STUDIES OF ONION INFLORESCENCE BLIGHT INCITED BY <u>BOTRYTIS</u> <u>ALLII</u> MUNN IN IRAQ

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MOUHAMED ABDUL - KHALIK AL-HAMDANY

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I certify that this thesis was prepared under my supervision at the university of Baghdad as a partial requirement for the degree of Master of Science in Plant Protection (Pathology).

Signature: Khalid M Hameed
Advisor: Khalid M. Hameed
Date : 10 June 1975

Signature: Sadic Al-Hassan
Advisor: Dr. S. Al-Hassan
Date : 10 June 1975

In view of the available recommendations I forward this thesis for debate by the Examining Committee.

Signature: Sadic Al-Hassan
Name: S. Al-Hassan
Chairman of the Departmental on Graduate Studies in Agriculture.
Date: 10 June 1975

We certify that we have read this thesis and as Examining Committee the student in its content and that in our opinion it is adequate with Excellent standing as a thesis for the degree of Master of Science in Plant Protection (Pathology).

Signature: Khalid M. Hameed
Name: Khalid M. Hameed
(Member)

Signature: ______________
Name: ______________
(Member)

Signature: A. S. al-Beldawi
Name: Dr. A. S. Al-Beldawi
(Member)

Signature: Sadie Al-Hassan
Name: Dr. S. Al-Hassan
(Chairman)

Approved for the University Committee on Graduate Studies.

Signature: ______________

Name: ______________

Dean of Agricultural College.

Date: ______________

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INTRODUCTION

Onion has been considered as an important crop in Iraq. During 1969-1970, the cultivated area to this crop was about 23700 acres while the total consumption was 141767 ton, the total onion yield in the same time was 133771 ton. Onion cultivation includes three main steps; planting of dry seeds to form onion sets, cultivation of onion sets to obtain bulbs, and then planting bulbs to obtain the flowering stage and harves dry seeds.

There was a high investment at the Great Mussayab Project to produce onion dry seeds by using a favored cultivar called Gieza 6. This variety gave considerably high yield of seed and bulb during the first cycle of cultivation. But, in the following years the yield dropped-off sharply because of the inflorescence blight disease. The distal part of the inflorescence stalks of this variety was invaded by Botrytis allii Munn inciting a severe blight to the floral parts before and after opening of the umble.

This disease is locally called by the name "Bayud", when the white coloration of the infected part appears. The present investigations were undertaken to study the followings: a) the squence of the disease development of the inflorescence stalks in six cultivars, namely; local varieties (Red, White, Bashiqa), Indian variety (Posared), Grano, and Geiza 6. b) Disease resistance of these cultivars at different stages of their development, c) Disease resistance of onion bulbs of the six cultivars under storage conditions. d) The manner in which this disease has been introduced and its epidimiology. e) A biological study of the causal organism under laboratory conditions, including; the effects of temperature, and the type of media upon which the fungus is grown.

LITERATURE REVIEW

Isolation of Botrytis spp:

The first isolation of *B. allii* was obtained by Munn in 1917 from infected onion bulbs and from discolored leaf tip or leaf blast, also Walker in 1926 isolated the same species from onion bulbs infected with neck rot disease, in storage and from leaf blast. Hickman and Answorth in 1943, found that many species of the genus Botrytis infect onion leaves but the most common one was *B. Squamosa*. The first isolation of *B. allii* from blighted inflorescence of onion was made by Blodgett in 1946 in the United States.

In Egypt, Abdul Salam in (1948) isolated the fungus *Botrytis* sp. along with other fungi from onion inflorescences which had become dry and exhibited dead flowers in the fields. Owen et al., in 1950 and Roed at the same year isolated *B. allii* from onion bulbs which had been cultivated in 1947 near Racine, Wisconsion and had been stored at 40°F for 10 months. Mackeen in 1951 found that *B. allii* causes, in May and early June in 1948, a serious loss in fields of Spanish onions in Leamington, Ontario. Bakry in 1952 and in 1953 isolated B. allii and B. squamosa from onion which was under storage in Egypt. Viennot-Bourgin (1952) is considered as the first who reported that B. squamosa, causes a firing of the tips on white onion variety.

Small sclerotia of the neck-rot fungus, B. squamosa were isolated from the margins of discrete, gryish-white depressed spot on the green leaves of bulbing onion which were grown at Bradford, Ontario (Page, 1955).

Air-Born Conidia of Botrytis spp.

Conidia of B. allii become air-born and get disseminated by wind to un-infected onion fields, (Walker, 1926). Hyde and Williams in 1949, exposed Sabouraud's Agar plates, to the open air on a weekday for ten minutes in mid-July. They counted on those plates 2988 colonies among them there were 69 colonies of Botrytis sp. Botrytis conidia were also isolated on spore traps in a flight over Atlantic Ocean (Pady and Kelly, 1954).

Lorbeer in 1966, isolated the conidia of B. squamosa by spore trapping from the air above onion fields in Florida. He reported that trapping occured during 36-hrs. of continuous exposure at 97% relative humidity at day time.

Sporulation of the Botrytis spp.

B. allii produced relatively sparse extramatrical mycelium and a low, dense, gray growth of the conidiophores and conidia with relatively little aerial mycelium. It was also found by the same auther that conidia of B. allii were measuring in the range of (4x6) - (8x16)u with most spores falling within the limits of (5x8) - (6x10)u (Walker, 1926).

Owen in 1948, reported that B. allii sporulated readily on all media used. Hancock and Lorber in 1962, were in full agreement with Walker about the size of conidia and they also showed that B. byssoidea did not produce either conidia nor sclerotia, but it was characteristic of B. allii to produce white colony, aerial mycelium. Follstad in 1966, found that most isolates of B. allii produced spores in five days when incubated under natural conditions, but there were no spores development in 1% or less oxygen. Maximum yield of B. cinerea mycelium were obtain at a relatively low temperature; in the range of 15^{0} to $30^{0}C$, (King et. al., 1969). Hyre in 1972, found that there were no significant differences in sporulation of Botrytis on Gerahium in light versus darkness at $20^{0}C$. He also, showed that sporulation of Botrytis increased as the temperature was increased from $10^{0}C$ to $25^{0}C$. A large lesion on Geranium leaves and more conidia occurred at $25^{0}C$ than at $20^{0}C$. Bergquist et al., 1972 pointed out that temperature above $25^{0}C$ inhibited the conidization of B. squamosa and the fungal growth inhibited at $32^{0}C$ of incubation.

Sclerotia Formation of Botrytis spp.

In the B. allii mycelium mats sometimes appear hard black bodies (solerotia), about the size of a barley kernal, they were made up of finely woven fungus hyphae, which can survive freezing winter weather (Walker, 1926). Owen in 1948, found that one isolate of B. byssoidea produced sclerotia on PDA when incubated at $4-12^{0}C$, for 30 days. The addition of 0.5% uranium nitrate have induced sclerotium formation at higher temperature, than at the $12^{0}C$. The same treatment of uranium nitrate caused no effect on sclerotium formation of B. allii. Owen et al., in 1959, showed that the upper half of the onion bulb, naturally infected in storate, was completely covered with conidiophores and conidia B. allii.

Black sclerotia were also numerous around the neck part of the bulbs. No precise measurements of the sclerotia produced by B. allii are available. However, Joshi and Sigh in 1967, reported that the size of sclerotia of B. cinerea were (0.5 to 0.8) x (1.5 to 4) mm in size.

A maximum rate of germination of sclerotia of B. tulipea was observed on agar at 25°C. But, when paper and soil were used as a medium the maximum sclerotia germination was reached at 5°C. There was no direct effect of moisture or pH on germination (Coley and Javed, 1972). Ryabsteva in 1972 pointed out that large sclerotia of B. cinerea were formed at 20°C and the smallest were observed at 3°C.

Mode of Infections By Botrytis spp.

Species of the genus Botrytis are well known saprophytes, some of these species become destructive pathogens which still live saprophytically on the dead tissues of their host plant. Conidia of

B. allii germinate on senescent plant parts or leaves which were dropped-off as the plant develops (Walker, 1926). Owen, et al. in 1949, used heavy spores suspension of *B. allii* sprayed directly on the onion plants as direct method of inoculating the leaves. Inoculation by *B. squamosa* was made by transfering small pieces of the culture on the leaf surface or by puncturing the plant tissue and introducing the inoculum into the wounded tissues (Viennot-Bourgin, 1952). Baker, et,al., in 1953, found that the leaf tip burn of column stalks which was caused by accumulation of soluble salt through evaporation of gutation drops, provided favorable infection courts for *B. cinerea* developed rot only after the fungus had established itself on a adhering dead floral parts. Style that had failed to dehisce also provided avenues of infection (Ogaw and Harley 1960). Powelson in 1960, reported that the clayx of the strawberry fruits were the primary pathway of infection by *B. cinerea*, while Netzer and Dishon, 1965 speculated that the spath of umble was the primary way of onion stalk seed infection by *B. allii*.

Diseases Caused by *Botrytis* spp.

Several diseases are incited by *Botrytis* spp. on a different crops and vegetables. Walker in 1926, suggested that the neck rot on onion incited by *B. allii* be designated as gray-mold neck-rot. He added in 1949 that the neck-rot disease on onion in storage appear shortly after harvest as a soft rot of the scale tissue. Tompkin in 1950, found that *B. cinerea* causes serious blight on cut Bouvardia flowers, and in the advanced stages of this disease, the flower became shriveled and deformed. *B. allii* attacks young seedlings of Spanish onion, at or slightly below the surface of the soil (Mc Keen, 1951). Bakry in 1952, reported that *B. allii*, *B. squamosa* and *B. byssoidea* caused a serious disease in Egyption storage of onion, also he considered that *B. allii* was a wound parasite. Blumer in 1952 showed that the inflorescences of Ponisettia may be attacked by *B. cinerea* at full bloom stage.

Viennot in 1952, found that in 1951-1952 near Rennes a firing of the tips of the white onion variety were caused by *B. aquamosa*.

During low-temperature condition, a storage rot of Carnation flowers were found to be caused by *B. cinerea* Pers., this disease was characterized by a water-soaked flecking of the oldest outer petals, followed by browning, molting of petals, and sporulation of the fungus (Gasiorkiewicz, 1957). Segal and Newhall in 1959, reported that the disease was well known in New York and other states. Other names of the disease include "blight", "tip burn" and tip blight of onion leaves. Also they showed that the symptom resulting from B. allii, B. cinerea and B. squamosa may be confused at times with those caused by Thrips, drought, or excessive soil moisture, all of which can cause eventual die back. About the mechanical effect of the fungus the same scientists found that there was no evidence of cuticular or stomatal penetration by the germinating spores of Botrytis spp., and hyphae were not found in the lesions. They showed that a number of Botrytis spp. can cause onion blast, but that B. allii was associated most frequently with onion under field conditions. Jackson in 1960, pointed out that B. cinerea attacks, the inflorescence of statice, Limonium sinuatum Mill and L. bonduelii Mill and rapidly renders them commercially valueless. Ogawa and Harley in 1960, reported that B. cinerea causes a blossom blight on almond varieties, also this fungus plays an important role in the blighting of santa plum blossom, they noted that the infection of petal of almond were enhanced by the presence of pollen which induced rapid conidial germination.

Adam et al., in 1961 reported that B. allii germinated on the onion leaves and grew extensively on the upper epidermis. Mac Wikhey in 1962, found that B. convoluta were the most frequent isolate from crown rot disease plant examined in the fall, winter, and spring months. B. allii was a poor foliar pathogen, producing no lesion on onion leaves or only a limited number even with heavy spore load. Hancock and Lorbeer, in 1962 made a comparative study between species of Botrytis on the basis of their ability to cause leaf spotting, they found that B. allii causes less spotting than B. cinerea or B. squamosa and in other experiments B. allii caused no leaf spots.

