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*Short Communication*

# Storing cowpea (*Vigna unguiculata)* seeds in active cattle kraals for suppression of *Callosobruchus maculates*

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**Post-harvest seed damage of cowpeas (*Vigna unguiculata)* by cowpea weevils (*Callosobruchus maculates)* is increasingly becoming a threat to food security among marginal communities. Effects of storing cowpea seeds in active cattle kraals (ACK) as an alternative to pesticide for suppression of *C. maculates* and improving seed quality were studied in three marginal communities of South Africa. A set of 500 seeds in 10 containers were infested with 20 *C. maculates* and inserted in 30-cm-deep holes within the ACK, while similar containers served as controls at the farmer level. At 120 days, relative to controls, ACK had reduced the final weevil population density by 76 to 82%, floating seeds by 86 to 98% and damaged sunken seeds by 36 to 53%, but increased undamaged sunken seeds by 358 to 572%. The treatment increased seedling emergence by 14 to 32%. In conclusion, suppression of weevil numbers and improvement of seed quality suggested that ACK may serve as alternative to pesticides in storage of cowpea seeds for planting in marginal communities and therefore, ensuring continued food security of this important crop.**

**Key words:** Active cattle kraal, *Callosobruchus maculates*, seed quality, *Vigna unguiculata*.

## INTRODUCTION

The cowpea weevil (*Callosobruchus maculates*) is an economic pest of cowpea (*Vigna unguiculata*) seeds during storage. Generally, the pest enters pods through holes and lays eggs on dry seeds prior to harvest, to serve as a source of inoculum during storage, where egress occurs, with larvae penetrating the seed coat and feeding on both the endosperm and the dormant embryo (Pierrard, 1986). Both the embryo and the endosperm are essential for successful germination and emergence of seedlings, with complete consumption of any, resulting in total failure of seed germination (Campbell, 1990).

In various countries, indigenous seed storage pest management systems are still being practiced at the farmer level, particularly in marginal communities (Pierrard, 1986; Saayman, 1995). Even with the advent of synthetic pesticides, for various reasons, most farmers in marginal communities continue to practice indigenous pest management technologies to manage storage pests (Ngobeni and Mashela, 2005; Saayman, 1995; Saxena et al., 1992). One advanced reason was that open-pollinated varieties were preferred in marginal communities since they provide the flexibility for both consumption and planting in the next season. Use of synthetic pesticides for seed storage for planting purposes did not provide the flexibility of consuming the stored seeds when unanticipated circumstances appear (Ngobeni and Mashela, 2005).

In southern Africa, over the years, the most preferred indigenous seed storage in marginal communities had been the use of active cattle kraals (ACK), where a pit is dug in the kraal, with seeds being stored in a waterproof container, sometimes as big as half a ton (Limpopo Traditional Healers' Association: pers. com.). ACK are secured wooden enclosures from where cattle are taken out for grazing in the veld during the day and returned in the evening for safe-keeping throughout the night.

Generally, ACK and caves were meant for long-term storage of large harvests-particularly during the colonial

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**Table 1.** Initial and final population densities of weevils on cowpea stored under normal farmer storage and active cattle kraal in three provinces of South Africa at 120 days after treatment (n = 20).

| Location | Initial inoculation | Final population density | | |
|---|---|---|---|---|
| | Number | Control | Kraal | Impact (%) |
| Kekana | 20 | 96 | 23 | -76** |
| Moletlane | 20 | 111 | 26 | -77** |
| Shatale | 20 | 141 | 25 | -82** |

Impact (%) = [(kraal/control) - 1] × 100; **indicate that the control and active cattle kraal treatments were different at P ≤ 0.05 according to Student-t test.

wars (Limpopo Traditional Healers' Association: pers. com.), whereas other storage types within the homestead were meant for short-term storage of small quantities.

