"STUDIES ON STORAGE ROT OF ONION CAUSED BY *Aspergillus niger* (Van Tieghem)"

THESIS

Submitted in partial fulfillment of the requirements

For the Degree of

MASTER OF SCIENCE

IN

PLANT PATHOLOGY

By

DHUMAL MANGESH SHIVAJI

(ADPM/19/2675)

DEPARTMENT OF PLANT PATHOLOGY,

COLLEGE OF AGRICULTURE, DAPOLI

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VIDYAPEETH, DAPOLI, RATNAGIRI (M.S.) 415712

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Prof. J. S. AREKAR
Subject Matter Specialist,
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DEPARTMENT OF PLANT PATHOLOGY,

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A thesis submitted to the

FACULTY OF AGRICULTURE
DR. BALASAHEB SAWANT KONKAN KRISHI VIDYAPEETH, DAPOLI
(AGRICULTURAL UNIVERSITY)
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In partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE (AGRICULTURE)

In

PLANT PATHOLOGY

By
DHUMAL MANGESH SHIVAJI
B. Sc. (Ag.)

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DECLARATION OF STUDENT

I hereby declare that the experimental work and its interpretation of the Thesis entitled, "STUDIES ON STORAGE ROT OF ONION CAUSED BY *Aspergillus niger* (Van Tieghem)" or part thereof has neither been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis/publication of any University or scientific organization. The source of materials used and all assistance received during the course of investigation have been duly acknowledged and that no part of the thesis has been submitted for any other degree or diploma.

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CERTIFICATE

This is to certify that the thesis entitled, **"STUDIES ON STORAGE ROT OF ONION CAUSED BY *Aspergillus niger* (Van Tieghem)"** submitted to the Faculty of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri, Maharashtra State, in the partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (Agriculture)** in **PLANT PATHOLOGY,** embodies the results of a piece of bonafide research carried out by **DHUMAL MANGESH SHIVAJI** under my guidance and supervision and that no part of this thesis has been submitted for any other degree or diploma or published in other form. All the assistance and help received during the course of investigation and the sources of literature have been duly acknowledged by him.

Place: Dapoli
Date: / 06/2021

(J. S. Arekar)
Chairman, Advisory Committee
and Research Guide

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Place: Dapoli
Date:

(Mangesh Shivaji Dhumal)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

ABBREVIATION'S USED

%	:	Per cent
/	:	Per
@	:	At the rate of
˚C	:	Degree Celsius
and	:	And
APEDA	:	Agricultural and Processed Food Products Export Development Authority
BOD	:	Biological Oxygen Demand
CD	:	Critical Difference
Conc.	:	Concentration
cm	:	Centimeter
CRD	:	Completely Randomized Design
CV	:	Co-efficient of Variation
d.f.	:	Degree of freedom
DAI	:	Days after inoculation
Dr.B.S.K.K.V.	:	Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth.
E.M.S.	:	Error mean sum of squares
et al.	:	And others
etc.	:	Etcetera
hrs.	:	Hour(s)
Fig.	:	Figures
f. sp.	:	Forma specialis
Gm	:	Gram(s)
HgCl2	:	Mercuric chloride
hrs	:	Hours
i.e.	:	That is
Kcal	:	Kilo calorie
Kg	:	Kilo gram
Lit.	:	Liter
m	:	Meter
M.S.S.	:	Mean sum of squares
Mg	:	Milligram

Ml	:	Milliliter
µm	:	Micrometer
mm	:	Millimeter
NaOCl	:	Sodium Hypochlorite
NHRDF	:	National Horticultural Research and Development Foundation
No.	:	Number
P.D.A.	:	Potato Dextrose Agar
PDI	:	Percent Disease Incidence
PGI	:	Percent Growth Inhibition
pH	:	Potential of hydrogen ions
Ppm	:	Parts per million
Psi	:	Pressure per square inch
S.E.	:	Standard error
S.Em.	:	Standard error of mean
Sig.	:	Significant
Spp	:	Species
SS	:	Sum of Squares
Sr.	:	Serial
Subsp	:	Subspecies
Tr./T	:	Treatment
UAE	:	United Arab Emirates
v/w	:	Volume / weight
viz.	:	Namely

DEPARTMENT OF PLANT PATHOLOGY
COLLEGE OF AGRICULTURE, DAPOLI

Title of thesis	:	Studies on storage rot of onion caused by *Aspergillus niger* (Van Tieghem).
Name of the student	:	Dhumal Mangesh Shivaji
Regd. No.	:	ADPM/19/2675
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ABSTRACT

Amongst the vegetable crops onion is one of the most important commercial crop in India and Maharashtra. It is observed that onion crop prone to several fungal as well as bacterial diseases in field and storage condition. Storage rot caused by *Aspergillus niger* (Van Tieghem) has been reported as major constraints in successful cultivation and post-harvest management of onion production.

Therefore present attempt on "Studies on storage rot of onion caused by *Aspergillus niger* (Van Tieghem)" was carried out at Department of Plant Pathology, College of Agriculture, Dapoli during 2020-21.

The survey on incidence of storage rot of onion was carried out for period of six months from July to December in Rajgurunagar, Chakan and Talegaon market during 2020. The results of present study revealed that, the highest storage rot incidence was recorded in December (28.33%) followed by November (26.33%), October (20.33%) and July (19.83%). While, lowest storage rot incidence was recorded in August (13.50%) followed by September (15.16%).

Aspergillus niger pathogen inciting storage rot of onion was isolated successfully from naturally diseased onion bulb showing rot symptoms by standard tissue isolation technique. Colony was black, circular with vigorous growth at initial stage later turns pale yellow within a period of 12-15 days. Pathogenicity of *Aspergillus niger* was successfully proved by without injury and with injury methods on healthy fresh red onion bulbs. Artificially inoculated bulbs exhibited typical symptoms within 7-10 days of inoculation.

Morphological characteristics of the isolated fungus were compared with the description in reviewed literature as well as the information available on standard websites for fungal identification such as www.indexfungorum.com and www.mycobank.org. On the basis of this comparison the pathogen was identified as *Aspergillus niger*.

Physiological weight loss of onion bulb was assess by inoculating *A. niger* and recorded weight loss 15, 30, 45 and 60 days after inoculation. White onion showed maximum physiological weight loss (22.87%) compared to red onion (10.41%) noted 60 days after inoculation.

Among the eight bioagents evaluated, maximum mycelial growth inhibition was observed in *Trichoderma harzianum* (81.11%) followed by *T. virens* (78.22%), *T. hamatum* (72.66%), *T. viride* (64.88%), *T. asperellum* (61.88%) and *Bacillus subtilis* (57.77%). Lowest mycelial growth inhibition was recorded in *Penicillium* spp. followed by *Pseudomonas fluorenscence* (55.55%).

Among all the botanicals studied, complete inhibition of the mycelial growth occurred in *Eucalyptus globules* (00.00mm). This was followed by *Zingiber officinale* (05.00mm), *Azadirachta indica* (27.60mm), *Ocimum sanctum* (31.60mm) and *Curcuma longa* (34.00mm). The least (45.50mm) mycelial inhibition was recorded with *Lantana camara* followed by *Syzygium aromaticum* (35.00mm). Maximum growth (90.00mm) was recorded in control.

CHAPTER I: INTRODUCTION

1. Background information :

The onion (*Allium cepa* L.) bulb of family Amaryllidaceae is an important vegetable crop widely cultivated and consume throughout the world as well as in India. Onion is a significant underground bulb vegetable crop of tropical and sub-tropical countries (Thompson and Kelly, 1979). According to Vavilov (1951), the primary centre of origin of onion lies in Central Asia. It is probably a native of Asia comprising North West India, Baluchistan and Afghanistan. The genus *Allium* is very large comprising of more than 500 *spp*. usually perennial bulbous plants. Among these, *Allium cepa* is the major cultivated species grown all over the world.

Area under onion cultivation in India was 12.20 lakh ha with annual production of 228.19 lakh MT during 2018-2019 with productivity of 18.70 tones/ha. In world rank, India comes after China in production as well as in productivity of onion bulbs. On the behalf of this, there is a lot of demand for the Indian onions in the world market. In the year 2019-2020, the country had exported 11.50 lakh MT of fresh onions worth Rs.2320.70 crores (Anonymous, 2016). Onion export from India to Dubai recorded the maximum onion shipments in UAE. The other major onion export destinations of India are Sri Lanka, Indonesia, Saudi Arabia, Kuwait, Qatar, Germany, Bangladesh and United Kingdom. In India, onion crop has two cycles, first harvesting starts in November to January and the second from January to May.

Maharashtra is the major onion growing state in the country with an area of 5.08 lakh ha under this crop and average annual production of 53.55 lakh MT. Madhya Pradesh ranks second with 1.50 lakh ha (38.59 lakh MT) followed by Karnataka 1.95 lakh ha (31.97 lakh MT), Gujarat 22.5 thousand ha (13.03 lakh MT), Rajasthan 64.7 thousand ha (12.92 lakh MT) and Bihar 53.77 thousand ha (12.49 lakh MT). Maharashtra contributes 28.32% to the total annual onion production of the country (Anonymous, 2020). The principal onion growing districts in the Maharashtra State are Satara, Nashik, Jalgaon, Pune, Solapur and Ahmednagar occupying about 94.68 per cent of area under cultivation of onion.

Red onion is used for domestic consumption and export while the white onion is used mostly for processing (Lawande *et al*., 2009). The major varieties found in India are Nashik Red, Agrifound Dark Red, Agrifound Light Red, NHRDF Red,

Agrifound White, Agrifound Rose, Agrifound Red, Pusa Ratnar, Pusa Red, Pusa White Round, etc. There are certain varieties in yellow onion which are suitable for export in European countries *viz.*, Tana F1, Arad-H, Suprex, Granex 55, HA 60 and Granex 429.

The local name of onion is state wise different. It is known as Kanda (Marathi) and Piyaz, Piaj, Ulli, Vengayan, Erangagam, Erulli, Dungli, Ganda, Payaz, etc. in other states. The bulb develops underground it is popularly used at both immature as well as mature stages as vegetable or as a spice. Processed product is marketed in the form of onion slices or powder.

The nutritive value of onion varies according to the variety but generally it contains 89.11g moisture, 1.1g protein, 0.1g lipids, 0.4g minerals, 1.7g fiber, 0.34g carbohydrate, 4.24g total sugar, 40Kcal energy, 0.99g sucrose, 0.35g ash, 23mg calcium, 29mg phosphorous, 0.21mg iron and 7mg vitamin C (Pareek *et al*., 2017). The pungency of onion is due to a volatile oil known as Allyl propyl disulphide ($C_3H_5S_2C_3H_7$) which acts as gastric stimulant and promotes digestion. Besides this it has very good medicinal value, as it contain phenols, flavonoids *etc*. that have anti-inflammatory, anti-cholesterol, anti-cancer and antioxidant properties. Onion is very much useful to protect from sunstroke in summer.

Onion crop suffers from many diseases at different growth stages which cause considerable losses in crop yields.

Table 1. Important field and post-harvest diseases of onion

Sr. No.	Name of Disease	Causal organism
1.	Purple blotch	*Alternaria porri*
2.	Botrytis leaf blight	*Botrytis squamosa*
3.	White rot of Onion	*Sclerotium cepivorum*
4.	Downy mildew	*Peronospora destructor*
5.	Black mould	*Aspergillus niger*
6.	Bacterial soft rot	*Erwinia carotovora* subsp. *carotovora*
7.	Green mould	*Penicillium spp.*
8.	Bacterial brown rot	*Pseudomonas spp.*

Storage rot/black mould rot is a serious disease of onion. Ko *et al*., (2002) reported up to 36% losses of bulbs by the infection of *Aspergillus niger*. Generally

this disease occurs more in white onions as compared to the red and pink onions. The phenol content in white onions is very low and therefore they are prone to the infection of *Aspergillus*. Onion storage rot disease causes extensive losses in storage and transit under tropical conditions (Thamizharasi and Narsimham, 1992).

Aspergillus niger is a cosmopolitan fungus mainly responsible for spoilage and bio-deterioration of food material (Samson *et al*., 2004). Being a saprophytic with filamentous growth, *Aspergillus niger* perpetuates in soil, forage, plant debris and food products (McDonald *et al*., 2004). Temperature within a range of 28°C– 34°C coupled with humid conditions is conducive for infection of this fungus (Tyson and Fullerton, 2004) .

Strains of *Aspergillus niger* are used in manufacture of several acids like citric acid, gluconic acid, itaconic acid *etc*. Inhalation the spores of this fungus can be dangerous as it may result in severe lung problems further terminating in Aspergillosis. Culture filtrates of *Aspergillus niger* exhibited phyto-toxicity in onion and tomato by reducing seed germination and root elongation (Narayana *et al*., 2007).

2. Importance and need of study :

Among all the post-harvest diseases of onion, storage rot disease occurs in more or less proportions every year and causes severe damage to the quality of bulbs. To overcome such losses by proper post-harvest disease management practices, this maiden attempt was carried out.

3. Objectives of the study :

The present study is an effort to revealed the importance of storage rot incited by *Aspergillus niger* pathogen under the following objectives:

- Survey of storage rot of onion in Rajgurunagar, Chakan and Talegaon markets.
- Isolation and pathogenicity of pathogens associated with storage rot of onion.
- To study the physiological weight losses of onion bulbs infected by *Aspergillus niger*.
- To evaluate the bio efficacy of bio agents and botanicals against *Aspergillus niger in vitro*.

4. Hypothesis or assumptions :

The findings of present study will determine the incidence of storage rot disease in onion markets, compare loss in weight occurred due to storage rot pathogen in red and white onion and also find out an effectiv management practice by using botanicals and bioagents *in vitro* condition which may need further study in field condition for their effectiveness in *in vivo* condition.

5. Scope and limitations of the study :

Scope :

The present study has scope in relevance to the management of post-harvest losses in onion production due to biotic factors. The storage rot disease of onion caused by various factors among them *A. niger* is important biotic factor. Present study open the doors for effective management of pathogen by beneficial microorganisms and also non chemical fungistatic agents. The inoculation of *A. niger* on white onion and red onion shows difference in physiological weight loss due to less or more catechol (phenolic) content.

Limitations :

Onion can be eaten as raw so for management of storage rot pathogen ecological methods like botanical and bioagents are quite suitable rather than any chemical methods.

CHAPTER II: REVIEW OF LITERATURE

Aspergillus niger is an extremely destructive fungal pathogen that causes severe losses of onion bulbs at storage condition (Khatoon *et al*., 2017). The literature available on storage rot of onion under the all aspects studied survey of incidence of pathogen, symptomatology, isolation and pathogenicity, physiological weight loss of infected bulbs and *in vitro* evaluation of bioagents and botanicals was reviewed and presented here under the following sub-heads.

2.1. Survey of storage rot of onion.

Currah and Proctor (1990) surveyed on specific problems on onion production and storage in tropical and sub-tropical regions and indicated that storage losses were serious in 44 out of 72 tropical countries and 19 Asian countries out of 21.

Kaur and Verma (2002) reported 20% losses of citrus fruits in Punjab markets due to black mold rot caused by *A. niger*.

Ko *et al*., (2002) observed that the black mould, soft rot and basal rot were the main causes of storage losses to the extent of 36, 25 and 14 per cent, respectively in onion.

Srinivasan *et al*., (2002) stated that *A. niger* was predominant pathogen associated with black mould rot of onion in storage conditions and recorded loss of 2.9% to 12.09% onion bulbs during the months of June to February.

Muhammed *et al*., (2004) surveyed the Central market, Kasuwar daji, Mabera, Minanata and Arkilla markets of Sokoto in northwestern Nigeria in 2001 and 2002 for diseases and aflatoxin contamination of tomato fruits.

Panchal (2008) carried out survey on post-harvest diseases of tomato at vegetable market, Anand during 2007 to 2008 revealed the presence of five pathogenic rots *viz.*, *Alternaria* (19.7%), *Rhizopus* (4.59%), *Aspergillus* (3.44%), *Penicillium* (2.6%) and *Fusarium* (2.2%), respectively.

Bhale (2011) observed several fungal microorganisms, among them *A. niger*, *Rhizoctonia solani* (Kuhn), *Geotrichum candidum* Link and *Penicillium spp*. were found major disease causing organisms in the markets of Osmanabad.

Gautam *et al.*, (2011) reported that *A. niger* an important spoilage fungi associated with various plant diseases resulting in huge economic loss.

Kadam *et al*., (2011) conducted field surveys in the Marathwada region of Maharashtra for collar rot (*Sclerotium rolfsii*) disease of groundnut crop and recorded maximum disease incidence (17.8%) in Renapur tahsil and minimum disease incidence (8-9%) in Nilanga tahsil.

Adongo *et al*., (2015) were conducted a survey of fungi associated with onion bulb deterioration and reported more incidence of black mold fungus during wet season in the markets of Anloga (31.3%) followed by Kwadaso (27.7%), Central (25.2%) and Abinchi (22.5%) from Ghana.

Kumar *et al*., (2015) reported about 35 to 40% loss of onion due to damage caused by storage diseases and the fungal bulb rot (*A. niger*) imparts to about 15 to 30% losses during storage of different varieties.

Mahmud and Monjil (2015) collected diseased onion bulbs of varieties Taherpuri, Faridpuri and Pusa Red (Indian) from three markets of Mymensingh, Naogaon and Shatkhira districts in Bangladesh and reported maximum disease incidence in Pusa Red (14.44%) followed by Faridpuri (11.81%) and Taherpuri (10.45%) in the month of September.

Chavda (2016) carried a survey of storage diseases of garlic in Anand, Petlad, Borsad markets in Gujarat and reported that the highest (24.33%) black mould rot incidence in the month of May followed by June (24.17%), April (18.33%), July (15.83%) and August (11%). The lowest incidence (7.67%) was recorded in the month of September.

Kumari and Singh (2017) reported 13.09 to 52% collar rot of groundnut infection. The incidence of disease was more in sandy soil (52%) followed by sandy loam soil (43%) in different tehsils of Sikar and Jaipur.

Orpin *et al*., (2017) observed 100 samples for spoilage of onion bulbs and found that highest frequency of occurrence of *Escherichia coli* (25.00%) and the lowest was *Pseudomonas sp.* (9.38%), whereas *A. niger* had the highest frequency of occurrence (18.75%) and the lowest was Mucor (6.25%).

Elias *et al*., (2019) collected rotten onion bulbs of var. 'Bawku Red' from two markets in Tamale and studied in the laboratory. The results showed that the onion bulb rot was caused by five fungi species including *A. niger, Aspergillus flavus, Penicillium sp*., *Rhizopus stolonifer* and *Fusarium oxysporum*. *A. niger* had the highest percentage occurrence of 30.66% and 25.66% for the Tamale Central and Aboabo markets, respectively.

2.2. Symptomatology

Walker (1952) found that black powdery mass of spores of *A. niger* are borne on exterior of the scales of onion bulbs and can be easily rubbed off.

Raju and Raj (1980) observed two types of typical symptoms in the rotted bulbs caused by *A. niger* and *Erwinia caratovora*. They observed dry scales of affected onion bulb with black conidial mass formed by *A. niger*, in combination with rotting of onion bulbs and offensive odour. Abundant spore masses of *Aspergillus spp*. were observed on the outer two or three scales, usually arranged along the veins.

Tiwari *et al*., (1984) studied how the fungus *A. niger* initially infects the outer scales of onion bulbs and further penetrates into the inner scales and produces large number of dark black color conidial masses which can be visible with naked eyes.

Rao and Rajasab (1992) reported that clusters of black spores of *A. niger* generally form along veins and on or between the outer papery scales of onion bulbs.

Salvestrin and Letham (1994) observed that in the favorable conditions, the sporulation of *A. niger* takes place after 24hrs.

Infected tissue of onion bulbs with *A. niger* initially has a water soaked appearance, later gradually dry and shrivel (Sinclair and Letham, 1996).

Ko *et al*., (2002) noted that the *A. niger* infected onion bulbs show blackening of the neck and black mycelial streaks beneath the outer scales, comprise black powdery spore mass.

Prajapati and Patil (2015) studied the symptomatology of black mould rot of onion incited by *A. niger*. They reported that the symptoms develops at the neck of the bulbs on injured or necrotic leaf tissues and may develop a black discoloration at the neck.

2.3. Isolation and Pathogenicity

Thom and Raper (1939) isolated *A. niger* by using tissue isolation method and found good mycelial growth on Czapek's medium followed by potato dextrose and malt agar.

Chaudhary *et al*., (1994) proved the pathogenicity by dipping healthy surface sterilized onion bulb into spore suspension of *A. niger* for 5 minutes.

Koycu and Ozer (1997) obtained good fungal growth of *A. niger* and *F. oxysporum* f. sp. *cepae* from naturally infected onion bulbs.

Muhammed *et al*., (2004) proved the pathogenicity of eight different fungi *viz*., *Aspergillus niger*, *A. ochraceous*, *A. flavus*, *A. fumigatus*, *Penicillium citrinum* and *Helminthosporium fulvum*, *Curvularia lunata* and *S. rolfsii* isolated from tomato fruits and found that *A. niger*, *A. ochraceous*, *A. flavus*, *S. rolfsii* and *P. citrinum* were highly pathogenic.

Srinivasan and Shanmugam (2006) isolated *A. niger* from dried outer scales, fleshy inner scales and rootlets of infected bulbs by tissue isolation technique and proved the pathogenicity of same.

Ara *et al.*, (2008) collected diseased onion samples from different markets of Mymensingh (Bangladesh) and found fungi *viz*., *A. niger*, *A. flavus*, *Penicillium spp*., *F. oxysporum* and *F. moniliforme* from the bulbs. Isolated fungi were inoculated with injury and without injury methods.

Kharwar *et al*., (2008) isolated *A. niger* from *Catharanthes rosea* (Sadafuli) as an endophytic fungus which can alter its metabolite production.

Gautam *et al.*, (2011) reviewed the diversity, toxicology and pathogenicity of *A. niger* in plants and humans.

Wani and Taskeen (2011) found *A. niger* Van Tieghem was associated with black mold rot of onion, on the basis of its morphological characteristics.

Sharma (2012) reported that *A. niger* is pathogenic to onion, peanut, yam, cherry, maize, grape, banana, tomato and mango fruits.

