MANAGEMENT OF POTATO COMMON SCAB IN CONTROLLED ENVIRONMENT

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Abstract

The study was carried out under greenhouse conditions to evaluate different control measures of the common scab disease of potato caused by *Streptomyces scabies.* Biological control., soil management and chemical treatments were considered. Testing of pathogenicity of *Streptomyces scabies* on recently harvested potato tubers was unsuccessful. Pathogenicity made on actively growing potato plants developed in heavily infested soil was quite successful. Scab control treatments revealed that daily watering, to maintain wet conditions, and biological control with antagonists such as *Streptomyces griseus* and *Pseudomnas putida* had shown promising disease control along with increasing tuber yield.

Sulphur amendment and application of Na-hypochlorite, thiophanate methyl were less effective in this regard.

INTRODUCTION

Potato [*Solanum tuberosum]* is one of the most important cash crops in Egypt due to the increasing demand either for local consumption or exportation to other countries.

Unfortunately, the crop is subject to many diseases that differ greatly in pathology, etiology and epidemiology. The endemic occurrence of the common scab at certain potato districts has attracted attention of interested pathologists in search for reasonable and practical disease control methods (Lacey & Wilson, 2001).

The common scab is caused by pathogenic strains of the actinomycetes differing in potential, thus producing either deep or shallow lesion in tuber flesh (Barakat,1970). Application of the flour sulphur as well as farmyard and green manures have been reported as the most classical methods of the disease control with variable degrees of success (Weinhold *et al.*, 1964). Therefore, attempts were made to develop practical protocols for common scab control. The measures of scab control has focussed generally on moisture control (Borowczak and Gladysiak, 1999); Sulphur application (Pickny *et al.*, 2002) and biological control (Neeno *et al.*, 2001 and Brakate *et al.*, 2002). The preplanting treatments with chemicals were also suggested (Errampalli and Johnston, 2001).

The study was concerned with the environmentally safe practices for common scab control through bioagents and cultural practices .

MATERIALS AND METHODS

1- Source of the common scab isolates

Six isolates of *Streptomyces scabies* pathogenic to potatoes were kindly provided by the Dept. of Bacterial diseases, Plant Pathology Res. Inst., Giza. Checking of the pathogenic potential was made according to Barakat (1970), in potted actively growing potato plants in heavily infested soil. The detached potato tuber technique as described by Barakat (1970) was also tried.

2- Sources of antagonists

Strains of *Streptomyces griseus, S.albus, S.antibioticus, S. aureofaciens, Pantoea agglomorans, Pseudomonas fluorescens* and *P. putida* were obtained from the Bacterial Diseases Dept., Plant Pathology Res. Inst. and screened for the antagonistic potential against the used isolates of the common scab pathogen isolates.

Plates of soil extract agar medium were streaked with the most virulent *S. scabies* isolate (Ss6) propagated on the same medium for 6 days. Streaks of bacteria and actinomycetes isolates [1and 6 days old slants, for bacterial and actinomycetes, respectively] were lined one centimeter apart from the pathogen streak. Plates were incubated for 6 days at 28C, and examined for presence or absence of the pathogen.

3- Greenhouse treatments

Clay loam soil was sterilized with formalin 2% (v:v) and kept covered with polyethylene sheets for 4 days before use. After adequate aeration for two additional days, the soil was distributed in formaldehyde sterilized plastic pots (25 cm in diam.). The scab pathogen, propagated on Waksman's egg-albumin agar plates for 7 days, was used (3 plates/pot), for soil infestation. The check treatment was prepared in the same way and the uninoculated Waksman's medium was applied at the same rate and kept under the same condition. Watering was made constantly day after day (300 ml/pot) for one week to provide moisture necessary for pathogen build up. The following preplanting preparations were made:

