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Survey on Incidence of Major Pests and Their Natural Enemy Complex in Direct Seeded Rice *vs* Transplanted Rice

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ABSTRACT

The survey was conducted at three stages of crop growth *viz.*, active tillering, panicle initiation (PI) and harvesting stages of Direct seeded Rice (DSR) and Puddled Transplanted Rice (PTR) fields of ten mandals *viz.*, Bapatla, Ponnur, Karlapalem, Cherukupalli, Amarthaluru, Pittalavanipalem, Nagaram, Kakumanu, Vatticherukuru and Pedanandipadu. Observations were recorded on incidence of BPH, WBPH, leaf folder, coccinellids, mirid bugs and spiders. The mean population of BPH, WBPH and natural enemies was higher in PTR when compared to DSR. Leaf folder infestation and damage was more in DSR when compared to PTR. Among surveyed mandals, Bapatla recorded the higher number of BPH (9.04/hill), whereas, higher number of WBPH were recorded at Vatticherukuru (4.24/hill) mandal during PI stage in PTR. The highest leaf folder larval number (1.31per hill) and damage was observed at Cherukupalli (5.54%/hill) DSR.

Survey provides a high level of general capability in representing a large population. As compared to other methods of data gathering, survey able to extract data that are near to the exact attributes of the population. Survey on natural enemies *viz.*, predators, parasitoids and pathogens which are specific against crop pests will indicate their impact on the population dynamics of the pest and play an important role in keeping the pest populations under control by evaluating the potential for the biological control of the pest. In India, rice is grown mainly by transplanting the seedlings into the puddled to the soil, which require a large amount of water and labors. In recent years both are scarce and expensive, making rice production less profitable. Also, drudgery involved in transplanting is of serious concern. All these factors demanded major shift from Puddled Transplanted Rice (TR) production to Direct Seeded Rice (DSR) in irrigated and assured or high rainfall areas. Rice is one of the cereal food crop half of the population of the world, it is an important target crop to provide food and livelihoods for millions. Rice is mainly grown by direct-seeded rice and transplanted rice. The recent years both the methods of sowing were scarce, expensive and less profitable coupled with excessive use of nitrogenous fertilizers and abuse of agrochemicals have further aggravated the pest menace in transplanted conditions. All these factors demanded a major shift from Transplanted Rice (TR) production to Direct Seeded Rice (DSR) in irrigated and assured or high rainfall areas (Edirisinghe and Bambaradeniya, 2006). Direct seeded rice technique is becoming popular nowadays because of its lowinput demanding nature. This method has become inevitable for tail-end farmers who receive less amount of irrigation water. Numerous guilds of insect pests attacked by Paddy crop in the field, but few cause significant losses. Losses caused by insect pests are the main constraints in achieving a high yield of rice (Rai *et al.*, 2000). The rice plant is subject to attack by more than 100 species of insects and 20 of them can cause economic damage. The major insect pests attacking rice are rice leaffolder, *Cnaphalocrocis medinalis* (Guenee), brown planthopper, *Nilaparvata lugens* (Stal), whitebacked planthopper, *Sogatella furcifera* (Horvath) and yellow stem borer, *Scirpophaga incertulas* (Walker). The loss due to yellow stem borer ranged from 3 to 65 percent (Muralidharan and Pasalu, 2005) and leaf folder to the extent of 5 to 39 percent (Shanmugam *et al.*, 2006). A change from transplanting to direct seeding may affect the status of various pests. Among the major insect pests attacking rice are yellow stem borer, leaf folder, green leafhopper, grasshopper, earhead

bug, white leafhopper. The average yield loss in rice have been accounted for 30% loss due to stem borers, while plant hoppers cause 20%, gall midge 15%, leaf folder 10% and other pests 25%, respectively (Krishnaiah and Varma, 2015) . This study describes possible changes in pest status in direct-seeded rice fields. It is felt that a complex and rich web of general and specific insect pests of directseeded rice (DSR) ecosystem is to be studied.

MATERIAL AND METHODS

A survey was conducted during *Kharif*, 2019 from randomly selected ten mandals of paddy growing areas in Guntur district. The ten mandals include Bapatla, Ponnur, Karlapalem, Cherukupalli, Amarthaluru, Nagaram, Pittalavanipalem, Kakumanu, Vatticherukuru and Pedanandipadu Observations were recorded on number of BPH, WBPH, leaf folder, coccinellids, mirid bugs and spiders from randomly selected 10 hills during active tillering, panicle initiation and harvesting stages of crop growth. The data on the population of planthoppers, leaf folder larvae, spiders, mirid bugs and coccinellids was transformed into square root values. Whereas, the data on the leaf damage by leaf folder were transformed into arc sine values. The data subjected to t- test analysis to compare the pest incidence in direct seeded and transplanted plots.

