The Pharma Innovation Journal 2022; 11(9): 1526-1531

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(9): 1526-1531

www.thepharmajournal.com
Received: 01-06-2022
Accepted: 08-07-2022

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Influence of different planting periods on damage of rice leaf folder, *Cnaphalocrocis medinalis* Guenee (Pyralidae: Lepidoptera)

NK Kavad, KA Patel, NV Radadiya, KM Patel and PD Ghoghari

Abstract
The field experiment was conducted on the influence of different planting periods on damage of rice leaf folder, *Cnaphalocrocis medinalis* Guenee (Pyralidae: Lepidoptera) during *Kharif* 2020 to 2021. Result revealed that significantly lowest leaf folder incidence was recorded in the early transplanted crop (2.97% DL), followed by normal transplanted crop (6.61% DL). Significantly highest % damaged leaves were observed by leaf folder in late transplanted crop (8.27% DL). Grain yield showed significantly highest grain yield (4981 kg/ha) while straw yield (5634 kg/ha) was found in early planting period and it was at par with normal planting period 4587 kg/ha grain yield and 5217 kg/ha straw yield. Significantly lowest grain yield (4362 kg/ha) and straw yield (4971 kg/ha) was found in late planting period.

Keywords: Rice, leaf folder, Cnaphalocrocis medinalis, influence, planting period

Introduction
Rice (*Oryza sativa* Linnaeus) belongs to the family of grasses (Poaceae). It is the staple food for more than two billion people in developing countries (Appala *et al*., 2018) [9]. About 45% of the total cultivated area of the nation is under rice cultivation. India ranks first by covering the largest area under rice and ranks second by contributing total food grain production of the world. In India, rice is grown in 43.86 million hectares, the production level is 112 million tonnes and the average productivity is about 2600 kg/ha. West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, Bihar, Chhatisgarh and Tamil Nadu are major state in rice production (Anon., 2020) [7]. Rice grown in the Gujarat state during the year 2019-20 is 0.90 million hectare and production is 1.98 million MT (Anon, 2021) [6]. Rice production is confined to South and Middle Gujarat representing the Agro-climatic Zones, I, II and III. Rice production is limited by both biotic and abiotic stresses of which insect pests alone caused about 25% losses (Dhaliwal *et al*., 2007) [11], hence, there is need to reduce the yield losses due to major pests. Rice crop is attacked by more than 100 species of insects (Jakarpong and Wiboon, 2017) [12], out of them rice leaf folder is one of the most serious and most important pest of rice crop in Indian subcontinent (Shanmugam *et al*., 2006) [17]. Rice leaf folder, *C. medinalis* is the most wide spread and important among eight species of rice leaf folder (Bhatti, 1995) [10]. It was earlier considered a minor pest but now a days it assumed major pest status. Due to rice leaf folder, the loss may extend up to 63 to 80% as reported by Rajendran *et al*. (1986) [15]. In India, climate change effects are becoming more visible every year through temperature and rainfall fluctuations affecting the farming systems by disrupting the normal planting schedule. Consequently, alternative planting and harvesting dates are suggested as potential farm-level adaptations to climate variability. It is vital to have the knowledge of population dynamics of insect pests in relation to planting dates and crop phenology for their efficient management (Anon., 2018a) [8]. In spite of its regular occurrence and importance of this pest in South Gujarat region, the information on its influence of different planting period is not available. Therefore, it is necessary to find out influence of different planting period for the effective management of rice leaf folder.