Netzer and Dishon in 1965, showed that B. allii causes inflorescence blight on onion in Palastine, this disease occurred at the beginning of the flowering stage, when the spath is still closed around the umble, also they reported that the spath turns yellowish and slightly shrivels at the base of the umble. Umbles affected in that manner do not produce any seeds and the losses due to this disease have reached up to 80% of the expected yield. B. cinerea causing a serious gray-mold of gram (Phaseolus aureus Roxb. in India (Joshi and Singh, 1967). Lytynska-Regina in 1968, and Harrow and Harris in 1969, pointed out that B. allii rot of onion have prevailed incidence on onion under storage conditions. Meer in 1970, showed that the fungus B. allii is a wound parasite and its pathogenicity was rather low. Another effect of B. allii was detected by decreased DNA content and nuclear size, also the disintegration of some nucleii (Kulfinski and Pappelis, 1969). Somasekhara and Pappelis in 1972, reported that when onion tissues were wounded and inoculated with B. allii, nuclei of cells in the epidermal tissues within 1 cm. of these sites moved toward the radial walls of cells around the sites.

Environmental Effect Upon Infection By Botrytis spp.

Infection by Botrytis is greatly affected by environmental conditions. Walker in 1926, reported that the saprophytic stages of B. allii causing neck-rot of onion bulbs was most effective in cool, moist seasons, and he pointed out that if such weather persists into the harvest periods, spores were most abundant and infection is greatest. Owen, et al., in 1949 found that high levels of air moisture greatly increased the occurrence of neck-rot disease caused by B. allii, and severe cases of this disease were especially prominant under wet conditions. Mc Keen in 1951 showed that the infection and decay by B. allii of young onion transplant were greatly influenced by soil temperature. Mortality were six to seven times higher at 15°C than at 25°C. Blumer, in 1952, pointed out that infection of Ponisettia inflorescence by B. cinerea developed slower at 14°C than at 20°C, but the fungus attack was much heavier at the lower temperature. Hunter and Rohbach in 1969, found that the incidence of infection by B. cinerea on Macadamia was positively correlated with; number of hours per week at which temperature ranges between 18° and 22°C, leaf wetness, and relative humidity of 95-100% . Temperatures above 22°C had significant negative correlation with the indcidence of B. cinerea infection. They showed that leaf wetness is more significant than the relative humidity in the incidence and severity of this disease. The degree of infection of onion bulbs by B. allii was strongly influenced by the inoculum density, temperature at which the cultures were stored and by strong duration, and finally the environmental conditions which follow inoculations, (Meer et al. 1970). In Switzerland during a rainy season of 1968, B. cinerea spores were the most frequently isolated and particularly during harvest (Carbaz, 1972).

Resistant Varieties of Onion To B. allii Infection:

White varieties were most easily infected by B. allii causing neck-rot disease. However, yellow and red varieties also the mild varieties of all colors were more susceptible than pungent varieties (Walker, et al. in 1949). Owen et al. 1949, reported that the neck-rot disease of onion was more severe on mild than pungent varieties and among the mild class there were no difference between colored and white varieties as far as disease resistance or susceptibility.

Among the strong class the colored varieties had significantly lower disease indices than white varieties. They suggested that a toxic material may be the primary basis of resistance to neck-rot caused by

B. allii. Meer, et al. in 1970 showed that seedlings of the cultivated onion Allium cepa hardly never showed any resistance to B. allii, while other Allium spp. proved highly resistant, during seedling stage. Red onion varieties showed greatest resistance to B. allii, (Somasckhara and Pappelis, 1972).

Clark and Lorbeer in 1972 found that white and red onion varieties were significantly more resistant to Botrytis brown stain than yellow onion varieties. Netzer and Dishon in 1965, found that only white variety were infected by B. allii causing an inflorescence blight in Palastine. In their comparison between yellow, "Gilboa" and the white varieties, they thought that resistance was due to purely climatic conditions, and to difference in varietal characteristics.

MATERIALS AND METHODS

Source of the Organism Studies:

Diseased onion inflorescence were brought from Hemiar field at the Great Mussayab Project in May 1973. Pieces of those inflorescences were plated after being surface sterilized by dipping for two minutes in mercuric chloride ($HgCl_2$) of 1/1000 dilution followed by washing with sterilized distilled water for five minutes. Some of these inflorescences were washed with sterilized distilled water and then placed inside moist chambers, and incubated at 15°C, 20°C, and 25°C, in an attempt to inhance mycelial growth and conidia formation.

Determination of Growth Rate of Mycelium on Different Media:

Five different media, namely, Potato Dextrose Agar (PDA) freshly prepared, Onion Dextrose Agar (ODA), Corn Meal Agar (CMA), Water Agar (WA), and Rose Bengal Agar (RBA), were used in studying growth rate of the pathogen, *B. allii* isolated from disease plants above, by placing uniform small pieces of fungal growth from PDA-plates in the centre of the dish. The cultures were incubated at 25°C and observed daily.

The mean colony diameter (MCD) was measured two days after inoculation, and recorded in millimeters. Growth measurements given are the means of three replicates.

<u>Effect of Temperature Upon Mycelial Growth and Sclerotia Formation:</u>

The effect of the incubation-temperature on the growth of the fungal mycelium and the formation of sclerotia was studied. Cultures of <u>B. allii</u> on PDA were incubated at 10°, 15°, 20°, 25°, 30°, and 35°C. Cultures were secured in polyethylene bags to prevent desiccation. Mean colony diameter of the fungal growth was measured two days after inoculation. Each treatment was replicated three times. The cultures were observed up to 14-15 days for the formation of sclerotia.

<u>Effect of Temperature Upon the Size of Sclerotia of B. allii:</u>

Standardized cultures of <u>B. allii</u> on PDA were incubated at 15°, 20° and 25°C with five plates at each temperature. The cultures were observed for the formation of sclerotia 30 days after inoculation. The diameter of 200 sclerotia were measured in millimeters in plates incubated, using a colony counter set-up.

Effect of B. allii Upon the Onion Seed Germination:

Groups of twenty five dry seeds from the Geiza 6 variety which brought from Great Mussayab Project were subjected to different treatments and plated in sterilized petridishes containing wet filter papper. The treatments were as follows a) surface sterilized seed by dipping in 10% commercial bleach solution containing 0.25% sodium hypochlorate. b) surface sterilized seeds and then inoculated with B. allii conidia suspension. c) surface sterilized seeds and inoculated with B. allii conidia suspension plus detergent. d) non-sterilized seeds (washed with sterilized distilled water only). e) non-sterilized seeds but inoculated with B. allii. f) non-sterilized seeds but inoculated with B. allii plus detergent.

All dishes were incubated on a room bench and at temperature of 20-27^{o}C. Data on seed germination were taken after 12 days of treatment by counting the germinating seed for each petridish and recorded.

Effect of Relative Humidity on the Development of the Inflorescence Blight:

Three concentrations of sulphuric acid in water were prepared, namely; 1.0, 1.25 and 1.40N to give relative humidities of 100%, 70% and 37% respectively. Solutions were housed inside tightly closed desecators to give six desecators for each given humidity. Onion inflorescences (umble) showing no disease symptoms, from Red and Geiza 6 - cultivars collected from the Great Mussayeb Project fields were surface sterilized by dipping in 10% commercial bleach solution containing 0.25% sodium hypochlorate for one minute.

Surface sterilized umbles were divided into two groups, one of which was inoculated by dipping in conidial suspension of B. allii. The inoculum was prepared by blending 20 days-old plate culture of B. allii which was incubated at 20°C with one liter of sterilized distilled water plus soap powder to reduce surface tension. Surface sterilized and inoculated umbles of the two cultivars, were errected inside small beakers placed inside separate desecators. Each desecator contained six umbles, three umbles of each cultivar, and treatments were replicated three times. All desecators were kept in day light at $25^{o}C \pm 4^{o}C$, and observed for the development of the disease symptoms.

The Response of Onion Bulbs From Six Cultivars To B. allii Inoculation Under Storage Conditions:

Onion bulbs from six cultivars namely; local Red, White, and Bashiqa along with imported cultivars, Indian posared, Grano, and Geiza 6, were inoculated and stored in a dark room with $18 \pm 2^{o}C$, and 60% relative humidity. Inoculation was made by dipping the onion bulbs in a conidial suspension of B.allii, and allowed to dry then placed inside polyethylene bags and transfered into the storage room. The bulbs in the control were washed with sterillzed distilled water and stored in the same manner as the other treatments. After 20 days the onion bulbs were brought out and the degree of the bulb rot and fungal infections were evaluated. The disease severity was rated on the basis of the following; 0 = no disease, 1 = little fungal growth and only outer scales affected, 2 = abundance of fungal growth and the bulb was halfway rotted, 3 = bulbs were covered with fungas and $\frac{3}{4}$ of the bulb was destroyed, and

4 = complete destruction.

Green House Work

The Role of Bulb-inoculation and Soil-infestation in Bulbs Germination:

Onion bulbs of six cultivars were made into three batches, in the first batch the bulbs were inoculated by dipping into a conidial suspension of *B. allii*. In the other two batches, bulbs were washed with sterilized distilled water only. Bulbs of the three groups were planted, separately in methyl bromide-treated soil inside seven inch. clay pots, two bulbs per pot. One of the non-inoculated groups received 100 ml. of conidial suspension per pot poured on the soil surface, while the other groups was left as a control. The results of experiment were taken on the basis of bulbs mortality after 270 days.

Field Work:

Three plots were chosen to carry out field work on the nature and development of the inflorescence blight incited by *B. allii*, as well as to screen six different cultivars for their resistance to this disease. Two plots were on the Great Mussayeb Project farms to serve planting in previously infested fields, Hemiar field, and a clean field

Reshaied field which was not planted to onion before. The third plot was set-up at the fields of the college of Agriculture, Abu-Ghraib.

The three plots were designed with 10 meter rows and planted with 50 bulbs per row, placed on both sides of each row. Experimental design was a split plot and randomized Block within each plot and each treatment was replicated four times. Soil and air temperatures as well as air moisture were monitored by setting thermohygrographs at each site equipped with soil probe sensors. Rain fall was also recorded.

<u>Field No. 1 Hemiar:</u>

This plot was set-up at the Great Mussayeb project about 80 km south-west of Baghdad with an area of 40 x 40 meters. It was previously cultivated in 1972-1973 for seed production of Geiza 6. Seed production however has suffered heavy losses due to severe infection with the inflorescence blight fungus. Soil dilution plates made with soil samples from this field revealed heavy infestation with <u>B. allii.</u> Thus the Hemiar-plot was utilized as an infested field, for screening the six cultivars and observing the development of the disease. Half of the plot was planted with Geiza 6 and the other half was cultivated with the six cultivars at random and replicated four times.

Field No. 2 Reshaied:

This field which was about 30 km. to south of Hemiar, was used as a non-infested site. This field was not under cultivation for ten years and had never been cultivated for onion before. Also, no B. allii colonies were observed on the soil dilution plates for soil samples collected therein. This plot was specifically designed to investigate the introduction of the inflorescence blight disease and its further development on the different cultivars. It also served as a control for the first plot at Hemiar.

Field No. 3 Abu-Ghraib:

This plot was laid out at the College of Agriculture, Abu-Ghraib, about 20 km. south east of Baghdad. About half of the field was planted with Geiza 6, while the other half was cultivated with six cultivars, the treatment was utilized in this experiment in which the onion bulbs were inoculated with B. allii (conidia suspension). The treatment was replicated four times and set-up in a randomized.

RESULTS

Source of The Organism Studied:

Piecies of surface sterilized diseased inflorescences plated on PDA, CMA, or stored in wet chamber, showed fungus growth after twenty four hours with dense gray conidia. This fungus was identified as *B. allii* Munn on PDA slant and maintained. The identification of this species was confirmed by Dr.Ellis of the Commonwealth Mycological Institute, Kew, Surrey, England.

