

DAMAGE CAUSED, LOSS ASSESSMENT AND EMERGENCE PATTERN OF *ACANTHOSCELIDES OBTECTUS* (SAY) ON THE BEANS, *PHASEOLUS VULGARIS* L. IN GABORONE

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ABSTRACT: The damage caused, loss assessment and emergence pattern of *Acanthoscelides obtectus* Say was studied under laboratory condition (temperature range 27.5-30.0°C and relative humidity 62-74%), on the beans *Phaseolus vulgaris* L. The mean percentage weight loss caused by *A. obtectus* on *P. vulgaris* during 2 months of storage was 13.7%. The percentage seed infestation was 81.5± 3.30 during 2 months of storage period. There was peak emergence of *A. obtectus* on the fourth day, thereafter the number of emerged adults decreased daily until the 17th day when there was no emergence. The number of adult emergence holes on *P. vulgaris* ranged from one to ten holes per seed. The results show that multiple infestations of *P. vulgaris* by *A. obtectus* can occur. In most cases one larva of *A. obtectus* infest one seed even though multiple infestations may occur in some cases.

Key words: *Acanthoscelides obtectus*, kidney bean, *Phaseolus vulgaris*, cowpea

INTRODUCTION

Acanthoscelides obtectus (Say) is the main pest of kidney bean seeds, *Phaseolus vulgaris* Linn. *A. obtectus* is a serious pest and attacks mostly kidney bean *P. vulgaris* and various other pulses (SILIM and AMBROSE, 1993). Infestation by *A. obtectus* begins in the field in drying pods, and continues in the stored beans (BAIER and WEBSTER, 1992). Genera of legumes; *Phaseolus*, *Vicia*, *Cajanus* and *Voandzeia* are the most suitable hosts for *A. obtectus* (SILIM and AMBROSE, 1993). Many names are used for *P. vulgaris*, these include French beans, kidney beans, haricot beans, snap beans, garden beans, dwarf beans, common beans, field beans, string beans, bush beans and pole beans. In some countries in East Africa (Kenya, Tanzania, Uganda) however they are referred to simply as beans.

In Kenya beans are by far the most important pulse crop and considerable quantities of beans are sold for canning. The occurrence of *A. obtectus* on different kinds of beans in East Africa has been reported (LE PELLE, 1959). The main pulses grown in Botswana include cowpeas (*Vigna unguiculata*), Bambara groundnut (*Voandzeia subterranea*); Soya bean (*Glycine max*); Pigeonpea (*Cajanus cajan*); Kidney bean (*P. vulgaris*); Lablab (*Dolichos lablab*) and Mung bean (*Vigna radiata*) (ALLOTEY *et al.*, 2010). Currently the beans *P. vulgaris* are becoming very important and farmers are being encouraged to grow *P. vulgaris*. It is also commonly sold in the supermarkets. Other crops grown in Botswana include cereals such as maize, sorghum and millet (ALLOTEY *et al.*, 2011 a, b; ALLOTEY and RAMONGALO, 2011; ALLOTEY and MOLOKO, 2015).

A. obtectus causes extensive economic losses since it is a pest both in the field and in storage (KOONA and BOUDA, 2006). It is of great importance for farmers to be able to store their beans without losses in order to sell them during the months when prices are highest. Losses in stored beans are correlated with the length of the

storage time (JONES, 1999). Furthermore secondary-rotting by micro-organisms can occur since bean bruchid larval stage completion creates favorable conditions for fungi and bacteria due to elevated temperature and relative humidity (RH) (JONES, 1999).

The larvae of *A. obtectus* attack *P. vulgaris*, *P. lunatus*, *Dolichos* sp., peas, field beans, chick peas, soy beans, lentils, common vetch and other pulses. Larvae develop within the bean causing serious damage and can reproduce repeatedly in dried pulses in store. The adults are short lived and do not feed on the produce. Each female lays an average of 40-50 whitish ellipsoidal eggs in loose groups of ten or more, in holes chewed in developing pods or are usually laid loosely among stored seeds. In the field, overripened pods which have split along the sutures and thereby exposing the seed are selected for oviposition. Each egg hatches into a hairy whitish larva which wanders freely for a while before boring into a seed or through the pod wall into the seed. In developing seed, the entry hole is almost invisible and as the seed grows the hole disappears. The larva feeds on the cotyledon inside the seed, moults four times before pupation and makes a tunnel almost to the surface. Before pupation, the larva prepares a circular exit hole which remains covered by the seed skin ("window"). After pupation the adult beetle emerges by pushing out the flap of seed coat, leaving a circular hole. Breeding goes on repeatedly as long as there is any food left in the beans (ALLOTEY, 2003).

The objective of the present study was to obtain information on the damage caused, loss assessment and emergence pattern of *A. obtectus* when reared on the beans, *P. vulgaris* under ambient laboratory conditions in Botswana.

