86	73.29	3.95	8.12	
42	15 <sup>th</sup> - 21 <sup>st</sup> Oct	33.63	24.84	86.00	76.00	9.34	5.42	
43	22 <sup>nd</sup> - 28 <sup>th</sup> Oct	32.61	23.04	85.43	72.71	2.61	9.42	
44	29 <sup>th</sup> - 4 <sup>th</sup> Nov	29.39	23.46	87.86	85.86	7.84	8.42	
45	5 <sup>th</sup> - 11 <sup>th</sup> Nov	28.60	21.89	87.14	73.29	1.15	13.56	
46	12 <sup>th</sup> - 18 <sup>th</sup> Nov	29.33	23.76	89.43	85.71	6.14	8.26	
47	19 <sup>th</sup> - 25 <sup>th</sup> Nov	29.63	22.9	88.43	85.00	22.56	4.31	
48	26 <sup>th</sup> - 2 <sup>nd</sup> Dec	28.94	21.13	87.14	78.29	12	6.32	
49	3 <sup>rd</sup> - 9 <sup>th</sup> Dec	31.29	20.87	86.86	74.00	0	7.28	
50	10 <sup>th</sup> -16 <sup>th</sup> Dec	29.71	20.01	87.43	69.71	0	6.42	
51	17 <sup>th</sup> -23 <sup>rd</sup> Dec	29.29	14.83	86.14	55.43	0	4.42	
52	24 <sup>th</sup> -31 <sup>st</sup> Dec	29.35	17.69	86.00	68.13	0	2.4	
1	1 <sup>st</sup> - 7 <sup>th</sup> Jan	29.70	18.04	86.00	69.57	0	2.14	1 <sup>st</sup> DOH
2	08 <sup>th</sup> - 14 <sup>th</sup> Jan	29.21	19.36	86.00	75.14	8.45	1.42	2 <sup>nd</sup> DOH
3	15 <sup>th</sup> - 21 <sup>st</sup> Jan	28.57	19.71	86.29	69.71	0.15	1	3 <sup>rd</sup> DOH
4	22 <sup>nd</sup> - 28 <sup>th</sup> Jan	29.99	19.27	84.86	56.43	0	1.71	4 <sup>th</sup> DOH

**Table 3. Correlation between rice leaf folder adults population with abiotic factors during *kharif*, 2021**

Variable	Correlation Co - efficient (r)
Maximum temperature ( <sup>0</sup> C)	-0.182
Minimum temperature ( <sup>0</sup> C)	-0.017
Morning relative humidity (%)	0.373
Evening relative humidity (%)	0.186
Rainfall (mm)	-0.154

**Table 4. Regression between rice leaf folder adult population with abiotic factors during *kharif*, 2021**

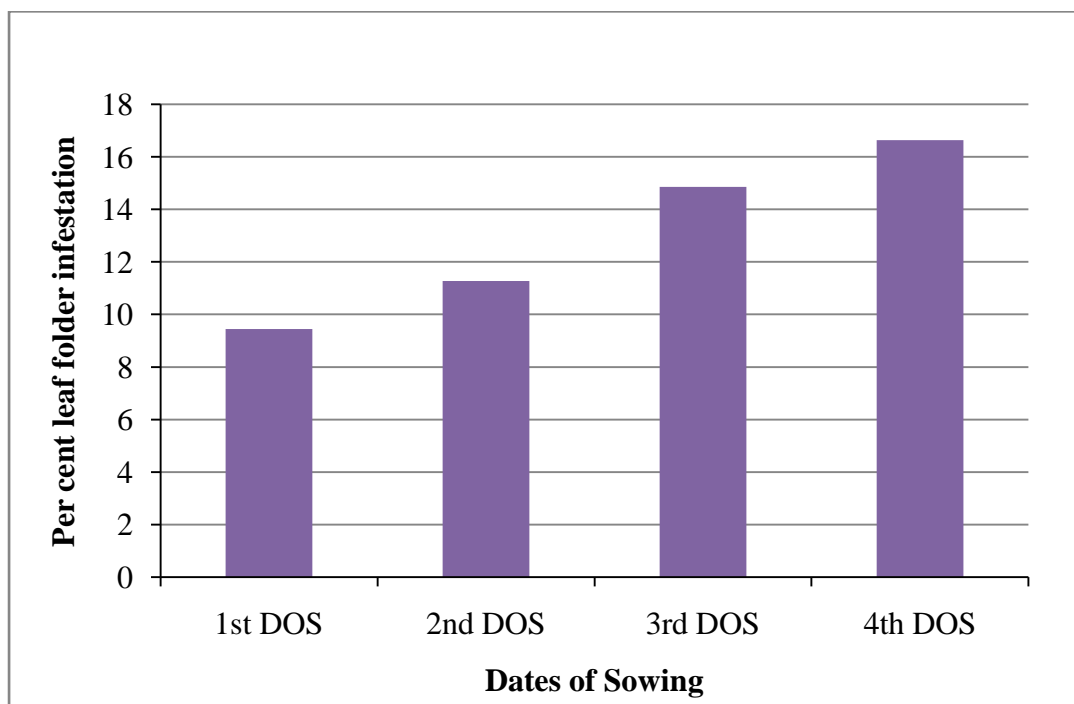
Sr. No.	Dates of sowing (DOS)	Regression equation	R <sup>2</sup> value
1	1 <sup>st</sup> DOS	$Y = -57.15 - 0.03X_1 + 0.15X_2 + 0.77X_3 - 0.08X_4 - 0.09X_5$	35.4
2	2 <sup>nd</sup> DOS	$Y = -141.89 - 0.20X_1 + 0.92X_2 + 1.81X_3 - 0.30X_4 - 0.22X_5$	42.2
3	3 <sup>rd</sup> DOS	$Y = -147.30 - 0.74X_1 + 1.50X_2 + 2.02X_3 - 0.39X_4 - 0.18X_5$	59.6
4	4 <sup>th</sup> DOS	$Y = -144.65 - 0.26X_1 + 1.05X_2 + 1.72X_3 - 0.17X_4 - 0.23X_5$	50.7