Effect of Temperatures Upon Mycelial Growth and Sclerotia Formation of *B. allii*:

The optimum temperature for mycelial growth on PDA was 25^{o}C. The fungus growth however was inhibited at 35^{o}C, as it never exceeded three millimeters after three days of incubation. Figure (1) shows the rates of the fungus growth, four days after inoculation. But until the mycelium covered the area of 95 mm plates incubated at 10^{o}, 15^{o}, 20^{o}, 25^{o}, 30^{o}, and 35^{o}C. The limit was reached by the fungus in 13 , eight, seven, six, and ten days respectively. Sclerotia began to show among the dense mycelium mats 12 days at 25^{o}C and 14 days at 15^{o}C after inoculation. These structures started as small

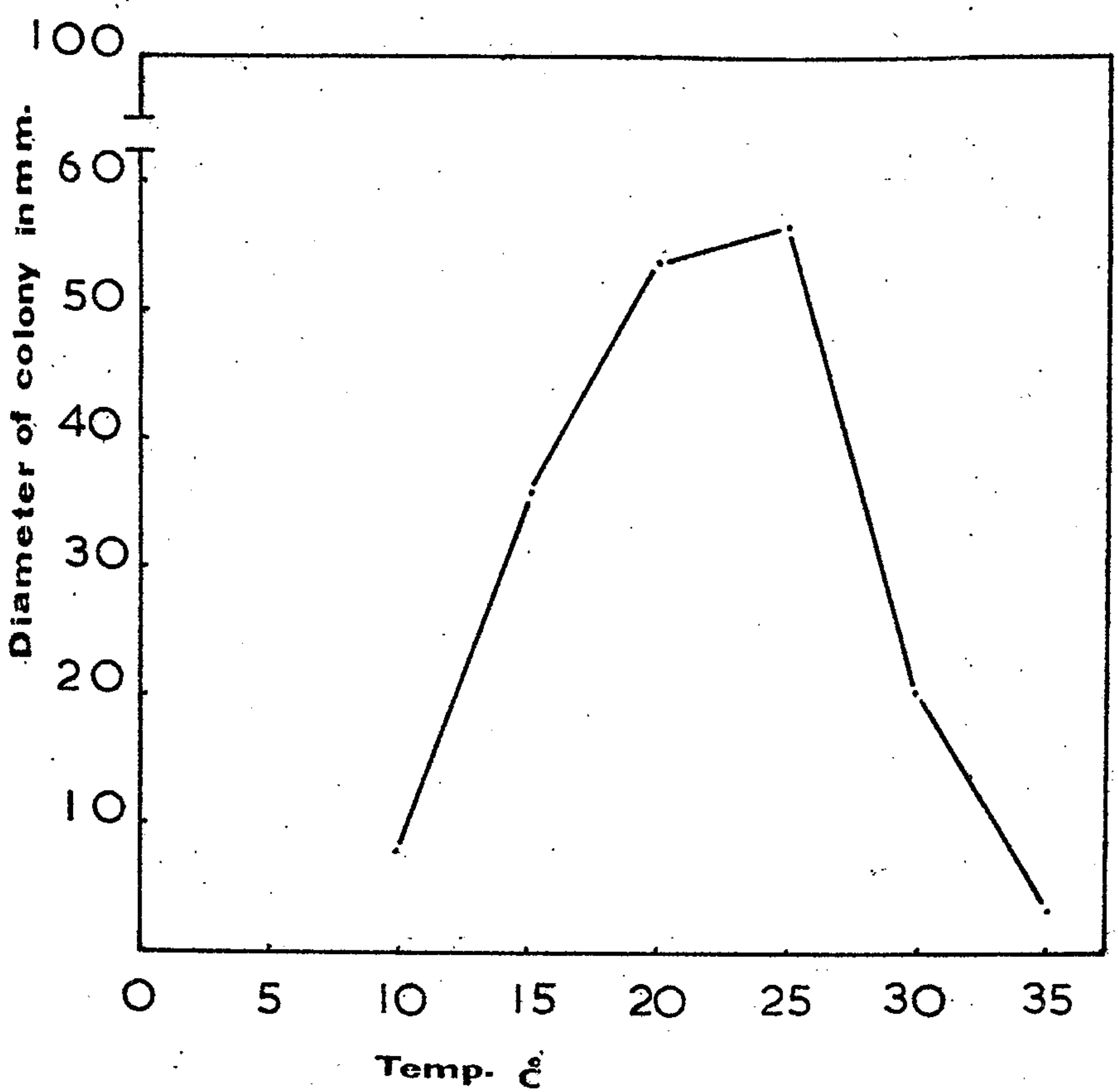

Fig. 1 *Botrytis allii* growth on PDA at day fourth incubated on different temperatures

balls of white cottony mycelium on the surface of medium and among the conidia. In two days, these balls resembled cream color, which became yellow then brown and finally became black. It took four-five days for a sclerotium to change to black. Three types of sclerotia were recognized based on their morphology. The first class were covered with gray mass conidia. The second type was covered by white mycelium only and the third type was not covered by any thing (Figure 2).

Determination of The Growth Rate of Mycelium On Five Different Media:

Potato Dextrose Agar proved to be the best medium for the good growth of the fungus (Figure 3). The fungus growth covered all the PDA plates in six days while it required seven days in the case of Onion Dextrose Agar (ODA), and eight days on CMA and ten days for Water Agar (WA), and sixty five dsys when RBA medium was used.

The fungal mycelium exhibited a very dense gray conidial mass formed on PDA, RBA while it was scarcely formed on ODA and very little produced on CMA and WA.

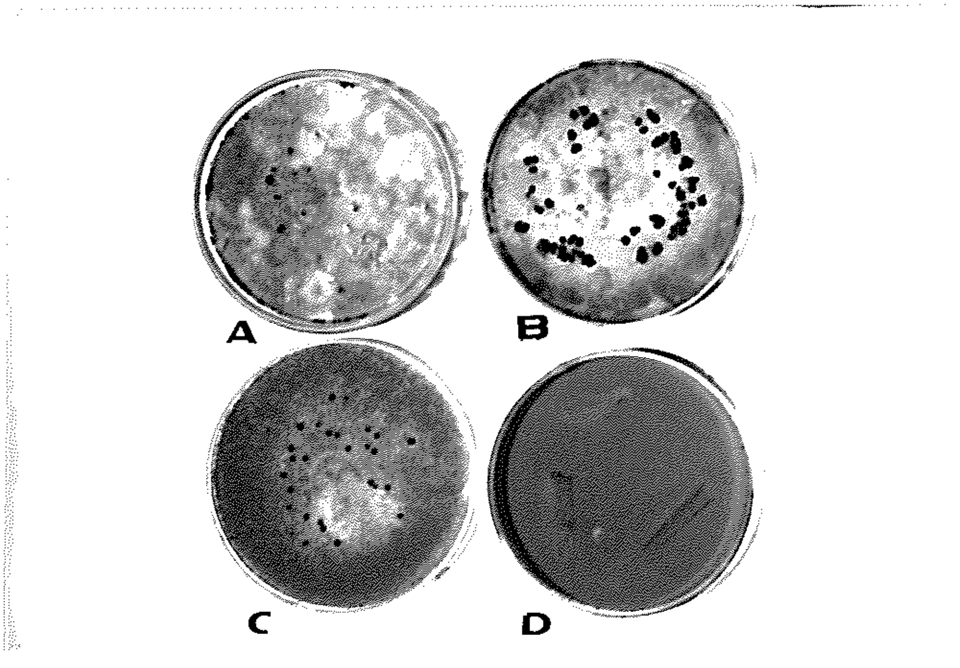

Fig. 2 The formation of sclerotia of B. allii, a- sclerotia covered by white mycelium, b- un-covered sclerotia and c- sclerotia covered by gray mass of conidia d- no sclerotia were formed in the presence of infected plant parts in the same plates.

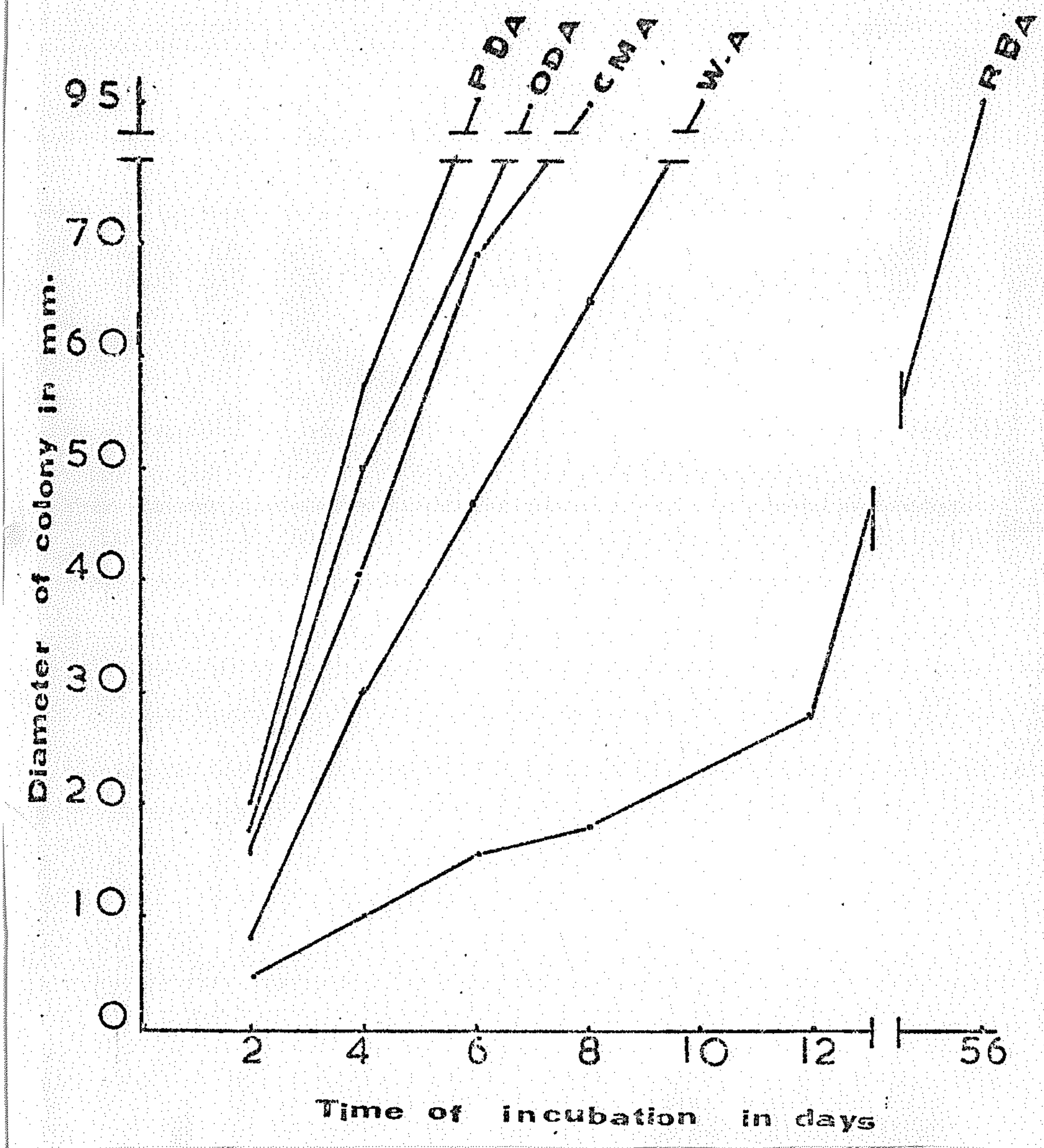

Fig. 3 A comparative study of mycelial growth of *Botrytis allii* on five different media incubated at 25 C°

Effect of Temperature Upon The Size of Sclerotia:

Data of this study showed that 30 days incubation at 25°C is the best condition for development of the sclerotia. The mean of sclerotial size was 2.4 x 1.9 mm , 2.3 x 2 mm, and 3 x 2.5 mm at 15°, 20°, and 25°C respectively , (Figure 4).

