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Evaluation of efficiency of two *Bacillus thuringiensis* subspecies *kurstaki* formulations againstPearl millet head miner *Heliocheilus albipunctella* (De Joaniss) (Lepidoptera: Noctuidae) under rain-fed conditions in North Kordofan, Sudan

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Abstract

This experiment was conducted for two successive seasons 2012-2013 in Molbus area, North Kordofan State, Sudan. The experiment aimed to evaluate the efficiency of *Bacillus thuringiensis* subspecies *kurstaki* to control *Heliocheilus albipunctella* (De Joaniss*)* on pearl millet. Protecto 94 and Agerin (WP 6.5), the two commercial *B.t* formulations were tested. The experiment was arranged in a randomized complete block design with four replications. The treatments were foliar applications of Protecto 94 at rate of 712.3 and 535.7 g/ha, Agerin at rate of 1190.5 and 892.9g/ha beside untreated control. Throughout the study Protecto 94 at all tested rates showed no *H. albipunctella* larvae followed by Agerin at rate of 1190.5 and 892.9g/ha which recorded 2.3 and 3.6 larva/10 heads respectively. According to the combined analysis of pearl millet grain yield the highest mean yields were obtained by Protecto at 712.3 and at 535.7 g/ha (479.8 and 463 kg/ha respectively). Agerin at 1190.5 g/ha proved less effective (398.9 kg/ha) followed by Agerin at 892.9 g/ha (343kg/ha), but were significantly superior compared to the untreated control (198 kg/ha). According to these results, *B. thuringiensis* subspecies *kurstaki* showed good potential as control agent against *H. albipunctella* on pearl millet under rain-fed conditions.

Keywords: Pearl millet, *Heliocheilus albipunctella*, *Bacillus thuringiensis*, control.

Introduction

Universally, cereals are important food crops, among which millet is the sixth most important cereal in the world (FAOSTAT, 2015). In Sudan pearl millet is an important cereal crop, next to sorghum (Abuelgasim and Jain1987). It contributes the stable food of the majority of inhabitants of Western part of Sudan (Darfur and Kordofan) where it occupies an area of 1.2- 2.938 million hectares. Most of the millet area in the Sudan (95%) is cultivated and harvested under traditional rain fed agriculture (Anonymous, 2014). Sudan produced 1.245 million metric tons of pearl millet in 2014 (AOAD, 2015). One of the main constrains of the production of pearl millet in Sudan is insect pests attacks (Sabil, 1991). The head miner *Heliocheilus albipunctella* (De Joaniss) locally called "Nafaasha" in western Sudan is most economically important pest attacks pearl millet (Mardi,2007). The larva of *H. albipunctella* is a destructive stage and the larvae complete their development in 23 to 39 days (Elhassan, 1985). Nwanze (1992) reported that the damage by varies larval age. The

young larvae feed on floral glumes having whitish excreta around the flowers. Full-grown larvae cut the floral peduncles, eating their way between the rachis and flower and pushing the damaged flowers or developing grains outwards in the process. This produces characteristic spiral mines on the earhead. Mardi (2007) stated that extensive damage by this pest may result in skeletonized panicles when the dislodged grain is blown off by wind. Bashir (1998) reported that the compact head pearl millet landraces such as "Dembi and Um Garffa" are tolerant to *H. albipunrvactella.* Although, no chemicals are registered for control *H. albipunctella* but usage of some insecticides were reported (Mardi, 2007).

Presently, *B. thuringiensis* is a Gram-positive, soil dwelling bacterium which is commonly used worldwide as pesticides against some insect pests on horticultural and field crops (Abdelrahman, 2014). Based on the trend of the minimize using of chemicals for insect pest control, the current study was designed to evaluate the efficacy of two *B. thuringiensis* subspecies *kurstaki* formulations in the field to control *H. albipunctella* on pearl millet under rain-fed conditions in North Kordofan, Sudan.

Materials and Methods

This experiment was conducted for two successive seasons 2012 and 2013 in Molbus area (Lat: 13 01 08 N, long: 30 14 50 E alt 547 m) North Kordofan State, Sudan. The soil of experimental site is sandy where the sand fraction amounts to more than 88%. Sound seeds of pearl millet variety "Ashana" were sown on 18 July and 19 July for the 2012 and 2013 seasons, respectively. Three seeds were planted at distances of 50 cm between holes and 75 cm between rows. Plot consisted of 6 rows 4 meters in length. Plots were weeded twice, after two and four weeks after planting. Manual harvesting was done 75- 80 days after planting. The experiment was arranged in a randomized complete block design with four replications. Five treatments were tested these include two B.t. commercial products. , Protecto 94 at rates of 712.3 and 535.7 g/ha and Agerin at rates of 892.9 and 1190.5 g/ha and untreated control.