Materials and Methods
The field investigation on influence of planting periods on incidence of rice leaf folder, *C. medinalis* was carried out at Main Rice Research Centre farm, Soil and Water Management

Research Unit, Navsari Agricultural University, Navsari, Gujarat during *Kharif* 2020 and 2021. The influence of planting periods were recorded on rice variety GR-11 (State susceptible check). For this purpose, GR-11 was transplanted in 400 m^2 area with three planting periods as early planting (15 day before normal planting), normal planting (1st week of July) and late planting (15 day after normal planting). Experiment design was Large Plot Technique with three (3) treatments and eight (8) repetitions by spot sampling of (1 × 1 m) from each planting period. The observations were recorded at 15 day interval in each planting period from 15th DAT to till harvest of the crop. The leaf folder damage was recorded by randomly selected 10 hills from 8 spots (1 x 1 m) from each planting period for counting of total number of leaves per hill and the number of damaged leaves per hill (only if one-third of leaf area is damaged). The recorded data were converted in % leaf damage. Grain and straw yield (kg/ha) from different 8 spots (1 x 1 m) was recorded and converted per hectare basis. All the post sowing recommended agronomical practices were followed. The experimental area was kept free from insecticide spray throughout the crop season in order to record incidence of rice leaf folder, *C. medinalis*. % leaf damage was worked out by using following formula given by Netam and Gupta (2015) [13].

$$\text{Leaf damage (\%)} = \frac{\text{Total number of damaged leaves}}{\text{Total number of leaves (Healthy + Damaged)}} \times 100$$

Results and Discussion

Influence of different planting periods on % damaged leaves by rice leaf folder, *C. medinalis*

The data on % damaged leaves (% DL) by leaf folder, *C. medinalis* during year *Kharif* 2020, 2021 and pooled are presented in Table 1 to 3 and Fig. 1 to 3. It revealed that the % damaged leaves was found significant during *Kharif* 2020, *Kharif* 2021 and also in pooled. During *Kharif* 2020, infestation started from 45 days after transplanting (DATP) in early and normal planting period, while in case of late planting period it started from 30 days after transplanting and continued up to harvesting of the crop. There was no any infestation found in early and normal planting periods while 1.27% DL was found in late planting period at 30 days after transplanting. Early transplanted crop recorded significantly lowest population than normal and late transplanted crop. The significantly lowest *C. medinalis* incidence was recorded in the early transplanted crop with 8.00% damaged leaves, followed by normal transplanted crop (17.30% DL) and the late transplanted crop which witnessed the highest % damaged leaves (20.38% DL) at 75 days after transplanting. Similarly, pooled data of different periods during *Kharif* 2020 showed that significantly lowest *C. medinalis* incidence was recorded in the early transplanted crop (2.74% DL) followed by normal transplanted crop (6.37% DL). Significantly highest % damaged leaves were observed in late transplanted crop (7.56%) (Table 1 and Fig. 1).

Table 1: Influence of different planting periods on damage of rice leaf folder, *C. medinalis* during *Kharif* 2020

Sr. No.	Treatment	% damaged leaves (% DL)							
		15 DATP	30 DATP	45 DATP	60 DATP	75 DATP	90 DATP	105 DATP	Pooled
1	T_1- Early Planting	0.71 (0.00)	0.71 (0.00)	1.53 (1.86)	2.04 (3.66)	2.91 (8.00)	2.19 (4.30)	1.35 (1.35)	1.80 (2.74)
2	T_2- Normal Planting	0.71 (0.00)	0.71 (0.00)	2.10 (3.94)	3.12 (9.28)	4.20 (17.30)	3.32 (10.57)	2.00 (3.52)	2.62 (6.37)
3	T_3- Late Planting	0.71 (0.00)	1.32 (1.27)	2.24 (4.57)	3.43 (11.28)	4.56 (20.38)	3.41 (11.22)	2.16 (4.21)	2.84 (7.56)
S. Em. (±)		-	0.03	0.05	0.06	0.10	0.08	0.05	0.04
C.D. at 5%		-	0.10	0.16	0.17	0.29	0.22	0.15	0.10
C.V. (%)		-	10.26	7.64	5.66	7.21	7.24	7.96	4.14

Note: Figures in the parentheses are original values, while those outside are square root ($\sqrt{X + 0.5}$) transformed values, DATP= Days after Transplanting