Effect of *B. allii* Upon Germination of The Onion Seeds:

The results in Table (1) show significant effects of *B. allii* on onion seeds germination, when inoculated seeds are compared with non-treated seeds or sterilized seeds. On the otherhand, there was no significant differences between non treated and sterilized seeds.

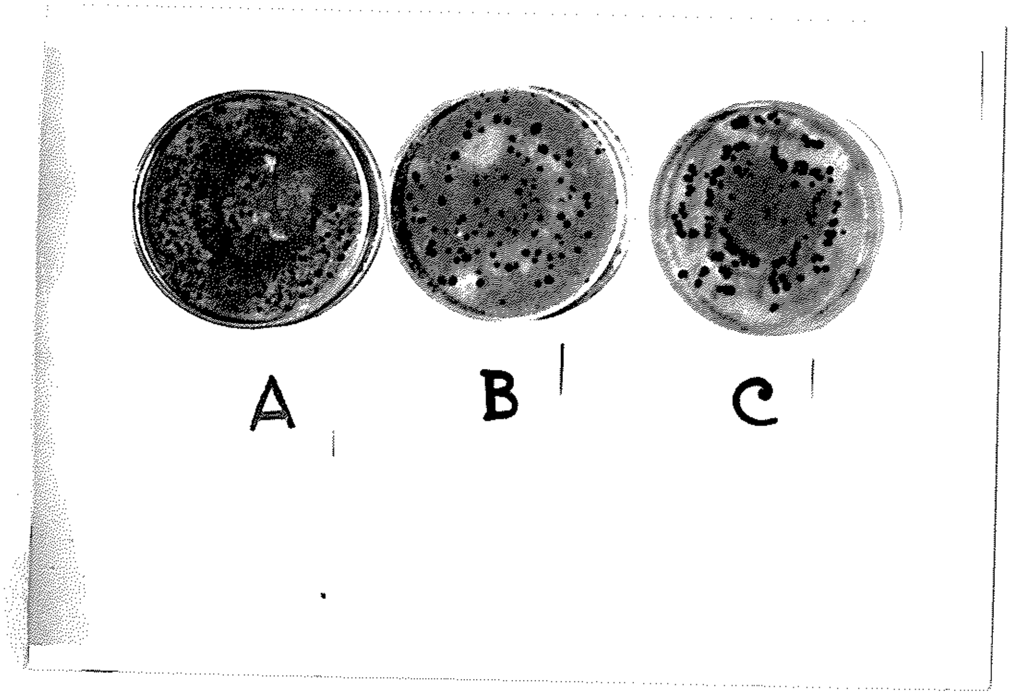

Fig. 4 The effect of different temperatures upon the size of B. allii sclerotia. a. at 15°C, b- at 20°C, and c- at 25°C.

Table 1 : Effect of B. allii on onion seeds germination in relation to surface sterilization and surface active agent treatments.

Seeds Condition	non-surface sterilized			surface sterilized[1]		
	non Inoculated	Inoculated[2]		non Inoculated	Inoculated	
		No Detergent	Plus[3] Detergent		No Detergent	Plus Detergent
Germinated	19 a	9,3 b	11.6 b	17 a	9.3 b	12.6 b
Non-Germinated	6	15.7	13.4	8	15.7	12.4

L.S.D. = 4.0 for germinated seeds.

Figures are mean of three replications and each replicate contained 25 seeds.

All treatments were housed inside 25°C incubator.

1. by soaking into 10% commercial bleach solution containing 0.25% sodium hypochlorates for three minutes.

2. Inoculated with spore suspension of B. allii by dipping.

3. Powdered scap, 1 gm./liter, of inoculum.

The Responese of Onion Bulbs From Six Cultivars To B. allii Under Storage Condition:

Storage experiments revealed that white, Grano, Geiza 6, and Indian were the most susceptible cultivars. The fungus caused complete distruction to the onion bulbs belonging to those cultivars compared with bulbs from the Red and the Bashiqa cultivars (Figure 5). These results demonstrated the resistance of the bulbs of Red and Bashiqa cultivars to distruction by the fungus under storage conditions. In check treatment all bulbs in the three replicates showed no sign of B. allii except Geiza 6, in which the gray conidia of the fungus covered most of the outer scales.

Also two bulbs of the Grano cultivar showed moderate decay incited by the fungi Penicillium spp. and Aspergillus spp. Table 2 . Sclerotia of B. allii observed between the scales of all inoculated bulbs.

Effect of Relative Humidity (RH) On The Development of The Inflorescence Blight Incited by B. allii.

The results showed that 70% and 100% RH were highly favorable for infection and symptoms development. All inoculated inflorescences of Geiza 6 exhibited typical symptoms of B. allii infection under both humi-

Fig. 5 Effect of B. allii on onion bulbs of six cultivars incubated in storage for 20 days.

dities. Two of the surface sterilized inflorescences of this cultivar, in the control treatment, at 100% and 70% RH developed disease symptoms because of incipient infection which was not curtailed by the surface sterilization treatment. One inflorescence out of nine from Red cultivar showed the symptom of the disease at 100% and 70% RH.

At 37% R.H., all inflorescence stalks became dry and no typical disease symptoms were observed on inoculated inflorescences of both cultivars. The surface sterilized un-inoculated inflorescences of the Red cultivar showed no disease under all conditions.

Table 2: Reaction of onion bulbs from six different cultivars to B. allii under storage room conditions.(1)

Treatment	Onion cultivars					
	Indian	Geiza 6	White	Red	Bashiqa	Grano
Inoculated	4	4	4	1	1	4
non-inoculated	0	1.6	0	0	0	2*

* Infected by fungi other than B. allii

(1) Room temperature of 20-18°C and 60% relative humidity for 20 days . Disease severity was rated on imperical scale of 0 to 4.

0 = non diseased

1 = little fungal growth and only the outer scales affected.

2 = abundance of fungal growth and bulbs were rotted half-way.

3 = bulbs were covered with fungus and 3/4th of the bulb was destroyed.

4 = complete destruction.

GreenHouse Work:

Plant of inoculated bulbs or planting into infested soil showed that Grano, Geiza 6, White and Indian bulbs are highly susceptible to B. allii infection in soil. This was very obvious in the case of inoculated bulbs. Most of the bulbs of Grano, Indian, and White failed to sprout in both experiments of infested soil and inoculated bulbs. Germinated bulbs were killed as a result of the severe infection in the scale leaves. The Red and Bashiqa gave good germination and showed no mortality after germination. Onion plants of all six cultivars and in all treatments including the control exhibited a varying degree of leaf tip burn. This was most severe in the case of the Indian, Geiza 6, and White cultivars. Upon planting small pieces of the affected area on PDA and after twenty four hours of incubation at 25°C, growth of B. allii and Alternaria spp. was observed on all plates of all cultivars. Five plates were utilized for each cultivar and each plate contained three pieces of dry leaf tips. Tip burn from the control plants revealed growth of Alternaria spp. only, except in the case of Geiza 6 where both fungi were present.

Field Work:

Hemiar Field:

This field is heavily infested with *B. allii.* Six onion cultivars[1] were planted in ten meters row distributed at random. Twenty five bulbs were planted on each side of the row, spaced 40 cm. between each bulb and the next. Bulbs of the different cultivars required different periods to germinate after planting. The Indian, Geiza 6, and Grano were the earliest to germinate followed next by the White, Red and Bashiqa. There was a certain percentage of mortality among bulbs of the different cultivars planted at this field. The magnitude of this mortality was 50%, 30%, 10%, 10%, 10% in the Indian, White, Grano, Red, and Bashiqa varieties respectively. These results are in full agreement with the results of planting in infested soil in the green-house experiment.

Leaf tip burn was a common symptom of all six cultivars. The severity of the tip burn, however,

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(1) Geiza 6 and Grano were obtained from the Great Mussayeb Project. White and Indian from the Zuffrania Exp. Sta. Red and Bashiqa were bought from the local market.

varied from one cultivar to another, with the Indian and Grano the most affected cultivars. Both fungi B. allii and Alternaria sp. were consistantly isolated from the affected area of the leaves. The six cultivars were also different in their flowering time. Table (3) shows that the Indian variety was the first to flower and the Bashiqa and Grano were the last.

The first infection was observed on the Indian cultivar, a few days after the first inflorescence had appeared. The Red and Bashiqa varieties were the last to show disease symptoms. The number of infected floral heads were counted periodically.

Table 3: Comparison among the six varieties in terms of time required for flowering to occur.

Cultivars	Time in days*
Indian	120
Geiza G	140
White	150
Red	170
Bashiqa	180
Grano	180

* Time in days from bulbs planting on 15th September 1973.

Percentage infected umbles among inflorescences of each cultivar was calculated and plotted against time for all six varieties used. Symptoms on closed umbles were discoloration of the spath, it became silver-white, and the presence of gray conidia mass on the pointed end of the floral buds (Figure 6).

Discolored spath when plated on PDA or placed inside moist chambers gave a massive growth of B. allii. Plating of normal-colored (green) and surface sterilized spath gave no fungal growth. These observations indicated a superficial presence of the pathogen at this stage of disease development. It also indicated a possible presence of toxin produced by the fungus to kill the host tissues prior to fungus invasion. Many of the closed inflorescences of Geiza 6 exhibited the same symptoms described above twenty days after inflorescences had appeared and ten days after the first infection was observed on the Indian variety.

Floral heads which were infected at the closed stage became shriveled and covered with gray mass of B. allii conidia (Figure 7A). Then an infection lesion developed progressing downward along the side

Fig. 6 The two pictures show the symptoms of B. allii infection on un-opened onion umbles ranging from the white silver-colored spath to full destruction of the young umbles (phase 1).

of the inflorescence stalk. This lesion was characterized by being a depressed yellow to silver-white with defined margins and it girdled the distal end of the stalk (Figure 7B,C,D), (8A). The cankered area showed no signs stayed free from the fungus conidia at first, two to three days later and after it had progressed three to four centimeters downward, the gray conidia of B. allii appeared on the region spath-stalk connection as it became dry (Figure 7E), (8B,C,D). Inflorescences may become infected at advanced stages of their development. Open umbles, infected with B. allii are characterized by sudden collapse of the flowerlet stalks rendering the inflorescence small and dirty yellow in appearance (Figure 8C) (9).

Fig. 7 Progressive stages of the development of the infection, A through E. Arrows point out the infected area. E, shows a single umble hanging downward after its stalk became weak by the fungus.

Fig. 8 Advance stages of the B. allii infection on opened inflorescences, A–D. Arrows show the girdling effect of the fungus at the base of the inflorescence.

Fig. 9 Comparative figure between diseased (left) and healthy appearing (right) inflorescences of onion. Diseased inflorescence is characterized by the collaps of flowerlets and the white coloration of the stalk at the base of the umbel.

There was no fungal growth in the case of the sterilized parts. The fungus was isolated most frequently from the spath.

Another phase of the disease incited by B. allii was a severe lodging of the inflorescence stalks. The fungus infected the base portion of the stalk after it had heavily colonized the fleshy leaves of the bulbs. The situation was greatly aggravted by the infestation of the insect Carpophilus dimidiatus (F.) (Nitulidea - coleoptera) which tunnelled into the stalk base. The region of the insect activity became vulnerable to further infection by B. allii then this region became soft and unable to support the inflorescence (fig. 10).

The Indian and Geiza 6 varieties suffered the highest lodging (about 70%) of inflorescence while the White cultivar showed a moderate damage (about 20%). The Red, Bashiqa and Grano varieties showed no lodging among all replicates. Inflorescences which were affected in this way contained healthy appearing flowers with no indications of blight infection at time of lodging.

