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Research Article

A survey and assessment of grasshoppers' population in various sugarcane growing areas of Harion municipality in Sarlahi district, Nepal

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ABSTRACT
A small-scale study of grasshopper populations was undertaken in Harion municipality of Sarlahi district to ascertain whether grasshopper population in sugarcane growing areas is changing in consecutive years 2014 and 2015. The regular sugarcane growing areas were randomly selected and the survey was conducted to estimate the population in those consecutive years in 14 different locations where outbreak of *Hieroglyphus banian* (Fabricius) has occurred. The per square meter population was estimated using a 'T' shape which was made by tying 1m long two sticks to estimate one square meter area. The population of two consecutive years was compared to study the relationship between two years populations. The grasshopper infestation by risk category indicated that infestation warranted rating of severe in ward seven, eight and nine for 2015 from the population of 2014 AD. For 2016 AD, the risk was found low as most of the areas was categorized as moderate to light category as the population was found low in 2015 AD. Grasshopper population densities were found higher in some areas of Sarlahi district in the first year as compared to the second year. The population level in the first year was not found to induce population in next year as the population decreased in the second year. The trend of grasshopper population was not so threatening as the population was not found increasing in these years so was risk for next year. This might be due to the management of grasshoppers in nymphal stage in previous year, weather parameters, location, inter-cultural operations, decreasing of the rationing crops or presence of natural enemies. These findings provide guidance for the farmers in relation to grasshopper management and for future survey programs in relation to targeting regions of the district at risk from grasshoppers.
Keywords: Grasshopper, Population trend, Risk category

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INTRODUCTION
Grasshoppers generally feed on grasses and weeds and often move to cultivated crops. Their populations vary from year to year and location to location. Several outbreaks of native grasshoppers *Hieroglyphus banian* (Fabricius) (Orthoptera: Acrididae) have caused sugarcane crop loss in various districts of Nepal (Ansari et al., 2016). Population density of grasshopper fluctuates over an area in response to weather (Gage & Mukerjee, 1977) and presence of

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predators (Belovsky & Slade, 1993). Drought conditions reduce natural vegetation, forcing grasshoppers to move to cultivated crops. The population is increasing in sugarcane growing areas of Nepal due to extensive ratooning of sugarcane without intercultural operations (Ansari et al., 2016). Several species of grasshoppers feed on sugarcane foliage of which the major is native grasshopper *H. banian*. Grasshoppers have been important pest of sugarcane in Nepal. In these few years grasshoppers had been causing damage to the sugarcane grown in central to eastern terai region which have been expanding to western part of Nepal. The severity of grasshopper is increasing year after year. The pest has been damaging crops other than sugarcane like rice, maize, wheat and many more crops. In case of severe infestation in sugarcane grasshoppers have fed upon all the leaves leaving only the mid ribs. The havoc of this pest has increased due to indiscriminate use of insecticides. Over use of chemical insecticides against grasshoppers has negative impact on the environment (Lomer et al., 2001). So the forecasting of grasshopper out-breaks and demarcating of potential outbreak areas is of need (Rubtzov, 1935; Capinera & Horton, 1989).The main aim of this study was to find a relation between the grasshopper populations in consecutive years and identify risk categories. Moreover, the investigations do also provide an avenue for the forecasting of grasshopper out-breaks and demarcating of potential outbreak areas preparing risk maps. Providing warnings of general level of populations and likelihood of damage of crop makes farmers easier for them to make pest control decisions primarily based on previous year population.