Khokhar *et al*., (2012) successfully isolated *A. niger* on PDA medium from diseased onion bulbs showing typical black mould rot symptoms by tissue isolation

method. The pathogen was identified and confirmed as *A. niger* on the basis of morphological and cultural characteristics.

Doullah *et al*., (2014) isolated *A. niger, A. flavus, Penicillium spp*., *F. oxysporum* and *F. moniliforme* fungi from rotted onion bulbs by employing tissue isolation method on PDA medium.

Arowora and Adetunji (2014) found the *A. niger* in rotted onion bulbs. The fungal cultures obtained were identified on the basis of cultural and morphological characteristics. Pathogenicity test confirmed the involvement of *A niger* in rotting.

Parveen *et al.*, (2014) studied the incidence of fungal rot of pear fruits and isolated the *A. niger* causing black mold rot of pear in Kashmir Valley of India.

Jidda and Benjamin (2016) revealed that *A. niger* and *Fusarium* spp. were in both white and red varieties of onion, while *Sclerotium cepivorum*, *R. stolonifer* and *Scopulariopsis brevicauli* were found to be associated with white bulbs only.

Kumar and Chahal (2016) successfully isolated twenty isolates of *A. niger* from diseased fruits of pomegranate and morphologically characterized. All the twenty isolates were inoculated on five cultivars of pomegranate (Ganesh, Ruby, Bhagwa, Jyoti and Mridula) for pathological characterization.

Khatoon *et al.*, (2017) reported the association of *A. flavus* and *A. niger* with rotten bulbs of onion and *A. niger*, *Penicillium sp*. and *Rhizopus oryzae* with rotten garlic by tissue isolation technique on PDA.

Kumari and Singh (2017) isolated and proved the pathogenicity of *A. niger* causing collar rot, soil born disease of groundnut crop

Uddin *et al*., (2019) collected diseased onion samples from different regions and isolated *A. niger*, major pathogen associated.

2.4. Physiological losses in weight of onion bulbs infected by *A. niger*.

Kulfinski *et al*., (1973) reported that the black mold of onion, caused by *A. niger* Van Teigh., is known to produce cellulolytic and pectinolytic enzymes, which may be responsible for occurrence of some tissue degradation.

Maini and Chakravarti (2000) reported 12 to 25% losses in physiological weight of onion bulbs due to various diseases such as soft rot, blue mould and black mould.

Sheth (2008) showed the severity of *Aspergillus* fruit rot (*A. niger*) disease in citrus fruits, in cork-borer wounding (52.00%) method followed by pin-prick (47.25%) method.

Ghangaonkar (2013) analyzed significant loss in weight of white and red onion bulbs by artificially inoculated with *A. niger* and *F. oxysporium*.

Kapadiya *et al*., (2013) reported that the maximum weight loss (5.44%) of onion bulbs was due to the infection of *A. niger*.

Mohmud and Monjil (2015) carried out an experiment to analyze the weight loss of onion of varieties Pusa Red, Taherpuri and Faridpuri and reported significant loss of weight in Faridpuri (78.67 g/Kg) onions in October followed by Taherpuri (69.67 g/Kg) and least loss was recorded in Pusa Red (32 g/Kg) in the month of May.

Chavda (2016) reported that garlic bulbs inoculated with *A. niger* showed loss in weight as compared to un-inoculated bulbs at 15, 30, 45 and 90 days after inoculation. Results revealed that the highest per cent physiological weight loss was recorded in Gujarat Garlic-4 variety (4.87g and 29.53%) followed by Gujarat Anand Garlic-6 (4.38g and 28.77%) after 60 days of inoculation.

Prajapati (2016) revealed the onion bulbs inoculated with *A. niger* showed loss in weight as compared to uninoculated bulbs at 30, 60 and 90 days after inoculation. Recorded highest per cent physiological weight loss in Gujarat Anand white onion-3 variety (10.48g and 16.70 %) followed by Nasik yellow (11.54g and 14.45 %) and Nasik red (11.73g and 10.59%) 90 days after inoculation.

Ahsanuzzaman *et al*., (2017) had conducted an experiment to assess the weight loss of onion bulb in storage condition. Weight loss per cent was recorded three times with 15 days interval of days of storage. Among six varieties of onion Pusa red variety showed the highest (35.7%) weight loss at 45 days of storage where the lowest (8.7%) was recorded in Zitka.

2.5. Evaluation of bioagents and botanicals against the pathogen.

Bhosle *et al*., (2008) analyze the use of botanicals against leaf blight of onion *in vivo* and found that among botanicals *Lantana camera* and *Pongamia pinnata* were found effective and gave 27.08% and 22.44% disease control, respectively.

Avasthi *et al.,* (2010) evaluated the efficacy of eight commonly used spices of medicinal plants against the mycelial growth of *A. niger* isolated from onion using poisoned food method. Among all botanicals tested *Syzygium aromaticum* L. (dry flower bud) and *Allium sativum* L. (bulb) extracts @20% found effective in inhibiting the complete mycelial growth of *A. niger*.

Lone *et al*., (2012) reported that under *in vitro Trichoderma harzianum* was the most effective bio-agent against *A. niger* (75% inhibition) followed by in *Cladosporium sphaerospermum* (72.2% inhibition). *Bacillus subtilis* was less effective against *A. flavus* and *A. terreus*.

Baig *et al*., (2012) found that *Pseudomonas fluorescens* and *Bacillus subtilis* can effectively suppress the growth of *A. niger* up to 73 and 60%, respectively in dual culture method.

Gajendra and Vakharia (2012) revealed that, *Trichoderma viride* was more effective (86.2% inhibition) against *A. niger* than *T. harzianum* (80.4% inhibition).

Khokhar *et al*., (2012) observed that the *Penicillium* species completely overgrew the *A. niger* colony. The study also revealed that some species of the genus *Penicillium* possessed a high antagonistic effect on the onion black rot pathogen.

Bashir *et al*., (2013) reviewed the antifungal activity of aqueous and ethanol extracts obtained from seed and leaf of *Jatropha curcas in vitro* against *A. niger* which revealed that the mycelial growth of *A. niger* was suppressed by 65.7 and 57 per cent, respectively at 160mg/ml. The *in vivo* study showed that aqueous extracts of seed and leaf reduced rot development by 59.4 and 54.4 % in onion bulbs.

Bhushan *et al*., (2013) studied antagonistic activity *B. subtilis* and *Pseudomonas fluorescens* against *A. flavus, A. fumigatus, A. niger, A. terreus* and *F. oxysporum* of *Pennisetum americanum* and observed that *B. subtilis* antagonistic isolate was able to significant reduction in seed-borne mycoflora than *P. fluorescens*.

Nandeesha *et al*., (2013) evaluated the efficacy of 14 isolates of *Trichoderma spp*. Among them, the isolates TAG-2, TAG-13, and TAG-10 showed maximum mycelial inhibition *i.e.,* 81.36%, 78.51% and 75.97%, respectively against *A. niger*.

Mokhtar and Dehimat (2014) tested *in vitro* and *in vivo* capability of *T. harzianum* to control the *Rhizopus* soft rot of tomato fruits (*Lycopersicon esculentum*). In *in vitro* condition *T. harzianum* showed 43.66% inhibition, whereas in *in vivo* 82.86% inhibition of the mycelial growth of *R. stolonifer* after seven day of the experiment.

Jagtap and Suryawanshi (2015) tested eleven bioagents against *Fusarium oxysporum f. sp. cepae* causing basal rot disease in onion. Among them, *T. viride* was found most effective (78.88%) followed by *T. harzianum* (73.33%). *B. subtilis* (23.75%) and *P. fluorescens* (12.85%) was observed with less inhibition of *F. oxysporium f. sp. cepae*.

Saifeldin *et al*., (2016) studied the *in vitro* ability of seed extract of *Prunus mahaleb* and resin extract of *Commiphora myrrha* at different concentration also dry bud extract of *Syzygium aromaticum* and root extract of *Panax ginseng* against soft rot of onion caused by *A. niger*. Among them, *Syzygium aromaticum* recorded 96% inhibition in spore germination and was at par with *Prunus mahaleb* (96%) while remaining two extracts recorded 88% inhibition.

Alka *et al*., (2017) carried out study to know the efficacy of various antagonists and its culture filtrates against the *Rhizopus* rot of tomato *in vitro* and *in vivo* conditions. Among six antagonists the culture filtrate of *T. asperellum* and *T. viride* found most effective in *in vivo* and *in vitro* and inhibition of mycelial growth of *R. oryzae* was recorded 0.45 and 0.45 % in pre-inoculation and post-inoculation treatments.

Saranya *et al*., (2018) reported that *T. viride* isolate T6 significantly reduced the growth (78.63%) of *A. niger* followed by the isolate T9 (75.51%). In comparison to this, *B. subtilis* was less antagonistic (61.27%). They also reported that among eight phyto-extracts maximum inhibition (71.19%) was found in *Lawsonia inermis* followed by, *Ocimum sanctum* (62.97%), *Zingiber officinale* (62.26%) and *Lantana camera* (61.59%). Minimum inhibition of the test fungus was recorded in *Jatropha curcas* (53.20%).

Pudake *et al*., (2018) evaluated seven botanicals @10% concentration against *A. niger*. Among all botanicals garlic clove extract and eucalyptus oil recorded cent per cent inhibition of mycelial growth. They were followed by leaf extract of *O. sanctum* (92.74%), *Azadirachta india* (76.10%) and onion bulb (52.05%) extract.

Futane *et al*., (2018) tested nine botanicals against *A. niger* and it was found that, maximum (50.99%) mycelial growth inhibition was recorded with *Allium sativum*, followed by *O. sanctum* (29.22%), *A. indica* (23.90%) and *Datura metal* (18.58%) while least growth inhibition was recorded by *L. camara*, *T. procumbens*, *P. pinnata*, *P. longifolia* and *Z. officinale* as against untreated control.

CHAPTER III: MATERIAL AND METHODS

All the experiments in the present research work **"Studies on storage rot of onion caused by *Aspergillus niger* Van Tieghem"** was carried out in the Department of Plant Pathology, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (M.S.).

The material used and methods or techniques adopted during the course of studies are described here in this chapter.

3.1 MATERIAL

3.1.1 Disease sample

The diseased onion bulbs showing typical masses of black spores develop as streaks along veins and between outer dry scales were collected in paper bags from local vegetable market, Dapoli, Dist. Ratnagiri and brought to the laboratory for further studies.

3.1.2 Culture medium

Potato dextrose agar (PDA), the common laboratory culture medium was used for isolation, purification, multiplication and maintenance of the pure culture of *Aspergillus niger*.

3.1.3 Chemicals

All the chemicals used in different experiments were of analytical grade.

3.1.4 Glassware

Standard Borosil brand glassware's were used during the course of research work.

3.1.5 Equipment

Common laboratory equipment's such as an autoclave, hot air oven, laminar air flow bench, incubator, distillery unit, refrigerator, burner, electronic top pan balance and binocular research microscope were used for lab work.

3.1.6 Bulbs

Fresh, mature and healthy red onion bulbs were collected from local vegetable market, Dapoli for pathogenicity test and white onion bulbs for physiological weight loss study.

3.1.7 Miscellaneous material

Cork borer, polythene bags, moist humidity chamber, forceps, inoculation needles, spirit lamp, cotton etc. were used during the course the of investigation.

3.2 METHODOLOGY

Preparation of culture media

Potato dextrose agar medium was used for isolation, pathogenicity test, maintaining stock culture of test pathogen and dual culture technique for fungal bioagents *viz*., *Trichoderma viride*, *T. harzianum*, *T. hamatum*, *T. virens*, *T. asperellum*, *Penicillium spp*. For culturing of *Pseudomonas fluorescens* and *Bacillus subtilis*, specific media were used.

Composition of PDA medium:

Peeled Potato	200.0 gm
Dextrose	20.0 gm
Agar	20.0 gm
Distilled water	1000.0 ml (Make up volume)
pH	7

Clean and peeled healthy potatoes of two hundred grams were taken and cut into small pieces. These pieces were boiled in 1000 ml distilled water and the extract was collected by filtering through muslin cloth. Each 20 gm of dextrose and agar-agar powder dissolved in potato extract one followed by another with continuous stirring. Final volume of one liter was made by adding distilled water and dispensed into conical flasks, plugged with non-absorbent cotton and finally wrapped with aluminium foil. This was then sterilized in an autoclave at 121°C temperature at 1.0kg/ cm^2 for 20 minutes.

3.2.1 Survey of storage rot of onion in Rajgurunagar, Chakan and Talegaon market

A survey was carried out at 15 days interval at Rajgurunagar, Chakan and Talegaon market to study the incidence of storage rot of onion on the basis of typical symptoms from August to December during 2020. One hundred samples were selected randomly from the retailers of each market. Thus totally 300 samples were

examined for each time from all three locations for the incidence of rot of onion caused by *A. niger*.

The per cent storage rot incidence was calculated by following standard formula:

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected bulbs}}{\text{Total number of examined bulbs}} \times 100$$

3.2.2 Isolation and pathogenicity of the associated organism

3.2.2.1 Isolation and purification of *Aspergillus niger*

Naturally infected onion bulbs showing typical symptoms of storage rot collected from the local vegetable market and brought to the laboratory for isolation. The diseased samples were washed gently with distilled water and blot dried. Diseased area was cut with sharp sterilized blade into small bits, keeping half healthy and half diseased portion intact and surface sterilized with 0.1 per cent aqueous mercuric chloride solution for 1-2 min. Then the bits were washed by giving three sequential changes with sterile distilled water in Petri plates to remove traces of mercuric chloride and again blot dried. The bits were then inoculated aseptically on autoclaved and cooled (45°C) potato dextrose agar medium in sterilized Petri plates. The plates were then incubated in inversed position at room temperature (27 ± 2°C) for seven days.

The plates were incubated in BOD incubator at 26 ± 2°C till the well-developed mycelial growth was achieved. When pure growth of fungus was achieved, 5 mm culture discs of the fungal mycelium was cut with sterilized cork borer and aseptically transferred with the help of inoculating needle to potato dextrose agar slants and allowed to grow. This pure culture slants were sealed with paraffin wax and maintained as stock culture and stored in refrigerator for further aspects.

3.2.2.2 Pathogenicity test of isolated organism:

Inoculation

Fresh, healthy and uniform sized onion bulbs were selected for artificial inoculation from local vegetable market and stored by the farmer. The bulbs were thoroughly washed in tap water, then surface sterilized by dipping in 0.1 per cent mercuric chloride solution for one minute followed by three successive washings with

distilled sterile water to remove the traces of mercuric chloride and then allowed to dry. Ten-days-old sporulating culture of *Aspergillus niger* on PDA were flooded with sterile distilled water and the mycelia was scraped with a spatula. The mycelial suspension was passed through glass wool to remove hyphal fragments and the filtrate containing conidia were collected.

With injury and without injury methods were used to prove the pathogenicity.

i) With injury

The onion bulbs were injured by pin-prick method (Venkat Narayan and Delvi, 1951) and then aseptically inoculated with absorbent cotton swab soaked in spore suspension. The samples were then placed in sterilized humidity chamber and incubated at room temperature (27 ± 2°C).

ii) Without injury:

In this method, selected healthy onion bulbs of without any injury were dipped for ten minutes in spore suspension of ten days old culture of inoculating test fungus. The samples inoculated by above methods were placed in sterilized polythene bags, provided with water soaked cotton pad to create humidity and incubated at room temperature 27 ± 2°C, uninoculated samples were kept as a check under observation.

Observations were recorded by observing daily development of symptoms on each and every inoculated onion bulb of with and without injury conditions. Any visual changes observed during incubation were recorded.

3.2.2.3 Reisolation

Reisolation of the causal organism showing typical symptoms of storage rot disease from the artificially inoculated onion bulbs was accomplished in the same way as described earlier in this chapter. The fungal growth obtained on potato dextrose agar medium after reisolation was compared for its cultural and morphological characters with the original culture of *A. niger* isolated from naturally rot diseased onion bulbs to fulfil Koch's postulates.

The pathogen isolated from the diseased sample and established in pure form was identified on the basis of colony and morphological characters.

3.2.3 Study the physiological losses in weight of onion bulbs infected by *A. niger*

Healthy and mature red and white onion bulbs with uniform size were taken for the study. The samples were washed with clean water to remove extraneous surface material and then sterilized with NaOCl (1%) and finally washed by distilled sterile water for three times. Then bulbs were separately inoculated with spore suspension of *A. niger* by pin prick method as described earlier.

The inoculated bulbs were incubated at ambient temperature. Physiological losses in weight of infected bulbs were assessed on 15^{th}, 30^{th}, 45^{th} and 60^{th} days after the inoculation of *A. niger*. Losses in weight were calculated by the following formula:

$$\text{Loss in weight} = \frac{W1 - W2}{W1} \times 100$$

Where,

W1 = weight of bulb recorded at the time of inoculation

W2 = weight of bulb recorded after 15^{th}, 30^{th}, 45^{th} and 60^{th} day after inoculation.

3.2.4 *In vitro* evaluation of bioagents and botanicals against *Aspergillus niger*

3.2.4.1 *In vitro* evaluation of bioagents against *A. niger*

Dual culture technique (Dennis and Webster, 1971) was adopted in present assay. Seven bioagents were evaluated against the test fungus.

Treatment Details :

Sr. No.	Name of biogents	Sr. No.	Name of biogents
1.	*Trichoderma viride*	6.	*Penicillium spp.*
2.	*T. harzianum*	7.	*Pseudomonas fluorescens*
3.	*T. hamatum*	8.	*Bacillus subtilis*
4.	*T. virens*	9.	Control
5.	*T. asperellum*		

To study the efficacy of bio-agents *in vitro,* trials were laid out in CRD (Completely Randomized Design) with three replications and eight treatments.

For this study, all fungal bio-agents and test pathogen separately grown on potato dextrose agar medium whereas, bacterial antagonists multiplied on NA (Nutrient Agar) media for ten days were used. The mycelial disc of 5 mm diameter of each antagonist and test fungus was cut with sterilized cork borer and placed aseptically at equidistance exactly on opposite ends of Petri plates containing 20 ml potato dextrose agar medium, whereas bacterial antagonists were streaked at one end of the medium with the help of the sterilized metal loop.

Three replications for each treatment were maintained and the plate with only pathogen at the centre, served as control. The plates were incubated at room temperature (28 ± 2°C) and radial growth of the test fungus and the bio-agents was measured by linear measurement.

The observations on colony diameter and sporulation of test fungus were recorded when, Petri plate in control treatment was fully covered with mycelial growth of test pathogen.

The per cent growth inhibition (PGI) of pathogen in each treatment was calculated by following formula (Asalmol *et al*., 1990).

$$I = \frac{C - T}{C} \times 100$$

Where,

I = Inhibition per cent

C = Colony diameter (mm) in control plate

T = Colony diameter (mm) in treated plate

3.2.4.2 *In vitro* evaluation of botanicals/phytoextracts against *A. niger*

1. Selection of test plants

Plant species reported in review with potential antifungal properties against *A. niger* and locally available in the farms and adjoining fields of the campus were collected.

Treatment Details :

Sr. No.	Name of plants	Botanical name of plants	Plant part used	Conc. (%)
1.	Ginger	*Zingiber officinale*	Rhizome	10
2.	Turmeric	*Curcuma longa*	Rhizome	10
3.	Neem	*Azadirachta indica*	Leaves	10
4.	Clove	*Syzygium aromaticum*	Cloves	10
5.	Tulsi	*Ocimum sanctum*	Leaves	10
6.	Nilgiri	*Eucalyptus obliqua*	Oil	10
7.	Ghaneri	*Lantana camara*	Leaves	10
8.	Control	-	-	-

The experiment was laid in CRD. Three replications were maintained per treatment.

2. Processing of plant parts used to test their antifungal properties

For crude extraction, method used by Sinha and Saxena (1989) was followed with slight modifications. Fresh and healthy plant parts (leaves/cloves/rhizomes) collected from fields were washed with distilled water and air-dried.

Hundred gram required plant parts were crushed in 100 ml of distilled water by W/v method with the help of mortar and pestle. The macerate was filtered through double layered muslin cloth followed by Whatman No.1 filter paper using funnel and filtrate was collected in volumetric flasks of 100 ml capacity. Same procedure were followed for each plant extract. The extract obtained in 100 percent concentration.

To obtain its 10 per cent, 90 ml potato dextrose agar was poured in conical flask (100 ml capacity) and 10 ml of standard plant extract poured in each flask with the help of sterilized pipette and thoroughly mixed. PDA medium amended separately with plant extracts was autoclaved and then poured (20 ml / plate) into sterile Petri plates (90 mm dia.) and allowed to solidify at room temperature. For each treatment, three replications were maintained.

Upon solidification of medium, mycelial discs of 5 mm diameter were cut from seven days old culture of *A. niger* with the help of sterilized cork borer. These discs were transferred aseptically to the center of solidified Petri plates of each

treatment. Medium devoid of the plant extract served as a control. All these plates were then incubated at room temperature (27 ± 2°C) for growth of fungus.

The observations on mean colony diameter of the fungus were recorded when the untreated control plates were fully covered with mycelial growth of the test fungus.

The per cent growth inhibition (PGI) of pathogen in each treatment was calculated by the following formula (Asalmol *et al*., 1990).

$$I = \frac{C - T}{C} \times 100$$

Where,

I = Inhibition per cent

C = Colony diameter in control (mm)

T = Colony diameter in treatment (mm)

Data obtained on per cent growth inhibition were subjected to statistical analysis.

