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EFFECT OF SOME CULTURAL PRACTICES ON COMMON SCAB (STREPTOMYCES SCABIES [THAXTER]) OF POTATO AT TWO PRODUCTION SITES IN KHARTOUM STATE

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Abstract
Purpose: A field experiment was conducted at two sites of potato production: El Dishinab and Wad Ramly on the western and eastern Nile bank, north Khartoum State, respectively. The aim of the experiment was to investigate the effect of application of ammonium sulphate and two water regimes (frequent watering, limited watering) on controlling soil-borne common scab *Streptomyces scabies* (Thaxter).
Design/methodology/approach: A split plot design was adopted with water regimes as the main plot and ammonium sulphate application as the subplot treatment. The effect of treatments on dry rot and black scurf incidence was also assessed.
Findings: Common scab (CS) was the most prevalent disease at the two locations. The incidence of common scab (CS), dry rot (DR) and black scurf (BSc) are generally higher at El Dishinab (95%, 22.8%, 13.4%, respectively) than at Wad Ramly (22.8%, 7.8%, 9.7%, respectively). The application of ammonium sulphate significantly increased total yield and decreased com-

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mon scab severity at El Dishinab. Limited watering significantly increased common scab (3.76% to 5.44 %) and decreased dry rot (2.85%, 2.47 %) at Wad Ramly.

Keywords: Common scab, Dry rot, Potato production, Water regimes, Ammonium sulphate

Paper type: Research paper

INTRODUCTION

Common scab of potatoes is caused by *Streptomyces scabies* (Thaxter), a very prevalent, soil-inhabiting bacterium. This disease can be found in all potato-growing areas throughout the world (Marais and Vorster, 1988; Dees and Wanner, 2012). The major loss from common scab is economically significant and lowers market quality, because tubers have surface or internal blemishes (Agrios, 1997; King *et al.*, 1992). The disease may initiate from infected seed or from pathogen inocula present in the soil (Wilson *et al.*, 1999; Wang and Lazarovits, 2005). Infected seed tubers are a major source of disease development during the growing season and also a source to soil infestation. Common scab inocula can be introduced into the soil by means of infected tubers and farming practices. Infested soil can spread by wind and rain to adjacent "clean fields".

The scab bacterium disseminates in pitted tubers and fleshy roots or in soil, and over-winters on living roots, weeds and crop residue left in the field or garden, Wind, water, farm machinery and tools all move soil from one location to another (RPD, 1988). Once established in a field, *S. scabies* can survive for extended periods on plant residues; consequently crop rotation provides only limited control of this pathogen (Rich, 1983). The extent of infection and subsequent losses to common scab are influenced by soil moisture (Lapwood and Hering, 1970), nutrient levels (Keinath and Loria, 1989), environmental conditions (Hooker, 1981) and crop management factors, such as planting and harvest dates (Waterer, 2002). Seed, soil or foliar applied chemicals provide only limited control of soil-borne scab (Davis *et al.*, 1974a).

In dry soil, a combination of control measures include using disease-free seed, applying organic manure, adding sulphate or acid-forming nitrogen fertilizer, rotation with small grains, grasses, corn, sorghum, Soya bean or alfalfa, and avoiding alternative hosts (Gowus, 2006). Severity of common scab is significantly reduced in soil pH of 5.2 and below. Soil moisture during tuberization has a profound effect on common scab infection. Thus, moisture stress should be avoided during the 2–6 weeks following tuberization (Loria, 1991; Davis *et al.*, 1976; Adams, 1975; Khatri *et al.*, 2010). In the last three years, common scab has become a threat to potato production in Khartoum state and was recorded in 67% of the fields visited in 2010/2011, and in 69% in 2011/2012.

