

EFFICACY OF SEED DRESSING INSECTICIDES AT DIFFERENT DOSES FOR THE CONTROL OF SORGHUM SHOOT FLY *ATHERIGONA SOCCATA* (ROND.) (DIPTERA: MUSCIDAE)

KHALIQ A¹, MASOOD SA¹, RAUF HA¹, FAHEEM U⁴, MEHMOOD K^{1,2}, BASIT A³, NADEEM M³, JABBAR A³, KHAN AA³, MUHAMMAD T¹

¹Cotton Research Institute, Khanpur, Pakistan

²Regional Agricultural Research Institute, Bahawalpur, Pakistan

³Fodder research institute Sargodha, Pakistan

⁴Entomological Research Institute, Sub-station, Multan, Pakistan

Corresponding author email address: s.ahtisham01@gmail.com, 03327338445

(Received, 17th August 2021, Revised 25th September 2022, Published 30th September 2022)

Abstract: Shoot fly, *Atherigona soccata* (Rondani); an invasive pest of sorghum/jowar. Selection of proper pesticide with suitable dose is the key to economical and effective control of shoot fly. Field experiments were conducted for two consecutive years 2014-2015 during kharif season in Fodder Research Institute, Sargodha-Pakistan to find out the impact of three seed dressing insecticides at different doses (Confidor @ 2.5g, 5g, 7.5g & 10g, Actara 2.5g, 5g & 7.5g and Hombre 2ml, 4ml & 6ml) for the control of sorghum/jowar shoot-fly. It was observed that all treated plots showed significantly lower dead hearts percentage caused as compared to control. Amongst chemicals the treatment with Actara (thiamethoxam) @ 7.5g and 5g/kg seed recorded significantly lowest dead hearts (11.5, 11.9%) and gave maximum yield (1.79, 1.73 t/h). Therefore, to avoid and reduce toxic effects of direct spray on sorghum against shoot fly and to maximize the yield it is recommended to use thiamethoxam @ 5 g/kg as a seed dressing insecticides for both fodder and seed crop of sorghum.

Keywords: Sorghum bicolor, dead hearts, *Atherigona soccata*, seed dressing, insecticides

Introduction

Sorghum (*Sorghum bicolor* L. Moench) belongs to family Gramineae, is very important crop of Asia, America, Africa and Australia. Sorghum is one of the oldest cultivated cereals, having its origin in Africa (Iqbal and Iqbal 2015). It is mainly grown for feed, food, fodder, forage and fuel purposes, throughout the globe. It ranks in fifth position in cereal crops after wheat, rice, maize and barley. It is liked as a staple food for large hungry and poor people (Mehmood *et al.*, 2008). It is grown to obtain both fodder and grains. Sorghum fodder contains >50% digestible nutrients including, protein 8%, fat 2.5% and 45% nitrogen-free extract (Habib *et al.*, 2013). However, its grains possess 70% carbohydrates, 10-12% protein and 03% fat, due to these properties it can replace the other grains crops from feeding menu for dairy animals and poultry (Ullah *et al.*, 2007). It also provides basic raw material for the preparing syrup, fiber, alcohol, starch, dextrose, biofuels and other useful items. It is excellent source of ethanol which can be used for fuel by saving precious foreign exchange (Reddy *et al.*, 2005). Sorghum considered as very important forage crop in many parts of the world (Bhatti *et al.*, 2008).

In Pakistan, sorghum is locally named as Jowar which is considered as an important kharif season fodder crop. Its fodder is an essential livestock feed used to maintain good animals health. Amongst other provinces of Pakistan, more land area is under sorghum cultivation in Punjab as it is the largest province in terms of population. Punjab having >64 million heads of animals and sorghum alone fulfills about 50% of feed requirement in rain fed areas (Punjab development statistics, 2013).