CHAPTER V: DISCUSSION

Onion is an important bulb crop. It's easy cultivation and adoption to mild weather and medium soil has made this crop an essential component of cropping system. In the recent past years, a number of storage diseases have been introduced and among these storage rot or black mold rot incited by *Aspergillus niger* was found most dreaded disease responsible for heavy storage losses and was a major constraint in post-harvest management. The storage diseases need to be controlled to maintain both the quantitative and qualitative yield levels. Presently the disease was managed by use of various storage structures but it seems insufficient, thus prompting to search strategies for control the disease by using phytoextracts, bio-agents and solely or in combination of each other to increase the storage health by reducing disease intensity and production cost. Hence, the present study was under taken to evaluate the in vitro efficacy of different phytoextracts and bio-agents against the pathogen *Aspergillus niger* inciting storage rot disease of onion. The results obtained are discussed below :

5.1 Survey of storage rot of onion in Rajgurunagar, Chakan, and Talegaon markets.

Survey was carried in three different locations of Pune districts *viz.,* Rajgurunagar, Chakan and Talegaon vegetable markets to assess the incidence of storage rot disease. The results of present survey substantiate with the results obtained by Adongo *et al*. (2015). They reported more incidence of *Aspergillus niger* fungus during wet season in the markets of Anloga (31.30%) followed by Kwadaso (27.70%), Central (25.20%) and Abinchi (22.50%) which are major markets in Kumasi Metropolis of Ghana.

Ko *et al*. (2002) reported the storage rot in onion were the main cause of storage losses up to 36 per cent. Mohmud and Monjil (2015) reported maximum disease incidence in Pusa Red (14.44%) followed by Faridpuri (11.81%) and Taherpuri (10.45%) varieties, in the month of September.

Chavda (2016) recorded the highest (24.33%) black mould rot incidence in the month of May followed by June (24.17%), April (18.33%), July (15.83%) and August (11%) in garlic bulb. The lowest incidence (7.67%) was logged in the month of September.

About 35 to 40% loss of onion due to damage caused by storage diseases and the fungal bulb rot, *A. niger* imparts to about 15 to 30% losses during storage of different varieties reported by Kumar *et al*. (2015).

5.2 Isolation and pathogenicity of pathogens associated with storage rot of onion.

5.2.1 Isolation

The storage rot disease causal organism, *A. niger* was isolated on PDA medium from diseased bulb showing typical rot symptoms by following standard tissue isolation method. The pure culture of the fungus was maintained on PDA medium for further use. Khokhar *et al*. (2012) successfully isolated *A. niger* on PDA medium from diseased onion bulbs. The pathogen was identified and confirmed as *A. niger* on the basis of morphological and cultural characteristics. Similarly, Srinivasan and Shanmugam (2006) isolated *A. niger* from dried outer scales, fleshy inner scales and rootlets of infected bulbs by tissue isolation technique.

Ara *et al.* (2008) collected diseased onion samples and isolated fungi *viz*., *A. niger*, *A. flavus*, *Penicillium spp*., *F. oxysporum* and *F. moniliforme* from the bulbs, isolated fungi were inoculated with injury and without injury methods.

5.2.2 Pathogenicity

Pathogenicity of isolated fungus was proved by inoculating culture on healthy red onion bulbs with injury and without injury methods. The characteristic symptoms of the disease were observed on bulbs after seventh day of inoculation as bulbs are discoloured black around the neck and affected scales shrivel, which at tenth day developed into streaks of masses of black spores along veins and between outer dry scales. The control bulbs without inoculation of pathogen did not produced any symptoms of storage rot. Upon reisolation the fungus from the artificially inoculated plants yielded the fungal colonies similar to the original one.

Results similar to the present investigation showing typical storage rot symptoms in healthy onion bulbs were reported by Arowora and Adetunji (2014). Chaudhary *et al*. (1994) proved the pathogenicity by dipping healthy surface sterilized onion bulb into spore suspension of *A. niger* for 5 minutes.

Sharma (2012) isolated *A. niger* and proved pathogenic to onion, peanuts, yam, cherry, maize, grapes, banana, tomato and mango fruits.

Muhammed *et al*. (2004) proved the pathogenicity of eight different fungi *viz*., *A. niger*, *Aspergillus ochraceous*, *A. flavus*, *Aspergillus fumigatus*, *Penicillium citrinum* and *Helminthosporium fulvum*, *Curvularia lunata* and *S. rolfsii* and isolated from tomato fruits.

5.3. To study the physiological losses in weight of onion bulbs infected by *Aspergillus niger*.

From the results it was observed that physiological weight of red and white onion bulbs inoculated with *A. niger* progressively decreased as the incubation period is increased over control.

The outcomes of this study are in agreement with the results obtained by Prajapati (2016). He revealed that the onion bulbs inoculated with *A. niger* showed loss in weight as compared to uninoculated bulbs at 15, 30, 60 and 90 days after inoculation. Recorded highest per cent physiological weight loss in Gujarat Anand white onion-3 variety (10.48g and 16.70 %) followed by Nasik yellow (11.54g and 14.45 %) and Nasik red (11.73g 10.59%) 90 days after inoculation.

Maini and Chakravarti (2000) reported 12-25 per cent losses in physiological weight of onion bulbs due to various diseases such as soft rot, blue mold and storage rot. Total losses during storage of 5-6 months were as high as 30-40 per cent.

Ahsanuzzaman *et al*. (2017) recorded weight loss per cent three times with 15 days interval in storage condition. Among six varieties of onion Pusa red variety showed the highest (35.7%) weight loss at 45 days of storage where the lowest (8.7%) was recorded in Zitka.

Kapadiya *et al*. (2013) reported maximum weight loss (5.44 %) in storage rot infected onion bulbs as compare to healthy bulbs (2.66%).

5.4 To evaluate the bio efficacy of bio agents and botanicals against *A. niger in vitro*.

5.4.1 Bioagents

Eight different bioagents were evaluated against *A. niger in vitro* and it was found that bioagents are able to suppress the mycelial growth of test fungus over control.

The results of present study are in agreement with the results obtained by Lone *et al*. (2012). They reported that *Trichoderma harzianum* was the most effective bio-agent against *A. niger* (75% inhibition) in *in vitro*.

Pseudomonas fluorescens and *Bacillus subtilis* can effectively suppress the growth of *A. niger* up to 73 and 60% respectively in dual culture method (Baig *et al*. (2012).

Saranya *et al*. (2018) reported that *T. viride* isolate T6 significantly reduced the growth (78.63%) of *A. niger* followed by the isolate T9 (75.51%). In comparison to this, *B. subtilis* was less antagonistic (61.27%).

Nandeesha *et al*. (2013) evaluated the efficacy of 14 isolates of *Trichoderma spp*. Among them, the isolates TAG-2, TAG-13, and TAG-10 showed maximum mycelial inhibition *i.e.*, 81.36%, 78.51% and 75.97% respectively against *A. niger*.

Gajendra and Vakharia (2012) revealed that, *Trichoderma viride* was more effective (86.2% inhibition) against *A. niger* than *T. harzianum*. (80.4% inhibition).

5.4.2 Phytoextracts

Seven phytoextracts (10 %) were screened against the mycelial growth of *A. niger in vitro* following the standard poisoned food technique (Nene and Thapliyal, 1979). The observations on the mycelial growth were recorded after seven days of incubation and the results obtained are presented in Table 4.4.

The results of present study are in agreement with the results obtained by Saranya *et al*. (2018). They reported mycelial inhibition against test fungus by *Ocimum sanctum* leaf extract (62.97%), *Zingiber officinale* rhizome extract (62.26%) and *Lantana camera* leaf extract (61.59%).

Saifeldin *et al*. (2016) screened the *in vitro* ability of dry bud extract of *Syzygium aromaticum* against soft rot of onion caused by *A. niger* and recorded 96% inhibition in spore germination.

Pudake *et al*. (2018) studied seven botanicals @10% concentration against *A. niger* and reported eucalyptus oil exhibited 100% inhibition of mycelial growth. They were followed by leaf extract of *O. sanctum* (92.74%), *Azadirachta india* (76.10%) extract.

Futane *et al*. (2018) evaluated nine botanicals against *A. niger* and it was found that maximum mycelial growth inhibition was recorded with *Allium sativum* (50.99%) followed by *O. sanctum* (29.22%), *A. indica* (23.90%), and least growth inhibition was recorded by *L. camara*, *Z. officinale* as against untreated control.

CHAPTER VI: SUMMARY AND CONCLUSION

Present investigations on "Studies on storage rot of onion caused by *Aspergillus niger* Van Tieghem" was carried out in the Department of Plant Pathology at College of Agriculture, Dapoli Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during, the year 2019-21. The summary of the research work carried out and conclusions drawn are described hereunder.

The study was undertaken with an aim to find out the incidence of storage rot at different markets, physiological weight loss of *A. niger* inoculated onion bulbs and to explore different bioagents and botanicals for effective management of disease under laboratory conditions.

The fungus incitant with naturally storage rot infected onion bulbs were isolated on potato dextrose agar medium by tissue isolation technique to obtain the culture of pathogen. The culture thus obtained was further purified and maintained by periodical transfer on PDA slants throughout the study. Pathogenicity of the fungus was proved following Koch's postulates and the pathogenic fungus was identified as *Aspergillus niger*.

In, *in vitro* evaluation of bio-agents, *Trichoderma harzianum* was emerged as the potential antagonist of *A. niger* which showed 81.11 per cent mycelial inhibition of the fungus and was followed by *T. virens* (78.22%) and *T. hamatum* (72.66%). While, *T. viride* (64.88%), *T. asperellum* (61.88%) and Bacillus subtilis (57.77%) were less effective in inhibiting the mycelial growth of *A. niger* followed by *Pseudomonas fluorescence* (55.55%) and *Penicillium spp*. (40.77%).

All the plant extracts tested in vitro for their efficacy against *A. niger* showed inhibitory action against storage rot pathogen. Nilgiri oil was expressed complete inhibition of A. niger. Plant extract of *Zingiber officinale*, *Azadirachta indica*, *Ocimum sanctum*, *Curcuma longa* and *Syzygium aromaticum* were also found effective against the test pathogen which showed 94.44%, 69.33%, 64.88%, 62.22% and 61.11% inhibition, respectively. Leaf extract of *Lantana camara* (49.67%) was poor in inhibiting *A. niger*.

Studies on physiological weight loss of onion bulbs infected with *A. niger* were carried out and the results revealed that bulbs inoculated with *A. niger* showed loss in weight as compared to uninoculated bulbs at 15, 30, 45 and 60 days after

inoculation. Maximum physiological weight loss was recorded in white onion (11.25g and 22.87%) followed by red onion (10.27g and 10.41%), after 60 days of inoculation (DAI). From the results, it was observed that white onion is more susceptible to the *A. niger* as compare to red onion as it has more catechol (phenol) than white onion.

Survey was carried out to assess the incidence of storage rot in the different vegetable markets and *Aspergillus niger* was recorded at Shri. Chhatrapati Shivaji Maharaj market yard, Rajgurunagar, Chakan Bhaji Mandai and Vegetable market, Talegaon. The highest storage rot incidence was recorded in December (28.33%) followed by November (26.33%), October (20.33%) and July (19.83%). While, lowest storage rot incidence was recorded in August (13.50%) followed by September (15.16%).

Thus, from the present investigation it is concluded that, *Aspergillus niger* is responsible for storage rot or black mold disease in onion and it is one of major threat to onion storage. Physiological weight loss of bulbs, occurs over a period of time inoculated with *A. niger*. The bioagent *Trichoderma harzianum* successfully inhibits the mycelial growth and sporulation of the pathogen *in vitro*. Various botanicals also play important role in mycelial growth inhibition. Any of these two control measures can be used to manage the disease under storage conditions.

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APPENDIX – I

ANOVA for *in vitro* evaluation of bioagents against *Aspergillus niger*

SOURCE	DF	SS	MSS	FCAL	F TAB 5%	F TAB 1%	RESULT
TREATMENT	8	118.399	14.7998	243.655	2.51016	3.70542	SIG
ERROR	18	1.09333	0.06074	-	-	-	-
TOTAL	26	119.492	-	-	-	-	-

SEm ±	0.14229
CD at 5%	0.42277
CD at 1%	0.57923
CV %	6.362

APPENDIX – II

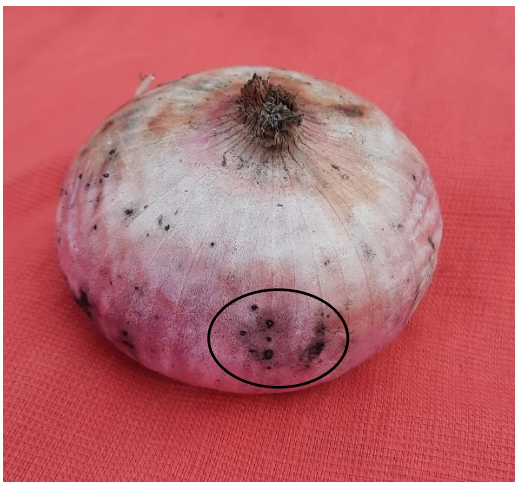
ANOVA for *in vitro* evaluation of phytoextracts against *A. niger*

SOURCE	DF	SS	MSS	FCAL	F TAB 5%	F TAB 1%	RESULT
TREATMENT	7	159.1983	22.74262	1137.131	2.657197	4.025947	SIG
ERROR	16	0.32	0.02	-	-	-	-
TOTAL	23	159.5183	-	-	-	-	-

SEm ±	0.08165
CD at 5%	0.24447
CD at 1%	0.33726
CV %	4.211

LIST OF PLATES

PLATE I



a) Black spore masses develop as streaks along veins and between outer dry scales

b) Pure culture of *Aspergillus niger* on Potato dextrose agar

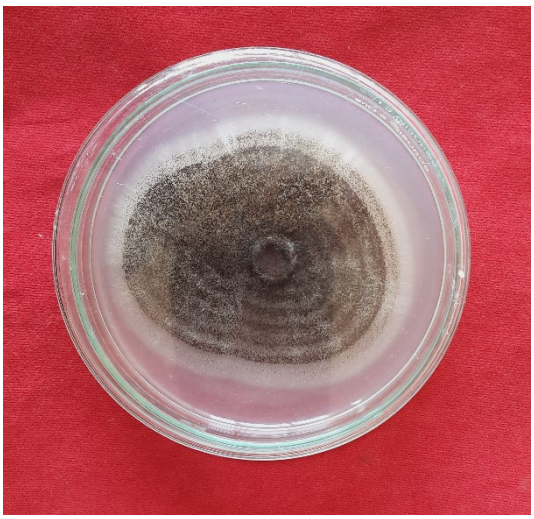
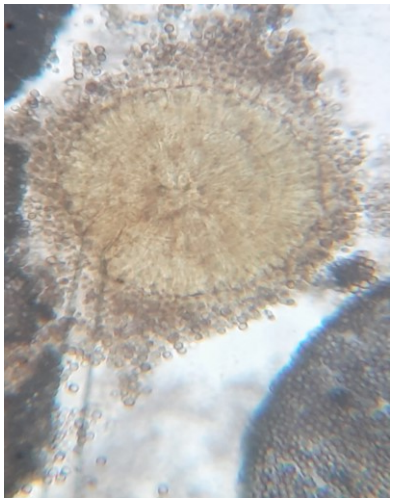


PLATE II

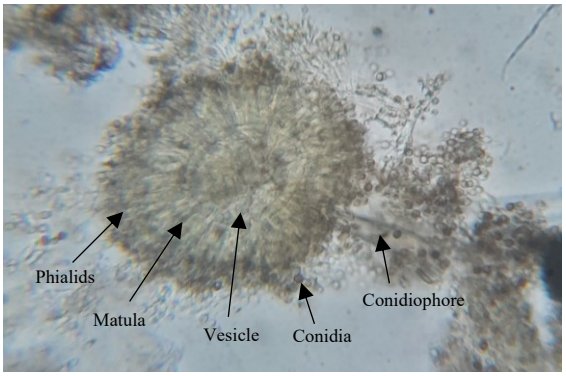
Pathogenicity test of *Aspergillus niger* on onion bulb

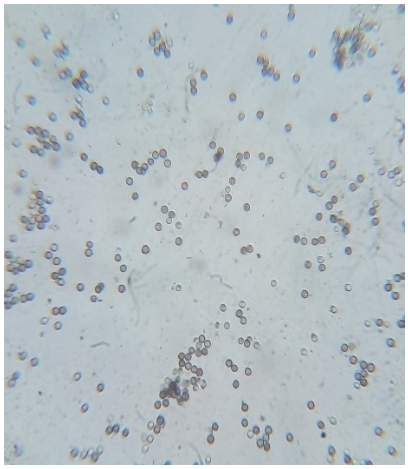
PLATE III



a) Photomicrograph of vesicle releasing conidiospores of *A. niger*

b) Photomicrograph of head of *A. niger*



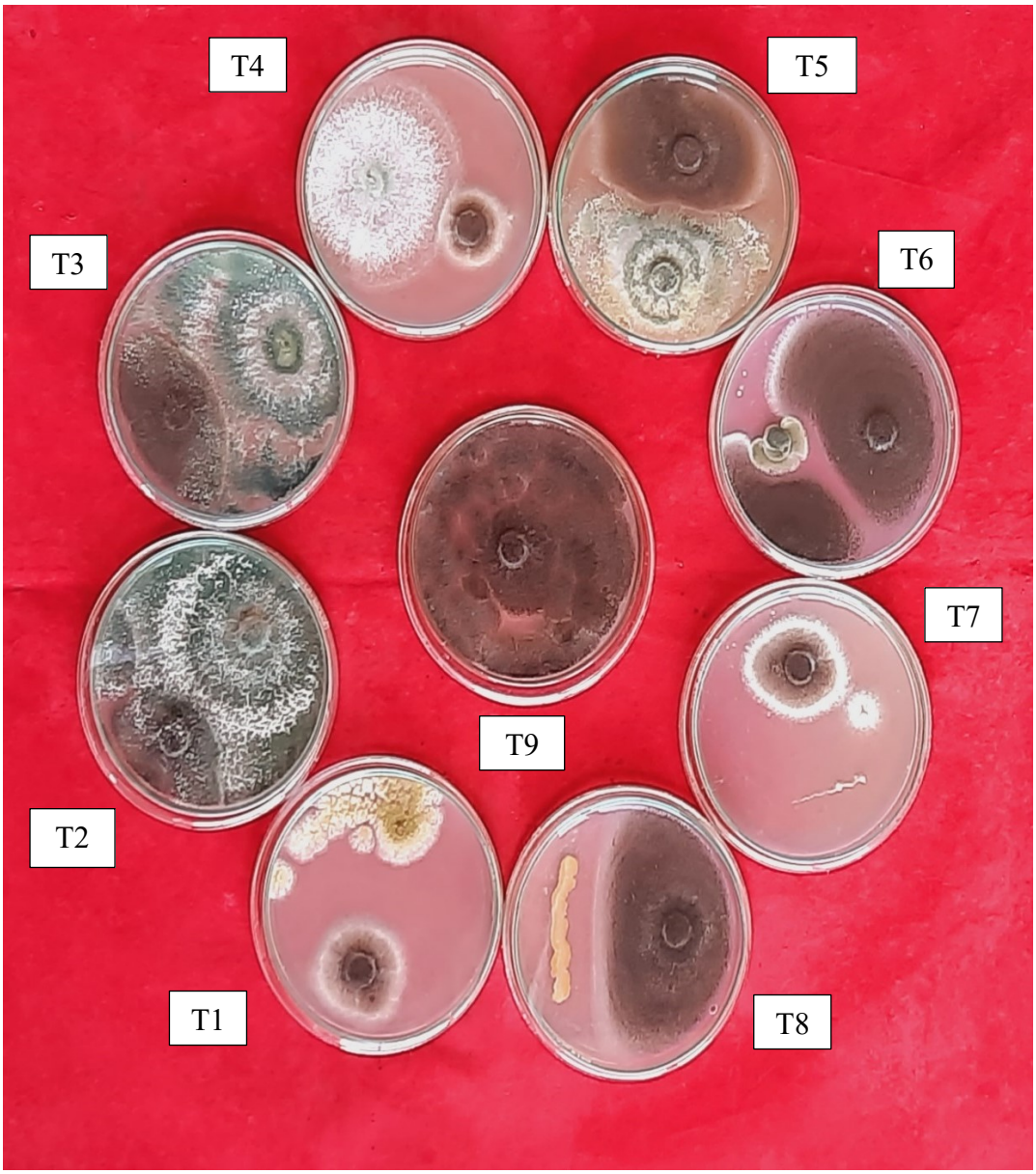


c) Photomicrograph of spores of *A. niger*

PLATE IV

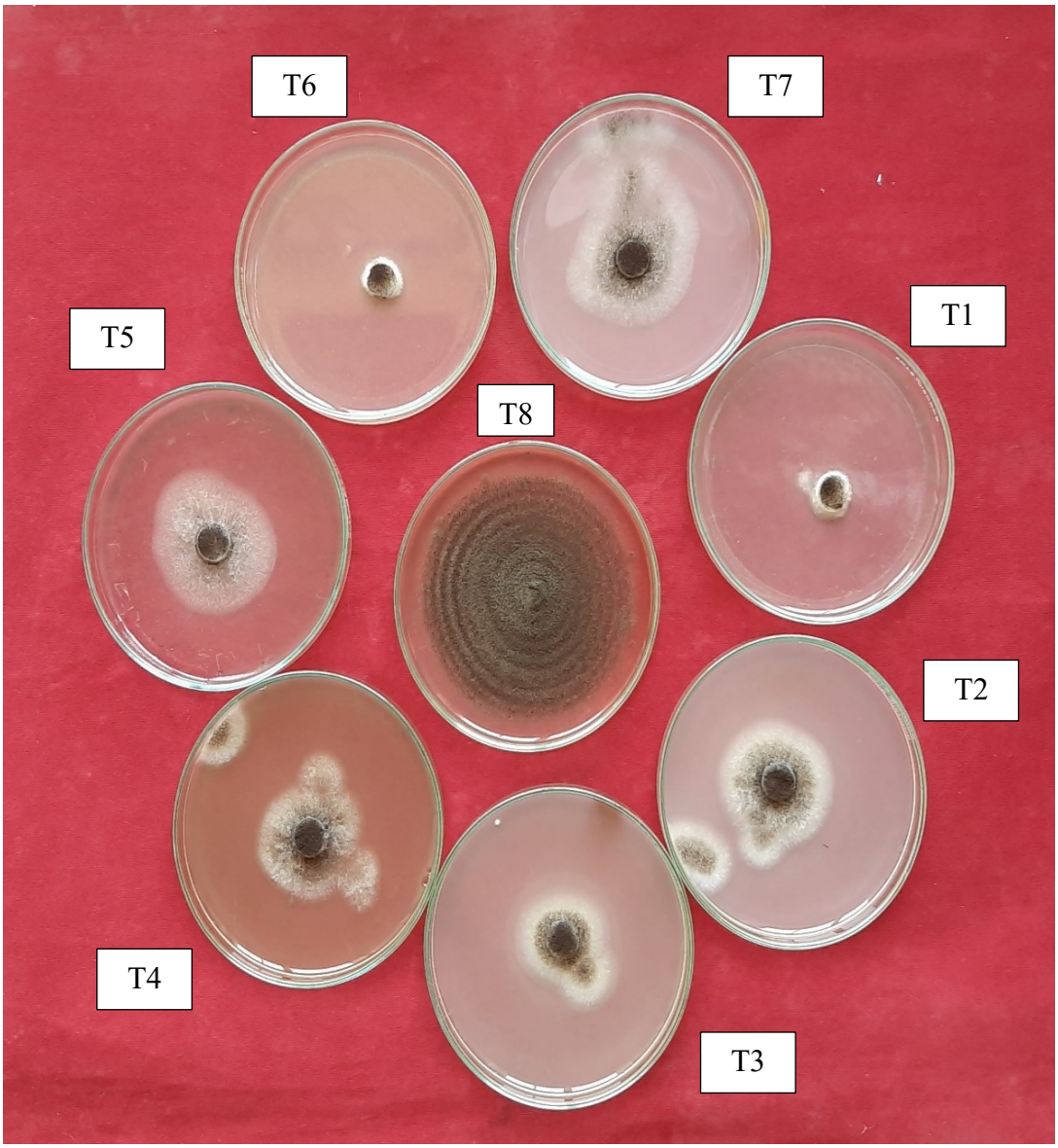
Bulbs before and after inoculation of *A. niger*