RESULTS AND DISCUSSION

At active tillering stage, the no. of BPH population per hill ranged from 3.62 (Kakumanu) to 5.41 (Karlapalem) and 4.24 (Kakumanu) to 7.86 (Nagaram) number per hill in DSR and PTR. At PI stage population of BPH ranged from 5.04 (Kakumanu) to 9.04 (Bapatla) and 5.51 (Cherukupalli) to 11.22 (Bapatla) and at harvesting stage, the no. of BPH ranged from 0.46 (Pedanandipadu) to 1.72 (Nagaram) and 1.02 (Karlapalem) to 2.40 (Cherukupalli) number per hill in DSR and PTR, respectively and there was a significant difference among the mandals and also method of rice cultivation.

The data on mean number of BPH was recorded as 4.63 (DSR) and 5.96 (PTR) number per hill at active tillering stage, increased in number at PI stage with 6.30 and 7.85 per hill but reduced at harvesting stage with 0.97 and 1.51 BPH per hill was recorded in DSR and PTR respectively. The results on population of BPH were found to be statistically lower in Direct Seeded Rice (DSR) when compared to the Puddled Transplanted Rice (PTR) (Table.1).

Regarding WBPH (Table.2) also, same trend was noticed in the number of WBPH was found to be statistically lower in DSR when compared to the PTR. The data on mean population of WBPH was 2.23 (DSR) and 3.14 (PTR) per hill at active tillering stage. At PI stage 3.45 and 3.75 per hill and at harvesting stage 0.45 and 0.51 BPH per hill in DSR and PTR respectively.

The WBPH (population ranged from 1.84 (Nagaram) to 2.76 (Kakumanu) and 2.70 (Bapatla) to 3.56 (Cherukupalli) number per hill at active tillering stage, while at panicle initiation stage from 2.82 (Bapatla) to 4.12 (Karlapalem) and 3.32 (Bapatla) to 4.24 (Vatticherukuru) number per hill and at harvesting stage, data ranged from 0.30/hill (Nagaram) to 0.62/hill (Pedanandipadu) and 0.38/ hill (Nagaram) to 0.90/hill (Karlapalem) in DSR and PTR respectively. There was a significant difference among the mandals and also method of rice cultivation.

The results pertaining to the larval population of leaf folder revealed that, infestation was statistically lower in PTR when compared to DSR in all the surveyed mandals. The data on mean population of leaf folder was 0.90 (DSR) and 0.60 (PTR) per hill at active tillering stage. At PI stage, 1.02 and 0.71 per hill and at harvesting stage 0.21 and 0.14 per hill in DSR and PTR respectively.

At active tillering stage, the leaf folder larvae population per hill ranged from 0.53 (Bapatla) to 1.27 (Cherukupalli) and 0.35 (Karlapalem) to 0.89 (Pedanandipadu) number per hill. At panicle initiation stage, it ranged from 0.42 (Karlapalem) to 1.31 (Cherukupalli) and 0.30 (Karlapalem) to 1.03 (Pedanandipadu) number per hill and at harvesting stage, the leaf folder larvae population ranged from 0. 14 (Amarthaluru) to 0.29 (Bapatla) and 0.06 (Vatticherukuru) to 0.24 (Kakumanu) number per hill in DSR and PTR respectively. (Table.3)

The damage by leaf folder recorded at active tillering stage was 4.37 and 2.80, but results revealed a decreasing trend in leaf damage at PI stage with 2.43 and 1.63 and at harvesting stage 1.96 and 1.14 per hill in DSR and PTR respectively.

