Effects Of Crowding On The Loss In Weight Of Sorghum Flour And On The Survival And Development Of Adult Confused Flour Beetle, *Tribolium Confusum* In Sorghum Flour

David Timothy
College Of Education, P.M.B 39, Minna, Niger State, Nigeria.
+2348036048295; titus_matthew@yahoo.com

Abstract: The research was carried out under laboratory conditions for 1-8 weeks of storage period. The mean environmental temperature ranged from 25^{0c} to 36^{0c}, and the humidity ranged from 43% to 84%. Samples of stored products beetles were collected from different parts of Niger State, such as Katcha, Badeggi, Bakeko and Paiko markets. Samples of infested grains were collected from markets, farmers, stores and large storage mills. The samples were then taken to the laboratory. One day old adult were used to set-up the research. The result clearly showed that, there was increase in number of adult *T.confusum* with advancement of storage period. Crowding increased the mortality rate for all the three initial population densities of 4,8 and 16 Beetles per 100g of sorghum flour. The fecundity decreased with increase in population build up in the bottles. The generation mortality was density dependent. There was average loss in weight of sorghum flour with the increase in storage period due to the increase in the number of *T.confusum* larvae, pupae and the young adult. [New York Science Journal. 2010;3(1):56-61]. (ISSN:1554-0200).

Key Words: Crowding, weight, sorghum flower, survival, development, beetle.

Introduction

Since the time of the early explorers, the importance of insects to agriculture and health has been realized in West Africa in general and in Nigeria in particular. Insects constitute more known species than all other animal species combined, it is a known fact that over three-quarters of a million species of insects are known in the world today and a large proportion of these occur in the African continent.

The first insects appeared in the Devonian period, approximately 400 million years ago. They are thought to have been inconspicuous wingless animals that liked under the leaves, probably resembling modern wingless brightletails. (Gil Brum etal 1994) These ancestors underwent a remarkable adaptive radiation, spurred by the evolution of flight. The ability to fly is of immeasurable importance. It allows insects to avoid predators, to cross barriers, and to exploit widely scattered resources (Gil Brum 1994).

Insects are also known to be the familiar pests or disease carriers, from bedbugs, houseflies and cloth moths to Japanese beetles and aphids; the annoyance such as mosquitoes, fleas, houseflies, and hornets and the conspicuous butterflies and moths.

Man seems to have survived by constant vigilance against encroaching natural forces that redeems inimical to his own highly organized society. Although his mystery does not yet extend to the overwhelming physical phenomena on all sides, it does include an influence over the organisms such as insect pests that not only compete with man for food or space but also damage his possessions or attack him personally. This sad aspect of insect-man relationship has been with man since he graduated some years ago from a primitive food-gathering and hunting culture; passing through a farming phase, and presently at the level of a highly sophisticated though unsteadily urbanized industrial culture.

The confused flour beetle, *Tribolium confusum*, is known to be one of the insect pests of stored food grains.

Chapman and Hall (1970) observed and compared the rate of egg-laying by the flour beetles. *Tribolium casteneum* and *Tribolium confusum* over a range of temperature from 25^{0c} to $30^{0c}{}_{0}$ The result shows that *Tribolium casteneum* laid twice as many eggs at 27^{0c} as at 25^{0c} but no more at 30^{0c} than at 27^{0c}, whereas *Tribolium confusum* laid three times as many eggs at 30^{0c} as at 27^{0c} but no information is available on the effect of crowding on the survival and development of the confused flour beetle in sorghum floor.

This research work was therefore designed to study in detail the effect of crowding on the survival and development of adult confused flour beetle and loss in weight of sorghum flour for a period ranging from 1-8weeks at three levels of initial infestation (4,8,16 beetle per 100g sorghum flour).

The remains of *Tribolium* that were found in a grain jar in an Egyptian tomb dating back to about 2,500 B.C is an indication that this beetle genus has been in existence for a long time. *Tribolium confisum* was first observed in the United States in 1893 (Metcalf 1962). Katung (1990) examined the effect of different levels of initials infestation of *T. confisum* in the population build-up and resultant loss of wheat in which it was found that, the loss in weight of wheat increased with advancement of storage period and with increase in initial density of infestation.

