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Test of Few Insecticides Against the Various Developmental Stages of *Hieroglyphus* Species (Hemiacridinae: Acrididae: Orthoptera)

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Abstract.-The species of *Hieroglyphus* reported as the most destructive pests of rice, maize, wheat and sugarcane in Pakistan. Population of these distressing pests is increasing widely from year to year due to favorable geographical conditions of the country. To reduce the grasshopper's population several strategies have been used from time to time but, insecticides have been the most effective control measure. Therefore, in this study two insecticides namely: Thiodan 35EC (Emulsifiable concentrate, containing 35% technical grade Endosulfan) Regent® 4SC (containing 4% Fipronil) and one control (untreated) treatment were replicated three time against the various stages of *H.perpolita* (Uvarov), *H.oryzivours* Carl and *H.nigrorepletus* I.Bolivar under laboratory condition. Results from the study suggested that the nymphs of the earlier stages die earlier and found to be more susceptible to insecticides than the later nymphal stages or the adults. This study concludes that both the insecticides used at the recommended rate were effective in controlling *Hieroglyphus*'s population.

Key words: *Hieroglyphus*, developmental stages, Thiodan 35EC, Regent® 4SC.

INTRODUCTION

The genus *Hieroglyphus* Krauss is one of the most destructive insect pests occurring throughout the Pakistan. It feeds on wide variety of rice, maize, wheat, sugarcane and other fodder crops both wild and cultivated, and sometimes does considerable damage in surrounding vegetation. The voracious feeding habits of *Hieroglyphus* are legendary. Populations of these distressing pests fluctuate widely from year to year due to climatic conditions and other variables in the field. There are several strategies *i.e.,* (mechanical, cultural, chemical and biological control) that have been adopted to control grasshopper populations. Mechanical control measures have been relied on to an immense extent. These measures, which include swatting, beating, dusting and hand-collecting of the insects, sometimes, prove rather protracted, especially after the insects have detached from the small swarms in which they occur during the first few weeks after hatching in field. Similarly, Riffat in 2008 reported that several species of Praying Mandis, frogs, snakes, lizards and birds fed on hoppers and adults of *Hieroglyphus* spp. but their role is not considered significant to reduce the occasionally attack of *Hieroglyphus* in field. It was considered, therefore, that an investigation of various insecticides against this pest would be rewarding.

Various workers have tried different insecticides to control grasshoppers. Corkins (1923) used Sodium arsenite whereas Granovsky (1926) and Kuznetsov (1928) applied arsenical dusts by air-plane. La-Rivers (1944) also used air-plane dusting to control *Anabrus simplex*. Mitchener (1951) tried emulsifiable formulations of aldrin and dieldrin against *Camnula pellucida* and *Melanoplus* sp. Srivastava (1957) tried 5% BHC dust (gammexane) which contains 0.65% gamm isomer and claimed that all the nymphal instars and the adults of *H.nigrorepletus* were satisfactorily controlled by this treatment. Sengupta and Behura (1957) recommended that dusting with 5, 7 and 10% BHC at the rate of 15-20 Ibs per acre were found effective in controlling both hopper and adults of *H.banin* and *H.nigrorepletus.* Pradhan and Peswani (1961) treated adults of *H.nigrorepletus* with different insecticidal dusts in laboratory. The dusts of endrin, lindane, dieldrin, aldrin, chlordane and toxaphene were found more effective in reduceing the population of grasshoppers. Grist (1975) suggested the following methods via: ploughing harrowing after harvest and digging bunds to destroy the eggs. Larvae are netted and adults killed by beating. Dusting with BHC has also been recommended.

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Agyen-Sampong (1976) also used aldrex 40, gamma-BHC, dieldrin and fenitrothion to compress the incidence of *H. daganensis*.

Although present authors published a series of manuscripts (Riffat and Wagan, 2007,a,b,c,d, 2008,a,b, 2009a) on the life-history characteristics, food plants, oviposition, mating behaviors, and ecological studies of *Hieroglyphus* spp. from Pakistan but there was no such account is available regarding the effective control measure of *Hieroglyphus* from this region. This current study was initiated to study the use of two insecticides against the developmental stages of *H.perpolita* (Uvarov), *H.oryzivours* Carl and *H.nigrorepletus* I. Bolivar respectively under laboratory condition. Results from this study are being reported for the first time.

