INCIDENCE OF RICE HISPA, *DICLADISPA ARMIGERA* (CHRYSOMELIDAE: COLEOPTERA) ON SUGARCANE CROP AND ITS CHEMICAL CONTROL

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ABSTRACT

The seasonality of infestation pest and population dynamics of *Dicladispa armigera* (Chrysomelidae: Coleoptera) commonly known as Rice Hispa were studied at Paroka experimental farm, University of Agriculture, Faisalabad, Pakistan in two consecutive years 2010-2011 on February and September season crops of sugarcane, respectively. A trial was also carried out during 2012 to find out the most effective insecticide against the pest. The results showed that peak population level of the pest (6-7 adults/sweep) was found in June during both years (2010 and 2011). The pest was absent in sweeps from November to January. Pest population in February and September crop was 2.611±0.543 and 1.944±0.383 per sweep, respectively. Damaged leaf area was higher in the months of June-September ranging from 30-70 percent in February crop and 10-35 percent in September crop. Temperature was the most important factor that favored the population with r =0.4375 to 0.7784. Damaged leaf area was highly significantly correlated with adult population in both season crops with r =0.8804 and r =0.7731, respectively. Percentage reduction of adult population was found maximum (94%) in the chlorpyrifos treatment showing rapid knockdown effects followed by acetamiprid (70%) and fenpropathrin (58.5%). Minimum of damaged leaf area and higher yields were also recorded in chlorpyrifos (6.2% and 81 kg/plot) and acetamiprid (7.26% and 74 kg/plot) treatments.

KEYWORDS: *Dicladispa armigera;* sugarcane Hispa; infestation; weather factors; temperature; chlorpyrifos; leaf area damage; Pakistan.

INTRODUCTION

Dicladispa armigera (Coleoptera: Chrysomelidae) commonly known as rice hispa is regarded as a major pest of paddy in some paddy growing areas of India, Bangladesh, Pakistan, Nepal, Myanmar and southern China (9). It has a long record of sporadic outbreaks in Bangladesh and India. In Pakistan, *Dicladispa armigera* became an important pest of rice in the wet season of 1983, when about 2500 hectares in Alipur and Muridke were affected (36). In Bangladesh, *D. armigera* attacks all four rice crops: aus (summer rice),

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transplanted aman (monsoon rice), deepwater rice, and Boro (winter rice). Sporadic outbreaks of *D. armigera* occur almost throughout Bangladesh. In India, both rice crops, kharif and rabi, are subjected to sporadic outbreaks of *D. armigera.* Annual yield losses of 20 percent in Andhra Pradesh (23), upto 50 percent in Bihar (1), 14-62 percent in Bangladesh (15) and 40-50 percent in south China (12) have been reported. It is a polyphagous pest feeding on a wide range of hosts including some major crops (rice, sugarcane, maize and wheat). When rice is not available, its populations move onto other alternate hosts such as crops, weeds and other wild grasses. In early March 1978, it was found attacking wheat at Kapurthala, Punjab, India and 3 to 6 adults per $10m^2$ were recorded (11). Wang (35) also reported pest feeding on wheat, *Leersia hexandra, Echinochloa crusgalli* and *Eleocharis egwisetina* before the emergence of rice seedlings. It has been documented on sugarcane in pest form (27). It is also known as corn army weevil (25). Sen and Chakravorty (30) have also reported that beetle had six generations a year, of which five were on rice and one on many alternative graminaceous food-plants on which it was recorded for the first time. Choudhary *et al.* (10) have also reported ten alternate hosts including *Sorghum halepense* for the first time in Himachal Pradesh. Two new alternate hosts, *Panicum dichotomiflorum* and *Brachiaria ramose* of rice hispa have also recently been recorded from the Palampur region of Himachal Pradesh (32).

