THE PREVALENCE AND RELATIVE IMPORTANCE OF POTATO TUBER DISEASES IN LEBANON

By

NAZIR AHMAD CHOUDHRY

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NAZIR AHMAD CHOUDHRY

Approved:

Adib T. Saad

Adib T. Saad: Assistant Professor of Plant Pathology. Advisor

W. W. Worzella

Wallace W. Worzella: Professor of Agronomy. Member of Committee

Eckart Schlosser

E. Schlosser: Associate Professor of Plant Pathology. Member of Committee

W. W. Worzella

Wallace W. Worzella: Professor of Agronomy and Coordinator of Graduate Studies

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POTATO TUBER DISEASES

CHOUDHRY

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AN ABSTRACT OF THE THESIS OF

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Title: The Prevalence and Relative Importance of Potato Tuber Diseases in Lebanon.

Surveys of the potato growing areas in Lebanon, and field experiments at the Agricultural Research and Education Centre, were carried out during 1966 and 1967 to study the prevalence and relative importance of potato tuber diseases and defects.

Black scurf, Common scab and Internal brown spot diseases were most prevalent in the Beqa'a plain, whereas Late blight was observed only in the coastal area. The Potato leaf roll virus was found to be widespread in Lebanon. Dry rot caused by Fusarium species occurred frequently. The incidences of other diseases were of minor importance. There were no striking differences in the incidence of the major diseases and defects between the year 1966 and 1967, except that Internal brown spot and Soft rot were more serious in 1966 than in 1967.

Potato varieties were found to differ in their susceptibility to the potato tuber diseases. The variety Arran Banner was highly sensitive to Internal brown spot and Potato leaf roll virus. The variety Glodia showed the lowest incidence of Common scab, but was severly affected by Soft rot, Growth cracks, Black lenticels, Knobbiness, and Rough skin as compared with other varieties. The varieties Up-to-Date and Alpha were most susceptible to Common scab.

The incidence of Silver scurf on Alpha, and Tuber moth on Akra was significantly higher than on all the other varieties. The reaction of all the varieties was similar to the other major tuber diseases.

In field experiments mulching significantly suppressed the development of the Black scurf whereas, the date of harvesting and source of seed had no effect on disease incidence.

It is evident from the present study that various diseases may cause serious losses to the potato crop in Lebanon. Introduction of resistant varieties, strict quarantine measures,

the use of certified seed and proper cultural practices were recommended to obtain a higher yield and better quality of the potato crop.

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I. INTRODUCTION

The potato (Solanum tuberosum) is one of the major food crops planted for human consumption and grown throughout most of the world. The potao produces more food per unit area than is obtained from cereal crops. Therefore, by producing potatoes, a greater number of people can be fed in over-populated areas under conditions of food scarcity. The centers of potato production are in central, northern, and eastern Europe. In these areas, potatoes form a large part of the people's diet. Europe, including the Soviet Union, produces almost 87 per cent of the world potato output, the balance of 13 per cent being made up by the combined production of all the other continents. More than one-third of this remaining 13 per cent is produced in North and Central America (10, p.174).

The potato crop ranks third in area and second in total yield among the field crops, and first in area and yield among vegetable crops in Lebanon. Ninety per cent of the potato crop in Lebanon is produced in the Beqa'a plain and the remaining 10 per cent in the coastal and mountainous areas (2).

In the Beqa'a plain potatoes are planted between February and May and in certain areas a second planting is done in July. Although early plantings, in February, are subject to the danger of frost, the growers take this risk in order to save on the irrigation water. The Beqa'a plain has

a continental-type climate, which towards Syria becomes desert-type (1).

In the coastal area the crop is mainly produced in the Akkar plain and to a smaller extent in the Southern areas. This region is characterized by a Mediterranean-type climate, with no frost, and a relative humidity during summer around 73 per cent (1).

In the mountainous region potatoes are planted as a garden crop especially in Metn and Bechari areas (2). This region has temperate summers but cold winters (1).

The average potato production in the United States and Europe is 13 to 14 tons per hectare, whereas, in Lebanon it is from eight to 10 tons per hectare. Estimation on losses due to diseases on the potato has been made in the United States, where they ran up to 17.5 per cent in 1954 and 13.8 per cent in 1965 (10, p.174). Some of these relative yield reductions are no doubt due to a higher percentage incidence of potato tuber diseases. These diseases vitiate a good part of the care exercised by the growers on other production practices.

It is of utmost importance to know the distribution and intensity of plant diseases in an area so that research and control measures commensurate with the extent of damage caused by them. This study has been undertaken to determine

the occurrence, prevalence and relative importance of potato tuber diseases in Lebanon. The results may lead to specific recommendations which may help in increasing the quality and the quantity of potato production in Lebanon.

II. REVIEW OF LITERATURE

Potato Tuber Diseases and their Distribution

Sixty five potato tuber diseases and defects of parasitic and non-parasitic nature have been reported to occur in different countries (5,46). The diseases of parasitic nature are caused by various agents like fungi, bacteria, actinomycetes, and viruses. The non-parasitic diseases are due to unfavorable environmental conditions for the growth of the potato plant causing abnormalities such as discoloration of tuber tissues, abnormal growth of parts, and yield reduction.

The main parasitic and non-parasitic diseases and defects reported in the literature and which are of concern to this study include the following:-

A. Diseases of parasitic nature:

Black scurf caused by
Rhizoctonia solani.

Common scab caused by
Streptomyces scabies.

Fusarium dry rot caused by
Fusarium species.

Late blight caused by
Phytophthora infestans.

Leaf roll disease caused by
Potato leaf roll virus.

Silver scurf caused by
Spondylocladium atrovirens.

Soft rot caused by

<u>Erwinia phytophthora</u>.

B. Diseases of non-parasitic nature:

Black lenticels due to

High temperatures of 37 to 42°C at the time of maturity.

Bottle neck due to

Wide variations in rate of tuber development. The delay of the first irrigation may cause bottle neck tubers.

Bruises due to

Rough treatment over the digger, during picking.

Enlarged lenticels due to

Excessive moisture before harvest.

Feathers due to

Mechanical injury to outer skin of immature tubers.

Greening due to

Exposure to sunlight before harvest.

Growth cracks due to

Uneven or sudden changes in growing conditions.

Heat injury due to

High temperatures, especially when vines die early on light, sandy soil.

Hollow heart due to

Heavy rains following a dry early growing period.

Internal brown spot due to

Probably soil moisture fluctuations under dry conditions.

Knobbiness due to

Various factors, the most common ones being fluctuations in soil moisture and fertility.

Quackgrass injury due to

Agropyron repens. Mechanical penetration of tubers by the sharp growing points of the stolons.

Rough skin due to

High fluctuation of moisture before harvest, sometimes Boron deficiency.

Sprout tubers due to

Planting seed pieces in cold, dry soils.

C. Insect Pests.

Mole cricket (Gryllotalpa gryllotalpa).
Grubs (Polyphylla fullo)
Tuber moth (Gnorimoschema operculella)

Black scurf and Soft rot are world wide in distribution and are serious under cool wet weather conditions (5, pp.9,67). Common scab and Fusarium dry rot are well known wherever the potato crop is grown, flourishing especially under dry warm conditions (44, p.329). Late blight is a major disease in cool humid regions of the temperate zone (46, p.335). Silver scurf which has been reported from many parts of the world seems to be of minor economical importance (44, p.357). The Potato leaf roll disease is one of the most important and widespread virus diseases of potatoes. The virus is scarce in the "seed" growing

districts of Scotland and Ireland, but is very common in the Southern parts of both countries. It is most serious in the Bordeaux region of France, in many parts of North America, and is prevalent in Lebanon, Syria, and Jordan (31,39, p.369).

Internal brown spot and Hollow heart are restricted to areas of particular environment conditions (5, pp.48-49). Enlarged lenticels disease is restricted to wet places and Feathers disease in areas with late fall frosts (5, pp.21,27).

