Research Article

VARIETAL SCREENING OF RICE AGAINST LEAF FOLDER (*Cnaplocrosis medinalis* Guenee), CASEWORM (*Nymphula depunctalis* Guenee*)* AND GRASSHOPPER (*Hieroglyphus banian* Fabricius) DAMAGE UNDER FIELD CONDITION IN CHITWAN, NEPAL

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ABSTRACT

The study on varietal screening of rice against major insect pests' damage was conducted during 2015 in Rampur, Chitwan to know about the resistance of different varieties of rice under field condition. The experiment was done using a RCBD with three replications and seven varieties of rice (i. Makawanpur-1 ii. Mansuli iii. Radha-4 iv. Ramdhan v. Sabitri vi. Sama Mansuli sub-1 and vii. Sukkha-3) as treatments. The findings revealed that the lowest population of Leaf folder, Caseworm and Grasshopper was recorded in Radha-4 variety followed by Ramdhan. Sabitri variety even had higher preference of insect pest but yield loss was minimum. The findings also showed that the yield loss was significantly lower in Radha-4 followed by Sabitri and Ramdhan. Therefore, Radha-4, Ramdhan and Sabitri would be good option in rice production for reducing insect pest damage.

Keywords: Insect population, screening, yield loss

INTRODUCTION

Rice is the major cereal crop of Nepal, which occupies 1.48 million ha out of 3.48 million ha total cereal cultivated area of the country with production of 5.04 million tons and 3.39 mt/ha productivity (AICC, 2015). Rice hold a vital role in national economy, as the share of rice in AGDP is 17.21% (CBS, 2013/14) and provides 50% of the total calorie requirement of Nepalese people (Basnet, 2008). Rice is indigenous to humid area of tropical and sub-tropical region. It is grown from the Terai 60 m to high mountains 3050 m altitude of Nepal (Mallick, 1981/82). Erratic rainfall, lack of irrigation, unavailability of quality seed, lack of fertilizer and incidence of insect pest are the causes of yield loss in Nepal. The rice crop is subjected to the persistent pressure of more than 100 different insect species (Khan & Pathak, 1987) and 20 of them are of major economic significance (Pathak & Khan, 1994). Among them, Stem borers, White backed plant hopper, Leaf folder and Grasshoppers are the pests of economic importance (Salim, 2002). Pathak & Khan (1994) also reported that average yield loss due to various insects pest was estimated to be 31.5% in Asia (excluding mainland China).

Ramzan et al. (1992) reported Leaf folder as one of the major rice pests. Rice Leaf folders are commonly found in most rice fields. Several species of rice Leaf folders are defoliators. Leaf folder larva fold the leaves with the help of silk strands where the larval and pupal stage survive. The silk contracts upon drying, roll the entire leaf blade into a tube (Shepherd et al., 1995). It was

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found that the Leaf folder incidence increased with increase in nitrogen application (Ramzan et al., 2007). Caseworm (*Nymphula depunctalis* Guenee) is a sporadic pest of rice and found in water stagnant condition. The first sign of caseworm is the characteristic cut leaves; the leaf blades are cut as if it is cut by scissors. Cut leaf sections are used by the larvae to make their protective tubular cases. Cut leaf blades naturally roll up into a tube, which the larvae attach with silk (Shepherd et al., 1995). Grasshopper (*Hieroglyphus banian* Fab.*)* is also important insect pest of rice which occurs in almost type of habitat including the tropics, temperate grassland, rain forest, desert and mountains. Both nymphs and adults feed on leaf tissue, consuming large sections from the edges of leaf blades (Shepherd et al., 1995). They make angular holes in the leaves causing an injury similar to that caused by army worm.

MATERIALS AND METHODS

The study was conducted at Agronomy Farm, Agriculture and Forestry University, Rampur from June 2015 to November 2015 at lowland condition, which is located at 27^0 37' N latitude and 84^0 25' E longitudes with an elevation of 198 m above mean sea level. The meteorological data for the cropping season were obtained from the NMRP, Rampur Chitwan.