MATERIALS AND METHODS

Collection of samples

The grasshopper used in this experiment were collected from the agriculture fields of rice, maize, sugarcane, millets, fodder crops and their surrounding vegetation of grasses with the help of traditional insect hand-net (8.89 cms in diameter and 50.8 cms in length) as well as by hand picking. The collection was made during the year 2005-2007. Collection began at the beginning of July, soon after the eggs started to hatch. Stock of insect's material was kept in cages as well as in separate glass jars under laboratory (25^0-$23^/$N 68^0-$24^/$ E) condition. About a thousand of hoppers could be kept in each cage. They were sorted into species on the basis of different developmental stages. For the insecticides tests, the hoppers were placed in experimental design cage (length 16.5 cm width 13.5 cm) and 50 individual of each stage were kept per cage for period of 72 h. The experimental insects allow feed on the treated leaves with Thiodan and Regent. Similarly, the same numbers of individual of untreated insects were cultured in separate cage but the size of cage was alike with treated insect's cages. The insects in these cages were fed on *Zea mays* which were changed after every 72 h.

Insecticides used in the treatments

Two different insecticides *viz.,* Thiodan 35EC (Emulsifiable concentrate, containing 35% technical grade Endosulfan), and Regent® 4SC (Soluble concentrate, containing 4% Fipronil) were tried against all the nymphal instars and the adults of *Hieroglyphus* spp. Trials were conducted in the laboratory where the temperature fluctuated between 28±2°C to 39±2°C with relative humidity of 26% to 61%. These temperature and relative humidity regimes are similar to field conditions. Two insecticide and one control (untreated) treatment were replicated three times. Different stages of grasshopper species were sorted out and separately kept in cages.

Estimation of quantities of insecticides

The initial number of insects used for each replication was 50. Liquid formulations of Thiodan with ratio of (0.005ml/Kg) and Regent (0.01 ml/Kg) separately were sprayed on fresh leaves of *Zea mays* than these leaves were uniformly served as food to experimental insects kept in different cages. Observation has been taken after application at 24, 48 and 72 h and mortality was recorded and dead hoppers were removed from the cages. Identification of specimen was carried out under the stereoscopic dissecting binocular microscope.

Statistical analysis

Data obtained from experimental groups were subjected to one-way analysis of variance (ANOVA) (SPSS 10.0 Soft-Ware) with repeated measures and significant means were determined using Duncan's New Multiple Range Test (DNMRT) and treatment means were compared using the Least Significant Difference Test (LSD).

RESULTS

Morality of developmental stages of *H.perpolita* has been shown in (Table I). It indicated that after the 24 h treatment of Regent was found more effective against the earlier developmental stages I-IV as compared to Thiodan. But, Thiodan was found to be more effective against the later stages. After the 48 h, there were no significantly difference in the mortality of hopper were noted when treated with Regent or on Thiodan with exception of last three stages. However, mortality

Table I.- Mortality (% Mean±SD) of different stages of *Hieroglyphus perpolita, H. oryzivorus* and *H. nigrorepletus* treated with different insecticides.