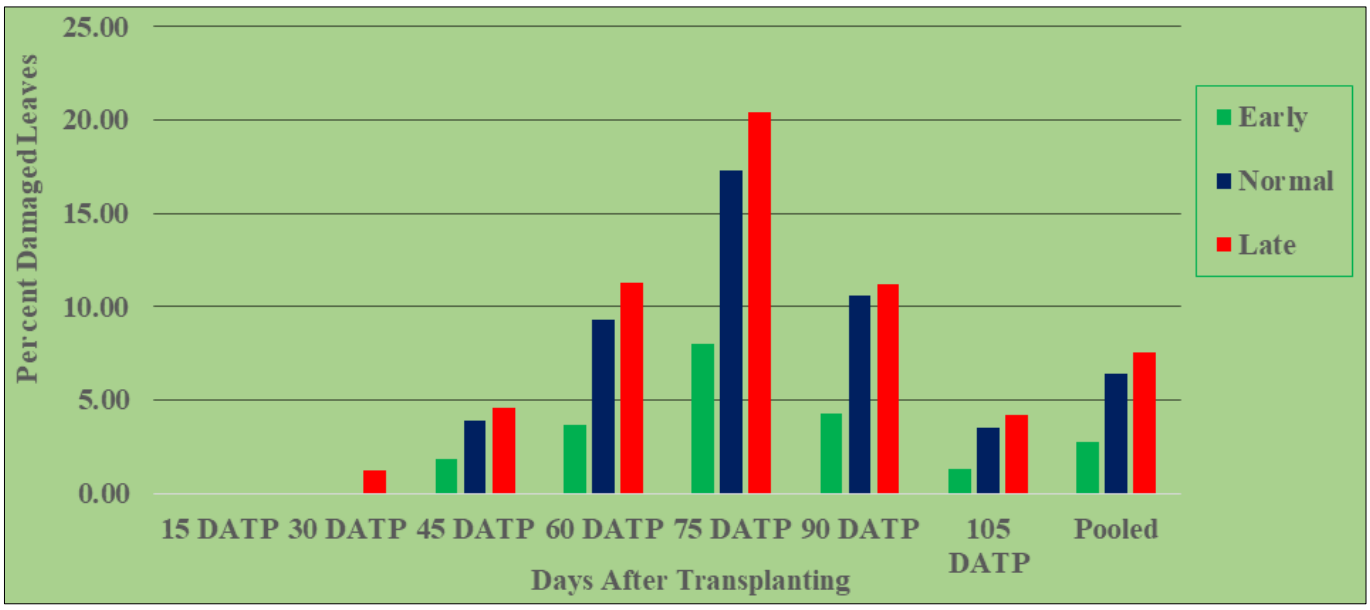

Fig 1: Influence of different planting periods on damage of rice leaf folder, *C. medinalis* during *Kharif* 2020

The similar trends was observed during *Kharif* 2021 (Table 2 and Fig. 2). Infestation started from 45 days after transplanting (DATP) in early and normal planting period, while in case of late planting period infestation started from 30 days after transplanting and continued up to harvesting of the crop. There was no any infestation in early and normal planting periods while 2.01% DL was found in late planting at 30 days after transplanting. The significantly lowest leaf folder incidence was observed in the early transplanted crop with a mean % damaged leaves (8.95% DL), followed by normal transplanted crop (18.37% DL) and the late transplanted crop with the highest % damaged leaves (21.88% DL) at 75 days after transplanting. Pooled data of different periods during *Kharif* 2021 showed that significantly lowest leaf folder incidence was recorded in the early transplanted crop (3.21% DL) and followed by normal transplanted crop (6.85% DL). Significantly highest % damaged leaves were observed in late transplanted crop (8.98% DL). The % damaged leaves were higher as compared to previous year (*Kharif* 2020).

