

Assessment of Damage by the Rice Moth, *Corcyra cephalonica* (St.) on Different Grains at Four Levels of Moisture Content.

NOORMA OSMAN
Department of Plant Protection,
Faculty of Agriculture
Universiti Pertanian Malaysia,
Serdang, Selangor, Malaysia.

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RINGKASAN

Taksiran kerosakan oleh *C.cephalonica* ke atas 'millet', sekoi, beras dan padi dalam keadaan peratus kandungan kelembapan yang berlainan telah ditentukan dengan menggunakan kaedah 'count and weigh method'. Parameter-parameter yang ditentukan adalah peratus kerosakan pada bijirin, peratus kehilangan berat kering serta berat kering 'frass' dan 'webbings'. Peratus larva yang berumur 12 ± 12 jam yang dapat meneruskan ke peringkat dewasa dan purata kala perkembangan larva ke peringkat dewasa juga ditentukan. Empat peringkat peratus kandungan kelembapan yang digunakan dalam kajian ini tidak mempengaruhi peratus kerosakan pada bijirin, peratus kehilangan berat kering serta berat kering 'frass' dan 'webbings'. Padi ialah yang terkurang sekali kerosakannya; sedikit sekali larva yang dapat meneruskan ke peringkat dewasa. Peratus larva yang dapat meneruskan ke peringkat dewasa, meningkat daripada peratus kandungan kelembapan 11.1% ke 13.2% bagi 'millet', sekoi dan beras, sementara pada peratus kandungan kelembapan 14.1%, ia susut. Peratus larva yang dapat meneruskan ke peringkat dewasa pada beras yang kandungan kelembapan 11.0% berbeza dengan jelas, dibandingkan dengan beras yang kandungan kelembapannya 14.1%. Purata kala perkembangan larva pada 'millet', sekoi dan beras yang kandungan kelembapan 11.1% berbeza dengan jelas dibandingkan dengan kandungan kelembapan 14.0%.

SUMMARY

Assessment of damage by *C.cephalonica* on millet, sorghum, milled rice and padi at four moisture contents was determined using the count and weigh method. The parameters determined were percent damaged kernels, percent dry weight loss and dry weight of frass and webbings. The percent survival and the average development period of 12 ± 12 -hr- old larva to adult were also determined. The four moisture contents used in this study did not influence the percent of damaged kernels, percent dry weight loss or the dry weight of frass and webbings. Rough rice was the least damaged of all the four grains; few larvae survived. The percent of larvae that survived to adult showed an increase from 11.1% MC to 13.2% MC for millet, sorghum and milled rice while at 14.1% MC, it decreased. For milled rice, the percent of larvae that survived at the lowest MC was significantly lower than at the highest MC. The development period in millet, sorghum and milled rice was significantly lower at the lowest MC.

INTRODUCTION

Loss assessment studies on the different stored grain insects have been reviewed by Adams (1976). Three methods of loss assessment were outlined by Adams and Schulten (1976) — the standard volume and weight method, determination of the percentage insect-damaged grain and its conversion into a weight loss using a multiplication factor, and the count and weigh method. The present study utilised the count and weigh method which assumed that undamaged grains

were totally undamaged. *Corcyra cephalonica* is an external feeder and thus hidden infestation is not a concern.

C. cephalonica has been reported to infest many types of stored products, from different parts of the world (Hodges 1979). However, few studies have been carried out to evaluate losses incurred by this pest. The present study was conducted to determine the quantitative loss caused by *C. cephalonica* in millet, sorghum, milled rice and padi store at $30 \pm 2^\circ\text{C}$ and various moisture contents.

