INCIDENCE OF MAIZE WEEVIL (*Sitophilus zeamais* Motsch) AND ITS ASSOCIATION WITH GREEN FUNGUS (*Aspergillus flavus* Link) IN MAIZE UNDER STORAGE AT CHITWAN AND SURKHET DISTRICTS OF NEPAL

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ABSTRACT

A survey of maize-growing areas of Surkhet and Chitwan, Nepal (April to May 2017) was conducted to know about the incidence, relationship and loss in stored maize due to Maize weevil (*Sitophilus zeamais* Motsch) and (*Aspergillus flavus* Link). Sixty households from each district were surveyed and the data was analyzed using SPSS and Microsoft Excel. Result revealed that there is severe infestation of maize weevil and green fungus in stored maize. 97.5% of stored samples had incidence of *Aspergillus,* whereas 96.7 % samples had maize weevils. 15.7% of the farmers apply sun drying and removal of the *A. falvus* infested seed while remaining 84.3% of the farmers use no any measure of control. Results from Chi- Square test indicated significant relation ($\chi^2 = 122.10$, $P<0.01$) between incidence of weevil infestation and occurrence of green fungus in the study area. The Phi coefficient value (1.00) shows the perfect relationship exist between weevil and green fungus occurrence in the study areas. The overall annual damage by the *A. flavus* was 6.39%. Therefore, it can be said that maize weevil is the major insect while *A. flavus* is major pathogen of maize grains at storage. The relationship between the occurrences of both pests was highly significant which indicated the positive relationship, i.e. the weevil plays an essential role in growth and spread of fungus.

Key words: Incidence, maize weevil, green fungus, storage, relationship

INTRODUCTION

Maize (*Zea mays* L.), belonging to the family Poaceae or Gramineae is ranking second in area cultivated and first in production and productivity in order of world grain production (FAO, 2013). It is popularly known as queen of cereals, because of very high yield potential than any other cereals (Singh, 2002). It occupies 26.12% of total cereal cultivated area and shares about 23.15% of the total cereal production in Nepal. Both in terms of area and production, maize ranks second after rice in Nepal. It is grown in 882395 ha of land with an average yield of 2.43 mt/ha (MoAD, 2014/15) which seems to be very low as compared to neighboring countries. The maize weevil (*Sitophilus zeamais* Motsch), known as the greater rice weevil**,** is a species of beetle in the family curculionidae. The maize weevils are small (2.5 mm to 4 mm length) brown black weevils with a long slender snout and four reddish brown spots on the wing covers (two spots on each wing cover). The head and thorax are nearly as long as the wing covers. In world, they are considered as a major pest of corn. Infestations not only cause significant economic losses but also result in elevated temperature and moisture conditions that lead to an accelerated growth of molds, including toxigenic species (Magan *et al*., 2003).

Aspergillus flavus Link is a saprobe, a pathogen and a producer of several mycotoxins that impact human and animal health (Masayuki and Gomi, 2010). It is an anamorphic genus consisting of about 250 recognized species. It is characterized by a distinctive spore-bearing structure, the aspergillum. It is cosmopolitan in distribution (Ramirez *et al,* 2012). It is important because it produces aflatoxin as a secondary metabolite in the seeds of a number of crops both before and after harvest. *A.*

flavus infections can occur while hosts are still in the field (pre-harvest), but often show no symptoms until post-harvest storage and/or transport. Post-harvest rot typically develops by colonization of the fungus in the seed on storage. In addition to causing pre-harvest and post-harvest infections, many strains produce significant quantities of toxic compounds known as mycotoxins, which, when consumed, are toxic to mammals (Agrios, 2005). Schneider (1987) reported post-production losses in Honduras of 6.5 to 8.7 percent in the field and of 7.4 to 13.9 percent in storage. In this regard, a survey was conducted to know about the incidence, relationship and loss in stored maize due to *S. zeamais* and *A. flavus* in Chitwan and Surkhet district of Nepal.

