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SOME OBSERVATIONS ON THE DECAY OF P-32 IN THE DESERT LOCUST-SCHISTOCERCA GREGARIA (FORSK)

HESHAMUL HUQUE and MOHAMMAD ABDUL KHALIQUE

Department of Plant Protection, Karachi 27

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Abstract. Biological half-life of P-32, when injected to immature and mature locust adults, was found to vary from 4.3 to 5.4 days to 4.5 to 6.2 days respectively. Except in case of mature, tagged males when mated with untreated females radioactivity persisted to a varying extent in the egg-pods and resultant hoppers obtained by mating the tagged mature and immature females, as well as the immature males when mated with opposite untreated sexes.

The desert locust, *Schistocerca gregaria* (Forsk)—family Acrididae (Orthoptera), is a pest of great economic importance to Pakistan and many Afro-Asian countries. Phase variation in this insect is the outstanding character which separates it from grasshoppers. Desert locust while in solitary phase occurs in a scattered form in the desert areas of many countries of Asia and Africa during recession period. Sometimes, however, vast territories of these continents are invaded by the gregarious migrating swarms of desert locust which cover an area of nearly 30 million km² of various countries. Pakistan is seriously affected by this menace during plague period since two breeding seasons, viz. spring and summer, occur every year. Thus the control of the desert locust on account of its migratory habit has been a serious problem in many of the affected countries.

Effective control of insect pests generally depends on the basic knowledge of their biology, life history, dispersal, movements, behaviour and ecology etc. In case of locust, egg laying generally takes place in inaccessible desert areas. For effective control measures it is necessary to locate and check the breeding patches during early stages and destroy the eggs and hoppers in young stages. Migratory habit of the locust adults necessitated studies on the estimation of numbers and trace the movement of swarms and their breeding behaviour, during solitary and gregarious phase.

With the advent of atomic age, however, great strides have now been made through the use of radioisotope tracer techniques, radioisotope labelling applied for such studies on flies and grasshoppers have yielded very useful results during recent years. Hoffman *et al.*[1] made flies radioactive by feeding them on P-32 in sugar solution, Baldwin *et al.*[2] tagged grasshoppers successfully with P-32 in a study on their dispersal. Huque[3] labelled three species of grasshoppers and Madeira cockroaches with P-32 and studied the persistence, decay and distribution of P-32 in these insects. Jenkins[4] suggested that radioactivity can be used to locate egg laying and overwintering sites of various insects.

Generally the beta-emitter radioisotopes like P-32 are used for ecological studies as they have many advantages such as suitable half-life, effective absorption and longer retention in insect body and easy handling. For these reasons P-32 radioisotope has been used in the present studies against desert locust to determine its persistance and mode of biological decay in adults and carry over to eggs and hopper stages.

Methods and Materials

Many methods, like dipping, feeding, spraying and injecting have been developed for labelling insects with radioisotopes. Injection method with a micro-sy ringe was found suitable for labelling adult locusts.

Immature and mature adults of the desert locust *Schistocerca gregaria* (Forsk) bred in the laboratory were used in these experiments. Adult males and females were taken in equal numbers. The technique for tagging was followed as described by Huque and Myser.[5] P-32 diluted with distilled water was taken in a micro-syringe, fitted with hypodermic needle and fixed on a micrometer stand. The adult specimen were placed horizontally and P-32 was inoculated by pushing the needle into the 3rd abdominal segment. This method facilitated administration of equal quantities of 1.0–1.8 μl of P-32 among all the individuals. Locusts tagged in this way were released into the rearing cages. Tagged males were released with untagged females and vice versa. Radioactivity of the insect body was measured per minute by a Geiger–Muller counter at regular intervals. This electronic scaler was connected to an automatic timer and to a G.M. tube of 900 V. For measuring the radioactivity, each individual locust was placed in a plastic specimen tube with its abdomen facing the open end of the tube which was covered with a piece of fine muslin cloth and tied with a rubber band.

Radioactivity of the egg-pods and that of hoppers which subsequently hatched from these egg-pods was also measured with the same scaler.

Results

Immature Locusts (*Pink Locusts*). In this experiment radioactivity of the pink locust was measured after 24 hr. In case of males, highest initial activity count per minute recorded was 23,274 and lowest initial activity count per minute was 18,832 (Table 1). In the females highest and lowest count per minute were 22,384 and 16,221 respectively. Males seem to

be more radiosensitive than the females because the highest count per minute was recorded in the tagged male population. The emission rate observed in the immature male is significantly higher than females at 5% level. The radioactivity of the tagged locusts was then measured after regular intervals of two days. They remained radioactive throughout their life span which was 40 days. Average count of males remained higher than females up to 18 days. But after this period females showed higher radiation counts than males. During the initial days of P-32 administration, the decay was very rapid.

