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Generations of *Rhyzopertha dominica* (fabricius) on stored sorghum under South Gujarat condition

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ABSTRACT

Lesser grain borer, *Rhyzopertha dominica* (Fabricius) is one of the major pests of stored cereals. It is widely distributed in the tropical regions of the world and met throughout India. Studies on the effect of prevailing temperature and relative humidity of south Gujarat during the year 2012-2013 on the development of *R. dominica* were carried out under laboratory conditions. The results revealed that the influence of temperature and relative humidity on the growth and development of *R. dominica* completed total eight generations on stored sorghum (variety GJ-42). The significantly negative correlation existed between maximum and minimum temperature, relative humidity with developmental period of *R. dominica*.

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INTRODUCTION

Lesser grain borer, *Rhyzopertha dominica* (Fab.) is an important internal and primary feeder of various stored sorghum grains and also attacks a wide range of stored cereals such as paddy, wheat, maize and sorghum rather than it also infest various other commodities including pulses and dried cassava root, etc. The beetle has been reported to breed extensively in a warm climate and is highly polyphagous and cosmopolitan in nature in tropical and subtropical regions of the world. Sorghum is one of the most widely adopted staple food crops for the mankind specially in semi-arid tropics. India is the fourth largest producer of sorghum in the world with 6.0 million tonnes during 2012 (Anonymous, 2012a). In Gujarat, sorghum is grown as grain crop in south Gujarat, dual purpose (grain as well as fodder) in north Gujarat, Kutchh, Saurashtra and partly as fodder in dairy developed area which occupies on an average about 1.80 lakh hectares (Anonymous, 2012b). Due to poor productivity and low return from the local varieties in south Gujarat, farmers are adopting newly developed varieties *viz.*, GJ-38, GJ-40 and GJ-42 which have a high yielding potentiality as compared to locals and posses grain quality similar to locals. The food industry demands to find suitable alternatives for stored pest control through government legislation and research projects. Alternatives should meet the demands of the consumers that should be low in use or elimination of pesticides, while at the same time, maintaining a high degree of control efficacy (Riudavets *et al*., 2010).

Hermetic storage of grain was practiced in ancient times in underground pits in the dry, subtropical regions of the middle east and other dry regions of the world, such as Africa and India. Underground pits for grain storage were used in Egypt during 1940s (Attia, 1948). Very old but active hermetic storages were reported in India (Girish, 1980) and in Yemen, Somalia, Sudan and Egypt (Kamel, 1980).

Toxicity responses of insects to modified atmospheres are similar to those with chemical fumigants. Moreover, no harmful residues remain after the treatment of the commodities with N_2 or CO_2. Carbon dioxide (CO_2) is now being used in several countries for the control of stored products, particularly grains in bulk quantities (Jay, 1984) and approved by the U.S. food and drug administration (FDA) as a fumigant based on its availability, convenience and safety of application (Johnson, 1981).

Data on the effects of different types of CO_2 treatments on key pests are available for many species and stages of stored-product pests under specific conditions (Banks and Annis, 1990; White *et al*., 1995; Annis and Morton, 1997). CO_2 is received considerable attention for the disinfection of stored foodstuffs, particularly durable products (Bailey and Banks, 1980; Annis, 1986; Bell and Armitage, 1992). The toxicity of CO_2 to insects is known to vary among species, developmental stages and age groups. Due to uncertain rain and uneven season in our country, food grains are required to be stored for a longer period *i.e.* about 6 to 12 months. Heavy losses are inflicted to grain under storage condition due to insect pests *viz.*, *R. dominica*. Insects are poilkilothermic that are largely affected by various environmental factors. Among all the climatic factors, temperature has probably the greatest effect on insect development. During the present investigation, the aim was to understand the effect of temperature and relative humidity on growth and development of *R. dominica* on stored sorghum and total number of generations in a year under laboratory condition. Information on thermal requirements of *R. dominica* development has important place in application of control programme as temperature determines the population growth and size and their variation under different conditions.