Symptomatology of Potato Tuber Diseases and Defects

According to Whitehead et al (48, p.281), symptomatology has been the most widely used criterion for the identification of potato tuber diseases.

Black scurf disease produces hard, black or dark brown bodies, called sclerotia, resting on the surface of tubers and are easily removed by the finger nail without injuring the skin surface. The sclerotia vary in size from small specks to large masses an inch across and one-fourth inch thick. Malformation of tubers is also common in many such cases (44, p.365).

Common scab is characterized by raised or crater like corky areas varying in size and shapes and appearing much like terraces in miniature. The color is grayish-white to dark tan.

On some varieties the scabby areas are frequently pitted (46, p. 375).

Fusarium dry rot produces sunken, shrivelled areas filled with powdery, dry, and decayed tissue. The surface and cavities in the tuber are covered and filled with masses of fungal mycelium and spores. The rot progresses rapidly, finally leaving the whole tuber as a light punky or stone hard mummy (44, p.359).

The late blight organism induces a brown or purplish-black metallic discoloration of the sunken skin and a reddish brown discoloration of the tissue just below the skin. A dry rot can be noticed in later stages, but other organisms may follow and produce a soft rot (46, p.334).

The Potato leaf roll virus rarely affects the tubers. Tubers appear perfectly normal externally. Internally few strains of the virus may cause net necrosis. In this case the phloem tissue is more or less filled with a net work of fine lines (39, p.369).

Silver scurf exhibits a grayish, smooth, leathery appearance of the skin and is distinquishable by a silvery sheen when the tubers are wet. Affected areas of the skin are slightly depressed. Careful inspection reveals that the surface is dotted with minute black specks or sclerotia (7).

Soft rot disease has been described by Blodgett (5, p.67) as a slimy, foul-smelling, wet rot, resulting in the final disintegration of the tubers.

Aerial tubers, described by Blodgett (5, p.108), are formed in the axils of stems above ground. These tubers vary in size, are misshaped and intense green or voilet in color.

Bottle neck has a small stem end and a large bud caused by a constriction near the middle of the tuber where a dumbell shaped tuber may develop (5, p.83).

Bruises are characterized by slight to severe breaks, punctures and scratches in many forms on the potato skin (5, p.17).

Enlarged lenticels, are prominent corky areas in the lenticels rather evenly distributed over the surface and appear like small kernels of powdery scab (5, p.27).

Feathered tubers, observed by Blodgett (5, p.21), give the appearance of having the skin tissue scuffed, scally, and broken.

Greening is described as light to intense green discoloration of tubers (5, p.65).

Growth cracks occur most often toward the bud end of the tuber. The cracks vary in size (46, p.415).

Heat injured tubers show slate-gray to brown patches in the tissue (5, p.43).

Hollow heart appears in the form of cavities usually near the center of large size tubers (22, p.247).

Internal brown spot (chocolate spot) produces no external symptoms, but forms necrotic brown spots scattered throughout the flesh of the tuber (43). The brown spots are sometimes, restricted to the vascular bundle (6, p.122).

Knobby potatoes show protuberances of various sizes and shapes attached to a primary tuber (5, p.81).

Rough skin tubers show a few to many rather short narrow cracks (22, p.245).

Sprout tubers are noticed forming short sprouts at the eyes of the tubers without the formation of any foliage (5, p.111).

Insect injured tubers with Mole cricket, and Grubs, show small to large feeding cavities. The irregular-shaped cavities usually are wider than deep and ridged roughly to the inside (5, p.99).

Tuber moth affected tubers show burrows throughout the tuber. The burrows are different in size. The portion of the burrow occupied by the larvae is fresh and white, but the older parts contain gray or brown refuse (5, p.103).

Factors Influencing the Occurrence and Development of Potato Tuber Diseases and Defects

Several authors have emphasized the role of one or more of the following factors for the development of potato tuber diseases and defects: moisture content of the soil, temperature, aeration, soil reaction, fertility of the soil, relative humidity of the atmosphere, addition of the farm yard manure, dates of planting and harvesting, effect of green manure, crop rotation, as well as lenticel proliferation, and various bacterial associates of the pathogen.

Dry neutral soils with temperature ranging from 23 to 25°C and infertile soils are most favorable for the rapid development of Black scurf (14, p.35). However, the frequency of the disease incidence was not greatly influenced by soil reaction, but was highly influenced by humus content, use of farm yard manure, and crop rotation (38). High summer temperatures inhibit the production of the sclerotia of the fungus (14). Cordon (9) and Sanford (35) found that the reduction of Black scurf and the apparent decline of the pathogen in the soil were the result of antibiotic effects of some of the associated soil fungi and bacteria.

Common scab infection occurs at an optimal temperature

of 27°C (37). Warm summers, dry soil conditions, calcarious soils, excessive application of nitrogen fertilizers, and short rotations with sugarbeet have been found to favor the development of Common scab (20,23,34,41). Acidic soils below a pH of 5.2, and soybean as a cover crop or green manure inhibit the development of the disease (42,45).

High temperatures, growing of successive crops of potatoes on the same land, high humus content of the soil with a wide pH range, and a water holding capacity of 50 per cent have been found most conducive to Fusarium dry rot infection (17,27,36,37). Bruises are considered to be the most important avenues for infection by the Fusarium fungus (15,17,26).

According to William et al (47) and Calderoni (8) the Late blight is very severe at temperatures between 13 and 18°C and a relative humidity of not less than 82 per cent. Elizabeth (13) found that the moist state of the soil, provide suitable conditions for the spread of infection.

The origin of the seed; whether healthy or infected, home garden plantings, as sources of infections and the development of aphid populations as vectors, have been found to be the most important factors for the occurrence and development of Potato leaf roll disease (4,18,39). Kassanis (21) observed that a humid atmosphere with a temperature of 37.5°C for approximately 24 days cures infected plants from the active

Potato leaf roll virus.

A temperature of 24°C, a 90 per cent relative humidity, a light soil with a fairly wide pH range of 9.4 to 4.39, and an excessive nitrate fertilization are optimum conditions for Silver scurf (11,29).

Soft rot develops rapidly under warm humid climates (3,19,30). Davidson (12) observed that the infection is supported by a delay in the suberization of the lenticels, particularly in tubers which have not reached maturity as a result of unfavorable climatic conditions.

Excessive moisture before harvest and a delay for the first irrigation were found to be most favorable for the development of Enlarged lenticels and Bottle neck defects, respectively (5, pp.27,83). High temperatures of 37 to 42°C favor the occurrence of Heat necrosis and Black lenticels, whereas, low temperatures of -2 to- 8°C are responsible for Frost necrosis (22, p.246).

The development of Hollow heart is most common under excessive moisture supplies after relatively dry periods and under wide spacing of plants (22,p.247). Levitt (24) found a higher disease incidence in the larger tubers. Lutz and Nylund (26,32) observed the disease in small tubers as small as 1.8 gm.

Soil moisture fluctuations under dry conditions, early plantings and large size tubers are most inducive for the

development of Internal brown spot symptoms (6,16,43).

Growth crack symptoms and Knobbiness are the result of uneven or sudden changes in growing conditions (5, pp. 26,81). Cold dry soils, shallow plantings, and mechanical injury to outer skin of immature tubers are responsible for Sprout tubers, Greening, and Feathers defects, respectively (5, p.111).

III. MATERIAL AND METHODS

The studies on the occurrence and prevalence of the potato tuber diseases involved extensive field surveys of the potato growing areas at harvest time, during 1966 and 1967. Potato samples were collected from different localities during the harvest periods shown in figure (1). Due to climate variation in various areas of Lebanon, potato harvesting could be seen almost all the year round. However, 80 per cent of the crop is harvested from July to September.

Most of the potato growers follow similar harvesting procedures. The potatoes are left in the field until the vines dry up. The dried up vines are then cleaned off and the field plowed by an ox-powered plow or by a tractor. Potato tubers, lifted to the surface, are picked up by hand in various types of containers and are hauled into a pile. Sorting out diseased, injured, and unmarketable tubers is usually done by hand in the field. Marketable tubers are bagged, and sent for storage or directly into the local market, or placed in special containers for export.