At active tillering stage, the per cent damage of leaf folder per hill ranged between 3.34 (Amarthaluru) to 5.54 (Cherukupalli) and 1.84

(Karlapalem) to 3.84 (Pedanandipadu) in DSR and PTR, at PI stage, it ranged from 1.70 (Amarthaluru) to 3.02 (Cherukupalli) and 1.22 (Karlapalem) to 2.44 (Cherukupalli) in DSR and PTR and at harvesting stage, the per cent damage of leaf folder per hill ranged from 1.10 (Pedanandipadu) to 2.64 (Kakumanu) and 0.66 (Cherukupalli) to 1.90 (Pittalavanipalem) in DSR and PTR, respectively and there was a significant difference among the mandals and also method of rice cultivation. (Table.4)

Regarding natural enemies, mirid bugs, spiders and coccinellids were recorded in both rice ecosystems of surveyed ten mandals. The number of the above natural enemies was statistically lower in DSR when compared to PTR in ten mandals surveyed at three stages. The data on mean number of mirid bugs collected at active tillering stage, was recorded as 2.18 (DSR) and 3.60 (PTR) per hill. At PI stage 1.20 and 1.92 and at harvesting stage it was recorded as 0.67 and 0.88 per hill in DSR and PTR respectively.

At active tillering stage, the mirid bug (Table.5) population ranged from 1.84 (Ponnur) to 5.42 (Karlapalem) and 3.12 (Pedanandipadu) to 6.04 (Karlapalem) number per hill in DSR and PTR. At PI stage, the mirid bug population ranged from 0.76 (Cherukupalli) to 1.76 (Pittalavanipalem) and 1.53 (Ponnur) to 2.66 (Kakumanu) number per hill in DSR and PTR, respectively. At harvesting stage, the mirid bug population ranged from 0.44 (Nagaram) to 1.04 (Kakumanu) and 0.58 (Nagaram) to 1.22 (Amarthaluru) number per hill in DSR and PTR respectively and there was a significant difference among the mandals and also method of rice cultivation.

The mean population of spiders (Table.6) was 0.50 (DSR) and 0.63 (PTR) per hill at active tillering stage. But, increased in number from PI stage with 0.78 and 0.92 per hill to harvesting stage 1.12 and 1.30 per hill in DSR and PTR, respectively.

At active tillering stage, the no. of spiders population ranged from 0.24 (Kakumanu) to 0.82 (Pedanandipadu) and 0.36 (Bapatla) to 0.86 (Pedanandipadu) number per hill in DSR and PTR, respectively and there was a significant difference among the mandals and also method of rice cultivation. At PI stage, the spider population ranged from 0.44 (Pittalavanipalem) to 1.13 (Ponnur) and 0.70 (Karlapalem) to 1.32 (Nagaram) number per hill in DSR and PTR, respectively and there was a significant difference among the mandals and also method of rice cultivation. At harvesting stage, the spider population ranged between 0.66 (Cherukupalli) to 1.50 (Pedanandipadu) and 0.80 (Amarthaluru) to 1.70 (Pittalavanipalem) number per hill in DSR and PTR, respectively and there was a significant difference among the mandals and also method of rice cultivation.

The data on mean number of coccinellids (Table.7) was recorded as 0.37 (DSR) and 0.54 (PTR) per hill active tillering stage. At PI stage, 0.67 and 0.79 per hill and at harvesting stage 0.95 and 1.14 per hill, in DSR and PTR respectively and there was a significant difference among the mandals and also method of rice cultivation.

At active tillering stage, the coccinellid population ranged from 0.22 (Ponnur) to 0.56 (Amarthaluru) and 0.30 (Pedanandipadu) to 0.94 (Amarthaluru) number per hill in DSR and PTR, respectively and there was a significant difference among the mandals and also method of rice cultivation. At PI stage, the coccinellid population ranged between 0.51 (Karlapalem) to 1.02 (Pittalavanipalem) and 0.58 (Kakumanu) to 1.11 (Pittalavanipalem) number per hill in DSR and PTR respectively and there was a significant difference among the mandals and also method of rice cultivation. At harvesting stage, the coccinellid population ranged from 0.72 (Kakumanu) to 1.20 (Nagaram) and 0.84 (Karlapalem) to 1.32 (Nagaram) number per hill in DSR and PTR, respectively and there was a significant difference among the mandals and also method of rice cultivation.