MATERIALS AND METHODS

Grains

Whole grains of the cereals were used. Broken grains and foreign materials were removed by using sieves of appropriate sizes for the different grains and by hand sorting. The grains were adjusted to the required moisture content (MC). Grains with an original MC higher than the required MC were air dried by spreading on paper at ambient conditions in the laboratory and the MC monitored using a Motomco moisture meter until the desired MC was reached. If the MC had to be increased, water was added to grains in a gallon jar which was then closed and shaken. The jars were shaken daily for two weeks to assure uniform conditioning/mixing. One hundred grams of each grain type that had reached the required MC was kept in a pint jar and stored in relative humidity (RH) chambers, controlled to maintain the appropriate equilibrated relative humidity. Jars were kept in the RH chambers for a week before larvae of *C.cephalonica* were transferred. Each grain type was replicated six times three for infestation with *C.cephalonica* and three for the controls.

Relative Humidity and Experimental Conditions

Saturated salt solutions of magnesium nitrate hexahydrate ($\text{Mg No } 3. 6\text{H}_2\text{O}$), sodium nitrite (Na No_2), sodium acetate trihydrate ($\text{Na Ac. } 3\text{H}_2\text{O}$) and potassium bromide (KBr) were used to maintain 50, 60, 70, and 80% RH, respectively (Winston and Bates 1960). The saturated solutions of each was prepared by dissolving excess salts at room temperature. These were allowed to stand for two weeks to ensure saturation before use.

Each RH chamber was a 87.6 litre brown plastic container with a diameter of 45.7 cm and height of 53.3 cm. A perforated pressed board placed about 25 cm. above the surface of the solution by means of metal pegs, was used as a platform to hold the jars of grains. The chambers were tightly sealed by means of petroleum jelly between the lid and rim of the container. Once the insects had been introduced into the jars, the chambers were opened up daily for five seconds to allow for ventilation. The relative humidity in each chamber was monitored by placing in each, a portable 12.7 cm diameter Abbeon Certified Hygrometer and Temperature indicator (Mod. HITAB 169B). All four hygrometers were calibrated at $70 \pm 2\%$ RH before use. The chambers were placed in a rearing room

with a temperature of $30 \pm 2^\circ\text{C}$ and a photoperiod of 14L:10D.

Insects

Corcyra cephalonica were reared on a standard medium (Osman *et al.*, 1983) and maintained in a rearing room at $27 \pm 1^\circ\text{C}$ and $68 \pm 2\%$ RH. One hundred newly hatched larvae were transferred into each pint jar containing 100 gm of the conditioned grains. After the first adult emerged, all jars were checked daily for adults. Adults were removed daily to avoid oviposition.

Experimental Design

A split plot design was used for this experiment. A relative humidity was randomly chosen for infestation. The three jars in that RH were infested and three were left uninfested as controls. For infestation of the jars, the RH chambers were randomly selected to be in the following order : 70%, 60%, 50%, 80%. Infestation was completed over two days to allow time for moisture tests and handling at the end of the experiment.

Measurement of Moisture Content

After all adults had emerged and had been removed from each jar, MC was determined for both infested and controlled grains. To prevent unnecessary exposure of grains to ambient conditions, grains from each jar were poured into a transparent 27.9 x 22.9 cm plastic bag and tightly closed. The grains were mixed well and two 10-gm samples per jar were weighed and placed in aluminium moisture tins. A total of six samples for each treatment were measured for their MCs.

A single-stage air-oven moisture determination method was used for all grains (AACC Method 44-15 1969). Millet, sorghum and milled rice were oven dried for 18 hrs at 120°C while padi was dried for 20 hrs at the same temperature. All moisture contents were expressed as percent of wet weight.

Loss Assessment Method

Each jar together with its contents was weighed. The jar was then emptied and weighed again. The difference gave the weight of the contents which included whole and damaged grains, larval webbings and frass. The contents of each jar was divided into four equal samples by weight and one was analysed for loss. Grains in the sample were separated and weighed. The number and weight of both damaged and undamaged kernels were noted. The contents of

the jars for the control were handled in the same manner.