MATERIAL AND METHODS

The test insect was obtained from local market through infested sorghum grain and maintained under the laboratory condition. The mass multiplication of stock culture was done on stored sorghum grains. The culture of this insect was sent to Insect identification cell, Division of Entomology, Indian Agricultural Research Institute, New Delhi for identification and confirmation. The text insect was identified as *Rhyzopertha dominica* (Fabricius). The grains of sorghum were disinfested at 55°C temperature in an oven for 4 hrs. before use. These grains were conditioned for 10 days under laboratory condition. The adults of *R. dominica* obtained from stock culture were released in the glass jar (21×15 cm) filled with 1 kg sorghum grains. The top of glass jar was secured with muslin cloth and tied with rubber band to avoid the escape of the insect. Similarly, the stock culture was maintained under laboratory condition for further investigation on *R.*

Table 1 : Generation wise developmental period of *R. dominica* under laboratory condition

Generation	Period of study	Temperature (°C) Minimum Range	Minimum Av. ± S.D.	Maximum Range	Maximum Av. ± S.D.	Relative humidity (%) Range	Av. ± S.D.	Duration of each generation (days) 1	2	3	4	5	6	7	8	9	10	Av.± S.D.	Over lapping period between two generations: Generation	Days
1st	09.06.2012-13.07.2012	26-30	28.85 ± 1.31	29-34	32.36 ± 1.35	75-87	81.46 ± 3.50	29	29	29	29	29	30	31	31	33	35	30.50±2.07	1-2	4
2nd	10.07.2012-16.08.2012	26-30	28.06 ± 1.20	29-32	30.54 ± 1.18	75-87	80.68 ± 3.86	28	28	29	30	34	35	37	37	38	38	33.40±4.22	2-3	5
3th	12.08.2012-22.09.2012	26-29	27.87 ± 1.40	28-32	30.49 ± 1.36	75-88	80.38 ± 3.86	31	33	33	34	36	36	38	38	40	41	36.00±3.27	3-4	5
4th	18.09.2012-11.11.2012	25-30	27.51 ± 1.31	27-32	29.96 ± 0.98	52-84	71.73 ± 8.46	40	42	46	46	48	48	48	48	51	51	46.80±3.52	4-5	7
5th	05.11.2012-09.01.2013	18-27	23.43 ± 2.00	23-29	26.67 ± 1.62	36-70	46.77 ± 8.31	47	49	52	53	53	56	58	60	60	60	54.80±4.73	5-6	10
6th	31.12.2012-18.03.2013	18-27	22.37 ± 2.51	22-30	26.26 ± 2.24	36-60	44.50 ± 5.49	55	56	57	61	61	61	65	65	67	67	61.50±4.45	6-7	17
7th	02.03.2013-28.04.2013	24-30	26.34 + 1.52	29-33	30.14 + 1.37	39-80	58.83 +11.81	47	48	49	50	50	53	53	53	54	54	51.10±2.60	7-8	7
8th	22.04.2013-26.05-2013	27-32	29.09 ± 1.29	30-35	32.91 ± 1.00	69-87	77.71 ± 4.97	28	28	28	29	30	31	31	34	34	34	30.70±2.54	8-9	5
Mean								38.13	39.13	40.38	41.50	42.63	43.75	45.13	45.75	47.13	47.50	43.10± 3.43	-	7.50 ±4.28

dominica aspects. Adults males were recognized by the presence of a punctuate grooves on the fifth abdominal sternite (Bousquet, 1990) whereas females were differentiated on the basis of female genetalia.

Ten pairs of newly emerged male and female were confined separately in Petri plates (1.5×9 cm) with 25 g sorghum grain variety GJ-42. Test was repeated for 10 times. After deposition of eggs, the adults were removed from the Petri plates. The plates were kept under observation till the emergence of first generation adults. One pair of adults from the first generation (F_1) was further caged to breed second generation (F_2). The same process was repeated for twelve months to know total number of generations of the insect completed in a year under laboratory condition. Thus, total number of generations of *R. dominica* was worked out.

