

MANAGEMENT OF BULB ROT OF BIG ONION (*Allium cepa* L.) DURING STORAGE USING FUNGICIDES

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ABSTRACT

Storage of onions is important in Sri Lanka as the production of this highly perishable commodity is seasonal. Bulb rotting caused by fungal pathogens is one of the major reasons for storage losses. It has been reported that bulb rot contributes to about 10- 50 % of storage losses of different onion varieties. Therefore, studies were conducted to identify fungal pathogens associated with rotting of onion bulbs and to minimize bulb rot incidence during storage by application of fungicides. Five fungal genera were isolated from rotten and healthy bulbs. Among them *Fusarium*, *Colletotrichum* and *Sclerotium* have the ability to cause bulb rot, but *Alternaria* and *Aspergillus* did not show bulb rot symptoms when artificially inoculated. Results of storage studies showed that storage losses of onions due to fungal pathogens could be reduced up to 40% by spraying carbendazim 50% WP, as a pre-harvest application two weeks before harvesting. Application of other fungicides such as thiophanate methyl + thiram, thiabendazole, captan + benomyl, chlorothalonil and thiophanate methyl at various stages of crop growth did not help to reduce storage losses of onion bulbs.

KEY WORDS: Bulb rot, Chemical Control, Fungal Pathogens

INTRODUCTION

Onions are an essential part of the daily diet creating a relatively constant year round consumer demand. However, production of onion in Sri Lanka is limited to a specific period, which results a market glut during this period. Therefore, storage is important to make it available to consumer at reasonable price during off seasons and to provide producers with an opportunity to receive a higher price. During storage, some losses occur due to sprouting, drying and rotting (Currah and Proctor, 1990). Department of Agriculture has developed recommendations for storage of onion bulbs to minimize storage losses. These are pre-harvest drying, careful harvesting, curing, protecting bulbs from sunburn and wounding, and proper storage conditions *i.e.* selection of bulbs, regular examination at storage and providing good ventilation (Anonymous, 1990). However, it is estimated that bulb rot contributes to 10-50% of storage losses of different varieties during three months storage period under local conditions (Metthananda, 1992).

Bulb rotting is caused by a number of microorganisms. Among them, fungi are the major causal agent responsible for storage losses (Currah and Proctor, 1990; Padule *et al.*, 1996a). In a tropical country like Sri Lanka, such losses may be higher because of the favourable weather conditions for the development of microorganisms throughout the year. However, no detail studies have been done to identify genera or species of fungal pathogens which caused rotting of onion bulbs in Sri Lanka. Therefore, a survey was undertaken to identify fungal pathogens, which cause bulb rot of stored onion

in Sri Lanka. Application of fungicides is one of the most effective method in controlling fungal pathogens associated with diseased plants. Therefore, a necessity has arisen to study the effect of pre- and post-harvest fungicidal treatments on control of bulb rotting fungi during storage. Furthermore, application of fungicides directly onto the onion bulbs would be harmful for human health. Therefore, series of field studies were carried out to identify suitable pre-harvest fungicides for the management of bulb rot of big onion during storage period.

MATERIALS AND METHODS

Isolation and identification of fungal pathogens

Rotted and healthy big onion bulbs were collected from seven stores including one at the Field Crops Research and Development Institute (FCRDI), Maha Illuppallama, three in Dambulla and another three in Galewela area. Sampling was done before storing and three months after storage to isolate fungal pathogens from onion bulbs. Pieces of bulbs were kept on Potato Dextrose Agar (PDA) and incubated for 7 d in room temperature. The mycelial growth, conidial and sclerotia development on PDA was observed. Conidial masses or sclerotial bodies were pick from colonies, which were suspected to be different genera of fungi. The fungi were re-isolated on PDA for further purification. Single spore inoculants of fungi genera were made. Each isolate was identified on the basis of microscopic observations of conidia and mycelia and culture characters on PDA. Pathogenicity of each isolate was tested by wound inoculation on healthy bulbs and symptom development.