One spray was applied by of *B.t.* formulations against the larval stage of head miner at 50% flowering (53 days from sowing). Pre-spray count of *H. albipunctella* larvae was made by selecting ten pearl millet heads randomly from each plot (replication) while post-spray count was made 7 days after spray. Pear millet grain yield (Kg/ha) was recorded at harvest for the two seasons of the study. Data were subjected to analysis of variance (ANOVA) for CRBD and means were separated by Duncan's Multiple Range Test (DMRT).

Results and discussion

One spray of insecticides was required to protect the pearl millet crop from the infestation of *H. albipunctella*. The observations on the larvae population were recorded one day before and seven days after treatment. According to Table 1 the insecticidal treatments reduced the larvae population significantly over the control days after treatment in 2012. However, significant differences existed between them with Protecto 94 at 712.3 and at 535.7 g/ha were best as no larvae were recorded. Agerin at 1190.5 g/ha (1.8 larvae/10 heads) and Agerin at 892.9 g/ha (2.8 larvae/10 heads).shared the 2nd rank. The same pattern was recorded in the second year (2013) as one spray was effective to control *H. albipunctella* on pearl millet. The two tested *B.t* insecticides with different doses reduced the larvae population compared to the untreated control (Table 1). Protecto at 712.3 and at 535.7 g/ha treatments were free of *H. albipunctella* larvae followed by Agerin at 892.9 and 1190.5 g/ha (2.8 and 4.5 larvae/10 heads) which were significantly

lower than the untreated control (24.3 larvae/10 heads respectively). This result agreed with Mardi (2012) who found that Agerin showed less efficacy than Protecto when applied under rain-fed conditions to control *Helicoverpa armigera* (Hub.). Similar results were reported on application Agerin and BTK to control *Antigastra catalaunalis* (Dup.) under such conditions (Suliman *et al*., 2013).

Effect of *B.t* insecticides on the yield of pearl millet

Yield of pearl millet grain (kg/ha) for the two seasons of experiment is shown in Table 2. The two commercial products of *B.t* at all tested doses supported higher yields than the untreated control. In the first season, Protecto at 712.3 g/ha resulted in the highest grain yield (507.2 kg/ha) followed in rank by Protecto at 535.7 g/ha while Agerin at 1190.5 and 892.9 g/ha shared a 3rd rank (413.5 and 409.2 kg/ha respectively) compared to Protecto at all tested doses. For the 2013 season, the highest grain yield was recorded equally for Protecto at 712.3 and at 535.7 g/ha (452.4 and 443 kg/ha respectively), followed by Agerin at 1190.5 g/ha (384.2 kg/ha) that ranked 2nd, which Agerin at 892.9 g/ha ranked 3rd with yield of 276.8 kg/ha. The combined analysis of pearl millet grain yield showed that, highest means yield were equally obtained by Protecto at 712.3 and at 535.7 g/ha (479.8 and 463 kg/ha respectively). The treatment of Agerin at 1190.5 g/ha ranked 2nd (398.9 kg/ha) followed by Agerin at 892.9 g/ha (343 kg/ha) which was also, significantly superior as compared to the untreated control (198 kg/ha). This might be attributed to their effect on the control of *H. albipunctella* larval damage. Similar results were reported by Mardi (2012) and Suliman *et al.* (2013) who applied some *B. thuringiensis* subspecies *kurstaki* formulations under rain- fed conditions to control of *H. armigera* and *A. catalaunalis* on sorghum and sesame respectively. In conclusion, the results of this study revealed significant control *H. albipunctella* by the Protecto formulation of *B. thuringiensis* subspecies *kurstaki* under rain-fed conditions. Such applications of bio-pesticides lack health hazards, environmentally friendly are step towards organic farming.

Table 1. Effect of some insecticides on number of pearl millet head worm *H. albipunctella* larvae (seasons 2013 and 2014)

Treatments (g/ha)	Mean number of larvae/10 heads			
	Season 2012		Season 2013	
	Pre-spray count	post-spray count	Pre-spray count	post-spray count
Protecto at 712.3	4.0 a	0.0 (0.7) c	12.0 a	0.0 (0.7) c
Protecto at 535.7	3.5 a	0.0 (0.7) c	11.0 ab	0.0 (0.7) c
Agerin at 1190.5	3.8 a	1.8 (1.5) b	9.5 b	2.8 (1.8) b
Agerin at 892.9	4.0 a	2.8 (1.8) b	11.0 ab	4.5 (2.2) b
Control (untreated)	4.3 a	12.3 (3.6) a	10.0 ab	24.3 (4.6) a
SE±	0.5	0.08	0.4	0.2
C.V. (%)	26	11.5	8.7	17.8
LSD	1.585	0.2923	1.462	0.5490

-Means with the same letter in the same column are not significantly different (P< 0.05) according to DMRT.

- Values between brackets were transformed to √x+0.5.

Table 2. The effect of application of some insecticides to control *H. albipunctella* on pearl millet yield (Kg/ha).