The results were in accordance with Ashrith *et al.* (2016) who reported that incidence of BPH was more in puddled transplanted rice when compared to the direct seeded rice under unprotected situation. Parasappa *et al.* (2017) investigated that WBPH infestation started from last week of July and the mean population (nymphs and adults per hill) was high in mechanical transplanted rice (4.40). The present findings were also in conformity with Ashrith *et al*. (2017), who reported that the number of leaf folder was more in direct seeded rice than the transplanted rice. Ashrith *et al.* (2017) who reported that the population of mirid bugs, which is a specific predator on BPH found to be more in transplanted rice than direct seeded rice. Ashrith *et al.* (2016) who reported that coccinellids population was more in transplanted rice *i.e.*, 2.48/hill and 1.96/hill compared to direct seeded rice. Girish *et al.* (2015)

reported that highest mean populationof spiders were recorded in transplanting method (0.90/hill). Ashrith *et al*. (2017) who reported that the leaf folder damage was more in direct seeded rice than the transplanted rice.

Table 1. Survey conducted on infestation of BPH in rice crop in Guntur district during *kharif* 2019

S. No.	Name of the mandal	No. of BPH Per Hill					
		Active Tillering Stage		Panicle Initiation Stage		Harvesting Stage	
		Direct Seeded Rice	Transplanted Rice	Direct Seeded Rice	Transplanted Rice	Direct Seeded Rice	Transplanted Rice
1	Bapatla	4.86	6.24	9.04	11.22	1.04	1.8
		-2.2	-2.5	-3.01	-3.35	-1.02	-1.34
2	Ponnur	4.22	5.08	7.82	9.72	0.84	1.16
		-2.05	-2.25	-2.8	-3.12	-0.92	-1.08
3	Karlapalem	5.41	6.04	7.91	9.38	0.96	1.02
		-2.32	-2.46	-2.81	-3.06	-0.98	-1.01
4	Cherukupalli	4.82	5.14	5.22	5.51	0.88	2.4
		-2.19	-2.27	-2.28	-2.35	-0.94	-1.55
5	Amarthaluru	5.12	5.52	6.44	8.44	0.66	1.75
		-2.26	-2.35	-2.54	-2.91	-0.81	-1.32
6	Pittalavanipalem	4.66	7.54	5.1	6.92	1.24	1.54
		-2.16	-2.74	-2.25	-2.61	-1.11	-1.24
7	Nagaram	5.21	7.86	5.3	6.99	1.72	1.96
		-2.28	-2.8	-2.3	-2.63	-1.31	-1.4
8	Kakumanu	3.62	4.24	5.04	6.66	0.76	1.15
		-1.9	-2.06	-2.24	-2.58	-0.87	-1.05
9	Vatticherukuru	4.04	5.82	5.44	7.16	1.22	1.72
		-2.01	-2.41	-2.33	-2.68	-1.1	-1.31
10	Pedanandipadu	4.44	6.26	6.82	8.66	0.46	1.32
		-2.11	-2.51	-2.61	-2.94	-0.68	-1.15
Mean		**4.63**	**5.96**	**6.3**	**7.85**	**0.97**	**1.51**
		-2.14	**-2.43**	**-2.5**	**-2.78**	**-0.97**	**-1.2**
t cal		****3.47**		***1.93**		****2.46**	
P-value		**<0.01**		**0.03**		**0.01**	

Values in the parenthesis are sqrt transformed values. **Significant at 1% level of significance * Significant at 5% level of significance

Table 2. Survey conducted on infestation of WBPH in rice crop in Guntur district during *kharif* 2019

S. No.	Name of the mandal	No. of WBPH per hill					
		Active tillering stage		Panicle Initiation stage		Harvesting stage	
		Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice
1	Bapatla	2.62	2.7	2.82	3.32	0.35	0.5
		-1.62	-1.64	-1.68	-1.82	-0.58	-0.69
2	Ponnur	2.04	3.12	4.04	3.56	0.49	0.4
		-1.43	-1.77	-2.01	-1.89	-0.69	-0.63
3	Karlapalem	1.9	2.96	4.12	3.64	0.41	0.9
		-1.38	-1.72	-2.03	-1.91	-0.64	-0.95
4	Cherukupalli	2.06	3.56	2.96	3.44	0.43	0.56
		-1.44	-1.89	-1.72	-1.85	-0.65	-0.71
5	Amarthaluru	2.56	3.24	3.16	3.7	0.54	0.42
		-1.6	-1.8	-1.78	-1.92	-0.73	-0.65
6	Pittalavanipalem	2.18	3.52	3.7	3.86	0.38	0.46
		-1.48	-1.88	-1.92	-1.96	-0.62	-0.68
7	Nagaram	1.84	2.9	3.3	3.78	0.3	0.38
		-1.36	-1.7	-1.82	-1.94	-0.55	-0.62
8	Kakumanu	2.76	2.92	3.66	4.02	0.58	0.62
		-1.66	-1.71	-1.91	-2	-0.76	-0.79
9	Vatticherukuru	2.46	3.46	3.42	4.24	0.32	0.48
		-1.57	-1.86	-1.85	-2.06	-0.57	-0.68
10	Pedanandipadu	1.96	3.1	3.5	3.98	0.62	0.78
		-1.4	-1.76	-1.87	-1.99	-0.79	-0.88
Mean		**2.23**	**3.14**	**3.45**	**3.75**	**0.45**	**0.51**
		-1.49	**-1.77**	**-1.85**	**(1.93**	**-0.65**	**0.72**
t cal		****6.44**		****1.86**		***1.70**	
P-value		**<0.01**		**0.03**		**0.05**	