Tribolium confisum pass their whole lives in flour, burrowing through it, eating it, defecating in it, laying

eggs in it, hatching, growing as maggots, pupating, emerging and mating in it. A heavy infestation spoils the flour, making it grey and stinking from the accumulation of fences, excretions, and corpses. Like the fruit flies, flour beetles breed quickly, and they are even easier to keep for all they need is a box of flour at roughly room temperature.

More information has been gathered on the population dynamics of *T. confisum* and life table constructed to assess the relative importance of some factors causing mortality in *T. confisum* in a flour medium in the laboratory and to judge their response to increasing population density.

Cannibalism has frequently been observed in insect species, especially at times of overcrowding or when food is in short supply. Cannibalism also commonly occurs when individuals suffer accidental injury or when they are temporarily incapacitated by moulting (Clark, etal 1967).

Tribolium confusum is a nation wide pest of flour and other stored agricultural products. They infest mostly the mills, factories and the warehouse in the following ways:

i. From infested food stored in the mill near the milling machinery.
ii. From infested flour returned to the mill from grocers, warehouse.
iii. From infested second hand flour bags.
iv. Through the entrance of beetle with the grain stream.
v. From infested flour used in blending operations.
vi. From infested second hard machinery.

Materials and Methods

Samples of stored products beetles were collected from Kacha, Baddegi, Paiko and Bakekko markets. Samples were collected from grains such as wheat, maize, sorghum and millet. The infested flour collected from all above mentioned sources was taken to the laboratory where the stored products confused flour beetles were sieved out using sieves of 20, 40 and 80 mesh sizes.

Tribolium confisum were identified and cultured in millet flour. The culture was observed in the laboratory in order to produce larger numbers of one day old adults for release into the sorghum floor to study the effect of crowding on the loss in weight of sorghum flour and on the survival and development of Adult confused flour beetle.

The disinfected sorghum flour was kept overnight to cool down to warm temperature, samples of sorghum flour each weighing 100g were placed into 200cm^2 specimen bottles.

The test insect species were sieved out from the breeding medium and one day old adults were selected and released into sorghum flour in he specimen bottles at three initial beetle densities of infestation; 4,8 and 16 beetles per 100g of sorghum flour. The opening of each specimen bottle was covered with perforated plastic covers. There were five replicates in each treatment. The research work was observed for eight weeks.

At the end of each week, the sorghum flour from each specimen bottle was sieved thoroughly with 40 wire-mesh size to separate the insects and flour in order to record the number of living and dead adults. The sorghum flour left over was weighed and loss in weight of the flour was calculated. The live adults, pupae and larvae were counted and recorded and then replaced into their bottles of initial infestation.

This procedure was repeated weekly for eight weeks.

Result and Discussion

Crowding effect of T.confusum on loss in weight (Grams) of sorghum flour.

The average loss in weight of sorghum flour increased with the increase in storage period due to the increase in the number of *T. confisum* larvae, pupae and the young adult.

The maximum loss in weight of sorghum flour for all the three beetle densities occurred during the eighth week of storage period. The average loss was 3.74g, 7.21g and 13.15g for initial infestation densities of 4, 8 and 16 respectively (Table 2).

The raw data for loss in weight of sorghum flour (App. Table 1a, b & c) was subjected to an analysis of variance (Table 1) to test for significant differences in the average loss in weight of sorghum flour between storage times, initial beetle densities and replicate. There was a significant difference between time ($P<0.001$), between densities ($p<0.001$) and between replicates ($p<0.01$).

EFFECT OF CROWDING ON THE SURVIVAL AND DEVELOPMENT OF ADULT *T. confusum*

The mean number of *T. confusum* (Table 4) increased with time of storage period for all the three initial infestation densities of 4, 8 and 16 beetles. The increase was as a result of the favourable temperature and humidity which ranged from 25^{0c} to 36.5^{0c} and 41% to 86% which tends to favour the reproductive activities of *T. confusum* especially in egg laying.

The raw data for adult *T. confusum* (App. Table 2a,b and c) was subjected to an analysis of variance (Table 3) to test for significant differences in the number of adults between storage time, initial beetle densities and replicates. There was a significant difference between the week of storage ($P<0.05$) and between densities ($P<0.001$) but none between the replicates.

The fall in the number of *T. confusum* in the first and second week was as a result of the cannibalistic

act of the insect in which male beetles often injure females with their thrusting male organ that the females die or in case whereby old adult *T. confusum* eat the young ones.