MATERIALS AND METHOD

The study was conducted on Chitwan and Surkhet districts of Narayani and Banke Zone, which lie in the mid-southern and western area of Nepal, respectively, were purposively selected for the study as they are the major maize growing area representing the terai and mid-hills of the country. Purposive selection of Shardanagar VDC of Chitwan and Dasarathpur VDC of Surkhet was done for study as shown in the map of Nepal showing Chitwan and Surkhet districts (Figure 1).

Figure 1: Map of Nepal showing Chitwan and Surkhet districts selected to conduct the survey
(Source: NGIIP, Nepal, 2004)

Selection of population and sample

All the farmers of the proposed study site involved in maize cultivation constituted the study population. Altogether, 120 maize growers, 60 from each district were selected for study by applying simple random sampling technique.

Sources of information and data collection techniques

Primary data were collected from the survey at the study site and secondary data were collected from published materials from MOAD, DOA, DADO, AEC, NARC, NGOs and INGOs etc.

The field survey was conducted in April-May 2017 for the collection of primary information. Interview schedule was designed in such a way that it could gather all the information that could address the research objectives. Similarly, key informant survey was carried out to collect the relevant information on maize production. Also face to face interview was carried out with the maize growers for collecting information about disease and pest on storage.

Data analysis

The primary information obtained from the survey was coded, tabulated and analyzed by using Statistical Package for Social Science (SPSS 20.0), and Microsoft Excel.

RESULT AND DISCUSSION

Occurrence of Maize weevil and its control measures

Overall 96.7 percent of HHs reported the occurrence of weevil during storage of maize as shown in table 1. More than 9 in 10 HHs reported occurrence of weevil as storage pests of maize in Surkhet district and all HHs reported occurrence of weevil as storage pests of Maize in Chitwan . Among insect pests, maize weevil (*S zeamais*) is the most important insects under storage of maize in Nepal (Sherpa *et al*., 1997; G.C., 2006).

Table 1: Households reporting storage pest of maize under storage, Surkhet & Chitwan, 2016 (N=60)

Storage insects		District					
		Surkhet		Chitwan		Overall	
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Weevil	Present	56	93.3	60	100	116	96.7
	Absent	4	6.7	0	0	4	3.3

Overall 70.8 percent of HHs used Celphos, 25.8 percent used botanicals (like neem dry leaves, bojho, neem oil etc) and 3.3 percent didn't use any means to control weevil; 73.3 and 68.3 percent of HHs in Surkhet and Chitwan used Celphos to control weevil respectively. Likewise, 20 and 31.7 percent of HHs in Surkhet and Chitwan used botanicals to control weevil in stored maize.

Table 2: Means used to control weevil on stored maize grains, Surkhet & Chitwan, 2016 (N=60)

Parameters		Districts					
		Surkhet		Chitwan		Overall	
		Freq.	%	Freq.	%	Freq.	%
Means used to control	Celphos	44	73.3	41	68.3	85	70.8
	Botanicals	12	20.0	19	31.7	31	25.8
	None	4	6.7	0	0.0	4	3.3
Results of methods	Unsatisfactory	7	12.5	8	13.3	15	12.9
	Satisfactory	49	87.5	52	86.7	101	87.1

Overall, 87.1 percent of HHs reported satisfactory results by using control measures while 12.9 percent reported unsatisfactory. The Chi-square (χ^2 =134.52, P<0.001) test shows the significant

relation between the means used and satisfaction of the farmer using the means. The cramer's value (0.749) shows the large relationship exist between the dependent and independent variables.

Similar result for the satisfactory effect of the chemicals against destructive activities of storage pests has been reported to be effective against stored products pests (Adedire *et al*., 2011). Adedire *et al*., (2011) reported that the destructive activities of storage pests has beeen subdued by chemical control methods comprising fumigation of stored commodity with carbon disulphide, celphos or dusting with malathion, carbaryl, pirimiphos methyl or permethrin. Similarly in case of botanicals, Gyawali (1993) reported that 50 plant species available in Nepal can be used against insect pests in crops and stored grains. Sweet flag stolen (*Acorus calamus*), neem *(Azadirachta indica*) dry leaves, oil, neem seed powder, timur (*Zanthoxylum armatum*), titepati (*Artimesia vulgaris*) have been reported to be superior in controlling the maize weevils (Paneru *et al.,* 1996).

