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Study on the effects of different host plants on development and growth rate of *Acrotylus humbertianus*

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Abstract

Acrotylus humbertianus Saussure is a major agriculture pest in Matiari district. This species consumes a wide variety of food plants from different families. During present study five food plants i.e. *Zea mays* (Maize), *Saccharum officinarum* (Sugarcane), *Sorghum bicolor* (Jowar), *Cynodon dactylon* (Grass) and *Brassica oleracea* (Cabbage) were found suitable for *A. humbertianus*. Growth rate of *A. humbertianus* was noted as 41.20±0.51 days, 39.35±12.50 days, 39.29±0.58 days, 33.28±0.79 days and 32.80±0.40 days on *Z. mays*, *S. officinarum*, *B. oleracea*, *C. dactylon* and *S. bicolor* respectively. However, survivability of *A. humbertianus* fed on these plants did not differ remarkably, although their survivability was higher on *S. officinarum* followed by *B. oleracea* and *Z. mays*, this learning will be proved a significant guideline for culturing of this species.

Keywords: *Acrotylus humbertianus*, agriculture pest, variety of plants, growth rate, survivability

1. Introduction

Studies on the food selection and feeding behavior of grasshoppers, locusts and their new relatives groups have attracted the attention of researchers throughout the world, at least partly because of the insects. Competition with mankind for food hence the current interest in their biology, this has triggered much research and has provided basic information on host selection and feeding behavior. Grasshoppers are the polyphagous insects and considerable damage to various important crops in many countries including Pakistan. *Acrotylus* has multidimensional importance in agriculture related areas. It reduces the average productivity of plants and damages the host plants seriously.

Research so far, conducted on *A. humbertianus* has mainly concentrated on its taxonomic status [1-5]. Beside this [6-13] studied feeding behavior of different grasshopper. Furthermore Riffat and Wagan [14] studied the effects of various plants on nymphal development and egg production in *Hieroglyphus perpolita* but none of these include this pest in their studies. On the other hand Bernays and Chapman [15] reported that survivability of insect also depends upon the type of food. Various studies in areas such as biology, ecology, behaviour and biomass have been done on different species of grasshoppers [16,17], beside its havoc, it is very beneficial to man products because of its high reproductive potential and gregarious status; this insect can be utilized as non-conventional sources of animal's protein-supplement for fishes. For utilization of this natural resource, biomass production through mass culture is important. To obtain a high amount of biomass, studies on the growth rate, as well as their survivability rate, are very essential because rapid growth and less mortality will directly influence their mass culture and biomass production. On the other hand growth is directly related to the digestion/assimilation of food. The type and nature of the food also plays vital role in growth of individual. However, no detailed studies on the effect of diet on growth and survivability of *A. humbertianus* have been carried out before this. This research focused on growth rate and survivability of this species fed on preferred food plants with a view to obtain basic information for biomass production of *A. humbertianus* from this region present investigation have designed first time.

2. Material and methods

2.1 Sampling

A large stock of *Acrotylus* ranging from different stages (nymph to adult) collected periodically from vast agricultural area of Matiari district (Latitudes 25° N and Longitude 68° E). They were collected from different fields of cotton, sugarcane, grass, maize, alfalfa, and rose plant.

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Acrotylus were collected with insect hand net (8.89 cm in diameter and 50.8 cm in length) and some by hand picking. They were immediately transferred to plastic jars and offered different varieties of crops for feeding as they survive for long time. The insect jar was also made conducive to keep specimen comfortably. Mostly the collection was made during the year 2013-14 in different months of the year (from May to November) samples were captured in early hours of the day before 12 O' clock and some were also collected in evening time between 5 O' clock to 7 O'clock (Table I - II).

2.2 Sorting out of various nymph stages

The collected specimen was sorted out into different developmental stages. They were transferred into different plastic jars where they were given different food plants. They were kept and reared isolated in 4 litre plastic jars at room temperature range was between 28 ± 2 °C to 39 ± 2 °C and relative humidity was $28 \pm 2\%$ to $55 \pm 2\%$ for rearing of insects method described by Riffat and Wagan [18] was adopted. The identified stages kept in plastic jar contained particular food plants that kept moist by water spray and hard stick was also kept in jar as well in the cage in order to imitate natural environment as *Acrotylus* feel it as natural home and comfort easy. All jars and cages were kept in hygienic conditions for this plastic jars were sterilized weekly kept in sun light for ample time (about 6 hours), while bottom paper sheet of plastic jar was changed daily. Dead insects also removed from cages and jars.

