Original Research Article

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

Abstract

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. 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^{-1} in last date of sowing to 5156 kg ha^{-1} in first date of sowing.

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

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Introduction

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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.

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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.

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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^{-1} 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

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

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

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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.

Mean per cent damage by leaf folder at 75 DAS

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.

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

Treatments	*Damage per cent at					
	45 DAS	60 DAS	75 DAS	90 DAS	105 DAS	MEAN
1st 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)
2nd 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)
3rd 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)
4th 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
CV(%)	10.43	9.81	12.23	8.47	8.69	5.18

*Figures in paranthesis are square root transformed values

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.

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Then add discussion

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 1st DOS followed by 11.27 in 2nd DOS, 14.86 in 3rd DOS and 16.64 in 4th 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, 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 30th). 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) 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 31st Standard Meteorological Week (SMW) to 4th SMW (Table 2). During this period, the average maximum and minimum temperatures were 31.24^{0}C and 22.36^{0}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, 45th SMW had the highest number of moths. The average maximum and minimum temperatures observed during this time were 28.60°C and 21.89°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 42nd SMW and 43rdSMW. During October, November, and December adult moth caught was highest.

During the 1stDOS, sowing the average moth number trapped was about 4.45 and during this period from 32nd SMW to 1st SMW average climatic conditions recorded were 31.71^{o}C maximum temperature, 22.91^{o}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 2nd sowing from 33rd SMW to 2nd SMW the average number of moths trapped were 4.50 and average climatic conditions recorded were 31.41^{o}C maximum temperature, 22.61^{o}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 3rd date of sowing from 35rd SMW to 3rd SMW the average number of moths trapped were 4.53 and average climatic conditions recorded were 30.86°C maximum temperature, 22.25°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 4th date of sowing from 36th SMW to 4th SMW the average number of moths trapped were 4.54 and average climatic conditions recorded were 30.95°C maximum temperature, 22.01°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 *kharif* 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	31st -5th Aug	36.16	26.37	62.43	12.14	0.00	0.14	1st DOS
32	6th - 12th Aug	37.19	26.43	76.43	58.14	6.1	2.33	2nd DOS
33	13th - 19th Aug	32.94	23.81	83.36	76.57	16.5	2.67	
34	20th - 26th Aug	28.07	24.57	86.00	75.43	11.68	1.67	3rd DOS
35	27th - 2nd Sep	30.51	24.07	88.29	85.86	7.4	1	4th DOS
36	3rd - 9th Sep	32.14	24.57	82.14	74.0	0.84	0.42	
37	10th - 16th Sep	34.23	25.71	81.00	62.57	0.14	2.28	
38	17th - 23rd Sep	34.76	25.39	83.57	74.00	9.03	1.28	
39	24th - 30thSep	32.76	24.61	86.57	81.29	21.89	1.71	
40	1st - 7th Oct	33.29	24.24	87.14	80.86	8.3	2.33	
41	8th - 14th Oct	33.86	24.74	85.86	73.29	3.95	8.12	
42	15th - 21st Oct	33.63	24.84	86.00	76.00	9.34	5.42	
43	22nd - 28th Oct	32.61	23.04	85.43	72.71	2.61	9.42	
44	29th - 4th Nov	29.39	23.46	87.86	85.86	7.84	8.42	
45	5th - 11th Nov	28.60	21.89	87.14	73.29	1.15	13.56	
46	12th - 18th Nov	29.33	23.76	89.43	85.71	6.14	8.26	
47	19th - 25th Nov	29.63	22.9	88.43	85.00	22.56	4.31	
48	26th - 2nd Dec	28.94	21.13	87.14	78.29	12	6.32	
49	3rd - 9th Dec	31.29	20.87	86.86	74.00	0	7.28	
50	10th-16th Dec	29.71	20.01	87.43	69.71	0	6.42	
51	17th-23rd Dec	29.29	14.83	86.14	55.43	0	4.42	
52	24th-31st Dec	29.35	17.69	86.00	68.13	0	2.4	
1	1st - 7th Jan	29.70	18.04	86.00	69.57	0	2.14	1st DOH
2	08th – 14th Jan	29.21	19.36	86.00	75.14	8.45	1.42	2nd DOH
3	15th – 21st Jan	28.57	19.71	86.29	69.71	0.15	1	3rd DOH
4	22nd – 28th Jan	29.99	19.27	84.86	56.43	0	1.71	4th DOH

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

Variable	Correlation Co - efficient (r)
Maximum temperature (^{0}C)	-0.182
Minimum temperature (^{0}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 *kKharif*, 2021 noneed