Dry raised nursery bed was prepared by ploughing the area of $8m^2$. In both nursery bed preparation and main field preparation, chemical fertilizer @ 100:50:50 Kg NPK/ha and FYM @12.5ton/ha was applied. 100 gm seed for each variety was sown in nursery bed in 22 June 2015 by line sowing. Seedlings of 30 days were transplanted in main field, in which half dose of nitrogen with full dose of Phosphorous and Potash was applied at the time of field preparation and remaining half dose of nitrogen was applied at 15 days after transplanting. The experimental field was laid out in randomized complete block design (RCBD) with seven varieties of rice as treatments (Makawanpur-1, Mansuli, Radha-4, Ramdhan, Sabitri, Sama Mansuli sub-1 and sukkha-3) and three replications. There were altogether 21 plot of size 2.5 x 2.5 m^2 area with crop geometry of 25 cm*25 cm (3-5 tillers per hill). Total size of whole plot was 376.25 m^2 with 100 cm gap between replication and 50 cm gap between treatments. These different varieties were screened against different insect pests in open field condition. Ten hill of rice were randomly selected and tagged for observation of the insect pest damage score from each plot. Damage was recorded on leaves and stem of sample plant. Insect occurrence and its infestation were assessed by using 0-9 scale separately for different insects (Table 1).

Table 1. Damage score rating

(**Score**	**Damage**
0	No Scraping
1	Less than 1 %
3	1-10%
5	11-25%
7	26-50%
9	51-100%

(Standard Evaluation System for Rice, IRRI, 2002)

Data of different insect damage were recorded at 15 days interval. Grain from 1 m^2 was harvested using quadrant in each plot and the harvested grains were weighed separately for each treatment. Yield loss percentage was calculated using potential yield and obtained yield as formula below.

$$\text{Yield loss (\%)} = \frac{\text{Potential yield- Obtained yield}}{\text{Potential yield}} \times 100$$

Microsoft excel was used for tabulation of data and for simple calculation. The collected data were statistically analyzed using R-Studio software package. Means of separation was done by DMRT at 5% level of significance (Gomez & Gomez, 1984).

RESULTS AND DISCUSSION

Field study showed significant difference on Leaf folder and Caseworm damage at 30 DAT, 45 DAT, 60 DAT and 75 DAT. At 30 DAT, Leaf folder and Caseworm damage was highly significant in Sabitri variety ($1.72^{a}\pm 0.20$) followed by Sama Mansuli sub-1 ($1.33^{b}\pm 0.14$) and Ramdhan ($1.1833^{bc}\pm 0.10$). Leaf folder and Caseworm damage was the lowest in Radha-4 ($0.750^{d}\pm 0.05$) which was at par with Makwanpur-1 ($0.90^{d}\pm 0.1$) and Mansuli ($0.78^{d}\pm 0.10$) followed by Sukkha-3 ($0.95^{cd}\pm 0.26$) respectively (Table 2).

At 45 DAT, Leaf folder and Caseworm damage was the highest in Sabitri variety (3.83^{a} ± 0.05) which was at par with Sama Mansuli sub-1 ($3.37^{a}\pm 0.35$) followed by Ramdhan ($2.50^{b}\pm 0.26$), Sukkah-3 ($2.40^{b}\pm 0.40$), Makwanpur-1 ($2.33^{b}\pm 0.35$) and Radha-4 ($2.20^{b}\pm 0.26$). The minimum Leaf folder and Caseworm damage was observed in Mansuli variety ($1.17^{c}\pm 0.30$) (Table 2). At tillering stage of rice maximum damage of Leaf folder and Case worm was observed among all varieties of rice. Kalita et al. (2015) also reported Leaf folder population maximum at 45 days after transplanting which coincide with tillering stage of rice. Rewa et al. (2013) also reported maximum infestation of Leaf folder and Caseworm at 45 days after transplanting

Table 2. Leaf folder and Caseworm damage score against different rice varieties under field condition in Rampur, Chitwan, 2015