Fig. 10 Symptoms of stalk base infection by B. allii and the infestation by Carpophilus dimidiatus (F.) lodging and heavy mycelium and conidia are noticible.

<u>Infection Percentage in Hemiar Field on Different Cultivars:</u>

Infection was first observed on the Indian posared variety which was the first to flower. This observation was made on 20 January 1974. Table (4) gives the meteorological data collected at the site of the experiment. Grano, Red, and Bashiqa cultivars had the lowest percentage of blighted inflorescences. These varieties did not flower until March 1974. (Figure 11, 12) show that Indian and Geiza 6 cultivars were highly susceptible to the disease. There was a 100% and 95% infection just before seed harvest time in those two varieties respectively. The white cultivar showed a moderate infection with 40% of the inflorescences were infected. Grano, Red, and Bashiqa were highly resistant to disease. All these cultivars showed that the percentage of infection was less than 4%, especially when the percentage of infection was made before harvest or 270 days after bulbs were planted.

Table 4: Meterological data showing Monthly averages of air and soil temperatures and atmospheric relative humidity.

Month	Reshaied				Remiar				Abu-Ghraib			
	Air Min	Temp. °C Max	soil Temp. °C	%RH	Air Min	temp. °C Max	soil Temp °C	%RH	Air Min	temp. °C Max	soil Temp. °C	%RH
Nov.73	12	32	18.5	51	8	27.5	14.1	56	9.5	31.5	13.0	45
Dec.73	10	27	10.3	60	6	24	9.3	78	7	29	10	64
Jan.74	6.3	16	4.8	75	5	18	5	70	5	19	7.1	72
Feb.74	8	18	5.8	65	6	20	5.6	65	6	22	7.9	59
Mar.74	10	26	14.4	66	8.5	24.5	15	59	9.5	27	15	55.5
Apr.74	13.5	29.5	17.8	58.5	12.5	29.5	20	55	16	32	18	50
May 74	18.5	37.5	25	43	16	33	24c	47	19	38.5	25	40

rain full in mm = 284.8 in Abu-Ghraib
= 340 in Great Mussayeb Project

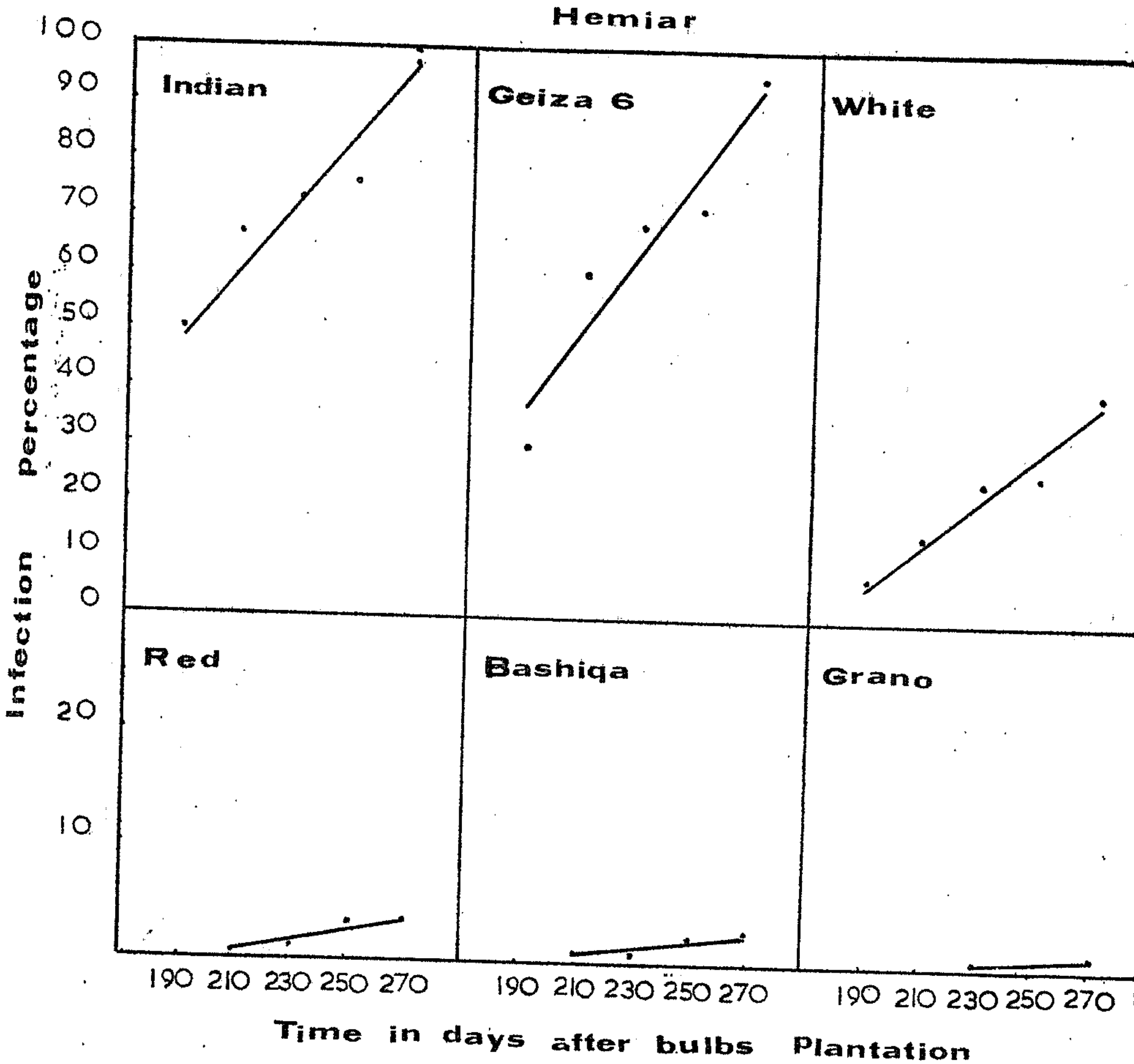

Fig. 11 Disease development of the inflorescence blight caused by *Botrytis allii* on six onion varieties: Indian, Geiza 6, White, Red, Bashiqa, and Grano at Hemiar field (Botrytis infested field).

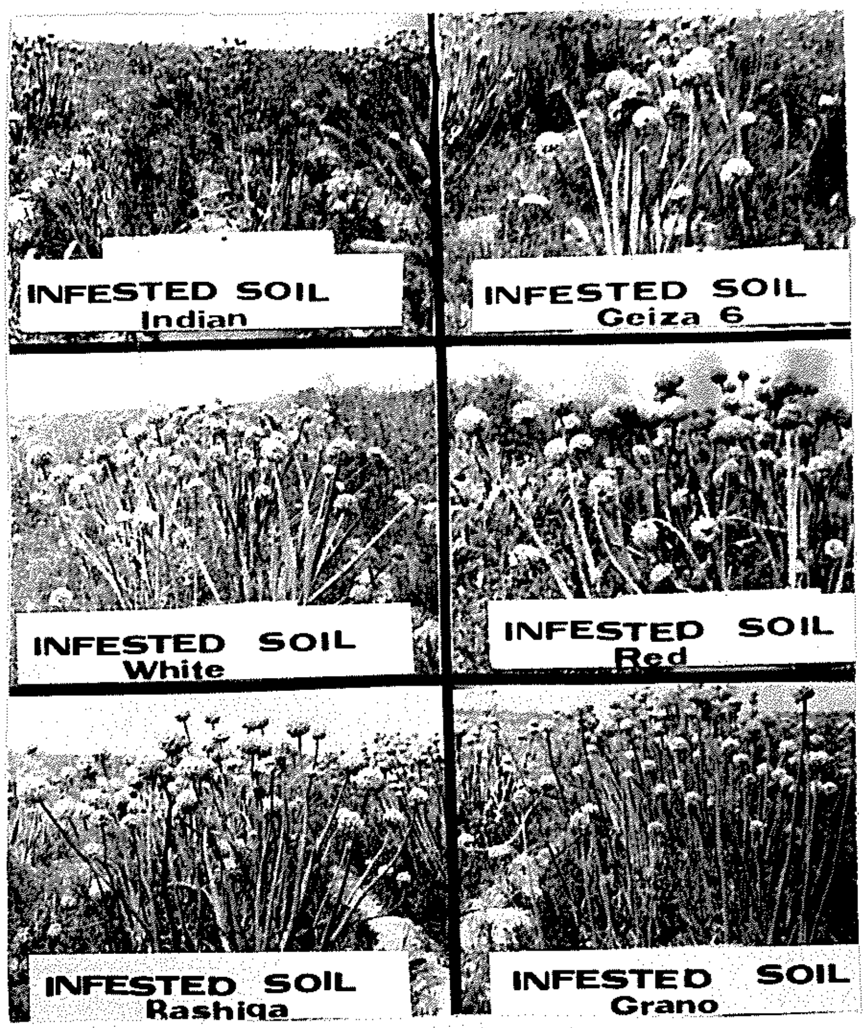

Fig. 12 Comparative appearance of the six onion cultivars grown at Hemiar field and the degree of their susceptibility to inflorescence blight disease. Notice that the Indian and Geiza 6, contain few healthy inflorescences in comparision with Bashiqa, Grano, and Red cultivars.

Reshaied Field:

Reshaied field was not previously planted with onion and its soil was proved free of *B. allii*. Rotting of onion bulbs was not observed at this field. Planting of tip-burn portion revealed no *B. allii* growth, except in the case of the Geiza 6. Sclerotia were observed between scale leaves of onion bulbs dug out at the field, belonging to the Geiza 6 variety. The same variety was the only one which showed about 5% lodging of the inflorescence stalks. The Indian cultivar flowered earlier than the other five varieties, followed by Geiza 6, White, Red, Bashiqa and Grano. But the first infection was observed on Geiza 6 on Feb. 1974. The first record of infection, at this field, was first observed 30 days later than it was observed at Hemiar field (Figure 13, 14).