Table 2: Influence of different planting periods on damage of rice leaf folder, *C. medinalis* during *Kharif* 2021

Sr. No.	Treatment	% damaged leaves (% DL)							
		15 DATP	30 DATP	45 DATP	60 DATP	75 DATP	90 DATP	105 DATP	Pooled
1	T_1- Early Planting	0.71 (0.00)	0.71 (0.00)	1.59 (2.03)	2.35 (5.11)	3.07 (8.95)	2.22 (4.49)	1.54 (1.90)	1.93 (3.21)
2	T_2- Normal Planting	0.71 (0.00)	0.71 (0.00)	2.17 (4.22)	3.27 (10.19)	4.34 (18.37)	3.40 (11.12)	2.13 (4.07)	2.71 (6.85)
3	T_3- Late Planting	0.71 (0.00)	1.57 (2.01)	2.86 (7.75)	3.61 (12.58)	4.71 (21.88)	3.74 (13.55)	2.36 (5.12)	3.08 (8.98)
S. Em. (±)		-	0.04	0.06	0.08	0.12	0.09	0.06	0.04
C.D. at 5%		-	0.10	0.17	0.24	0.36	0.28	0.18	0.13
C.V. (%)		-	9.99	7.40	7.56	8.52	8.48	8.72	4.93

Note: Figures in the parentheses are original values, while those outside are square root ($\sqrt{X + 0.5}$) transformed values, DATP= Days after Transplanting