Presumably, ammonia and $CO_2$ from hydrolysis of urine (Bremner and Krogmeier, 1989) prevented storage pests from reaching and entering storage containers for feeding on the seeds. However, whether this type of storage was effective on suppressing pests which had already infested the seed prior to storage is not documented. Therefore, the objective of this study was to determine the efficacy of ACK in suppressing cowpea weevils which were inside the storage containers prior to storage and the subsequent quality of the stored seeds.

## MATERIALS AND METHODS

### Study area and preparation of plant materials

Three experiments were conducted at three locations in South Africa: Kekana Village in North West Province (25°24′27″S, 28°17′8″E), Moletlane Village in Limpopo Province (24°21′0″S, 29°20′0″E) and Shatale in Mpumalanga Province (24°50′0″S, 31°4′0″E), with different types of grazing. *C. maculates* populations were raised on cowpea seeds using weevil-tight plastic containers at the University of Limpopo (23°53′10″S, 29°44′15″E) in a growth chamber (25°C, 50% RH). At the beginning of the planting season, 0.25 ha of cowpea variety Glenda was planted at each location in order to produce locally-adapted seeds. At the end of the season, pods were collected and kept unshelled at the local household to minimise infection by weevils.

### Inoculation and experimental design

500 seeds each in 500-ml plastic bottles were infested with ten female and ten male weevils since mating inevitably results in the killing of males by females (Pierrard, 1986; Saayman, 1995). Ten 30-cm-deep holes were dug in the center of an active kraal using a soil auger within a 2-m radius. Ten bottles, labelled one to ten, were arranged in a completely randomised design (CRD) and each inserted into a separate hole in an upright position. Ten bottles with the same number of seeds and weevils were stored at 25°C to emulate seed storage at the farm level and ensuring that they were arranged in a CRD.

### Data collection

At harvest, 120 days after storage, containers were dug out and along with the control containers taken to the VLIR Nematology Laboratory of the University of Limpopo for assessment. The floating test was used to evaluate the presence or absence of embryos in seeds (Hartmann et al., 1988). Briefly, seeds were poured into a 5-L bucket, half-filled with water and then classified as floating seeds, damaged sunken seeds and undamaged sunken seeds. Additionally, the floating test facilitated weevil capturing and counting.

### Viability test

Four sets of 50 seeds/location from controls of undamaged sunken seeds and ACK undamaged sunken seeds were sampled at random and sown in seedling trays containing Hygromix (Hygrotech, Pretoria North, South Africa) in the greenhouse (mean day/night temperature 25/13°C) at the University of Limpopo, South Africa. Seeds from each location were replicated four times and irrigated to field capacity when necessary. 19 days after sowing, emerged seedlings were recorded.

### Data analysis

In all experiments, data were analysed using the Student-t test. Unless otherwise stated, only significant ($P \leq 0.05$) treatment effects were discussed.

## RESULTS AND DISCUSSION

Relative to farmer control, ACK reduced final weevil population densities by 76 to 82% (Table 1). However, the mechanism involved in suppression of weevils is not clear, although we presumed that anaerobic conditions might have played a significant role. Generally, hydrolysis of urine results into the release of ammonia and $CO_2$ with increased acidic conditions, which favour growth and development of bacterial communities (Campbell, 1990; Bremner and Krogmeier, 1989). In turn, high concentrations of $CO_2$ results in anaerobic conditions, which also favour bacterial growth. Consequently, it may probably be that the created anaerobic conditions were responsible for the suppression of final weevil population densities in ACK. Similar anaerobic conditions had been created in controlled atmosphere storages which are widely used in fruit storage and hermetically-sealed containers for seed storage (Hartmann et al., 1988).