Treatments	Leaf folder & Caseworm damage score/hill				Average Leaf folder and Caseworm damage score
	30 DAT	45 DAT	60 DAT	75 DAT	
Makwanpur-1	$0.90^{d}\pm 0.15$	$2.33^{b}\pm 0.35$	$2.30^{b}\pm 0.26$	$0.73^{b}\pm 0.15$	$1.57^{b}\pm 0.213$
Mansuli	$0.78^{d}\pm 0.10$	$1.17^{c}\pm 0.30$	$1.27^{de}\pm 0.15$	$0.23^{c}\pm 0.32$	$0.86^{c}\pm 0.168$
Radha-4	$0.75^{d}\pm 0.05$	$2.20^{b}\pm 0.26$	$2.23^{b}\pm 0.25$	$0.47^{bc}\pm 0.57$	$1.41^{b}\pm 0.174$
Ramdhan	$1.18^{bc}\pm 0.10$	$2.50^{b}\pm 0.26$	$1.73^{c}\pm 0.21$	$0.60^{bc}\pm 0.17$	$1.51^{b}\pm 0.062$
Sabitri	$1.72^{a}\pm 0.20$	$3.83^{a}\pm 0.05$	$1.67^{cd}\pm 0.25$	$0.50^{bc}\pm 0.20$	$1.92^{a}\pm 0.044$
Sama Mansuli sub-1	$1.33^{b}\pm 0.14$	$3.37^{a}\pm 0.35$	$2.83^{a}\pm 0.21$	$1.20^{a}\pm 0.30$	$2.18^{a}\pm 0.156$
Sukkha-3	$0.95^{cd}\pm 0.26$	$2.40^{b}\pm 0.40$	$0.97^{e}\pm 0.21$	$0.77^{b}\pm 0.25$	$1.27^{b}\pm 0.254$
P value	***	***	***	**	***
LSD	0.26	0.54	0.40	0.41	0.278
CV%	13.86	11.97	12.24	35.95	10.21

DAT: Days After Transplanting, CV: Coefficient of Variation, LSD: Least Significant Difference. Value with the same letter in column is not significantly different at 5% by DMRT and figures after ±indicate standard error, **indicate significant, *** indicate highly significant at 0.001

At 60 DAT, Leaf folder and Caseworm damage was highly significant in Sama Mansuli sub-1 (2.83^{a}±0.21) followed by Makwanpur-1 (2.30^{b}±0.26) and Radha-4 (2.23^{b}±0.25). Similarly, Ramdhan (1.73^{c}±0.21) and Sabitri variety (1.67^{cd}±0.25) had intermediate damage of Leaf folder and Caseworm. The lowest Leaf folder and Caseworm damage was observed in Sukkah-3 (0.97^{e}±0.21) and Mansuli variety of rice (1.27^{de}±0.15) (Figure 1).

At 75 DAT, Leaf folder and Caseworm damage was the highest in Sama Mansuli sub-1 variety (1.20^{a}±0.30) followed by Sukkah-3 (0.77^{b}±0.25) and Makwanpur-1(0.73^{b}±0.15). Similarly, Leaf folder and Caseworm damage was intermediate in Ramdhan (0.60^{bc}±0.17), Sabitri (0.50^{bc}±0.20) and Radha-4 variety (0.47^{bc}±0.57) and the lowest damage was observed in Mansuli variety (0.23^{c}±0.320) of rice (Figure 1).