The problem has been aggravated by planting potatoes continuously on the same field with very narrow spacing, or without rotation due to land shortage. Therefore there is an urgent need to investigate the potential suppression of some cultural practices on common scab development in potato. Further research should focus on integrating the pest management approach to achieve control of soil borne scab (Dees and Wanner, 2012), which is very difficult because of the complexity of factors affecting the development of the disease, such as the present density of the causal organism in the soil. The aim of this study was to investigate the effect of the application of ammonium sulphate and two water regimes (frequent watering, limited watering) on controlling soil borne common scab *Streptomyces scabies* (Thaxter).

MATERIALS AND METHODS

Field experiments were conducted in the winter of 2011 at two sites of commercial potato fields in Khartoum State. Fields with a history of problems with common scab were chosen for the trial (Table 1), the soil type was medium textured soil, silty clay to silty alkaline soil reaction where the pH ranged from 7.8 to 8.6 during the seasonal cropping time. The experimental design used was a split plot with water regimes at 7 and 10 days as the main plots and ammonium sulphate was broadcast with the third irrigation (0, 3.6 kg /plot and 7.2 kg /plot) as the subplot treatment.

Table 1. Streptomyces scabies load in potato field season 2011-201

Location	Count of S. scabies (cfu/g)* maximum	Soil pH	ECe(dS/m)**	Incidence	Severity
El Dishinab	$3.8*10^5$	7.0	0.35	95.7	2.1
Wad Ramly	$3.0*10^5$	7.2	0.24	22.9	0.75

***cfu/g:** colony forming units/g
**ECe (dS/m): the electrical conductivity of saturated soil water extracts

The treatments were replicated three times. Certified seed tubers of cv. Bellini halved tubers were planted on the northern side of the east-west ridges. Spacing was 70 cm between ridges and 25 cm between hills. Plot size was 6x6 m^2; all plots received 2N applied 1N after emergence and the 1N with earthing up. Prophylactic spray against early blight and aphids was applied. At the end of the season in Feb–March, all tubers from the two middles rows were harvested, sorted and total yield per plot was determined by weighing tubes. The disease incidence of potatoes and weight loss were estimated. The disease incidence was calculated by dividing the number of infected tubers by the total number of tubers.

The percentage of loss due to disease was calculated by dividing the weight of diseased tuber by the total weight of the sample. The main fungal and bacterial diseases associated with potato tubers in storage and fields were also assessed. An unbiased sample of 20 tubers was chosen at random and rated for scab severity on a scale of 0-4 based on the percentage of tubers surface covered with scab lesion 0=no lesion, 1=1-10% of the surface area of tuber affected, 2=11-25% affected ,3=26-50% affected, and 4=>50% affected. The effect of applied treatments on scab incidence, severity and tuber yield was analyzed by ANOVA and LSD was calculated at p=0.05 using GenStat Release 10.3DE (Pc/windows).

RESULTS AND DISCUSSION

Tables 2–7 show the effect of ammonium sulphate and water regimes on the incidence (%); of common scab (CS), dry rot (DR) and black scurf (BSc) and (%) weight loss due to their infection. The incidence of common scab, dry rot and black scurf was generally higher at El Dishinab (95%, 22.8% and 13.4%, respectively) than at Wad Ramly (22.8% 7.8% and 9.7, respectively). Common scab was the most prevalent disease at the two locations. The irrigation effect was significant on dry rot incidence at Wad Ramly. Dry rot was lower with limited watering regime. The limited watering regime significantly increased common scab and decreased dry rot at Wad Ramly. The common scab number was significantly affected by the water regime coupled with ammonium sulphate. Limited watering significantly affected dry rot (%) incidence and associated weight loss (%) at El Dishinab. At Wad Ramly, frequent watering significantly increased dry rot incidence.