ACK also reduced damaged floating seeds and damaged sunken seeds by 86 to 98% and 36 to 53%, respectively, but increased undamaged sunken seeds by

**Table 2.** 500 cowpea seeds/container infested with 10 weevils and stored under farmer storage (control) and active cattle kraal in three provinces of South Africa at 120 days after the treatment (n = 20).

| Location | Damaged floating Seeds | | | Damaged sunken seeds | | | Undamaged sunken seeds | | |
|---|---|---|---|---|---|---|---|---|---|
| | Control | Kraal | Impact (%) | Control | Kraal | Impact (%) | Control | Kraal | Impact (%) |
| Kekana | 303 | 42 | -86** | 140 | 85 | -39** | 57 | 383 | 572** |
| Moletlane | 320 | 8 | -98** | 136 | 64 | -53** | 84 | 428 | 410** |
| Shatale | 298 | 6 | -98** | 121 | 77 | -36** | 91 | 417 | 358** |

Impact (%) = [(kraal/control) - 1] × 100; **indicate that the control and active cattle kraal treatments were different at $P \leq 0.05$ according to Student-t test.

**Table 3.** Seedling emergence (%) of undamaged sunken cowpea seeds without holes stored under normal farmer storage (control) and active cattle kraal sown at 10 days after the treatment (n = 20).

| Place of seed collection | Number of seeds | Number of seedlings | | |
|---|---|---|---|---|
| | | Control | Kraal | Impact (%) |
| Kekana | 50 | 44 | 50 | 14** |
| Moletlane | 50 | 38 | 50 | 32** |
| Shatale | 50 | 40 | 50 | 25** |

Impact (%) = [(kraal/control) - 1] × 100; **indicate that the control and active cattle kraal treatments were different at $P \leq 0.05$ according to Student-t test.

358 to 572% (Table 2). Additionally, ACK increased seedling emergence of undamaged sunken seeds by 14 to 32% (Table 3). Overall, the treatment improved the quality of seeds and the subsequent vigour of seedlings during emergence, both of which are important in propagation of crops through seeds (Hartmann et al., 1988). Previously, Bremner and Krogmeier (1989) demonstrated that the adverse effect of urea fertilisers on seed germination in soil was due to ammonia and $CO_2$, which are released during hydrolysis of urea by soil urease. Apparently, in this storage form, ammonia played a negligible role since there was no inhibition of seed germination. Probably, $CO_2$ played a major role since its presence would enhance embryo dormancy, which could explain the relatively higher percentage of seedling emergence in seeds from ACK.

## Conclusions

The use of ACK for storage of cowpea seeds suppressed final weevil population densities, while improving seed quality. Although, the mechanism involved is not yet clear, the technology could be used to store cowpea seeds for planting in the next season and thereby ensuring the availability of quality seeds. Also, pesticide-treated cowpea seeds which remain after planting can be stored for the next season using this technology since pesticides have a limited lifespan. Future studies on ACK seed storage are necessary in order to: (1) establish the shelf-life of cowpea seeds stored under this technology, (2) determine the mechanisms involved in suppression of weevil numbers and improved seed quality, and then (3) establish whether the technology cannot be expanded to seeds of other plant species, all of which would be intended to improve food security in marginal communities.

## REFERENCES


Bremner JM, Krogmeier MJ (1989). Evidence that the adverse effect of urea fertiliser on seed germination in soil is due to ammonia formed through hydrolysis of urea by soil urease. Proc. Natl. Acad. Sci. 86:8185-8188.

Campbell NA (1990). Biology, 2nd ed. Benjamin/Cummings, Redwood City, California. P. 1165.

Hartmann HT, Kofranek AM, Rubatzky VE, Flocker WJ (1988). Plant science: Growth, development and utilisation of cultivated plants, 2nd ed. Prentice Hall, Englewood Cliffs. P. 674.

Ngobeni DN, Mashela PW (2005). Effect of tamboti on weevils on stored cowpea seeds. Afr. Crop Sci. 13:381-385.

Pierrard G (1986). Control of the cowpea weevil *Callosobruchus maculatus* at the farm level in Senegal. Trop. Pest Manage. 32:197-200.

Saayman T (1995). Development of practical, low cost methods to control pests and disease of storage grains. Plant Prot. News 42:16-17.

Saxena RC, Dixit OP, Harshan V (1992). Insecticidal action of *Lantana camara* against *Callosobruchus chenesis* (coleoptera: Bruchidae). J. Stored Prod. Res. 28:279-281.