Management of *Chilo partellus* (Swinhoe) (Lepidoptera: crambidae) Using *Jatropha curcas* Seed Powder on Maize (*zea mays l.*) At Melkassa

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Abstract

Rate and frequency determination of seed extracts of physic nut (*Jatropha curcas*) against *Chilo partellus* (Swinhoe) on maize at Melkassa was studied at the rates of 22.2, 44.4, 66.7 and 88.6 kg per ha, and frequencies of two times, three times and four times at weekly interval starting from two weeks after crop emergence. Stand count, lower leaf damage percent, and leaf damage score, larval density, percent dead larvae and grain yield were the parameters considered to evaluate the treatments. The result obtained clearly indicates that *C. partellus* infestation was significantly higher and lower in the highest and lowest rate, respectively with four times application. In conclusion, application of seed powders of Physic nut at the rate of 88.6 kg per/ha with four times application at weekly interval starting from two weeks after crop emergence was found to be effective in the control of C. partellus on maize which could be recommended to be used by small scale maize producers in Ethiopia and beyond.

Key words: *Chilo partellus, Jatropha curcas, Maize*

Introduction

Maize is the staple food and one of the main sources of calories in the major producing regions (Kebede *et al*., 1993). The crop has been selected as one of the national commodity crops to satisfy the food self-sufficiency program of the country to feed the alarmingly increasing population. National average yield of maize is 2.54 ton/hectare which could be considered the lowest. Biotic and abiotic factors contribute to the low yield. Among the biotic constraints, Lepidopteran stemborers, *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae) and *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae) are the most destructive insect pests of maize in Ethiopia (Seshu Reddy, 1998). In Ethiopia, *C. partellus* is a predominant species at lower altitudes and in warm areas with climbing trends to the higher elevation, where as the indigenous *B. fusca* is a predominant species at high altitude (1750-2600) and cooler areas of the country (Gebre Amlak, 1985; Emana and Tsedeke, 1999; Asmare, 2011). Depending on the level of infestation, losses due to these insect pests could reach up to 100% in Ethiopia and elsewhere in Africa (Assefa, 1988a and 1988b. Asmare, 2008).

A number of control options are available for the management of stem borers (Minja, 1990; Skovgard and pats, 1996). However, none of them kept the population of stem borers below economic threshold level. Hence, there is a need to look for different options (Chadwick and

Marsh, 1993; Bruce, 2010). Developing cost effective and environmentally friendly alternative control options, such as employing botanicals would be of high relevance especially to poor African farmers who cannot afford paying for insecticides (Van den Berg and Nur, 1998, Asmare *et al*., 2010). Botanical pesticides are biodegradable and their use in crop protection is a practical sustainable alternative (Devlin and Zettel, 1999). Indigenous use of botanical pesticides could be one way of mitigating the problems associated with the inappropriate use of synthetic pesticides (Koul, 2008; Koul and Walia, 2009). Use of these natural compounds in place of conventional insecticides can reduce environmental pollution, preserve non-target organisms, and avert insecticide induced pest resurgence, more over they are not costly, available and easily prepared. Among bio-pesticide plants, *Jatropha curcas,* or physic nut oil, is one of the best alternatives (Asmare, 2012). Toxicity of Physic nut seeds can be caused by several components, including saponinns and phrobal esters, which activate the important cellular target protein kinase C (PKC) and constitute the most active components. Physic nut oil containing phorobal esters has been shown strong insecticidal effects against *B. fusca* and *Sesamia calamists (Hampson)* larvae at an early stage of maize growth (Mengual, 1997). *Jatropha* is available in warmer areas of eastern and northern part of the country and its efficacy on stem borer was ratified and recommended as a useful option for integrated management of maize stem borers (Asmare *et al*., 2011). As there are some similarities between maize stem borer and spotted stem borer, there could be also a possibility of the botanical to be effective against the latter species of stem borer. Hence, the current study was conduct to see the efficacies of *Jatropha* at different rates and frequencies against *C. partellus*.

Materials and Methods

Description of the study area

Field trial was conducted during the main cropping season of 2012/13 at Melkassa Research Center (MARC). MARC is located 15 km south east of Adama in the semi-arid region of the Central Rift Valley of Ethiopia at 8° 24'N latitude and 39° 12'E longitude and at an elevation of 1550 meter above sea level (m.a.s.l.). The site receives 763 mm mean annual rainfall. The maximum and minimum annual mean temperatures are 28°C and 14°C, respectively (MARC, 1996).

Procedures, Treatment Preparation and Application

Maize variety, Melkassa II was sown on the onset of rainfall on a plot having 4 m by 4.5 m size with the spacing of 25 cm and 75 cm between plants and rows, respectively. All agronomic practices were applied per the recommendation for the site (Kidane and Abuhay 1997). The experiment was laid out in a Randomized Complete Block Design in three replications in a factorial arrangement.