2.3 Stock culture for the study of effect of various host plants on life history

For this parameter, 3-4 weeks old leaves of five preferable host plants, viz. *Zea mays*, *Saccharum officinarum*, *Sorghum bicolor*, *Cynodon dactylon* and *Brassica oleracea* were served in the experiment. These plants were grown in the green house (maintained at home) and also collected from the field where these insects were captured, the stock culture consist of adult females from the field was only established to provide a regular source of nymphs and adults for the actual experiment which was carried out only for one generation.

2.4 Identification of different development stages

The identification of specimens was conducted in laboratory under the Stereoscopic Dissecting Binocular Microscope with help of the keys and description given by Kevan and Popov

[19] and Riffat and Wagan [20].

2.5 Statistical analysis

Data obtained from experimental groups were subjected to one way analysis of variance (ANOVA) (SPSS 16.0 Software) with repeated measures and significant means were determined using Least Significant Difference Range Test (LSD) this test was used to compare the means of various treatments.

3. Results

3.1 Food selection

Food plants which were used in the present research work are maize, sugarcane, grass (*C. dactylon*), jowar and cabbage. These all plants belongs to Poaceae, Brassicaceae families amongst maize, sugarcane, grasses, jowar are the members of Poaceae, cabbage belongs to Brassicaceae Table. III suggests that Poaceae was found more preferable by this pest compare to other families were tested. Month wise collection of different nymphal instars and adults of *A. humbertianus* during the year 2013 has been described in Table. I and Fig. I, which indicates that highest collection was noted during the month of July i.e. 613 with 21.13% followed by June and May (523 with 17.94% and 514 with 17.63%), respectively, while lowest collection was seen during month of November (45 with 1.5%) followed by October and September (254 with 8.71% and 383 with 13.13%), respectively. As far as collection record of 2014 is concerned it indicates that prevalence of hoppers and adults of *A. humbertianus* was highest in the month of July i.e. (641 with 21.21%) followed by August and June i.e. (600 with 19.85%) and (551 with 18.23%) respectively. Lowest collection was in month of November, October and September i.e. (56 with 1.85%), (266 with 8.8%) and (399 with 13.2%) respectively (Table. II and Fig. II). Table. III showed that in *A. humbertianus* maturation period observed was faster on maize i.e. (41.2 ± 0.51 days) than sugarcane, cabbage, grass and jowar i.e. (39.35 ± 12.50 days), (39.29 ± 0.58 days), (33.28 ± 0.79 days) and (32.80 ± 0.40 days) respectively. Beside this, Table IV showed that total developmental period and adult life span on different food plants was highest on sugarcane followed by cabbage, maize, jowar and grass (*C. dactylon*) i.e. 100.36 days, 90.10 days, 84.54 days, 73.83 days and 72.30 days, respectively.

Table I: Collection of different developmental stages of *Acrotylus humbertianus* during the various months of the year 2013 from Matiari district

Month	Developmental stages							Total	Percentage of collection
	1 st	2 nd	3 rd	4 th	5 th	6 th	Adult		
May	210	177	73	47	7	0	0	514	17.63%
June	198	165	92	53	15	0	0	523	17.94%
July	36	43	62	98	126	131	117	613	21.13%
August	16	23	41	86	134	157	126	583	20%
September	0	0	7	45	78	138	115	383	13.13%
October	0	0	4	9	17	98	126	254	8.71%
November	0	0	0	0	5	13	27	45	1.5%
Total	460	408	279	338	382	537	511	2915	100%

Table II: Collection of different developmental stages of *Acrotylus humbertianus* during various months of the year 2014 from Matiari district

Month	1 st	2 nd	3 rd	4 th	5 th	6 th	Adult	Total	Percentage of collection
May	200	172	76	51	8	2	0	509	16.8%
June	205	180	98	48	17	3	0	551	18.23%
July	42	48	59	103	131	140	118	641	21.21%
August	21	21	43	90	132	153	140	600	19.85%
September	0	0	10	50	68	152	119	399	13.2%
October	0	0	7	11	15	102	131	266	8.8%
November	0	0	0	3	6	17	30	56	1.85%
Total	468	421	293	356	377	569	538	3022	100%

Table III: Conversion duration of *Acrotylus humbertianus* into next stage on different food plants