Screening of fungicides

Series of studies was conducted during *yala* 1995 to *maha* 1997/98 at the FCRDI, Maha Illuppallama to select suitable fungicides for application during pre-harvest stages to minimize storage losses of big onion. Crops were grown in *yala* seasons and storage studies were started after harvesting of the bulbs. In all studies, five-week-old nursery raised seedlings were transplanted in raised beds of 1 m x 2 m at a spacing of 10 cm x 10 cm. Recommendations of DOA was followed (Anonymous, 1990). Hand weeding was done at 2, 4 and 6 weeks after transplanting (WAP). Fenthion 500 g/l EC (30 ml/10 l) and carbaryl 80% WP (10 g/ 10 l) were applied to control onion thrips.

Bulbs were carefully harvested after crop maturation for storage in each season. Thin necked bulbs of different treatments were selected and stored in a well ventilated room to a thickness of about 10 -12 cm on wire meshed racks after curing for 5 d. Five kilograms of bulbs that were obtained from different treatments were arranged in a randomized complete block design with four or five replications. Rotted and sprouted bulbs were separated

and weighed at every two weeks. Weight of healthy bulbs was measured at the end of the 3 month period to calculate storage losses during this period.

Study 1: Three fungicides were used and each one was applied twice to the crop, *i.e.* at planting and two weeks before harvesting (2 WBH) (Anonymous, 1990). Fungicide treatment at planting was done by dipping bulblet of seedlings in different fungicide solutions for 30 min. before transplanting in the field. Fungicide treatment at 2 WBH was done by spraying to the crop. Variety Rampure was used for this study. Storage losses were estimated at the end of three month period. The experiment was laid out in randomized complete block design with four replications.

Treatments

1. Thiophanate methyl 50% WP + thiram 30% WP at the rate of 20 g/10 l
2. Thiabendazole 60% WP at the rate of 20 g/10 l
3. Captan 80% WP + benomyl 50% WP (2:1 ratio) at the rate of 20 g/10 l
4. Untreated control

Study 2: In this study, crops were grown as above and fungicides were applied at different crop growing stages as given below (Anonymous, 1990; Padule

et al., 1996a). Variety Rampure was used for this study. Storage losses were estimated at the end of 3 month period. Treatments were arranged factorially in a randomized complete block (three factor factorial) design with five replicates. Treatment combinations are given below.

Treatments

Factor 1 Fungicide applied in nursery.

1. Thiophanate-methyl 50% WP + thiram 30% WP as seed treatment at sowing and seedling treatment at planting,
2. Untreated control.

Factor 2 Fungicides applied at 2 & 4 WAP.

1. Chlorothalonil 70% WP at 2 WAP and thiophanate -methyl 50% WP at 4 WAP in the field,
2. Untreated control.

Factor 3 Pre-harvest application of fungicide.

1. Carbendazim 50% WP at 2 WBH,
2. Untreated control.

Application of fungicides were practised as follows:

- * Seed treatment by mixing seeds with thiophanate-methyl 50% WP + thiram 30% WP, at the rate of 2 g/1 kg seeds.
- * Seedling treatment by dipping bulbs of five weeks old seedlings in thiophanate-methyl 50% WP + thiram 30% WP solution for 30 min., at the rate of 70 g/50 l.

- * Spraying of fungicides - chlorothalonil 70% WP at the rate of 20 g/10 l. was sprayed at 2 WAP and thiophanate -methyl 50% WP at the rate of 5.5 g/10 l at 4 WAP of seedling in the field.
- * Spraying of carbendazim 50% WP at the rate of 7 g/10 l at 2 WBH.

Study 3: Crop was grown as above and carbendazim 50% WP at the rate of 7 g/10 l was sprayed as pre-harvest application at 2WBH. Carbendazim was selected for this study as pre-harvest application according to results of study 2. Three varieties *i.e.* Rampure, Agrifound Light Red and N-53 were used for the study. Storage losses were estimated at the end of three month period. Treatments were arranged factorially in a randomized complete block (two factor factorial) design with four replicates.

RESULTS AND DISCUSSION

Bulb rotting caused by storage fungi is one of the major reasons for storage losses of onions in Sri Lanka as well as in other countries in the world (Currah and Proctor, 1990; Padule *et al.*, 1996a). The field survey revealed that different fungal genera were associated with rotten and healthy bulbs collected from onion stores in different places in Sri Lanka. Colony characters on PDA and microscopic observations of isolated fungi are reported in Table 1. Different fungal genera were identified by comparison of their colony characters on PDA and microscopic observations with published data (Booth, 1969; Kenneth B. Raper *et al.*, 1973; Sutton, 1992). Five different groups of fungi were mainly isolated from rotten and healthy looking onion bulbs.