Values in the parenthesis are sqrt transformed values. **Significant at 1% level of significance * Significant at 5% level of significance

Table 3. Survey conducted on infestation of leaf folder in rice crop in Guntur district during *kharif* 2019

S. No.	Name of the mandal	No. of larvae per hill					
		Active tillering stage		Panicle Initiation stage		Harvesting stage	
		Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice
1.	Bapatla	0.53 (0.73)	0.63 (0.77)	0.65 (0.81)	0.72 (0.85)	0.29 (0.54)	0.21 (0.46)
2.	Ponnur	0.65 (0.81)	0.45 (0.67)	0.83 (0.91)	0.41 (0.64)	0.25 (0.50)	0.12 (0.35)
3.	Karlapalem	0.98 (0.97)	0.35 (0.59)	0.42 (0.65)	0.30 (0.55)	0.19 (0.44)	0.15 (0.39)
4.	Cherukupalli	1.27 (1.11)	0.85 (0.92)	1.31 (1.14)	0.92 (0.96)	0.24 (0.49)	0.18 (0.42)
5.	Amarthaluru	0.72 (0.85)	0.61 (0.78)	0.85 (0.92)	0.60 (0.78)	0.14 (0.42)	0.09 (0.31)
6.	Pittalavanipalem	1.10 (1.05)	0.83 (0.91)	0.92 (0.96)	0.49 (0.70)	0.26 (0.51)	0.22 (0.47)
7.	Nagaram	0.95 (0.97)	0.43 (0.66)	1.21 (1.10)	0.63 (0.79)	0.28 (0.53)	0.14 (0.37)
8.	Kakumanu	1.22 (1.10)	0.71 (0.84)	0.95 (0.97)	0.69 (0.84)	0.18 (0.42)	0.24 (0.49)
9.	Vatticherukuru	0.77 (0.88)	0.41 (0.64)	0.99 (0.99)	0.79 (0.89)	0.20 (0.45)	0.06 (0.28)
10.	Pedanandipadu	0.96 (0.97)	0.89 (0.93)	1.29 (1.14)	1.03 (1.01)	0.23 (0.48)	0.19 (0.44)
Mean		**0.90 (0.94)**	**0.60 (0.77)**	**1.02 (1.01)**	**0.71 (0.84)**	**0.21 (0.47)**	**0.14 (0.35)**
t cal		****3.01**		****2.36**		****3.16**	
P-value		**<0.01**		**0.01**		**<0.01**	

Values in the parenthesis are sqrt transformed values. **Significant at 1% level of significance * Significant at 5% level of significance

Table 4. Per cent leaf damage by leaf folder in rice crop in rice crop Guntur district during *kharif* 2019