The samples, 50-100 tubers each, used for this study, were collected at random from the potato field before the sorting was done. Every sample was accompanied by a label on which the following information appears: name of farmer,

locality, variety, date of planting, crop rotation, and the source of seed.

During sample collection the growers were also interviewed about the following: the most severe diseases and defects observed on the crops, the percentage losses due to diseases and defects, the total yield per dunum, and disease control measures applied by the growers. The samples were brought in paper bags to the laboratory for examination.

Potato samples were also collected for disease incidence checking from the vegetable varietal field experiment conducted at the Agriculture Research and Education Center (AREC) during the summer of 1966. The experiment was laid out in a completely randomized block design with four replications.

In the summer of 1967 samples of Arran Banner variety were also collected from field experiments conducted to study the effect of mulching, source of seed, and dates of harvesting on the incidence of the Black scurf disease. The experiment was laid out in a split-split plot design with two replications.

For disease diagnosis the tubers were first examined thoroughly for the presence of external defects, abnormalities or disease symptoms. After this thorough external examination, the tubers were cut horizontally one cut on each end, followed

by a longitudinal cut to observe any internal symptoms on the tuber flesh. Symptoms were then compared to those reported in the literature by Whitehead et al (46, p.282). In case of doubtful diagnosis, isolations of the pathogens, on culture media, were tried to varify the identity of the causal organisms.

The infection of tubers by the Potato leaf roll virus was checked by the technique described by Moericke (28, p.462). This involved removal of a two cm portion on the stem end of the tuber and making thin cross sections through the vascular bundles area. The sections were treated for three to five minutes in a Resorcin blue solution (Appendix A) and examined under the microscope to check for deep blue stained vascular elements which indicate increased callus formation - a typical diagnostic feature of Leaf roll virus infection of potato tubers. Five sections from each tuber were examined. If more than one stripe of blue colored callus were present, the tuber was considered to be showing a positive indication of a Potato leaf roll virus infection.

To varify doubtful initial symptoms of the Internal brown spot disease, a special staining technique described by Braun and Nienhaus (6) was used. Sections from the vascular bundles of the potato tubers were taken and kept for two to five minutes in Rhodamin-B solution (Appendix A). The material was then examined under the microscope. Cells with stained walls

were considered as initial stages of the Internal brown spot disease.

The incidence magnitudes of diseases and defects were calculated as percentages. Statistical analysis of the data, taken from the different field experiments, were made by employing Analysis of variance and Duncan's test as described by Le Clerge *et al* (25).

IV. RESULTS AND DISCUSSION

The Prevalence and Relative Incidence of the Diseases and Defects

The different diseases and defects detected on potato tubers collected from several potato growing areas of Lebanon are summarized in Table 1.

As seen in Table 1, Black scurf (Fig.2), Common scab (Fig.3), Fusarium dry rot (Fig.4), Late blight (Fig.5), Potato leaf roll virus, Soft rot, Silver scurf (Fig.6), Growth cracks, and Tuber moth (Fig.7) were very prevalent, occurring in all the localities surveyed.

Common scab and Black scurf were most common in the Beqa'a plain. Silver scurf did not seem to be wide spread in the mountainous range: This is probably because the disease develops at relatively higher temperature than those present in the mountains. Mooi (31) found the optimal temperature for Silver scurf development to be 24°C.

The occurrence of the Late blight disease was restricted to the coastal area because of the favorable high humidity conditions which typify this region. The incidence of the disease is high at a temperature of 13 to 18°C and a relative humidity not less than 82 per cent (8, 13). These conditions prevail

during the potato growing season in the coastal area in late fall, winter and early spring.

The Potato leaf roll disease was found to be prevalent in the Beqa'a plain and in the mountainous area. The coastal strips have not yet been checked for the presence of this disease. One reason for the wide distribution of this virus disease may be the favorable conditions for the development and spread of the aphid vectors during spring in the Beqa'a plain and during the summer in the mountains.

The incidence of Internal brown spot (Fig.8) was high in the Beqa'a plain and very low in other areas. One reason for the higher incidence in the Beqa'a plain could be the possible pronounced fluctuations in the soil moisture under hot dry conditions that affect the development of disease symptoms on the maturing tubers.

Enlarged lenticels (Fig.9), and Growth cracks were more common in the mountainous area than in the other localities. These defects are known to be caused by frequent changes in soil moisture and temperatures.

The potato tuber moth occurred mainly in the Beqa'a plain and in the coastal area, whereas, other insect injuries were rather restricted to the coastal area. Data on other diseases and defects indicate no consistent differences among

the different localities or the incidences were too low for comparisons.

In comparing the data on disease incidence for the variety Alpha in Table 1, differences in disease prevalence due to different environmental conditions can very well be demonstrated. The Alpha variety showed a serious incidence of Common scab in the Beqa'a plain compared to a very low one in the coastal area. Black scurf was not influenced by differences in locations. Silver scurf was most prevalent in the coastal area. Silver scurf disease, as found by Mooi (31), develops very favorably under a high relative humidity and an optimal temperature of 24°C. The same differences were observed for Fusarium dry rot and Late blight disease. Other defects on potato tubers, such as Rough skin (Fig.10) and injury by the Tuber moth were higher in the Beqa'a plain than in the coastal area.

Another comparison may be made between the incidences of the diseases and defects on the variety Arran Banner grown in the Beqa'a plain and in the mountainous area (Table 1). Black scurf and Silver scurf incidences were slightly higher in the Beqa'a plain in comparison with those in the mountainous area. Internal brown spot showed much higher incidence in the Beqa'a plain than in the mountains.

Enlarged lenticels and Growth cracks have been found,

mainly, in the mountains. Enlarged lenticels are usually an indication of a high moisture content of the soil. This high soil moisture, with a lesser degree of fluctuations, has inhibited, most probably, the development of Internal brown spot symptoms.

The distribution and relative incidence of the major potato tuber diseases and defects, for four potato growing areas in the Beqa'a plain, are shown in Table 2. Zahle and Housh Sneid had a higher incidence of the Black scurf disease than the other areas. Zahle had a higher incidence of Common scab but a slightly lower incidence of Internal brown spot than the other areas. Housh Sneid and Terbol areas showed a high prevalence of Silver scurf, while only the Terbol area suffered high incidence of Soft rot. Fusarium dry rot was uniformly distributed throughout the plain. These differences can not be explained by mere comparisons of the climatic conditions of these areas.

In the mountains, there were no consistent differences in the distribution or relative disease incidence between Metn and Becharre areas (Table 3).

The relative percentage incidence of the major diseases on the potato variety Arran Banner, in the Beqa'a plain, for the years 1966 and 1967 are shown in Table 4. Internal brown spot, Soft rot, and Black scurf were more serious in 1966 than in 1967. On the other hand, Silver scurf had higher incidence in 1967 than in 1966.

Table 1. Average percentage incidence of potato tuber diseases and defects in Lebanon during the years 1966 and 1967.

Diseases or Defects	Coast		Beqa'a		Mountain		
	Average of Varieties	Alpha	Alpha	Average of Varieties	Arran Banner	Arran Banner	Average of Varieties
Black scurf	5	10	10	21	11	9	12
Common scab	2	1	14	12	8	3	5
Fusarium dry rot	9	13	2	5	4	3	3
Late blight	11	13	0	0	0	0	0
Potato leaf roll disease	-	-	-	13	31	40	29
Silver scurf	9	16	4	5	6	1	1
Soft rot	2	1	4	8	4	2	2
Aerial tubers	0	0	0	0	0	T	T
Black lenticels	T	T	1	T	T	0	0
Bottle neck	T	T	4	1	1	0	0
Bruises	0	0	2	1	1	3	2
Enlarged lenticels	T	T	T	1	1	9	10
Feathers	0	0	T	T	0	0	0
Greening	3	3	1	T	T	0	0
Growth cracks	1	1	2	1	1	5	6
Heat injury	2	2	4	1	1	0	0
Hollow heart	0	T	1	T	1	0	0
Internal brown spot	T	T	1	6	19	3	1
Knobbiness	0	0	1	T	T	0	T
Quack grass	0	0	0	T	T	0	T
Rough skin	2	2	14	T	T	0	T
Sprout tubers	T	T	0	T	T	0	T
Mole cricket & Grubs	6	6	0	2	2	0	T
Tuber moth	8	8	32	9	8	2	2

T = Trace
- = Not checked

Table 2. Average percentage incidence of the major potato tuber diseases in the different areas of the Beqa'a plain of variety Arran Banner.