Different fungal groups

Isolate group 1 was collected from rotten bulbs in all locations and identified as *Fusarium* species.

Isolate group 2 was collected from both rotten and healthy bulbs in all locations and identified as *Colletotrichum gloeosporioides*.

Isolate group 3 was collected from both rotten and healthy bulbs and were identified as species of *Aspergillus*, mainly *A. niger* and *A. flavous*. This fungal genus was also found on healthy onion bulbs before storing.

Isolate group 4 was found from both rotten and healthy bulbs in some locations and was identified as an *Alternaria* species.

Isolate group 5 was found in some locations from rotten bulbs after 3 months storage period and was identified as *Sclerotium* spp.

Table 1. Characteristics of different fungal genera associated with big onion bulbs during storage

<i>Isolate Group</i>	<i>Colony Colour</i>	<i>Reverse Colony Colour</i>	<i>Conidia Shape</i>
<i>Fusarium</i>	White at early Stage B-purple when colony older.	Purple	Conidia produced openly within hyphae and exposed to the air. Conidia two types. Macro conidia - Sickle shape, 3-5 cells, larger size. Micro conidia - Cylindrical, 1-2 cells, smaller size.
<i>Colletotrichum</i>	Grey at early Stage G-black when colony older	Black	Straight rounded ends, unicellular. Conidia produced in black colour acervuli as conidia masses.
<i>Aspergillus</i> <i>A. niger</i>	Black moulds concentric zonation on colony surface	Yellow-white	Conidial heads globose, splitting into columns.
<i>A. flavus</i>	Green moulds	Dark-brown	Conidial heads radiate, splitting into several columns.
<i>Alternaria</i> spp.	White at early, Stage Dark when older.	Black	Conidia dark, pear shaped, multicellular with both transverse and longitudinal cross walls. Conidia produced on erect conidiophores.
<i>Sclerotium</i> spp.	White	White	No conidia produced, Brown coloured sclerotia produced from mycelium

Among the fungal genera isolated from onion bulbs, *Fusarium* spp., *Colletotrichum* sp. and *Sclerotium* sp. were proved to be responsible for rotting of onion bulbs. *Alternaria* and *Aspergillus* grew on surface of onion bulbs but did not cause rotting when inoculated artificially. Major storage fungal pathogens which were reported as causal agents of rot of onion in other countries are *Aspergillus niger*, *Botrytis allii*, *Fusarium oxysporum*, *Colletotrichum circinans*, *Alternaria porri*, *Sclerotium cepivorum*, *Perenospora destructor*, *Colletotrichum gloeosporioides* and *Penicillium* species (Maude, 1990, Padule *et al.*, 1996a). These indicate that common fungal genera are involved in rotting of onion bulbs during storage in different countries.

Omveer Singh *et al.* (1987) and Padule *et al.* (1996a) have reported that fungicides could be used to minimize the storage losses of onion bulbs. Of the fungicides tested in other countries, carbendazim was reported as most effective in controlling storage pathogen of onion (Gupta *et al.*, 1991; Omveer Singh *et al.* 1987; Padule *et al.*, 1996a). Among the fungicides used in Sri Lanka, thiram, thiophanate-methyl, thiabendazole and captan have been recommended for controlling fungal pathogens such as *Fusarium*, *Colletotrichum*, *Sclerotium* and *Alternaria* species which are associated in diseased plants (Anonymous, 1997). Data in Table 2 revealed that application of these recommended fungicides *i.e.* thiophanate-methyl or thiabendazole or captan at planting and 2 WBH did not help to reduce rotting or total storage losses of stored onion bulbs significantly when compared to the controls. However, bulb rot percentage during storage period was low (<10%) in all treatments of this study compared to 10- 50% bulb rot reported by Metthananda (1992). It may be due to low inoculum density of fungal

propagules on stored onion or weather conditions that prevailed being unfavourable to develop fungi on onion bulbs during the particular season.