Green fungus and its control

Overall, 97.5 percent of HHs reported appearance of green fungus during storage; 95 percent and 100 percent HHs in Surkhet and Chitwan respectively reported the occurrence of green fungus. Similarly Fandohan *et al.,* (2003) has reported that storage fungi like *Fusarium* and *Aspergillus* contributes to loss of more than 50 % of maize grain, and ranks second after insects as the major cause of deterioration and loss of maize. 39.31 percent of HHs reported occurrence of green fungus has been prevented by sun drying and removal of diseased seeds while 60.69 percent of HHs reported occurrence of green fungus but didn't use any means to control the disease. Majority of HHs in Surkhet did not use any means to control the disease (Table 3).

While those HHs applying green fungus control measures reported satisfactory results of applied control measures. The Chi-square (χ^2 =120.00, P<0.001) test shows the significant relation between the means used and satisfaction of the farmer using the means. The Phi coefficient value (1.00) shows the perfect relationship exist between the dependent and independent variables. Similar result for the control of the fungus by drying the seeds below 13 percent moisture is reported (Stack and Carlson, 2006; Wrather, 2008, Abbas 2005). Moisture content is by far the most important factor affecting the growth of micro-organism in stored maize. After harvest, maize should be sun dried or mechanically dried to 15 percent moisture content within 24 hours. Grain going into long term storage should be dried to 13 percent moisture (Stack and Carlson, 2006; Wrather, 2008; Abbas 2005).

Table 3: Households with green fungus as storage disease and means used for its control, Surkhet & Chitwan, 2016 (N=60)

Parameters		Districts					
		Surkhet		Chitwan		Overall	
		Freq.	%	Freq.	%	Freq.	%
Occurrence of green fungus	Yes	57	95	60	100	117	97.5
	No	3	5	0	0.0	3	2.5
Means used to control	Sun drying and removal of diseased seeds	9	15.7	37	61.6	46	39.31
	No any means used	48	84.2	23	38.3	71	60.69
Means used	Satisfactory	9	100	37	100	46	100
	Unsatisfactory	0	0.0	0	0.0	0	0.0

Factors favoring incidence of pests in stored maize grains

Early harvesting and excess moisture in grains during storage seems to be major causes for occurrence of pests during storage in the study site. 9 in 10 HHs reported excess moisture in grain while storage as major cause of incidence of storage pests; 86.7 percent and 98.3 percent of HHs in Sukhet and Chitwan districts respectively reported more moisture in grain while storage as major cause of occurrence storage pest and rest of HHs reported early harvesting as the major factor. The Chi-square (χ^2 =123.85, P<0.001) test shows the significant relation between factors governing the pest and its occurrence. The Phi coefficient value (1.00) shows the perfect relationship exist between the dependent and independent variables. Brich (1994), reported similar result for the high moisture content over 10 percentage and immature harvest of the crop are the reason for rise in pest occurrence. Increase in moisture leads larvae to tunnel in grains and are responsible for most of the damage. Pupation takes place inside the grain and adults chew their way out through the outer layer of the grain (Mound, 1989).

Table 4: Factors governing incidence of storage pests in maize grains, Surkhet & Chitwan, 2016 (N=60)

Factors governing incidence of storage insects	Districts					
	Surkhet		Chitwan		Overall	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Early harvesting	8	13.3	1	1.7	9	7.5
More moisture in grain while storage	52	86.7	59	98.3	111	92.5

Incidence of green fungus at various crop stages

Overall 59.2 percent of HHs reported incidence of green fungus in ready to harvest cob and 38.3 percent of HHs reported incidence both in ready to harvest cob and during storage, while only 2.5 percent reported no incidence. During the study, 80 and 38.3 percent HHs in Surkhet and Chitwan districts respectively reported incidence of green fungus in ready to harvest cob while 15 and 61.7 percent HHs reported incidence in both the cases. The Chi-square (χ^2 =124.16, P<0.001) test shows the significant relation between the green fungus occurrence and various crop stages of infestation. The Cramer's value (0.73) shows the existence of higher relationship between the dependent and independent variables. Campos *et al.,* (2008) reported similar relation for the infestation of *A. flavus* is influenced by many factors and can occur at any stage of food production, from pre-harvest to storage and processing.