METHODOLOGY

The estimation of population of grasshoppers was done via survey. It was conducted in 2014 and 2015 AD to estimate the grasshopper population in vegetative stages of sugarcane. This survey was conducted in 14 different sugarcane growing areas (n=14) of Harion Municipality of Sarlahi district where outbreak of native grasshopper *Hieroglyphus banian* (Fabricius) has occurred (Figure 1). In each location the data were taken from 10 different areas in 'Z' shape which was later averaged to estimate grasshopper population per sq. m of area in June when the crop was on growing stage. The sampling was done on the sugarcane field with the help of 1m long stick tied with 1m length another stick to make a 'T' shape. The numbers of grasshoppers resting and jumping in the field were recorded moving the T shape across the field to estimate 1 sq. m area in morning hours. On the basis of the population of the year the previous year population was again confirmed after asking with farmers. In the first year of the survey the Global Positioning System (GPS) coordinate was recorded which was traced in the second year survey. The two years grasshopper population (n=14), ward wise grasshopper population were compared using t-test. The areas were categorized as severe (> 12 adults/ m^2), moderate (8-12 adults/ m^2), light (4-8 adults/ m^2), very light (2-4 adults/ m^2) and none to very light (< 0- 2 adults/ m^2) risk for next year as given by Riegert 1968.

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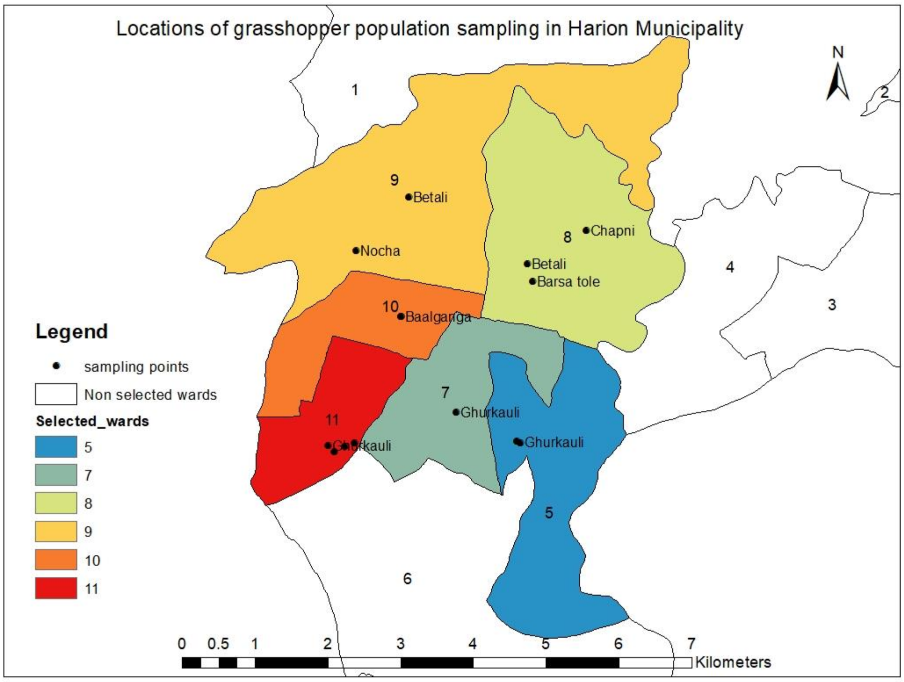

Figure 1: Locations of grasshopper population sampled in 2014 and 2015 at Harion Municipality of Sarlahi district

RESULTS AND DISCUSSION

The out break of *Hieroglyphus banian* (Fabricius) has occurred in the year 2014 and 2015 AD. The species was the dominating one while *Oxya chinensis* (Thunberg, 1815) was found in few numbers. The population of two consecutive years was compared to study the relationship between two year populations and risk category. The population of grasshopper was not significantly different ($t = 1.75$, $df = 28$, $P = 0.090$) in two consecutive year 2014 and 2015 (Figure 2). The population was higher in ward-11 in 2015 than that of 2014 ($t= 4.12$, $df = 3$, P 0.015) however the population in ward-07 significantly decreased in 2015 in comparison to 2014 ($t = 2.73$, $df = 7$, $P = 0.018$) (Figure 3). The population of grasshopper was not found significantly different in 2014 and 2015 in ward-08 ($t = 2.10$, $df = 3$, $P = 0.103$) (Figure 3). The risk has also been increased in 2015 as the risk increased from severe to moderate which was estimated to be light for the year (Table 1). The risk has also been increased in 2015 as the risk increased from severe to moderate (Table 1). This might be due to microclimatic variation (i.e. warm, dry season) which is favorable for population built-up due to increase in fecundity and population's survival rate. Rainfall also might be the cause which favors the population built up as it influences the growth of fresh food-plants and the stimulated development of the eggs due to rise in humidity. This is why there is complex relations to explain sensitiveness of grasshoppers to climate and seasonal changes in weather (Dempster, 1963; Uvarov, 1977; Joern & Gaines, 1990). While in ward-07 and 08 the population of grasshopper was found to be decreasing from 2014 to 2015 AD. The risk was also low for the next year. This might be due to the management of grasshopper population in the previous year and cultivation of the plant cane replacing ratoon crop. The grasshopper infestation by risk category indicated that infestation warranted rating of severe in ward seven, eight and nine for 2015 AD from the population of 2014 AD. For 2016 AD the risk was found low as most of the areas was categorized as moderate to light category as the population was found low in 2015 AD (Table 1).