S. No.	Name of the mandal	Per cent of leaf damage					
		Active tillering stage		Panicle Initiation stage		Harvesting stage	
		Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice
1.	Bapatla	5.00 (12.65)	2.52 (8.98)	1.96 (7.92)	1.44 (6.79)	1.38 (6.65)	0.78 (5.00)
2.	Ponnur	3.98 (11.29)	1.98 (7.96)	2.60 (9.17)	1.5 (6.93)	1.96 (7.92)	1.16 (6.09)
3.	Karlapalem	4.62 (12.16)	1.84 (7.67)	2.58 (9.09)	1.22 (6.25)	2.58 (9.09)	1.82 (7.63)
4.	Cherukupalli	5.54 (13.32)	3.72 (10.91)	3.02 (9.83)	2.44 (8.84)	1.72 (7.42)	0.66 (4.60)
5.	Amarthaluru	3.34 (10.34)	2.90 (9.63)	1.70 (7.38)	1.91 (7.80)	2.60 (9.12)	0.92 (5.43)
6.	Pittalavanipalem	4.22 (11.62)	2.72 (9.33)	1.84 (7.67)	1.38 (6.65)	2.42 (8.80)	1.9 (7.80)
7.	Nagaram	4.12 (11.58)	2.44 (8.84)	2.64 (9.19)	1.86 (7.72)	1.92 (7.84)	1.32 (6.50)
8.	Kakumanu	4.28 (11.64)	3.30 (10.28)	2.66 (9.23)	1.30 (6.45)	2.64 (9.19)	0.9 (5.37)
9.	Vatticherukuru	3.38 (10.40)	2.78 (9.43)	2.46 (8.87)	2.04 (8.08)	1.30 (6.45)	1.04 (5.77)
10.	Pedanandipadu	5.44 (13.20)	3.84 (11.09)	2.88 (9.60)	1.32 (6.45)	1.10 (5.93)	0.94 (5.48)
Mean		**4.37 (11.78)**	**2.80 (9.41)**	**2.43 (8.79)**	**1.63 (7.19)**	**1.96 (7.84)**	**1.14 (5.96)**
t cal		****4.88**		****4.21**		****3.68**	
P-value		**<0.01**		**<0.01**		**<0.01**	

Values in the parenthesis are arc transformed values. **Significant at 1% level of significance * Significant at 5% level of significance

Table 5. Survey conducted on mirid bug population in rice crop in Guntur district during *kharif* 2019

S. No.	Name of the mandal	No. of mirid bugs per hill					
		Active tillering stage		Panicle Initiation stage		Harvesting stage	
		Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice
1.	Bapatla	3.82 (1.95)	4.24 (2.06)	0.90 (0.95)	1.70 (1.30)	1.00 (1.00)	0.90 (0.95)
2.	Ponnur	1.84 (1.36)	3.82 (1.95)	1.15 (1.05)	1.53 (1.22)	0.52 (0.72)	1.00 (1.00)
3.	Karlapalem	5.42 (1.82)	6.04 (1.89)	0.84 (0.92)	2.03 (1.43)	0.95 (0.97)	1.20 (1.08)
4.	Cherukupalli	3.32 (1.31)	3.56 (1.56)	0.76 (0.87)	2.10 (1.45)	0.55 (0.69)	1.04 (1.02)
5.	Amarthaluru	3.54 (1.88)	3.93 (1.97)	1.32 (1.14)	1.91 (1.38)	0.82 (0.91)	1.22 (1.10)
6.	Pittalavanipalem	3.91 (1.97)	4.64 (2.15)	1.76 (1.33)	2.09 (1.45)	0.64 (0.80)	1.08 (1.04)
7.	Nagaram	2.52 (1.59)	3.24 (1.80)	1.12 (1.06)	1.86 (1.36)	0.44 (0.66)	0.58 (0.76)
8.	Kakumanu	3.10 (1.76)	4.42 (2.10)	1.53 (1.22)	2.66 (1.63)	1.04 (1.02)	1.12 (1.06)
9.	Vatticherukuru	2.64 (1.62)	3.84 (1.96)	1.46 (1.21)	2.04 (1.43)	0.76 (0.87)	0.84 (0.92)
10.	Pedanandipadu	2.54 (1.60)	3.12 (1.76)	1.26 (1.12)	2.24 (1.50)	0.96 (0.98)	1.02 (1.01)
Mean		**2.18 (1.66)**	**3.6 (1.91)**	**1.20 (1.08)**	**1.92 (1.37)**	**0.67 (0.80)**	**0.88 (0.93)**
t cal		****2.35**		****4.5**		***1.7**	
P-value		**0.01**		**<0.01**		**0.05**	

Values in the parenthesis are sqrt transformed values. **Significant at 1% level of significance * Significant at 5% level of significance

Table 6. Survey conducted on spider population in rice crop Guntur district during *kharif* 2019