Tables 8–12 show the effect of treatments on total number of marketable and unmarketable tubers, common scab severity and

Table 2. Effect of ammonium sulphate and water regimes on (%) incidence of common scab (CS) at El Dishinab and Wad Ramly (2011-2012)

Location	El Dishinab				Wad Ramly			
	Ammonium sulphate dose (kg/plot)				Ammonium sulphate dose (kg/plot)			
Water regime (days)	3.6	7.2	0	Mean	3.6	7.2	0	Mean
7	9.6 (93.07)	9.8 (95.7)	9.7 (93.57)	9.7 (94.11)	3.72 (14)	3.99 (16)	3.56 (13.6)	3.76 (14.8)
10	9.95 (99.02)	9.76 (95.43)	9.67 (93.70)	9.8 (96.05)	4.54 (20.9)	6.16 (38.6)	5.63 (33.3)	5.44 (30.9)
Mean	9.69 (94.04)	9.77 (95.57)	9.67 (93.63)	9.75 (95.08)	4.13 (17.5)	5.08 (27.7)	4.59 (23.4)	4.60 (22.9)
SE ± irr.	0.0581				0.514			
SE± Dos.	0.0327				0.418			
SE± inter.	0.0693*				0.705			
CV%	0.8000					22.2		

Data transformed to $\sqrt{x}$, actual data in parentheses

Table 3. Effect of ammonium sulphate and water regimes on (%) weight loss due to common scab at El Dishinab and Wad Ramly (2011-2012)

Location	El Dishinab				Wad Ramly			
Water regime (days)	Ammonium sulphate dose (kg/plot)				Ammonium sulphate dose (kg/plot)			
	3.6	7.2	0	Mean	3.6	7.2	0	Mean
7	9.746 (95.00)	9.774 (95.57)	9.798 (96.00)	9.773 (95.52)	3.70 (13.7)	3.93 (16.7)	3.84 (15.3)	3.82 (15.2)
10	9.982 (99.32)	9.830 (96.63)	9.801 (96.07)	9.871 (97.44)	4.79 (23.1)	5.79 (33.8)	6.32 (42.1)	5.63 (33.0)
Mean	9.864 (97.3)	9.802 (96.10)	9.799 (96.03)	9.822 (96.48)	4.24 (18.4)	4.86 (25.3)	5.08 (28.7)	4.73 (24.1)
SE ± irr.	0.0590				0.744			
SE± Dos.	0.0492				0.256			
SE± inter.	0.0819				0.800			
CV%		1.2				13.2		

Data transformed to $\sqrt{x}$, actual data in parentheses

Table 4. Effect of ammonium sulphate and water regimes on (%) incidence of dry rot (DR) at El Dishinab and Wad Ramly (2011-2012)

Location								
Water regime (days)	Ammonium sulphate dose (kg/plot)				Ammonium sulphate dose (kg/plot)			
	3.6	7.2	0	Mean	3.6	7.2	0	Mean
7	3.07 (9.6)	4.79 (23.9)	4.58 (24.4)	4.15 (19.0)	2.24 (5.4)	3.46 (12.8)	2.87 (9.5)	2.85 (9.3)
10	4.28 (18.5)	5.61 (32.1)	5.36 (29.00)	5.08 (26.5)	2.10 (4.5)	2.58 (7.1)	2.74 (7.7)	2.47 (6.4)
Mean	3.68 (14.1)	5.20 (28.00)	4.97 (26.2)	4.62 (22.7)	2.17 (5.00)	3.02 (10.00)	2.80 (8.6)	2.66 (7.8)
SE ± irr.		0.095*				0.059*		
SE± Dos.		0.525				0.388		
SE± inter.		0.614				0.451		
CV%			27.9				35.6	

Data transformed to √x, actual data in parentheses

Table 5. Effect of ammonium sulphate and water regimes on (%) weight loss due to dry rot (DR) at El Dishinab and Wad Ramly (2011-2012)