MATERIALS AND METHODS

Rearing and experimentation: Beans utilized for experimentation were examined for damages or holes due to infestation occurring naturally from the field before utilization. The study was from November 2015 to May 2016. Only whole and undamaged seeds were used for rearing and experimentation. Forty-five replicate cultures of *A. obtectus* were kept in rearing glass jars (7.5 cm. × 3.0 cm diam.), using *P. vulgaris* beans obtained from the Botswana Agricultural Marketing Board. The jars were covered with muslin cloths held in place with rubber bands to allow for aeration and to prevent emerged adults from getting out of the cultures. Each culture contained 100g of beans and 20 randomly selected newly emerged *A. obtectus* adults. The insects were obtained from laboratory stock cultures maintained at the insectary of the Department of Biological Sciences, University of Botswana. Fourteen days after the introduction of the insects, dead insects were removed using a pair of forceps and observations were made daily up to the first emergence of new adults which were recorded. All equipment used in handling the insects and *P. vulgaris* beans were dry-heat treated sterilised in a Gallenkamp oven at 100°C and 80°C, respectively for 2 hours before experimentation as a routine measure to prevent diseases or cross infestations (ALLOTEY and MORRIS, 1993; ALLOTEY and RAMONGALO, 2011). The procedures for maintaining cultures were similar to those described by ALLOTEY and GOSWAMI (1992). Cultures and experimental set-ups were maintained at room temperature range 27.5-30.0°C and relative humidity 62-74%, with a photoperiod of 12:12 (L:D).

Damage and loss assessment: Fifteen of the 45 replicates were selected to study adult bean weevil emergence on daily basis; while the remaining 30 replicates were left for a storage period of 2 months. For the 15 selected replicates the number of insects

emerging each day were counted and recorded from each replicate until there was no longer adult emergence. The replicates that were left for 2 months were used to assess infestation levels, damage and losses caused. The number of infested beans and un-infested beans were determined in each replicate. The infested beans were classed into two, viz., i) infested beans with holes and ii) infested beans without holes (i.e. carrying the final developmental stage of the insect seen through the seed skin cover of the oval window). The mean numbers of infested beans (infested with holes and without holes) and un-infested beans (whole seeds) were determined. Damage and percentage damage caused were determined using the mean numbers of infested and un-infested beans.

Loss assessment (weight loss) was determined by obtaining the mean final weight of beans from all 30 replicates and subtracting it from the mean initial weight. The weight loss was calculated using the formula; $WL = (W_i - W_f)$, where WL = weight loss, W_i = initial weight and W_f = final weight (ALLOTEY and DANKWAH, 1996).

RESULTS AND DISCUSSION

The first new adult bean weevils emergences from the experimental set-ups were recorded on the 33rd day. The damages caused by *A. obtectus* on *P. vulgaris* caused by the emerged adults are given in Table-1. The mean numbers for the infested seeds with holes (external damage) and infested seeds without holes (internal damage) were 104.3 ± 2.20 and 131.8 ± 4.20 , respectively. While the mean number for un-infested seeds (whole and undamaged) was 53.8 ± 1.79 . The percentage seed infestation was 81.5 ± 3.30 . This level (81.5%) of damage constitutes economic damage leading to economic loss. Thus large numbers of the beans were damaged by *A. obtectus*. Emergence holes were not the only indicators of damage caused by *A. obtectus* as there were damages caused by the developing larvae in the seeds. These damages were due to feeding effects internally that did not end in external holes on the seeds. Some of these affected seeds showed signs of infestation such as oval window but having no holes.

Damage in the seeds caused contamination with frass, exoskeleton, insect body parts, dead and live insects, excretory products and in severe damage, noxious odour comes from damaged seeds. These feeding effects and damage caused make the food unsuitable for human consumption. In cases where the cotyledons or embryos are destroyed, the seeds can no longer be used for planting as there will be no germination from such affected seeds. Partially damaged grains or seeds have been reported to have their germinating power and taste quality destroyed (KOONA and BOUDA, 2006). *A. obtectus* was well maintained on *P. vulgaris* as significant damages were caused in short period of 2 months.

Table-1: Damage caused by *A. obtectus* on *P. vulgaris* for 2 months

Condition	Mean ($\bar{x} \pm SE$), *n=30
Infested seeds with holes (external)	$104.3 \pm 2.20(5-235)^1$
Infested seeds without holes (Internal)	$131.8 \pm 4.20(24-222)$
Un-infested seeds	$53.8 \pm 1.79(11-91)$
Percentage seeds infestation (%)	81.5 ± 3.30

*n= denote number of replicates

¹= figures in parenthesis denote range of hole or un-infested seeds

Table-2: Weight loss caused by *A. obtectus* on *P. vulgaris* during 2 months

Condition	Mean ($\bar{x} \pm SE$), *n=30
Initial weight (g)	100.0 \pm 0
Final weight (g)	86.3 \pm 0.18 (76.7-96.2) [†]
Percentage weight loss (%)	13.7 \pm 0.18

*n= denote number of jars (replicates)

[†]= figure in parenthesis denote range of damage caused

Table-2 shows the weight loss caused by *A. obtectus* on *P. vulgaris* during 2 months storage period. The feeding effects caused damages that resulted in weight loss of 13.7% from the initial weight used. Considering the short storage period of 2 months, the percentage weight loss recorded can be said to be substantial. KOONA and BOUDA (2006) reported that the larvae of *A. obtectus* usually eat the pod/seed contents completely, decreasing the yield by 50-60%. Table 2 also shows the damage caused by *A. obtectus* on *P. vulgaris* during 2 months storage period.