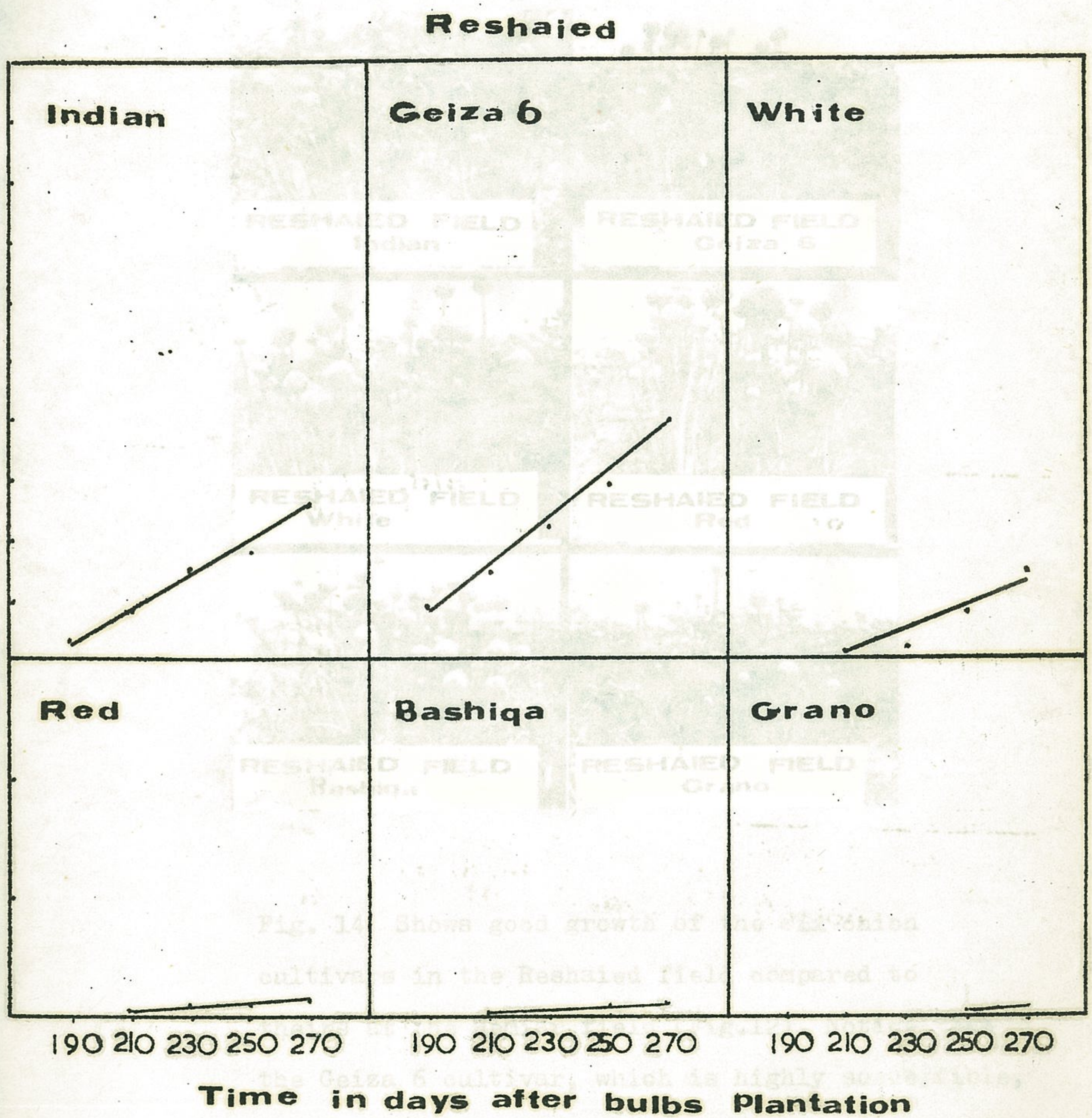

Fig. 13 Disease development of the inflorescence blight caused by *Botrytis allii* on six onion varieties: Indian, Geiza 6, White, Red, Bashiqa, and Grano at Reshaied field (None infested soil).

Fig. 14 Shows good growth of the six onion cultivars in the Reshaied field compared to theirs at the Hemiar field (Fig.12). Notice that the Geiza 6 cultivar, which is highly susceptible, shows considerable degree of inflorescence blight.

Abu-Ghraib Field:

Inoculated bulbs of six cultivars indicated that B. allii had an adverse effect upon the bulbs germinated and causes bulbs mortality both before and after germination in the Indian, Geiza 6, Grano, and White cultivars. Red and Bashiqa suffered moderate bulb rotting. B. allii and Alternaria spp. were isolated from the leaf tip-burn portions. The leaf tip-burn was a very common symptom among all cultivars especially Geiza 6, Indian, Grano and White. The first infection was observed on the inflorescences of Indian followed by Geiza 6, White, Red, Bashiqa, and Grano (Figure 15, 16).

Inflorescence lodging was most obvious at this field (Figure 17). The Indian, Geiza 6, and White cultivars were affected most. Red, Grano, and Bashiqa however showed no lodging. This infection causes a severe loss to the first two cultivars. High incidence of Carpophilus dimidiatus (F.) infestation was also observed on the base portion of inflorescence stalks of those two cultivars. Heavy gray conidia masses were observed in outer scales and around the stalk (Figure 17). Sclerotia were present in large numbers on onion bulbs dug out of the rows. Many bulbs especially those belonging to the Grano, Indian, and White cultivars were completely digested by the fungus in the soil.

On the basis of the statistical analysis of the results from the three fields, the regression coefficient of the disease development and its significance were calculated (Table 5, 6). Also the analysis of variance for three fields, six varieties, and the times of infection percentage were made on a Split Plot Design in (Appendix 1), which shows that there were a highly significant different between the fields, six varieties, and the times of infection percentage. Beside that there were a highly significant in, Vars. X Field, Time X Field, Time X Vars., Time X Field X Vars. at 1% level.

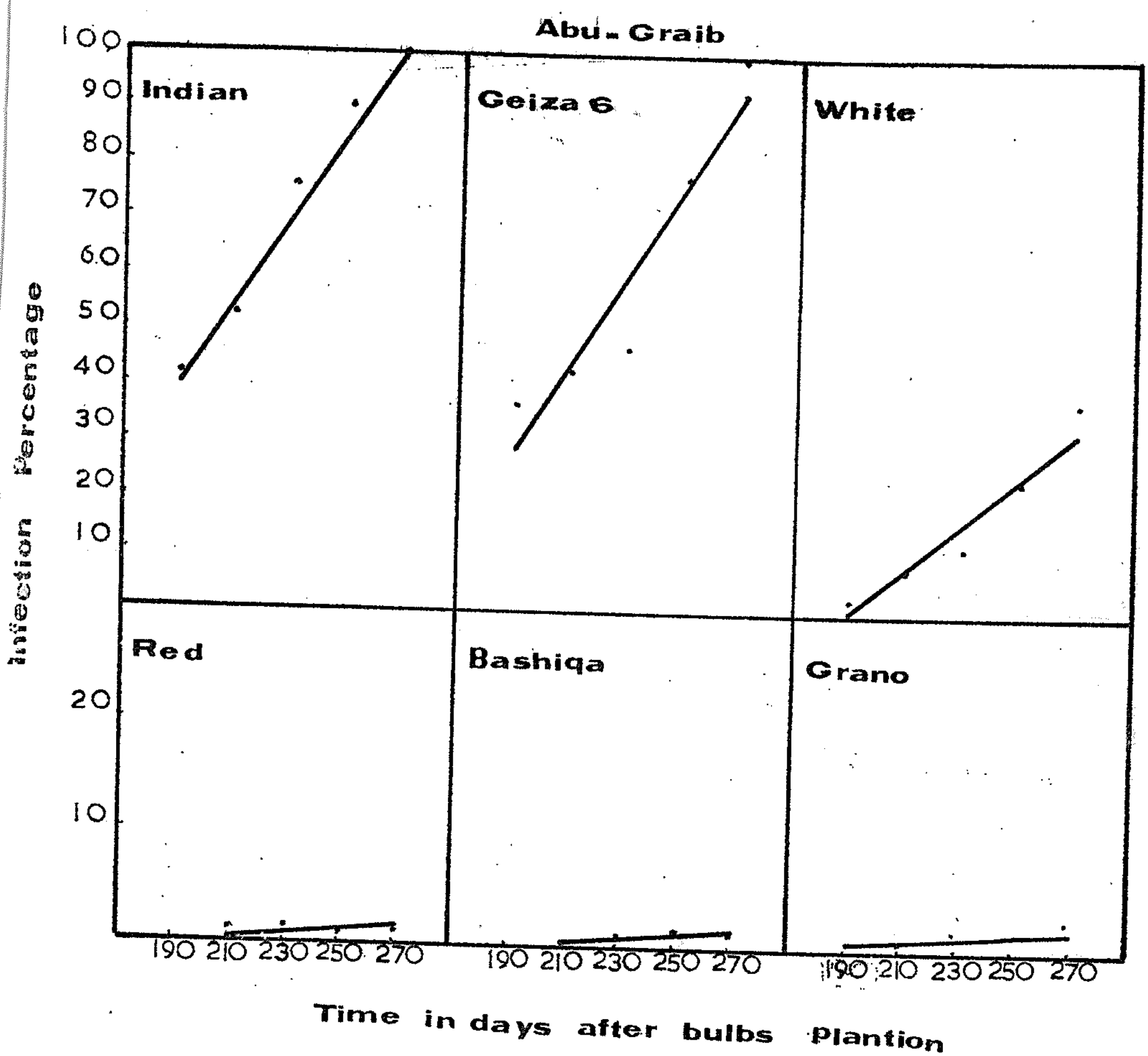

Fig. 15 Disease development of the inflorescence blight caused by *Botrytis allii* on six onion varieties: Indian, Geiza 6, White, Red, Bashiqa, and Grano at Abu-Ghraib field (Inoculated onion Bulbs with *Botrytis allii*).

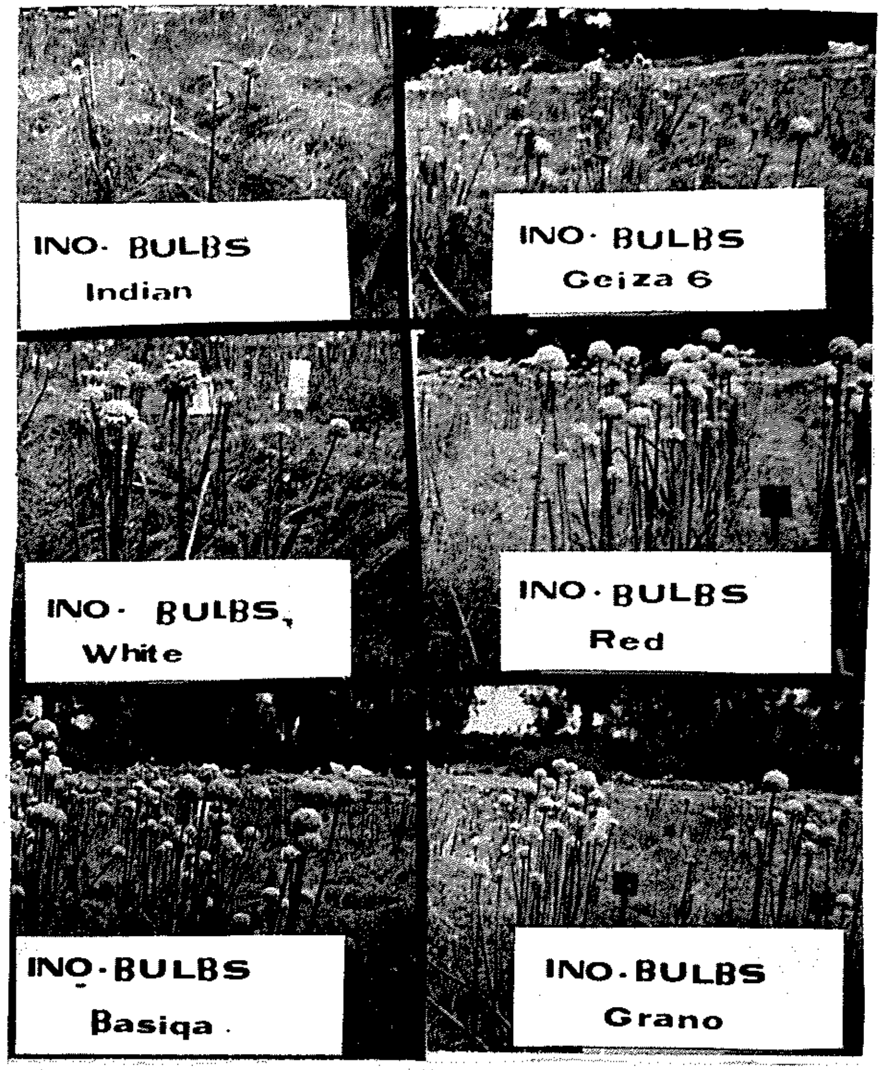

Fig. 16 A comparison among the six onion cultivars showing the impact of the high inoculum level, introduced by dipping onion dry bulbs inside conidial suspension prior to planting. Bashiqa, Red and Grano were the most resistant cultivars. Indian and Geiza 6 were completely wiped out.