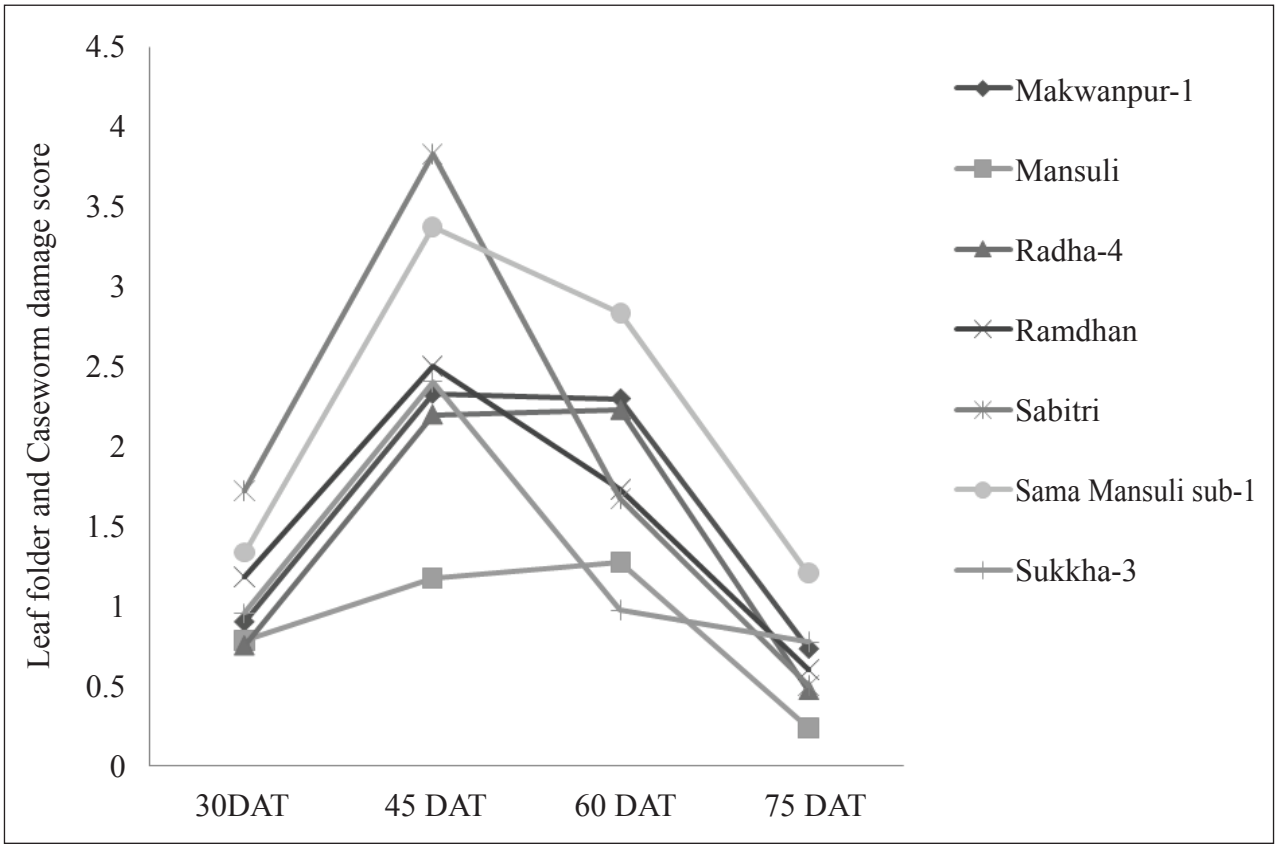

Figure 1. Leaf folder and Caseworm damage score against different varieties of Rice in Rampur, Chitwan, 2015

Leaf folder infestation appeared after four weeks of transplanting and reached to peak during maximum tillering stage while after flowering it again appeared to be low and similar trend was also reported by De Kraker et al. (1999). Leaf folder appeared as major pest in this study. Leaf folder has been noticed as minor pest for a long time but became serious pest after the introduction of high yielding varieties of rice in Nepal (Rehman et al., 2003). In this study maximum Leaf folder and

Caseworm damage was observed in 45 days after transplanting. Singh & Singh (2014) reported that Caseworm preferred rice at seedling and tillering stages then its damage reduced after tillering stage. Adhikari (2016) also reported Caseworm population maximum at early stage of growth.

On average, Leaf folder and Caseworm damage was the highest in Sama Mansuli sub-1 ($2.183^{a}\pm0.156$) and Sabitri ($1.929^{a}\pm0.044$) variety followed by Makawanpur-1 ($1.5667^{b}\pm0.213$), Ramdhan ($1.504^{b}\pm0.062$), Radha-4 ($1.412^{b}\pm0.174$) and Sukkha-3 variety ($1.270^{b}\pm0.254$). Leaf folder and Caseworm damage was the lowest in Mansuli variety ($0.863^{c}\pm0.168$) of rice (Table 2).