## Yield (Kg ha<sup>-1</sup>)

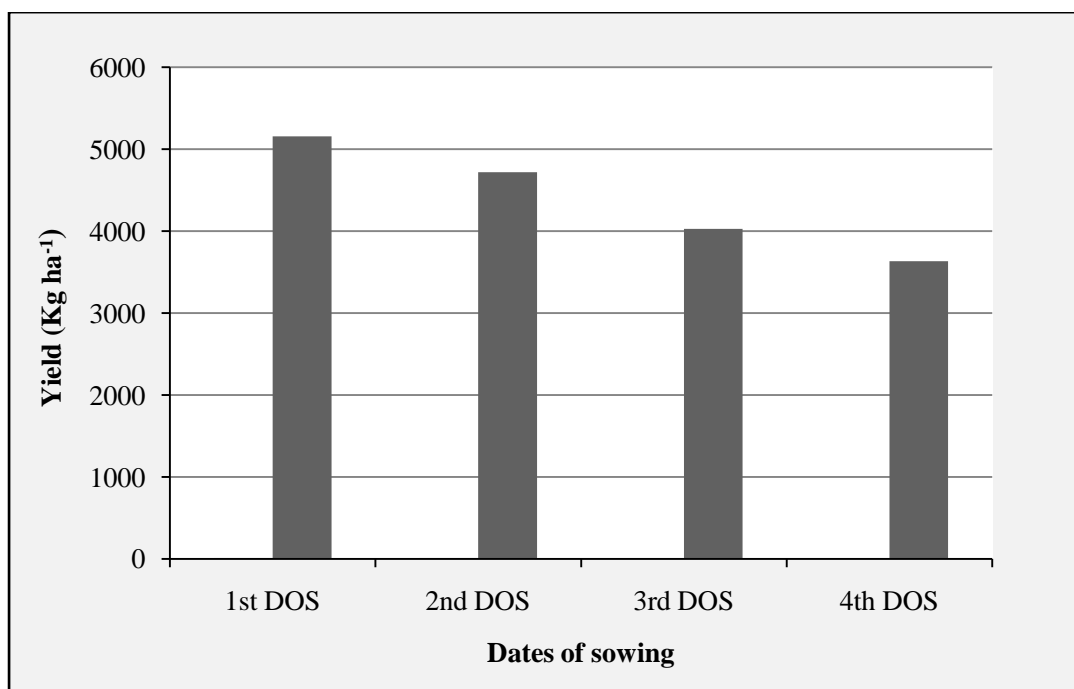
As our experiment is conducted without plant protection measures the yield data collected at different sowing dates under DSR ranged from 3632 kg ha<sup>-1</sup> to 5156 kg ha<sup>-1</sup> (Fig 2). Potential yield of BPT 2782 variety was 6000 to 7000 kg ha<sup>-1</sup>. Each delay in transplanting time resulted in a steady decrease in grain yield (Table 5). The highest yield was observed at 1<sup>st</sup> DOS *i.e.* 5156 kg ha<sup>-1</sup> followed by in 2<sup>nd</sup> DOS 4719 kg ha<sup>-1</sup>, 4026 kg ha<sup>-1</sup> in 3<sup>rd</sup> DOS and 3632 kg ha<sup>-1</sup> at 4<sup>th</sup> DOS (Table 5). The sowing time is critical in rice crop for three reasons. Firstly, it assures that vegetative growth takes place at a period of favourable temperatures and high sun radiation. Second, each cultivar's optimal sowing time guarantees that the cold sensitive stage occurs when the minimum night temperatures are historically the warmest. Third, sowing on time ensures that grain filling occurs during the cooler autumn temperatures, resulting in superior grain quality (Farrell *et al.* 2003). In late sowings as the climatic conditions are not favourable for rice less number of tillers will be produced and at that time leaf folder suck the sap and decreases the chlorophyll content so there will higher loss in the yield this might be one of the reason for decrease in the yield. Dawadi and Chaudhary (2013) reported that early sowing has shown maximum yield when compared to late sowing in DSR. **The early sowing dates produce a high grain yield more than later ones, delaying sowing date from 15th July decrease the grain yield (t/ha), Khalid *et al.* 2015.** The results are in accordance with Rautaray *et al.* (2019) who reported that early transplanted rice has minimum infestation with higher yield while late transplanted rice has maximum infestation with lower grain yield.