Prevailing weather conditions greatly affect the multiplication and spread of the pest in endemic form. In the past, severe outbreaks of *D. armigera* were reported due to unusually heavy rains followed by unusually low rainfall (24). Rice hispa incidence has increased in recent years, particularly in the wet season. The climate with high rainfall and humidity had been reported to be conducive for its incidence and multiplication (20). It is also reported that increase in temperatures had an impact on the biology of the pest (14). Its emergence has been reported to be influenced by the onset of monsoon rains. During early monsoon rains of May and June, a sudden emergence of winter diapausing adults occurs that feed on the alternate hosts (23).

Various control methods have been tested on the pest in the past including, cultural, biological, biopesticidal, mycopathogenical and chemical control. Among cultural control leaf tops clipping is the only method reported so far to control 75-92 percent of grubs at vegetative stage (18). Its effectiveness is high against infestation of eggs (2, 19, 24, 29, 31). Among biopesticides, leaf and seed extracts of various plants have been found to control the pest efficiently. Anti-feedant and ovicidal effect of neem products has also been reported (6, 22). The highest mortality of hispa was reported by Azacel (4) while feeding and oviposition deterency of seed extracts of *Amoora ruhituka* has been also reported (26). Among mycopathogens *Beauveria bassiana* was found superior in controlling rice hispa and leading to an increase in the yield (13). Despite many studies and trials of nonchemical control the insecticidal control has been dominating measure to counter this pest. Past studies have reported the application of different insecticides, both as granules and sprays, to find out their efficacy to control this pest. Formothion 25 EC, quinalphos 25 EC and 1.5% dust, monocrotophos 40 EC, phosphamidon 100 EC. phosalone 35 EC and 4% dust, methyl demeton 25 EC, dimethoate 30 EC, methyl parathion 2% dust, BHC 10% dust and DDT 5% dust were initially found effective against this pest (7), with the addition of carbofuran (8) and cypermethrin (0.003%) in later studies (5). Chlorpyrifos, fenthion and monocrotophos sprays have been reported to have rapid knockdown effects. Quinalphos, fenthion and chlorpyrifos sprays were also effective against pupae in their mines (21). Recently, clothianidin and bifenthion were reported as the most effective treatments in controlling the adult and grub damage with their immediate knockdown effect and persistent toxicity (17).

Despite its polyphagous nature, incidence of rice hispa on hosts other than paddy is not reported from Pakistan. The only literature available, is very old, that is from India, Bangladesh and neighboring countries, from where it was reported on alternate hosts. Thus more studies are needed to prevent the outbreaks on other economically important crops as the damage caused by this pest, especially at vegetative growth stages of the plant, results in extensive losses that are insurmountable toward yield factors. Recently, emergence of *D. armigera* as a serious pest was noticed on sugarcane crop at Paroka experimental farm, University of Agriculture, Faisalabad, Pakistan

Snap-1

Snap-2

Emergence of rice hispa on sugarcane crop

since 2009 (snap 1 and 2). Despite measures taken to control the pests it was reported that pest spread to adjacent crops causing heavy losses. *D. armigera* was reported in 2009 to be severely attacking February and September season sugarcane crop and the following rations.

The present studies were therefore, carried out to figure out the population dynamics and control of *D. armigera* on sugarcane at Faisalabad, Pakistan.

MATERIALS AND METHODS

A two-year study was carried out on sugarcane crop at paroka experimental farm, University of Agriculture, Faisalabad during the year 2010-11 to observe the occurrence and population dynamics of rice hispa in relation to weather factors. Sugarcane crop of both seasons (February and September) were sampled fortnightly. On the time of sampling September crop almost completed the tillering stage while February crop was matured and it was to be harvested. Adults were sampled through sweep netting by walking in the field in one direction for 25 feet. Five sweep nettings were done from 5 stools that were 5 feet apart. The exact procedure was repeated and another location was sampled diagonally (5 sweeps/5 stools/location). For larval infestation, percentage damaged leaf area was estimated visually and average was taken. Sampling was done in the early evening hours when the adults were most active. Adult data were expressed as individuals/sweep net while larval infestations as percentage damaged leaves. Data regarding weather factors, i.e., maximum temperature, minimum temperature, relative humidity and total rainfall, were collected from a climatic observatory of University of Agriculture, Faisalabad. The pest population trends were visualized through Excel graphing. Data were correlated with the weather factors by calculating Pearson's correlation coefficients through STATISTICA-10. Multiple linear regression was applied to model the variation in hispa population and leaf damage in both crops. Comparisons were also made regarding pest population levels between February and September season crops.