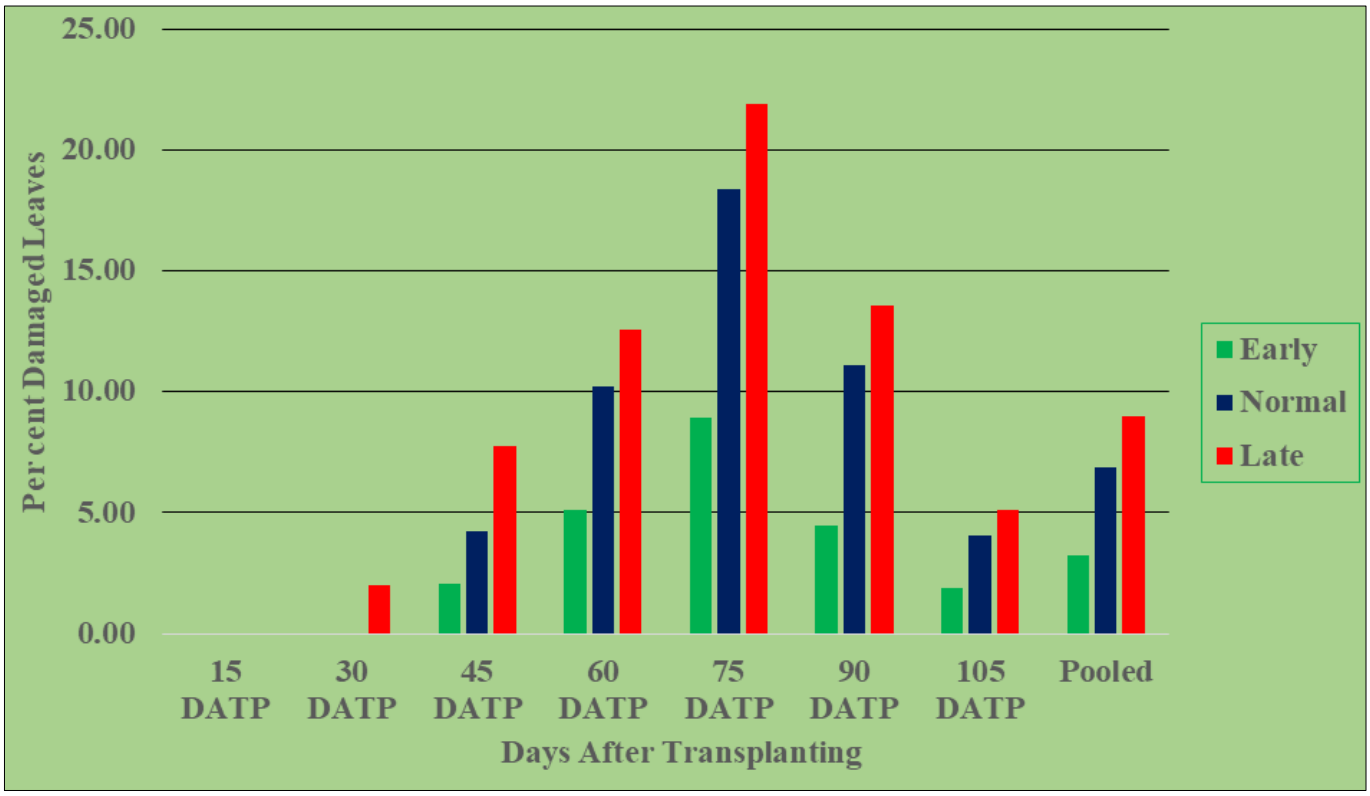

Fig 2: Influence of different planting periods on damage of rice leaf folder, *C. medinalis* during *Kharif* 2021

Pooled data showed that the infestation trend was similar as observed in both the years. The different planting dates had significant effect on the incidence of rice leaf folder. There was no any infestation was found in early and normal planting periods while 1.64% DL was found in late planting at 30 days after transplanting. The significantly lowest leaf folder infestation was found in the early transplanted crop with a mean % damaged leaves of 8.47%, followed by normal transplanted crop (17.84% DL) and the late transplanted crop with the highest % damaged leaves (21.13%) at 75 days after transplanting. Overall pooled data (*Kharif* 2020 & 2021) of different periods, showed that significantly lowest leaf folder incidence was recorded in the early transplanted crop (2.97% DL) and followed by normal transplanted crop (6.61% DL). Significantly highest % damaged leaves were observed by leaf folder in late transplanted crop (8.27% DL). Thereafter, the % infestation continuously declining up to the harvest of the crop (Table 3 and Fig. 3).

Table 3: Influence of different planting periods on damage of rice leaf folder, *C. medinalis* (Pooled)

Sr. No.	Treatment	% damaged leaves (% DL)							
		15 DATP	30 DATP	45 DATP	60 DATP	75 DATP	90 DATP	105 DATP	Overall pooled
1	T_1- Early Planting	0.71 (0.00)	0.71 (0.00)	1.56 (1.94)	2.20 (4.39)	2.99 (8.47)	2.21 (4.39)	1.45 (1.62)	1.86 (2.97)
2	T_2- Normal Planting	0.71 (0.00)	0.71 (0.00)	2.14 (4.08)	3.20 (9.74)	4.27 (17.84)	3.36 (10.84)	2.07 (3.79)	2.67 (6.61)
3	T_3- Late Planting	0.71 (0.00)	1.62 (1.64)	2.57 (6.16)	3.52 (11.93)	4.64 (21.13)	3.58 (12.38)	2.27 (4.66)	2.96 (8.27)
S. Em. (±)		-	0.02	0.05	0.06	0.09	0.07	0.04	0.04
C.D. at 5%		-	0.07	0.14	0.17	0.26	0.21	0.13	0.11
C.V. (%)		-	7.28	6.40	5.57	6.25	6.69	6.56	4.09

Note: Figures in the parentheses are original values, while those outside are square root ($\sqrt{X + 0.5}$) transformed values, DATP= Days after Transplanting