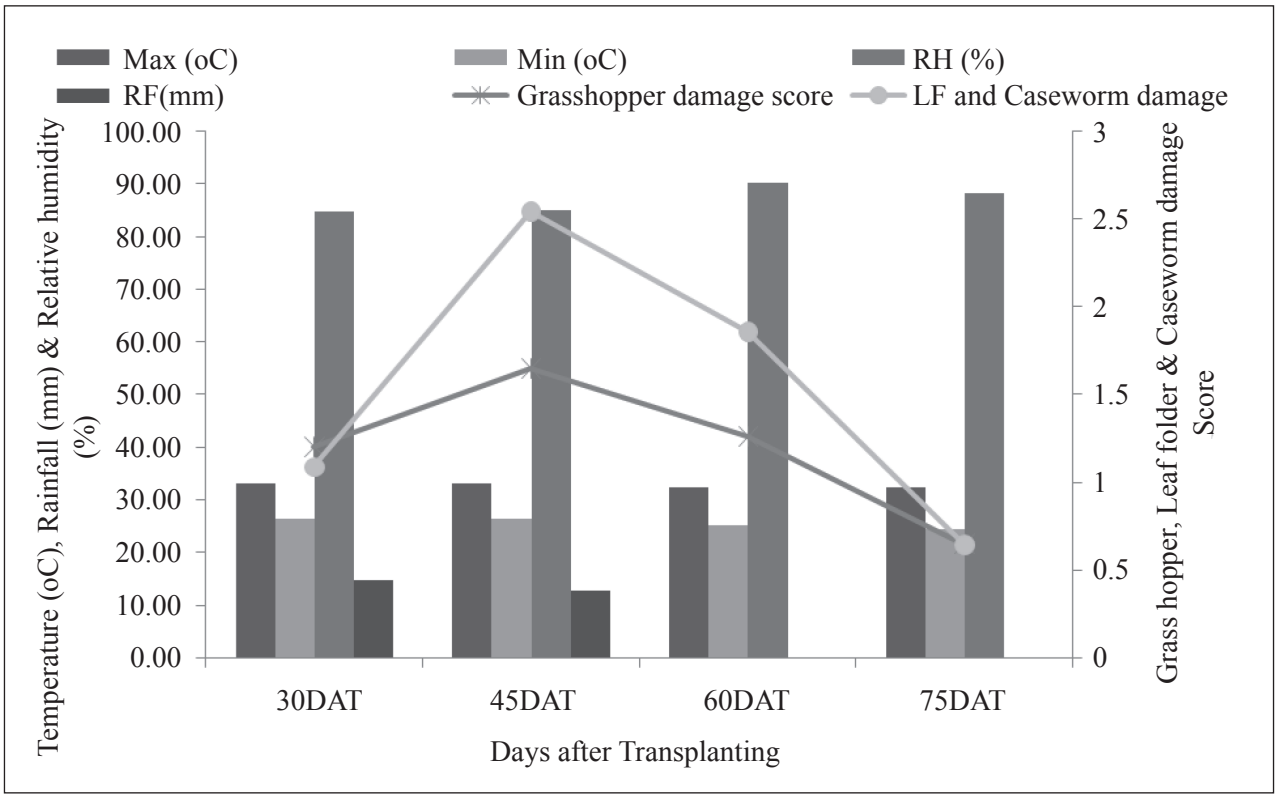

Figure 2. Relationship between weather paratmeter and average insect pests damage score at different days after transplanting in Rampur, Chitwan, 2015

The study showed significant difference on Grasshopper damage at 30 DAT, 45 DAT, 60 DAT and 75 DAT in different varieties of rice. At 30 DAT, Grasshopper damage was the highest in Sabitri variety ($2.233^{a}\pm0.152$) followed by Radha-4 ($1.433^{b}\pm0.115$) and Makwanpur-1 ($1.266^{bc}\pm0.115$). The lowest leaf damage was observed in Sama Mansuli sub-1 ($0.300^{e}\pm0.100$) followed Mansuli ($1.033^{d}\pm0.115$), Ramdhan ($1.066^{cd}\pm0.057$) and Sukkha-3 ($1.100^{cd}\pm0.100$) variety of rice (Table 3).

Table 3. Grasshopper damage score and Stem borer damage in different varieties of rice under field condition in Rampur, Chitwan, 2015

Treatments	Grasshopper damage score/hill				Average Grasshopper damage	Total number white head/ 10 hills
	30 DAT	45 DAT	60 DAT	75 DAT		
Makawanpur-1	1.26^{bc}±0.11	1.43^{b}±0.15	2.06^{a}±0.25	1.20^{a}±0.17	1.49^{a}±0.09	0.67±0.67 (1.00^{b})
Mansuli	1.03^{d}±0.11	1.33^{b}±0.15	0.86^{cd}±0.16	0.63^{b}±0.15	0.96^{c}±0.28	1.00±0.58 (1.17^{b})
Radha- 4	1.43^{b}±0.11	0.90^{c}±0.20	0.73^{d}± 0.15	0.56^{b} ±0.15	0.90^{c}±0.08	14.33±3.38 (3.80^{a})
Ramdhan	1.06^{cd}±0.05	2.46^{a}±0.21	1.66^{ab}±0.46	0.53^{b}±0.15	1.43^{a}±0.15	3.33±1.45 (1.88^{b})
Sabitri	2.23^{a}±0.15	2.23^{a}±0.16	0.80^{d}±0.10	0.56^{b}± 0.25	1.46^{a}±0.08	2.33±1.20 (1.57^{b})
Sama mansuli	0.30^{e}±0.10	1.50^{b}±0.26	1.46^{b}±0.21	0.46^{b}±0.15	0.93^{c}±0.08	3.00±2.08 (1.68^{b})
Sukkha-3	1.10^{cd}±0.10	1.70^{b}±0.17	1.26^{bc}± 0.31	0.60^{b}± 0.35	1.16^{b}±0.04	12.00±2.08 (3.51^{a})
P value	***	***	***	*	***	***
LSD	0.197	0.361	0.433	0.377	0.158	4.93(0.96)
CV%	9.17	12.28	19.20	32.54	7.44	52.94(25.74)

DAT: Days after Transplanting, CV: Coefficient of Variation, LSD: Least Significant Difference. Value with the same letter in column is not significantly different at 5% by DMRT and figures after ±indicate standard error, **indicate significant, *** indicate highly significant at 0.05, value in parenthesis are square root transformation (sqrt(x+0.5)).