Table 1: ANOVA for loss in weight (Grams) of sorghum flour at three density level of initial infestation of *Tribolium confusum*

Source of variation	DF	SS	MS	F	P
Time	7	844.32	120.62	7.88	<0.001
Densities	2	434.49	217.24	14.48	<0.001
Replicates	4	204.67	51.17	3.41	<0.001
Residual	106	1623.43	15.31	-	-
Total	119	3106.91	-	-	-

Table 2: Mean (+S.E) loss in weight (Grams) of sorghum flour at different initial beetle densities.

TIME (WEEKS)	INITIAL BEETLE DENSITIES 4	8	16
1	0.07+0.096*	0.19±0.01c	0.36±0.02f
2	0.18±0.01b	0.45±0.04c	1.40±0.11e
3	0.36±0.02b	1.49±0.08c	2.87±0.26e
4	0.78±0.02b	3.40±0.15bc	4.34±0.40de
5	1.30±3.51a	4.33±0.18ab	7.03±0.35cd
6	2.04±0.01a	5.57±0.36a	8.70±0.38bc
7	2.65±0.04a	6.10±0.44a	10.56±0.49ab
8	3.74±0.08a	7.21±0.17a	13.15±0.35a

* Means followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

Table 3: ANOVA for the number of adult *Tribolium confusum* over eight weeks of storage period at three initial density levels of infestation.

Source of variation	DF	SS	MS	F	P
Time	7	16203.87	2314.84	2.23	<0.05
Densities	2	16739.82	8369.91	8.07	<0.001
Replicates	4	.237.62	.59.40	0.06	NS
Residual	106	109962.74	.1037.38	-	-
Total	119	143144.05	-	-	-

Table 4:- Mean (+S.E) number of *Tribolium confusum* adults at different levels of initial infestation.

TIME (WEEKS)	INITIAL BEETLE DENSITIES 4	8	16
1	3.8±0.2c*	7.4±0.2d	15.6±0.0.2d
2	3.8±0.2c	7.0±0.0d	15.2±0.3d
3	3.6±0.2c	6.8±0.2d	14.6±0.4d
4	3.6±0.2c	6.8±0.2d	14.6±0.4d
5	10.6±0.ac	15.4±1.2cd	24.4±2.0d
6	22.8±1.3bc	38.4±1.ab	56.6±2.8c
7	45.4±1.5a	57.2±2.0b	107.4±5.2b
8	58.2±1.0a	87.2±3.1a	130.4±4.2a

*Means followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range tests.

As the number of larvae, pupae and young *T. confusum* increases, the average loss in sorghum flour weight also increases with the advancement of storage period. Similar trends in loss in weight of wheat was reported by Katung (1990) when he examined the effect of different levels of initial infestation of *T. confusum* in population build-up and resultant loss in wheat.

The fall in the number of *T. confusum* during the second week was because of the low temperature in the month of April when the experiment was set-up. The temperature range from 17^{0c} to 20^{0c} has an adverse effect in the development of *T. confusum* especially egg-laying. Katung (1990) reported similar trends in which average room temperature which varied from 17^{0c} to 20_{0c} had an adverse effect in the population build-up during the month of April.

Recommendation

It is a known fact that *T. confusum* is a nation wide insect flour. They infest mostly the mills factories etc.

To guide against further infestation the following recommendations are made:-

i. Second hand flour bags should be made clean before use or if the condition is worst, they should be burnt.

ii. Un use bags in the home should be thrown away or burnt to prevent a hid-out for the confused beetles.

iii. Food stores, mills, kitchen and factories should be kept tidy always.

iv. Second hand machinery should be refurbished before put into use.

Conclusion

Result in this study show that the number of *T. confusum* increased with increase in storage period which resulted into further loss in weight of sorghum flour and also subjected the insects into more crowding. Overcrowding of *T. confusum* leads to mortality irrespective of the initial population density. Mortality was density dependent because mortality varies according to the initial infestation density. Mortality among the *T. confusum* is caused by predation of the eggs, larvae, pupae and young adult by older adults, which is the main militating factor in survival and development of *T. confusum* in the sorghum flour.