Two parameters of estimating damage were used : percentage damaged kernels and percentage dry weight loss. The percentage damaged kernels was calculated by dividing the number of damaged kernels by the total number of kernels per sample. The percentage dry weight loss was determined by using a formula described by Adams & Schulten (1976):

$$\% \text{ weight loss} = \frac{U(Nd) - (D)Nu}{U(Nd + Nu)} \times 100$$

Where U = weight of undamaged
Nu = number of undamaged
D = weight of damaged
Nd = number of damaged

Means of treatments for each type of grain were compared by using the least significant difference statistics (LSD).

RESULTS AND DISCUSSION

The percentage of dry weight loss, dry weight of frass and webbings and the percentage of larvae that survived to adult were lowest for all four grains at the lowest MC. The development period from 12 + 12-hr-old larva to adult emergence was the longest at the lowest MC for all the grains.

Percentage Damaged Kernels, Percentage Dry Weight Loss and Dry Weight of Frass and Webbings.

The MC of grains used in this study appeared to have a variable effect on the percent of insect-damaged grains (Table 1). The only significant difference detected was the percent damaged grains of millet at 12.1% and 14.1% MC ($P < 0.05$).

The data on the percent dry weight loss is also shown in Table 1. It increases as MC increases for milled rice and padi while a similar trend is not seen for millet and sorghum.

The percent dry weight loss is generally lower compared to the percent of damaged kernels. Unlike *Sitotroga cerealella*, *C.cephalonica* is an external feeder. There seems to have been a preference for the germ of kernels although there were kernels that were found to have parts of the endosperm damaged. The dry weight loss of milled rice is only in the range of 3 - 7% as compared to millet and sorghum which had a

range of 12.6 to 21.5%. *C.cephalonica* was observed to feed solely on the germ of milled rice kernels. No kernels were found to have portions of the endosperm consumed.

The percent damaged grains, percent dry weight loss and the dry weight of frass and webbings for rough rice are extremely low compared to the other three grains. The husk covering the kernels probably prevented the larvae of *C.cephalonica* from feeding on the germ although there were kernels that had husks slightly damaged at the tip. Moreover, the few survivors of *C.cephalonica* may have caused the low dry weight loss.

With the exception of millet, the dry weight of frass and webbings increased from the lowest to the highest MC (Table 1). No significant differences were detected among the grains for the MC.

Chatterji (1952) determined that the weight loss of sorghum due to damage by *C.cephalonica* at 75% RH was 9.9% and the percent damaged kernels was 23.1% Sidik (1981) reported that the percent dry weight loss of milled rice due to *Tribolium castaneum* after 20 weeks of storage was 2.19%. This study was conducted at $29 \pm 1^\circ\text{C}$ and $70 \pm 5\%$ RH. Percent dry weight loss by *Sitophilus oryzae* was 37.0% under similar conditions.

The percent weight loss of padi stored for a period from 6 to 9 months due to damage by *Sitotroga cerealella* ranged from 4.2 - 11.9 and with 3.4 - 12.0% infested kernels in Bangladesh (Shahjahan, 1974).

The amount of frass and webbing caused by *C.cephalonica* in our samples increased from the lowest to the highest MC for sorghum, milled rice and rough rice (Table 1) but was inconsistent for millet. The differences were not significant for any grain.

Percent of 12 ± 12-hr-old Larvae that Survived to Adult and Their Developmental Periods.

More larvae of *C.cephalonica* survived on millet and sorghum of about 13% MC (Table 2). The percentage of larval survival on milled rice increased as MC increased. Larval survival on milled rice is significantly different ($P < 0.05$) between the lowest MC (11.0%) and the highest (14.0%). Least larvae survived at the lowest MCs for all the four grains. This could be attributed to the fact that the range of the lowest MC for this study (11.1 - 11.2%) was a drier than optimum condition for larval survival.

TABLE 1
Loss assesement of grains at different moisture contents,
by the rice moth, *Corcyra cephalonic*.