To test the efficacy of different insecticides against the pest in sugarcane, an experiment was conducted in 2012, during June when the pest population reached its peak. The treatments included nine insecticides and a control treatment in which only water was sprayed. The insecticides applied were acetamiprid 20 SP (125ml/acre), carbosulfan 250 EC (250ml/acre), carbofuran 3G (8 kg/acre), chlorpyrifos 40 EC (500 ml/acre), emamectin benzoate 1.9 EC (100ml/acre), fenpropathrin 10 EC (0.5 g a.i./ha), indoxacarb 150 EC (100ml/acre), monomehypo 5G (9 kg/acre) and spinosad 240 SC (50ml/acre). The experiment was conducted in a RCBD with three blocks. The plot size was 10x10 m^2 and a buffer zone of one meter wide was kept between each plot to isolate them from each other. Treatments were assigned at random. Spray volume was 100 litre per hectare. Sprayable treatments were applied using a knapsack sprayer with flat-fan nozzle, while granules were broadcasted in 1st week of June on February crop that was most susceptible to pest attack. At the time of treatment, crop was at tillering stage. Before treatment adult population was recorded from each plot through the same sampling procedure mentioned above. After assessing the pretreatment adult population the treatments were applied at field recommended dose rates. Data were again recorded at 1, 10, 20, 40 and 60 DAT (days after treatment). Adult data after pesticide application was expressed as percentage reduction in adult population while larval infestation was expressed as percentage damaged leaf area (not reduction). At the end of experiment cane yields were also recorded from each plot. Data were subjected to GLM procedure with repeated measures in SPSS. Post-Hoc comparison between treatments means were made using Tuckey's HSD test.

RESULTS AND DISCUSSION

Population dynamics

The results showed that adult *D. armigera* population showed peak levels (6-7 adults/sweep) during May-July in both season crops for the years 2010 and 2011. Although the population peaks occurred simultaneously in both crops but numerically more number of adults per sweep were recorded in February season crop. The pest was absent in sweeps in the months of November-January. Analysis of adult population showed significantly higher population levels in February crop than in September crop ($p<0.05$). The mean number of adults per sweep were 2.611±0.543 and 1.944±0.383 (Fig. 1). The findings are not supported by Rawat and Singh (34) and Bhattacharjee and Ray (4) who reported maximum population levels and

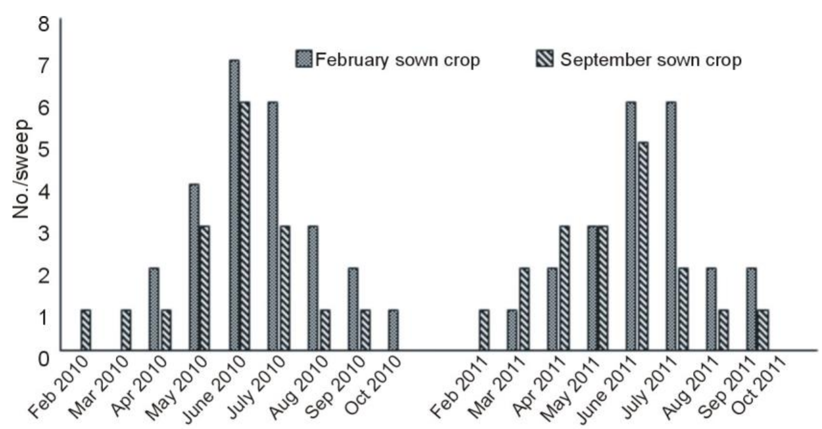

Fig. 1. Number of adult Hispa per sweep in two season crops (2010 and 2011)