Diseases	Baalbeck	Housh Sneid	Terbol	Zahle
Black scurf	9	13	8	15
Common scab	3	7	7	15
Fusarium dry rot	3	4	4	4
Late blight	0	0	0	0
Potato leaf roll virus	-	-	31	-
Silver scurf	4	8	7	3
Soft rot	1	1	8	3
Internal brown spot	27	21	22	14

- = Not Checked

Table 3. Average percentage incidence of the major potato tuber diseases in two different mountainous areas on commonly grown varieties, during 1967.

Diseases	ARRAN BANNER		UP-TO-DATE	
	METN	BECHARI	METN	BECHARI
Black scurf	6	12	10	7
Common scab	3	2	8	5
Fusarium dry rot	1	4	10	2
Late blight	0	0	0	0
Potato leaf roll virus	0	1	3	2
Soft rot	0	3	7	2
Internal brown spot	3	2	0	0

Table 4. Average percentage incidence of the major potato tuber diseases in 1966 and in 1967 on variety Arran Banner grown in Beqa'a plain.

Diseases	1966	1967
Black scurf	12	7
Common scab	8	5
Fusarium dry rot	3	3
Late blight	0	0
Potato leaf roll virus	-	31
Silver scurf	4	8
Soft rot	7	2
Internal brown spot	28	12

- = denotes not checked.

Relative Varietal Susceptibility to Potato Tuber Diseases & Defects

Percentage incidences of potato diseases and defects on four commonly grown varieties, in the Beqa'a area, are shown in Table 5. There were no pronounced differences in susceptibility to Black scurf, Silver scurf and Fusarium dry rot among the four varieties. The Up-to-Date and Alpha varieties had higher incidences of Common scab and Tuber moth than did the other varieties. In some samples of Up-to-Date variety the Common scab incidence ran up to 93 per cent.

Variety Glodia had the lowest percentage incidence of the Common scab disease and Tuber moth but was very susceptible to the Soft rot bacteria and had highest percentages of Black lenticels, Bottle neck, Growth cracks and Rough skin tubers. There may be a close correlation between Rough skin and Growth cracks and the incidence of Soft rot disease since the bacteria which cause this disease are wound parasites. Rough skined potatoes are more liable to have wounds made on the skin during handling.

Arran Banner was highly sensitive to Internal brown spot. The average percentage disease incidence is reported in Table 5 as 19 per cent, but in some samples up to 70 per cent of the tubers exhibited symptoms of this disease. The other varieties checked were less sensitive or resistant to the Internal brown spot.

Table 5. Average percentage incidence of potato tuber diseases & defects on four potato varieties grown in the Beqa'a plain during 1966 & 1967.

	Diseases	Arran Banner	Up-to-Date	Alpha	Glodia
I	Black scurf	11	14	10	15
	Common scab	8	16	14	2
	Fusarium dry rot	4	7	2	7
	Late blight	0	0	0	0
	Leaf roll virus	31	20	-	-
	Silver scurf	6	8	4	2
	Soft rot	4	2	4	20
II	Aerial tubers	0	0	0	0
	Black lenticels	T	1	1	43
	Bottle neck	1	T	4	10
	Bruises	1	0	2	3
	Enlarged lenticels	1	1	T	0
	Feathers	0	0	T	0
	Greening	T	0	1	0
	Growth cracks	1	1	2	10
	Heat injury	1	1	4	0
	Hollow heart	1	0	1	3
	Internal brown spot	19	5	1	0
	Knobbiness	T	0	1	8
	Qurack grass	T	0	0	0
	Rough skin	T	T	14	24
	Sprout tubers	T	0	0	0
	Mole cricket & Grubs	2	3	0	0
	Tuber moth	8	12	32	1

T = Trace

- = Not checked.

The variety Alpha was highly susceptible to Tuber moth and had a relatively high percentage of Rough skin and Heat injured tubers.

The results on the relative susceptibility of three different varieties to tuber diseases and defects grown in the mountainous area are summarized in Table 6. Here again, the results indicate that variety Arran Banner was highly susceptible to the Potato leaf roll virus and had a higher incidence of the disease than either Up-to-Date or a local variety. The local variety had a high incidence of Black scurf but low in Fusarium dry rot, and was found to be free of Soft rot and Silver scurf. The percentage incidences of other diseases and defects are so low that accurate comparisons based on such low figures are not possible.

No discussion on potato varietal susceptibility to the different tuber diseases and defects under coastal area conditions will be made since samples were collected from only two varieties grown under different conditions (Table 7). Variety Alpha was grown in Akkar plain, whereas the other local variety was grown at Jubail and El-Jieh in the Central and Southern sections of the coastal area, where environmental conditions vary considerably from Akkar plain.

Table 6. Average percentage incidence of potato tuber disease and defects on potato varieties grown in the mountain area in 1967.

Diseases	Arran Banner	Up-to-Date	Local
Black scurf	9	9	19
Common scab	3	7	6
Fusarium dry rot	3	6	1
Late blight	0	0	0
Leaf roll virus	40	20	26
Silver scurf	1	3	0
Soft rot	2	5	0
Aerial tubers	T	0	0
Black lenticels	0	0	0
Bottle neck	0	0	0
Bruises	3	4	T
Enlarged lenticels	9	7	9
Feathers	0	0	0
Greening	0	2	0
Growth cracks	5	4	7
Heat injury	0	0	0
Hollow heart	0	0	0
Internal brown spot	3	0	T
Knobiness	0	0	0
Quack grass	0	0	0
Rough skin	0	3	2
Sprout tubers	0	0	0
Mole cricket & Grubs	0	1	T
Tuber moth	2	0	0

T = Trace.

Table 7. Average percentage incidence of potato tuber diseases and defects on two potato varieties in the coastal area in 1967.

Diseases	Alpha	Local
Black scurf	10	8
Common scab	1	7
Fusarium dry rot	13	5
Late blight	13	8
Leaf roll virus	-	-
Silver scurf	16	1
Soft rot	1	1
Aerial tubers	0	0
Black lenticels	T	0
Bottle neck	T	0
Bruises	0	0
Enlarged lenticels	T	0
Feathers	0	0
Greening	3	2
Growth cracks	1	2
Heat injury	2	0
Hollow heart	T	0
Internal brown spot	T	0
Knobiness	0	0
Quack grass	0	0
Rough skin	2	1
Sprout tubers	T	0
Mole cricket & Grubs	6	25
Tuber moth	8	4

T = Trace

- = Not checked.

Experiment on Varietal Reactions to Potato Tuber Diseases

Data on disease incidence on the potato varieties grown at AREC during 1966 in a varietal field experiment are shown in table 8. The Arran Banner variety was not included among the varieties tested in the experiment, hence statistical analysis did not include it. However, it is included in the table for comparison since it is a widely grown variety in the Beqa'a area.

It may be seen from the data given in Table 9, that variety Alpha was highly susceptible to Silver scurf disease and was significantly different from varieties Desire, Extase, and Spartaan. There was no significant difference in the susceptibility to Silver scurf diease among varieties Alpha, Radosa, Akra and Patroness. The variety Radosa was significantly more susceptible than variety Spartaan. The difference in the susceptibility to Silver scurf disease among the rest of the varieties were not significant statistically.

The variety Akra was found significantly more susceptible to Tuber moth infestations than the other varieties. All the varieties had shown high susceptibility to Common scab, a medium susceptibility to Black scurf, and low susceptibility to Fusarium dry rot. There were no significant differences among the varieties. There was no consistent difference among the incidences

Table 8. Average percentage incidence of potato tuber diseases and defects on different potato varieties at AREC in 1966.