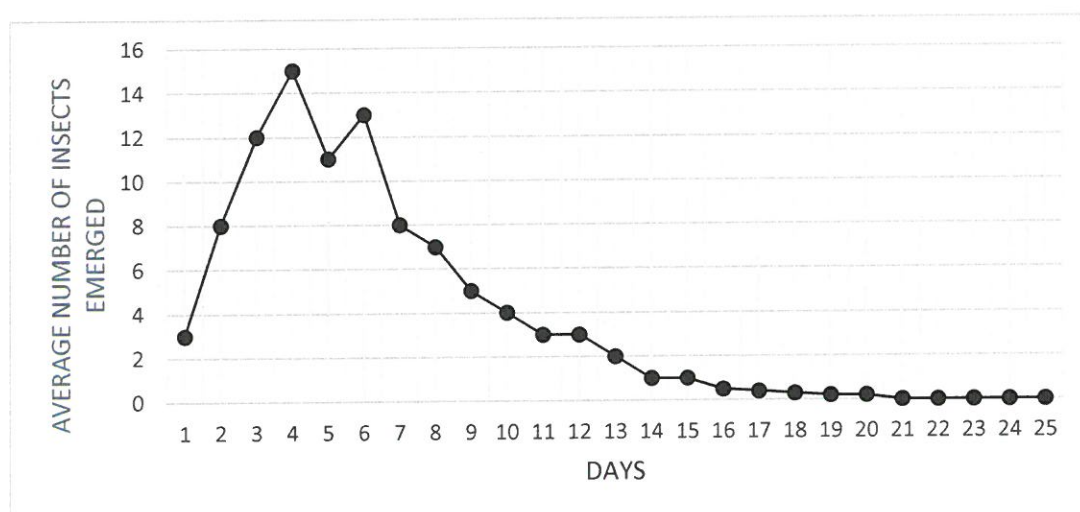


Fig- 1: Emergence of *A. obtectus* on *P. vulgaris* beans

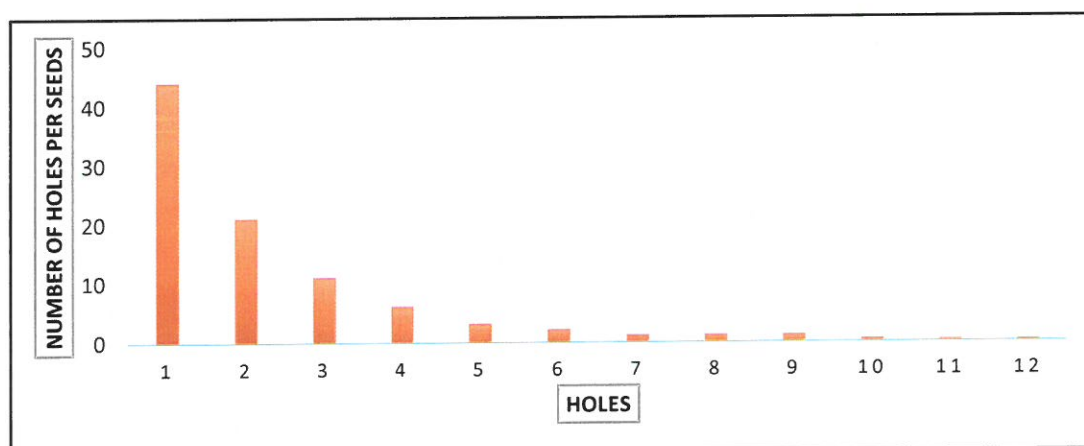


Fig-2: Holes created on *P. vulgaris* beans during damage by *A. obtectus*

Figure 1 shows the daily mean emergence pattern of *A. obtectus* from *P. vulgaris* after 33 days development period. There were high numbers of emergences on day 4, followed by a decline until the 17th day after which there was no emergence. Figure 2 shows the number of adult emergence holes on *P. vulgaris* from one hole per

seed to multiple holes per seed (ranging from one to ten per seed). The results show that multiple infestations of *P. vulgaris* by *A. obtectus* can occur. In most cases one larva of *A. obtectus* infest one seed even though multiple infestations may occur in some cases (Fig. 2). Multiple infestations occur mainly when the food gets depleted or when all the seeds are infested with larvae. *A. obtectus* larva usually shows no mechanism for inhibition of multiple infestations. Heavy multiple infestation results in emerging adults being weak and small in size because of lack of nutritional resources.

CONCLUSION: *A. obtectus* pose a big threat to storage of beans by the damages they cause in a short period of time. From the short development period (33 days), *A. obtectus* can cause much damage to the seeds (81.5% damage) and 13.7 % weight loss in just 2 months.

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