Many insect pests invade sorghum crop which reduce production and cause economic losses. More than 150 insect pest species infest the sorghum crop starting from sowing till harvesting (Shekharappa and Bhuti, 2007). Among these insects, shoot fly as a major yield reducing factor of sorghum (Kumar *et al.*, 2008). Shoot fly mainly attacks sorghum during 1- 4th week after crop emergence. Female lays cigar shaped white eggs on the lower side of leaf (Padmaja *et al.*, 2010). Emerging maggots enter the central whorl by cutting the central leaf and feed on decaying material. Due to which central shoot dries off showing typical dead heart symptoms (Dhillon *et al.*, 2006a). Shoot fly takes 17-21 days to complete its life cycle (Sharma *et al.*, 2003). In India 68% of forage yield and 80-90% of grain yield losses was



observed due to shoot fly attack on sorghum crop (Balikai and Bhagwat, 2009; Kahate et al., 2014). Many shoot fly management approaches have been carried out to reduce its losses, including cultural/agronomic practices, host plant resistance, natural enemies and synthetic insecticides (Kumar et al., 2008), but application of all these management practices is not always possible. As farmers often use chemical pesticides sprays against shoot fly that are very harmful to the natural beneficial insects and to the environment. Further, spray chemicals are also not efficient to control shoot fly as its larvae feed inside the leaf whorls where insecticide seldom reach. Therefore, this study was carried out to find out most effective seed dressing insecticides with their best doses that not only increase fodder and grain yield of sorghum but also reduce hazardous

issues being low toxic as compared to direct spray on fodder crops.

Materials and methods

The field experiment was conducted during kharif season for two years (2014-2015) at Fodder Research Institute, Sargodha-Pakistan. The genotype, Hegari was sown during mid-July each year. There were four rows of sorghum with row spacing of 45 cm and 15 cm plant to plant having the plot size of 5x1.8 meters in each treatment. Total 11 treatments were replicated thrice using randomized complete block design. All agronomic practices viz; ploughing, fertilizer application, irrigation, thinning etc. were same in all 11 treatments except seed dressing by different chemicals with different doses (Table 1). The measured quantity of the chemicals was mixed with seeds and after mixing, the treated seeds were dried under the shade and used for sowing.

Table 1: Detail of seed dressing treatments

Treatments	Trade Name	Common Name	Dose/Kg Seed
T-0	Control	-	-
T-1	Confidor 70 WS	Imidacloprid	2.5 g
T-2	Confidor 70 WS	Imidacloprid	5 g
T-3	Confidor 70 WS	Imidacloprid	7.5 g
T-4	Confidor 70 WS	Imidacloprid	10 g
T-5	Actara 70 WS	Thiamethoxam	2.5 g
T-6	Actara 70 WS	Thiamethoxam	5 g
T-7	Actara 70 WS	Thiamethoxam	7.5 g
T-8	Hombre 186.25 FS	Imidacloprid +Tebuconazole	2ml
T-9	Hombre 186.25 FS	Imidacloprid +Tebuconazole	4 ml
T-10	Hombre 186.25 FS	Imidacloprid +Tebuconazole	6 ml

Data collection

Data was collected after 15, 25, 35 days after sowing by counting the number of dead hearts percent caused by shoot fly from middle rows from each treatment. Percentage was calculated using following formula:
 Dead heart incidence (%) = (Number of plants having dead heart / number of total plants) × 100. Finally the obtained yield was recorded and data was statistically analyzed to know the efficacy of each treatment against shoot fly (Rangaswamy, 2002).

Benefit of each treatment = (Obtained yield of each treatment – Obtained yield of control plot) X NPV of sorghum

Where NPV is net present value of sorghum grains

Net benefit = Benefit of each treatment – Cost of each treatment

Cost and benefit Analysis

Cost benefit Ratio

Cost/benefit ratio was calculated to see the net benefit of each treatment to farmers using below given formula.

Statistical Analysis

Data was statistically analyzed to find the difference among treatments at a significance level of 0.05 and ANOVA, analysis of variance was performed using Statistix 8.1. From the data, the homogenous groups are kept with similar letters based on Tukey’s test values. Dead heart %age was calculated using Rangaswamy’s formula (Rangaswamy 2002).

$$\text{Dead hearts \%age} = \frac{\text{No. of Plant with dead hearts}}{\text{Total No. of observed Plants}} \times 100$$

Results

Efficacy of seed dressing chemicals on incidence of shoot fly

[Citation: Khaliq, A., Masood, S.A., Rauf, H.A., Faheem, U., Mahmood, K., Basit, A., Nadeem, M., Jabbar, A., Khan, A.A., Muhammad T. (2022). Efficacy of seed dressing insecticides at different doses for the control of sorghum shoot fly *Atherigona soccata* (Rond.) (Diptera: Muscidae). *Biol. Clin. Sci. Res. J.*, 2022: 120. doi: <https://doi.org/10.54112/bcsrj.v2022i1.120>]