Diseases	Alpha	Akra	Desiree	Radosa	Patroness	Extase	Spartaan	Arran Banner
Black scurf	13	6	15	12	18	16	13	14
Common scab	23	38	41	42	39	39	42	11
Fusarium dry rot	5	5	3	10	2	3	3	2
Late blight	0	0	0	0	0	0	0	0
Leaf roll virus	-	-	-	-	-	-	-	-
Silver scurf	22	12	9	16	11	9	3	12
Soft rot	2	2	0	1	T	1	T	2
Aerial tubers	0	0	0	0	0	0	0	0
Black lenticels	1	2	0	T	T	3	T	2
Bottle neck	1	1	T	T	0	1	1	0
Bruises	4	T	0	1	3	2	2	0
Enlarged lenticels	T	3	0	0	0	0	0	0
Feathers	2	1	2	1	0	0	0	0
Greening	1	0	T	0	0	0	0	0
Growth cracks	5	2	3	5	0	4	0	1
Heat injury	2	2	1	T	1	1	0	0
Hollow heart	T	0	0	1	1	0	0	1
Internal brown spot	1	2	0	3	0	0	0	31
Knobbiness	0	0	0	0	0	0	0	0
Quack grass	0	0	0	0	0	0	0	0
Rough skin	1	4	3	T	6	2	0	10
Sprout tubers	0	0	0	0	0	0	0	0
Mole cricket & Grubs	6	0	2	1	7	2	9	0
Tuber moth	24	48	4	22	12	18	8	12

T = Trace
- = Not checked

Table 9. Statistical comparison between the different potato varieties for their reaction to major diseases and defects.

	Diseases	Alpha	Radosa	Akra	Patroness	Desiree	Extase	Spartaan
A.	Silver scurf	22	16	12	11	9	9	3

		Akra	Alpha	Radosa	Extase	Patroness	Spartaan	Desiree
B.	Tuber moth	48	24	22	18	12	8	4

	Patroness	Extase	Desiree	Alpha	Spartaan	Radosa	Akra
Black scurf	18	16	15	13	13	12	6

	Radosa	Spartaan	Desiree	Extase	Patroness	Akra	Alpha
Common scab	42	42	41	39	39	38	23

	Radosa	Akra	Alpha	Desiree	Extase	Spartaan	Patroness
Fusarium dry rot	10	5	5	3	3	3	2

of other diseases and defects on the various varieties or the incidences were too low for comparisons.

If Arran Banner was to be compared with the other varieties, two significant differences are apparent: a higher susceptibility to Internal brown spot and more tolerance to Common scab.

Field Experiment on The Black Scurf Disease

Data on the effects of the source of seed, date of harvesting, and mulching on the incidence of Black scurf disease on the variety Arran Banner are summarized in Table 10. The results indicate that the source of seed and the date of harvesting do not affect the incidence of the disease. However, mulching has a significant effect on the disease incidence and has reduced the disease significantly in comparison to the non-mulched check. These results are in agreement with those of Cordon et al (9) and Sanford (35). They concluded that mulching, which helps in the multiplication of the bacterium Bacillus simples suppressed the growth of Rhizoctonia solani.

Table 10. The effect of mulching, date of harvesting, and source of seed on the incidence of Black scurf on variety Arran Banner.

Source of Seed	IRELAND		HOLLAND		Average
Time of Harvesting	Normal	Late	Normal	Late	
Mulching	7	14	17	15	13 X
Check	33	46	45	52	44
Average	20	30	31	34	

X Significant at 5 per cent level.

V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The prevalence and relative importance of potato tuber diseases and defects were studied through extensive surveys of potato growing areas in Lebanon, during 1966 and 1967 and also through field experiments carried out at AREC.

Twenty four different parasitic and non-parasitic diseases and defects were found and identified. The most important ones as to prevalence and magnitude of incidence were Black scurf, Common scab, Fusarium dry rot, Potato leaf roll virus, Late blight, Silver scurf, Soft rot, Internal brown spot and injuries due to the Tuber moth.

Black scurf and Common scab were most prevalent in the Beqa'a plain, whereas Late blight was restricted to the coastal area. Silver scurf was more common in the Beqa'a and in the coastal area than on the mountains. The incidence of the Internal brown spot disease was high in the Beqa'a plain and low in the other areas. The Potato leaf roll disease was found to be widespread in Lebanon.

There were no striking differences in the incidence of the major diseases and defects between the years 1966 and 1967, except that the Internal brown spot and Soft rot diseases were more serious in 1966 than in 1967.

Of the commonly grown varieties: Arran Banner showed a very high susceptibility to Internal brown spot and Potato leaf roll virus, while Up-to-Date and Alpha were more susceptible to Common scab. The variety Glodia had the lowest incidence of Common scab, but was severely affected by the Soft rot pathogen and highly susceptible to Black lenticels and Rough skin defects. The variety Alpha showed a heavy incidence of Common scab in the Beqa'a plain but a very low one in the coastal area. Silver scurf and Fusarium dry rot were very common on this variety.

Mulching significantly suppressed the development of the Black scurf disease, whereas the date of harvesting and source of seed had no effect on disease incidence.

The susceptibilities, of variety Alpha to Silver scurf disease and variety Akra to Tuber moth were significantly higher than those shown by the other varieties. The reaction of all the varieties tested to the other major tuber diseases was not different significantly.

To control the most important and widespread diseases and defects of potato tubers, the following recommendations may be made:

1. For Black scurf, late planting, certified seed, and use of green manure are most effective for its control.

2. The use of acidic fertilizers, the planting of rye and mustard, as green manure, and the treatment of the tuber seed with mercuric chloride are recommended to reduce the incidence of Common scab.
3. Care should be taken in handling the potato tubers, so that there would be no wounds for the penetration of the Fusarium dry rot organism.
4. The control of aphid vectors, the eradication of volunteer plants, and the planting of certified seed are the basic necessities for the control of the widely spread Potato leaf roll virus.
5. The eradication of volunteer plants, the planting of disease free seed, the use of resistant varieties and the proper spraying of fungicides are recommended to overcome the Late blight fungus.
6. Soft rot disease can be avoided, to a certain degree, by using whole seed tubers and planting under favorable conditions for growth.
7. To reduce the severe loss of the commonly grown variety Arran Banner in the Beqa'a plain, due to Internal brown spot, further investigations should be made to find out the proper dates of planting, soil moisture and soil temperature effects.
8. Varieties resistant to the most common diseases should be introduced to Lebanon.

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APPENDIX

Appendix A-

i Three grams of Resorcin blue were dissolved in 200 ml of distilled water, then 1 ml of concentrated NH_3 was added and heated for 10 minutes in an Erlenmeyer flash. This was then kept under room temperature for one to two days until the solution was blue green in color. After heating the solution for another hour in the boiling water bath, it was filtered and kept in a flat dish on the water bath until all NH_3 had evaporated. This stock solution was kept in a brown colored bottle. For staining, one to two ml of the stock solution were diluted in 10 ml of water.

ii Rhodamin - B Solution was prepared by dissolving 1 gm of the chemical in 5000 ml of distilled water.

Figure 1.

