

SUSCEPTIBILITY OF POTATO CULTIVARS TO *SPONGOSPORA SUBTERRANEA* UNDER FIELD CONDITIONS

SHAMIM IFTIKHAR, ATIQ-UR-REHMAN RATTU, SHAHZAD ASAD
AND KHURSHID BURNEY

*Crop Diseases Research Program,
Institute of Plant and Environment Protection,
National Agricultural Research Centre, Park Road, Islamabad-45500, Pakistan.*

Abstract

Spongospora subterranea f. sp. *Subterranean*, the causal organism of powdery scab of potato is a severe problem in many areas of the world where potato crop is grown. Due to seed and soil borne nature of the pathogen, it is difficult to manage using a single method of control. Therefore, growers are heading towards an integrated management approach for effective control of powdery scab. The most cost-effective, long term and environment friendly way of controlling the disease is to identify the cultivars resistant to the disease. During the current study, 6 potato varieties viz., Sante, Diamant, Cardinal, Desiree, Faisalabad white and Faisalabad red were screened against *S. subterranea* in a naturally infested field at Sharan in Kaghan valley. All six varieties showed different levels of susceptibility to *S. subterranea*. Desiree cultivar showed lowest percent incidence of disease with low severity. Statistical analysis revealed significant differences in weight and number of tubers in Diamant, Faisalabad white and Faisalabad red but this has no correlation with the disease incidence and severity.

Introduction

Powdery scab of potato, caused by *Spongospora subterranea* f.sp. *subterranea* (Wallr.) Lagerh, is a well known disease in many areas of the world. The major factors involved in infection are high soil moisture and low ambient temperature (Karling, 1968, Bhattacharyya, 1974; Hughes, 1980). Powdery scab produces masses of resting spores that aggregate to form spore balls (cystosori) in scab lesions on the tuber surface and therefore seriously reduces tuber quality and marketability. The infected seed tubers are rejected for establishment of high quality crops. The pathogen reduces total crop yields by reducing plant growth (Falloon *et al.*, 1998a), forms galls on stolons and roots of potato plants, establishment from infected seed tubers reduces the size of tubers (Falloon *et al.*, 1996a).

Recently the disease has gained importance in USA and Europe (Christ, 2002; Wale, 1987) due to its seed borne nature and subsequent build up of inoculum levels in soils. An integrated approach for management using resistant cultivars, (Genet *et al.*, 2000), chemicals (Falloon *et al.*, 1996b), and application of appropriate cultural practices (Falloon *et al.*, 1997) can play an important role in disease control. The major part of the strategy is the use of disease resistant cultivars which provide the most sustainable way of limiting the disease. The latest recommendations for integrated management of powdery scab (Burgess & Wale, 1994; Falloon *et al.*, 1999; Genet *et al.*, 1996, 2000) have included disease resistance as a component of integrated powdery scab management program. Difference in susceptibility to powdery scab in different potato cultivars, breeding lines and germplasm accessions have been recognized from as early as 1930 (Karling 1968), and later by several other workers (Hughes, 1980; Kirkhan, 1986; Gans *et al.*, 1987; Jellis *et al.*, 1987; Wastie *et al.*, 1988; Eraslan & Turhan, 1989; de Boer

1991; Wastie, 1991; Torres *et al.*, 1995). Potato genotypes have different level of susceptibility to powdery scab disease. Out of 513 tested genotypes, only 13 were found highly resistant, 19 resistant, 84 susceptible and 397 were highly susceptible (Bhattacharya *et al.*, 1985) to *Spongospora subterranea*. Several cultivars including Gladiator, Red Rascal, Ilam Hardy, Nadine, Russet Burbank and Desiree have good to moderate resistance to powdery scab, while Tekau, Rua, Concorde, Agria and Iwa are more susceptible to the disease. No cultivars have been found completely immune to the disease (Anon., 1996). In heavily infested soils, a cultivar that is resistant to powdery scab can have much less disease than a susceptible one. In another study out of two varieties, Agria was found very susceptible to powdery scab as compared to Kaimai (Falloon *et al.*, 1999). Latest studies carried out in New Zealand released cv. Gladiator, with good powdery scab resistance and has been used as reference for the last 8 years trials (Genet *et al.*, 2000).

In Pakistan no work has been done on the management of the disease since its first confirmation in the soil of different potato producing agro-ecological zones (Iftikhar, 2001). Therefore, a study was undertaken to determine the relative susceptibility of local cultivars to powdery scab keeping in view the provision of information to potato breeders so that they can incorporate it into new cultivars.