PLATE V



In vitro* evaluation of bioagents against *A. niger

PLATE VI



In vitro evaluation of phytoextracts against *A. niger*

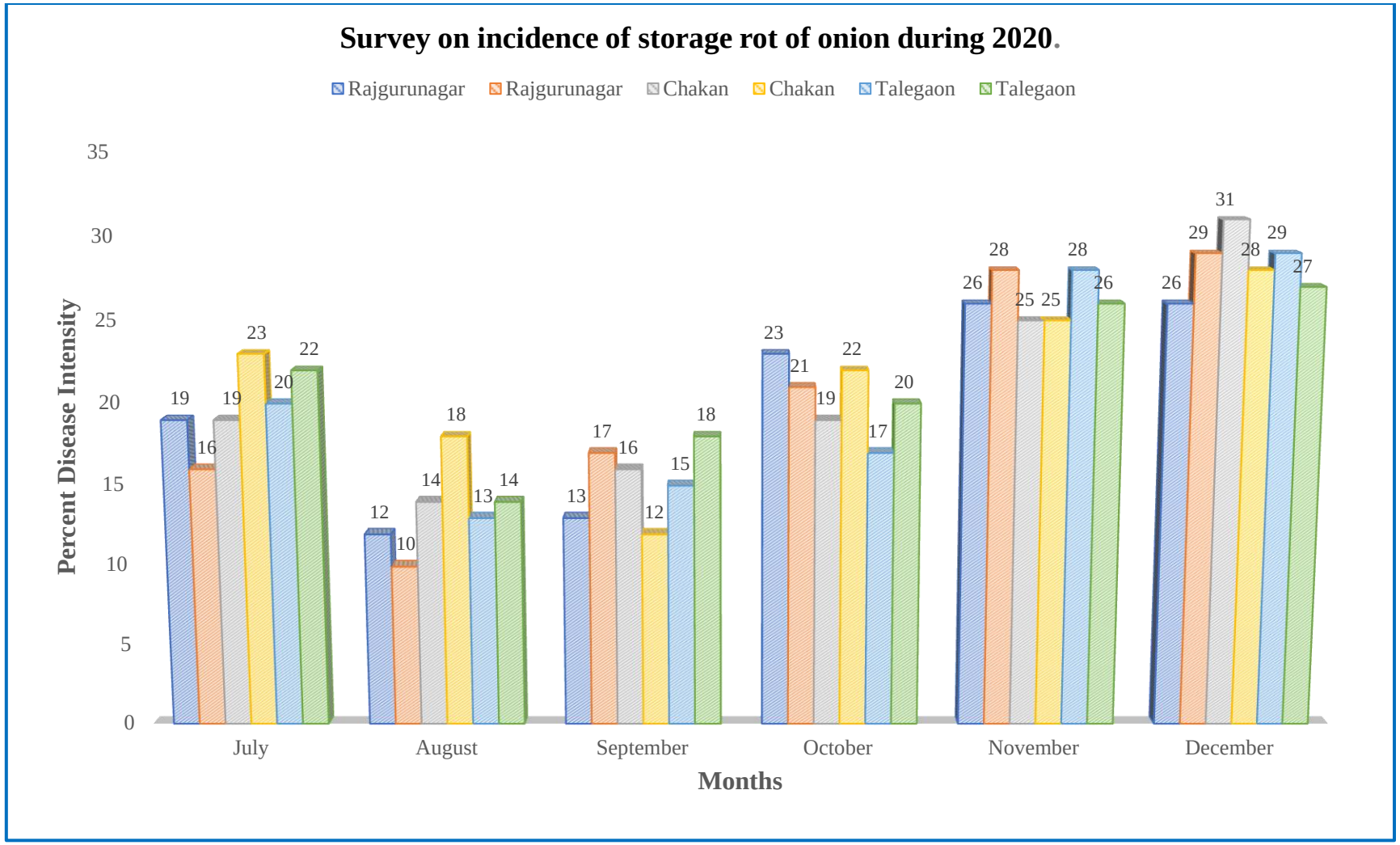


Fig. 1: Survey on incidence of storage rot of onion during 2020.

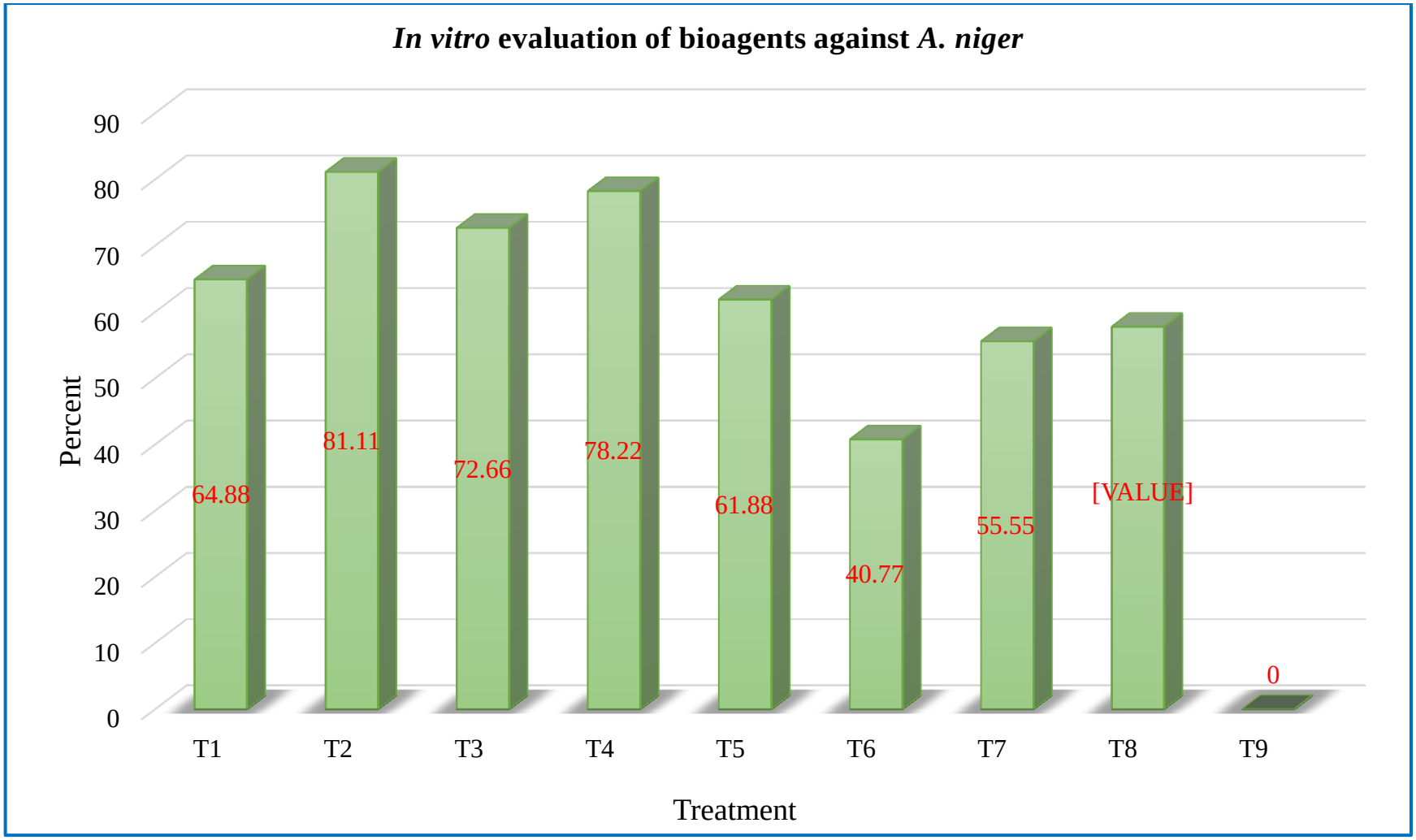


Fig. 2: *In vitro* evaluation of bioagents against *A. niger*

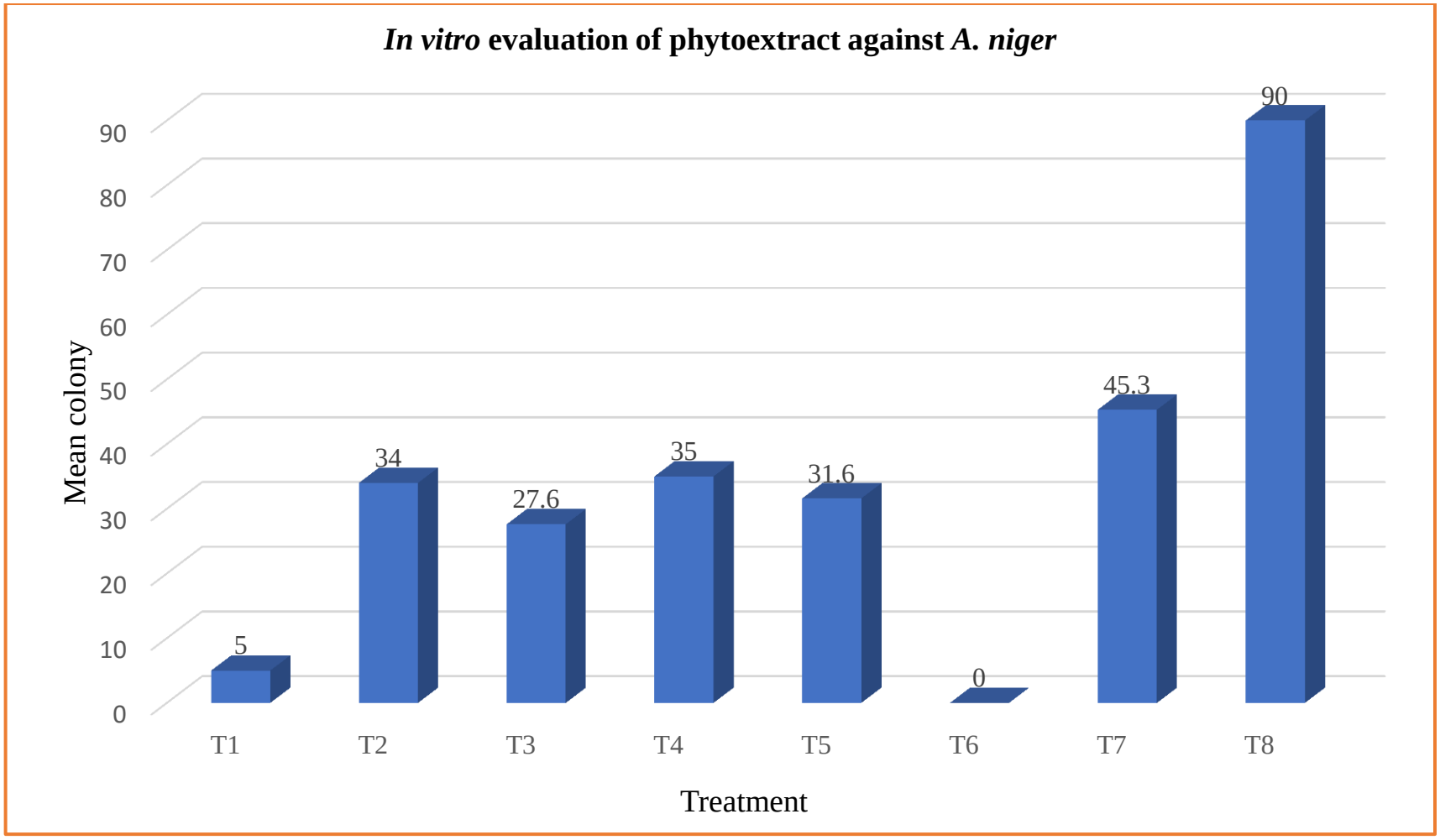


Fig. 3: *In vitro* evaluation of phytoextract against *A. niger*

LEGENDS

PLATE-V & Table No. 3

In vitro evaluation of bioagents against *A. niger*

Tr. No.	Bioagents used
T1	*Trichoderma viride*
T2	*T. harzianum*
T3	*T. hamatum*
T4	*T. virens*
T5	*T. asperellum*
T6	*Penicillium spp.*
T7	*Pseudomonas fluorenscence*
T8	*Bacillus subtilis*
T9	Control

LEGENDS

PLATE-VI & Table No. 4

In vitro evaluation of phytoextract against *A. niger*

Tr. No.	Treatments	Concentration
T_1	*Zingiber officinale*	10%
T_2	*Curcuma longa*	10%
T_3	*Azadirachta indica*	10%
T_4	*Syzygium aromaticum*	10%
T_5	*Ocimum sanctum*	10%
T_6	*Eucalyptus globules*	10%
T_7	*Lantana camara*	10%
T_8	Control	-

VITAE

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1.	SSC	2013	Maharashtra State Board of Secondary and Higher Secondary Education, Pune	86.55
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CHAPTER I: INTRODUCTION 1. Background information :

The

as well as in India. Onion is a significant underground bulb vegetable crop of tropical & sub-tropical countries (Thompson & Kelly, 1979). According to Vavilov (1951), the primary centre of origin of onion lies in Central Asia. It is probably a native of Asia comprising North West India, Baluchistan and Afghanistan. The genus Allium is very large comprising of more than 500 spp. usually perennial bulbous plants. Among these, Allium cepa is the major cultivated species grown all over the world.

Area under onion cultivation in India was 12.20 lakh ha with annual production of 228.19 lakh MT during 2018-2019 with productivity of 18.70 tones/ha (APEDA, 2019-20). In world rank, India comes after China in production as well as in productivity of onion bulbs. On the behalf of this, there is a lot of demand for the Indian onions in the world market. In the year 2019-2020, the country had exported 11.50 lakh MT of fresh onions worth Rs.2320.70 crores (Anonymous, 2020). Onion export from India to Dubai recorded the maximum onion shipments in UAE. The other major onion export destinations of India are Sri Lanka, Indonesia, Saudi Arabia, Kuwait, Qatar, Germany, Bangladesh and United Kingdom. In India, onion crop has two cycles, first harvesting starts in November to January and the second from January to May. Maharashtra is the major onion growing state in the country with an area of 5.08 lakh ha under this crop and average annual production of 53.55 lakh MT. Madhya Pradesh ranks second with 1.50 lakh ha (38.59 lakh MT) followed by Karnataka 1.95 lakh ha (31.97 lakh MT), Gujarat 22.5 thousand ha (13.03 lakh MT), Rajasthan 64.7 thousand ha (12.92 lakh MT) and Bihar 53.77 thousand ha (12.49 lakh MT). Maharashtra contributes 28.32% to the total annual onion production of the country (Anonymous, 2020). The principal onion growing districts in the Maharashtra State are Satara, Nashik, Jalgaon, Pune, Solapur and Ahmednagar occupying about 94.68 per cent of area under cultivation of onion. Red onion is used for domestic consumption and export while the white onion is used mostly for processing (Lawande et al., 2009). The major varieties found in India are Nashik Red, Agrifound Dark Red, Agrifound Light Red, NHRDF Red, Agrifound White, Agrifound Rose, Agrifound Red, Pusa Ratnar, Pusa Red, Pusa White Round, etc. There are certain varieties in yellow onion which are suitable for export in European countries viz., Tana F1, Arad-H, Suprex, Granex 55, HA 60 and Granex 429. The local name of onion is state wise different. It is known as Kanda (Marathi) and Piyaz, Piaj, Ulli, Vengayan, Erangagam, Erulli, Dungli, Ganda, Payaz, etc. in other states. The bulb develops underground it is popularly used at both immature as well as mature stages as vegetable or as a spice. Processed product is marketed in the form of onion slices or powder. The nutritive value of onion varies according to the variety but generally it contains 89.11g moisture, 1.1g protein, 0.1g lipids, 0.4g minerals, 1.7g fiber, 0.34g carbohydrate, 4.24g sugar total, 40Kcal energy, 0.99g sucrose, 0.35g ash, 23mg calcium, 29mg phosphorous, 0.21mg iron and 7mg vitamin C (Pareek et al., 2017). The pungency of onion is due to a volatile oil known as Allyl propyl disulphide (C3H5S2C3H7) which acts as gastric stimulant and promotes digestion. Besides this it has very good medicinal value, as it contain phenols, flavonoids etc. that have anti-inflammatory, anti-cholesterol, anti-cancer and antioxidant properties. Onion is very much useful to protect from sunstroke in summer. Onion crop suffers from many diseases at different growth stages which cause considerable losses in crop yields. Table 1. Important field and post-harvest diseases of onion Sr. No. Name of Disease Causal organism

1. Purple blotch Alternaria porri

2. Botrytis leaf blight Botrytis squamosa

3. White rot of Onion Sclerotium cepivorum

4. Downy mildew Peronospora destructor

5. Black mould Aspergillus niger

6. Bacterial soft rot Erwinia carotovora subsp. carotovora

7. Green mould Penicillium spp.

8. Bacterial brown rot Pseudomonas spp.

Storage rot/black mould rot is a serious disease of onion. Ko et al., (2002) reported up to 36% losses of bulbs by the infection of Aspergillus niger.

the red and pink onions. The phenol content in white onions is very low and therefore they are prone to the infection of Aspergillus. Onion storage rot disease causes extensive losses in storage and transit under tropical conditions (Thamizharasi and Narsimham, 1992). Aspergillus niger is a cosmopolitan fungus mainly responsible for spoilage and bio-deterioration of food material (Samson et al., 2004). Being a saprophytic with filamentous growth, Aspergillus niger perpetuates in soil, forage, plant debris and food products (McDonald et al., 2004). Temperature within a range of 28°C–34°C coupled with humid conditions is conducive for infection of this fungus (Tyson and Fullerton, 2004). Strains of Aspergillus niger are used in manufacture of several acids like citric acid, gluconic acid, itaconic acid etc. Inhalation the spores of this fungus can be dangerous as it may result in severe lung problems further terminating in Aspergillosis. Culture filtrates of Aspergillus niger exhibited phyto-toxicity in onion and tomato by reducing seed germination and root elongation (Narayana et al., 2007). 2. Importance and need of study : Among all the post-harvest diseases of onion, storage rot disease occurs in more or less proportions every year and causes severe damage to the quality of bulbs. To overcome such losses by proper post-harvest disease management practices, this maiden attempt was carried out. 3. Objectives of the study : The present study is an effort to revealed the importance of storage rot incited by Aspergillus niger pathogen under the following objectives:

• Survey of storage rot of onion in Rajgurunagar, Chakan and Talegaon markets.

• Isolation and pathogenicity of pathogens associated with storage rot of onion. • To study the physiological weight losses of onion bulbs infected by Aspergillus niger. • To evaluate the bio efficacy of bio agents and botanicals against Aspergillus niger in vitro. 4. Hypothesis or assumptions : The findings of present study will determine the incidence of storage rot disease in onion markets, compare loss in weight occurred due to storage rot pathogen in red and white onion and also find out an effective organically management practice by using botanicals and bioagents in vitro condition which may need further study in field condition for their effectiveness in in vivo condition. 5. Scope and limitations of the study : Scope : The present study has scope in relevance to the management of post-harvest losses in onion production due to biotic factors. The storage rot disease of onion caused by various factors among them A. niger is important biotic factor. Present study open the doors for effective management of pathogen by beneficial microorganisms and also non chemical fungistatic agents. The inoculation of A. niger on white onion and red onion shows difference in physiological weight loss due to less or more catechol (phenolic) content. Limitations : Onion can be eaten as raw so for management of storage rot pathogen ecological methods like botanical and bioagents are quite suitable rather than any chemical methods.

CHAPTER II: REVIEW OF LITERATURE Aspergillus niger is an extremely destructive fungal pathogen that causes severe losses of onion bulbs at storage condition (Khatoon et al., 2017). The literature available on storage rot of onion under the all aspects studied survey of incidence of pathogen, symptomatology, isolation and pathogenicity, physiological weight loss of infected bulbs and in vitro evaluation of bioagents and botanicals was reviewed and presented here under the following sub-heads.