District	Schedule of the Planting & Harvesting Season of Potato Tubers in Lebanon											
	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Akkar	■	■		▒	▒	▒						
Becharre				■	■			▒	▒	▒		
Batroun					■	■			▒	▒		
Jbeil		▒			■				▒	■		
Metn	▒	▒								■		
Baabdah					■				▒			
Aley	■			▒								
West Beqa'a			■	■		■						
Zahle			■			■						
Baalbek			■			■	▒	▒	▒	▒		

■ Time of Planting

▒ Time of Harvesting

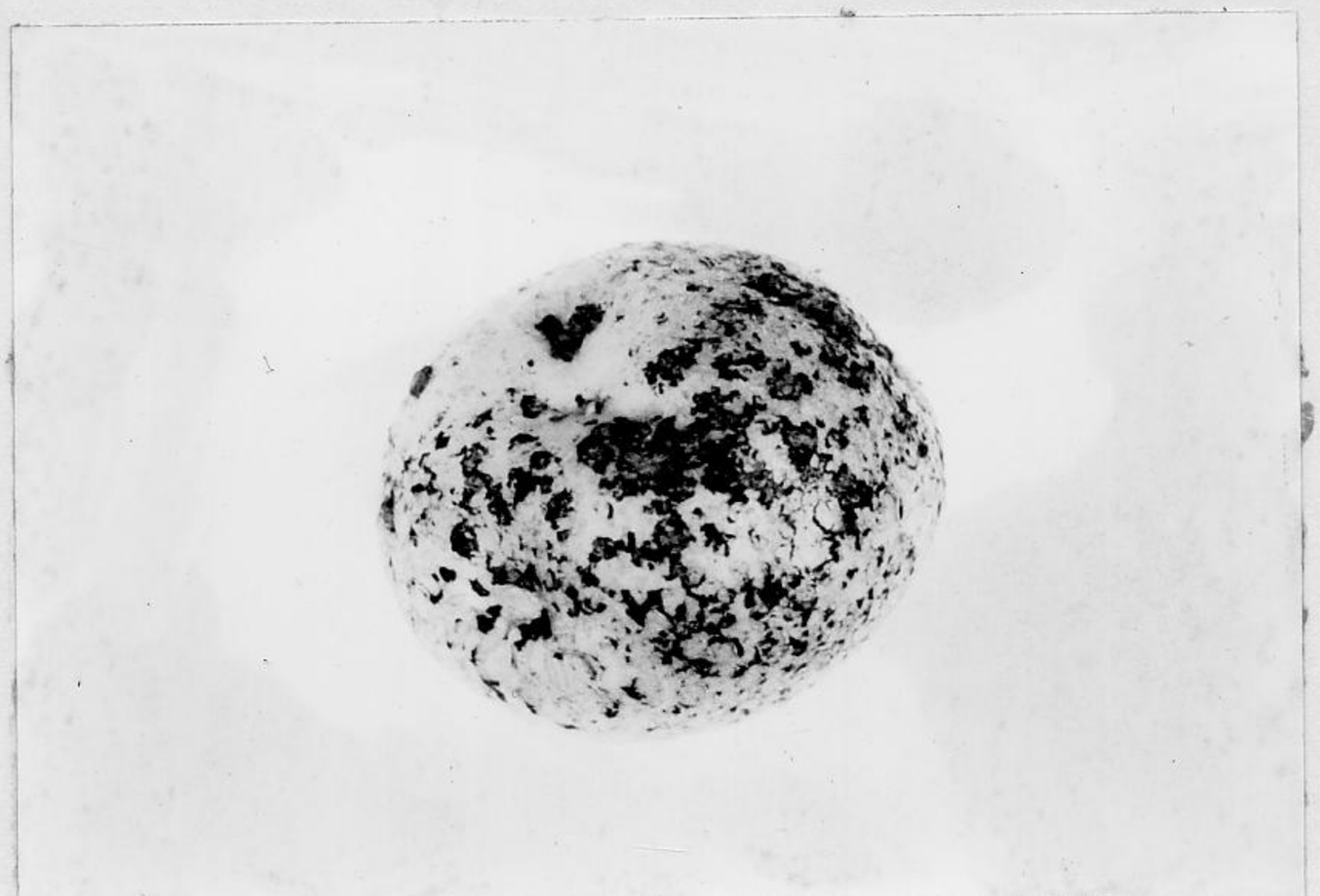

Figure 2. Black scurf (Rhizoctoni solani). Hard, black sclerotia scattered over the surface of the tuber.

Figure 3. Common scab (Streptomyces scabies). Corky superficial roughened areas, irregular in shape.

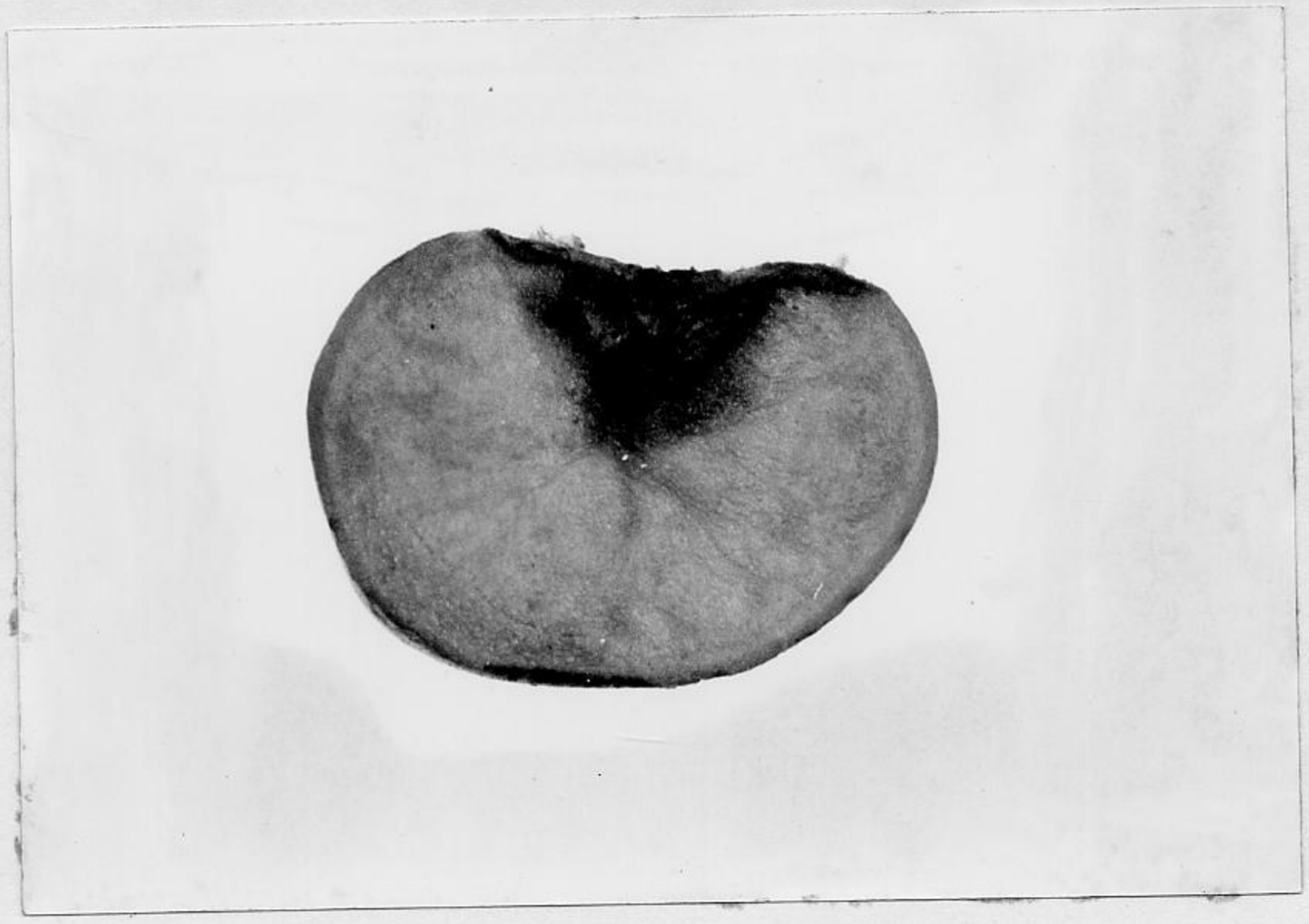

Figure 4. Fusarium dry rot (Fusarium species) Sunken shrivelled areas filled with powdery, dry, decayed tissue.

Figure 5. Late blight (Phytophthora infestans). Brownish dry rot extending to about 2 cm below the surface.