At 45 DAT, Grasshopper damage was the highest in Ramdhan (2.466^{a}±0.208) which was at par with Sabitri (2.233^{a}±0.157). Sukkha-3 (91.700^{b}±0.173), Sama mansuli (1.500^{b}±0.264), Makwanpur-1 (1.433^{b}±0.153) and Mansuli (1.333^{b}±0.153) variety had intermediate damage caused by Grasshopper, whereas the lowest damage was observed in Radha-4 (0.900^{c}±0.200) variety of rice (Table 3).

At 60 DAT, Grasshopper damage was the highest in Makwanpur-1 (2.067 ^{a}±0.252) and Ramdhan (1.667^{ab}±0.462). Sama Mansuli sub-1(1.467^{b}±0.208) and Sukkha-3 variety (1.267^{bc}± 0.306) had intermediate damage. Radha-4 (0.73^{d} ±0.462) and Sabitri (0.800 ^{d}±0.100) variety had the lowest leaf damage caused by Grasshopper followed by Mansuli (0.867^{cd} ±0.156) (Table 3).

At 75 DAT, Grasshopper damage was the highest in Makwanpur-1(1.200 ^{a}±0.173), whereas Sama Mansuli (1.200 ^{a}±0.173), Ramdhan (0.533 ^{b}±0.153), Radha-4 (0.566 ^{b} ±0.153), Sabitri, Sukkha-3 (0.600 ^{b}± 0.346) and Mansuli (0.633 ^{b} ±0.153) had the lowest leaf damage caused by Grasshopper (Table 3). The result showed that the Grasshopper damage increased with increase in maximum-minimum temperature and rainfall intensity however relative humidity had insignificant relationship with Grasshopper damage (Figure 3). Lanjar et al. (2002) and Adhikari (2016) reported that the higher mean temperature was favorable for maximum population of Grasshopper.