Tagged male locusts on maturation were crossed with the normal virgin females and vice versa. Tagged females fed normally but after egg laying they became sluggish and ultimately died. It was observed that the tagged locusts mated once only while control insects mated thrice during their life span. When tagged males were allowed to mate with virgin females, the resultant egg-pods and hoppers did not show any radioactivity and their behaviour was normal. But, on the other hand, tagged female locusts when crossed with normal males, laid egg-pods which were found radioactive. The radioactivity was measured with the same counter at the rate of 846 counts per minute from a single egg-pod (Table 2). However, there was gradual decline in the count. Subsequently the hatched hoppers were also found radioactive. Radioactivity of these hoppers was measured and is given in Table 3. Highest count per minute recorded from a hopper was 145. Hoppers remain radioactive up to 4th stage.

Mature Locusts (*Yellow Locusts*). The results obtained show that mature females are more radioactive than the males as they gave highest count per minute, i.e. 29,731, and the lowest count per minute was 18,675 (Table 4). Highest count per minute recorded from the male group was 24,531 while the lowest count per minute was 18,787. When radioactivity was measured at regular intervals of two days, it was found that the average radiation count in females was higher as compared to males. The emission rate observed in mature females is significantly higher than mature males at 5% level. The radioactive induced locusts survived up to 20 days.

Tagged males and females were released in the rearing cages with normal females and males for mating. Tagged male locusts crossed with normal virgin females and laid egg-pods which were radioactive (Table 5). But the resultant hoppers failed to exhibit any radioactivity. On the other hand, offsprings of the tagged females and normal males gave rise to radioactive egg-pods (Table 6) and subsequently to radioactive hoppers (Table 7) which remained radioactive up to 5th stage. Faeces of the locust and hoppers were also found radioactive but the amount of radioactivity was negligible in the latter case.

The biological half-life of P-32 on the basis of initial count taken after 24 hr in mature locust varied from 4.5 to 6.2 days (Table 4). It is seen from Tables 5 and 6 that the gradual decay of P-32 in egg-pods is also similar.

Discussion

Fuller *et al.*[6] observed that grasshoppers labelled with P-32 retained a good quantity of radioactivity for

TABLE 1. COUNTS PER MINUTE RECORD OF IMMATURE LOCUST.

Locust specimen	After 24 hr	Days after treatment																		Half-life
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	36	40	42	
F1	20184	15766	10637	7652	5233	3159	3006	2200	1856	1488	1129	1020	948	816	662	417	380	323	289		4·2
F2	16221	11842	8468	5247	3868	3016	2755	3107	1876	1541	1093	956									5·0
F3	22384	16832	11754	9535	6929	4755	3803	3256	2692	2118	1955	1169	998	802	723	542					4·8
F4	18344	12766	9872	6723	5119	3683	2915	1993	1468	1149	988	766	592	318	168						4·5
F5	19524	14683	10372	7956	5744	4163	3677	2327	2058	1509	1131	878									5·0
M1	21100	15863	12822	9732	6658	4632	3788	2939	2132	1850	1095										5·4
M2	18832	13580	10226	7895	5318	3981	2935	1982													5·2
M3	22534	17246	13052	9170	6939	4723	3450	2877	1852	1112	936	781	543	388	210	161	143				5·0
M4	19570	14791	11375	8581	5732	4046	3267	2672	2007	1853	1209	988	870	692	530						5·1
M5	23274	17325	12181	9822	7151	4938	3885	2898	2115	1768	1114	922	787								4·3
Average counts of females	19331	14378	10220	7422	5732	3755	3251	2376	1973	1574	1291	1084	846	610	445						
Average counts of male	21062	15761	11931	9040	6360	4454	3455	2673	2026	1646	1088	897	733	540	370						

M, male locust; F, female locust.

TABLE 2. COUNTS PER MINUTE OF EGGS (Immature treated female × Untreated male locusts).

Specimen	Days after treatment							
	1	2	4	6	8	10	12	13
Egg-pod 1	846	815	754	696	635	576	518	Eggs hatched
Egg-pod 2	833	803	741	682	625	568	509	

TABLE 3. COUNTS PER MINUTE OF HOPPERS (Immature treated females × Untreated male locusts).