Treatments (g/ha)	Season		Combined
	2012	2013	
Protecto at 712.3	507.2 a	452.4 a	479.8 a
Protecto at 535.7	483.0 b	443.0 a	463.0 a
Agerin at 1190.5	413.5 c	384.2 b	398.9 b
Agerin at 892.9	409.2 c	276.8 c	343.0 c
Control (untreated)	204.0 d	191.9 d	198.0 d
SE±	5.0	10.6	6.0
C.V. (%)	2.8	6.8	5.1
LSD	16.94	36.82	29.38

-Means with the same letter in the same column are not significantly different (P< 0.05) according to DMRT.

References

Abdelrahman, A.A. (2014). *Integrated Pest Management With Special Reference to the Gezira Scheme*. Sudan Currency Printing Press, Khartoum, Sudan.180pp

Abuelgasim, H.E.and Jain, R.P. (1987). Breeding pearl millet for drought in the Sudan. Proceedings of the international Pearl Millet Workshop (7-11 April, 1986), ICRISAT Center India pp: 307-308.

Anonymous. (2014). Statistics of the Rain-fed Sector Administration. Federal Ministry of Agriculture, Khartoum, Sudan.

AOAD (2015). *Arab Agricultural Statistics Yearbook No. 32*. Arab Organization for Agricultural Development, Khartoum, Sudan.

Bashir, Y.G. (1998). Pearl millet research, Entomology section, Elobeid Research Station, Agricultural Research Corporation, Annual Report, P 12.

Elhassan, A.E.M. (1985). Insect survey of Elobeid area, Entomology section, Elobeid Research Station. Agricultural Research Corporation, Annual Report, P 77.

FAOSTAT (2015). Food and Agriculture Organization (FAO). http://faostat3.fao.org/faostat-gateway/go/to/download/Q/*/E.

Mardi, H. G. (2007). Pearl millet research, Entomology section, Elobeid Research Station, Agricultural Research Corporation, Annual Report, P 21.

Mardi, H. G. (2012). Pearl millet research, Entomology section, Elobeid Research Station, Agricultural Research Corporation, Annual Report, P 17.

Nwanze, K. F. (1992). Insect pests of pearl millet in West Africa. *Review of*

Agicultural Entomology, 80, (12): 1134-1155.

Sabil, A.H. (1991). Environmental Constrains to pearl millet Production in North Darfur, Sudan. M.Sc. Thesis, University of Reading U.K., 192pp.

Suliman, E. H., Bashir, N. H. H. and Asad, Y. O. (2013). Efficacy of two *Bacillus thuringenesis* subspecies *Kurstkati* formulations in the field against Sesame webworm, *Antigastra catalaunalis* (Dup.) (Lepidoptera: Pyraustidae) on sesame. *Entomol Ornithol Herpetol*, 2 (2): 74 (Abstract).

تقييم فعالية مستحضرين من البكتريا الممرضة للحشرات *Bacillus thuringiensis* subspecies *kurstaki* ضد حافرة أنفاق رأس الدخن اللؤلؤى *Heliocheilus albipunctella* (De Joaniss) تحت ظروف الأمطار فى شمال كردفان، السودان

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المستخلص:

أُجريت هذه التجربة حقلية لموسميين (2012 و 2013) فى منطقة الملبس، ولاية شمال كردفان ، السودان لتقييم فعالية البكتريا الممرضة للحشرات *Bacillus thuringiensis* subspecies *Kurstkati* لمكافحة حافرة أنفاق رأس الدخن اللؤلؤى. تم إختبار إثنين من المستحضرات التجارية بروتيكتو 94 و أقرين (VP65). رُتبت التجربة فى تصميم القطاعات العشوائية الكاملة باربع مكررات. تم إختبار 5 معاملات كالأتى : بروتيكتو بمعدل 712,3 و 535,3 جرام/هكتار، أقرين بمعدل 1190,5 و 892,9 جرام/ كتار و الشاهد غير المعامل .طوال فترة الدراسة أظهر المستحضر التجارى بروتكتو 94 عدم وجود يرقات فى كل معدلاته المختبرة تلاه أقرين بمعدل 1190,5 و 892,9 جرام/هكتار و الذين سجلا متوسط 2,3 و 3,6 يرقة/10 قندول على التوالى. أوضح التحليل التجميعى لإنتاجية حبوب الدخن إن أعلى متوسط إنتاجية قد نتج عن المعاملة بمبيد بروتيكتو بمعدل 712,3 و 535,3 جرام/هكتار (479,8 و 463 كيلوجرام/هكتار). أعطى أقرين بمعدل 1190,5 جرام/هكتار 398,9 كيلوجرام/هكتار تلاه أقرين بمعدل 892,9 جرام/هكتار والذى أعطى 431 كيلوجرام/هكتار بينما أعطى الشاهد غير المعامل 198 كيلوجرام/هكتار. إعتماداً على هذه النتائج، أظهرت البكتريا الممرضة للحشرات *B. thuringiensis* subspecies *Kurstkati* فعالية جيدة كعنصر مكافحة ضد يرقات حافرة أنفاق رأس الدخن اللؤلؤى تحت ظروف الرى بالأمطار.