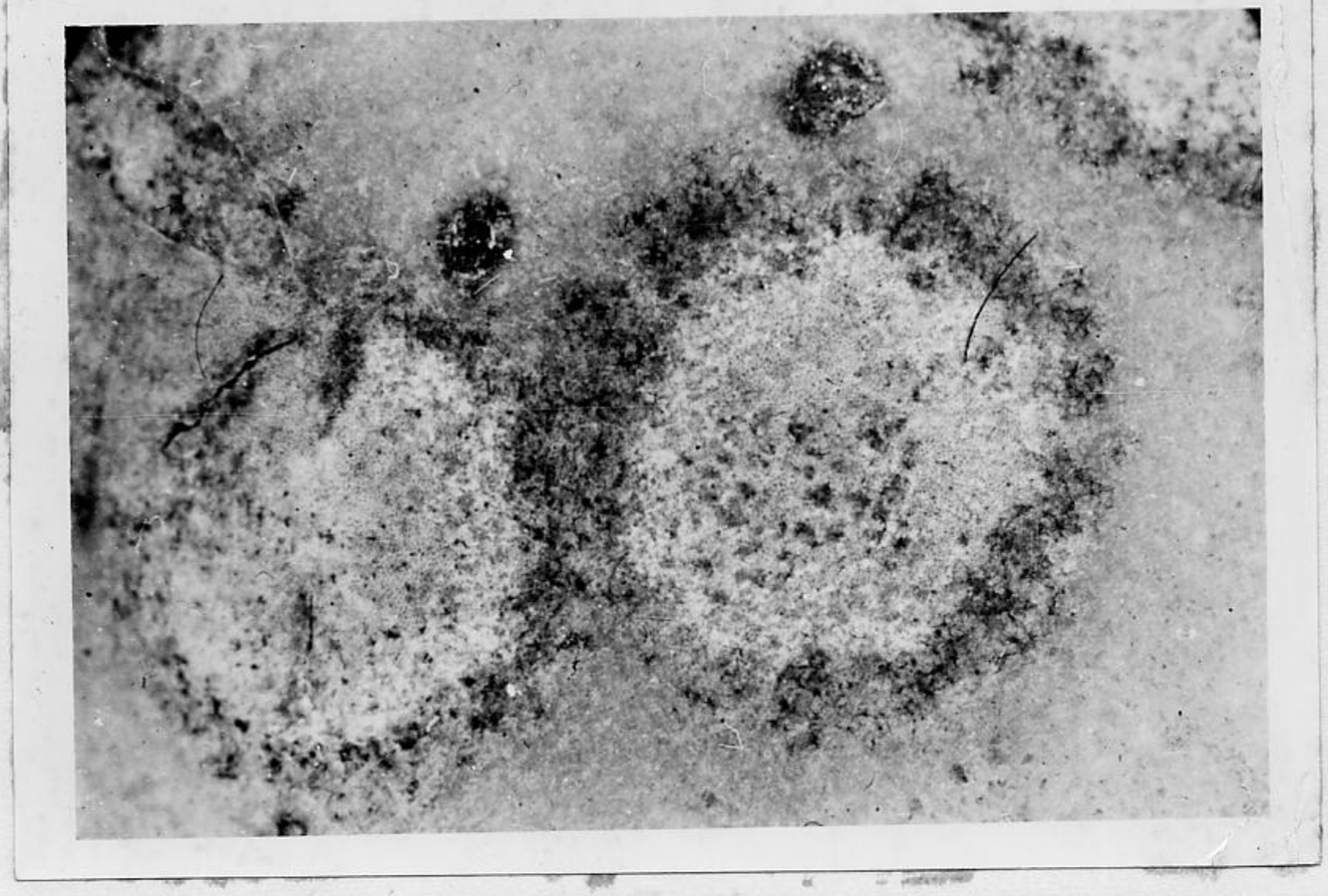

Figure 6. Silver scurf (Spondylocladium atrovirens) The surface of the tuber is dotted with minute black specks or sclerotia and has a silvery smooth appearance.

Figure 7. Tuber moth (Gnorimoschema operculella). Superficial galleries formed in the tuber containing black-headed caterpillar and mealy debris.

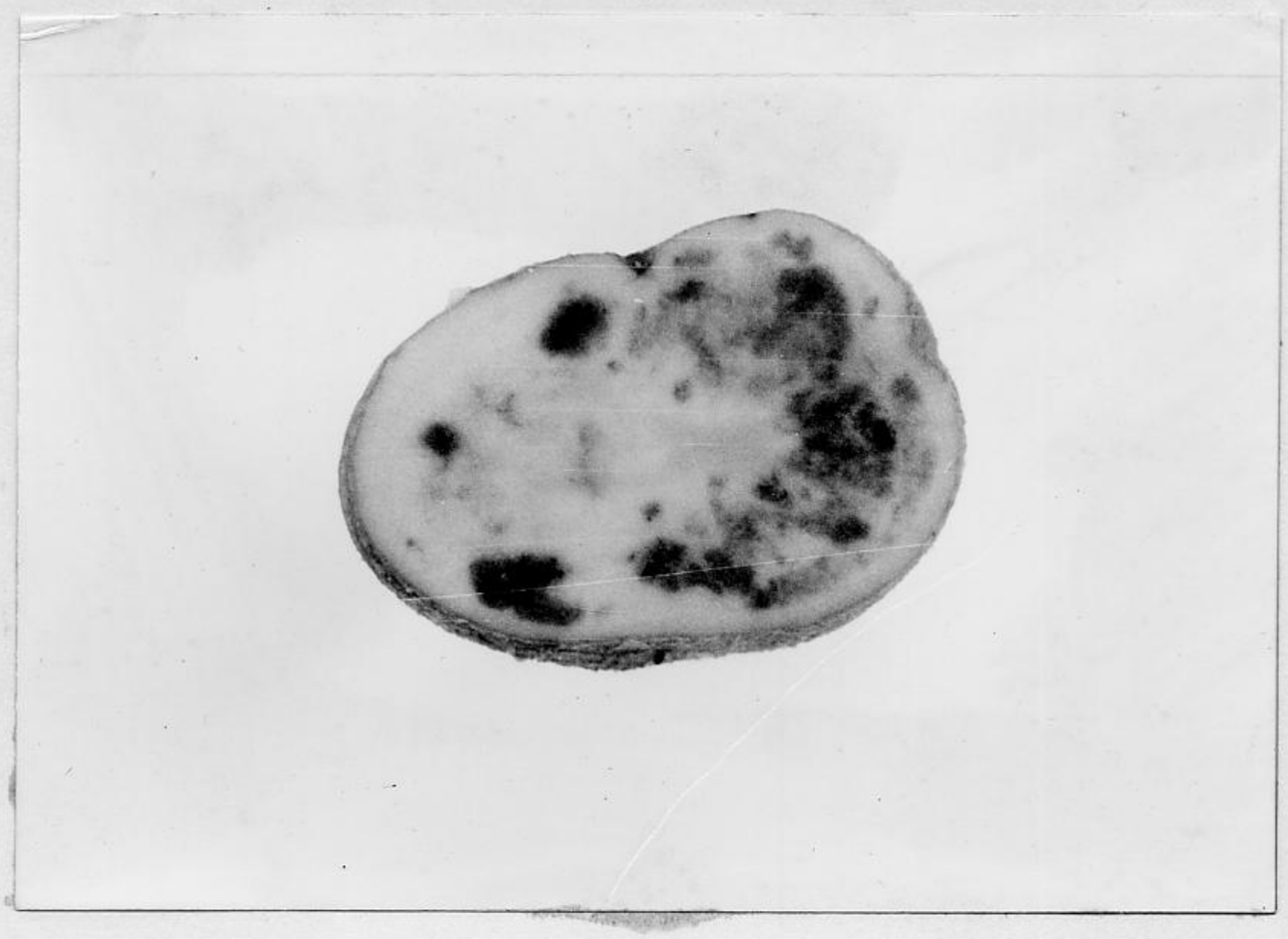

Figure 8. A- Internal brown spot.
Brown necrotic spots scattered throughout the flesh.