After one week of germination shootfly maggots were found in non-treated plots in sufficient numbers causing dead hearts in the crop. Maximum number of dead hearts were found in crop after 35 days of germination but crop situation was visibly different after 25 days of germination between different treatments (Figure 1 A,B,C). Among the seed treatments in Trial I, minimum % no of dead hearts (11.5) were found in Actara treated plot with 7.5g dose followed by Actara 5g (11.9%), Confidor 10 (13.1%), Confidor 7.5g (13.3%) as compared to

control plot (34.7%). Among different dressing treatments maximum damage (22.4%) was observed in Confidor 2.5g treated plot as shown in Figure 1. Similar trend was found in Trial II with 12.3%, 12.6%, 13.4%, 13.8%, 38.6% in Actara 7.5g, Actara 5g, Confidor 5g, Confidor 10g and control plot respectively (Figure 1D). While comparing the dead heart percentage at different time intervals between 15, 25 and 35 DAS, more damage was observed during 25-35 DAS in all treatments from both trials (Figure 1,2).

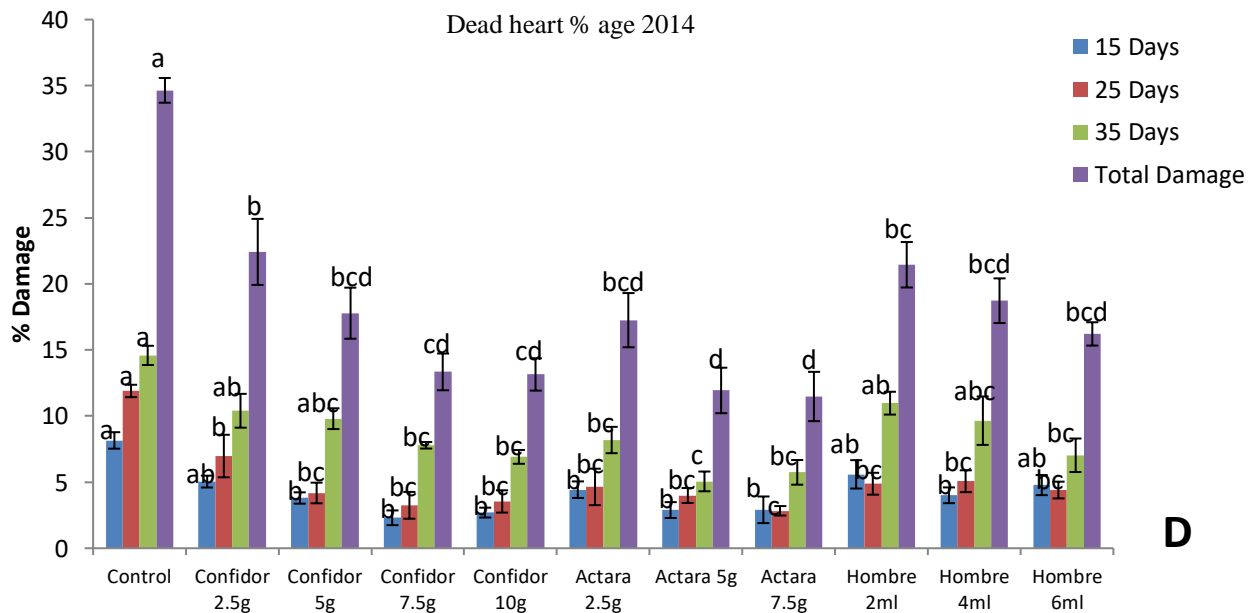


Figure 1: Shoot fly maggots on dead hearts (A), Dead hearts of sorghum on non treated plot (B) Crop situation in treated crop with Actara 5g (C), Comparisons of different treatments with respect to dead heart percentage in 2014

[Citation: Khaliq, A., Masood, S.A., Rauf, H.A., Faheem, U., Mahmood, K., Basit, A., Nadeem, M., Jabbar, A., Khan, A.A., Muhammad T. (2022). Efficacy of seed dressing insecticides at different doses for the control of sorghum shoot fly *Atherigona soccata* (Rond.) (Diptera: Muscidae). *Biol. Clin. Sci. Res. J.*, 2022: 120. doi: <https://doi.org/10.54112/bcsrj.v2022i1.120>]

Sorghum seed dressing was done with different doses of Confidor, Actara and Hombre to see their effect on sorghum as evident from dead hearts caused by shoot

fly. Maximum dead hearts were found in control plot and minimum in plot treated with Actara 7.5g.