heavy infestation in September-October in rice. In this study, percentage damaged leaf area was higher in the months of June-September ranging from 30-70 percent in February season crop while 10-35 percent in September season crop. On contrary, damage symptoms by grub were reported to be highest in August in another study (17). February crop suffered twice as much damage as September season crop that was found significant ($p<0.05$) with mean values of 27.67±5.76 and 13.11±2.31 respectively (Fig. 2). These results do not agree to the findings of Prakasa *et al.* (24) who reported lighter damage to crops planted before mid-July, than crops planted in August. Recovery of the crop was probably high in July crop. Percentage damaged leaf area was highly significantly correlated with adult population in both season crops with r =0.8804, $p<0.05$ and r =0.7731, $p<0.05$ respectively (Fig 3 and 4).

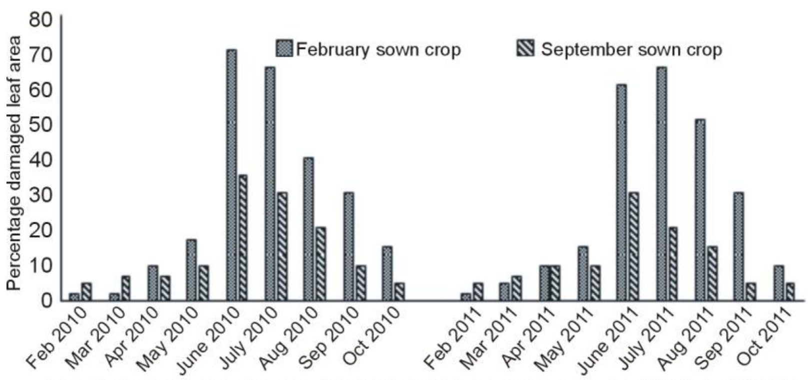

Fig. 2. Percentage damaged leaf area in two season crops (2010 and 2011)

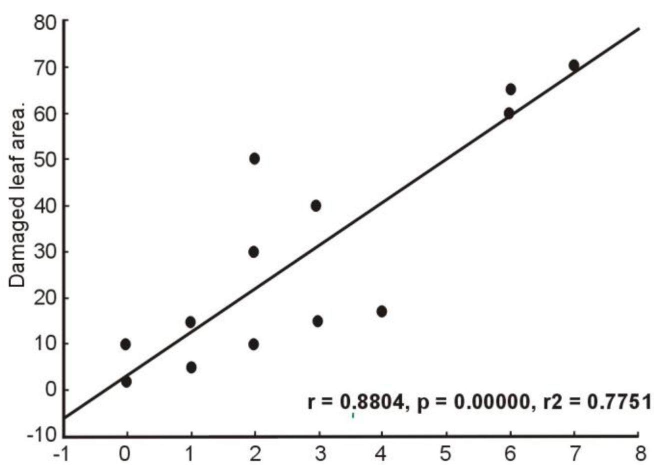

Fig. 3. Correlation of hispa population with leaf damage in February crop.