Ripened seeds of *J. curcas* were depulped to separate the husk from seeds and the de- husked seed was pounded using a pestle and mortar and stored in airtight polyethylene bags in a refrigerator. The treatments were three levels of frequency (2, 3 and 4 times), four rates of application (22.2, 44.4, 66.7 and 88.6 kg/ha) and the untreated check. Treatment application started two weeks after crop emergence by placing the botanical powder to the funnels of each maize seedling and continued on weekly basis based on the treatments. All applications were conducted in the afternoon to avoid wind disturbance.

Data collection

Data collection started two weeks after treatment application. Data were taken on total plants (stand count), number of infested plants and leaf score damage from the three centeral or harvested rows. More over, ten plants were randomly selected from border rows and examined for dead and live larvae by dissecting the stem with knife. Leaf infestation damage score was taken using 0 to 5 scales where 0 for no infestation,1 for less infested, 2 for infested, 3 for highly infested, 4 for severly infested , 5 for dead plants) as developed by Carlson and Andrew (1976) and Ampofo *et al*., (1987).

Data analysis

Data were analyzed using the Proc GLM procedure of SAS (SAS, 9.0). Before ANOVA, data voilating normality were transformed. Accordingly, count data were transformed to log-transformation (log10+1), while percentage data were transformed to the square root (x+√0.5) transformation as described by Gomez and Gomez (1984). Significant Means were separated using Student-Newman-Keuls Test (SNK) at 5% probability level.

Results

The Effect of Different Rate and Frequency of *Jatropha curcas* Seed powder to the control of *Chillo partellus* on Plant Density and extent of leaf damage

The present study revealed that there were a significant (P<0.05) differences between rates of application in plant density. Plots treated with *Jatropha curcas* seed powder at the rate of 88.6 kg ha^{-1} had the highest plant density, while those treated with 66.7 kg ha $^{-1}$ obtained the lowest (Table.1). Two times application was better than the other frequencies. As compared to the untreated plots, better maize denisty was recorded in the treated plots (59 plants) than the untreated plots (42 plants/plot). There were significant (P<0.05) differences among rates in leaf damage score (0 to 5 scale). Significantly, lower leaf damage (3.2) was recorded in plots treated with 88.6 kg ha^{-1} *J. curcas* seed powder and the highest damage score (4.7) was recorded at the rate of 22.2 kg ha^{-1}. Moreover, significantly lower leaf damage score (3.2) was recorded at the highest application frequency (4 times) as compared to the highest score (4.7) at 2 times application of *J. curcas* seed powder. In addition, significantly lower leaf damage scores were recorded in treated plots (3.3) than the untreated plot (5.0) (Table.1).

Table 1. The effect of rate and frequency of *J.curcas* on Maize stand count, leaf damage(%) and leaf damage score(0-5).

Treatments	Stand count	Leaf Damage (%)	Leaf damage Score(0-5 scale)
Rate (kg ha^{-1})			
22.2	59.7ab	81.5a	4.7a
44.4	58.9b	79.1a	4.2a
66.7	58.5b	68.2b	3.3b
88.6	60.7a	65.2b	3.2b
LSD(0.05)	1.02	10.03	0.63
Frequencies 2	60.1a	79.3a	4.7a
3	59.4a	70.6ab	3.6b
4	58.9a	70.5b	3.2b
LSD(0.05)	NS	8.69	0.54
CV (%)	25.26	5.28	30.37
Treated vs Control			
Treated	59.4a	73.6b	3.3a
Control	41.8a	94.5a	5.0a
LSD(0.05)	NS	4.57	NS
CV (%)	12.06	1.55	12.5

Means in a column followed by the same letter are not significantly different from each other at 5% significance level (Means were separated by SNK at P<0.05)

The Effect of Different Rate and Frequency of *Jatropha curcas* Seed powder to the control of *Chillo partellus* Larval density/plant and dead larvae percent