RESULTS AND DISCUSSION

R. dominica was reared on sorghum grains (variety GJ-42) from June 9, 2012 to May 26, 2013, during that period total eight generations were completed. The data presented in Table 1 revealed that the average duration of first, second, third, fourth, fifth, sixth, seventh and eight generations were 30.50 ± 2.07, 33.40 ± 4.22, 36.00 ± 3.27, 46.80 ± 3.52, 54.80 ± 4.73, 61.50 ± 4.45, 51.10 ± 2.60 and 30.70 ± 2.54 days, respectively. The time taken during the sixth generation was the maximum (61.50 ± 4.45 days) at temperature of 22.37 ± 2.51 to 26.26 ± 2.24°C coupled with 44.50 ± 5.49 per cent relative humidity, whereas, it was minimum (30.50 ± 2.07 days) during the first generation at an average temperature of 28.85 ± 1.31 to 32.36 ± 1.35°C with 81.46 ± 3.50 per cent relative humidity. Previously, Hashem (1989) reported that the total developmental period of *R. dominica* required 33.0 ± 4.2 days on wheat at 30 ± 1°C temperature and 70 ± 5 per cent RH, while Pireva (1992) observed that the developmental period of *R. dominica* was averaged 28.06 days on an average at 34°C and 75 per cent RH on stored wheat. The present results are more or less in conformity with above findings.

The duration of generation varied from 28 to 67 days with an average 43.10 ± 3.43 days for completion of one generation. It was also observed that the duration of overlapping period between two generations varied from 4 to 17 days with an average of 7.50 ± 4.28 days. The total number of generations observed during the present investigation was eight in a year as compared to seventh generation reported by Faroni and Garcia (1992). The discrequncy in generations of *R. dominica* in a year on sorghum might be due to difference in prevailing geographical location and weather effect. Adler *et al.* (2000) worked on modified atmospheres in alternatives to pesticides in stored products. Bera *et al.* (2008) also worked on the same topic in storage of seed quality parameters of paddy.

The data presented in Table 2 and depicted in Fig. 1 showed that the negative correlation existed between weather parameters (minimum, maximum temperature and relative humidity) and developmental days. It can be observed that the developmental days of *R. dominica* had significant negative correlation with minimum temperature (‘r’ = -0.93220), maximum temperature (‘r’ = -0.90656) and relative humidity (‘r’ = -0.94999). Thus, as temperature and relative humidity decreased, developmental period of *R. dominica* was significantly increased and *vice-versa*. The findings of the present investigation are in agreement with Bains (1971), who found that developmental period of *R. dominica* decreased with increase in temperature and relative humidity. Bailey and Banks (1980) worked on the effects of controlled atmospheres on stored product.

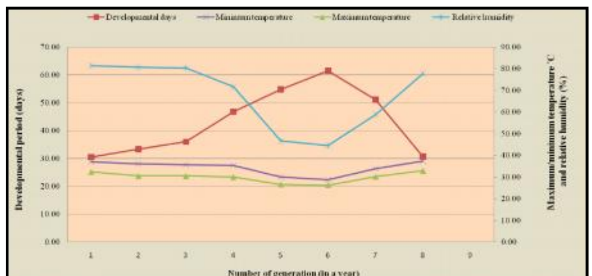

Fig. 1 : Influence of weather parameters on the developmental period of R. dominica during 2012-2013

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Table 2 : Impact of weather parameters on developmental period of *R. dominica* on stored grain under laboratory condition

Parameters	Minimum temperature	Maximum temperature	Relative humidity	Developmental period (days)
Developmental period (days)	-0.93220*	-0.90656*	-0.94999*	1.00000
Relative humidity	0.96084*	0.88866*	1.00000	-
Maximum temperature	0.96847*	1.00000	-	-
Minimum temperature	1.00000	-	-	-

* indicates of significance of values at P=0.05, respectively

insect in stipulated time span.

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