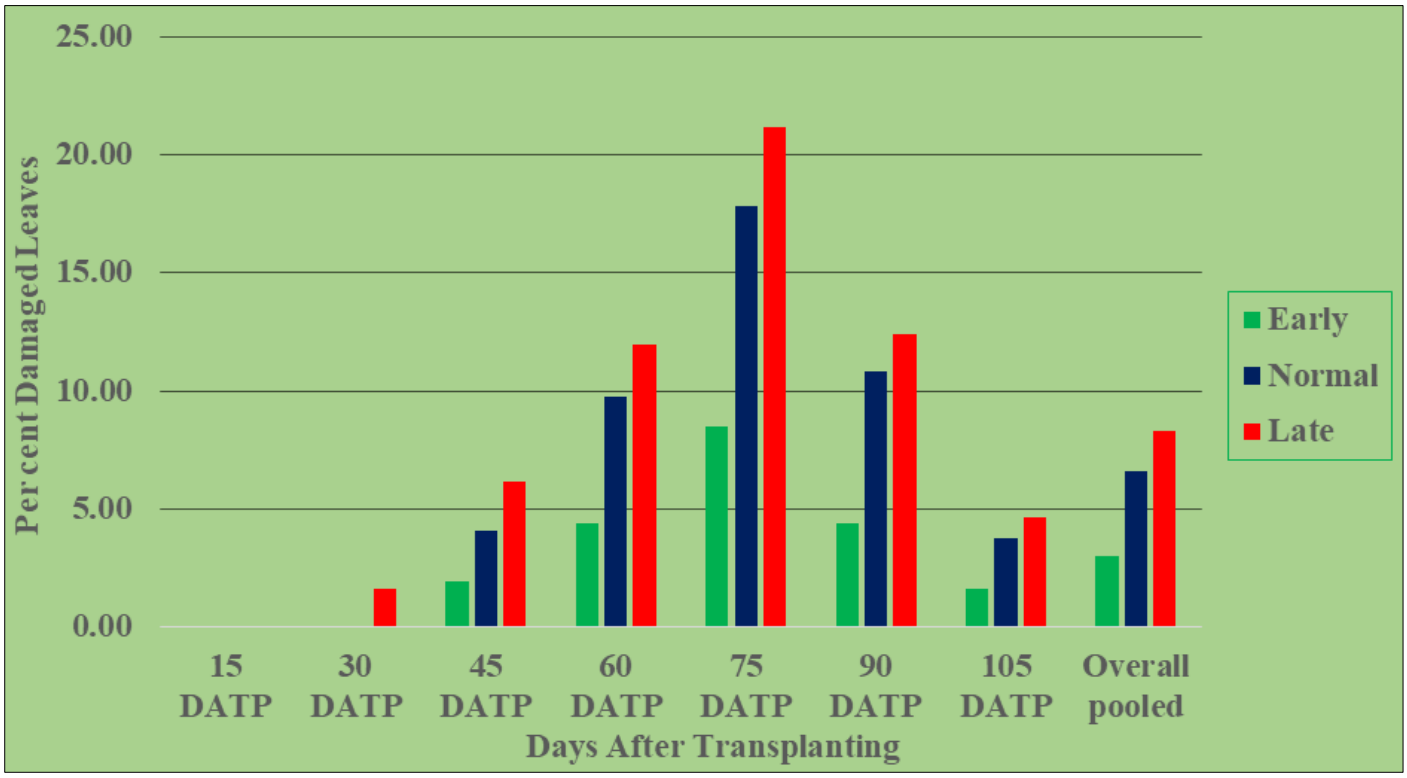

Fig 3: Influence of different planting periods on damage of rice leaf folder, *C. medinalis* (Pooled)

On the basis of grain yield (Table 4 and Fig. 4), early planting period was recorded the significantly highest grain yield (5012 kg/ha) and it was at par with normal planting period (4612 kg/ha). Early planting period was recorded significantly highest straw yield (5675 kg/ha) which was at par with normal planting period (5241 kg/ha). Significantly lowest grain yield (4400 kg/ha) and straw yield (5029 kg/ha) was found in late planting period during *Kharif* 2020. Same trends was observed during *Kharif* 2021. In *Kharif* 2021, early planting period was recorded significantly highest grain yield (4950 kg/ha) and it was at par with normal planting period (4562 kg/ha). For considering straw yield, early planting period was recorded the significantly highest straw yield (5592 kg/ha) which was at par with normal planting period (5193 kg/ha). Significantly lowest grain and straw yield was found in late planting period *i.e.* 4325 kg/ha and 4913 kg/ha. Overall grain and straw yield was low in *Kharif* 2021 due to more infestation of leaf folder as compare to *Kharif* 2020. In pooled, significantly highest grain yield (4981 kg/ha) and straw yield (5634 kg/ha) was found in early planting period and it was at par with normal planting period with grain yield (4587 kg/ha) and straw yield (5217 kg/ha). Significantly lowest grain yield (4362 kg/ha) and straw yield (4971 kg/ha) was found in late planting period.