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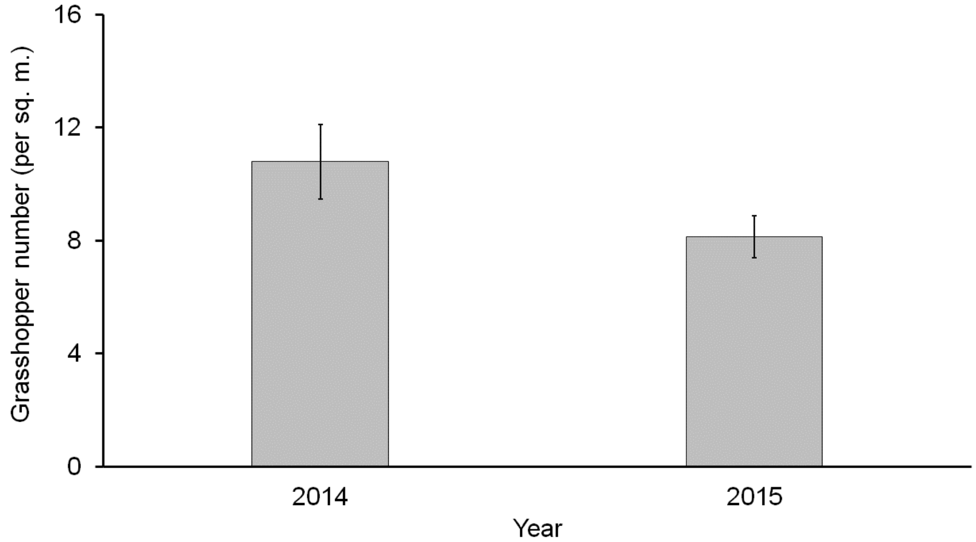

Figure 2: Estimated average number of grasshopper number sampled from 15 location of Hariwon Municipality of Sarlahi district in 2014 and 2015. The population was not significantly different in two consecutive year (p =0.5).