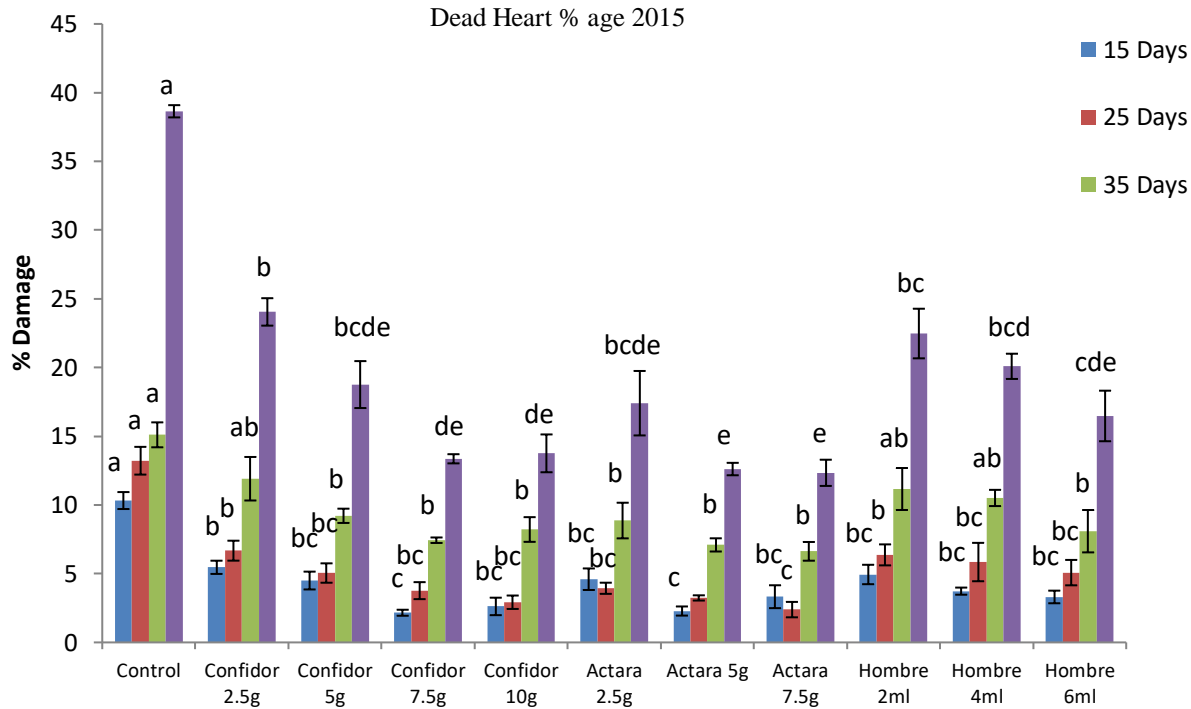


Figure 2: Dead heart percentage of sorghum in different treatments in 2015

The present study was confirmed from the results of Vadodaria et al. (2001) who recorded the efficacy of thiamethoxam and imidacloprid as seed dressing chemicals against sucking pests of cotton. The results obtained by Patil et al. (2004) on the efficacy of thiamethoxam as seed treatment for the control of sucking insect pests of cotton further confirmed the

current study. Daware et al, 2011 reported that thiamethoxam (70 WS) @ 3.1 gm a.i./kg recorded significantly lowest dead hearts (22.66 %) and next best treatment was imidacloprid (70WS) @ 7.0 gm a.i./kg this further confirmed our results. Further, some new dead hearts were observed in crop at maturity stage (Figure 3).