From available source of literature it revealed that Suresh *et al.* (1991) [19] the incidence of rice leaf folder was significantly higher in delayed planting and during the 2nd stage of growth. According to Anonymous (2015, 2016, 2017 and 2018b) [1, 2, 3, 4], the incidence of rice leaf folder in rice was low in prior to normal sowing and it was higher in late sowing time as compared to prior to normal and normal sowing. Anonymous (2018a) [8] investigated an effect of planting dates on insect pest incidence from 21 locations during *Kharif* 2018 and found that the highest % damage by leaf folder was (22.11%) reported in late planting followed by Pusa in early planting 12.60% and grain yield varied from 48.8 to 95.0 q per ha in all plantings at Titabar. Anonymous (2019) [5] reported that the incidence of rice leaf folder in rice was low in prior to normal sowing and it was higher in late sowing time as compared to prior to normal and normal sowing in all eleven periods *i.e.* 10, 20, 30, 40, 50, 60, 70, 80, 90, 100 and 110 days after transplanting of rice. Rautaray *et al.* (2019) [16] studied that significant differences existed among all transplanting dates pertaining to percentage of leaf folder incidence (LFI). The late transplanted rice crop was heavily infested by leaf folders (15.42%) and minimum infestation by leaf folders was recorded (7.83%) in early transplanted crop. The rice crop transplanted on early proved

to be the best for obtaining higher grain yield and lowest yield in late transplanted crop. Prasad (2020) [14] revealed that earlier were the date of transplanting, significantly lesser were the intensities of attack of leaf folder and *vice versa*. The crop transplanted early, normal, delayed and very delayed planting crop, yielded 44.46, 39.85, 34.64 and 29.20 q per ha during 2015 and 46.90, 40.90, 35.75 and 30.80 q per ha during 2016, respectively. Singh *et al.* (2020) [18] found that the planting dates had significant effect on the incidence of the pests. Early transplanted crop recorded significantly lower population than the late transplanted crop. The significantly lowest *C. medinalis* incidence was observed in the early transplanted crop with a mean % damaged leaves 2.29%, followed by normal transplanted crop (5.01%) and the late transplanted crop (6.46%). Slight deviation in % damaged leaves by leaf folder in planting periods could be due to variation in the cropping pattern and prevailing environmental conditions in a particular locality during the season.

Table 4: Influence of different planting periods of rice leaf folder, *C. medinalis* on grain and straw yield (Pooled)

Sr. No.	Treatment	*Kharif* 2020		*Kharif* 2021		Pooled	
		Grain Yield	Straw Yield	Grain Yield	Straw Yield	Grain Yield	Straw Yield
		Kg/ha	Kg/ha	Kg/ha	Kg/ha	Kg/ha	Kg/ha
1	T_1- Early Planting	5012	5675	4950	5592	4981	5634
2	T_2- Normal Planting	4612	5241	4562	5193	4587	5217
3	T_3- Late Planting	4400	5029	4325	4913	4362	4971
S. Em. (±)		166	171	157	169	158	163
C.D. at 5%		488	503	461	496	466	478
C.V. (%)		10.03	9.11	9.62	9.11	9.65	8.71