Sr. No.	Dates of sowing (DOS)	Regression equation	R^2 value
1	1stDOS	Y= -57.15 - 0.03X1 + 0.15X2 + 0.77X3 – 0.08X4 - 0.09X5	35.4
2	2ndDOS	Y= -141.89 - 0.20X1 + 0.92X2 + 1.81X3 – 0.30X4 – 0.22X5	42.2
3	3rdDOS	Y= -147.30 - 0.74X1 +1.50X2 + 2.02X3 – 0.39X4 – 0.18X5	59.6
4	4thDOS	Y= - 144.65 – 0.26X1 + 1.05X2 + 1.72X3 – 0.17X4 - 0.23X5	50.7

Yield (Kg ha^{-1})

As our experiment is conducted without plant protection measures the yield data collected at different sowing dates under DSR ranged from 3632 kg ha^{-1} to 5156 kg ha^{-1}(Fig 2). Potential yield of BPT 2782 variety was 6000 to 7000 kg ha^{-1}.Each delay in transplanting time resulted in a steady decrease in grain yield (Table 5). The highest yield was observed at 1st DOS *i.e*. 5156 kg ha^{-1} followed by in 2nd DOS 4719 kg ha^{-1}, 4026 kg ha^{-1}in 3rd DOS and 3632 kg ha^{-1} at 4th 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 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^{-1})
1st DOS (02-08-2021)	5156
2nd DOS (12-08-2021)	4719
3rd DOS (22-08-2021)	4026
4th DOS (02-09-2021)	3632
SEm±	191.35
CD (P= 0.05)	589.63
CV (%)	9.76

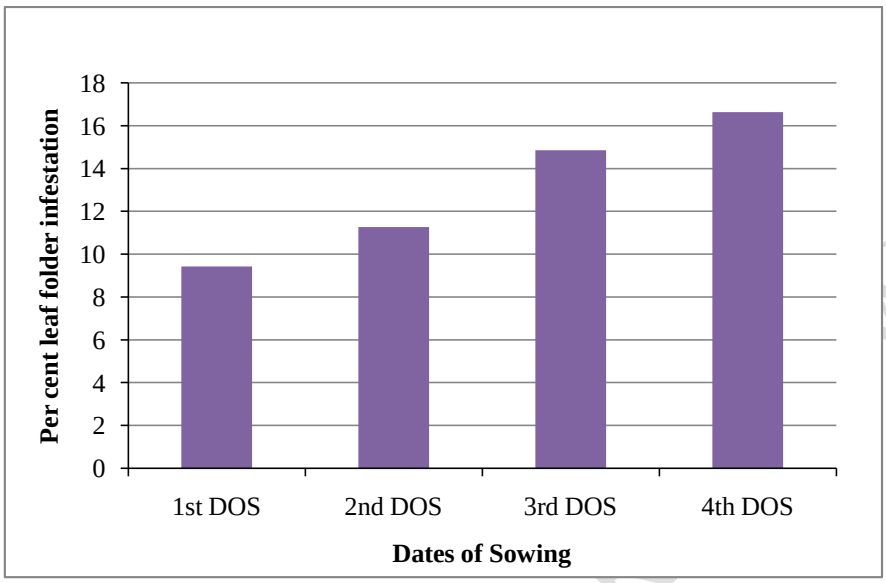

Fig. 1. Per cent leaf folder infestation at different sowing dates in DSR under field conditions during *kharif*, 2021

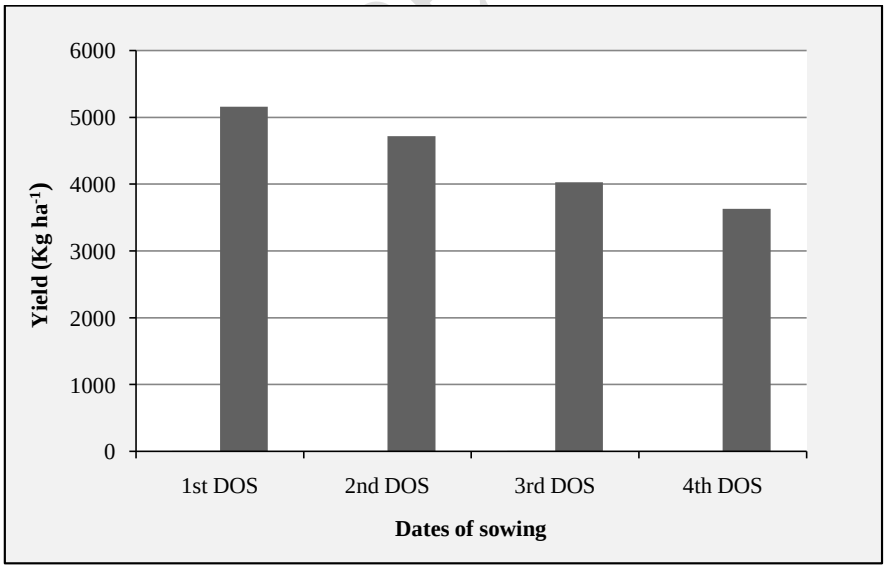

Fig 2. Impact of different sowing dates on yield in DSR under field conditions during *kharif*, 2021

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