Figure 8. B- Internal brown spot.
Brown necrotic spots restricted to the vascular bundle.

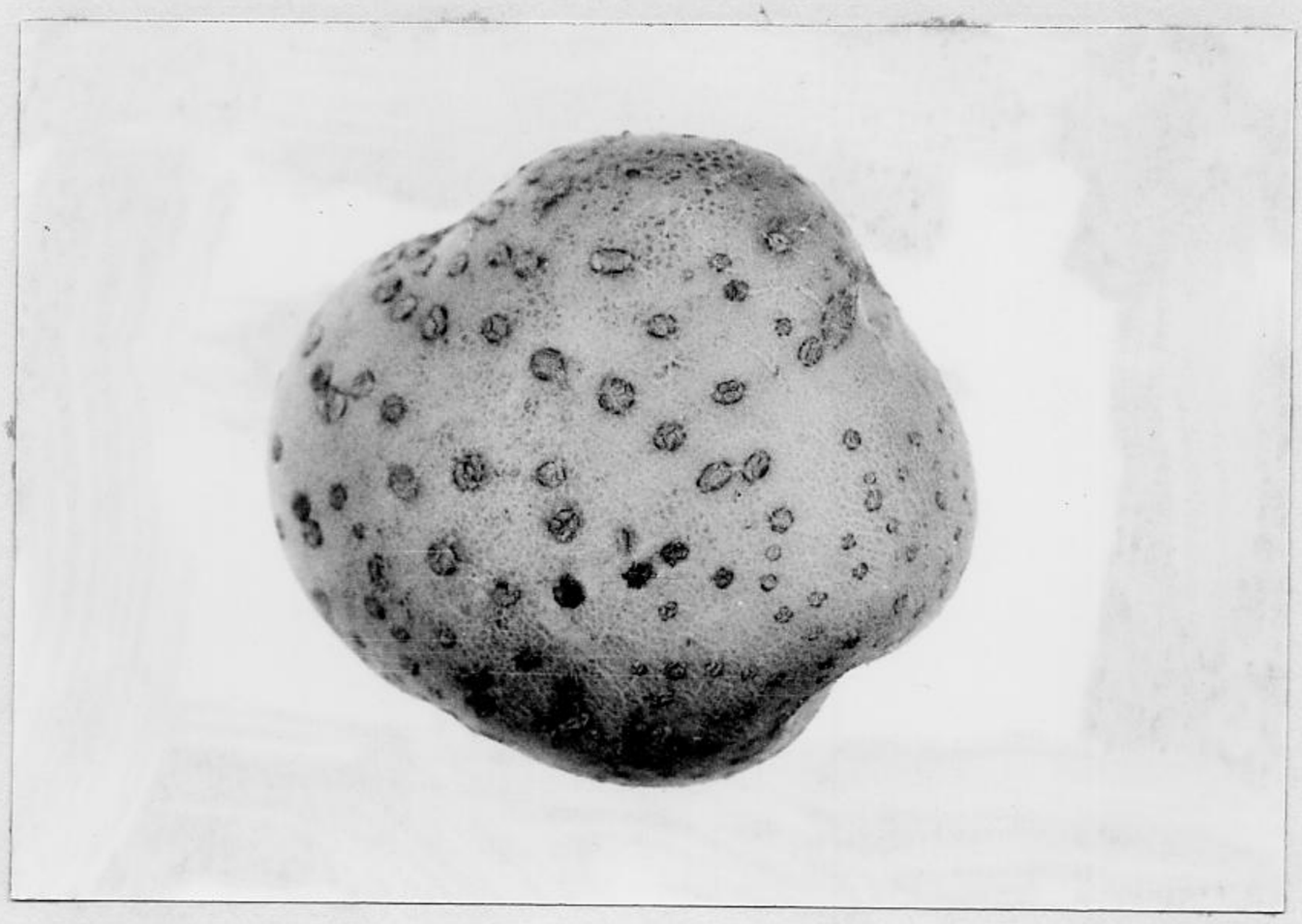

Figure 9. Enlarged lenticels.
Prominent corky areas in the lenticels, evenly distributed over the surface of the tuber.

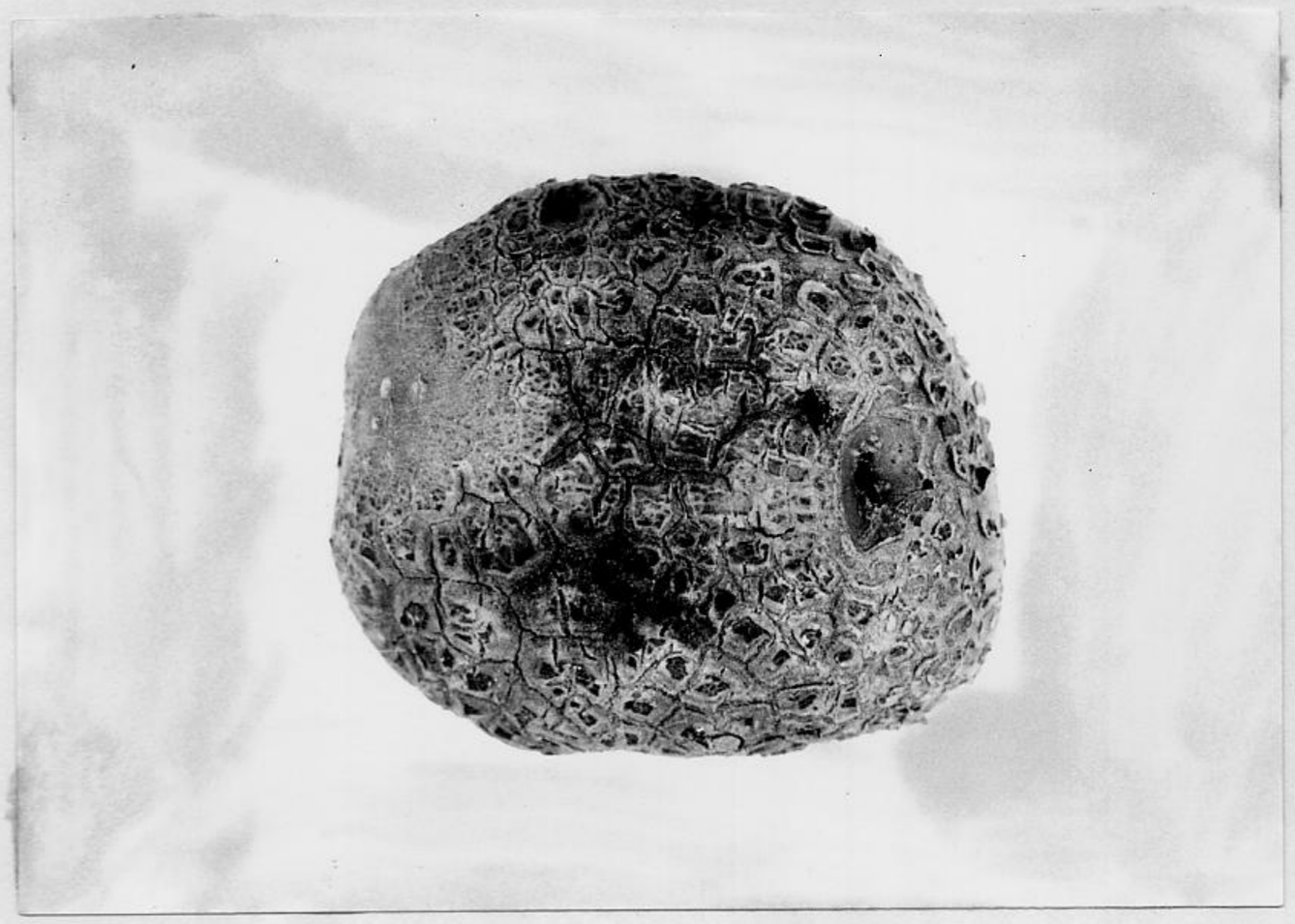

Figure 10. Rough skin.
Short narrow cracks on the surface of the tuber resulting in a roughened scaly surface.