2.1. Survey of storage rot of onion. Currah and Proctor (1990) surveyed on specific problems on onion production and storage in tropical and sub-tropical regions and indicated that storage losses were serious in 44 out of 72 tropical countries and 19 Asian countries out of 21. Kaur and Verma (2002) reported 20% losses of citrus fruits in Punjab markets due to black mold rot caused by A. niger. Ko et al., (2002) observed that the black mould, soft rot and basal rot were the main causes of storage losses to the extent of 36, 25 and 14 per cent, respectively in onion.

conditions and recorded loss of 2.9% to 12.09% onion bulbs during the months of June to February. Muhammed et al., (2004) surveyed the Central market, Kasuwar daji, Mabera, Minanata and Arkilla markets of Sokoto in northwestern Nigeria in 2001 and 2002 for diseases and aflatoxin contamination of tomato fruits. Panchal (2008) carried out survey on post-harvest diseases of tomato at vegetable market, Anand during 2007 to 2008 revealed the presence of five pathogenic rots viz., Alternaria (19.7%), Rhizopus (4.59%), Aspergillus (3.44%), Penicillium (2.6%) and Fusarium (2.2%), respectively. Bhale (2011) observed several fungal microorganisms, among them A. niger, Rhizoctonia solani (Kuhn), Geotrichum candidum Link and Penicillium spp. were found major disease causing organisms in the markets of Osmanabad. Gautam et al., (2011) reported that A. niger an important spoilage fungi associated with various plant diseases resulting in huge economic loss.

for collar rot (Sclerotium rolfsii) disease of groundnut crop

tahsil. Adongo et al., (2015) were conducted a survey of fungi associated with onion bulb deterioration and reported more incidence of black mold fungus during wet season in the markets of Anloga (31.3%) followed by Kwadaso (27.7%), Central (25.2%) and Abinchi (22.5%) from Ghana. Kumar et al., (2015) reported about 35 to 40% loss of onion due to damage caused by storage diseases and the fungal bulb rot (A. niger) imparts to about 15 to 30% losses during storage of different varieties. Mohmud and Monjil (2015) collected diseased onion bulbs of varieties Taherpuri, Faridpuri and Pusa Red (Indian) from three markets of Mymensingh, Naogaon and Shatkhira districts in Bangladesh and reported maximum disease incidence in Pusa Red (14.44%) followed by Faridpuri (11.81%) and Taherpuri (10.45%) in the month of September. Chavda et al., (2016) carried a survey of storage diseases of garlic in Anand, Petlad, Borsad markets in Gujarat and reported that the highest (24.33%) black mould rot incidence in the month of May followed by June (24.17%), April (18.33%), July (15.83%) and August (11%). The lowest incidence (7.67%) was recorded in the month of September. Kumari and Singh (2017) reported 13.09 to 52% collar rot infection.

soil (43%) in different tehsils of Sikar and Jaipur. Orpin et al., (2017) observed 100 samples for spoilage of onion bulbs and found that highest frequency of occurrence of Escherichia coli (25.00%) and the lowest was Pseudomonas sp. (9.38%), whereas A. niger had the highest frequency of occurrence (18.75%) and the lowest was Mucor (6.25%). Elias et al., (2019) collected rotten onion bulbs of

Symptomatology Walker (1952) found that black powdery mass of spores of A. niger are borne on exterior of the scales of onion bulbs and can be easily rubbed off. Raju and Raj (1980) observed two types of typical symptoms in the rotted bulbs

caused by A. niger and Erwinia caratovora. They observed dry scales of affected onion bulb with black conidial mass formed by A. niger, in combination with rotting of onion bulbs and offensive odour. Abundant spore masses of Aspergillus spp. were observed on the outer two or three scales, usually arranged along the veins. Tiwari et al., (1984) studied how the fungus A. niger initially infects the outer scales of onion bulbs and further penetrates into the inner scales and produces large number of dark black color conidial masses which can be visible with naked eyes. Rao and Rajasab (1992) reported that clusters of black spores of A. niger

onion bulbs. Salvestrin and Letham (1994) observed that in the favorable conditions, the sporulation of A. niger takes place after 24hrs. Infected tissue of onion bulbs with A. niger initially has a water soaked appearance, later gradually dry and shrivel (Sinclair and Letham, 1996). Ko et al., (2002) noted that the A. niger infected onion bulbs show blackening of the neck and black mycelial streaks beneath the outer scales, comprise black powdery spore mass. Bagwan (2011) reported that collar rot and aflarot in mango caused by A. niger and A. flavus respectively. Prajapati and Patil (2015) studied the symptomatology of black mould rot of onion incited by A. niger. They reported that the symptoms

and may develop a black discoloration at the neck. 2.3. Isolation and Pathogenicity Thom and Raper (1939) isolated A. niger by using tissue isolation method and found good mycelial growth on Czapek's medium followed by potato dextrose and malt agar. Chaudhary et al., (1994) proved the pathogenicity by dipping healthy surface sterilized onion bulb into spore suspension of A. niger for 5 minutes. Koycu and Ozer (1997) obtained good fungal growth of A. niger and F. oxysporum f. sp. cepae from naturally infected onion bulbs. Muhammed et al., (2004) proved the pathogenicity of eight different

isolated from tomato fruits and found that A. niger,

Srinivasan and Shanmugam (2006) isolated A. niger from dried outer scales, fleshy inner scales and rootlets of infected bulbs by tissue isolation technique and proved the pathogenicity of same. Ara et al., (2008) collected diseased onion samples from different markets of Mymensingh (Bangladesh) and found fungi viz., A. niger, A. flavus, Penicillium spp., F. oxysporum and F. moniliforme from the bulbs. Isolated fungi were inoculated with injury and without injury methods. Kharwar et al., (2008) isolated A. niger from Catharanthes rosea (Sadafuli) as an endophytic fungus which can alter its metabolite production. Gautam et al., (2011) reviewed the diversity, toxicology and pathogenicity of A. niger in plants and humans. Wani and Taskeen (2011) found A. niger Van Tieghem was associated with black mold rot of onion, on the basis of its morphological characteristics. Sharma (2012) reported that A. niger is pathogenic to onion, peanut, yam, cherry, maize, grape, banana, tomato and mango fruits. Khokhar et al., (2012) successfully isolated A. niger on PDA medium from diseased onion bulbs showing typical black mould rot symptoms by tissue isolation method. The pathogen was identified and confirmed as A. niger on the basis of morphological and cultural characteristics. Doullah et al., (2014) isolated A. niger, A. flavus, Penicillium spp., F. oxysporum and F. moniliforme fungi from rotted onion bulbs by employing tissue isolation method on PDA medium. Arowora and Adetunji (2014) found the A. niger in rotted onion bulbs. The fungal cultures obtained were identified on the basis of cultural and morphological characteristics. Pathogenicity test confirmed the

involvement of A niger in rotting. Parveen et al., (2014) studied the incidence of fungal rot of pear fruits and isolated the A. niger causing black mold rot of pear in Kashmir Valley of India. Jidda and Benjamin (2016) revealed that A. niger and Fusarium spp. were in both white and red varieties of onion, while Sclerotium cepivorum, R. stolonifer and Scopulariopsis brevicauli were found to be associated with white bulbs only. Kumar and Chahal (2016) successfully isolated twenty isolates of A. niger from diseased fruits of pomegranate and morphologically characterized. All the twenty isolates were inoculated on five cultivars of pomegranate (Ganesh, Ruby, Bhagwa, Jyoti and Mridula) for pathological characterization. Khatoon et al., (2017) reported the association of A. flavus and A. niger with rotten bulbs of onion and A. niger, Penicillium sp. and Rhizopus oryzae with rotten garlic by tissue isolation technique on PDA. Kumari and Singh (2017) isolated and proved the pathogenicity of A. niger causing collar rot, soil born disease of groundnut crop Uddin et al., (2019) collected diseased onion samples from different regions and isolated A. niger, major pathogen associated. 2.4. Physiological losses in weight of onion bulbs infected by A. niger. Kulfinski et al., (1973) reported that the black mold of onion, caused by A. niger Van Teigh.,

Maini and Chakravarti (2000) reported 12 to 25% losses in physiological weight of onion bulbs due to various diseases such as soft rot, blue mould and black mould. Sheth (2008) showed the severity of Aspergillus fruit rot (A. niger) disease in citrus fruits, in cork-borer wounding (52.00%) method followed by pin-prick (47.25%) method. Ghangaonkar (2013) analyzed significant loss in weight of white and red onion bulbs by artificially inoculated with A. niger and F. oxysporium. Kapadiya et al., (2013) reported that the maximum weight loss (5.44%) of onion bulbs was due to the infection of A. niger. Mohmud and Monjil (2015) carried out an experiment to analyze the weight loss of onion of varieties Pusa Red, Taherpuri and Faridpuri and reported significant loss of weight in Faridpuri (78.67 g/Kg) onions in October followed by Taherpuri (69.67 g/Kg) and least loss was recorded in Pusa Red (32 g/Kg) in the month of May. Chavda (2016) reported that garlic

Results revealed that the highest

after 60 days of inoculation. Prajapati (2016) revealed the

inoculation. Ahsanuzzaman et al., (2017) had conducted an experiment to assess the weight loss of onion bulb in storage condition. Weight loss per cent was recorded three times with 15 days interval of days of storage. Among six varieties of onion Pusa red variety showed the highest (35.7%) weight loss at 45 days of storage where the lowest (8.7%) was recorded in Zitka. 2.5. Evaluation of bioagents and botanicals against the pathogen. Bhosle et al., (2008) analyze the use of botanicals against leaf blight of onion in vivo and found that among botanicals Lantana camera and Pongamia pinnata were found effective and gave 27.08% and 22.44% disease control, respectively. Avasthi et al., (2010) evaluated the efficacy of eight commonly used spices of medicinal plants against the mycelial growth of A. niger isolated from onion using

poisoned food method. Among all botanicals tested Syzygium aromaticum L. (dry flower bud) and Allium sativum L. (bulb) extracts @20% found effective in inhibiting the complete mycelial growth of A. niger. Lone et al., (2012) reported that under in vitro Trichoderma harzianum was the most effective bio-agent against A. niger (75% inhibition) followed by in Cladosporium sphaerospermum (72.2% inhibition). Bacillus subtilis was less effective against A. flavus and A. terreus. Baig et al., (2012) found that Pseudomonas fluorescens and Bacillus subtilis can effectively suppress the growth of A. niger up to 73 and 60%, respectively in dual culture method. Gajendra and Vakharia (2012) revealed that, Trichoderma viride was more effective (86.2% inhibition) against A. niger than T. harzianum (80.4% inhibition). Khokhar et al., (2012)

95%	MATCHING BLOCK 16/103	W	https://doi.org/10.2478/v10146-012-0003-5

observed that the Penicillium species completely overgrew the A. niger colony. The study also revealed that some species of the genus Penicillium possessed a high antagonistic effect on the onion black rot pathogen.

Bashir et al., (2013) reviewed

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the antifungal activity of aqueous and ethanol extracts obtained from seed and leaf of Jatropha curcas in vitro against A. niger

which revealed that the mycelial growth of A. niger was suppressed by 65.7 and 57 per cent, respectively

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at 160mg/ml. The in vivo study showed that aqueous extracts of seed and leaf reduced rot development by 59.4 and 54.4 % in onion bulbs.

Bhushan et al., (2013) studied antagonistic activity B. subtilis and Pseudomonas fluorescens

80%	MATCHING BLOCK 20/103	SA	STUDIES ON SEEDBORNE MYCOFLORA OF SELECTED VEG ... (D33775063)

against A. flavus, A. fumigatus, A. niger, A. terreus and F. oxysporum of Pennisetum americanum

and observed that B. subtilis antagonistic isolate was able to significant reduction in seed-borne mycoflora than P. fluorescens.

74%	MATCHING BLOCK 18/103	W	http://14.139.51.37/centrallibrary/admin/book/ ...

Nandeesha et al., (2013) evaluated the efficacy of 14 isolates of Trichoderma spp. Among them, the isolates TAG-2, TAG-13, and TAG-10 showed maximum mycelial inhibition i.e., 81.36%, 78.51% and 75.97%, respectively against A. niger.

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Mokhtar and Dehimat (2014) tested in vitro and in vivo capability of T. harzianum to control the Rhizopus soft rot of tomato fruits (Lycopersicon esculentum). In in vitro condition T. harzianum

showed 43.66% inhibition, whereas in in vivo 82.86% inhibition of the mycelial growth of R. stolonifer after seven day of the experiment. Jagtap and Suryawanshi (2015) tested eleven bioagents against Fusarium oxysporum f. sp. cepae causing basal rot disease in onion. Among them, T. viride was found most effective (78.88%) followed by T. harzianum (73.33%). B. subtilis (23.75%) and P. fluorescens (12.85%) was observed with less inhibition of F. oxysporium f. sp. cepae. Saifeldin et al., (2016) studied the in vitro ability of seed extract of Prunus mahaleb and resin extract of Commiphora myrrha at different concentration also dry bud extract of Syzygium aromaticum and root extract of Panax ginseng against soft rot of onion caused by A. niger. Among them, Syzygium aromaticum recorded 96% inhibition in spore germination and was at par with

Prunus mahaleb (96%) while remaining two extracts recorded 88% inhibition. Alka et al., (2017) carried out study to know the efficacy of various antagonists and its culture filtrates against

conditions. Among six antagonists

in vitro and inhibition of mycelial growth of R. oryzae was recorded 0.45 and 0.45 % in pre-inoculation and post-inoculation 0.45 and 0.45% in post-inoculation treatments. Saranya et al., (2018) reported that T. viride isolate T6 significantly reduced the growth (78.63%) of A. niger followed by the isolate T9 (75.51%). In comparison to this, B. subtilis was less antagonistic (61.27%). They also reported that among eight phyto-extracts maximum inhibition (71.19%) was found in Lawsonia inermis followed by, Ocimum sanctum (62.97%), Zingiber officinale (62.26%) and Lantana camera (61.59%). Minimum inhibition of the test fungus was recorded in Jatropha curcas (53.20%). Pudake et al., (2018) evaluated seven botanicals @10% concentration against A. niger. Among all botanicals garlic clove extract and eucalyptus oil cent per cent inhibition of mycelial growth. They were followed by leaf extract of O. sanctum (92.74%), Azadirachta india (76.10%) and onion bulb (52.05%) extract. Futane et al., (2018) tested nine botanicals against A. niger and it was found that, maximum (50.99%) mycelial growth inhibition was recorded with Allium sativum, followed by O. sanctum (29.22%), A. indica (23.90%) and Datura metal (18.58%) while least growth inhibition was recorded L. camara, T. procumbens, P. pinnata, P. longifolia and Z. officinale as against untreated control.

CHAPTER IV: EXPERIMENTAL RESULTS Storage rot of onion, caused by major pathogen named as Aspergillus niger is considered as a key threat to the post-harvest storage of onion because of its destructiveness under favourable conditions. To overcome this storage losses, the study was taken up during 2020-21 to initiate the work on isolation and pathogenicity test, in vitro evaluation of bio-agents and phytoextracts in the Department of Plant Pathology at College of Agriculture, Dapoli, Dr. BSKKV, Dapoli. In addition, survey of storage rot of onion was carried out at Rajgurunagar, Chakan and Talegaon vegetable markets. The results of the experiments conducted on this aspects were presented in this chapter. 4.1 Survey on incidence of storage rot of onion in Rajgurunagar, Chakan and Talegaon market. The survey was carried out at 15 days interval at Rajgurunagar, Chakan and Talegaon vegetable market for assessing the incidence of storage rot of onion during July to December, 2020. The results revealed that the presence of Aspergillus spp. (storage rot) at Shri. Chatrapati Shivaji Maharaj market yard, Rajgurunagar, Chakan Bhaji Mandai and Vegetable market, Talegaon. Table 4.4: Survey on incidence of storage rot of onion in Rajgurunagar, Chakan and Talegaon during 2020. Locations Per cent Disease Incidence (PDI) Mean

Rajgurunagar Chakan Talegaon Months I II I II I II July 19.00 16.00 19.00 23.00 20.00 22.00 19.83 August 12.00 10.00 14.00 18.00 13.00 14.00 13.50 September 13.00 17.00 16.00 12.00 15.00 18.00 15.16 October 23.00 21.00 19.00 22.00 17.00 20.00 20.33 November 26.00 28.00 25.00 25.00 28.00 26.00 26.33 December 26.00 29.00 31.00 28.00 29.00 27.00 28.33

I = 1st fortnight, II = 2nd fortnight The data presented in Table 4.4 (Fig. 1) showed that, the disease incidence was observed in range of 12-29 per cent at Shri. Chhatrapati Shivaji Maharaj market yard, Rajgurunagar. Highest (29%) disease incidence was recorded in 2nd fortnight of December. While, lowest (12%) disease incidence was observed in 1st fortnight of

Rajgurunagar I July August September October November December 19 12 13 23 26 26 Rajgurunagar II July August September October November December 16 10 17 21 28 29 Chakan I July August September October November December 19 14 16 19 25 31 Chakan II July August September October November December 23 18 12 22 25 28 Talegaon I July August September October November December 20 13 15 17 28 29 Talegaon II July August September October November December 22 14 18 20 26 27

Months

Percent Disease Intensity

Fig. 1 : Survey on incidence of storage rot of onion during 2020. August at Shri. Chhatrapati Shivaji Maharaj market yard, Rajgurunagar. Similar results were found in Bhaji Mandi, Chakan. At Chakan vegetable market, per cent storage rot incidence was ranged from 12-31 per cent. Highest storage rot incidence i.e. 31% was recorded in 1st fortnight of December, while lowest incidence (12%) was recorded in 2nd fortnight of September. In case of Talegaon vegetable market, the highest storage rot incidence and lowest incidence was recorded in 1st fortnight of December (29%) and August (13%), respectively. The highest storage rot incidence was recorded in December (28.33%) followed by November (26.33%), October (20.33%) and July (19.83%). While, lowest storage rot incidence was recorded in August (13.50%) followed by September (15.16%). 4.2 Isolation The freshly storage rot infected onion bulb samples were collected and brought to the laboratory. Isolated on PDA medium by following standard tissue isolation technique. The culture thus obtained was further purified by single spore

studies. 4.3 Pathogenicity The pathogenicity test was carried out to prove the Koch's postulates by with injury and without injury methods to the samples. Healthy samples of onion bulbs of uniform size were used to prove the pathogenicity test. The procedure followed during pathogenicity was described earlier under material and methods chapter. The symptoms of storage rot disease were seen after seven days of artificial inoculation of pathogen (Plate II). It was also observed that the disease development was very slow in uninjured bulbs compared to injured bulbs. However, the control bulb sample dipped only in distilled water remained healthy and did not produced any kind of symptom throughout the period of observation.

LIST OF PLATES PLATE I

a) Black spore masses develop as streaks along veins and between outer dry scales

b) Pure culture of Aspergillus niger on Potato dextrose agar

PLATE II

Control

Inoculated

Pathogenicity test of Aspergillus niger on onion bulb

4.3.2 Reisolation After development of symptoms on artificially inoculated bulbs, the fungus was reisolated by following standard tissue isolation method. On incubation, the similar type of culture was obtained with similar morphological characters of mycelium and spores. Thus the Koch's postulates were confirmed. The culture of the test pathogen

re-isolated organism were done by comparing morphological characters

and the organism was identified, up to genus level. The fungus produced filamentous hyphae which was white at initial stage but becomes black after a few days by production of spore mass. The edges of colonies were found pale yellow. On microscopic examination, it was found that the fungus produced smooth coloured conidiophores and conidia (Plate III). Sterile cells produced by conidiophore vesicles (metulae) support the phialides on the conidiophores. The conidia produced by the fungus were rough in texture, dark brown coloured and 4-5 µm in diameter.

PLATE III

a) Photomicrograph of vesicle releasing conidiospores of A. niger

Vesicle

b) Photomicrograph of head of A. niger

Phialids

Matula

Conidia

Conidiophore

c) Photomicrograph of spores of A. niger

4.4 Physiological weight loss The

results presented in Table 4.2 revealed that onion bulbs inoculated with A. niger exhibited loss in weight at 15, 30, 45 and 60 days after inoculation as compared to uninoculated bulbs. Maximum physiological weight loss was recorded in white onion (11.25g and 22.87%) followed by red onion (10.27g & 10.41%), after 60 days of inoculation (DAI). Table 4.2: Physiological weight loss of onion bulbs inoculated with A. niger.

Sr.No. Cultivar Average bulb wt. (g) before inoculation Bulb wt. (g) after inoculation at Physiological weight loss (g) Per cent physiological weight loss 15 DAI 30 DAI 45 DAI 60 DAI 15 DAI 30 DAI 45 DAI 60 DAI 15 DAI 30 DAI 45 DAI 60 DAI 1 Red

onion 98.65 97.55 95.31 91.25 88.38 1.10 3.34 7.40 10.27 1.11 3.38 7.50 10.41 2 White onion 49.18 48.31 45.41 42.03 37.93 0.87 3.77 7.15 11.25 1.76 7.66 14.53 22.87 DAI = Days after inoculation White onion variety seems to be more susceptible to the storage rot disease as infection of the fungus was at greater intensity compared to red variety. Same results were obtained by Clark and Lorbeer (1973) and concluded that catachol (phenol) was less in white onions as compare to red, yellow and brown varieties which responsible for inhibiting the growth of fungi. It was observed that physiological weight of red and white

onion bulbs inoculated with A. niger progressively decreased as the incubation period is increased over control.

PLATE IV

Bulbs before inoculation of Aspergillus niger

Physiological weight loss of bulbs 60 days after inoculation of

Aspergillus niger 4.5.1 In vitro evaluation of bioagents against A. niger Eight antagonists viz., Trichoderma viride, T. harzianum, T. hamatum, T. virens, T. asperellum, Penicillium spp., Pseudomonas fluorescens and Bacillus subtilis were evaluated in vitro for their antagonistic effect against A. niger by dual culture

method. The

and are presented in Table 4.3 (Plate V). It was observed

transformation.

PLATE V

Treatment

Percent

Fig. 2 : In vitro evaluation of

bioagents against

A. niger Significantly

virens (78.22 %) followed by T. hamatum (72.66 %), T. viride (64.88 %) after seven days of incubation. While average effect on mycelial growth inhibition of A. niger was noticed in T. asperellum (61.88 %) and Bacillus subtilis (57.77 %). Lowest (40.77%) mycelial growth inhibition was observed in Penicillium spp. followed by P. fluorescens (55.55 %).

glyoviridin from Trichoderma spp.

and cell wall degrading enzymes such as glucanases, endochitinases, chitinases and mycoparasitism. 4.5.2

In vitro evaluation of phytoextracts against A. niger The water extracts of seven plant species were studied against Aspergillus niger to test their antifungal properties. All the plant extracts were tested at 10 per cent concentration by 'Poisoned food technique'. The plant extracts under study showed antifungal activity against A. niger.