Stages	Thiodan35EC			Regent ®4SC			Control		
	24 hrs	48hrs	72hrs	24 hrs	48hrs	72hrs	24 hrs	48hrs	72hrs
H. perpolita									
First instar	94.2 3±4.85	95.5±3.690	99.0±1.41	97.4±4.24	97.25±4.85	98.50±1.73	1.75±2.87	2.25±1.70	2.0±1.63
Second instar	83.25±11.44	92.25±8.25	96.75±5.18	90.25±15.19	93.25±7.58	96.50±5.19	1.0±1.15	1.5±3.0	2.25±1.70
Third instar	73.25±14.25	93.75±4.85	95.25±3.30	84.5±9.60	96.25±3.30	96.50±4.04	1.25±0.95	2.50±2.38	0.75±0.95
Fourth instar	69.25±12.12	85.25±5.25	97.5±3.10	79.25±10.34	92.75±4.99	96.50±5.19	2.0±1.41	1.0±0.81	1.25±0.95
Fifth instar	66.75±9.60	85.75±6.39	93.0±4.96	52.0±21.65	92.0±1.32	92.32±14.0	2.25±1.70	2.0±2.44	1.5±1.91
Sixth instar	57.50±13.69	69.0±16.08	94.75±5.56	60.75±16.37	90.13±5.41	91.14±5.32	1.0±1.41	1.0±1.51	1.51±1.73
Adult	48.75±13.96	62.75±21.34	91.4±11.34	47.25±13.57	87.0±15.64	84.50±9.32	1.0±2.0	1.25±1.50	0.75±0.95
H. oryzivorus									
First instar	96.20±4.50	99.25±0.95	95.0±5.59	70.25±4.57	95.25±5.85	96.25±3.25	6.50±5.68	1.75±2.0	2.75±2.75
Second instar	90.32±3.20	95.5±8.34	92.50±5.70	64.75±14.43	94.75±5.56	93.0±5.51	3.25±4.27	2.0±2.44	4.0±2.82
Third instar	90.12±1.35	95.5±4.65	91.0±3.25	69.50±13.79	92.75±8.18	91.32±6.23	1.50±1.91	2.0±2.82	3.0±3.87
Fourth instar	80.34±7.39	84.75±12.78	93.35±4.35	59.0±10.58	65.0±23.49	90.25±10.14	2.25±2.62	3.0±3.5	2.0±2.44
Fifth instar	53.75±14.63	77.75±11.17	93.61±4.55	50.0±10.67	65.0±16.35	87.25±16.25	0.75±0.95	2.0±1.8	2.0±1.5
Sixth instar	42.50±16.98	74.50±6.16	91.55±12.11	56.25±18.24	67.25±12.81	85.75±14.63	1.50±1.90	3.0±3.8	0.75±0.95
Adult	19.50±13.50	54.0±6.16	92.0±4.350	14.75±2.62	40.75±10.12	78.25±15.12	0.75±0.95	1.5±1.91	1.72±1.70
H. nigrorepletus									
First instar	94.75±3.59	96.23±10.23	99.12±1.32	62.25±21.77	75.25±26.58	97.50±3.10	1.75±2.06	2.75±3.40	3.5±3.4
Second instar	92.25±13.57	94.12±11.50	97.13±4.32	56.25±15.39	64.25±6.55	95.13±1.23	1.75±1.25	1.0±2.0	2.75±2.21
Third instar	91.75±7.41	92.33±8.63	95.25±8.22	43.50±15.08	79.50±10.59	93.12±4.35	3.5±3.41	3.25±4.03	2.25±2.62
Fourth instar	64.25±6.55	96.14±3.26	93.23±5.32	65.25±11.02	88.25±6.39	94.75±5.10	1.5±1.29	4.25±3.40	1.5±1.29
Fifth instar	50.50±9.57	87.13±2.35	91.13±4.45	44.75±9.94	84.75±17.57	94.0±6.32	1.75±1.91	1.5±1.91	0.75±0.95
Sixth instar	20.25±6.50	85.12±7.36	92.17±3.25	46.50±18.35	56.75±14.66	86.75±10.81	1.25±1.5	1.75±1.70	0.5±1.0
Adult	16.75±4.78	84.75±9.42	90.19±2.32	11.25±6.02	27.25±7.13	84.75±17.87	0.75±0.95	1.75±2.06	1.5±1.2

ratio was significantly highest after 72 h of application of insecticides. The mortality ratio of untreated (control) hoppers was significantly low during the earlier 24 and 48 h but, it was slightly highest in the earlier stages I-IV after 72 h.

The tests of these two insecticides against the various developmental stages of *H. oryzivorus* (Table I) showed that during the first 24 h there was no significant difference in the mortality of I-III stages whether it treated with Regent or with Thiodan. Yet, there were significantly disparity was found in later stages these finding indicated that Regent is more effective against the later stages of *H. oryzivorus*. Opposing to this, after the 48 h mortality ratio was significantly highest when hoppers were treated with Thiodan compared to Regent. Similarly, mortality was recorded significantly highest after the 72 h application of Thiodan and Regent when treated against the stages I-IV. Mortality rate of untreated hoppers (I-II) was reported 6.50±5.68 and 3.25±4.27, respectively, was also high during the first 24 h. Though, there was no significantly mortality was reported in later stages of untreated insects.

Net percentage of mortality of *H.nigrorepletus* has been shown in (Table I) it stated that during the earlier 24 h casualty of hoppers I-III was significantly highest when treated with Thiodan compared to Regent. Conversely, Regent was found more effective against the later stages of *H. nigrorepletus* compared to Thiodan. Nevertheless, after the 48 h application of Thiodan 35EC mortality ratio of all the developmental stage of *H. nigrorepletus* was significantly highest compare to Regent. Thiodan was found to be more effective against the all developmental stages of *H. nigrorepletus* after the test of 72 h. Similarly, casualty of hoppers I-V was reported significantly highest when treated with Regent with exception of last stages. Mortality of untreated hoppers was insignificant after the 24, 48 h except stage III. However, mortality rate was recorded significantly highest in the earlier stages I-III after the 72 h.

Comparative mortality of *Hieroglyphus* spp. has been shown in Table II. It stated that mortality of developmental stages particularly stages (I to III) was significantly higher, 24 h after the application of insecticide (Table II). These stages were found more susceptible to insecticides as compared to the later stages and adults. However, utmost 84% to 98% mortality was observed in the all stages of *Hieroglyphus* species after 72 h. The mortality ratio of untreated insects (control) found minimum *i.e.* 1% to 2% as compared to the insects treated with different insecticides. Overall findings indicated that two insecticides were tested in the laboratory against the *Hieroglyphus* spp. Both these insecticides were found to be most effective in controlling hoppers of all three species.