S#	Host plants	Sex	First Instar (Mean±SD)	Second Instar (Mean±SD)	Third instar (Mean±SD)	Fourth instar (Mean±SD)	Fifth instar (Mean±SD)	Sixth instar (Mean±SD)	Adult (Mean±SD)	Total days Mean±SD)
1	Maize	M	3.77 ±0.27	3.76±0.22	6.02±0.21	5.84±0.19	5.85±0.27	9.78±0.30	6.02±0.30	41.20±0.51
		F	3.51±0.31	3.76±0.22	6.02±0.21	5.84±0.19	5.50±0.20	8.99±0.31	5.58±0.27	39.37±0.55
2	Sugarcane	M	2.97±0.11	2.44±0.22	5.62±0.37	5.68±0.26	4.70±0.26	3.08±0.22	14.85±0.27	39.35±12.50
		F	2.96±0.11	2.42±0.25	5.61±0.37	5.67±0.29	4.70±0.26	3.11±0.24	14.82±0.29	39.32±12.48
3	Grasses	M	3.14±0.23	3.28±0.23	4.08±0.23	5.37±0.33	5.98±0.19	5.46±0.44	5.94±0.21	33.28±0.79
		F	3.04±0.19	3.13±0.16	3.94±0.15	5.17±0.21	5.92±0.19	5.37±0.44	5.90±0.18	32.50±0.69
4	Jowar	M	3.40±0.34	3.13±0.19	6.36±0.23	5.57±0.30	6.89±0.18	3.72±0.18	3.12±0.17	32.80±0.40
		F	3.27±0.22	3.13±0.19	6.19±0.22	5.57±0.30	6.86±0.20	3.35±0.22	3.12±0.17	31.51±0.43
5	Cabbage	M	4.39±0.25	4.00±0.29	7.10±0.21	6.43±0.36	8.20±0.25	4.21±0.25	4.94±0.21	39.29±0.58
		F	4.20±0.36	3.86±0.34	6.96±0.11	6.43±0.36	8.02±0.19	4.07±0.11	4.85±0.18	38.41±0.65

Table IV: Life span of *Acrotylus humbertianus* both (nymph & adults) on various food plants under laboratory condition

S#	Host Plants	Sex	Nymph life (Mean ±SD)	Adult Life (Mean ±SD)	Total days
1.	Maize	M	41.20±0.51	43.34±0.65	84.54
		F	39.37±0.55	47.08±0.50	86.45
2.	Grasses	M	33.28±0.79	39.02±0.81	72.30
		F	32.50±0.69	35.06±0.60	61.69
3.	Cabbage	M	39.29±0.58	50.81±0.73	90.10
		F	38.41±0.65	47.03±0.45	85.44
4.	Sugar cane	M	39.35±12.50	61.01±9.03	100.36
		F	39.32±12.48	52.38±7.89	91.70
5.	Jowar	M	32.80±0.40	41.07±0.71	73.83
		F	31.51±0.43	37.22±0.38	68.73