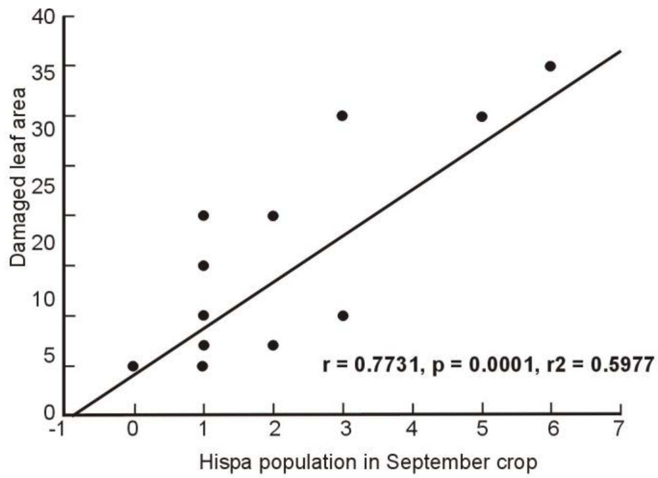

Fig. 4. Correlation of hispa population with leaf damage in September crop

Temperature was found as the major determinant of both hispa population and larval infestation in both season crops (r =0.4375 to 0.7784; p<0.05). Minimum temperature showed greater impact on pest population and extent of pest attack than maximum temperature. Among other factors, relative humidity showed significant negative correlation with adult population in September crop only while rainfall was significantly (p<0.05) positively correlated with leaf damage in September crop. These two parameters did not show any serious correlation with pest population throughout the study period. Rawat and Singh (28) had reported that excessive rainfall in June-August and low temperature during plant growth resulted in rapid pest multiplication and attack in September. Multiple linear regression revealed lower R values for September crop pest population (R= 55 to 60%) than February crop (R= 74%). This indicated that other factors were involved in regulating the pest population in September season crop. These might include crop growth stage, crop age and photoperiod that were not included in the present study (Table 1).

Table 1. Pearson correlation coefficients of hispa population and larval infestation with weather factors.

Parameter	Feb. crop adult population	Feb. crop leaf damage	Sep. crop adult population	Feb. crop leaf damage
Max temp	0.6976**	0.511**	0.4798*	0.4935*
Min temp	0.7784**	0.7697**	0.4375	0.6573**
Relative humidity	-0.2935	0.1489	-0.4984*	-0.0897
Rainfall/day	0.3643	0.5602*	0.0093	0.4488*
Multiple linear regression	73.56%	74.35%	55.17	60.8791

Efficacy of insecticides

Percentage reduction in adult population: A comparison of percentage reduction in pest population through intervention with insecticidal application revealed that chlorpyrifos was the most effective treatment with mean mortality of more than 90 percent (94±0.895%) followed by acetamiprid (70.13±2.13%) and fenpropathrin (58.5±2.73%) (Fig. 5). Among other treatments, emamectin, indoxacarb and spinosad provided intermediate control causing 42.87±1.33%, 38.27±1.45% and 36.53±1% morality, respectively, while *monomehypo, carbosulfan* and *carbofuran* were the least effective against the pest. This is important to mention that these three insecticides are widely used in this region for sugarcane pest control. All treatments differed significantly ($p<0.05$) from the control treatment (12.67±4.44%) in which no insecticide was applied (Fig. 5).

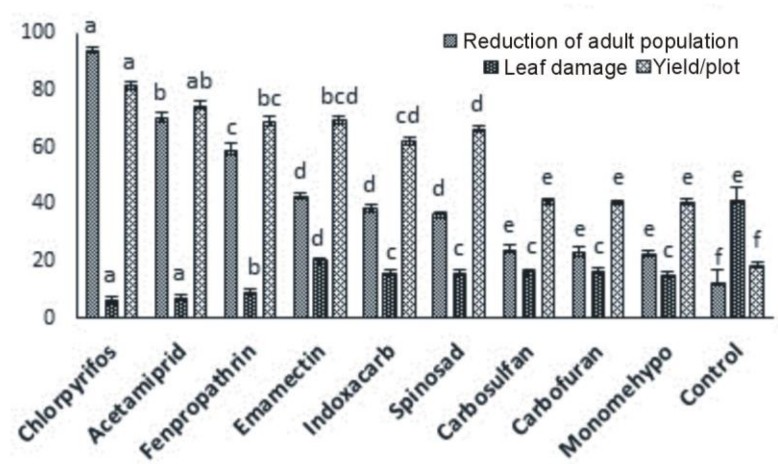

Fig. 5. Comparison of reduction in adult population, percentage damaged leaf area and yield/plot in different insecticide tretmentsReduction of adult population

Percentage damaged leaf area: The lowest percentage of damaged leaf area was recorded in chlorpyrifos treatment (6.2±1.38%) that was at par with that of acetamiprid (7.26±0.99%) (Fig. 5). Fenpropathrin was also an effective treatment for minimum leaf damage (9.33±1.1%). Emamectin although resulted in almost 40 percent reduction in adult population but lagged behind all other treatments recording the highest leaf area damage and ineffectiveness against the larval infestation. In all other treatments, damaged leaf area was about 16 percent while in control higher leaf area damage upto 42 percent was recorded.