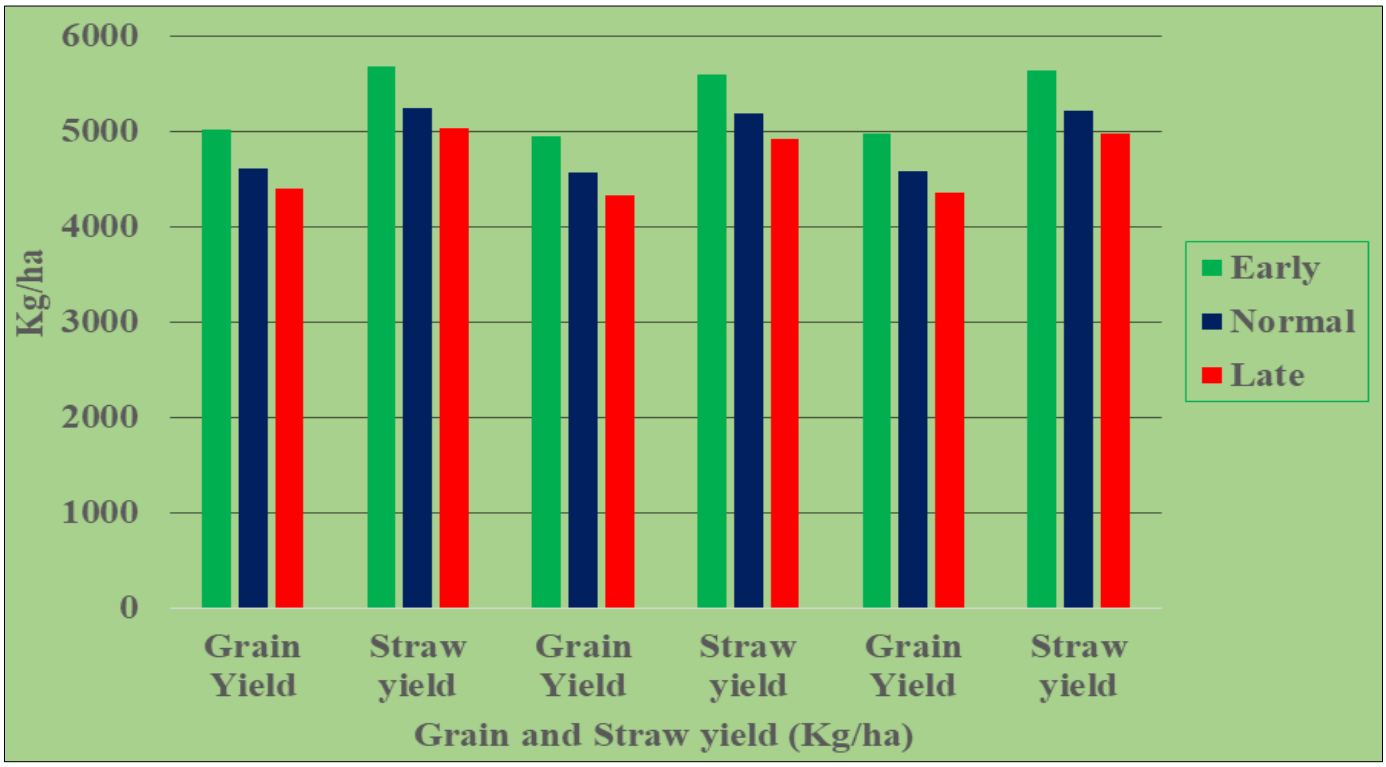

Fig 4: Influence of different planting periods on damage of rice leaf folder, *C. medinalis* on grain and straw yield (Pooled)

Conclusion

Influence of different planting periods on the infestation of leaf folder started from 45 days after transplanting in early and normal transplanting period, while in case of late transplanting period infestation started from 30 days after transplanting. Lower % damaged leaves by *C. medinalis* was found in the early transplanted crop followed by normal transplanted crop and late transplanted crop at 75 days after transplanting. Incidence of rice leaf folder was higher in delayed transplanting. Thereafter % infestation started declining continuously up to harvest of the crop. Early transplanted crop period was recorded higher grain and straw yield as compare to normal transplanting period. Lower grain and straw yield was recorded in late planting period. Early transplanting period proved to be the best for minimum leaf folder infestation and obtaining maximum grain and straw yield. Furthermore, the knowledge on rice transplanting periods would be useful to minimize and planning of integrated management strategy against rice leaf folder under field conditions.

Acknowledgement

The authors are thankful to Navsari Agricultural University, Navsari for providing facilities during research work.

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