Location								
Water regime (days)	Ammonium sulphate dose (kg/plot)				Ammonium sulphate dose (kg/plot)			
	3.6	7.2	0	Mean	3.6	7.2	0	Mean
7	3.31 (11.9)	4.74 (24.6)	4.39 (23.4)	4.15 (20.0)	2.30 (5.6)	3.38 (11.8)	2.53 (8.5)	2.74 (8.6)
10	4.59 (21.3)	6.20 (38.6)	5.18 (27.2)	5.32 (29.1)	1.77 (3.9)	2.61 (7.3)	3.01 (9.3)	2.47 (6.8)
Mean	3.95 (16.6)	5.47 (31.6)	4.79 (25.3)	4.74 (24.5)	2.04 (4.7)	3.00 (9,6)	2.77 (8.9)	2.60 (7.7)
SE ± irr.	0.155*					0.151		
SE± Dos.	0.700					0.420		
SE± inter.	0.823					0.508		
CV%		36.2					39.5	

Data transformed to √x, actual data in parentheses

Table 6. Effect of ammonium sulphate and water regimes on (%) incidence of black scurf at El Dishinab and Wad Ramly (2011-2012)

Location	El Dishinab				Wad Ramly			
Water regime (days)	Ammonium sulphate dose (kg/plot)				Ammonium sulphate dose (kg/plot)			
	3.6	7.2	0	Mean	3.6	7.2	0	Mean
7	3.05 (7.3)	4.14 (14.4)	2.97 (11.2)	3.39 (11.00)	2.00 (5)	3.01 (11.7)	3.39 (13.3)	2.80 (10.00)
10	3.59 (12.3)	4.34 (13.00)	3.60 (11.5)	3.84 (12.3)	3.14 (11.7)	2.54 (6.7)	3.00 (10.0)	2.89 (9.4)
Mean	3.32 (9.8)	4.24 (13.7)	3.28 (11.4)	3.62 (11.6)	2.57 (8.3)	2.78 (9.2)	3.19 (11.7)	2.85 (9.7)
SE ± irr.	0.047*					0.627		
SE± Dos.	0.266					0.866		
SE± inter.	0.311					1.180		
CV%		18.00					74.5	

Data transformed to √x, actual data in parentheses

Table 7. Effect of ammonium sulphate and water regimes on (%) weight loss due to black scurf at El Dishinab and Wad Ramly (2011-2012)

Location	El Dishinab				Wad Ramly			
Water (days)	Ammonium sulphate dose (kg/plot)				Ammonium sulphate dose (kg/plot)			
	3.6	7.2	0	Mean	3.6	7.2	0	Mean
7	3.52 (8.9)	3.50 (14.00)	3.25 (11.5)	3.42 (11.5)	2.02 (5.2)	3.07 (13.7)	3.25 (12.7)	2.78 (10.3)
10	3.72 (14.00)	4.16 (13.4)	4.14 (15.2)	4.01 (14.2)	3.37 (14.1)	2.87 (9.00)	3.16 (12.7)	3.13 (11.9)
Mean	3.62 (11.5)	3.83 (13.7)	3.69 (13.3)	3.71 (12.8)	2.70 (9.7)	2.97 (11.3)	3.20 (12.4)	2.96 (11.1)
SE ± irr.	0.349					0.451		
SE± Dos.	0.418					1.056		
SE± inter.	0.596					1.300		
CV%		27.5					87.5	

Data transformed to √x, actual data in parentheses

Table 8. Effect of ammonium sulphate and water regimes on total number of tubers at El Dishinab and Wad Ramly (2011-2012)

Location	El Dishinab				Wad Ramly			
Water regime (days)	Ammonium sulphate dose (kg/plot)				Ammonium sulphate dose (kg/plot)			
	3.6	7.2	0	Mean	3.6	7.2	0	Mean
7	97.7	80.3	86	88	69	66.7	57	64.2
10	88	67.7	77.7	77	65.7	65.7	65.9	65.8
Mean	83.8	74	81.8	79.9	67.3	66.2	82.3	71.9
SE ± irr.		2.24				16.97		
SE± Dos.		4.41				12.23		
SE± inter.		5.56				22.08		
CV%			13.5				41.7	

