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Possible Experimental Mistakes in Field Crop Insect Pests' Research; in the Case of Evaluation of Insecticides for the Control of Rice Stalk-Eyed Fly (*Diopsis longicornis*) under Rainfed Condition of Lowland Rice

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Abstract

The initial objective of the experiment was to evaluate insecticides for the control of rice stalk-eyed flies in Fogera district with two locations, within 3km distance apart from each other. Due to the low insect pest population presence within the current experimental site, it was difficult to collect the data for the initial objective of the experiment (insect population data for insecticides for the stalk-eyed fly control experiment). Hence, the objective of the initial experiment (evaluation insecticides for the control of rice stalk-eyed fly) was reformed to answer, the possible cause of the current field experiment failures (low stalk-eyed insect pest population presence within the experimental site). Most of the data were collected from literature, field experiments, and observation. From our observation, a possible cause for the current experiment failure (low insect pest population presence in the experimental site) perhaps due to the following factors, experimental site temperature, the current study site average monthly temperature in the study year (June to October) was 19.6-20.3oc, this temperature is lower than the stalk-eyed fly suitable temperature for its development. The second reason is perhaps the rice variety tolerance to stalk-eyed fly or preference. The other factor may be the ecological cause, from our field observation the stalked eyed fly was found more densely within the high water level with the rotten area, but the current experimental site was conducted with no more dirty water, this may be one reason for the low number of stalk-eyed fly population presence. The other possibility may be small number of experimental location with similar environmental condition. Before conducting applied research like the stalk-eyed fly control experiment, insect ecology preference (pure water, water with rotten material), insect suitable temperature, and other environmental parameters' should be determined. It is also advised, the experiment should be conducted in a controlled environment, to avoid the above-motioned kinds of uncontrolled experimental error. It is also recommended that the experiment should be conducted with more experimental locations, which are found in different environmental conditions.

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Keywords

Stalk-eyed fly, possible cause, ecology preference.

Introduction

Rice production was constrained by several factors: technological, bio- physical, socioeconomic, institutional and financial. Of these constraints, biotic and abiotic factors are the most important. Abiotic stresses include, variable rainfall, with drought and flooding occurring in the same season; poorly-drained soils of the coastal lowlands, and alkalinity in dry areas. Biotic stresses include, weeds, insect pests (stem borers such as stalk-eyed flies, African rice gall midge and rice bugs), diseases (blast, brown spot, and viral diseases), rats, and birds (Hadush, 2015).

Several insects feed on rice, but stem borers are considered the most important rice pests, in particular *Scirpophaga incertulas* and *S. innotata* (Walker) (Lepidoptera: Pyralidae). The onset of flooding and stem elongation provided a more favorable environment for *S. incertulas*. The rice borers' activity increased steadily during the first 3 to 4 months of flooding, to an average of 23% damaged stems by the flowering stage. Borer's activity continued at about the same level as the water receded; to reach maximum annual levels of 38 to 44% damaged stems at the late-ripening stage. At harvest, 60% of the fields were at outbreak level (> 40% damaged stems) (Catling *et al.,* 1984). It was the serious pest species of rice throughout the Orient, and abundant both on lowland rice and upland rice attacking young plant even in the nursery stage (Litsinger *et al.,* 1987). These borers vary in severity of damage and population intensity. The rice stem borer, infesting the plant from seedling to maturity, was one of the main problems and yields limiting factors in the rice fields (Sarwar, 2011).

Stalk-eyed flies (*Diopsis longicornis* and *Diopsis apicalis*) are among the stem borers which are widely-distributed and devastating pests of rice (Savary *et al.,* 1997). Stalk-eyed fly larvae usually affect the central meristem of the plant, which is bored, resulting in a condition known as dead heart. Stalk-eyed flies attack the plants at a young stage and lay eggs on the upper growing shoot of the leaves or on the leaf sheath of tall plants. Its larva is very harmful to rice plants. These eggs develop into larvae which enter the growing shoot of the plant and damage the crop.