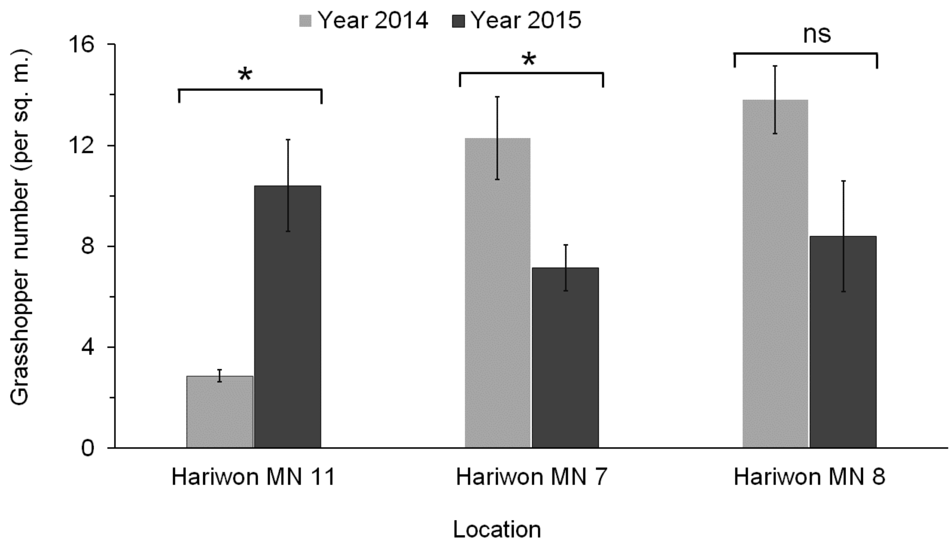

Figure 3: Grasshopper population in each ward of Hariwon Municipality in consecutive years 2014 and 2015.

Factors influencing grasshopper population dynamics in various regions of Nepal are still not well understood. There is the fact that biotic influences like density-dependent processes due to food limitation and drastic population reductions by predator causes fluctuations in population (Belovsky & Slade, 1995). However, Richards and Waloff (1954) stated that these can be neglected also. Climate in general will affect ecologically similar species in similar ways with several exceptions also. Kohler et al. (1999) found no significant correlations between annual precipitation-temperature indices and population density of the three species of grasshoppers. In

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this study also the population of the grasshopper in consecutive years was not found to be only related to weather parameters as the population was not to follow same pattern.

Table 1: The estimated grasshopper population and their risk category in various sugarcane growing locations of Harion Municipality of Sarlahi district (2014-2016)

Location	GPS Coordinate of the location (Longitude, Latitude)	Estimated average population per m^2 in 2014 AD	Maximum Risk Rating for 2015 AD	Estimated average population per m^2 in 2015 AD	Maximum Risk Rating for 2016 AD
Harion MN-11, Barsa tole	357443.16'E 2997335.69'N	3.2	Light	14	Severe
Harion MN-11, Baalganga	355610.59'E 2996935.63'N	3	Light	8.2	Moderate
Harion MN-11, Baalganga	355610.99'E 2996936.18'N	2.4	Light	9	Moderate
Harion MN-07, Baalganga	354757.96'E 2995193.17'N	3	Light	8.6	Moderate
Harion MN-07, Ghurkauli	354897.01'E 2995234.87'N	12.6	Severe	5.8	Light
Harion MN-07, Ghurkauli	354605.41'E 2995133.23'N	15.8	Severe	7.8	Light
Harion MN-07, Ghurkauli	354526.11'E 2995213.37'N	14.8	Severe	4	Light
Harion MN-07, Ghurkauli	356304.50'E 2995584.99'N	12.4	Severe	4.4	Light
Harion MN-07, Ghurkauli	357114.30'E 2995159.43'N	12.2	Severe	10	Moderate
Harion MN-07, Ghurkauli	357165.07'E 2995132.82'N	15.2	Severe	9.4	Moderate
Harion MN-08, Chapni	358205.60'E 2997993.54'N	13	Severe	8.8	Moderate
Harion MN-08, Betali	355803.05'E 2998562.78'N	16.4	Severe	4.4	Light
Harion MN-08, Betali	357378.70'E 2997577.96'N	12	Severe	12	Moderate
Harion MN-09, Nocha	355041.48'E 2997868.61'N	13.6	Severe	5.75	Light

There have been several studies around the world for analyzing densities of grasshoppers as pest species in relation to weather data mainly to predict outbreaks (Edwards, 1960; Gage & Mukerji, 1977; Fielding & Brusven, 1990). The Cropping system with major ratooning crop in sugarcane growing areas are found to cause increase in population of grasshoppers in terai region of Nepal (Ansari et al., 2016). The grasshopper population on 2015 decreased from first year to second due to replacement of ratoon crop with plant cane. The early management of grasshoppers were also found to decrease population of grasshoppers in the consecutive years. Thus, it is recommended that further study is necessary to explore the various other cause of change in population of grasshoppers and damage in various crops.