Hoppers	After hatching	Days after treatment											
		2	4	6	8	10	12	14	16	18	20	22	24
H 1	139	133	126	120	81	72	64	56	35	29	20	12	Zero
H 2	145	139	129	119	79	70	62	55	34	25	19	12	,,
H 3	141	134	125	117	79	72	63	55	33	25	18	11	,,

H, locust hoppers.

TABLE 4. COUNTS PER MINUTE OF MATURED LOCUSTS.

Locust specimen	After 24 hr	Days after treatment												Half-life
		2	4	6	8	10	12	14	16	18	20	22	24	
F1	19146	14891	10972	8538	6618	5118	4251	3607	2532					5·0
F2	22183	16365	11861	10732	7925	5897	4783	3992	2855	2056	1574			4·5
F3	18675	13634	10924	9265	6654	5539	4309	3795						6·0
F4	23596	18267	14162	11628	9895	7522	5138							5·0
F5	29731	22428	19123	14436	12736	9376	7835	6630	4192					6·2
M1	19178	13278	99523	8358	6257	4829	4108	3638	2192					4·5
M2	20565	15345	12593	10690	8097	5934	4389							5·8
M3	24531	20522	16336	12955	9562	8183	6940	6203	5845					5·2
M4	18787	12876	10638	9082	7885	5941	4173	3462						6·0
M5	23597	19109	16982	12346	9833	8359								5·0
Average counts of females	22228	17117	13408	10921	8565	6694	5516	4679	4192					
Average counts of male	21331	16226	13300	10686	8326	6649	4902	4427	4018					

M, male locust; F, female locust.

TABLE 5. COUNTS PER MINUTE OF EGGS (Mature treated male × Untreated female locusts).

Specimen	Days after treatment							
	1	2	4	6	8	10	12	13
Egg-pod 1	254	245	229	210	190	172	153	Eggs hatched
Egg-pod 2	249	240	223	205	185	168	150	

TABLE 6. COUNTS PER MINUTE OF EGGS (Mature treated female × Untreated male locusts).

Specimen	Days after treatment							
	1	2	4	6	8	10	12	13
Egg-pod 1	3098	2994	2787	2578	2372	2160	1954	Eggs hatched
Egg-pod 2	3023	2918	2712	2501	2293	2092	1889	

TABLE 7. COUNTS PER MINUTE OF HOPPER (Mature treated females × Untreated male locusts).

Hoppers	After emergence	Days after hatching															
		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32
H1	573	529	488	476	387	369	349	332	180	166	153	78	66	59	51	18	Zero
H2	365	554	528	499	398	386	362	331	187	173	156	79	63	54	42	11	„
H3	576	550	517	487	393	379	352	320	178	159	146	72	59	47	32	9	„

H, Locust hoppers

a period of 28 days. Huque[3] tagged three species of grasshoppers, *Malanoplus differentialis*, *Malanoplus femurrubrum* and *Dechomorpha viridis*, with P-32 and measured radioactivity in these species for a period of 30 days. Kettle-Well[7] reported persistence of radioactivity up to 5 weeks in the desert locust when labelled with P-32. The present work showed that the persistence of P-32 in mature and immature adult locust was 20 and 40 days respectively.

The biological half-life of P-32 in immature locusts varies from 4.3 to 5.4 days while in mature locust it varies from 4.5 to 6.2 days on the basis of initial count taken 24 hr after application. But in similar studies with P-32 on *Madeira roaches*, Huque[3] reported a longer biological half-life of 10 days. Radioactivity in locust was also found to decrease very rapidly during initial days of treatment. After 6th day the decay of P-32 was gradual within the body of the locusts.

Studies pertaining to developmental stages and sterilization offer some interesting results. Immature tagged females when crossed with normal males on maturation produced egg-pods and hoppers which were found radioactive. In the latter instance radioactivity sustained up to 4th instar. Similarly mature tagged female when cross-mated with untagged males, gave rise to egg-pods and hoppers which were fairly radioactive. The hoppers also remained radioactive up to 5th stage. An important effect of tagging was observed when immature tagged male locusts on maturation were crossed with normal females, the resulting egg-pods and hoppers were free from radiation. An interesting phenomena was observed on yellow locust, when tagged males were crossed with normal females they produced egg-pods and hoppers but only egg-pods were radioactive.

With a view to make use of radiation techniques in locust survey particularly in locating egg beds further work on the radioactivity, half-life of labelling material and its transmission in the progeny of locust will be necessary.

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