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First Record of Pachnoda interrupta Olivier Outbreak on Sorghum, Pearl Millet and Sunflower in Sudan

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Abstract: During the autumn season of 2011, an outbreak of the sorghum chafer *Pachnoda interrupta* Olivier (Coleoptera: Cetoniidae) occurred for the first time in Sudan on four genotypes of sorghum (*Sorghum bicolor*), four of pearl millet (*Pennisetum glaucum*) and eight of sunflower (*Helianthus annuus*) in the Gezira Research Station Farm. The objective of this study was to quantify the damage caused by the sorghum chafer to these crops. The percentage of infested panicles (PIP), infested discs (PID), panicle damage (PPD) and disc damage (PDD) and number of beetles per panicle/disc were determined. Two sorghum genotypes (Jumbo and Pannar) showed tolerance to the beetle, as they scored the lowest PIP and PPD, whereas the other two (Kambal and Sugar graze) were highly susceptible. All pearl millet genotypes showed high susceptibility, scoring a range of 92.9-94.2 PIP and 98.2-98.8 PPD. Alexandra sunflower genotype showed high tolerance, securing "zero" PID and PDD; Pac 361, Pan 7033, Pan 7351 and Hysun 33 genotypes showed tolerance; Sirena and ARC 310 had comparatively high disc attraction and grains sensitivity, and Pac 317 showed the highest disc attraction and seed sensitivity to the beetle. The study concluded that *P. interrupta* has become a new potential serious pest of sorghum, pearl millet and sunflower in Sudan. Infestation is variety/hybrid dependent with sorghum and sunflower hybrids, and all tested pearl millet genotypes were highly sensitive to the beetle.

Key words: *Pachnoda interrupta*; sorghum; pearl millet; sunflower

INTRODUCTION

Pachnoda interrupta is present in the semi-arid parts of Africa, which are subjected to strong seasonal variation in rainfall and temperature, mainly

in the Sahel and Sudan ecoregions (Schmutterer 1969; Grunshaw 1992; Jago 1995; Sastawa and Lale 2000). Although the *Pachnoda* genus has six occasionally reported species in the Sudan, none of them had attained the "Pest" status before this report. These are *P. interrupta* Olivier, *P. marginata* (Drury) var. *zonaria*, *P. cordata* Drury, *P. sinuata* F., *P. discoidalis* Moser and *P. massajae* Gerst. Historically, *P. interrupta* first record was in Bara in 1917 (T. E. Abdalla, personal communication, 2012). *P. interrupta* beetle is 13-17 mm in length, 7-11 mm in width, with black colour; the pronotum and elytra bear a number of reddish-brown spots and stripes.

No studies on the biology, ecology and control of *P. interrupta* were done in the Sudan. However, observations from elsewhere showed that oviposition takes place in soils of high organic matter, during June-July, and ranges from 12.6 to 24 eggs/female/week (Grunshaw 1992). Duration of egg-first larval instar lasts 9.2 days. The larva passes through three instars, during 52.2 days, and feeds on cattle dung and decaying organic matter. Clarke and Crowe (1978) described cattle dung as the most important larval food. At the end of the third larval instar, the larva constructs a pupal cell from the soil medium by cementing it with its saliva, and goes into pupation. The pupal stage lasts 18.6 days. The egg-adult period takes 79.9 days. Emergence is triggered by moisture from the onset of the rainy season. Emerged beetles consume grains of many crops at the milky stage. The beetle goes through one generation over a period of one year, covering the rainy months and most of the dry season. The flight peaks take place during June-July and September-October. The immature stages occur during the summer (July-October), adults are present all the year round and aestivate in the soil for 7-8 months (November – June) (Wolde-Hawariat *et al*. 2007). At the first showers in June, adults emerge to feed and mate and form dense aggregations afterwards on sorghum, pearl millet and sunflower, *etc*. The mating season ends with the onset of the rains, and the females start to oviposit in the topsoil (Seneshaw and Mulugeta 2002).

Clarke and Crowe (1978) stated that *P. interrupta* can become a serious pest of sorghum and pearl millet heads and other crops when certain

ecological circumstances such as failed/delayed rainy season occurs. Jonas *et al*. (2009) reported that *P. interrupta* is a key pest of sorghum, millet and sunflower, causing 58%-71% reduction of sorghum yield in Ethiopia. Yitbarek and Hiwot (2000) found that the pest eats immature grains of some crops, hampers fructification and seed setting, and causes sorghum yield loss of up to 70% in severely affected areas.