[Citation: Khaliq, A., Masood, S.A., Rauf, H.A., Faheem, U., Mahmood, K., Basit, A., Nadeem, M., Jabbar, A., Khan, A.A., Muhammad T. (2022). Efficacy of seed dressing insecticides at different doses for the control of sorghum shoot fly *Atherigona soccata* (Rond.) (Diptera: Muscidae). *Biol. Clin. Sci. Res. J.*, 2022: 120. doi: <https://doi.org/10.54112/bcsrj.v2022i1.120>]



Figure 3: Mature treated crop showing fresh dead hearts

Effect of seed dressing chemicals on yield

At maturity of crop visible difference was observed in plots with different treatments (Figure 4A, B). More number of dead hearts led to low final yield of crop. After dead heart percentage calculations for damage assessment actual effect on yield was also measured in both trials. Highest yield was observed in Actara treated plots (1.79, 1.73 t/h) both @ 5g and 7.5g respectively in trial I. This was significantly higher than all other treated plots with observed yield of 1.66, 1.62, 1.35, 1.26, 1.24 t/h in Confidor 10g, Confidor 7.5g, Hombre 6ml, Confidor 5g and Actara 2.5g respectively (Figure 4C). Yield of all treatments was significantly higher than control plot with

Net benefit of seed treatments

Although, maximum yield was obtained from Actara treatment @7.5g but when net benefit was calculated, it was observed that maximum net benefit was obtained with Actara treatment @ 5g due to its less cost as compared to Actara treatment @ 7.5g. Net benefit of Actara 5 g was followed by Confidor 10g as shown in figure 4.

Discussion

Sorgham is major fodder crop of Kharif that is attacked by many biotic factors mainly, Shootfly. Sorgham shootfly severely damages the crop at seedling stage. Many control strategies are applied to manage this serious pest (Mohammad et al 2016). Many strategies are employed to manage this serious crop pest including host plant resistance, biocontrol agents, botanicals and chemical pesticides. Further, chemical pesticides are either used as foliar sprays,

observed yield of 0.50 t/h. Similar trend was observed in Trial II where maximum yield was found in Actara 7.5g and 5g (1.67T/H & 1.59 t/h) respectively as compared to control plot with observed yield of 0.48 t/h (Figure 4C). Grain yield of sorghum per plot was obtained from each treatment and converted into yield tons/hectare and it was observed that due to low shoot fly infestation and minimum number of dead hearts the maximum yield (1.79 and 1.67 t/h) was obtained from Actara 7.5g treated plot and minimum yield (0.50 and 0.48 t/h) was obtained from control plot. These results are in accordance with Daware et al, 2011 as they observed highest sorghum grain yield from thiamethoxam treated plots.

seed dressing or both. Selection of suitable pesticide with effective dose management is key to success of any pest control program. Wrong selection of pesticides is not only wastage of pesticide but also leads to ineffective control thus reducing the crop yields. Further, proper dose management of selected pesticide is equally important as pesticide selection. High dose applications may give better control of target pest as observed in current study where best control was observed in T7 (Actara 7.5g/kg) seed with 11.5% dead hearts followed by T6 (Actara 5g/kg) seed with 11.9% dead hearts. Similar results were observed in previous studies (Daware et al 2011; Sridhar et al 2016). On the other hand high dose of seed dressing chemicals may cause severe side effects like reduction of pollinators and damage to soil fauna (Zaller et al 2016). Further, we worked out yield losses and cost benefit ratio against

[Citation: Khaliq, A., Masood, S.A., Rauf, H.A., Faheem, U., Mahmood, K., Basit, A., Nadeem, M., Jabbar, A., Khan, A.A., Muhammad T. (2022). Efficacy of seed dressing insecticides at different doses for the control of sorghum shoot fly *Atherigona soccata* (Rond.) (Diptera: Muscidae). *Biol. Clin. Sci. Res. J.*, 2022: 120. doi: <https://doi.org/10.54112/bcsrj.v2022i1.120>]

different seed dressing chemicals with different doses. It was observed that Actara 7.5g gave maximum yield/economic (1.67 t/h) benefit followed by Actara 5g (1.59 t/h) which was significantly higher as compared control treatment (0.48 t/h). However, the difference of economic benefit among Actara 7.5g and Actara 5g was not statistically significant. Hence, it is concluded to use thiamethoxam @ 5 g/kg to control shootfly with maximum control and minimum side effects, similar approach was used by Daware et al (2011).