The data are presented in Table 4.4 (Plate VI & Fig. 3). Table 4.4: In vitro evaluation of phytoextract against A. niger Sr. No. Plant Name Scientific Name Conc.(%) Mean

colony diameter(mm)* Per cent Inhibition

T1 Ginger Zingiber officinale 10 05.00 94.44 (76.36) T2 Turmeric Curcuma longa 10 34.00 62.22 (52.07) T3 Neem Azadirachta indica 10 27.60 69.33 (56.37) T4 Clove Syzygium aromaticum 10 35.00 61.11 (51.41) T5 Tulsi Ocimum sanctum 10 31.60 64.88 (53.65) T6 Nilgiri Eucalyptus globules 10 00.00 100.00 (90) T7 Ghaneri Lantana camara 10 45.30 49.67 (44.80) T8 Control - - 90.00 - S.Em $\pm$ 0.08 C.D. at 1% 0.33 *Mean of three replications. Figures in parenthesis are arcsine

transformation.

PLATE VI

T8 T7 T6 T5 T4 T3 T2 T1 Mean colony diameter of A. niger against various botanicals T1 T2 T3 T4 T5 T6 T7 T8 5 34 27.6 35 31.6 0 45.3 90

Treatment

Mean colony

Fig. 3 : In vitro evaluation of

phytoextract against A. niger

All the botanicals tested showed significant inhibition of mycelial growth of A. niger at 10 per cent concentration. Cent per cent mycelial growth inhibition of A. niger was recorded with E. globules followed by Zingiber officinale (94.44 %) and Azadirachta indica (69.33%). The least (49.67%) mycelial inhibition was recorded with Lantana camara.

CHAPTER V: DISCUSSION Onion is an important bulb crop. It's easy cultivation and adoption to mild weather and medium soil has made this crop an essential component of cropping system. In the recent past years, a number of storage diseases have been introduced and among these storage rot or black mold rot incited by Aspergillus niger was found most dreaded disease responsible for heavy storage losses and was a major constraint in post-harvest management. The storage diseases need to be controlled to maintain both the quantitative and qualitative yield levels. Presently the disease was managed by use of various storage structures but it seems insufficient, thus prompting to search strategies for control the disease by using phytoextracts, bio-agents and solely or in combination of each other to increase the storage health by reducing disease intensity and production cost. Hence, the present study was under taken to evaluate the in vitro efficacy of different phytoextracts and bio-agents against the pathogen Aspergillus niger inciting storage rot disease of onion. The results obtained are discussed below : 5.1 Survey of storage rot of onion in Rajgurunagar, Chakan, and Talegaon markets. Survey was carried in three different locations of Pune districts viz., Rajgurunagar, Chakan and Talegaon vegetable markets to assess the incidence of storage rot disease. The results of present survey substantiate

with the results obtained by Adongo et al. (2015). They reported more incidence of Aspergillus niger fungus during wet season in the markets of Anloga (31.30%) followed by Kwadaso (27.70%), Central (25.20%) and Abinchi (22.50%) which are major markets in Kumasi Metropolis of Ghana. Ko et al. (2002) reported the storage rot in onion were the main cause of storage losses up to 36 per cent. Mohmud and Monjil (2015) reported maximum disease incidence in Pusa Red (14.44%) followed by Faridpuri (11.81%) and Taherpuri (10.45%) varieties, in the month of September. Chavda et al. (2016) recorded the highest (24.33%) black mould rot incidence in the month of May followed by June (24.17%), April (18.33%), July (15.83%) and August (11%) in garlic bulb. The lowest incidence (7.67%) was logged in the month of September. About 35 to 40% loss of onion due to damage caused by storage diseases and the fungal bulb rot, A. niger imparts to about 15 to 30% losses during storage of different varieties reported by Kumar et al. (2015). 5.2 Isolation and pathogenicity of pathogens associated with storage rot of onion. 5.2.1 Isolation The storage rot disease causal organism, A. niger was isolated on PDA medium from diseased bulb showing typical rot

Khokhar et al. (2012) successfully isolated A. niger on PDA medium from diseased onion bulbs. The pathogen was identified and confirmed as A. niger on the basis of morphological and cultural characteristics. Similarly, Srinivasan and Shanmugam (2006) isolated A. niger from dried outer scales, fleshy inner scales and rootlets of infected bulbs by tissue isolation technique. Ara et al. (2008) collected diseased onion samples and isolated fungi viz., A. niger, A. flavus, Penicillium spp., F. oxysporum and F. moniliforme from the bulbs, isolated fungi were inoculated with injury and without injury methods. 5.2.2 Pathogenicity Pathogenicity of isolated fungus was proved by inoculating culture on healthy red onion bulbs with injury and without injury methods. The characteristic symptoms of the disease were observed on bulbs after seventh day of inoculation as bulbs are discoloured black around the neck and affected scales shrivel, which at tenth day developed into streaks of masses of black spores along veins and between outer dry scales. The control bulbs without inoculation of pathogen did not produced any symptoms of storage rot. Upon reisolation the fungus from the artificially inoculated plants yielded the fungal colonies similar to the original one. Results similar to the present investigation showing typical storage rot symptoms in healthy onion bulbs were reported by Arowora and Adetunji (2014). Chaudhary et al. (1994) proved the pathogenicity by dipping healthy surface sterilized onion bulb into spore suspension of A. niger for 5 minutes. Sharma (2012) isolated A. niger and proved pathogenic to onion, peanuts, yam, cherry, maize, grapes, banana, tomato and mango fruits. Muhammed et al. (2004) proved the pathogenicity of eight different fungi viz., A.

and isolated from tomato fruits. 5.3. To study the physiological losses in weight of onion bulbs infected by Aspergillus niger. From the results presented in Table 4.3 it was observed that physiological weight of red and white

revealed that the

inoculation. Maini and Chakravarti (2000) reported 12-25 per cent losses in physiological weight of onion bulbs due to various diseases such as soft rot, blue mold and storage rot. Total losses during storage of 5-6 months were as high as 30-40 per cent. Ahsanuzzaman et al. (2017) recorded weight loss per cent three times with 15 days interval in storage condition. Among six varieties of onion Pusa red variety showed the highest (35.7%) weight loss at 45 days of storage where the lowest (8.7%) was recorded in Zitka.

To evaluate the bio efficacy of bio agents and botanicals against A. niger in vitro. 5.4.1 Bioagents Eight different bioagents were evaluated against A. niger in vitro and it was found that bioagents are able to suppress the mycelial growth of test fungus over control.

Lone et al. (2012). They reported that Trichoderma harzianum was the most effective

bio-agent against A. niger (75% inhibition) in in vitro. Pseudomonas fluorescens and Bacillus subtilis can effectively suppress the

followed by the isolate T9 (75.51%). In comparison to this, B. subtilis was less antagonistic (61.27%).

Gajendra and Vakharia (2012) revealed that, Trichoderma viride was more effective (86.2% inhibition) against A. niger than T. harzianum. (80.4% inhibition). 5.4.2 Phytoextracts Seven phytoextracts (10 %) were screened against the mycelial growth of A. niger in vitro following the standard poisoned food technique (Nene and Thapliyal, 1979).

of present study are in agreement with the results obtained by

Saranya et al. (2018). They reported mycelial inhibition against test fungus by Ocimum sanctum leaf extract (62.97%), Zingiber officinale rhizome extract (62.26%) and Lantana camera leaf extract (61.59%). Saifeldin et al. (2016) screened the in vitro ability of dry bud extract of Syzygium aromaticum against soft rot of onion caused by A. niger and recorded 96% inhibition in spore germination. Pudake et al. (2018) studied seven botanicals @10% concentration against A. niger and reported eucalyptus oil exhibited 100% inhibition of mycelial growth. They were followed by leaf extract of O. sanctum (92.74%), Azadirachta india (76.10%) extract. Futane et al. (2018) evaluated nine botanicals against A. niger and it was found that maximum mycelial growth inhibition was recorded with Allium sativum (50.99%) followed by O. sanctum (29.22%), A. indica (23.90%), and least growth inhibition was recorded by L. camara, Z. officinale as against untreated control.

CHAPTER VI: SUMMARY AND CONCLUSION Present investigations on "Studies on storage rot of onion caused by Aspergillus niger Van Tieghem"

Dapoli Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli during the year 2019-21. The summary of the research work carried out and conclusions drawn are described hereunder. The study was undertaken with an aim to find out the incidence of storage rot at different markets, physiological weight loss of A. niger inoculated onion bulbs and to explore different bioagents and botanicals for effective management of disease under laboratory conditions. The fungus incitant with naturally storage rot infected onion bulbs were isolated on potato dextrose agar medium by tissue isolation technique to obtain the culture of pathogen. The culture thus obtained was further purified and maintained by periodical transfer on PDA slants throughout the study. Pathogenicity of the fungus was proved following Koch's postulates and the pathogenic fungus was identified as Aspergillus niger. In, in vitro evaluation of bio-agents, Trichoderma harzianum was emerged as the potential antagonist of A. niger which showed 81.11 per cent mycelial inhibition of the fungus and was followed by T. virens (78.22%) and T. hamatum (72.66%). While T. viride (64.88%), T. asperellum (61.88%) and Bacillus subtilis (57.77%) were less effective in inhibiting the mycelial growth of A. niger followed by Pseudomonas fluorescence (55.55%) and Penicillium spp. (40.77%). All the plant extracts tested in vitro for their efficacy against A. niger showed inhibitory action against storage rot pathogen. Nilgiri oil was expressed complete inhibition of A. niger. Plant extract of Zingiber officinale, Azadirachta indica, Ocimum sanctum, Curcuma longa and Syzygium aromaticum were also found effective against the test pathogen which showed 94.44%, 69.33%, 64.88%, 62.22% and 61.11% inhibition, respectively. Leaf extract of Lantana camara (49.67%) was poor in inhibiting A. niger. Studies on physiological weight loss of onion bulbs infected with A. niger were carried out and the results

revealed that

red onion (10.27g & 10.41%), after 60 days of inoculation (DAI).

From the results it was observed that white onion is more susceptible to the A. niger as compare to red onion as it has more catechol (phenol) than white onion. Survey was carried out to assess the incidence of storage rot in the different vegetable markets and Aspergillus niger was recorded at Shri. Chhatrapati Shivaji Maharaj market yard, Rajgurunagar, Chakan Bhaji Mandai and Vegetable market, Talegaon. The highest storage rot incidence was recorded in December (28.33%) followed by November (26.33%), October (20.33%) and July (19.83%). While, lowest storage rot incidence was recorded in August (13.50%) followed by September (15.16%). Thus, from the present investigation it is concluded that, Aspergillus niger is responsible for storage rot or black mold disease in onion and it is one of major threat to onion storage. Physiological weight loss of bulbs, occurs over a period of time inoculated with A. niger. The bioagent Trichoderma harzianum successfully inhibits the mycelial growth and sporulation of the pathogen in vitro. Various botanicals also play important role in mycelial growth inhibition. Any of these two control measures can be used to manage the disease under storage conditions.

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APPENDIX – I ANOVA for in vitro evaluation of bioagents against Aspergillus niger

SOURCE

DF

SS

MSS

FCAL

F TAB 5%

F TAB 1%

RESULT

TREATMENT

8

118.399

14.7998 243.655

2.51016

3.70542

SIG

ERROR

18

1.09333

0.06074

-

-

-

-

TOTAL

26

119.492

-

-

-

-

-

SEm ± CD at 5%

CD at 1%

CV %

0.14229 0.42277

0.57923

6.362

APPENDIX –II ANOVA for in vitro evaluation of phytoextracts against A. niger

SOURCE

DF

SS

MSS

FCAL

F TAB 5%

F TAB 1%

RESULT

TREATMENT

7

159.1983

22.74262

1137.131

2.657197

4.025947

SIG

ERROR

16

0.32

0.02

-

-

-

-

TOTAL

23

159.5183

-

-

-

-

-

SEm ± CD at 5%

CD at 1%

CV %

0.08165 0.24447

0.33726

4.211

2

T1 T2 T3 T4 T5 T6 T7 T8 5 34 27.6 35 31.6 0 45.3 90

Treatment

Mean colony

Rajgurunagar I July August September October November December 19 12 13 23 26 26 Rajgurunagar II July August September October November December 16 10 17 21 28 29 Chakan I July August September October November December 19 14 16 19 25 31 Chakan II July August September October November December 23 18 12 22 25 28 Talegaon I July August September October November December 20 13 15 17 28 29 Talegaon II July August September October November December 22 14 18 20 26 27

Months

Percent Disease Intensity

[VALUE]

T1 T2 T3 T4 T5 T6 T7 T8 T9 64.88 81.11 72.66 78.22 61.88 40.770000000000003 55.55 57.77 0 Treatment

Percent

[Metadata removed]

Curiginal

Hit and source - focused comparison, Side by Side

Submitted text As student entered the text in the submitted document.

Matching text As the text appears in the source.

1/103	SUBMITTED TEXT	21 WORDS	89%	MATCHING TEXT	21 WORDS
onion (Allium cepa L.) bulb of family Amaryllidaceae is an important vegetable crop widely cultivated & consume throughout the world			Onion (Allium cepa L.) bulb of family Amaryllidaceae is an important vegetable crop widely cultivated and used throughout the world.		

W https://www.researchgate.net/publication/277279299_Black_Mould_Rot_An_Important_Post_Harvest_Dise ...

2/103	SUBMITTED TEXT	12 WORDS	100%	MATCHING TEXT	12 WORDS
Generally this disease occurs more in white onions as compared to			Generally this disease occurs more in white onions as compared to		

W https://www.researchgate.net/publication/315972547_Bio-Efficacy_of_Trichoderma_Spp_And_its_Liquid ...

3/103	SUBMITTED TEXT	21 WORDS	65%	MATCHING TEXT	21 WORDS
Srinivasan et al., (2002) stated that A. niger was predominant pathogen associated with black mould rot of onion in storage			Srinivasan et al. (2002) reported that Aspergillus niger was found to be the predominant pathogen associated with black mould rot of onion during storage.		

W https://www.researchgate.net/figure/Effect-of-relative-humidity-on-black-mould-rot-of-onion-bulbs ...

4/103	SUBMITTED TEXT	14 WORDS	91%	MATCHING TEXT	14 WORDS
Kadam et al., (2011) conducted field surveys in the Marathwada region of Maharashtra			Kadam et al. (2011) conducted field surveys of groundnut in the Marathwada region of Maharashtra		

W http://14.139.51.37/centrallibrary/admin/book/fc2f92fd41Manju%20Pawanda%20(M.Sc.%20Ag)%20Plant%20 ...

5/103	SUBMITTED TEXT	17 WORDS	100%	MATCHING TEXT	17 WORDS
and recorded maximum disease incidence (17.8%) in Renapur tahsil and minimum disease incidence (8-9%) in Nilanga			and recorded maximum disease incidence (17.8%) in Renapur Tahsil and minimum disease incidence (8.9%) in Nilanga.		

W http://14.139.51.37/centrallibrary/admin/book/fc2f92fd41Manju%20Pawanda%20(M.Sc.%20Ag)%20Plant%20 ...

Curiginal

8/103	SUBMITTED TEXT	16 WORDS	84%	MATCHING TEXT	16 WORDS

The incidence of disease was more in sandy soil (52%) followed by sandy loam

The incidence of collar rot was more in sandy soil (52.00%) followed by sandy loam (43.00%).

W https://www.researchgate.net/publication/342834240_Collar_rot_Aspergillus_niger_a_serious_disease ...

9/103	SUBMITTED TEXT	59 WORDS	86%	MATCHING TEXT	59 WORDS

var. 'Bawku Red' from two markets in Tamale and studied in the laboratory. The results showed that the onion bulb rot was caused by five fungi species including A. niger, Aspergillus flavus, Penicillium sp., Rhizopus stolonifer and Fusarium oxysporum. A. niger had the highest percentage occurrence of 30.66% and 25.66% for the Tamale Central and Aboabo markets, respectively. 2.2.

var. 'Bawku Red' samples were collected from two markets in Tamale and studied in the Spanish laboratory, Faculty of Agriculture, University for Development Studies, Nyankpala. The results showed that the onion bulb rot was caused by five fungi species including Aspergillus niger, Aspergillus flavus, Penicillium sp., Rhizopus stolonifer and Fusarium oxysporum. A. niger had the highest percentage occurrence of 30.66% and 25.66% for the Tamale Central and Aboabo markets, respectively.

W https://www.researchgate.net/publication/278301917_Post_Harvest_Management_of_Fungal_Diseases_in_ ...

6/103	SUBMITTED TEXT	14 WORDS	100%	MATCHING TEXT	14 WORDS

generally form along veins and on or between the outer papery scales of

generally form along veins and on or between the outer papery scales of

W https://www.researchgate.net/publication/277279299_Black_Mould_Rot_An_Important_Post_Harvest_Dise ...

7/103	SUBMITTED TEXT	14 WORDS	100%	MATCHING TEXT	14 WORDS

develops at the neck of the bulbs on injured or necrotic leaf tissues

develops at the neck of the bulbs on injured or necrotic leaf tissues.

W https://www.researchgate.net/publication/277279299_Black_Mould_Rot_An_Important_Post_Harvest_Dise ...

10/103	SUBMITTED TEXT	21 WORDS	55%	MATCHING TEXT	21 WORDS

fungi viz., Aspergillus niger, A. ochraceous, A. flavus, A. fumigatus, Penicillium citrinum and Helminthosporium fulvum, Curvularia lunata and S. rolfsii

fungi were Aspergillus niger, Aspergillus ochraceous, Aspergillus flavus, Aspergillus fumigatus, Penicillium citrinum and Helminthosporim fulvum, Curvularia lunata and Sclerotium rolfsii.

W https://www.researchgate.net/publication/290603587_Fungi_Associated_with_Storage_Rots_of_Onion_Bu ...

Curiginal

11/103	SUBMITTED TEXT	17 WORDS	87%	MATCHING TEXT	17 WORDS

A. ochraceous, A. flavus, S. rolfsii and P. citrinum were highly pathogenic.

A. ochraceous, A. flavus, Sclerotium rolfsii and P. citrinum were highly pathogenic

W https://www.researchgate.net/publication/290603587_Fungi_Associated_with_Storage_Rots_of_Onion_Bu ...

12/103	SUBMITTED TEXT	23 WORDS	75%	MATCHING TEXT	23 WORDS

is known to produce cellulolytic and pectinolytic enzymes, which may be responsible for occurrence of some tissue degradation.

is known to produce cellulolytic and pectinolytic enzymes (Kulfinski et al. 1973), which may be responsible for some of the tissue degradation

W https://www.jstage.jst.go.jp/article/cytologia1929/43/2/43_2_411/_pdf/-char/en

13/103	SUBMITTED TEXT	24 WORDS	85%	MATCHING TEXT	24 WORDS

bulbs inoculated with A. niger showed loss in weight as compared to un-inoculated bulbs at 15, 30, 45 and 90 days after inoculation.

bulbs inoculated with A. niger showed loss in weight as compared to uninoculated bulbs at 30, 60 and 90 days after inoculation.

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

14/103	SUBMITTED TEXT	23 WORDS	65%	MATCHING TEXT	23 WORDS

per cent physiological weight loss was recorded in Gujarat Garlic-4 variety (4.87g and 29.53%) followed by Gujarat Anand Garlic-6 (4.38g and 28.77%)

per cent physiological weight loss was recorded in Gujarat Anand white onion-3 variety (10.48 g and 16.70%) followed by Nasik yellow (11.54 g and 14.45%)

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

15/103	SUBMITTED TEXT	58 WORDS	91%	MATCHING TEXT	58 WORDS

onion bulbs inoculated with A. niger showed loss in weight as compared to uninoculated bulbs at 30, 60 and 90 days after inoculation. Recorded highest per cent physiological weight loss in Gujarat Anand white onion-3 variety (10.48g and 16.70 %) followed by Nasik yellow (11.54g and 14.45 %) and Nasik red (11.73g 10.59%) 90 days after

Onion bulbs inoculated with A. niger showed loss in weight as compared to uninoculated bulbs at 30, 60 and 90 days after inoculation. Highest per cent physiological weight loss was recorded in Gujarat Anand white onion-3 variety (10.48 g and 16.70%) followed by Nasik yellow (11.54 g and 14.45%) and Nasik red (11.73 g and 10.59%) after 90

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

Curiginal

16/103	SUBMITTED TEXT	38 WORDS	95%	MATCHING TEXT	38 WORDS

observed that the Penicillium species completely overgrew the A. niger colony. The study also revealed that some species of the genus Penicillium possessed a high antagonistic effect on the onion black rot pathogen.

observed that the Penicillium species completely overgrew the A. niger colony. The study revealed that some species of the genus Penicillium possessed a high antagonistic effect on the onion black rot pathogen.

W https://doi.org/10.2478/v10146-012-0003-5

17/103	SUBMITTED TEXT	22 WORDS	78%	MATCHING TEXT	22 WORDS

the antifungal activity of aqueous and ethanol extracts obtained from seed and leaf of Jatropha curcas in vitro against A. niger

The antifungal activity of aqueous and ethanol extracts obtained from seed and leaf of Jatropha curcas were investigated using agar incorporation method in vitro against Aspergillus niger,

W https://www.researchgate.net/publication/265815049_Occurrence_and_Biological_Control_of_Postharve ...

19/103	SUBMITTED TEXT	30 WORDS	93%	MATCHING TEXT	30 WORDS

at 160mg/ml. The in vivo study showed that aqueous extracts of seed and leaf reduced rot development by 59.4 and 54.4 % in onion bulbs.

at 40 mg/ml.The in vivo study showed that aqueous extracts of seed and leaf reduced rot development, 59.4 and 54.4 % in onion bulbs.

W https://www.researchgate.net/publication/265815049_Occurrence_and_Biological_Control_of_Postharve ...