REFERENCES

1. Ameh, S. (1986) Distribution of Tribolium in different grains types in Kano. Unpublished dissertation submitted to the department of Biological Sciences. Bayero University, Kano.
2. Chapman, R.N and Hall, D.W (1970) Introduction to the study of Animal Populations. New York: McGraw Hill.
3. Colinvaux, P.A (1930) Introduction to Ecology. New York: John Wiley and Sons Inc.
4. Clark, K.R, Geier, P.W, Hughes, R.D and Morris, R.F (1967). The Ecology of Insect population in theory and practice. London: Chapman and Hall Ltd.
5. David, T. (2007) Effect of overcrowding on the development and survival of the larvae and pupae of the confused flour Beetle (Tribolium confusum) in sorghum flour: Multi-disciplinary Journal of Research Development (MULTIJORED) 9(1) Pg 182-187.
6. Gil .B, Larry M. and Gerry K. (1994) Biology: Exploring life. New York: John Wiley and Sons, Inc.
7. Katung, K.C (1990) The effect of different levels of initial infestation of T.confusum on population build-up and resultant loss of wheat. Unpublished dissertation submitted to the Department of Biological Sciences, Bayero University, Kano.
8. Metcalf, C.L (1962) Destructive and useful insects: Their Habits and Control. . New York: McGraw Hill.
9. Sylvia S. Madder (1996) Biology (fifth edition) New York: McGraw Hill.

Appendix Table 1a: Loss in weight of sorghum flour during eight weeks of storage periods at an initial infestation density of 4 beetles per 100g sorghum flour

TIME (WEEKS)	REPLICATES 1	2	3	4	5
1	0.06	0.08	0.05	0.06	0.09
2	0.17	0.19	0.16	0.18	0.27
3	0.34	0.39	0.33	0.35	0.38
4	0.73	0.79	0.76	0.77	0.84
5	1.04	1.13	1.35	1.43	1.57
6	2.03	2.06	2.05	2.01	2.04
7	2.65	2.76	2.63	2.67	2.56
8	3.75	3.87	3.54	3.68	3.87

Appendix Table 1b:- As Appendix Table 1a but for an initial infestation density of 8 beetles.

TIME (WEEKS)	REPLICATES 1	2	3	4	5
1	0.08	0.19	0.21	0.22	0.17
2	0.39	0.41	0.51	0.55	0.38
3	1.46	1.64	1.62	1.41	1.33
4	3.53	3.73	3.43	3.23	3.07
5	4.04	4.34	4.59	4.67	4.01
6	4.76	5.06	6.06	6.08	5.89
7	5.03	5.77	6.78	6.89	6.65
8	6.83	7.03	7.45	7.53	7.13

Appendix Table 1c: As Appendix Table 1a but for an initial infestation density of 16 beetles.

TIME (WEEKS)	REPLICATES 1	2	3	4	5
1	0.33	0.43	0.37	0.35	0.34
2	1.27	1.34	1.74	1.31	1.35
3	2.09	3.04	3.06	3.07	3.09
4	3.14	4.67	4.74	4.76	4.56
5	6.34	7.56	7.74	665	6.87
6	7.56	8.86	9.21	8.73	9.08
7	9.32	10.31	11.09	10.51	11.57
8	12.09	13.42	13.56	13.27	13.47

Appendix Table 2a:- Number of adult T.confusum during eight weeks of storage period at initial infestation density of beetles per 100g of sorghum flour.

TIME (WEEKS)	REPLICATES 1	2	3	4	5
1	4	3	4	4	4
2	4	3	4	4	4
3	3	3	4	4	4
4	3	3	4	4	4
5	9	8	13	12	11
6	21	19	27	24	23
7	46	43	49	48	41
8	59	57	61	59	55

Appendix Table 2b:- As Appendix Table 2a but for an initial infestation density of 8 densities.

TIME (WEEKS)	REPLICATES 1	2	3	4	5
1	7	8	7	8	7
2	7	7	7	7	7
3	7	7	7	7	7
4	7	7	6	7	7
5	15	18	11	17	16
6	38	42	31	41	40
7	55	61	51	62	57
8	81	93	80	96	86

Appendix Table 2c:- As Appendix Table 2a but for an initial infestation density of 16 densities.

TIME (WEEKS)	REPLICATES 1	2	3	4	5
1	16	16	15	15	15
2	16	16	15	14	15
3	15	16	14	14	14
4	15	16	14	14	14
5	27	31	23	21	20
6	58	67	54	53	51
7	106	128	101	102	100
8	135	141	117	134	125