The control measures consist of cultural, use of attractants, biological and chemical methods. The cultural measures include ploughing or harrowing to expose larvae and pupae to dehydration and predators, destruction of wild hosts, hand collection of adults, smoking, shaking every stand of plants, burning of compost heaps and mass trapping of adults. The attractants comprise the floral lure phenethyl propionate / euganol / geraniol at 3:7:3, respectively, and eugenol from extract of clove, use of rotting fruits of guava, peach, cactus and banana to lure beetles. The chemical measures include mixing baits with insecticides, spraying of persistent insecticides on compost and manure and spot spraying. The biological methods consist of the use of *Pyrgotidae eutrixopsis* (Diptera: Tachinidae) and *Adapsila latipennis* (Diptera: Pyrgotidae) parasitoids, *Metarhizium anisopliae*, *Beauveria bassiana* and *Verticilium lecani* fungi, and some species of *Heterorhabditis* and *Steinernema* genera of nematodes (Jonas *et al*. 2009).

The objective of this study was to quantify the damage of the grains/seeds caused by *P. interrupta* first outbreak on some sorghum, pearl millet and sunflower genotypes.

MATERIALS AND METHODS

Two experiments were conducted during the autumn season of 2011 in the Gezira Research Station Farm, Wad Medani, Sudan, and all cultural operations were carried out as per the ARC standards. The first experiment targeted quantification of *P. interrupta* damage on sorghum (Kambal cultivar and Jumbo, Pannar 888 and Sugar graze hybrids) and pearl millet (The local, Ashana and Ugandi cultivars and a hybrid) Sowing was carried out in 17 m² plots in July 2011, in a randomized

complete block design with three replicates. The quantification was carried out during 10-17 October 2011. The percentage of infested panicles (PIP), percentage of panicle damage (PPD) and number of beetles per panicle were determined. The sample size was *Ca*. 100 panicles for each parameter. Infested panicles were those which harboured the beetle and/or showed its characteristic symptoms and damage. The symptoms appeared at the start of infestation from the top of the spike / panicle and developed towards the bottom; the infested part turned chafed. The damage appeared as partial or complete consumption of the grain's endosperm. The panicle damage was evaluated visually by estimating the percentage of the panicle damaged parts.

The second experiment targeted quantification of *P. interrupta* damage on the sunflower hybrids: Sirena, ARC 310, Pac 361, Pac 317, Alexandra, Pan 7033, Pan 7351 and Hysun 33. Sowing was carried out in 160 m² plots in July 2011, in a randomized complete block design with three replicates. The quantification was done during September 2011. The percentage of infested discs (PID), percentage of disc damage (PDD) and number of beetles/disc were determined. The sample size was *Ca*. 100 discs. Infested discs were those harbouring the beetle and/or showing its characteristic damage. The disc damage was evaluated visually.
Data on PIP, PPD, PID, PDD and number of beetles per panicle/disc were transformed, as required, and then subjected to analysis of variance and Duncan's multiple range test using MSTAT-C software.

RESULTS AND DISCUSSION

Damage of *P. interrupta* on sorghum and pearl millet

Infestation on sorghum was variety/hybrid dependent. The beetles avoided direct sun rays, found mostly in clusters on shady parts of the panicle and consumed all or most of the grain's endosperm, and the damaged panicles turned chafed. The number of beetles / panicle was influenced by the growth stage of the plant and phase of the panicle's maturity. At the assessment period, grains of Kambal and Sugar graze were at the milky - paste stage (vulnerable stage to the beetle), and the

panicle harboured significantly high number of beetles, *viz*. 2.9 each. Grains of Jumbo and Pannar were also at a vulnerable stage, the paste-ripening, but the number of beetles was significantly lower, (0.1 each/panicle) than those of Kambal and Sugar graze. Jumbo and Pannar scored significantly the lowest PIP (6.7% and 10.3%) and the lowest PPD (0.6% and 1.8%), respectively, compared with all other genotypes. Kambal and Sugar graze recoded 100% and 97% PIP and 99.7%, and 96.7% PPD, respectively (Table 1).