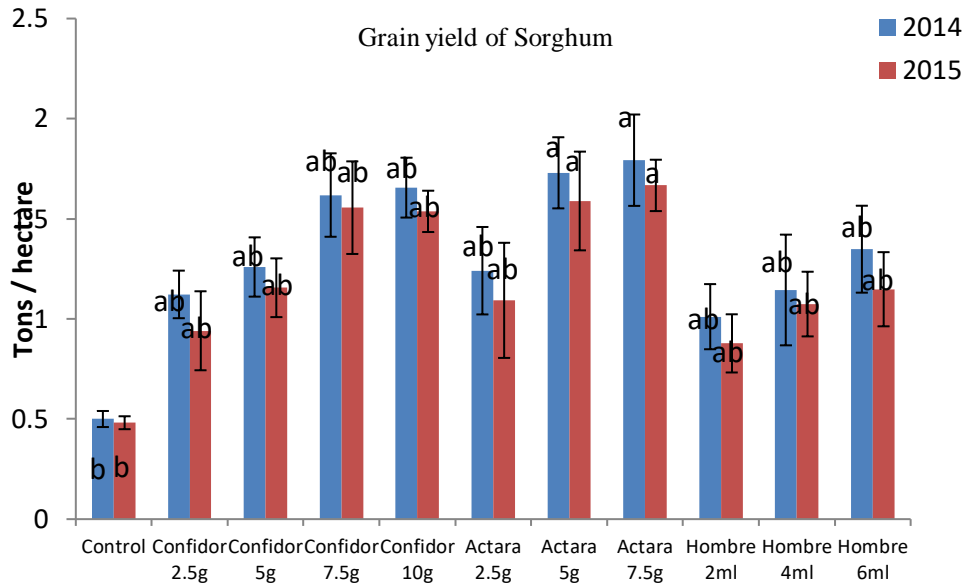
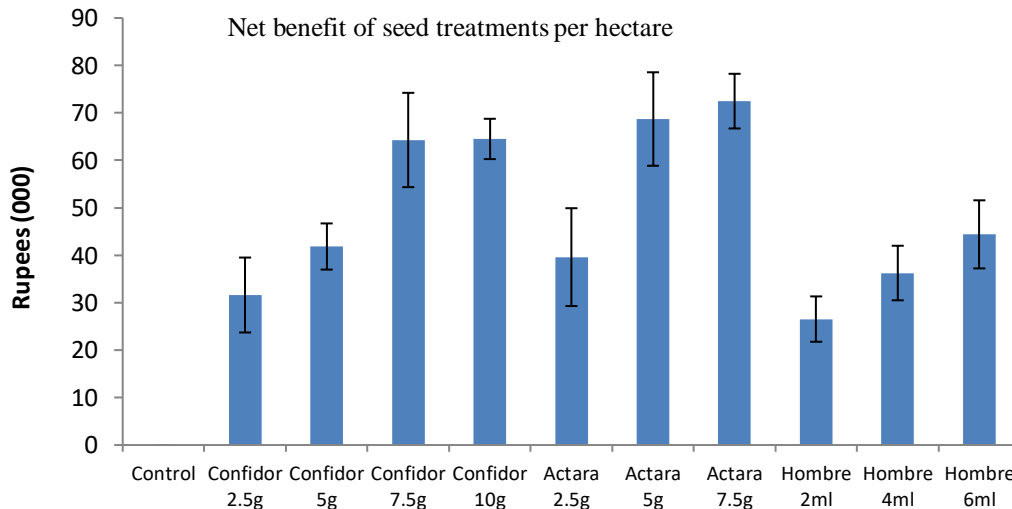


Figure 4: Yield (t/h) of sorghum in different treatments to control shoot fly



Conflict of interest

The authors declared absence of conflict of interest.

References

Kumar A. A, Reddy, B. V. S., Sharma, H. C., & Ramaiah B. (2008). Shoot fly (*Atherigona soccata*) resistance in improved grain sorghum

[Citation: Khaliq, A., Masood, S.A., Rauf, H.A., Faheem, U., Mahmood, K., Basit, A., Nadeem, M., Jabbar, A., Khan, A.A., Muhammad T. (2022). Efficacy of seed dressing insecticides at different doses for the control of sorghum shoot fly *Atherigona soccata* (Rond.) (Diptera: Muscidae). *Biol. Clin. Sci. Res. J.*, 2022: 120. doi: <https://doi.org/10.54112/bcsrj.v2022i1.120>]