From the two main species, Diopsid can be found in all rice ecological zones of Tropical Africa (Breniere, 1983) but preferentially in humid and shady lowlands (Appert and Deuse, 1988; Banwo, 2002) and also in irrigated rice fields (Heinrichs and Barrion, 2004). Damage from Diopsid larvae is similar to the primary damage made by Lepidopteran larvae. The central meristem of the plant is bored, resulting in the dead heart (Descamps, 1957; Breniere, 1983). One larva can destroy between 3 to 10 rice stems (Heinrichs and Barrion, 2004). In cases of high infestation, larvae can attack rice panicles (Bijlmakers and Verhoek, 1995). Diopsis sp. is present on rice throughout the growing period but they are more abundant in the field at pre-tillering and tillering stages (Joshi *et al.,* 1992). Feeding by the larvae significantly decreases tiller density, effective panicles, grain weight and the total yield (Heinrichs and Barrion, 2004) and increases the number of immature panicles. In endemic areas, 66% of the tillers and 100% of the hills can be infested (Scheibelreiter, 1974).

Estimates of yield losses due to insects in Africa range from 10% to 15% (Nwilene *et al.,* 2013). Stalk-eyed fly damage significantly reduces the following: tiller density, number of panicles, grain weight and numbers of mature panicles (Togola *et al.,* 2011). Farmers depend upon a lot of insecticide applications, even though a lot of insecticide applications are not effectual (Sarwar *et al.,* 2005).

The challenge today was to produce effective insecticides since the pest was not being easily contaminated by most of the insecticides (Rubia, 1994). Short rice varieties are more tolerant to stalk-eyed shoot flies than long varieties. This is because short varieties grow early, before most eggs hatch.

In Ethiopia, Geteneh *et al.,* 2021, survey report showed that 13 rice insect pests were recorded in the rice-growing area of south Gondar, from those recorded insects, the maximum infestation (15.73%) was caused by a stalk- eyed fly.

Although the survey result showed the stalk-eyed fly has in Ethiopia is one of the important rice fields pest, there is limited information on the fly's population and its potential threat to rice production.

Since rice producers' farmers have no other pest control option, the use of insecticides for insect control might be important. Moreover, there is no resistant rice varieties to insect pest released in Ethiopia. The use of insecticides for the management of rice pests became widespread, especially in endemic areas where appropriate resistant varieties are not available.

This study was initially intended to evaluate the insecticides for the control of low land rice stalk-eyed fly under rain fed conditions. Even though, the initial goal of the experiment is to point out, evaluation of the insecticides. But, due to low stalk-eyed fly insect pest population presence within the experimental site, the insecticides (treatments) not applied. Hence a new objective was set to assess the possible experimental faller, evaluation of insecticides for the control of rice stalk-eyed fly under rain fed condition of low land rice.

Materials and Methods

The experiment was conducted in, Fogera with two location, within 3km distance.

It was arranged in simple Randomized Complete Block Design (RCBD) with three replications in plot size of 2.4x3m. The distance between plots and blocks were 1m to protect insecticides drift problem. In this study systemic and non-systemic registered insecticides were tested against stalked eyed fly. All of the treatments are foliar in method of application.

The treatments were assumed to be applied twice; the former application were held at the vegetative stage/ tillering stage up to 65 days of crop emergence 2-3 days of laid egg and the second were made at the reproductive stage of the crop with recommended doses of the company. Insecticides were applied by manual/ hand sprayers.

The experiment insect pest population was very low, Due to low insect pest population presence within the current experimental site, it was difficult to collect the data for the initial objective of the experiment.

Hence, the objective of initial experiment diverted to answer, the possible cause of the current field experiment failures (low insect pest population presence in the experimental site), in the case of evaluation of insecticides for the control of rice stalk-eyed fly.

Data collected

The initial experiment assumed data was number of tillers/hill, Number of dead hearts/hill, number of white heads per hill, 1000-grain weight and Yield per plot.

$$\text{Dead heart (\%)} = \frac{\text{No. of infested tillers}}{\text{No. of total tillers}} \times \frac{\text{No. of infested hills}}{\text{No. of hills in sample area}} \times 100$$

Even though the above data was assumed for the initial experimental objective, due to the low insect pest population within the field experiment (insects found below the economic threshold level) representative dead heart data did not record. Hence, the data collected was from the field (temperature, and rain fall), field observation (agronomic practice, natural enemy, water quality and level) and literature review.

Results and Discussion

Year 1 (2018)

In the 2018 season, at Quhar abo station the stalk-eyed fly population remained at low density throughout the season. Consequently, there was no significant difference among treatments in dead heart infestation. Similarly, the grain yield also showed a non-significant difference.