1- Seed-tubers disinfection was made with 500 ppm NaOCl for 10 minutes.
2- Seed-tubers treated with thiophenate methyl TPM, (0.5gm/1 kg tubers).
3- Elementary sulfur (1g/pot)was added to the soil.
4- Constant daily watering with 300 ml./pot.
5- Soil infestation with antagonist *S. griseus* at rate of 3 evenly grown actinomycetes plates/pot grown for 7 days on glycerol asparagine medium.
6- Soil infestation with the antagonist *P. putida* at rate of 30 ml/pot, nutrient glucose broth grown for 2 days (10^8 cfu/ml).
7- Untreated control treatments: Diamant potato tubers were surface sterilized by instant dip in 0.1% phenol solution (w:v) before planting (1 tuber/pot)with

consideration of 5 replicates/treatment in a complete randomized design. Watering was made day after day for one week to maintain adequate soil moisture for tuber development (300 ml/pot). At maturity stage, approximately 90 days after planting, the tubers were collected, examined for scab symptoms, and the disease severity was calculated according to the grading system proposed by Weinhold *et al.*, (1964), using numerical grades from 0 to 5. Readings were converted to disease index percentage. The number of tubers in each grade category was multiplied by the corresponding numerical grade and the produced figures were added together. The summation was divided by the maximum numerical grade for the given number of tubers and multiplied by 100 to obtain the disease index value, (Weinhold *et al.* 1964).

RESULTS

Table (1) show the pathogenic potential of the six scab isolates under investigation. The percentage of disease index were invariably different for the isolates in concern ranging from 4 to 80.

Table 1. The pathogenic potential of the *S. scabies* isolates.

Isolates No.	Disease index (%)	
	Detached tubers	Developing tubers
Ss 5	* 0.0	4.0
Ss 2	* 0.0	14.7
Ss 1	* 0.0	26.7
Ss 4	* 0.0	52.0
Ss 6	* 0.0	61.3
Ss 3	* 0.0	80.0

* No evidence of infection

Table 2. Efficacy of bioagents, soil improvement, soil moisture and chemicals on disease incidence and yield .

Treatments	Inoculated soil			Disease index %	Uninoculated soil			Disease index %
	Plant growth parameters				Plant growth parameters			
	Average of:				Average of:			
	No of tubers /pot	Weight of one tuber (g)	Yield/ pot (g)		No of tubers/ pot	Weight of one tuber (g)	Yield/pot (g)	
Excess of soil moisture [watering every day]	6.8	40.7	300.7	4.2	7.2	43.0	309.6	0.0
Biological control [*S. griseus*]	5.6	40.2	247.0	8.2	6.4	42.2	319.8	0.0
Biological control [*P. putida*]	4.8	38.0	224.2	13.4	7.0	43.4	311.8	0.0
Soil improvement [sulfur]	4.0	23.5	111.0	16.7	5.8	41.3	239.5	0.0
Chemicals (NaOCl)	3.4	25.1	100.3	21.3	6.8	33.8	248.0	0.0
Chemicals [TPM]	3.0	27.2	99.2	24.9	6.2	35.6	236.2	0.0
Control [Untreated]	2.2	33.5	93.7	30.3	5.6	37.0	214.2	0.0
L.S.D. at 0.05	1.809	N.S	140.5	11.33	N.S	N.S	N.S	-

Table (2) shows that the daily watering treatment had decreased the disease severity to 4.2% compared to 30.3% for the untreated control. Biological control treatments with either *S. griseus* and *P. putida,* significantly decreased disease severity, being 8.2% and 13.4%, respectively; followed by sulphur application. Sodium hypochlorite and TPM on the other hand caused a slight non significant decrease in disease severity, and were considered non-effective.

Regarding the tuber yield/pot, table (2) show that the daily watering caused a significant increase in yield being 300.7 g/pot, followed by *S. griseus* treatment that increased the yield to 247.0 g/pot, compared to 93.7 gm in check treatment. These treatments, however, did not cause significant increase in the average weight of tubers, contrary to the number of tubers that showed a highly significant increase.

It is interesting to note that the un-inoculated treatments did not show any significant increase in number of tubers, weight of tuber as well as the tuber yield/pot.

DISCUSSION

Tubers and the underground parts of potato plants are subject to many pathogenic forms of soil-borne organisms (Mazurkeiwicz, 2002 and Jacobsen, 2002).

The common scab caused by *S. scabies* and powdery scab caused by *Spongospora subterranea* are among the most important marketing diseases of potatoes. The mode of dessimination from one potato district to another had been essentially reported by scabby seedtuber, as well as the organic manures containing the pathogenic strains (Mishra and Srivastava, 1999).