20/103	SUBMITTED TEXT	16 WORDS	80%	MATCHING TEXT	16 WORDS

against A. flavus, A. fumigatus, A. niger, A. terreus and F. oxysporum of Pennisetum americanum

SA STUDIES ON SEEDBORNE MYCOFLORA OF SELECTED VEGETABLES AND THEIR BIOCONTROL by Ms. Manisha Arun Pa ... (D33775063)

18/103	SUBMITTED TEXT	41 WORDS	74%	MATCHING TEXT	41 WORDS

Nandeesha et al., (2013) evaluated the efficacy of 14 isolates of Trichoderma spp. Among them, the isolates TAG-2, TAG-13, and TAG-10 showed maximum mycelial inhibition i.e., 81.36%, 78.51% and 75.97%, respectively against A. niger.

Nandeesha et al. (2013) evaluated the efficacy of 14 isolates of Trichoderma spp. In culture technique, the isolates TAG-2, TAG-13 and TAG-10 showed maximum mycelium inhibition percentage of (81.36, 78.51 and 75.97, respectively) against A. niger.

W http://14.139.51.37/centrallibrary/admin/book/fc2f92fd41Manju%20Pawanda%20(M.Sc.%20Ag)%20Plant%20 ...

Curiginal

21/103	SUBMITTED TEXT	32 WORDS	78%	MATCHING TEXT	32 WORDS

Mokhtar and Dehimat (2014) tested in vitro and in vivo capability of T. harzianum to control the Rhizopus soft rot of tomato fruits (Lycopersicon esculentum). In in vitro condition T. harzianum

Mokhtar and Dehimat (2014) [7] tested in vitro and in vivo T. harzianum to control the Rhizopus soft rot of fruits (Lycopersicon esculentum). The results of direct confrontation (in vitro) of T. harzianum

W https://www.researchgate.net/publication/318910492_Effect_of_Trichoderma_Spp_and_its_culture_filt ...

22/103	SUBMITTED TEXT	11 WORDS	100%	MATCHING TEXT	11 WORDS

the Rhizopus rot of tomato in vitro and in vivo

the Rhizopus rot of tomato in vitro and in vivo.

W https://www.researchgate.net/publication/318910492_Effect_of_Trichoderma_Spp_and_its_culture_filt ...

23/103	SUBMITTED TEXT	17 WORDS	81%	MATCHING TEXT	17 WORDS

the culture filtrate of T. asperellum and T. viride found most effective in in vivo and

the culture filtrate of T. asperellum and T. viride found most effective both in pre-(0.45 & 0.45 %) and

W https://www.researchgate.net/publication/318910492_Effect_of_Trichoderma_Spp_and_its_culture_filt ...

24/103	SUBMITTED TEXT	14 WORDS	80%	MATCHING TEXT	14 WORDS

isolation. The pure culture of the pathogen was maintained on PDA for further

isolation method. The pure culture of the fungus was maintained on PDA medium for further

SA Touhid Tambe Thesis.pdf (D109476412)

28/103	SUBMITTED TEXT	21 WORDS	68%	MATCHING TEXT	21 WORDS

was maintained on PDA slants for further experimental work. 4.3.3 Identification of the pathogen The identification of

SA pawar, n..pdf (D56589692)

Curiginal

29/103	SUBMITTED TEXT	17 WORDS	93%	MATCHING TEXT	17 WORDS

with the information available in reviewed literature, as well as on standard websites for fungal identification

with the information available in the reviewed literature as well as on the standard websites for fungal identification. 3.2.6.

SA Touhid Tambe Thesis.pdf (D109476412)

25/103	SUBMITTED TEXT	67 WORDS	40%	MATCHING TEXT	67 WORDS

results presented in Table 4.2 revealed that onion bulbs inoculated with A. niger exhibited loss in weight at 15, 30, 45 and 60 days after inoculation as compared to uninoculated bulbs. Maximum physiological weight loss was recorded in white onion (11.25g and 22.87%) followed by red onion (10.27g & 10.41%), after 60 days of inoculation (DAI). Table 4.2: Physiological weight loss of onion bulbs inoculated with A. niger.

results presented in Tabl e 1 revealed that onion bulbs inoculated with Aspergillus niger showed loss in weight as compared to uninoculated bulbs at 30, 60 and 90 days a? er inoculation. Highest per cent physiological weight loss was recorded in Gujarat Anand white onion-3 variety (16.70%) followed by Nasik yellow (14.45%) and red (10.59%), a?er 90 days of inoculation (DAI). It was observed that physiological weight of onion bulbs decreased quickly when inoculated with A. niger

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

26/103	SUBMITTED TEXT	268 WORDS	51%	MATCHING TEXT	268 WORDS

Sr.No. Cultivar Average bulb wt. (g) before inoculation Bulb wt. (g) after inoculation at Physiological weight loss (g) Per cent physiological weight loss 15 DAI 30 DAI 45 DAI 60 DAI 15 DAI 30 DAI 45 DAI 60 DAI 15 DAI 30 DAI 45 DAI 60 DAI 1 Red

Sr. No. Treatments Initial bulb wt. (g) at the period Bulb wt. (g) after inoculation at different periods Physiological loss in weight Per cent physiological loss DAI 60 DAI 90 DAI 30 DAI 60 DAI 90 DAI 30 DAI 60 DAI 90 DAI 1. Nasik red 106.27 109.2 110.71 104.29 103.48 98.98 1.98 5.72 11.73 1.86 5.24 10.59 2.

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

27/103	SUBMITTED TEXT	36 WORDS	90%	MATCHING TEXT	36 WORDS

onion bulbs inoculated with A. niger progressively decreased as the incubation period is increased over control.

onion bulbs inoculated with A. niger progressively decreased as the incubation period was increased over control

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

Curiginal

31/103	SUBMITTED TEXT	49 WORDS	34%	MATCHING TEXT	49 WORDS

Aspergillus niger 4.5.1 In vitro evaluation of bioagents against A. niger Eight antagonists viz., Trichoderma viride, T. harzianum, T. hamatum, T. virens, T. asperellum, Penicillium spp., Pseudomonas fluorescens and Bacillus subtilis were evaluated in vitro for their antagonistic effect against A. niger by dual culture

Aspergillus niger. 4. In-vitro Evaluation of bio-control agents against niger Seven bio-control agents Trichoderma hamatum, T. lignorum, T. harzianum, T. viride, Pseudomonas evaluated in vitro for their efficacy against Aspergillus niger by applying dual culture

W https://www.researchgate.net/publication/333194224_In-vitro_evaluation_of_Phyto-extracts_and_bio- ...

32/103	SUBMITTED TEXT	23 WORDS	65%	MATCHING TEXT	23 WORDS

observations on mycelial growth inhibition (PGI) recorded when the untreated control plates were fully covered with mycelial growth of the test fungus

SA Kawathe Nayan.pdf (D82125260)

30/103	SUBMITTED TEXT	13 WORDS	87%	MATCHING TEXT	13 WORDS

that all the bioagents significantly inhibited the mycelial growth of A. niger

that all the fungicides significantly inhibited the mycelial growth of A. niger

W http://14.139.51.37/centrallibrary/admin/book/fc2f92fd41Manju%20Pawanda%20(M.Sc.%20Ag)%20Plant%20 ...

37/103	SUBMITTED TEXT	838 WORDS	47%	MATCHING TEXT	838 WORDS

over control. Table 4.3: In vitro evaluation of bioagents against A. niger Sr. No. Treatments *Average colony diameter(mm) Per cent inhibition over control T1 Trichoderma viride 31.60 64.88 (53.65) T2 T. harzianum 17.00 81.11 (64.23) T3 T. hamatum 24.60 72.66 (58.47) T4 T. virens 19.60 78.22 (62.18) T5 T. asperellum 34.30 61.88 (51.87) T6 Penicillium spp. 53.30 40.77 (39.68) T7 Pseudomonas fluorenscence 40.00 55.55 (48.18) T8 Bacillus subtilis 38.00 57.77 (49.47) T9 Control 90.00 - S.Em ± 0.14 C.D at 1% 0.57 *Mean of three replications. Figures in parenthesis are arcsine

SA Arjun Shinde Thesis PDF.pdf (D80256449)

Curiginal

38/103	SUBMITTED TEXT	27 WORDS	79%	MATCHING TEXT	27 WORDS

T2 T1 T8 T7 T6 T5 T3 T4 T9 In vitro evaluation of bioagents against A. niger [VALUE] T1 T2 T3 T4 T5 T6 T7 T8 T9 64.88 81.11 72.66 78.22 61.88 40.770000000000003 55.55 57.77 0

SA Kawathe Nayan.pdf (D82125260)

33/103	SUBMITTED TEXT	18 WORDS	83%	MATCHING TEXT	18 WORDS

highest mycelial growth inhibition was recorded in T. harzianum (81.11 %) which was at par with T.

highest mycelial percent growth inhibition (60.54 %) was recorded in T. harzianum and it was at par with T.

W https://www.researchgate.net/publication/318910492_Effect_of_Trichoderma_Spp_and_its_culture_filt ...

34/103	SUBMITTED TEXT	28 WORDS	63%	MATCHING TEXT	28 WORDS

The growth inhibition of A. niger could be due to fast growing nature of bio-agent, secretion of harmful extra – cellular compounds like antibiotics i.e. gliotoxin and

The growth inhibition of the R. oryzae could be due to fast growing nature of Trichoderma spp., as well as secretions of harmful extra-cellular compounds like antibiotics i.e. gliotoxin, glyoviridin and

W https://www.researchgate.net/publication/318910492_Effect_of_Trichoderma_Spp_and_its_culture_filt ...

35/103	SUBMITTED TEXT	13 WORDS	100%	MATCHING TEXT	13 WORDS

and cell wall degrading enzymes such as glucanases, endochitinases, chitinases and mycoparasitism. 4.5.2

and cell wall degrading enzymes such as glucanases, endochitinases, chitinases and mycoparasitism.

W https://www.researchgate.net/publication/318910492_Effect_of_Trichoderma_Spp_and_its_culture_filt ...

36/103	SUBMITTED TEXT	86 WORDS	46%	MATCHING TEXT	86 WORDS

The data are presented in Table 4.4 (Plate VI & Fig. 3). Table 4.4: In vitro evaluation of phytoextract against A. niger Sr. No. Plant Name Scientific Name Conc.(%) Mean

The data is presented in Table 4 and Fig. 3. Table 4. In vitro exploration of botanicals against P. vexans Tr. No. Plant extracts Botanical Name Conc. (%) Mean* (

SA Touhid Tambe Thesis.pdf (D109476412)

Curiginal

42/103	SUBMITTED TEXT	820 WORDS	31%	MATCHING TEXT	820 WORDS

T1 Ginger Zingiber officinale 10 05.00 94.44 (76.36) T2 Turmeric Curcuma longa 10 34.00 62.22 (52.07) T3 Neem Azadirachta indica 10 27.60 69.33 (56.37) T4 Clove Syzygium aromaticum 10 35.00 61.11 (51.41) T5 Tulsi Ocimum sanctum 10 31.60 64.88 (53.65) T6 Nilgiri Eucalyptus globules 10 00.00 100.00 (90) T7 Ghaneri Lantana camara 10 45.30 49.67 (44.80) T8 Control - - 90.00 - S.Em ± 0.08 C.D. at 1% 0.33 *Mean of three replications. Figures in parenthesis are arcsine

T 6 Ginger (Z. officinale) 26.67 24.17 20.33 23.72 70.37 (57.00) 73.15 (58.77) 77.41 (61.60) 73.64 (59.12) T 7 Karanj (P.pinnata) 60.67 52.50 47.83 53.67 32.59 (34.80) 41.67 (40.19) 46.85 (43.18) 40.37 (39.39) T 8 Neem (A. indica) 30.00 25.17 22.67 25.94 66.67 (54.72) 72.04 (58.06) 74.81 (59.85) 71.17 (57.54) T 9 Parthenium (P.T 10 Turmeric (C.longa) 42.33 35.33 29.83 35.83 52.96 (46.68) 60.74 (51.18) 66.85 (54.83) 60.19 (50.90) T 11 Garlic (A. T 12 Control 90.00 90.00 90.00 90.00 0.00 (0.00) 0.00 (0.00) 0.00 (0.00) 0.00 (0.00) S. C.D.(Mean of three replications, Figures in parentheses are arcsine

W https://www.ijcmas.com/7-11-2018/Vasudha%20A.%20Kadam,%20et%20al.pdf

49/103	SUBMITTED TEXT	55 WORDS	50%	MATCHING TEXT	55 WORDS

T8 T7 T6 T5 T4 T3 T2 T1 Mean colony diameter of A. niger against various botanicals T1 T2 T3 T4 T5 T6 T7 T8 5 34 27.6 35 31.6 0 45.3 90

SA Kawathe Nayan.pdf (D82125260)

39/103	SUBMITTED TEXT	22 WORDS	92%	MATCHING TEXT	22 WORDS

symptoms by following standard tissue isolation method. The pure culture of the fungus was maintained on PDA medium for further use.

symptoms by following standered tissue isolation method. The pure culture of the fungus was maintained on PDA medium for further use.

SA Touhid Tambe Thesis.pdf (D109476412)

40/103	SUBMITTED TEXT	18 WORDS	73%	MATCHING TEXT	18 WORDS

niger, Aspergillus ochraceous, A. flavus, Aspergillus fumigatus, Penicillium citrinum and Helminthosporium fulvum, Curvularia lunata and S. rolfsii

niger, Aspergillus ochraceous, Aspergillus flavus, Aspergillus fumigatus, Penicillium citrinum and Helminthosporim fulvum, Curvularia lunata and Sclerotium rolfsii.

W https://www.researchgate.net/publication/290603587_Fungi_Associated_with_Storage_Rots_of_Onion_Bu ...

Curiginal

41/103	SUBMITTED TEXT	21 WORDS	90%	MATCHING TEXT	21 WORDS

onion bulbs inoculated with A. niger progressively decreased as the incubation period is increased over control.

onion bulbs inoculated with A. niger progressively decreased as the incubation period was increased over control

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

43/103	SUBMITTED TEXT	17 WORDS	70%	MATCHING TEXT	17 WORDS

The outcomes of this study are in agreement with the results obtained by Prajapati (2016). He

The results of present study are in agreement with the results obtained by Salman (2005) [17]. He

W https://www.researchgate.net/publication/318910492_Effect_of_Trichoderma_Spp_and_its_culture_filt ...

44/103	SUBMITTED TEXT	59 WORDS	91%	MATCHING TEXT	59 WORDS

onion bulbs inoculated with A. niger showed loss in weight as compared to uninoculated bulbs at 15, 30, 60 and 90 days after inoculation. Recorded highest per cent physiological weight loss in Gujarat Anand white onion-3 variety (10.48g and 16.70 %) followed by Nasik yellow (11.54g and 14.45 %) and Nasik red (11.73g 10.59%) 90 days after

Onion bulbs inoculated with A. niger showed loss in weight as compared to uninoculated bulbs at 30, 60 and 90 days after inoculation. Highest per cent physiological weight loss was recorded in Gujarat Anand white onion-3 variety (10.48 g and 16.70%) followed by Nasik yellow (11.54 g and 14.45%) and Nasik red (11.73 g and 10.59%) after 90

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

45/103	SUBMITTED TEXT	23 WORDS	86%	MATCHING TEXT	23 WORDS

Kapadiya et al. (2013) reported maximum weight loss (5.44 %) in storage rot infected onion bulbs as compare to healthy bulbs (2.66%). 5.4

Kapadiya et al., [12]. ?ey reported maximum weight loss (5.44%) in black mould rot infected onion bulbs as compare to healthy bulbs (2.66%)

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

46/103	SUBMITTED TEXT	14 WORDS	100%	MATCHING TEXT	14 WORDS

The results of present study are in agreement with the results obtained by

The results of present study are in agreement with the results obtained by

W https://www.researchgate.net/publication/318910492_Effect_of_Trichoderma_Spp_and_its_culture_filt ...

Curiginal

47/103	SUBMITTED TEXT	42 WORDS	35%	MATCHING TEXT	42 WORDS

growth of A. niger up to 73 and 60% respectively in dual culture method (Baig et al. (2012). Saranya et al. (2018) reported that T. viride isolate T6 significantly reduced the growth (78.63%) of A. niger

growth of A. niger up to 85 and 80 per cent, respectively in groundnut through dual culture technique. Bhale et al . (2013) revealed that T. harzianum could inhibit mycelial growth of A. niger

W https://www.researchgate.net/publication/315972547_Bio-Efficacy_of_Trichoderma_Spp_And_its_Liquid ...

48/103	SUBMITTED TEXT	40 WORDS	74%	MATCHING TEXT	40 WORDS

Nandeesha et al. (2013) evaluated the efficacy of 14 isolates of Trichoderma spp. Among them, the isolates TAG-2, TAG-13, and TAG-10 showed maximum mycelial inhibition i.e., 81.36%, 78.51% and 75.97% respectively against A. niger.

Nandeesha et al. (2013) evaluated the efficacy of 14 isolates of Trichoderma spp. In culture technique, the isolates TAG-2, TAG-13 and TAG-10 showed maximum mycelium inhibition percentage of (81.36, 78.51 and 75.97, respectively) against A. niger.

W http://14.139.51.37/centrallibrary/admin/book/fc2f92fd41Manju%20Pawanda%20(M.Sc.%20Ag)%20Plant%20 ...

50/103	SUBMITTED TEXT	30 WORDS	67%	MATCHING TEXT	30 WORDS

The observations on the mycelial growth were recorded after seven days of incubation and the results obtained are presented in Table 4.4. The results

The observations on myceliumgrowth and per cent growth inhibition (PGI) recorded after seven days of incubation and the results obtained are presented in Table 3 and The results

W https://www.researchgate.net/publication/315972547_Bio-Efficacy_of_Trichoderma_Spp_And_its_Liquid ...

52/103	SUBMITTED TEXT	14 WORDS	84%	MATCHING TEXT	14 WORDS

was carried out in the Department of Plant Pathology at College of Agriculture,

SA Roshan Joy.pdf (D108814714)

51/103	SUBMITTED TEXT	38 WORDS	87%	MATCHING TEXT	38 WORDS

bulbs inoculated with A. niger showed loss in weight as compared to uninoculated bulbs at 15, 30, 45 and 60 days after inoculation. Maximum physiological weight loss was recorded in white onion (11.25g and 22.87%) followed by

bulbs inoculated with A. niger showed loss in weight as compared to uninoculated bulbs at 30, 60 and 90 days after inoculation. Highest per cent physiological weight loss was recorded in Gujarat Anand white onion-3 variety (10.48 g and 16.70%) followed by

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

Curiginal

53/103	SUBMITTED TEXT	15 WORDS	100%	MATCHING TEXT	15 WORDS

Storage rot fungi and seed-borne pathogens of onion. Journal of Science and Technology., 35(2): 13-21.

Storage rot fungi and seed-borne pathogens of onion | Journal of Science and Technology (

W https://www.ajol.info/index.php/just/article/view/124076

54/103	SUBMITTED TEXT	39 WORDS	100%	MATCHING TEXT	39 WORDS

Patil, R. K. and Prajapati, B. K. (2017). Effect of Trichoderma spp. and its culture filtrate antagonists on growth and management of Rhizopus rot of tomato fruit in vitro and in vivo. Journal of Pharmacognosy and Phytochemistry., 6(4): 394-398.

Patil, R. K. and Prajapati, B. K. 2017. Effect of Trichoderma spp. and its culture filtrate antagonists on growth and management of Rhizopus rot of tomato fruit in vitro and in vivo. Journal of Pharmacognosy and Phytochemistry. 6(4): 394-398.

W https://www.ijcmas.com/9-10-2020/Vidhi%20Chamoli,%20et%20al.pdf

57/103	SUBMITTED TEXT	24 WORDS	100%	MATCHING TEXT	24 WORDS

Ara, M.A.M., Khatun, M. L. and Ashrafuzzaman, M. (2008). Fungi causing rots in onions at storage and market. J. Bangladesh Agril. Univ., 6(2): 245–251.

Ara M.A.M., Khatun M.L. and Ashrafuzzaman M. (2008)., Fungi causing rots in onions at storage and market., J. Bangladesh Agril. Univ., 6(2), 245-251.

W http://www.isca.in/IJBS/Archive/v6/i1/4.ISCA-IRJBS-2016-148.php

59/103	SUBMITTED TEXT	28 WORDS	96%	MATCHING TEXT	28 WORDS

Arowora, K. A. and Adetunji, C. O. (2014). Antifungal effects of crude extracts of Moringa oleifera on Aspergillus niger associated with post-harvest rot of onion bulb. 1(2): 214-223.

Arowora K.A. and Adetunji C.O. (2014)., Antifungal Effects of crude extracts of Moringa oleifera on Aspergillus niger V. Tieghem associated with post harvest rot of onion bulb.,

W http://www.isca.in/IJBS/Archive/v6/i1/4.ISCA-IRJBS-2016-148.php

55/103	SUBMITTED TEXT	24 WORDS	97%	MATCHING TEXT	24 WORDS

Sen B and Awasthi J. (1990) Role of temperature and pH in antagonism of Aspergillus niger and Trichoderma viride against Fusarium solani. Indian

Sen B and Awasthi J (1990). Role of temperature and pH in antagonism of Aspergillus niger and Trichoderma viride against Fusarium solani. Proc. Indian

W https://www.researchgate.net/publication/315972547_Bio-Efficacy_of_Trichoderma_Spp_And_its_Liquid ...

Curiginal

56/103	SUBMITTED TEXT	24 WORDS	88%	MATCHING TEXT	24 WORDS

K. and Bhadauria, R. (2010). Antifungal activity of plant products against Aspergillus niger: A potential application in the control of a spoilage fungus.

K., Gautam and R. Bhadauria (2010). Antifungal activity of plant products against Aspergillus niger: A potential application in the control of a spoilage fungus.

W http://14.139.51.37/centrallibrary/admin/book/fc2f92fd41Manju%20Pawanda%20(M.Sc.%20Ag)%20Plant%20 ...