In principle, an insecticide should be applied when the average insect population or infestation reached at economic threshold level, unfortunately, insecticide was sprayed without any more infestation.

Year 2 (2019)

In 2019 season, the minimum stalked eye fly infestation (dead heart) was 0.5 % and the maximum infestation 4%. Even though there was a low number of insect populations on rice, the dead heats were counted before insecticide application.

Since the insect infestation was not equally distributed thorough out the treatment, it is difficult to conclude the grain yield difference is due to insecticide effectiveness. When insects equally distributed throughout the treatment and then treated by the chemical, maximum grain yield is considered as good enough controlled by the insecticide than lower yielded treatment.

Possible cause for the current experiment failure/ low insect pest population on the experimental site

According to Geteneh *et al.*, 2021, survey report, stalk-eyed flies were present in three rice growing districts of South Gondar, Ethiopia with an average number of 16.37 insects per field, and this insect infestation was recorded up to 15.73%.

In contrast the above Geteneh *et al.*, 2021, study, the stalk eyed fly population was very low, below the economic threshold level in the current study site. Hence, it was difficult to collect the right data for the current experiment. There could be a different possibility for previous and current study stalk-eyed fly difference. A possible cause for the current experiment failure may be the following.

Experimental site temperature and other environmental factors

Temperature causes the direct effects like survival, growth and development, voltinism, and dispersal of insect pests (Karuppaiah and Sujayanad, 2012).

Insects do not bear the challenge against high and low thresh hold temperatures. The favorable optimal relative humidity for the abundance of *D. longicornis* and *D. apicalis* was between 48% -75%. Likewise, the favorable optimal temperature for the occurrence of *D. longicornis* and *D. apicalis* was between 25°C - 29°C for all the agro-ecological zones.

The low stalk eyed fly population presence in the study experimental site may be due the insects' temperature suitability difference. According to Charles *et al.*, the optimum/favorable temperatures for stalk eyed abundance were between 27°C and 29°C. In contrast to the above literature, the current study site average monthly temperature in the study year (June to October) was 19.6-20.3°c (Figure 2). Similarly the average monthly rainfall was in the experimental site (June to October) was 38.5ml to 458ml (Figure 3).

This means, the current experimental site temperature and rain fall might not be suitable for the stalk-eyed fly preference and development. So, low temperature and other environmental factors affect the stalk-eyed fly development, and preference should be determined based on the Ethiopian condition. After knowing or determination of suitable temperature, rainfall, and other environmental parameters' for the stalk-eyed fly, it is advisable to conduct other stalk eyed fly control options.

The rice variety used for the current experiment

The second reason perhaps the rice variety tolerance to stalk eyed fly or preference. The second factor may be the level of tolerance or resistance of rice variety used in the current experiment for stalk eyed fly. The dominant rice varieties grown in south Gondar are X-Jigna, Gumara, and NERICA-4 and currently Shaga is widely cultivated in Fogera. Shaga (without knowing its tolerance level to stalk eyed fly) was used for the current experiment, low stalk eyed fly presence within the experimental site may be due to the variety tolerance to stalk eyed fly or non-preferred by the insect, hence the susceptible rice to stalk eyed fly should be identified and relatively susceptible rice variety should be used for the current kind of experiment.

Site selection related to crop history and agronomic practice

All crop production practices affect insect pest populations either positively or negatively. Geteneh *et al.*, 2021, survey report agronomic practices carried out by rice producer were draining a rice field, transplanting, crop rotation, and fertilization, very few farmers used row planting methods, with rain-fed system and is in cluster base. In contrast to farmers practice the current experiment was conducted in row, which may not be suitable for stalk eyed fly. Regarding to the crop rotation, in each year the rice crops grown in rainy season (June-November) and then followed by non-rice crop (mostly vegetable, and grass pea) by irrigation (from December-May) this practice perhaps removes the pests' food source and reduce their population buildup (Geteneh *et al.*, 2021). Furthermore, the current experiment conducted with two locations within a 3 km distance difference, this site may be with similar environmental conditions, which may not good enough to see the experimental site variability. So the experiment should be conducted with more experimental locations, which are found in different environmental conditions.