Table 5: Households reporting incidence of green fungus at various crop stages, Surkhet & Chitwan, 2016 (N=60)

Crop stages	Districts					
	Surkhet		Chitwan		Overall	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Harvest ready cob	48	80.0	23	38.3	71	59.2
Both (harvest ready and storage)	9	15.0	37	61.7	46	38.3
Not-observed	3	5.0	0	0.0	3	2.5

Loss of storage grain by green fungus

Maize production of 1.05 quintal per kattha and 1.35 quintal per kattha was observed in Surkhet and Chitwan districts, respectively; 6.81 and 5.97 percent damage due to green fungus infestation was reported in Surkhet and Chitwan districts respectively; with overall, 6.39 percent loss due to green fungus (Table 6). Similar findings were reported by Schneider (1987) in Honduras about 6.5 to 8.7 percent in the field and of 7.4 to 13.9 percent in storage.

Table 6: Loss of maize due to fungal infestation, Surkhet & Chitwan, 2016 (N=60)

Districts	Production(Quintal/kattha)	Fungal Damage (%)
Surkhet	1.05	6.81
Chitwan	1.35	5.97
Overall	1.20	6.39

Relationship between weevil infestation and green fungus infestation

Almost all (90 percent) HHs in Surkhet and all HHs in Chitwan district having weevil infestation reported occurrence of green fungus diseases in storage (Table 8). Results from Chi- Square test indicated significant relation (χ^2 = 122.10, P<0.01) between incidence of weevil infestation and occurrence of green fungus in the study area. The Phi coefficient value (1.00) shows the perfect relationship exist between the dependent and independent variables.

Diener *et al.* (1987) reported insects physically move conidia adhering to their bodies while feeding and leave them via defecation. Similarly, Dix and All (1987) reported that maize weevil (*S. zeamais*) is of special interest with respect to the *A. flavus* infestation problem because it functions as both a pre-harvest and storage insect. He further reported that heat and moisture generated by weevil activity in stored maize grain showed enhanced growth of *A. flavus*.

Table 7: Weevil infestation and green fungus occurrence, Surkhet & Chitwan, 2016 (N=60)

District	Parameters				Frequency
Surkhet	Weevil infestation	No	Green fungus observed	No	1
				Yes	3
		Yes	Green fungus observed	No	2
				Yes	54
Chitwan	Weevil infestation	No	Green fungus observed	No	0
				Yes	0
		Yes	Green fungus observed	No	0
				Yes	60

CONCLUSION

Field survey in Shardanagar VDC of Chitwan and Dasarathpur VDC of Surkhet revealed *S. zeamais* and *A. flavus* were the major pest in all most all HHs during the maize storage. Most of the (93.3%) HHs in Dasarathpur and all (100 %) HHs in Shardanagar VDCs reported weevil infestation and 95% and 100% HHs in Dasarathpur and Shardanagar VDC reported *A. flavus* infestation in storage. 73.3% used Celphos tablet followed by botanicals (20%) to control the storage pest. Similarly 15.7% of the farmers apply sun drying and removal of the *A. falvus* infested seed while remaining 84.3% of the farmers use no any measures due to the busy agricultural schedule. The lack of knowledge

about the moisture maintenance is a main factor against the high infestation of the pest and disease in storage. Results from Chi- Square test indicated significant relation (χ^2= 122.10, P<0.01) between incidence of weevil infestation and occurrence of green fungus in the study area. The Phi coefficient value (1.00) shows the perfect relationship exist between weevil and green fungus occurrence in the study areas. The overall annual damage by the *A. flavus* was 6.39%. 90 percent HHs in Surkhet and all HHs in Chitwan district having weevil infestation reported occurrence of *A. flavus* in storage. Therefore, maize weevil as major insect while *A. flavus* as major disease of maize grains on storage was recorded on all most all HHs in the study areas. And their relationship was highly significant which indicates their positive relationship, i.e. the weevil plays an essential role in growth and spread of fungus.

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