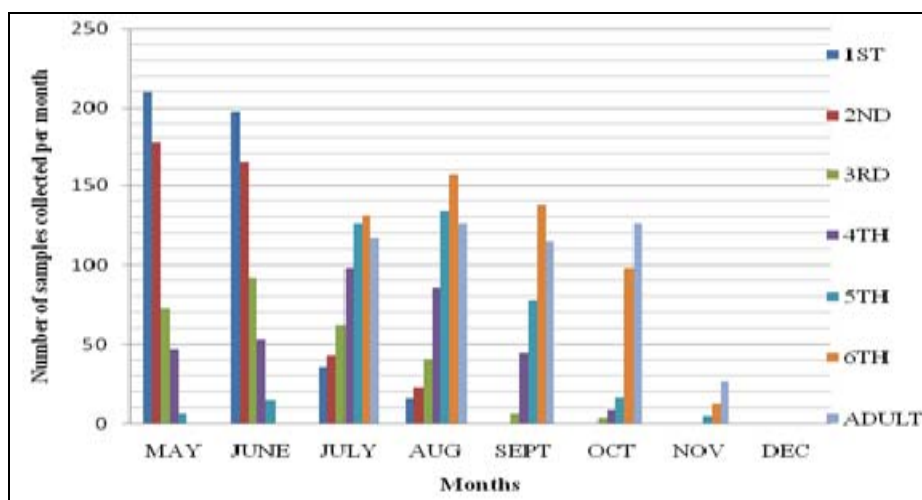


Fig 1: Month wise collection of *Acrotylus humbertianus* during the year 2013

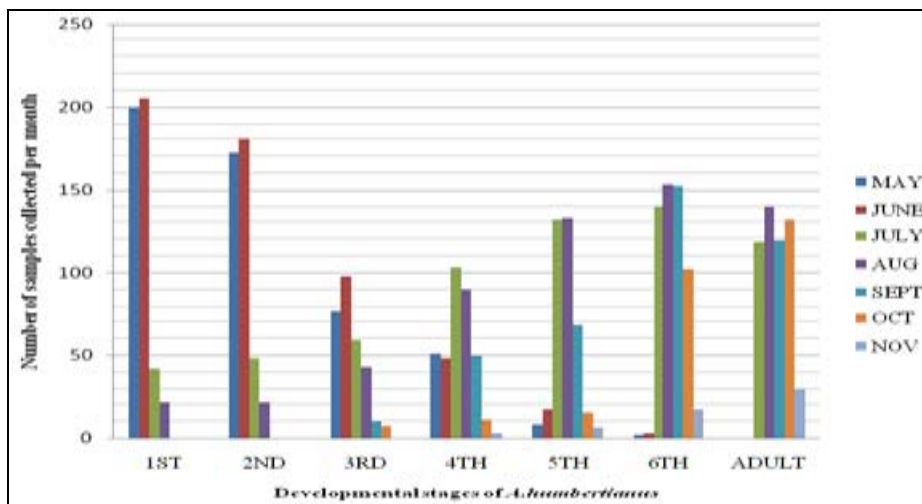


Fig II: Month wise collection of *A. humbertianus* during the year 2014

4. Discussion

Grasshoppers are known as most important members of class Insecta because they constitute all important groups of pest species and pose a constant threat to agricultural yield such as cereals, vegetables, grassland, forest, cash crops and other herbs and shrubs plantation occurring all over the world. *Acrotylus* most of important genus of subfamily Oedipodinae is well known due to cosmopolitan distribution. They are polyphagous in nature, consume all types of vegetation and play havoc with many cash earning crops. It might be reason that they found in i.e. rocky places, uncultivated areas, soil, sand, grassy fields and most abundance near the Maize, Sorghum, ground nuts fields. Food selection study of insect provides bedrock for all pest management authorities, without which no control measures can be taken. Many studies would be taken many studies on the food selection and feeding behavior of important grasshoppers, locusts and their closely near relatives was carried out by [21-24], which provide the comprehensive reports of host selection pattern in phytophagous insects. Beside this, [25, 9, 26] have provided reviews dealing specifically with Orthoptera particularly Acridoidea from different regions of the world.

Uvarov [9] has reported that grasshopper is largely phytophagous insects and present study is in agreement with this. Beside this, it was found that the growth rate and survivorship of *A. humbertianus* was higher on sugarcane followed by cabbage and maize in the light of these facts present study suggests that sugarcane was the most favorable food plant among the ten maintained mass culture of *A. humbertianus* to produce a higher biomass. Presently data based on various localities in this study indicates that *A. humbertianus* feeds regularly on varieties of plants most of which are belonging to the family Poaceae. Present study suggests that insect is polyphagous and graminivorous in nature similar observation was also reported by [27, 28] for *Oedaleus nigeriensis* Uvarov from Nigeria. Das *et al.* [29] while studying the *Hieroglyphus banian* observed that after 8 days the survivability of adult samples of *H. banian* females was similar about 86% when she fed on *Cynodon dactylon* and *Oryza sativa* were used as food plant but decreased somewhat about 80% when offered *C. kyllingia*. In present study significant greater survival time of *A. humbertianus* was noted on maize and jowar. Present study recommends that its possible reason is diet difference. In some cases it was also noted that survivability decreased with the advancement of insect's age hence after becoming mature there is little survivorship. Present study recommends that it might be reason that after egg laying female could not survive for longer period of time. Current research may be fruitful to fill gap in scientific literature about feeding behavior of *Acrotylus* species and its quality of damage to host plant this attempt has been carried out first time hopefully it will boost fresh biological literature regarding area of proposed research.

5. Conclusion

Acrotylus humbertianus Saussure is a major agriculture pest in Matiari district. During the present study it was observed that *A. humbertianus* having incomplete development cycle and go through nymphal instars. An identification key was used for its easy separation. This species consumes a wide variety of food plants from different families. *Z. mays*, *S. officinarum*, *S. bicolor*, *C. dactylon* and *B. oleracea* were highly suitable for *A. humbertianus* and in the present study the development time of *A. humbertianus* on *Z. mays*, *S. officinarum*, *B. oleracea* and *C. dactylon* was observed as

41.20±0.51 days, 39.35±12.50 days, 39.29±0.58 days and 33.88±0.97 days, respectively.

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