**Table 5. Yield from different sowing dates under DSR during *kharif*, 2021**

Date of sowing	Yield (Kg ha <sup>-1</sup> )
1 <sup>st</sup> DOS (02-08-2021)	5156
2 <sup>nd</sup> DOS (12-08-2021)	4719
3 <sup>rd</sup> DOS (22-08-2021)	4026
4 <sup>th</sup> DOS (02-09-2021)	3632
SEm±	191.35
CD (P= 0.05)	589.63
CV (%)	9.76



**Fig. 1.** Per cent leaf folder infestation at different sowing dates in DSR under field conditions during *kharif*, 2021



**Fig 2.** Impact of different sowing dates on yield in DSR under field conditions during *kharif*, 2021

## Conclusions

The results pertaining to, “Studies on the impact of sowing dates on Rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) in direct seeded rice,” conducted at Agriculture College Farm Bapatla during *kharif*, 2021 are summarized in this chapter.

Regarding the impact of sowing dates on rice leaf folder *Cnaphalocrocis medinalis* in DSR under field conditions during *kharif* 2021, an experiment was conducted with four different sowing dates *i.e.* 02-08-2021, 12-08-2021, 22-08-2021 and 02-09-2021 and the data on damage caused by rice leaf folder was recorded from 45 DAS to 105 DAS. The mean per cent damage in different sowing dates was recorded as 9.44 (1<sup>st</sup> DOS), 11.27 (2<sup>nd</sup> DOS), 14.86 (3<sup>rd</sup> DOS) and 16.64 (4<sup>th</sup> DOS). The results revealed that damage per cent was increased from first DOS to fourth DOS.

During the period of experiment, number of adults with light trap was recorded. Average number of moths trapped during 1<sup>st</sup> DOS was 4.45, 4.50 in 2<sup>nd</sup> DOS, 4.53 in 3<sup>rd</sup> DOS, 4.54 in 4<sup>th</sup> DOS. The weather data revealed that, maximum and minimum temperatures during crop period of four dates of sowing were 31.24<sup>0</sup>C and 22.36<sup>0</sup>C respectively, with an average morning relative humidity of 85.65 per cent, evening relative humidity of 73.48 per cent.

Correlation analysis of light trap catch data shown a positive correlation with morning ( $r = 0.373$ ) and evening ( $r = 0.186$ ) relative humidity while a negative correlation with maximum ( $r = - 0.182$ ) and minimum ( $r = - 0.017$ ) temperatures and rainfall ( $r = - 0.154$ ).

Multiple Linear Regression (MLR) of trapped adult number and climatic conditions at different sowing dates revealed that weather parameters contributed to the variation in moth number trapped in light trap by 35.4 per cent in first date of sowing, 42.2 per cent in second date, 59.6 per cent in third date of sowing, 50.7 per cent in fourth date of sowing.

Yield data at different sowings recorded were 5156 kg ha<sup>-1</sup> (1<sup>st</sup> DOS), 4719 kg ha<sup>-1</sup> (2<sup>nd</sup> DOS), 4026 kg ha<sup>-1</sup> (3<sup>rd</sup> DOS), 3632 kg ha<sup>-1</sup> (4<sup>th</sup> DOS). Yield gradually decreased from 1<sup>st</sup> DOS to 4<sup>th</sup> DOS.

## References

Aziz Khakwani, A., Zubair, M., Mansoor, M., Khalid, N., Inayat, H.S and Abdul Wahab. 2006. Agronomic and Morphological Parameters of Rice Crop as Affected by Date of Transplanting. *Journal of Agronomy*. 5:248-250.

Bhambhro, S.A. 2000. Rice Crop Threatened by Plant Hoppers. Daily DAWN Press, Pakistan.