Grain	Moisutre content (%)	Insect-Damaged grain. (%)	Dry Weight Loss (%)	Dry weight of frass and webbing (g)
Millet	11.2	62.08	12.61	5.56
	12.1	73.59	16.02	6.89
	13.3	58.64	15.43	5.96
	14.1	45.82	13.94	5.28
Sorghum	11.1	75.16	18.57	5.69
	12.1	84.75	20.73	6.08
	13.2	68.21	18.89	7.47
	14.1	70.19	21.54	9.52
Milled rice	11.2	68.88	3.91	0.89
	12.2	62.50	4.45	0.98
	13.1	69.90	5.36	1.58
	14.1	69.46	7.73	2.96
Padi	11.1	.071	7.80 ⁻⁴	.027
	12.1	.108	8.75 ⁻⁴	.02
	13.2	.141	9.09 ⁻⁴	.02
	14.3	.140	1.64 ⁻³	.03

Rearing *C.cephalonica* on wheat feed, glycerol and yeast at 30°C., Cox *et al.* (1981) reported that the survival from egg hatch to adult emergence of a Burma strain at 50, 70, and 80% RH was 55, 82 and 83%, respectively. These figures are relatively higher than that of the present study. Wheatfeed and glycerol are probably a better medium for larvae than the four grains used in our study.

At 70% RH and 28°C, the percentages of larvae of an African strain (Tchad) of *C.cephalonica* that survived to adult on millet and sorghum were 36 and 58, respectively (Russel *et al.*, 1980). The survival rate from larvae to adults of a Camaroon strain on millet and sorghum was 69.7 and 48%, respectively. In the present study, the percentage larval survival at 13.0% (70% RH) on millet and sorghum was 63.50 and 55.15%, respectively.

The developmental period from newly-hatched larvae to adult is significantly longer ($P < 0.05$) at the lowest MC for all grains (Table 2). Dry grains are not conducive for larval development.

At 30°C, Cox *et al.* (1981) reported that the developmental periods from egg hatch to adult emergence at both 70 and 80% RH was 26 days (range 23 – 36 days). At 28°C and 70% RH, the larvae of *C.cephalonica* took an average of 41.0 days on millet (range 25 – 56 days) while it took 58.33 days (range 38 – 82 days) on sorghum (Russel *et al.* 1980). There does not appear to be much discrepancy in the data found between the present study and that reported by Russel *et al.* (1980). The relatively small differences could be attributed to the different variety of grains and strains of the insect species.

CONCLUSION

The four moisture contents studied did not influence percent of damaged kernels, percent dry weight loss or the dry weight of frass and webbings. Padi was the least damaged of all the grains and few larvae survived. The percent of larvae that survived to adult showed an increase from 11.0% MC to 13.0% MC for millet, sorghum and milled rice while at the highest MC (14.0%) it decreased. On milled rice, the percent of larvae that survived at the lowest MC is significantly

ASSESSMENT OF DAMAGE BY THE RICE MOTH *CORCYRA CEPHALONICA* ON DIFFERENT GRAINS.

TABLE 2
The development of *Corcyra cephalonica* on grains at
different moisture contents.

Grain	Moisture content (%)	Laval survival to adult (%)	Development period (days)
Millet	11.2	53.99	62.98
	12.1	57.50	55.35
	13.3	63.50	53.15
	14.1	59.67	49.02
Sorghum	11.1	47.50	67.03
	12.1	50.84	54.01
	13.2	55.15	55.29
	14.1	48.84	52.24
Milled rice	11.2	25.17	82.87
	12.2	36.15	63.20
	13.1	52.50	65.08
	14.1	54.82	53.22
Padi	11.1	0.33	130.94
	12.1	0.50	126.91
	13.2	0.67	126.14
	14.3	0.67	123.66

lower than at the highest MC. The developmental period in millet, sorghum and milled rice was significantly longer at the lowest MC (11.0%).

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