Material and Methods

A naturally infested field was selected at Potato Research Station, Sharan (8000 ft above sea level) in Kaghan valley to evaluate the susceptibility of potato cultivars to powdery scab under natural conditions. The test material consisted of local potato varieties including Sante, Diamant, Cardinal, Desiree, Faisalabad white and Faisalabad red. Five tubers of each cultivar were sown in a single row of 1m length replicated thrice in a randomized complete (RCBD) block design in selected plots during the summer 2004. Normal doze of NPK was applied at the time of planting followed by cultural practices. Two periodical harvesting were conducted. During the first harvesting roots were carefully observed for the presence of galls and individual tubers of each cultivar for scab lesions, in addition number of tubers and weight of tubers was also recorded. At the second harvesting after 93 days of germination, number of tubers, weight of tubers, disease incidence and severity on 0-5 scale was noted (Anon., 1985). The scale was categorized as 0 =No infection (highly resistant) 1= less than 1% (resistant), 2 = 1-10% (moderately resistant), 3 = 11=20% (moderately susceptible), 4 = 21-50% (susceptible) and 5 = 51% and more area affected (highly susceptible).. Data was statistically analysed.

Results and Discussion

Six local potato cultivars including Santee, Diamant, Cardinal, Desiree, Faisalabad white and Faisalabad red were screened against *Spongospora subterranea* f.sp. *subterranea* in an infested field at Sharan. Different levels of susceptibility to the pathogen were detected. Results showed no significant differences among the varieties when data was subjected to statistical analysis using M stat-C-DMR test. Maximum number of tubers were formed in Cardinal variety (6.0) while minimum were observed in Desiree (3). Maximum weight of the tubers was observed in Sante (80.6 gm) next to Cardinal (80.4 gm) while Faisalabad white had the least weight (34.2 gm). Maximum disease incidence was observed in Faisalabad red 44.3% and disease severity rating of 2 while rest of the varieties showed severity rated at 1 with different percent incidence during the first harvesting (Table 1). The results during the first harvesting revealed non-significant differences among the

Final harvesting ●

1 st harvesting ●		Final harvesting ●					
		Inc. (%)	Seve. (0-5)				
ub. ●	W. tub. ● (gm)	Root galls	Symp. of P.s	No. tub. ●	W. tub. ● (gm)	Inc. (%)	Seve. (0-5)
.0	51.2	+	28.0	1	238 ab	39.0	2
.0	80.4	+	23.0	1	206 bc	37.0	1
.0	72.2	-	16.6	1	185 bc	29.0	1
.0	34.2	+	23.3	1	323 a	24.0	1
.0	67.2	+	33.3	1	106 c	41.3	2
2NS	3.05NS		44.3	2	7.63**	44.0	2
36	0.06				4.36*		
-	-				0.0034		
					13.82		
					108.7		

●, * = p<0.05, + = Present, - = Absent, ● = mean of 3 replicates

varieties in all the cases. In the second harvesting, (93 days after sowing) maximum number of tubers and maximum weight was observed in Faisalabad white (26 Nos. and 323 gm), while minimum number and weight of tubers was observed in Faisalabad red (2 Nos. and 106 gm). Maximum disease incidence was in Faisalabad red 44% with severity 2 while minimum disease incidence was on Desiree with 24% disease incidence and severity 1. Cultivar Sante, Faisalabad white and Faisalabad red show disease severity rated 2 while rest of the varieties Diamant and Cardinal showed disease severity 1. Cardinal has already been categorized among very susceptible varieties (Genet *et al.*, 2000). Statistical analysis of final harvesting data revealed that in terms of number of tubers the variety Faisalabad white is highly significantly different compared with the varieties Sante, Cardinal, Desiree and Faisalabad red at $p < 0.01$ levels while in term of weight of the tubers variety Faisalabad white is significantly different from Faisalabad red at $p < 0.05$ levels. The maximum disease incidence 44% with severity 2 has been observed in Faisalabad red followed by Faisalabad white (incidence 41.3% & severity 2), while minimum disease incidence (24%) and severity 1 has been found in cv. Desiree. Desiree cultivar reacted in a similar manner against the local isolate of *S. subterranea* as reported in New Zealand (Falloon *et al.*, 1997) which showed its low susceptibility or moderate resistance to *S. subterranea*. However, in final harvesting the number of tubers and weight of tubers did not show any correlation with the disease incidence and severity. This suggests that cv. Desiree has some resistance to local isolate of *Spongospora subterranea*.