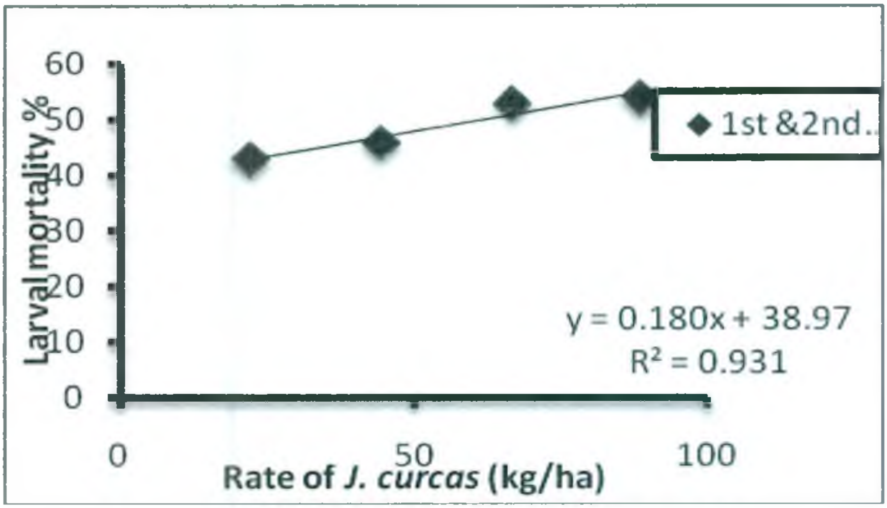
Significant difference were found among the rates of *J.curcas* powder treatments regarding larval density. Higher rates of *J. curcas* had lower larval density (3.0). The highest larval density (4.6) were obtained in plots treated with the lowest rate (22.2 kg ha^{-1}). Better results was obtained in plots of 4 times applications. When compared to the untreated check. There was less number of larvae (2.8) in the treated plots than the untreated check (3.7). (Table 2).

Significant differences were observed among rates and frequencies in proportion of dead larvae. As a result, the dead larvae increased as the rate increased up to 88.6 kg ha^{-1} and caused significantly high mortality (37%). The lowest number of dead larvae (16%) was recorded at a low rate of 22.2 kg ha^{-1}. The highest proportion of dead larvae (33%) was recorded in plots treated four times. In both factors, high larval mortality occurred in 1st and 2nd instars of larvae and the rate and frequencies had positive relationship with mortality (R^2= 0.931) in the (Fig. 1&2).

Table 2. The effect of rate and frequency of *J. curcas* on larval density and dead larvae (%) of *C. Partellus*

Treatments	*Larval density/plant	*Dead larvae (%)
Rate (Kg/ha)		
22.2	4.6(0.75)a	16(4.00)b
44.4	4.2(0.72)a	20(4.53)ab
66.7	3.5(0.65)b	29(5.43)ab
88.6	3.0(0.60)b	37(6.12)a
LSD(0.05)	0.07	2.02
Frequency		
	4.2(0.72)a	19(4.42)b
2	3.7(0.67)a	28(5.34)ab
3	3.6(0.66)a	33(5.78)a
4		
LSD(0.05)	NS	1.30
CV (%)	2.63	28.18

Means in a column followed by the same letter are not significantly different from each other at 5% significance level (Means were separated SNK at P<0.05)



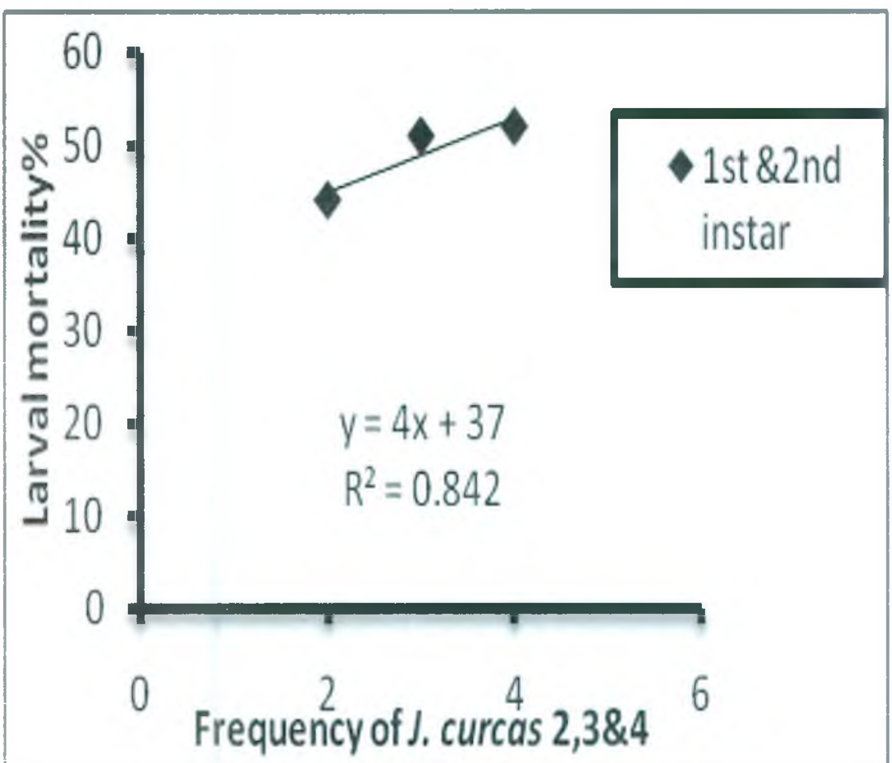


Figure 1. The relationship between rates and frequency of *J. curcas* and larval instars (1st and 2nd) mortality (%)