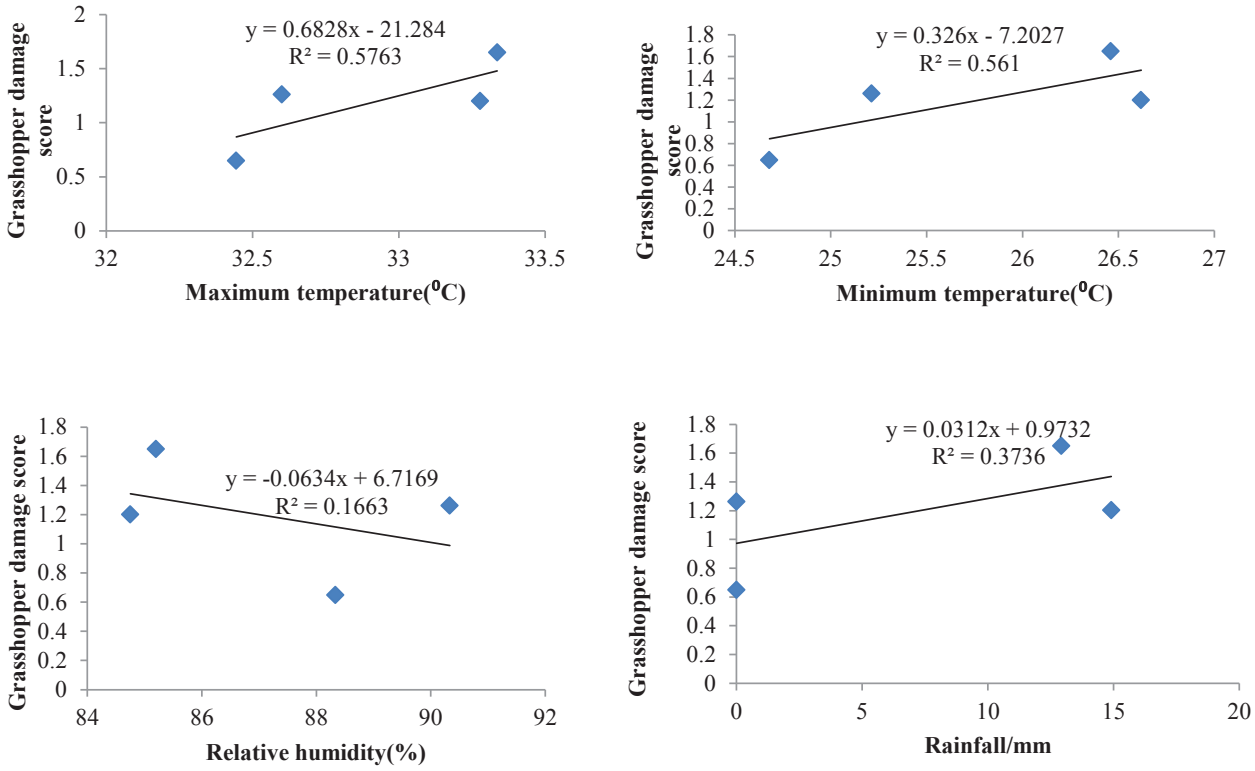

Figure 3. Relationship between average Grasshopper damage score and weather parameter in Rampur, Chitwan, 2015.

The study showed that total white head/10 hill before harvest was the highest in Radha-4 (14.33) and sukkha-3 variety (12.00). Total number of white head was minimum in Makawanpur-1 (0.66), Mansuli (1.00), Sabitri (2.33), Sama mansuli Sub-1 (3.00) and Ramdhan (3.33). The Stem borer damage reduced Sukkha-3 variety yield drastically (Table 3). Rao and Israel (2004) considered Stem borers as a major pest of rice. The Stem borers' presence regularly throughout the rice growing season and attacked plants from seedling to maturity stage (Adhikari, 2016; Ragini et al., 2005).

Table 4. Average yield and yield loss of different varieties of rice under field condition in Rampur, Chitwan, 2015

Varieties	Average yield (mt/ha)	Potential yield (mt/ha)	Yield loss (%)
Makawanpur-1	3.633	4.8	24.312
Mansuli	2.760	3.5	21.143
Radha-4	3.170	3.2	0.937
Ramdhan	4.703	4.9	4.020
Sabitri	3.925	4.0	1.875
Sama mansuli sub-1	2.867	4.5	36.289
Sukkha-3	2.750	3.7	25.676

Source of potential yield: Adhikary & Adhikari (2014)

Yield loss was maximum in variety Sama Mansuli sub-1 (36.289%) followed by Sukkha-3 (25.676%), Makawanpur-1 (24.312%) and Mansuli (21.143%). Comparatively minimum yield loss was recorded in Radha-4 (0.937%), Sabitri (1.887) and Ramdhan (4.020%) variety of rice (Figure 4).

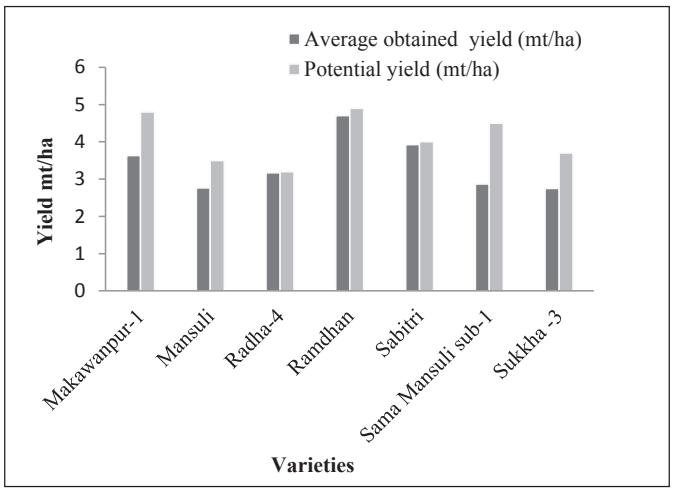

Figure 5. Comparison between obtained yields and potential yield of different rice varieties due insect pests damage under field condition in Rampur, Chitwan, 2015.

CONCLUSIONS

The experiment revealed higher insect preference but minimum yield loss in Sabitri variety so it was concluded to be comparatively tolerant variety. Similarly, Radha-4 and Ramdhan varieties considered as comparatively resistant varieties having less insect pests' preference and minimum yield loss. Sama Mansuli sub-1 variety had maximum yield loss which was highly susceptible to insect pest attack followed by Sukkha-3, Makawanpur-1 and Mansuli variety. This study concluded that Radha-4, Ramdhan and Sabitri variety of rice can be recommend for farmers to grow rice in this area because these varieties either have minimum insect preference or even with insects' preference yield loss was minimum.