References

- Anonymous. 1996. Powdery scab- A research progress report. New Zealand Commercial Growers, 51(1): 15-18.
- Anonymous. 1985. Powdery scab Key No. 63. Disease assessment manual for crop variety trials. National Institute of Agricultural Botany, Cambridge.
- Bhattacharyya, S.K. 1974. Studies on powdery scab. Central Potato Research Institute. 25th Scientific Report, 67-69.
- Bhattacharyya, S.K., S. Raj and R. Dwivedi. 1985. Sources of resistance to powdery scab in potatoes. *Indian Phytopathology*, 38: 174-175.
- Burgess, P.J. and S.J. Wale. 1994. Development of an integrated control strategy for powdery scab of potatoes. In ' Brighton crop protection conference. Pests and diseases – 1994, vol. 1. pp. 301-306 (British Crop Protection Council: Farnham, UK).
- Christ, B.J. 2002. Is powdery scab a new concern? Valley Potato Grower (March): 26–27.
- de Boer, R. F. 1991. Evaluation of potato cultivars in the greenhouse and field for resistance to powdery scab. *Australian Journal of Experimental Agriculture*, 31: 699-703.
- Eraslan, F. and G. Turhan. 1989. Studies on powdery scab of potato with special regard to the reactions of certain potato cultivars and clones. *Zeitschrift fur Pflanzenkrankheiten und Pflanzenschutz*, 96: 353-360.
- Falloon, R.E., R.A. Genet and J. Marshall. 1997. *Powdery scab of potato- the pathogen and progress towards control*. Crop & Food Research, Broadsheet No. 40, New Zealand Institute for Crop & Food Research Limited.
- Falloon, R.E., R.A. Genet, H.M. Nott, A.R. Wallace, J.D. Fletcher and W. F. Braam. 1998. Sulfur soil treatment for powdery scab control. *New Zealand Commercial Grower*, 53 (4): 23-24.
- Falloon, R.E., R.A. Genet, A.R. Wallace and H.M. Nott. 1999. IPM use for powdery scab. *Commercial Grower*, 54(3): 33-34.
- Falloon, R.E., A.R. Wallace, M. Braithwait, R.A. Genet, H.M. Nott, J.D. Fletcher and W.F. Braam. 1996b. Assessment of seed tuber, in-furrow, and foliar chemical treatments for control of

- powdery scab (*Spongospora subterranea* f. sp. *subterranea*) of potato. *New Zealand Journal of Crop and Horticultural Science*, 24: 341-353.
- Falloon, R.E., M. Braithwait, H. M. Nott, J.D. Fletcher, R.A. Genet, W.F. Braam and J. Marshall. 1996a. Powdery scab-A research progress report. *New Zealand Commercial Grower*, 51(1): 15-18.
- Falloon, R.E., R.A. Genet and H.M. Nott. 1998b. Powdery scab reduces potato plant productivity. Abstract No. 2.8.1, 7th International Congress of Plant Pathology, Edinburgh, UK.
- Gans, P.T., W.D. Carson and M.B. Bishop. 1987. The susceptibility of potato cultivars to powdery scab caused by *Spongospora subterranea* (Wallr.) Lagerh. *Journal of the National Institute of Agricultural Botany*, 17: 337-343.
- Genet, R.A., R.E. Falloon, M. Braithwaite, A. Wallace, J. Fletcher, Nott, H. and F. Braam. 1996. Disease resistance and chemicals for control of powdery scab (*Spongospora subterranea*): progress towards integrated control in New Zealand. Abstracts of Conference Papers, Posters and Demonstrations, 13th Triennial Conference of the European Association of Potato Research, Veldhoven, The Netherlands, July 1996. pp. 28-29.
- Genet, R.A., W.F. Braam, A.R. Wallace and R.E. Falloon. 2000. Resistance to Powdery Scab. *New Zealand Commercial Grower*, 55(1): 26-28.
- Hughes, I.K. 1980. Powdery scab (*Spongospora subterranea*) of potatoes in Queensland; occurrence cultivar susceptibility time of infection effect of soil pH, chemical control and temperature relations. *Australian Journal of Experimental Agriculture and Animal Husbandry*, 20: 625-632.
- Iftikhar, S. 2001. *Biology and epidemiology of powdery scab of potato in Pakistan*. Ph.D. Thesis. Quaid-i-Azam University, Islamabad, Pakistan.
- Jellis, G.J., P.S. Phul and N.C. Starling. 1987. Evaluation of potato germplasm for resistance to powdery scab (*Spongospora subterranea*). Tests of Agrochemicals and Cultivars No. 8 (*Annals of Applied Biology* 110, Suppl.), 154-155.
- Karling, J.S. 1968. *The Plasmodiophorales*. 2nd edn. Longon: Hafner.
- Torres, H., M.A. Pacheco and E.R. French. 1995. Resistance to potato to powdery scab (*Spongospora subterranea*) under Andean field conditions. *American Potato Journal*. 72: 355-363.
- Wale, S.J. 1987. Powdery scab – are there any easy solutions? *Potato World*, 4(4): 8-9.
- Wastie, R.I. 1991. Resistance to powdery scab of seedling progenies of *Solanum tuberosum*. *Potato Research*, 34: 249-252.
- Wastie, R.I., P.D.S. Caligari and S.J. Wale. 1988. Assessing the resistance of potatoes to powdery scab (*Spongospora subterranea* (Wallr.) Lagerh). *Potato Research*, 31: 167-171.

(Received for publication 30 March 2006)