The Effect of Different Rate and Frequency of *Jatropha curcas* Seed powder to control of *Chillo partellus* on Grain yield and yield advantage

Grain yield varied significantly and ranged from 49.5 to 61.1qt ha^{-1}. The highest yield was recorded in plots treated with 88.6 kg ha^{-1}, while the lowest yield was recorded in plots treated with 22.2 kg ha^{-1} *J.curcas* seed powder. There was no significant yield difference among the three application frequencies in grain yield. However, high grain yield (57.1 qt ha^{-1}) was recorded three times applications. The treated plots gave significantly higher yield than the untreated check (Table 3). Highest grain yield advantage of 87-131.5% was obtained from treated plots. The entire rate gave high grain yield advantage as the rate increased from 22.2 to 88.6 kg ha^{-1} and the yield advantages also increased from 87% to 131.5%.

Table 3. The effect of rate and frequency of *J. curcas* powder on yield (kg ha^{-1}) and yield advantage

Treatments	Yield q ha^{-1}	Yield advantage (%)
Rate (kg ha^{-1})		
22.2	49.5b	87.3
44.4	54.1b	105.0
66.7	59.5a	125.5
88.6	61.1a	131.5
Untreated check	26.4c	------
LSD(0.05)	4.89	
Frequency		
0	26.4c	------
2	54.6a	106.7
3	57.1a	116.2
4	56.5a	114.1
LSD(0.05)	NS	
CV (%)	8.92	
Control vs. Treated		
Treated	57.5a	117.7
Control	26.4b	------
LSD(0.05)	18.79	
CV (%)	12.76	

Means in a column followed by the same letter are not significantly different from each other at 5% significance level,(Means were separated by SNK at P<0.05)

Discussion

The current findings obtained the highest stand population which agrees with the research results of Beniam (2007) who stated that stand count of maize plants increased at 3% in a plot received Milletia spray. Stand count at 1% treated plots was significantly lower than that of 3 and 5% treated plots, but significantly higher than the untreated plots which are so low. The results of highest mortality of larvae and lower larval density due high dosage of physic nut agree with the result report of Arnubio *et al.* (2006). Who reported that six leaf extract concentration of *Jatropha gossypiifolia* showed high toxicity to neonate larvae of *B. fusca* at higher dose concentration and it reduced leaf damage of sorghum. Also agreed with Geber Amelak and Azerefegne (1999), they stated that

Persian lilac fruit extracts either fresh or dried at different rates were found to be effective in reducing the number of larvae. The rates 2, 10 and 20 kg ha^{-1} for fresh leaves and 1, 2 and 10 kg ha^{-1} for dried leaves significantly reduced the number of larvae compared to the untreated control.

Another result reported by Nathan and Schoon (2006) stated that methanolic extracts from leaves and seeds of chinaberry tree, *Melia azedarach L.* (Meliaceae) had high bioactivity at all doses when tested against the larvae of *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae) while leaf extracts proved to be active only at the higher doses.

The current study yield and yield advantage result similar with, Asmare (2008) reported that with rate of 0.65-1.0g and frequency of 3-4 times application of pyrethrum flower powder, tobacco leaf powder, neem seed powder and *E. schmperiana* leaf powder resulted in yield increment of 46-69%, 48-55%, 51-56%, 31-53%, and 39-57% of sorghum over the untreated control respectively. Aboubakary *et al.* (2005) also reported that filtrate from ground neem kernels at 200 l ha^{-1} through seven foliar sprays considerably reduced yield losses caused by *Sesamia* stem borers on sorghum. Rashad *et al* (2007) reported that crop yields from the plots treated with neem granules at 12 kg and 14 kg ha^{-1} were as effective as carbofuran and cartap and the yields varied significantly and ranged between 16.37 to 50.67 tons/ha and 13.43 to 42.07 tons/ha respectively in all treatments including the control .Other research result indicated that significantly higher amount of yield was obtained when maize was protected from *B. fusca* attack by *Milletia ferruginea* treatment. The highest yield was obtained for the insecticide treated maize which was similar with 5% Milletia treated plots. The 10% concentration protected about 94% while the 5% about 97% yield loss compared with yield obtained from untreated plots Beniam (2007).
Generally highest rate (88.6 kg ha^{-1}) and four times' application frequency was effective in controlling *C. partellus* on Maize. Thus this rate and frequency could be recommended to small scale farmers, for efficient utilization of *J. curcas* to manage the stem borer population in main season.

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