DISCUSSION

Pest management can be achieved most effectively through the combination of different techniques including biological, cultural, mechanical, chemical, and regulatory/ legal methods. The present investigations recommended that if the control operation has been carried out in extensive area, there is very little possibility of damaging the crops. Grasshopper can be controlled at all the stages *i.e.* egg, hopper and adult but the most effective and economical control is achievable on hopper stages. Most vulnerable stages from control point of view are (I to III) stages once the hoppers pass into the IV stages and onwards and successive stages the affected area increases and control work and expenditure also increase proportionately. If the chemical control operations are carried out at the proper time (particularly against stages I to III) then the area to be treated can be considerably reduced. The present investigations by using different insecticide with the same dosage and within the same period of time indicate the usefulness of the insecticides in the laboratory and field as well.

Previously, Alam and Alam (1977) recommended 0.05% bidrin lebaycid, dimecron or diazinon, or 0.07% folithion or thiodan to control *H. banian, H. oryzivorus* and *Oxya* spp. In addition to this, Jotwani and Butani (1978) suggested deep ploughing to destroy the eggs, mechanical collection of larvae and adults, and dusting with 5-10% BHC effective control methods against *H. nigrorepletus*. Roonwal (1978) stressed the use of both mechanical and chemical control; he stated that younger hopper can be killed either by dusting or baiting. He further

Table II.- Comparative mortality of *Hieroglyphus* spp. (hoppers and adults) treated with different insecticides.

Treatments	*H. perpolita*		*H. oryzivorus*		*H. nigrorepletus*	
	Hoppers	Adults	Hoppers	Adults	Hoppers	Adults
Thioden	85.66±10.93[a]	67.63±21.74[a]	85.41±7.16[a]	55.16±36.26[a]	85.15±14.10[a]	63.89±40.92[a]
Regent	88.85±10.00[b]	72.91±22.26[b]	77.41±13.60[b]	44.58±31.92[b]	73.24±20.21[b]	41.08±38.65[b]
Control	1.59±0.31[c]	1.0±0.25[c]	2.44±0.16[c]	1.32±0.50[c]	2.06±0.30[c]	1.33±0.52[c]
$F_{(0.05)}$	$_{(58.70)}03.85^{*}$	$_{(47.18)}82.90^{ns}$	$_{(55.68)}98.61^{ns}$	$_{(33.68)}60.21^{*}$	$_{(53.48)}93.38^{ns}$	$_{(35.43)}61.96^{*}$

Mean in the same column followed by the same letters are not significantly different from one another at 5% level of probability (DNMRT)
*=p≤ 0.05 ns =not significant p≥ 0.05

claimed that 5% BHC (gamma benzene hexachloride) is very constructive to control the *Hieroglyphus* population in field whereas an Anonymous (1978) suggested these two insecticides hexidole 5D at 20Kg/ha or Sumithion 5D at 8 kg/ha to restrict population of *H.banian* in more effective way.

During the present study it was found that the nymphs of the earlier stages die earlier and was found to be more susceptible to insecticides than the later nymphal stages or the adults. The possible cause of this high mortality is that the younger stages are more sensitive to insecticides. Apparently the reason for their being less sensitivity is their cuticle, which is soft in younger stages, gets hardened and becomes less sensitive in the later stages. The softness of the cuticle makes the penetration of the insecticide into the body of the insect easier; hence they died more easily. Similarly Roonwal (1978) reported that control operation should be taken against the younger hopper stages which are less active and would also require lesser quantities of insecticides. Present study recommends the use of insecticides *i.e.* Thioden and Regent because these were found to be more effective in reducing the maximum insect's population due to their active ingredient which disrupts the nervous system of the insects. However, to control the grasshopper's incidence in the field Regent1186.08 ml per hectare and Thioden 2857.14 ml per hectare is recommended by pest control agencies.

During the present investigations chemicals treatment was investigated. In lacking control strategy for this genus we have to keep in mind if the economic status of crop is significant. Paddy crop is of course, of economic significance. The control of *Hieroglyphus* spp. has to be considered in this light. Rice at the nursery stage is not much damaged by these pests as the emergence of hopper from over wintered egg is such that it escapes the attack of this pest. The damage level may depend on the sequences of management strategy focused from the point when the pest goes into hibernation after autumn. Maize crop is not severely damaged however it should be monitored for this pest. If required spots spray of insecticides can be done. The grassland ecology in Pakistan does not warrant any control operations due to economic constrains.

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