CONCLUSION

Grasshoppers' population level decreased in 2015 as compared to that of 2014 in survey areas. The population level in the first year was not found to induce population in second year. Further study should be done for the grasshopper severity/risk maps with several year's data to forecast the population of grasshopper in sugarcane field for succeeding year. The forecasting risk of grasshopper could be done via the crop sampling and estimation of the future population which is useful for preparing grasshopper risk map.

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Authors' contributions
Mr. Kapil Paudel was the lead investigator and responsible for the conceptualization, methodology development, data curation and drafting the manuscript of this study. Dr. Naresh Dangi was responsible for review, editing and formal analysis of the manuscript. Mr. Anisur Rahman Ansari and Mrs. Rashmi Regmi were responsible for the literature search, data generation and drafting of this manuscript.

Conflict of Interest
The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

REFERENCES
Ansari, A.R., Paudel, K., & Bista, S. (2016). Insect Pest Problems and their Management options associated with Sugarcane Crop in Nepal. In: Proceedings of Workshop on Review and Strategy Development of Entomological Research Works in Nepal (Joshi, S.L., Thapa, R.B., Bista, S. eds). Proceedings of Workshop on Review and Strategy Development of Entomological Research Works in Nepal (Vol 2), held on 4-6 March 2012 at Entomology Division, Khumaltar, Nepal; Lalitpur, Nepal, pp.205-211.

Belovsky, G.E., & Slade, J.B. (1993). The role of vertebrate and invertebrate predators in a grasshopper community. *Oikos, 68*, 193-201.

Belovsky, G.E., & Slade, J.B. (1995). Dynamics of two Montana grasshopper populations: relationships among weather, food abundance and intraspecific competition. *Oecologia*, *101*, 383-396.

Capinera, J.L., & Horton, D.R. (1989). Geographic variation in effects of weather on grasshopper infestation. *Environment Entomology, 18*, 8-14.

Dempster, J.P. (1963). The population dynamics of grasshoppers and locusts. *Biological Reviews, 38,* 490-529.

Edwards, R.L. (1960). Relationship between grasshopper abundance and weather conditions in Saskatchewan, 1930-1958. *Canadian Entomologist, 92*, 619-624.

Fielding, D.J., & Brusven, M.A. (1990). Historical analysis of grasshopper (Orthoptera: Acrididae) population responses to climate in Southern Idaho, 1950-1980. *Environmental Entomology*, *19*, 1786-1791.

Gage, S.H., & Mukerji, M.K. (1977). A perspective of grasshopper population distribution in Saskatchewan and interrelationship with weather. Environmental Entomology, 6, 469-479.

Joern, A., & Gaines, S.B. (1990). Population dynamics and regulation in grasshoppers. In: Chapman, R. F. and Joern, A. (eds), Biology of grasshoppers. John Wiley and Sons, pp. 415-482.

Kohler, G., Perner, J., & Schumache, J. (1999). Grasshopper population dynamics and meteorological parameters: lessons from a case study. *Ecography. Ireland*, *22*, 205-212.

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Lomer, C.J., Bateman, R.P., Johnson, D.L., Langewald, J., & Thomas, M. (2001). Biological Control of Locusts and Grasshoppers. *Annual Review of Entomology, 46*, 667-702.

Olfert, O., & Giffen, D. (2006). Analysis of grasshopper (Orthoptera: Acrididae) population surveys in Saskatchewan: 1972-2004. *Canadian Entomologist, 138*,875-887.

Richards, O.W., & Waioff, P.D. (1954). Studies on the biology and populations dynamics of British grasshoppers. *Anti-Locust Bull, 17*, 1-182.

Riegert, P.W. (1968). A history of grasshopper abundance surveys and forecasts of outbreaks in Saskatchewan. *Memoirs of the Entomological Society of Canada, 52*, 1-99.

Rubtzov, I.A. (1935). Regularities in the development and behaviour of Siberian Acrididæ in connection with climatic factors (In Russian with German summary). *Bulletin of the Academy of Sciences of the USSR, 5*, 789–824.

Uvarov, B.P. (1977). Grasshoppers and locusts. Behaviour, ecology, biogeography, population dynamics. Centre for Overseas Pest Research, London, 2, ix+613 pp.