Table 9. Effect of ammonium sulphate and water regimes on disease severity at El Dishinab and Wad Ramly (2011-2012)

Location	El Dishinab				Wad Ramly			
Water regime (days)	Ammonium sulphate dose (kg/plot)				Ammonium sulphate dose (kg/plot)			
	3.6	7.2	0	Mean	3.6	7.2	0	Mean
7	1.9	1.8	1.87	1.88	0.733	0.733	0.767	0.744
10	2.33	1.97	1.9	2.06	0.887	0.733	0.667	0.756
Mean	2.12	1.88	1.8	1.93	0.8	0.733	0.717	0.75
SE ± irr.		0.193				0.008		
SE± Dos.		0.189*				0.154		
SE± inter.		0.291				0.178		
CV%			21.7			50.2		

Table 10. Effect of ammonium sulphate and water regimes on number of unmarketable tubers at El Dishinab and Wad Ramly (2011-2012)

Location	El Dishinab				Wad Ramly			
Water regime (days)	Ammonium sulphate dose (kg/plot)				Ammonium sulphate dose (kg/plot)			
	3.6	7.2	0	Mean	3.6	7.2	0	Mean
7	23.3	17	16	18.8	12.3	15.3	19.7	15.8
10	18	15.7	19.7	17.8	16.3	13	15.6	16.6
Mean	20.7	16.3	17.8	18.3	14.3	14.2	17.5	16.2
SE ± irr.		2.01				1.28		
SE± Dos.		2.39				2.3		
SE± inter.		3.42				3.01		
CV%			32				32.5	

Table 11. Effect of ammonium sulphate and water regimes on weight (tonlfed) of unmarketable tubers at El Dishinab and Wad Ramly (2011-2012)

Location	El Dishinab				Wad Ramly			
Water regime (days)	Ammonium sulphate dose (kg/plot)				Ammonium sulphate dose (kg/plot)			
	3.6	7.2	0	Mean	3.6	7.2	0	Mean
7	0.700	0.513	0.583	0.599	0.583	0.653	0.84	0.692
10	0.653	0.537	0.583	0.591	0.583	0.443	0.587	0.538
Mean	0.677	0.525	0.583	0.595	0.583	0.543	0.713	0.615
SE ± irr.		0.047				0.006*		
SE± Dos.		0.054				0.089		
SE± inter.		0.078				0.103		
CV%			22.4				35.5	

Table 12. Effect of ammonium sulphate and water regimes on weight (tonlfed) of marketable tubers at El Dishinab and Wad Ramly (2011-2012)

Location	El Dishinab				Wad Ramly			
Water regime (days)	Ammonium sulphate dose (kg/plot)				Ammonium sulphate dose (kg/plot)			
	3.6	7.2	0	Mean	3.6	7.2	0	Mean
7	11.69	10.43	11.43	11.18	15.23	14.20	12.87	14.1
10	1192	8.47	9.61	10.00	12.93	12.93	12.14	12.8
Mean	11.8	9.45	10.52	10.59	14.08	13.75	12.50	13.45
SE ± irr.		0.408				0.554		
SE± Dos.		0.471*				0.554		
SE± inter.		0.68				1.072		
CV%			10.9				16.9	

weight of marketable and unmarketable tubers at El Dishinab and Wad Ramly. Ammonium sulphate application had significant effect on common scab severity and total marketable yield at El Dishinab. This was in accordance with the findings of Davis *et al.* (1974b) and Lapwood and Hering (1970). The interaction between limited watering and ammonium sulphate had a significant effect on the severity of common scab at El Dishinab. However, there was no significant effect of ammonium sulphate application on yield and severity at Wad Ramly. This may be attributed to low soil inocula at Wad Ramly (Table 1).The interaction of water regime and ammonium sulphate was not significant.

CONCLUSION

The experiment results concluded that irrigation interval positively affected potato scab control. Reduction in soil pH values during the growing period played a major role in disease control.

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