Table 2. Percentage storage losses of big onion bulbs treated with pre-harvest application of different fungicide during three months storage period

<i>Treatment</i>	<i>Storage Loss due to Rotting (%)</i>	<i>Total Storage Loss (%)</i>
Thiophanate methyl + thiram	3.5	25.6
Thiabendazole	5.7	26.3
Captan + benomyl	2.8	28.0
Untreated control	2.4	26.8
	ns*	ns*

ns* - Not significantly different at $p=0.05$

Data in Table 3 revealed that rotting losses as well as total storage losses of stored onion bulbs decreased (35% and 10% respectively) when carbendazim 50% WP (7 g/10 l) was applied 2 WBH. Application of fungicides in the nursery stage (thiophanate-methyl 50% WP + thiram 30% WP) or in the field (chlorothalonil 70% WP at 2 WAP and thiophanate-methyl 70%WP at 4 WAP) had no effect on controlling rotting in the storage period. Although carbendazim is not recommended in Sri Lanka to control most of the fungal pathogens listed in Table 1 (Anonymous, 1997), pre harvest application of carbendazim is used in some countries to reduce the rotting losses of stored onion (Omveer Singh *et al.*, 1987; Padule *et al.*, 1996a). It has also been reported that carbendazim could be used to control spoilage fungal pathogens such as *Fusarium*, *Colletotrichum*, *Alternaria*, *Rhizoctonia*, *Aspergillus* and *Penicillium* species (Nene and Thapliyal, 1984; Anonymous, 1999).

Table 3. Percentage storage losses of big onion bulbs treated with different fungicides during three months storage period

<i>Treatment</i>	<i>Storage Loss due to Rotting (%)</i>		<i>Total Storage Loss (%)</i>	
	<i>With Carb</i>	<i>without Carb</i>	<i>with Carb</i>	<i>without Carb</i>
* Fungicide for seed & seedling + Fungicides at 2 & 4 WAP	10.0	13.1	38.8	44.0
* Fungicide for seed & seedling + No fungicides at 2 & 4 WAP	11.2	19.6	40.2	47.9
* No fungicide for seed & seedling + Fungicides at 2 & 4 WAP	12.8	18.9	44.7	50.8
* No fungicide for seed & seedling +No fungicides at 2 & 4 WAP	13.1	14.6	44.4	45.7

F test ($p=0.05$)

Factor 1	ns	ns
Factor 2	ns	ns
Factor 3	*	*
Interaction	ns	ns

* - Significantly different at $p=0.05$

ns - Not significantly different at $p=0.05$

With Carb - Application of carbendazim at 2 WBH

Without Carb - Without carbendazim application

Benefit of carbendazim as a pre harvest applicant to control losses of stored onion was further confirmed by the data in Table 4 showing that

spraying of carbendazim decreased the percentage losses (30-50%) due to rotting significantly in three varieties and it helped to reduce the total storage losses of onion bulbs. Fungicides studies in three seasons indicated that among the tested fungicides, spraying of carbendazim 50% WP (7 g/10 l) at 2 WBH only helped to reduce the storage losses of big onion. Post-harvest intervals of all fungicides used in these studies are 14 d (Anonymous, 1997). Therefore, pre-harvest application of fungicides was done two weeks before crop harvesting.

Table 4. Percentage storage losses of bulbs of big onion varieties as affected by pre-harvest application of carbendazim during a three months storage period

Treatment	Percentage Rotting (%)		Total Storage Losses (%)	
	With Carb	Without Carb	With Carb	Without Carb
Rampure	4.5	10.1	16.3	16.3
Agrifound Light Red	7.4	10.4	27.5	46.0
N-53	4.8	7.2	20.7	30.6

F test at $p=0.05$

Variety	ns	*
Carbendazim	*	*
Interaction	ns	ns

* - Significantly different at $p=0.05$, ns - No significantly different at $p=0.05$, With Carb - Application of carbendazim 2 WBH, Without Carb - Without carbendazim application

CONCLUSIONS

Five fungal genera are found to be associated with rotting of big onion bulbs. Among them, major causal agents of rotting of big onion bulbs are *Fusarium*, *Colletotrichum gloeosporioides* and *Sclerotium*. *Alternaria* and *Aspergillus* grew on surface of onion bulbs but did not cause rotting. Application of carbendazim 50% WP two weeks before harvesting only helped to reduce the storage losses of big onion up to 40% due to fungal pathogens.

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