- hybrids. *Journal of Semi Arid Tropics, Agricultural Research*, **6**, 1-4.
- Bhatti, I. H., Ahmad, R., Jabbar, A., Nazir M. S., & Mahmood, T. (2008). Competitive behaviour of component crops in different sesame legume intercropping systems. *International Journal of Agriculture & Biology*, **8**, 165-167.
- Balikai R. A., & Bhagwat, V. R. (2009). Evaluation of integrated pest management components for the management of shoot fly, shoot bug and aphid in rabi sorghum. *Karnataka Journal of Agricultural Sciences*, **22**, 532-534.
- Dhillon M. K., Sharma, H. C., Reddy, B. V. S., Ram, S., Naresh, J. S. (2006). Inheritance of Resistance to sorghum Shoot Fly, *Atherigona soccata*. *Crop Sciences*, **46**, 1377-1383.
- Jotwani. M.G., & Sukhani, T. L. (1971). Seed treatment for the control of sorghum shootfly. *Pesticides*, **5**(4), 3-14.
- Mote, U.N. (1983). Relative damage due to major pests and losses caused by them on kharif ratoon and rabi sorghum. *Pesticides*, **17**(4), 19-20.
- Shekharappa and Bhuti, S. G. (2007). Integrated Management of sorghum Shoot fly, *Atherigona soccata* Rondani. *Karnataka Journal of Agricultural sciences*, **20**(3), (535-536)
- Ullah A., Khan, A. A., Nawab, K., Khan, A., & Islam, B. (2007). Growth characters and fodder production potential of sorghum varieties under irrigated conditions. *Sarhad Journal of Agriculture*, **23**, 265-268.
- Yadav, O.P. (1994). Relative performance of pearl millet hybrids and open pollinated varieties in arid environments. *International sorghum and Millet Newsletter*, **35**: 67-68.
- Iqbal, M.A., & Iqbal, A. (2015). Overviewing forage shortage for dairy animals and suitability of forage sorghum for ensiling. *Global Veterinaria*, **14**(2), 173-177.
- Punjab development statistics. (2013). *Govt. of Punjab, Pakistan. Annual Reports*, 80-140.
- Mehmood, S., Bashir, A., Amad, A., & Akram, Z. (2008). Molecular characterization of regional *Sorghum bicolor* varieties from Pakistan. *Pakistan Journal of Botany*, **40**, 2015-2021.
- Kahate N. S., Raut, S. M., Ulemale, P. H., Bhogave, A. F. (2014). Management of sorghum Shoot Fly. *Popular Kheti*, **2**, 72-74.
- Mohammed, R., Are, A.K., Munghate, R. S., Bhavanasi, R., Polavarapu, K. K. B., & Sharma, H. C. (2016). Inheritance of Resistance to sorghum Shoot Fly, *Atherigona soccata* in sorghum, *Sorghum bicolor* (L.) Moench. *Frontiers in plant science*, **7**.
- Padmaja P. G., Madhusudhana, R., Seetharama, N. (2010). Sorghum Shoot Fly. Hyderabad: Directorate of Sorghum Research. *Asian Journal of Agriculture and Rural Development*, **3**(5) 2013, 283-289.
- Sharma H. C., Taneja, S. L., Kameswara, Rao, N., Prasada, & Rao, K. E. (2003). Evaluation of Sorghum Germplasm for Resistance to Insect Pests. Information Bulletin no. 63, Patancheru: *International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)*.
- Sridhar, K., Sridharan, S., & Muthukumar, M. (2016). Management of shoot fly *Atherigona soccata* (Rondani) with different seed dressing chemicals. *International Journal of Plant Protection*, **9**(1), 191-196.
- Vadodaria, M.P., Patel, U.J. Patel, C.J., Patel, R. B., & Masuria, I.M. (2001). Thiamethoxam (Cruiser) 70 WS: A new seed dresser against sucking pest of cotton. *Pestology*, **25**(9), 13-19.
- Subbarayudu, B., Indira, S., & Rana, B.S. (2002). Effect of integrated pest management modules on the incidence of sorghum shoot fly. *Journal Research of Acharya N.G. Ranga Agricultural University*, **30**(2), 22-29.
- Rai, S., & Jotwani, M.G. (1977). Estimation of losses at various levels of shootfly infestation. *Entomologist's Newsletter*, **7**, 15-16.
- Zaller, J. G., König, N., Tiefenbacher, A., Muraoka, Y., Querner, P., Ratzenböck, A., & Koller, R. (2016). Pesticide seed dressings can affect the activity of various soil organisms and reduce decomposition of plant material. *BMC ecology*, **16**(1), 37.



Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

© The Author(s) 2022