61/103	SUBMITTED TEXT	22 WORDS	100%	MATCHING TEXT	22 WORDS

Baig M., Fatima S., Kadam V. B. and Shaikh Y. (2012). Utilization of antagonist against seed borne fungi. Trends in Life

SA STUDIES ON SEEDBORNE MYCOFLORA OF SELECTED VEGETABLES AND THEIR BIOCONTROL by Ms. Manisha Arun Pa ... (D33775063)

58/103	SUBMITTED TEXT	45 WORDS	98%	MATCHING TEXT	45 WORDS

Bashir, L. U., Gashua, I. B., Isa, M. A. and Ali, A. (2013). The antifungal activity of aqueous and ethanol extracts of Jatropha curcas against Aspergillus niger Van Tieghem. that cause black mould rot of onion bulbs in Sokoto, Nigeria. International Journal of Environment. 2(1):83-90.

Bashir L.U., Gashua I.B., Isa M.A. and Ali A. (2013)., The antifungal activity of aqueous and ethanol extracts of Jatropha curcas L. against Aspergillus niger (Van Tieghem) that cause black mould rot of onion bulbs in Sokoto, Nigeria., International Journal of Environment, 2(1), 83-90,

W http://www.isca.in/IJBS/Archive/v6/i1/4.ISCA-IRJBS-2016-148.php

63/103	SUBMITTED TEXT	16 WORDS	83%	MATCHING TEXT	16 WORDS

Molecular characterization and management of Aspergillus niger causing black mould of garlic, Allium sativum L.

Molecular characterization and management of Aspergillus niger Van Tieghem causing black mold of garlic (Allium sativum L.) •

W https://www.semanticscholar.org/paper/Post-harvest-management-of-black-mould-rot-of-onion-Shanmug ...

60/103	SUBMITTED TEXT	13 WORDS	100%	MATCHING TEXT	13 WORDS

The role of phenols in Botrytis brown stains of onion. Phytopath., 65(3): 338-341.

The role of phenols in botrytis brown stains of onion. Phytopath 65: 338-341. 20.

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

Curiginal

65/103	SUBMITTED TEXT	21 WORDS	64%	MATCHING TEXT	21 WORDS

Currah, L, Proctor FJ (1990). Onions in Tropical Regions. Bulletin (No. 35) Natural Resources Institute, Chatham Maritime, Kent, UK : 1-232.

Currah, L. and F.J. Proctor.,1990, Onion in tropical region. Bulletin no.35, Natural Resources Institute, Chatham, Maritime, Kent, UK, 79

W https://www.ijcmas.com/vol-4-6/Vinay%20Kumar,%20et%20al.pdf

62/103	SUBMITTED TEXT	19 WORDS	100%	MATCHING TEXT	19 WORDS

Webster, J. (1971). Antagonistic Properties of Species Groups of Trichoderma III Hyphal Interactions. Trans. Br. Mycol. Soc; 57: 363-369.

Webster J. Antagonistic Properties of Species III Hyphal Interactions. Trans. Br. Mycol. Soc. 1971; 57:363-369. 3.

W https://www.researchgate.net/publication/333194224_In-vitro_evaluation_of_Phyto-extracts_and_bio- ...

64/103	SUBMITTED TEXT	27 WORDS	94%	MATCHING TEXT	27 WORDS

Fungi associated with onion (Allium cepa L.) bulb rot and the impact of storage containers on the occurrence of the fungi in market centres, Tamale, Ghana.

Fungi associated with onion (Allium cepa L.) bulb rot and the impact of storage containers on the occurrence of the fungi in market centers, Tamale, Ghana

W https://www.researchgate.net/publication/278301917_Post_Harvest_Management_of_Fungal_Diseases_in_ ...

72/103	SUBMITTED TEXT	32 WORDS	53%	MATCHING TEXT	32 WORDS

Futane A. S., Dandnaik B. P., Jadhav P. P. and Salunkhe S. S. (2018). Management of storage diseases of onion by using different botanicals. Int. J. Curr. Microbiol. App. Sci. 7(3): 3708-3719.

Futane, A.S., B.P. Dandnaik, S.S. Salunkhe, P.P. Jadhav and Magar, S.J. 2018. Management of Storage Diseases of Onion by Using Different Fungicides and Antibiotics. Int.J.Curr.Microbiol.App.Sci. 7(02): 1149-1158.

W https://www.ijcmas.com/7-2-2018/A.S.%20Futane,%20et%20al.pdf

66/103	SUBMITTED TEXT	31 WORDS	100%	MATCHING TEXT	31 WORDS

H. P. and Vakharia D. N. (2012). Production of lytic enzymes by Trichoderma isolates during in vitro antagonism with Aspergillus niger, the causal agent of collar rot of peanut. Brazilian

H.P. and Vakharia, D.N. (2012). Production of lytic enzymes by Trichoderma isolates during in vitro antagonism with Aspergillus niger, the causal agent of collar rot of peanut. Brazilian.

W http://14.139.51.37/centrallibrary/admin/book/fc2f92fd41Manju%20Pawanda%20(M.Sc.%20Ag)%20Plant%20 ...

Curiginal

67/103	SUBMITTED TEXT	21 WORDS	91%	MATCHING TEXT	21 WORDS

Sharma, S., Avasthi, S. and Bhadauria, R. (2011). Diversity, pathogenicity and toxicology of Aspergillus niger : An important spoilage fungi.

Sharma S., Avasthi, S. and Bhadauria, R. (2011) Diversity, Pathogenicity and Toxicology of A.niger An Important spoilage fungi.

W http://14.139.51.37/centrallibrary/admin/book/fc2f92fd41Manju%20Pawanda%20(M.Sc.%20Ag)%20Plant%20 ...

68/103	SUBMITTED TEXT	27 WORDS	100%	MATCHING TEXT	27 WORDS

Kadam, T. S., Khalikar, P. V. and Nikam, P. S. (2011). Survey and surveillance of collar rot of groundnut caused by Sclerotium rolfsii in Marathwada region.

Kadam, T.S. Khalikar, P.V. and Nikam, P.S. (2011). Survey and surveillance of collar rot of groundnut caused by Sclerotium rolfsii in Marathwada region.

W http://14.139.51.37/centrallibrary/admin/book/fc2f92fd41Manju%20Pawanda%20(M.Sc.%20Ag)%20Plant%20 ...

69/103	SUBMITTED TEXT	17 WORDS	87%	MATCHING TEXT	17 WORDS

Effect of artificial injuries and fresh neck cutting against black mould (Aspergillus niger) on onion bulb.

Effect of arti?cial injuries and fresh neck cutting against black mould (aspergillus niger) on onion bulb.

W https://www.researchgate.net/publication/306038607_Studies_on_Effect_of_A_niger_on_Physiological_ ...

70/103	SUBMITTED TEXT	22 WORDS	100%	MATCHING TEXT	22 WORDS

Studies on fungi associated with storage rot of onion (Allium cepa L.) and garlic (Allium sativum L.) bulbs in Odisha, India.

Studies on fungi associated with storage rot of onion (Allium cepa L.) and garlic (Allium sativum L.) bulbs in Odisha, India -

W http://www.isca.in/IJBS/Archive/v6/i1/4.ISCA-IRJBS-2016-148.php

71/103	SUBMITTED TEXT	21 WORDS	92%	MATCHING TEXT	21 WORDS

Mushtaq, S. (2012). Biological control of Aspergillus niger, the cause of Black-rot disease of Allium cepa L. (onion), by Penicillium

Mushtaq., 2013, Biological control of Aspergillus niger the cause of Black -rot disease of (Allium cepa L).Onion by Penicillium

W https://www.researchgate.net/publication/278301917_Post_Harvest_Management_of_Fungal_Diseases_in_ ...

Curiginal

77/103	SUBMITTED TEXT	20 WORDS	85%	MATCHING TEXT	20 WORDS

Koycu, N. D. and Ozer (1997). Determination of seedborne fungiin onion and their transmission to onion sets. Phytoparasitica., 25(1): 25-31.

Koycu, N.D. and Ozer, N. (1997). Determination of seedborne fungi in onion and their transmission to onion sets. Phytoparasitica, 25,

W http://healthdocbox.com/Nutrition/94929455-Mycotoxins-in-fruits-and-vegetables.html

73/103	SUBMITTED TEXT	38 WORDS	84%	MATCHING TEXT	38 WORDS

Kulfinski, F. B., Pappelis, A. J. and Pappelis, G. A. (1973). The effects of Botrytis allii and A. niger on nuclei of onion bulb scale epidermis. Shokubutsu Byogai Kenkyu (Forsch. Gebiet Pflanzenkrankh.) Kyoto 8: 103-114. Kumar, A. and

Kulfinski, F. B., Pappelis, A. J., and Pappelis, G. A., 1973. The effects of Botrytis a11and Asper gillus niger on nuclei of onion bulb scale epidermis. Shokubutsu Byogai Kenkyu (Forsch. Gebiet Pflanzenkrankh.) Kyoto 8: 103-114. Narain, A., and

W https://www.jstage.jst.go.jp/article/cytologia1929/43/2/43_2_411/_pdf/-char/en

74/103	SUBMITTED TEXT	11 WORDS	100%	MATCHING TEXT	11 WORDS

Post-harvest management of fungal diseases in onion - A Review

Post Harvest Management of Fungal Diseases in Onion - A Review

W https://www.researchgate.net/publication/278301917_Post_Harvest_Management_of_Fungal_Diseases_in_ ...

78/103	SUBMITTED TEXT	23 WORDS	81%	MATCHING TEXT	23 WORDS

Collar rot (Aspergillus niger) a serious disease of groundnut, its present status and future prospects. IJCS. 5(4):914-919. Kumari Manju and Mahabeer Singh (2017).

Collar rot (Aspergillus niger) a serious disease of groundnut, its present status and future prospects Manju Kumari, Dr. Sharma and Mahabeer singh

W https://www.chemijournal.com/archives/2017/vol5issue4/PartN/5-4-150-426.pdf

75/103	SUBMITTED TEXT	14 WORDS	88%	MATCHING TEXT	14 WORDS

Investigation of disease occurrence and pathogenicity test of A. niger causing collar rot

Investigation of disease occurrence and pathogenicity test of Aspergillus niger causing collar rot

W https://www.researchgate.net/publication/342834240_Collar_rot_Aspergillus_niger_a_serious_disease ...

Curiginal

76/103	SUBMITTED TEXT	22 WORDS	84%	MATCHING TEXT	22 WORDS

Dar, M. (2012). Antagonistic potentiality of Trichoderma harzianum against Cladosporium spherospermum, Aspergillus niger and Fusarium oxysporum. J. Bio. Agri. Healthcare, 2(8): 72-76.

Dar MS. Antagonistic Potentiality of Trichoderma harzianum against Cladosporium spherospermum, Aspergillus niger and Fusarium oxysporum. J Biol. Agri. Healthcare

W https://www.researchgate.net/publication/333194224_In-vitro_evaluation_of_Phyto-extracts_and_bio- ...

83/103	SUBMITTED TEXT	25 WORDS	56%	MATCHING TEXT	25 WORDS

Maini, S. B. and Chakravarty, A. K. (2000). Post-harvest management of onion and garlic. In: souvenir, national symposium on onion and garlic: production and

Maini, S.B. and A.K. Chakrabarti. (2000). Post-harvest management of onions and garlic, Souvenir, National Sym. on onion and garlic prod. and

W https://www.arccjournals.com/uploads/articles/R3442.pdf

79/103	SUBMITTED TEXT	21 WORDS	100%	MATCHING TEXT	21 WORDS

Management of diseases of onions and garlic. In Diseases of fruits and vegetables. Eds. Naqvi SAMH. Kluwer Academic Publishers. The

Management of diseases of onions and garlic. In Diseases of fruits and vegetables. Eds. Naqvi SAMH. Kluwer Academic Publishers. The

W https://www.researchgate.net/publication/278301917_Post_Harvest_Management_of_Fungal_Diseases_in_ ...

80/103	SUBMITTED TEXT	31 WORDS	94%	MATCHING TEXT	31 WORDS

Dehimat, A. (2014) In vitro and In vivo efficiency of T. harzianum against Rhizopus soft rot occurred on tomato fruits (Lycopersicon esculentum). Agriculture and Biology Journal of North America. 5(6): 240-244.

Dehimat A. In vitro and in vivo efficiency of Trichoderma harzianum against Rhizopus soft rot occurred on tomato fruits (Lycopersicon esculentum). Agriculture and Biology Journal of North America. 2014; 5(6):240-244. 8.

W https://www.researchgate.net/publication/318910492_Effect_of_Trichoderma_Spp_and_its_culture_filt ...

81/103	SUBMITTED TEXT	31 WORDS	73%	MATCHING TEXT	31 WORDS

S., Shehu, K. and Amusa, N. A. (2004). Survey of the market diseases and aflatoxin contamination of fruits & vegetables in Sokoto. North Western Nigeria. Nutrition & food Science. 34(2): 72-76.

S., Shehu K. and Amusa N.A. (2004)., Survey of the market Diseases and aflatoxin contamination of tomato (Lycopersicon escolentus Mill.) fruits Sokoto, Northwestern Nigeria., Nutrition food science, 34 (2), 72-76,

W http://www.isca.in/IJBS/Archive/v6/i1/4.ISCA-IRJBS-2016-148.php

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82/103	SUBMITTED TEXT	37 WORDS	100%	MATCHING TEXT	37 WORDS

Nandeesha, B. S., Kumar, M. R. and Reddy N. P. E. (2013). Evaluation of different fungicides and their compatibility with potential Trichoderma spp. for the management of Aspergillus niger, Incitant of collar rot of groundnut. Asian

Nandeesha, B. S. Kumar, M. R. and Reddy, N. P. E. (2013). Evaluation of different fungicides and their compatibility with potential Trichoderma spp. for the management of Aspergillus niger, incitant of collar rot of groundnut. Asian.

W http://14.139.51.37/centrallibrary/admin/book/fc2f92fd41Manju%20Pawanda%20(M.Sc.%20Ag)%20Plant%20 ...

85/103	SUBMITTED TEXT	16 WORDS	89%	MATCHING TEXT	16 WORDS

M. and Lakshmi N. (2007) Toxic spectrum of Aspergillus niger causing black mould rot of

M. and Lakshmi, N. (2007). Toxic spectrum of Aspergillus niger rot of

W https://www.researchgate.net/publication/291808814_In_Vitro_Evaluation_Of_Selected_Plant_Extracts ...

89/103	SUBMITTED TEXT	22 WORDS	78%	MATCHING TEXT	22 WORDS

Nene, Y. L. and P. N. Thapliyal. (1979). Fungicides in plant disease control. Oxford and IBH Publishing Co., New Delhi, 11

SA STUDIES ON SEEDBORNE MYCOFLORA OF SELECTED VEGETABLES AND THEIR BIOCONTROL by Ms. Manisha Arun Pa ... (D33775063)

84/103	SUBMITTED TEXT	13 WORDS	100%	MATCHING TEXT	13 WORDS

Investigation of microorganisms associated with the spoilage of onions around Dutsinma Metropolis.

Investigation of Microorganisms Associated with the Spoilage of Onions around Dutsinma Metropolis

W https://www.researchgate.net/publication/290603587_Fungi_Associated_with_Storage_Rots_of_Onion_Bu ...

92/103	SUBMITTED TEXT	11 WORDS	100%	MATCHING TEXT	11 WORDS

Wani, A. H., Bhat, M. Y., Pala, S. A. and

SA STUDIES ON SEEDBORNE MYCOFLORA OF SELECTED VEGETABLES AND THEIR BIOCONTROL by Ms. Manisha Arun Pa ... (D33775063)

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86/103	SUBMITTED TEXT	13 WORDS	87%	MATCHING TEXT	13 WORDS
and Management of Aspergillus niger Van Tieghem causing black mold rot of			and management of Aspergillus niger Van Tieghem causing black mold of		

W https://www.semanticscholar.org/paper/Post-harvest-management-of-black-mould-rot-of-onion-Shanmug ...

87/103	SUBMITTED TEXT	13 WORDS	100%	MATCHING TEXT	13 WORDS
Black Mould Rot: An important post-harvest disease of onion and its management,			Black Mould Rot: An Important Post Harvest Disease of Onion and Its Management		

W https://www.researchgate.net/publication/277279299_Black_Mould_Rot_An_Important_Post_Harvest_Dise ...

88/103	SUBMITTED TEXT	11 WORDS	100%	MATCHING TEXT	11 WORDS
In vitro evaluation of Phyto-extracts and bio-agent against Aspergillus niger.			In-vitro evaluation of Phyto-extracts and bio- agent against Aspergillus niger		

W https://www.researchgate.net/publication/333194224_In-vitro_evaluation_of_Phyto-extracts_and_bio- ...

93/103	SUBMITTED TEXT	18 WORDS	90%	MATCHING TEXT	18 WORDS
Rao, C. V. and Rajasab, A. H. (1992). Investigations on black mould (Aspergillus niger) of onion. Onion			Rao, C.V. and Rajasab, A.H. (1992) Investigations on black mold (Aspergillus niger) of onion. Onion		

W https://www.researchgate.net/publication/226681205_Storability_of_Onion_Bulbs_Contaminated_by_Asp ...

90/103	SUBMITTED TEXT	31 WORDS	83%	MATCHING TEXT	31 WORDS
In vitro evaluation of selected plant extracts as biocontrol agents against black mould (Aspergillus niger Van Tieghem) of onion bulbs (Allium Cepa L.) International Journal of Scientific and Technology Research, 5:147-152.			In Vitro Evaluation Of Selected Plant Extracts As Biocontrol Agents Against Black Mold (Aspergillus Niger Van Tieghem) Of Onion Bulbs (Allium Cepa L.)International Journal of Scientific & Technology Research 5(1):147-152 ·		

W https://www.researchgate.net/publication/291808814_In_Vitro_Evaluation_Of_Selected_Plant_Extracts ...

91/103	SUBMITTED TEXT	15 WORDS	100%	MATCHING TEXT	15 WORDS
Salvestrin J. and Letham D. (1994). The control of Aspergillus niger in Australia. Acta			Salvestrin J and Letham D. 1994. The control of Aspergillus niger in Australia. Acta		

W https://www.researchgate.net/publication/277279299_Black_Mould_Rot_An_Important_Post_Harvest_Dise ...

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97/103	SUBMITTED TEXT	18 WORDS	93%	MATCHING TEXT	18 WORDS

Frisvad (2004). New ochratoxin A or sclerotium producing species in Aspergillus section Nigri Studies in Mycology, 50: 45–61.

Frisvad JC (2004). "New ochratoxin A or sclerotium producing species in Aspergillus section Nigri" (PDF). Studies in Mycology. 50: 45–6. • ^

W https://en.wikipedia.org/wiki/Aspergillus_niger

101/103	SUBMITTED TEXT	16 WORDS	76%	MATCHING TEXT	16 WORDS

Sharma Ruchi (2012). Pathogenicity of a Aspergillus niger in plants Cibtech Journal of Microbiology. 1(1): 47-51.

Sharma, R. 2012. Pathogenicity of Aspergillus niger in plants. Cibtech Journal of Microbiology.

W https://wiki.bugwood.org/Aspergillus_niger

94/103	SUBMITTED TEXT	17 WORDS	90%	MATCHING TEXT	17 WORDS

and its management, An M. Sc. (Agri.) Thesis submitted to Anand Agricultural University, Anand, Gujarat., : 1-82

and its M. Sc. (Agri.) thesis submitted to Anand Agricultural University, Anand, Gujarat, 2014. 9.

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95/103	SUBMITTED TEXT	29 WORDS	86%	MATCHING TEXT	29 WORDS

Sinclair, P. J. and Letham, D. B. (1996). Incidence and sites of visible infection of Aspergillus niger on bulbs of two onion onion cultivars. Aust. Plant Pathol., 25: 8-11.

Sinclair, P.J. and Letham, D.B. (1996). Incidence and sites of visible infection of Aspergillus niger on bulbs of two onion (cepa) cultivars. Australasian Plant Pathol., 25,

W http://healthdocbox.com/Nutrition/94929455-Mycotoxins-in-fruits-and-vegetables.html

96/103	SUBMITTED TEXT	18 WORDS	100%	MATCHING TEXT	18 WORDS

Srinivasan, R. and Shanmugam, V. (2006). Post-harvest management of black mould rot of onion. Indian Phytopathology., 59: 87-93.

Srinivasan, R. and Shanmugam, V., 2006, Post harvest management of black mould rot of onion. Indian Phytopathology.59 (3): 333 -339.

W https://www.researchgate.net/publication/278301917_Post_Harvest_Management_of_Fungal_Diseases_in_ ...

Curiginal

98/103	SUBMITTED TEXT	22 WORDS	90%	MATCHING TEXT	22 WORDS

Influence of fertilizers host factor and storage conditions in relation to disease severity a case study of black mould of onion.

Influence of fertilisers, host factors and storage conditions in relation to disease severity: A case study of black mould rot of onion

W https://www.researchgate.net/figure/Effect-of-relative-humidity-on-black-mould-rot-of-onion-bulbs ...

99/103	SUBMITTED TEXT	25 WORDS	91%	MATCHING TEXT	25 WORDS

Tyson, J. L. and Fullerton, R. A. (2004). Effect of soil born inoculum on incidence of onion black mould (Aspergillus niger) New Zealand Plant

Tyson, J.L. and Fullerton, R.A. (2004). Effect of soil-borne inoculum on the incidence of onion black mould (Aspergillus niger). New Zealand Plant

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100/103	SUBMITTED TEXT	17 WORDS	100%	MATCHING TEXT	17 WORDS

Isolation and identification of fungal pathogens associated with diseases of onion crop in district Swat, Pakistan.

Isolation and Identification of Fungal Pathogens Associated with Diseases of Onion Crop in District Swat, Pakistan

W https://www.researchgate.net/publication/226681205_Storability_of_Onion_Bulbs_Contaminated_by_Asp ...

103/103	SUBMITTED TEXT	18 WORDS	87%	MATCHING TEXT	18 WORDS

J. Life Sci., 2 (2): 91-99. Vavilov, N. I. (1926). Studies on the origin of cultivated plants.

SA Botany, INGALE SUNITA TUKARAM PhD Thesis pdf.pdf (D48618519)

102/103	SUBMITTED TEXT	36 WORDS	100%	MATCHING TEXT	36 WORDS

Wani, A. H. and Taskeen-Un-Nisa (2011). Management of black mold rot of onion Mycopath. 9(1): 43-49.

Wani, A.H. and Taskeen-Un-Nisa (2011). Management of black mold rot of onion. Mycopath 9(1):43-49.

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