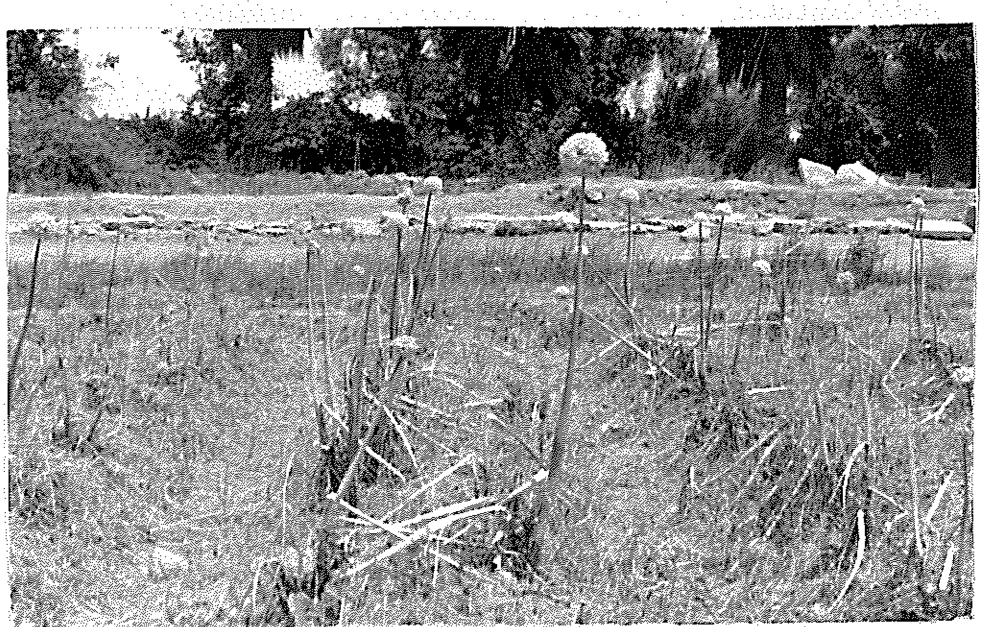

Fig. 17 The lodging of the onion stalks due to the activity of B. allii and C. dimidiatus (F.) at the stalk base.

Table 5: Regression coefficient of the disease development in the six cultivars at the three locations.

Cultivar	Field Locations		
	Reshaied	Hemiar	Abu-Ghraib
Geiza 6	0.351	0.692	0.804
Indian	0.267	0.531	0.748
White	0.185	0.379	0.419
Red	0.019	0.045	0.012
Bashiqa	0.014	0.032	0.019
Grano	0.004	0.011	0.035

Table 6: Test of significant of regression coefficient value "b"* of infection percentage for six onion cultivars at three different field locations.

Cultivar	Field Locations		
	Reshaied	Hemiar	Abu-Ghraib
Indian	20.50	8.70	18.70
Geiza 6	17.55	11.72	8.46
White	9.25	13.50	11.63
Red	9.47	9.57	5.45
Bashiqa	4.11	10.30	7.60
Grano	5.79	6.87	9.70

* Statistical significant coefficient "t" from tables at 1% level with degree of freedom 18, = 2.80.

$$b = \frac{Xy}{X2}, \quad \text{where}$$

X = time

y = percentage of infection

Dry Seeds Yield:

On June 1974 all three plots were harvested for dry seeds yield. Seedswere collected clean from dirt and debris then air dried and weighed. Yield was figured on the basis of Kilogram of dry seeds per one Donum (2500 sq. meter). Result of dry onion seed yields are summerized in Table (7). The analysis of variance for fields, varieties, of onion dry seeds yield which tabulate in Appendix (5) show that there were a highly significance differences between the three field, six varieties, and also in the interaction between varieties X field.

The analysis of variance of onion dry seeds for each three fields in Appendix (2, 3, 4) indicated that there were a highly significance differences between the six varieties in Reshaied, Hemiar, and in Abu-Ghraib fields.

The averages of onion dry seed yield for six varieties in Table (8) shows:

a. Fields test:

The Reshaied field was a best field to onion seed yield because there was a highly significant different comparing with both Hemiar, and Abu-Ghraib at 1% level, also there was a significant different between Hemiar, and Abu-Ghraib which indicated that Abu-Ghraib was best than Hemiar field.

b. Varieties test:

1. There was no significant different between the averages of Indian cultivar from three fields with Geiza 6 from three fields in onion dry seeds yield.
2. There were a highly significance differences between Indian and White, Indian with Red, Indian with Bashiqa, and also between Indian and Grano cultivars.
3. Highly significance differences between Geiza 6 with, White, Red, Bashiqa, and Grano cultivars.
4. White cultivar have a highly significance differences with Red, Bashiqa and with Grano but at 5% level.
5. Red cultivar different with Bashiqa, Grano, White, Geiza 6, and with Indian in a highly significance differences.

The conclusion of these data indicated that Bashiqa cultivar was the best cultivar to onion seeds production. Followed by Red, White, Grano , Geiza 6 and Indian, depending on the L.S.D. test for varieties.

The test of the Interaction Between Varieties X Fields:

Indian : The average of onion seed from Reshaied differ with both Hemiar and Abu-Ghraib fields. While there was no significant different between the same cultivar in Hemiar and Abu-Ghraib in seed production.

Geiza 6 : Reshaied field give a high yield comparing with Hemiar and Abu-Ghraib fields. Also there were no any significances differences between each Hemiar and Abu-Ghraib fields in seeds production.

White : The yield of this cultivar was very high in Reshaied field comparing with Hemiar and Abu-Ghraib fields. High significance difference between the Reshaied with both Hemiar, Abu-Ghraib, while there was no significant difference between Hemiar and Abu-Ghraib fields.

Red : Highly significance differences between Reshaied field with each Hemiar or with Abu-Ghraib . Also there was significant different between Hemiar and Abu-Ghraib field. Reshaied was a best field followed by Abu-Ghraib, then Hemiar.

Bashiqa : Reshaied field was a best field to onion production of this cultivar. There were a highly significance differences between Reshaied and both of Hemiar or Abu-Ghraib, also a significant difference between Hemiar and Abu-Ghraib. Abu-Ghraib was best than Hemiar.

Grano : No significant difference between Hemiar and Abu-Ghraib. While a highly significance differences between Reshaied and both of Hemiar or with Abu-Ghraib field.

In the end,Reshaied field was a good field for onion seed production.

Table 7 : Comparision of dry seed yield at the three experimental fields which represented, clean field (Reshaied), naturally infested field (Hemiar) and artificially infested field (Abu-Ghraib) by planting onion bulbs inoculated with B. allii.

Cultivar	Experimental Fields		
	Reshaied kg/Donum	Hemiar kg/Donum	Abu-Ghraib kg/Donum
Bashiqa	167.4 a	38.4 a	58.1 a
White	144.4 b	18.5 d	20.5 c
Red	130.0 c	37.4 b	57.7 a
Grano	94.4 d	24.4 c	29.7 b
Geiza 6	87.9 d	3.4 e	0.0 d
Indian	63.1 e	0.0 f	0.0 d

L.S.D. at 5% level = 7.71, 0.75, and 2.49 for Reshaied, Hemiar, and Abu-Ghraib fields respectively.

Data are average of four replications.

Table 8 : Averages of onion dry seed yield for six cultivars in three fields.

Cultivar	Fields locations			L.S.D.of V xF		Mean	L.S.D. of varieties	
	Reshiaed	Hemiar	Abu-Ghraib	5%	1%		5%	1%
Indian	63.13**	0	0	5.27	7.02	21.40 f	9.49	12.64
Geiza 6	87.65**	3.38	0			30.34 e		
White	144.13**	18.56	20.53			61.07 c		
Red	130.0 **	37.25	54.82			74.02 b		
Bashiqa	167.64**	38.38	58.09			88.04**a		
Grano	94.56**	24.38	29.68			49.54 d		
Average	114.52**	20.33	27.19					

L.S.D. for Field = 4.14 at 5% and 6.27 at 1% levels.

** Highly significant difference comparing with both two fields.

DISCUSSION

The present study was undertaken to explore the role of some factors in the epidimology of the inflorescence blight disease of onion incited by the pathogen *B. allii*. Results of the temperature effect on fungus growth indicated that 25°C was an optimum temperature for growth of this fungus. This result agrees with those obtained by Coly-Smith (1972). Thus, this optimum temperature is characteristic of the species *B. allii* regardless of the locality which it was isolated from.

The temperature record and disease development at the three fields, Hemiar, Abu-Ghraib, and Reshaied showed that the infection of the onion inflorescences began to increase as the air temperature approached 25°C during the day. Air moisture played an important role in disease incidence and severity, before and after opening of the inflorescence. The number of infected un-opened flowers increased after each time it rained. The rainy season was characterized by alternating wet and dry periods, which permitted this observation. Blodgett (1946), Netzer and Dishon (1965) in their studies speculated that high humidity and moderate temperatures were necessary conditions for infection of onion inflorescences by B. Allii. The present investigation showed that 70% R.H. is necessary for development of typical symptoms on excised opened inflorescences inoculated under laboratory conditions.

Infections on both un-opened and opened inflorescences is initiated by air-borne conidia, which may land at suitable infection coart. This is supported by the readiness of surface sterilization of plant parts. In one case, however, healthy appearing, surface sterilized inflorescence of Geiza 6 indicated an incipient infection. Such infection is further documented in case of the dry bulbs of onion. The present work supported Ticheiaar (1967) results.

It further demonstrated that the pathogen was introduced into a clean field (Reshaied) by planting carrier bulbs. The inoculum sources are represented by rotted necks of planted bulbs, infested-soil and dead leaf tip tissues (tip-burn). In a disease control program one has to facilitate cutting down on the air-borne inoculum by planting clean bulbs in a clean soil and minimizing the chance of having dead tissues accessable to the fungus.

It was anticipated for this pathogen B. allii to live as a saprophyte upon its host. This anticipation is supported by the quick discoloration of the spath leaves following the infections at the pointed tip of the un-opened flower buds. The sudden collapse of the flowerlets of the umble and immediately after the infection of the base portion of the umble, or the distal end of the stalk presented another evidence supporting a toxing production prior to colonization by the pathogen. Segal and Newhall (1959) in an earlier work with onion leaf blight speculated on the presence of a toxin produced by those fungi. This point of interest requires further investigation. Senescent spath leaves became infection courts whenever air temperature and moisture were favourable for conidia germination and fungus growth. It is seen herein that a micro-climatic condition existed beneath the opened umbles and where the old spath leaves hide providing an excellent infection court. Disease resistance, however, seems to be unrelated to this morphological characteristic. This is well eastablished as a varietal dependent mechanism.

The effect of B. allii on onion seed germination was assesed in this study. There was significant differences in seed germination between inoculated and non inoculated seed, wheather those seeds were previously surface sterilized or not. The fungus caused mortality to most inoculated seeds before and after germination. This indicates the economic importance of this disease in sets production.

The infection of stalks bases of some varieties was more severe in Abu-Ghraib field because of the presence of a high number of C. dimidiatus which prefere the fermented plant parts and tunnels through it, as Cotton (1963) reported. These insects predisposed the stalk base for further infection by B. allii. This phenomenon was not observed by either Blodgett (1946) or Netzer and Dishon (1965), who have delt with field research on this disease.

Statistical analysis of disease percentage of six onion cultivars in three fields indicated that there was a highly significant differences at 1% level, among the six cultivars, fields, and also time of infection. This indicated that the differences among those varieties are due to the varietial genetic characteristics while differences among the fields are due to inoculum dencity of B. allii.

Infection percentages and disease severity have progressed to higher levels with time. This conclusion was supported by the values of the regression coefficient and the "t" test to all varieties in three fields. Data of the regression coefficient value "b" lead in a very obvious way to diffrentiate between the susceptible and resistance varieties.

About the onion seeds yield of six cultivars, the statistical analysis showed there was a high significant different at 1% level among the varieties and also among fields. At Reshaied field the mean yield for all cultivars was significantly higher than Abu-Ghraib and Hemiar. This showed the magnitude at which this disease could be distructive to dry seed yield in naturally infested or contaminated field.