The other possible ecological cause may be stalk-eyed fly ecology preference, from our field observation the stalked eyed flies were found more densely within the high water level with rotten area, but the current experimental site was conducted with no more dirty water, this may be one reason for low number of stalk-eyed fly population presence. Hence, stalk-eyed fly ecology preference (pure water, water with rotten material) would be determined.

The third reason perhaps the presence and effect of Natural enemy of stalk eyed fly

Different natural enemies of rice pests have been recorded in the three rice-growing areas of south Gondar, Ethiopia (Geteneh *et al.*, 2021), hence, the low insect infestation may perhaps due to the presence of effective natural enemies, or other cultural practices used by the farmers. So, the experiment should be conducted with controlled environment like a cage, to avoid such kinds of warry.

The current experiment did not fill its objective. But, the experiment faller give insight for researchers about what precondition should be considered. The experiment should be conducted with more experimental location, which found in different environmental condition, the other hint what we learn from the current experiment, susceptible variety should be identified for such kinds of experiment, which means tolerance level of rice variety to stalk eyed fly or preference should be determined prior to conduct the types of current research. The other hint, the current experiment showed, the pest ecology should be determined and known before conducting applied experiment like the current experiment.

Fig.1 Location map of the Fogera District

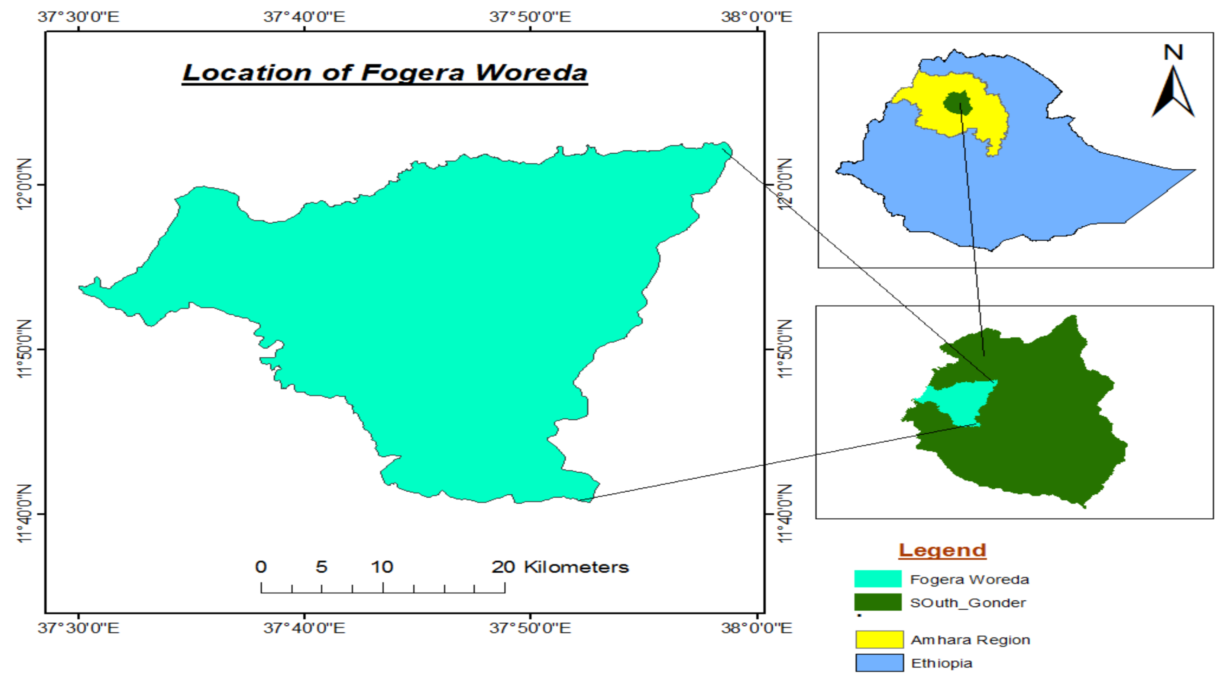


Fig.2 Showed that monthly temperature in the study area

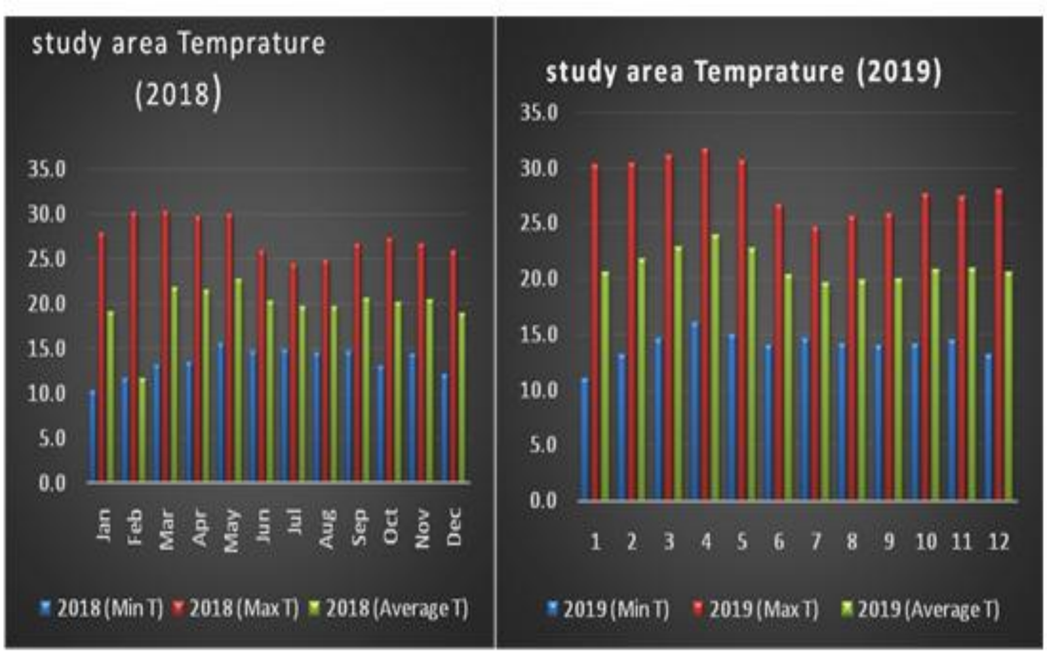
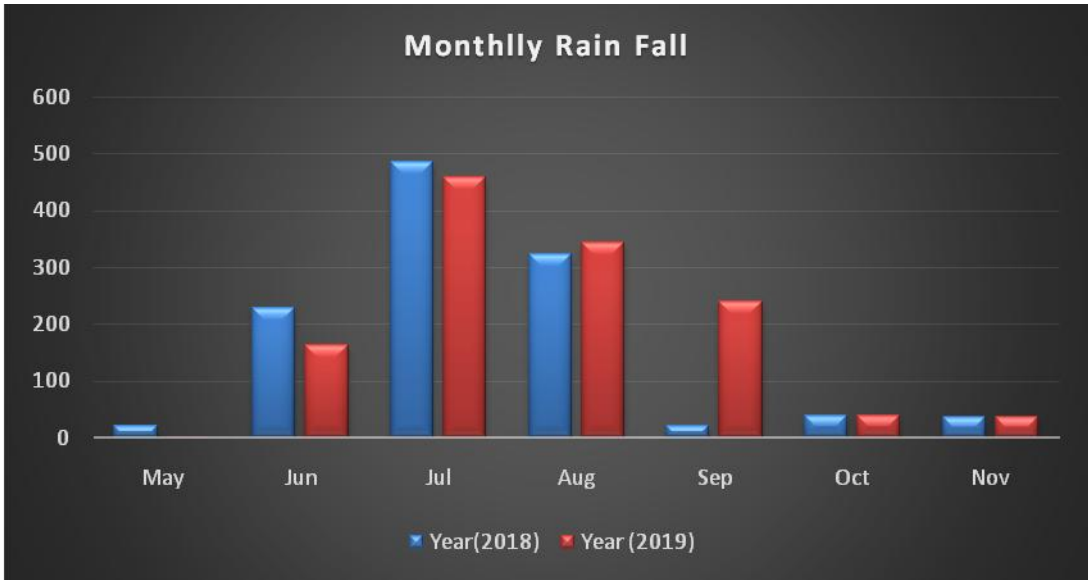


Fig.3 Showed that monthly rain fall in the study area



In general, the current experiment should be repeated in a controlled environment or with artificial infestation. Hence without enough insect infestation on the treatment it is difficult to analysis treatment difference. From this we recommend that to get successful results it is recommended that the insecticide evaluation for stalk-eyed fly experiment should be done with artificial infestation.

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