Management of Stored Product Pests by Controlled Atmosphere using Biogas

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Seed of blackgram *Vigna mungo* Linn. with a moisture content of 10.5 ± 1% were used for studies of controlled atmosphere storage using biogas with composition 61% methane and 38% carbon dioxide in various storage structures at ambient conditions of 26°–32°C and 50–60% relative humidity. Narrow mouth glass containers of 2 kg capacity with provision for inlet of the gas and for making them airtight with rubber corks were used. Twenty–five adults of one–day–old *Callosobruchus maculatus* Fab. were placed into each of the containers and biogas introduced at a rate of 10 L/kg of grain. The containers were left undisturbed for one month. In another treatment, biogas was introduced and the containers were kept closed for only 24 hours. These treatments were compared with phosphine fumigation and an untreated control. All treatments were replicated five times. Observations were made on the effect on adult insects at hourly intervals after treatment, mortality and recovery of adults after 24 hours, development of successive generations at monthly intervals, consumer acceptability of the treated product, and germination of seeds after two months.

To assess the potential of biogas controlled atmospheres for management of insect pests in field situations, wheat stored in metal and solid polyethylene structures of 100 kg capacity and flexible polyethylene structures of 50 kg capacity were tested under ambient conditions using the test insect *Sitophilus oryzae* Linn. The mortality of weevils was recorded as previously. Further, the repeated use of biogas at weekly, 10 and 15 day, and monthly intervals was tested in metal containers to observe the effect on the development of subsequent generations of insects.

Mortality of *Callosobruchus maculatus* adults exposed to biogas was 100% (Table 1) when the gas was applied and left undisturbed for a month, and 97.6% when the gas was vented after 24 hours. The mortality was 98.4% following phosphine fumigation, while mortality in the untreated control was nil.

Data on the development of successive generations following various treatments (Table 1) indicated that treating with biogas and keeping the enclosure closed for one or two months had a marked influence on the immature stages of the insects. The number of adults emerging from 1 kg of pulse after one month was highest (79 per kg) in the control, followed by aluminium phosphide treatment (22 per kg), biogas treated and kept intact for 24 hours (3 per kg), and zero in the biogas treatment kept closed for a month. Similarly, after two months, there was no emergence of adults where the biogas was maintained without leakage. This was followed by the 24 hour treatment, the aluminium phosphide and the untreated control where adult emergence increased to a maximum of 152 per kg of pulse.

Consumer acceptability of the grain was not impaired by biogas treatment as there was no discernable difference between the treated and untreated grains in either appearance or colour. None of the fifty consumers tested could identify any variation between the biogas treated and untreated pulses.

When the use of biogas controlled atmospheres for insect pest management in large-scale storage of wheat was tested with various structures, it was found that in metal containers prevention of leakage was difficult and the mortality of weevils thus reduced. The data (Table 2) revealed that in metal containers the mortality of weevils was only 44% after 24 hours, while it was 90% or more in solid and flexible polyethylene structures. Similarly, due to the variation in leakage of introduced biogas, the development of successive generations was higher in metal containers than in the other two structures. In the untreated control, mortality was zero and development more rapid.

Attempts to use the biogas as single and multiple doses at different intervals proved (Table 3) that a single dose had no greater influence in reducing the development of *S. oryzae*. The population of 25 adults initially introduced could multiply to 34 in a period of one month. However, repeated use of biogas as multiple doses could dramatically reduce the initial population of 25 to 12, 8, and

Table 1. Effect of controlled atmosphere using biogas on *C. maculatus* and seeds of Blackgram.

Treatment	Mortality of adults %	Recovery of adults %	Development of generation 1 month after	Development of generation 2 months after	Germination after two months %
Exposed to Biogas for 1 month	100	0	0	0	92.2
Exposed to Biogas for 24 hours	97.6	2.4	3.2	7.0	82.6
Phosphine fumigation	98.4	1.6	21.6	66.2	69.4
Control	0	100	78.6	151.6	37.2
SED	3.70	-	9.53	2.93	5.27
C.D.(P=0.05)	7.98	-	20.56	6.32	11.37

Table 2. Effect of biogas on *S. oryzae* in different storage structures.

Structures	Mortality %	Development of generations I	II
Metal bin	44	32	74
Solid polyethylene	90	Nil	Nil
Flexible polyethylene	98	Nil	Nil
Control	Nil	86	193

Table 3. Effect of single and multiple doses of biogas on development of *S.oryzae*

Doses	Initial population	After 1 month
Single dose	25	34
Weekly intervals	25	Nil
10-day intervals	25	8
15-day intervals	25	12

zero in a period of one month, when used at 15 days, 10 days, and weekly intervals, respectively. It can therefore be concluded that even in relatively poorly sealed storage structures, biogas can be effectively used for the management of stored product pests.