Table 1. Percentage of infested panicles (PIP), percentage of panicle damage (PPD) and number of *Pachnoda* beetles/panicle of sorghum and pearl millet, GRSF, 2011

Genotype	PIP (%)	PPD (%)	Beetles/panicle
		Sorghum	
Jumbo	(6.7) 14.7b	(0.6) 4.4b	(0.1) 0.8b
Pannar 888	(10.3) 18.5b	(1.8) 7.5b	(0.1) 0.8b
Kambal	(100.0) 90.0a	(99.7) 88.1a	(2.9) 1.8a
Sugar graze	(97.0) 84.4a	(96.7) 79.9a	(2.9) 1.8a
		Pearl millet	
Local pearl millet	(93.9) 78.4a	(98.2) 84.0a	(0.1) 0.8b
Ashana	(94.2) 76.6a	(98.8) 85.1a	(0.0) 0.7b
Ugandi	(92.9) 75.4a	(98.7) 84.7a	(0.1) 0.8b
Pearl millet hybrid	(93.5) 75.5a	(98.8) 85.1a	(0.1) 0.8b
SE±	3.6	2.5	0.1
CV%	9.7	6.6	8.6

GRSF = Gezira Research Station Farm

Data on PIP and PPD were transformed to arcsin√x and on beetles/panicle to √x+0.5 (Actual figures in parenthesis).

Means in a column followed by the same letter are not significantly different at $P \leq 0.001$, according to Duncan's multiple range test.

Jumbo and Pannar, unlike Kambal and Sugar graze, were characterized by open panicles consisting of long, pliant and dark spikes. The length and pliancy characters seemed to have restricted landing and clustering and prevented adequate shelter and shade for the beetles. The colour is another factor that had an influence on the beetle's behaviour. Yitbarek

and Hiwot (2000) stated that many scarabaeid beetles, including *P. interrupta*, display attraction to the yellow flowers. Therefore, it is assumed that the dark spikes displayed counter effect on the beetles that had ultimately supported none attractiveness and none preference of Jumbo and Pannar. This was proved by the low results of PIP and PPD recorded. Accordingly, panicle structure and colour operated as morphological resistance factors that repelled *P. interrupta* from Jumbo and Pannar sorghum hybrids. However, presence/absence of other morphological, physiological and chemical repelling / attracting factors are not excluded.

All hybrids of pearl millet showed extremely high panicle attraction and grains sensitivity to the beetle. This was reflected in the high PIP (92.9% to 94.2%) and the high PPD (98.2%-98.8%), that resulted in serious damage to the grains (Table 1).

Damage of *P. interrupta* on sunflower

The beetle appeared in the field at the flowering stage. The damage started from the periphery of the disc towards the centre, following fertilization. Infestation was hybrid dependent. The beetles were mostly found in clusters, and their numbers were influenced by the growth stage of the plant and field management, especially irrigation. High numbers were recorded in areas that suffered irrigation deficiency, and *vice versa*. This was due to cracks formed in the surface of the dry heavy soil that ease emergence of the aestivated adults. Bent stalks, with discs directed towards the ground, were less affected. Discs infected with the fungal head rot formed good habitat for beetles to cluster inside.

As shown in Table 2, none of Alexandra discs were infested with the beetle and no damage was caused to the seeds. This indicated the repulsive effects of the discs and distasteful character of the seeds as food. Accordingly, sunflower/beetle interaction seemed to be hybrid dependent. Pac 361, Pan 7033, Pan 7351 and Hysun 33 were next to Alexandra in PID, PDD and number of beetles/disc. Sirena discs were as attractive as Pac's 361, Pan's 7033, Pan's 7351 and Hysun`s 33 to the beetle, but its

seeds were much highly favoured. ARC 310 revealed moderate disc attraction and moderate seed suitability as food. Pac 317 scored the highest PID (10.3%) and the highest PDD (84.8%), categorizing the discs as the most attractive and the seeds as the most favoured (Table 2).