The etiology and epidemiology of the common scab have been a matter of controversy for a long period of time because of the specific nature of pathogenesis with actionmycetes in general and liability of tubers for infection, at different stages of development, in particular (Shalaby, 1980).

In this work physical (watering), biological and chemical treatments were tried for the control of common scab under controlled environment. Daily watering, was the most promising scab management under controlled conditions followed by the biological control by *S. griseus.* In this regard, control of common scab by biological means was reported by many investigators (Neeno *et al.,* 2001; Jacobsen, 2002 and Mazurkiewicz, 2002) who attributed the favourable effect of farmyard and green manuring to the increased incidence of antagonist. Excess watering of potato at early stages of tuber development was also reported by (Ridder, 1999 and Borowczak & Gladysiak, 1999), as a promising scab control. This finding also explains the greater incidence of tuber scab in light textured soil that may be easily attributed to low water holding capacity of soil. The same may apply to the low incidence of the disease in clay soil, because of the higher retention of water, compared to sandy soil (Szutkowska and Lutomirska, 2002). The high soil moisture was correlated with the low oxygen tension which is unfavourable to the pathogen, since it is rated as strictly aerobic organism (Schaad, 1988). The value of the use of thiophanate methyl and sodium hypochlorite was found limited in scab control under the condition of the experiment contrary to findings by Errampalli and Johnston (2001).

Regarding the yielding potential of plants of different treatments under the conditions of the experiment, the daily watering caused significant increase in tuber yield. Other treatments invariably increased the yield. Watering in excess at the preliminary stages of tuber development may coincide with the quick enlargement of the tuber in general and improvement of tuber resistance to infection in particular. Therefore, it could be concluded that excess watering of potatoes had a beneficial qualitative and quantitative effect.

Last but not least, it is important to note that pathogenicity trials made in this work on detached tubers failed completely to develop any scab lesions, contrary to that reported by Barakat (1970). He reported that six isolates were pathogenic on enlarged tubers developed after 55-90 days of planting. Two to six weeks after

inoculation and maintenance of the detached tubers in wet under bell jar conditions, the pustules were developed.

The failure of the scab pathogen to infect the detached tubers is known to coincide with the degree of periderm formation which is enhanced under humid conditions. Moreover, infection with *S. scabies* is known to take place essentially through lenticels, to some extent through stomata, and to less extent through wounds. The detached tuber technique as described by Barakat (1970) needs further investigations.

In retrospect, we can conclude that increasing the depth or irrigation and/or shortening the duration of irrigation periods are recommended for scab control. Such recommendation is of paramount importance for potatoes developed in sandy newly reclaimed areas. Avoidance of using chemicals for scab control may be suggested in light of the afore-mentioned recommendation, for the environmental safety measures.

Further investigation are needed to determine the best irrigation regimes under different soil conditions.

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تهيئة الظروف البيئية لمقاومة مرض الجرب العادى فى البطاطس

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أجريت دراسة تحت ظروف الصوبة لتقييم بعض الطرق المختلفة لمقاومة مرض الجرب العادى فى البطاطس الذى يسببه الاكتينوميستس ستربتوميسس سكابس. حيث استخدمت طرق المقاومة الحيوية والتحكم فى الظروف الطبيعية للتربة واختبار المعاملات الكيماوية. ومن خلال هذه الدراسة تم التأكيد على فشل إمكانية إحداث العدوى للدرنات بعد الحصاد والعكس صحيح. واتضح أن أكثر الطرق فاعلية فى مقاومة هذا المرض وأيضاً فى زيادة المحصول الناتج هى استمرار وجود الرطوبة حول الدرنات فى التربة وأيضاً استخدام المقاومة الحيوية باستخدام كلاً من الاكتينوميستس مثل الاستربتوميسس جريسيس أو البكتريا سيدوموناس بيوتدا. فى حين أن معاملة التربة بالكبريت أو معاملة الدرنات بالكيماويات مثل هيبوكلوريت الصوديوم أو ثيوفونات الميثيل كانتا أقل فاعلية فى هذا الخصوص.