S. No.	Name of the mandal	No. of spiders per hill					
		Active tillering stage		Panicle initiation stage		Harvesting stage	
		Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice
1.	Bapatla	0.32 (0.57)	0.36 (0.60)	0.91 (0.95)	0.96 (0.98)	1.26 1.12	1.66 (1.29)
2.	Ponnur	0.48 (0.69)	0.52 (0.72)	1.13 (1.05)	0.90 (0.95)	1.44 (1.20	1.5 (1.22)
3.	Karlapalem	0.36 (0.60)	0.64 (0.80)	0.49 (0.68)	0.70 (0.84)	1.30 (1.14)	1.1 (1.05)
4.	Cherukupalli	0.54 (0.73)	0.56 (0.75)	0.78 (0.88)	0.84 (0.92)	0.66 (0.81)	0.84 (0.92)
5.	Amarthaluru	0.58 (0.76)	0.72 (0.85)	1.06 (1.03)	1.02 (1.01)	0.92 (0.96)	0.80 (0.89)
6.	Pittalavanipalem	0.64 (0.80)	0.59 (0.76)	0.44 (0.66)	0.88 (0.94)	0.88 (0.92)	1.70 (1.30)
7.	Nagaram	0.52 (0.72)	0.84 (0.92)	1.12 (1.06)	1.32 (1.15)	0.82 (0.95)	1.38 (1.17)
8.	Kakumanu	0.24 (0.49)	0.76 (0.87)	0.62 (0.72)	0.72 (0.85)	0.70 (0.84)	1.04 (1.02)
9.	Vatticherukuru	0.56 (0.75)	0.48 (0.69)	0.96 (0.98)	1.04 (1.02)	0.98 (0.96)	1.36 (1.37)
10.	Pedanandipadu	0.82 (0.91)	0.86 (0.93)	0.52 (0.68)	0.93 (0.95)	1.50 (1.22)	1.62 (1.27)
Mean		**0.50 (0.70)**	**0.63 (0.78)**	**0.78 (0.86)**	**0.92 (0.95)**	**1.12 (0.89)**	**1.30 (1.16)**
t cal		***1.68**		***1.47**		****3.2**	
P-value		**0.05**		**0.04**		**<0.01**	

Values in the parenthesis are sqrt transformed values. **Significant at 1% level of significance * Significant at 5% level of significance

Table 7. Survey conducted on coccinellid Population in rice crop in Guntur district during *kharif* 2019

S. No.	Name of the mandal	No. of coccinellids per hill					
		Active tillering stage		Panicle initiation stage		Harvesting stage	
		Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice	Direct seeded rice	Transplanted rice
1.	Bapatla	0.26 (0.51)	0.50 (0.69)	0.54 (0.73)	0.82 (0.91)	0.96 (0.98)	1.02 (1.01)
2.	Ponnur	0.22 (0.47)	0.68 (0.72)	0.66 (0.81)	0.74 (0.86)	1.12 (1.06)	1.21 (1.10)
3.	Karlapalem	0.28 (0.53)	0.58 (0.71)	0.51 (0.71)	0.79 (0.89)	0.84 (0.92)	0.96 (0.98)
4.	Cherukupalli	0.46 0.68)	0.42 (0.64)	0.71 (0.87)	0.87 (0.91)	0.86 (0.93)	1.04 (1.02)
5.	Amarthaluru	0.56 (0.75)	0.94 (0.97)	0.78 (0.88)	0.93 (0.92)	0.80 (0.88)	0.84 (0.92)
6.	Pittalavanipalem	0.40 (0.60)	0.46 (0.66)	1.02 (1.01)	1.11 (1.05)	0.94 (0.97)	0.98 (0.99)
7.	Nagaram	0.32 (0.57)	0.38 (0.62)	0.60 (0.78)	0.64 (0.80)	1.20 (1.12)	1.32 (1.15)
8.	Kakumanu	0.38 (0.62)	0.34 (0.58)	0.52 (0.72)	0.58 (0.76)	0.72 (0.85)	1.16 (1.08)
9.	Vatticherukuru	0.50 (0.71)	0.75 (0.87)	0.64 (0.80)	0.72 (0.85)	0.76 (0.87)	0.92 (0.96)
10.	Pedanandipadu	0.30 (0.60)	0.78 (0.88)	0.85 (0.92)	0.98 (0.96)	1.04 (1.02)	1.10 (1.04)
Mean		**0.37 (0.60)**	**0.54 (0.72)**	**0.67 (0.81)**	**0.79 (0.88)**	**0.95 (0.97)**	**1.14 (1.06)**
t cal		****2.44**		***1.82**		***1.77**	
P-value		**0.01**		**0.04**		**0.03**	

Values in the parenthesis are sqrt transformed values. **Significant at 1% level of significance * Significant at 5% level of significance

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