Effect of treatments on yield: Higher cane yield with a mean value of 81 kg per plot was recorded from the plots in which chlorpyrifos was applied followed by acetamiprid (74 kg) (Fig. 5). In plots where fenpropathrin, spinosad, indoxacarb and emamectin were applied, 62-69 kg yield was recorded. The granular applications were found as inferior ones in terms of yields, giving only 40 kg per plot. Yield in the control plot was the lowest with an average of 18 kg.

Although infestation and damage caused to sugarcane crops have not been reported to the extent as evident in case of rice (9) but present results showed 4th consecutive year of infestation on sugarcane crop by this pest and it is becoming a major problem in adjacent fields of present experimental farm. Since its first report on a small scale, area under attack to this pest has now increased to 20 hectares. This experimental farm harbors diversified cropping intensity. Rice is not a major crop included in the cropping pattern of this area. Wheat and sugarcane mostly dominate the area as major crops, with fodder and oilseeds as minor crops. The main abiotic determinant of *D. armigera* population was temperature. High temperature favored the population buildup. The relation of pest population with weather factors not been reported earlier and thus these results will serve as baseline data for future studies. Banerjee and Nath (3) have reported some reasons for increased attack of hispa including sunny weather interrupted by quick showers, no summer plowing and lack of insecticide application. However, a study on weather conditions during outbreak years showed that these outbreaks were favored by unusually heavy rains in July that encouraged the growth of grasses on which the pest multiplied. Afterwards unusually low rainfall in August-September also caused withering of the grasses and migration of the pest to rice (24).

Past studies have also reported the reduction in pest population due to application of various pesticides. For example Permethrin has also been reported to give promising and consistent results to control *D. armigera.* In another study organophosphates mostly used to control this pest included 0.04% quinalphos and 0.04% dicrotophos gave 100 percent mortality (34). In present study the persistent insecticide such as chlorpyrifos controlled the pest efficiently. However, in previous studies (3, 33, 34) cypermethrin and a few others than organophosphates have also been tested and found effective in reducing *D. armigera* population levels. Krishnaiah and Kalode (21) reported that chlorpyrifos spray had rapid knockdown effects on adult hispa. Chlorpyrifos spray was also effective against pupae in their mines. In another study, cypermethrin (0.003%) was the most economically viable treatment with CBR of 1: 3.63. Islam *et al.* (16) reported that Imidacloprid caused the highest mortality (69.63%) at 0.05 ml/L as compared to chlorpyrifos 48EC (58.57%) and Deltamethrin 2.5EC (57.25%) after one month of application.

The reduction in percentage damaged leaf area and increase in yield have also been reported in previous studies (7) where insecticide treatment significantly decreased number of adults/hills percentage of damaged leaves and percentage of damaged leaf area, as compared with no treatment. It significantly increased the tiller height, number of panicles/hill, panicle length, number of grains/panicle and grain yield in rice.

Planting time and season might be crucial for survival and mortality of the pest. Thus, quite different pictures were presented by both seasons crop. Conditions that rendered the *D. armigera* population susceptible to mortality might include vulnerability to temperature extremes, heavy or no rainfall, non-preferred crop growth stage. Cane yields recorded from treatment plots were quite low as compared with the actual yields/acre in this area free of the pest. So, single application of pesticides against this pest might not give the desired results as required. Thus successive chemical applications remain the sole control strategy against this pest. Although the infestation of hispa on sugarcane is not a widespread phenomenon but this pest might cause excessive losses in future if goes unchecked on its alternate hosts.

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