Table 2. Percentage of infested discs (PID), percentage of disc damage (PDD) and number of *P. interrupta* beetles /disc of sunflower, GRSF, 2011

Genotype	PID (%)	PDD (%)	Beetles/disc
Sirena	(2.4) 1.4bc	(25.3) 27.5b	(1.5) 1.4a
ARC 310	(7.2) 2.6ab	(7.4) 15.2bc	(2.7) 1.7a
Pac 361	(1.0) 1.0cd	(2.1) 8.2bc	(1.0) 1.0a
Pac 317	(10.3) 3.2a	(84.8) 68.4a	(1.5) 1.2a
Alexandra	(0.0) 0.0d	(0.0) 0.0c	(0.0) 0.0b
Pan 7033	(3.0) 1.7bc	(1.2) 6.3c	(1.9) 1.3a
Pan 7351	(3.4) 1.5bc	(1.0) 5.7c	(2.5) 1.6a
Hysun 33	(2.3) 1.5bc	(2.9) 9.8bc	(1.2) 1.1a
SE±	0.38	4.3	0.13
(CV%)	40.3	41.8	19.0
Sig. level	**	***	***

GRSF = Gezira Research Station Farm

Data on PID and beetles/disc were transformed to √x and on PDD were to arcsin√x (Actual figures in parenthesis).

Means in a column followed by the same letter(s) are not significantly different at P ≤ 0.01 (***) and 0.05 (**), according to Duncan's multiple range test.

It is worth mentioning that when adequately irrigated, Pac 317 did not show high beetles' infestation and damage, confirming that *P. interrupta* is a drought induced pest. However, *P. interrupta* potential hazard is especially alarming because of the inevitable drought which is becoming unusual in both irrigated and rainfed agriculture in Sudan.

The results of this study strongly support those of Clarke and Crowe (1978), Yitbarek and Hiwot (2000) and Jonas *et al*. (2009)

CONCLUSIONS

P. interrupta has become a new potential serious pest of sorghum, pearl millet and sunflower in Sudan. Its attack and damage to sorghum and sunflower is cultivar/hybrid dependent, and all the tested pearl millet hybrids showed high sensitivity. Studies on the interaction of *P. interrupta* with the cultivated crops and determination of integrated control tactics are urgently needed.

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أول تسجيل لتفشى خنفساء الذرة الرفيعة علي الدخن وزهرة الشمس والذره الرفيعه في السودان

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المستخلص: تفشت خنفساء الذرة الرفيعة *Pachnoda interrupta* Olivier (Coleoptera: Cetoniidae) في موسم 2011 لأول مرة بالسودان في مزرعة محطة بحوث الجزيرة على أربعة طرز من الذرة الرفيعة (*Sorghum bicolor*) و أربعة طرز من الدخن (*Pennisetum glaucum*) و ثمانية طرز من زهرة الشمس (*Helianthus annuus*). هدفت الدراسة إلى تحديد ضرر الخنفساء على هذه الطرز الوراثية. تم تحديد النسبة المئوية للقناديل و الأقراص المصابة و نسبة الضرر في القناديل و الأقراص و عدد الخنافس في القندول / القرص. أظهر طرازا الذرة جومبو و بانار تحملا للخنفساء بإحرازهما لأقل نسبة مئوية من الإصابة و الضرر على القناديل بينما أظهر الطرازان كمبال و شوقر قريز حساسية عالية لها. أبدت جميع طرز الدخن المختبرة حساسية عالية للخنفساء بتسجيلها لنسبة إصابة على القناديل تراوحت بين92.9% و 94.2 % ، و نسبة ضرر بين 98.2% و 98.8%. أبدى طراز زهرة الشمس أليكساندرا تحملا عاليا للخنفساء بعدم تسجيله لأي إصابة أو ضرر على الأقراص، و الطرز بان 7033 و بان 7351 و هايسن 33 تحملا لها بينما عكست أقراص و حبوب الطرز سايرينا و ARC 310 جاذبية عالية نسبيا لها و سجل الطراز باك 317 أعلى درجة جذب للأقراص وأعلى درجة تفضيل للحبوب من قبل الخنفساء. خلصت الدراسة إلى أن خنفساء الذرة الرفيعة أضحت آفة خطيرة محتملة على الذرة الرفيعة و الدخن و زهرة الشمس بالسودان، و أن الإصابة بها تعتمد على الأصناف / الهجن المزروعة من الذرة الرفيعة و زهرة الشمس. أما الدخن، فلقد عكست جميع طرزه المختبرة حساسية عالية تجاهها.