Chakraborty, K and Chandra Deb, D. 2011. Incidence of adult leaf folder. *Cnaphalocrocis medinalis* (Lepidoptera:Pyralidae) on paddy crop in the agro-climatic conditions of the Northern parts of West Bengal, India. *World Journal of Agricultural Sciences*.7 (6): 738-742.

Chhavi, Srivastava, A and Sharma, P.K. 2016. Population buildup of rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) under mid-hill conditions of Himachal Pradesh. *Journal of Insect Science*. 29 (1): 37-42.

Dawadi, K.P and Chaudhary, N.K. 2013. Effect of sowing dates and varieties on yield and yield attributes of direct seeded rice in Chitwan condition. *The Journal of Agriculture and Environment*. 14: 121-130.

Farrell, T.C., Fox, K., Williams, R.L., Fukai, S and Lewin, L.G. 2003. Avoiding low temperature damage in Australia's rice industry with photoperiod sensitive cultivars. *Proceedings of the 11<sup>th</sup> Australian Agronomy Conference*. Deakin University, Geelong (Feb. 2-6), Victoria, Australia.

FAO. 2017. *Crops*. 7 March 2017. <http://www.fao.org/faostat/en#data/QC>.

Haider, I., Akhtar, M., Noman, A and Qasim, M. 2021. Population trends of some insect pests of rice crop on light trap and its relation to abiotic factors in Punjab Pakistan. *Pakistan Journal of Zoology*. 1-9.

Hassan G, Khan N.U and Khan Q.N.2003. Effect of transplanting date on the yield and yield components of different rice cultivars under high temperature of D.I. Khan. *Journal of Zhejiang University SCIENCE B*. 16(2):129-137.

Khan, Z.H and Ramamurthy, V.V. 2004. Influence of weather factors on the activity of rice leaf folder, *Cnaphalocrocis medinalis* (Guenee). *Annals of Plant Protection Sciences*. 12 (2): 263-266.

Kumari, A and Prasad, R. (2021). Effect of date of transplanting of rice on the incidence of leaf folder (*Cnaphalocrocis medinalis*, Guenee) in Ranchi, Jharkhand. *Journal of Crop and Weed*. 17(3): 98-102.

Osman, K.A, Mustafa, A.M., Yassir, M.A and Elsheikh, A.E.I. 2015. Influence of different sowing dates on growth and yield of direct seeded rice (*Oryza sativa* L) in semi-arid zone (Sudan), *International Journal of Agronomy and Agricultural Research*. 6(6):38-48.

Magunmder, S.K.G., Ali, M.P., Choudhury, T.R and Rahin, S.A. 2013. Effect of variety and transplanting date on the incidence of insect pests and their natural enemies. *World Journal of Agricultural Sciences*. 1(5): 158-167.

Moniperumal S. 1989. Response of rice variety Laxmi to different dates of planting and plant density. M. Sc (Ag) Thesis, Kerala Agriculture University. 120.

Prasad, R. 2020. Effect of different dates of rice transplanting on incidence and abundance of major pests and the crop yield. *Journal of Eco-friendly Agriculture*, 15(1):67-69

Rai, A.K., Sinha, R.B.P and Singh, A.K. 2000. Effect of abiotic factors on the population of rice leaf folder, *Cnaphalocrocis medinalis* (Guenee). *Annals of Plant Protection Sciences*. 8(2): 154-158.

Rani, S.T and Pillai, R. 2013. Seasonal and varietal influence on pest and disease incidence in rice. *Plant Archives*. 12: 201-204.

Rautaray, S., Bhattacharya, D., Panigrahi, T., Panda, R and Dash, S.R. 2019. Effect of planting dates on incidence of rice leaf folder and its impact on grain yield in north eastern coastal plains of Odisha. *Journal of Entomology and Zoology Studies*. 7(5): 1287-1290.

Singh, A.P., Singh, R.B., Lal, M.N and Sharma, R.C 2013. Effect of planting dates on incidence of insect-pests and their predators in rice field. *Trends in Biosciences*. 6 (6): 818-819.

Statista 2021. Retrived from <https://www.statista.com/statistics/255937/leading-rice-producers-worldwide>

Tashiro, T., Saigusa, M and Shibuya, K. 1999. A trial of no-tillage direct seeding of rice (*Oryza sativa* L.) at early spring in cold climate region in Japan. *Japanese Journal of Crop Science*. 68(1):146-150.

Udayababu, P., Sowjanya, P and Jogarao, P. 2021. Population dynamics of rice Insect pests through light trap catches and its relation to abiotic factors in high altitude tribal zone

of Seethampeta in Andhra Pradesh, India. *International Journal of Environment and Climate Change*. 11(12): 187-194.

Vimal, K., Gupta, P.K., Singh, R.B and Singh, J.P. 2015. Effect of date of planting on rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) in aromatic rice. *Annals of Plant and Soil Research*.17:568-569.