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REFERENCES

Adhikari, C. (2016). Abundance and diversity of rice insect pests in Chitwan and Lamjung districts of Nepal (Master Thesis). Agriculture and Forestry University, Rampur, Chitwan, Nepal.

Adhikary, B. H., & Adhikari, R. R. (2014). *Released and registered crop varieties in Nepal (1960-2013)*. Kumaltar, Lalitpur: NARC, Communication, Publication and Documentation Division. Retrieved from www.narc.gov.np

AICC. (2015). Agriculture dairy (Nepali). Agriculture Information and Communication Centre, Harihar Bhawan, Lalitpur, Nepal.

Basnet, B. M. S. (2008). Environment friendly technologies for increasing rice productivity. *The Journal of Agriculture and Environment*, 9, 34-40.

CBS. (2013/14). *Share of Agriculture GDP in Nepal.* Central Bureau of Statistics, Thapathali, Kathmandu, Nepal.

De Kraker, J., Van Huis, A., Heong, K. L., Van Lenteren, J. C., & Rabbinge, R. (1999). Population dynamics of rice leaffolders (Lepidoptera: Pyralidae) and their natural enemies in irrigated rice in the Philippines. *Bulletin of entomological research*, *89*(5), 411-421.

Gomez, K. A., & Gomez, A. A. (1984). *Statistical procedures for agricultural research*. John Wiley & Sons.

IRRI. (2002). Standard Evaluation System for Rice.56p

Kalita, H., Avasthe, R. K., & Ramesh, K. (2015). Effect of weather parameters on population buildup of different insect pests of rice and their natural enemies. *Indian Journal of Hill Farming*, *28*(1).

Khan, Z. R., & Pathak, M. D. (1987*). Prospects of host plant resistance in rice against major insect pests and diseases*. In: International Plant Protection: Focus on the Developing World. Vol. I. E. D. Magallona (ed.) Proceedings of the 11th International Congress of Plant Protection, Manila, Philippines. pp. 510-519.

Lanjar, A. G., Muzaffar, A. T., Rab, D. K., & Khalid, H. Q. (2002). Occurrence and abundance of grasshopper species in rice. *Pakistan Journal of Applied Science*, *2*(7), 763-767.

Mallick, R. N. (1981/82). *Rice in Nepal*. Kala Prakashan, Kathmandu, Nepal.

Pathak, M. D., & Khan, Z. R. (1994). *Insect pests of rice*. International Rice Research Institute, UPLB, Philippines.

Ragini, J. C., Thangaraju, D., & David, P. M. M. (2000). Relative abundance of rice stem borer species in Tamil Nadu. *Madras Agricultural Journal*, *87*(4/6), 228-234.

Ramzan, M. S., Hussain, S., & Akhter, M. (2007). PARC Rice Programme Kala Shah Kaku, Rice Research Institute Kala Shah Kaku, *Journal of Animal and Plant Science 17(3-4).*

Ramzan, M., Mann, R. A., & Chatha, M. R. (1992). Leaf folder: The most deleterious pest of rice. Pakistan and Gulf Economist: 15-21

Rao, Y. and Israel, P. (2002). The major insect pests of rice plant. In Proceeding of Symposium. IRRI, Philippines, September. 1964. pp. 317-324.

Rehman, A., Salim, M., & Ramzan, M. (2003). *Integrated management strategies for leaffolder: A major pest of rice in Pakistan*. Booklet Publication. Rice Programme, NARC-PARC, Islamabad, 2003. pp. 8.

Rewa, D., Tripathi, K., & Saxena, A. (2013). Evaluation of local, improved and Hybrid rice varieties. *Interantional Journal of Scientific and Research Publication*, *3*(11), 8–11.

Salim, M. (2002). Final technical DFID project report. Tillage by nutrient interaction in rice-wheat system, NARC, Islamabad. pp.13-25.

Shepard, B. M., Barrion, A. T., & Litsinger, J. A. (1995). Rice-Feeding Insects of Tropical Asia (Manila: International Rice Research Institute). 234p.

Singh, B. B., & Singh, R. (2014). Major rice insect pests in northeastern UP. *International Journal of Life Sciences Biotechnology and Pharma Research 1 (3)*, 124-143.