This study shows that Bashiqa, Red and Grano posses genotypes which carry factors of disease resistance in contrast with the Indian and Geiza 6 which were most susceptible. Apparently the White cultivar may represent a genome of a moderate resistance. These results could be coupled with the storage ability, yield of dry bulb, taste and dry seed yield in choosing a certain cultivar for economic production, at the clean or contaminated site.

Many field trips to onion fields in northern and north west of Iraq, resulted in concluding that the disease is rather limited to the area of the Great Mussayeb Project. This it may be an introduced disease which come along with the dry seeds and/or the dry bulbs imported for seed production. Besides all cultivars used in fields other than the Great Mussayeb Project were of a resistant genotype, Bashiqa, Red and White. Hence it is advised here to cultivate Bashiqa and Red cultivars for dry seeds production at the Great Mussayeb Project. For dry seed production of Geiza 6 should shifted to the area of Ana and Rawa provided using *B. allii* - free dry bulbs.

SUMMARY

Cultivation of onion for dry seed production was comitted at the Great Musseyeb Project since 1965. Geiza 6, a recommended onion cultivar, gave high yield of dry seeds, sets and dry bulbs during the first two years (1965-1968).

In the following years however the dry seeds yield was greatly decreased. The inflorescence stalks became infected with <u>Botrytis</u> <u>allii</u> Munn which caused disease named inflorescence blight.

The laboratory studies demonstrated that PDA was the best media for fungus growth. Also 25°C was optimum temperature for both fungal growth and for production of large sclerotia. Fungal growth was very limited at 35°C.

Field work included cultivation of six cultivars namely Indian, Geiza 6, White, Bashiqa and Grano in three fields Hemiar (naturally-infested soil with <u>B. allii</u>), Reshaied (no <u>B. allii</u>), and Abu-Ghraib field (bulbs inoculated with <u>B. allii</u> suspension). Results indicated that there were two phases of

infection, the first phase began with the infection of the tip of the un-opened spath of inflorescences by conidia of B. allii. Those conidia came from either infested soil, contaminated bulbs or on the leaf tip burn of onion colonized by the fungus as a saprophyte. Few days after the spath became white-silver and then the un-opened inflorescence became shrivelled and covered with gray conidia and dry. Then the fungus moved via the spath into the stalk and caused dry canker.

The second phase occurred after spath-opening and at the time of fully opened inflorescence. This phase began when the dry open spath became infected by the air borne conidia. The fungus reproduced on the spath which by then became shaded by the umble. Then the fungus attacked the neck of the stalk. Infection progressed downward five to six centimeters. Infected region became whitish at seed harvest. All affected inflorescence at either phase were unable to produce dry seeds.

The six cultivars showed different response toward the inflorescence blight disease. Geiza 6 and Indian were susceptible cultivars, White was moderate while Red, Bashiqa, and Grano appeared as resistant varieties. Bulbs from these cultivars were differently affected by *B. allii* in storage. Geiza 6, Indian Grano and White cultivars were very susceptible while Bashiqa and Red cultivars were resistant.

A severe lodging to inflorescence stalks was observed at Hemiar and Abu-Ghraib fields in Geiza 6, Indian and White cultivars. This was attributed to the weakening of stalk base due to the infection by *B. allii* coupled with the infestation of *C. dimidiatus*.

Dry seeds harvest from the six cultivars, 270 days after bulbs plantation showed that Bashiqa cultivar with the highest yield under the condition of the three fields. Geiza 6 and Indian cultivars however produced no seeds in Hemiar and Abu-Ghraib fields.

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A P P E N D I X

Appendix 1 : Analysis of variance for fields, varieties, and time of infection percentages.

S.V.	d.f.	S.S.	M.S.	F.cal.	F. tab. 5%	F. tab. 1%
Main Plot						
Rep.	3	8.17	2.72	6.90*	4.76	9.78
Field	2	29365.18	14682.59	37265.46**	5.14	10.92
Error a	6	2.369	0.394			
Sub-plot						
Varieties	5	188102.75	37620.55	57877.77**	2.38	3.37
Var XFie.	10	40827.226	4082.722	6281.11**	2.00	2.66
Error b	57	33.41	0.65			
sub.sub-plot						
Time	4	19637.50	4909.38	29049.59**	2.41	3.41
Tim.X F	8	2603.75	325.47	1925.86**	1.98	2.60
Tim.X Var.	20	18904.96	945.24	5593.14**	1.62	1.97
T.X F.X Var.	40	3979.01	99.48	588.64**	1.45	1.69
Split plot error	204	34.67	0.169			
Total	359	303498.98				

Appendix 2 : Analysis of variance of onion dry seeds yield for Reshaied field.

S.V.	d.f.	S.S.	M.S.	F.cal.	F. tab. 5%	F. tab. 1%
Rep.	3	19.78	6.59	0.25	3.29	5.42
Vars.	5	30744.77	6148.95	233.53**	2.90	4.56
Error	15	394.91	26.33			
Total	23	31159.46				

L.S.D. = 7.71 at 5% level

** Highly significant at 1% level.

Appendix 3 : Analysis of variance of onion dry seeds yield for Hemiar field.

S.V.	d.f.	S.S.	M.S.	F.cal.	F.tab. 5%	F.tab. 1%
Rep.	3	0.43	0.13	0.59	3.29	5.42
Vars.	5	5257.14	1051.43	4779.23**	2.90	4.56
Error	15	3.35	0.22			
Total	23	5260.92				

L.S.D. = 0.75 at 5% level

** Highly significant at 1% level.

Appendix 4 : Analysis of variance of onion dry seeds yield for Abu-Ghraib field.

S.V.	d.f.	S.S.	M.S.	F.cal.	F.tab. 5%	F.tab. 1%
Rep.	3	7.37	2.46	0.91	3.29	5.42
Vars.	5	13425.26	2685.05	998.16**	2.90	4.56
Error	15	40.30	2.69			
Total	23	13472.93				

L.S.D. = 2.49 at 5% level.

** Highly significant at 1% level.

Appendix 5 : Analysis of variance for fields and varieties,of onion dry seeds yield.

S.V.	d.f.	S.S.	M.S.	F.cal.	F.tab. 5%	F.tab. 1%
Reps.	3	141.482	47.16	2.28	4.67	9.78
Fie.	2	2117246.00	10586.23	51489.44**	5.14	10.92
Error a	6	123.37	20.56			
Vars.	5	628029.0	125605.75	916.8**	2.42	3.44
Var.X Fie.	10	157686.5	15768.64	115.09**	2.05	2.75
Error b	45	6168.96	137.0			
Total	71	2909393.31				

** Highly significant at 1% level.

الخلاصـــــــة

حضيت زراعة البصل لانتاج البذور اهمية كبيرة في مشـــــروع المسيب الكبير منذ عام ١٩٦٥ فالصنف المصرى جيزة (٦) يعتـــــبر من الاصناف الجيدة حيث اعطى انتاجا عاليا من البذور الجافـــة او الفسق وكذلك رؤوس البصل الجاف خلال السنتين الاوليتين مـــن البدء بزراعته (١٩٦٥ ــ ١٩٦٨) اما في السنوات التالية فلقـــد حدث انخفاض خطير في انتاج بذور البصل فلقد اصيبت سيقـــــان النورات الزهريه للبصل بالفطر (Botrytis allii Munn) الـــذى يسبب مرضا يدعى بلفحة النورات الزهريه •

أشارة الدراسة المختبرية الى ان الوسط الغذائـــــي (Potato Dextrose Agar (PDA) يعتبر من احسن الاوساط الغذائيـــة لنمو الفطر كذلك تعتبر درجة الحرارة ٢٥ م هي الدرجة الحراريـــه المثلى لكل من نمو الفطر وكذلك لانتاج الاجسام الحجرية (Sclerotia) الكبيرة الحجم •

أما بالنسبة الى درجة ٣٥ م فلقد لوحظ ان هذه الدرجـــة تحدد نمو الفطـــر •

ان العمل الحقلي لهذه الدراسة شمل على زراعة ستة اصناف من البصل المعروفة في العراق وهي الهندى ، جيزة ٦ ، ابيـــض محلي ، احمر محلي ، بعشيقه محلي وكرانو في ثلاث حقول مختلفـــة هي حقل حمير (تربه ملوثه بصورة طبيعية بالفطر B. allii) حقل الرشايد (تربه لاتحتوى على الفطر المذكور) وحقل ابو غريـــــب (زراعة رؤوس بصل ملوثه بحالق الفطر) •

أن النتائج تشير الى ان هناك مرحلتين للاصابه بالمـــرض •

المرحلة الاولى تبدأ مع بداية اصابة غلاف النوره الزهريه الغير متفتح بواسطة كونيديا الفطر B. allii وهذه الكونيديا تأتي اما من التربه الملوثه او من الرؤوس الملوثه وكذلك من اطراف اوراق البصل الذابله والتي يتواجد عليها الفطر بسبب معيشته الرميه • وبعد عدة ايام يلاحظ ان غلاف النوره يتحول الى لون ابيض فضي ثم تصبح النوره الغير متفتحه جافه وتغطي على مراحل بالكونيديا الرماديه التي تسبب قتلها • بعد هذه المرحله يبدأ الفطر بمهاجمة ساق النوره الزهريه فيسبب حدوث مناطق غائره جافه عند العنق •

أما المرحلة الثانية من الاصابه تحدث بعد تفتح غلاف النوره او في الوقت الذى تتفتح فيه النوره • ان هذه المرحلة تبدأ عندما يصاب غلاف النوره المتفتح والذى يصبح جافا بالكونيديا الهوائيه للفطر B. allii فنلاحظ ان الفطر يتكاثر على هذا الغلاف والذى يكون في مكان منزو مضلل بواسطة مجموعة الازهار لذلك يبدأ الفطر مباشرة بمهاجمة ساق النوره الزهرية عند العنق ولا تلبث منطقة الاصابه ان تمتد باتجاه الاسفل لمسافة ٥ — ٦ سم • ان منطقة الاصابة هذه تتحول الى لون ابيض عند فترة حصاد البذور •

والنورات الزهرية التي تصاب بالمرحلة الاولى او في المرحلة الثانية تصبح غير قادره على انتاج بذور البصل ان الاصناف الستة المزروعة اظهرت استجابات مختلفه باتجاه مرض لفحة النورات الزهرية • فالصنف جيزه (٦) والصنف الهندى كانت اصناف حساسه للمرض وكان الصنف الابيض المحلي متوسطا بينما ظهرت الاصناف الاحمر المحلي والبعشيقه المحلي والكرانو كانت اصناف مقاومة للمرض •

أما بالنسبة الى تاثير الفطر B. allii على رؤوس البصل عند الخزن فلقد دلت الدراسة على ان الاصناف جيزه (٦) ، الهندى ،

كرانو والابيض كانت اصناف حساسه جدا لوجود الفطر بينما كانـــت الاصناف الاحمر والبحشيقه اصناف مقاومة .

لوحظ في حقول حمير وابو غريب ظاهرة خطيرة في النـــورات الزهرية وهي اضطجاع سيقان النورات الزهرية وكانت الاصناف جـــيزة ٦ ، هندى ، والابيض هي الاصناف التي ظهر بها هذه الحالـــة بينما انعدمت في بقية الاصناف .

ان هذه الظاهرة تعزى الى ضعف قاعدة ساق النورة ونتيجة للاصابة بالفطر B. allii مضافا اليها اصابة لحشرة تدعـــــــى (Carpohilus dimidiatus (F.)) تحدث في قاعدة الساق .

حصاد البذور للاصناف الستة بعد ٢٧٠ يوما من زراعـــة روءوس البصل اظهر ان الصنف بحشيقه قد اعطى انتاجا عاليا تحـت ظروف الحقول الثلاثة . اما الاصناف جيزه ٦ والصنف الهندى فلـم تعطى اية كمية من البذور في حقلي ابو غريب وحمير .