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OCCURRENCE AND DISTRIBUTION OF BLACK SCURF OF POTATO IN PAKISTAN

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Abstract

During field survey, 525 potato tuber samples weighing 2-5 kg were taken and found that black scurf caused by *Rhizoctonia solani* was a common fungal disease in all the eight potato production agro-ecological zones of Pakistan. The highest mean disease prevalence, incidence and severity of 99.50%, 65.55% and 2.95 rating, respectively, was found in zone 2, comprising of the Punjab province. The lowest mean disease prevalence 59.19%, incidence 12.81% and severity 1.19 rating was found in zone 7 comprising of Northern Areas of Pakistan. Hundred percent locations surveyed in the remaining six zones were found having this disease. Ten locations in zone 7 namely Booni, Mastuj, Laspur, Shahidaas, Chinar, Garam Chasma, Roi, Norcoraite, Kajal and Murdan were found disease free. These locations could be used for disease free potato seed production. The results of this survey indicate that zone 2, a major potato production area of Pakistan, is heavily affected by black scurf. Moreover, this is the zone which out flows tubers for seed purpose to the remaining potato growing areas of the country. This alarming situation of black scurf at zone 2 demands some emergent multi-dimentional measures instantly be taken with respect to disease management, seed certification, farmers motivation with respect to avoid potato mono-culture and vigilant export of healthy seed tubers to other parts of the country.

Introduction

Potato (*Solanum tuberosum* L.), a major vegetable crop of Pakistan, is grown on an area of 101.5 thousand hectares with an annual production of 666.1 thousand tonnes (Anon., 2005). Among the biotic limitations to its production, 18 diseases incited by a range of pathogens have been reported of which 13 are of regular occurrence. Their significance varies greatly in eight diverse potato production zones (Ahmad *et al.,* 1991). Black scurf, early and late blights, common and powdery scabs, stem, soft and brown roots and wilts are generally occurring fungal diseases of potato in Pakistan (Ahmad, 1998). For the last few years, soil and seed-borne diseases have become main threat to potato production in Pakistan (Ahmad *et al.,* 1995). Among these diseases, *Rhizoctonia* canker commonly called black scurf, caused by the fungus *Rhizoctonia solani* Kühn has been a severe problem in all potato production agro-ecological zones of the country (Ahmad *et al.,* 1995a-d; Khan *et al.,* 1995).

Rhizoctonia disease can arise on potato plants at some time during planting to harvest and potato plants are most seriuosly damaged at early stages soon after planting. This leads to killing of underground sprouts resulting in reduced patchy stand of weak plants and consequent yield reduction (Hooker, 1981). Promising potato sprouts may become infected causing girdling and stem crumple. The perfect stage of the pathogen, *Thanatephorus cucumeris* (Frank.) Donk crop up on stems immediately above the soil line as a whitish gray rug which bear basidiospores giving the surface a powdery look. Black to dark brown sclerotia become apparent on the outside of mature tubers (Carling & Leiner, 1986; Frank, 1981). The disease causes a reduction in the size of young tubers as well as in produce (Carling & Leiner, 1986; Dillard *et al.,* 1993; Leach & Webb, 1993). The tuber symptoms comprise of cracking, deformity and pitting leading to poor quality tubers.

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Table 1. Agro-ecological zones, areas and important locations surveyed during 2001-2004.

Zone	Area	Important locations	Month/Year
1	Sindh	Khairpur, Satharja, Tharushah, Ghotki, and Shikarpur	January, 2004
2	Parts of Punjab	Sahiwal, Arifwala, Pakpatan, Okara, Depalpur, Pasrur, Daska, Jhang, and Chiniot	January/March 2002, and February 2004
3	Parts of Punjab and NWFP*	Taxila, Hazro, and Ghazi	May, 2002
4	Parts of NWFP	Abbottabad, Bajna, Baffa, Shinkiari, Malakand, and Buner	April, 2003
5	Parts of NWFP	Swat, Malam Jabba, Miandam, and Balakot	September/ October, 2002
6	Parts of NWFP (Kaghan valley)	Kaghan valley, Naran, Batakundi, and Kalam valley	October, 2002
7	Northern Areas	Ganche, Baltistan, Gilgit, Hunza, Sost, Naltar Bala, Chitral, Mastung, Booni, and Garam Chashma	September/ October, 2002
8	Balochistan	Quetta, Mastung, Kalat, Mangochar, Qila Saifullah, Kan Mehterzai, Pishin, and Ziarat	August, 2001

*****North West Frontier Province

Scanty information is available on occurrence and distribution of black scurf of potato in Pakistan (Ahmed *et al*., 1995, 1995a, 1995b, 1995c; Munir *et al*., 1994; Turkensteen, 1988). An extensive survey was thus planned with the objective to study the incidence, severity and distribution of black scurf disease in different potato production agro-ecological zones of Pakistan.

Materials and Methods

Potato tuber samples weighing 2 to 5 kg were at random taken from harvesting plants diagonally in the field. At each location, the number of farms surveyed and sample size were subjected to the accessibility of farmers and their willingness to permit the sampling. All tuber samples were brought to laboratory and assessed for black scurf disease. Details about zones, areas, locations and time of survey are presented in Table 1 and depicted in Fig.1.

Disease prevalence was calculated on the basis of percentage of farms found infected in a locality surveyed. For the disease appraisal, two parameters, disease incidence and disease severity were taken into account. The incidence was based on percentage of tubers infected in a sample and severity was assessed on a visual 0-5 rating scale based on percent tuber surface showing disease symptoms. Black scurf rating was given a score as per the scale where 0 = no disease symptoms on potato tubers; 1 = less than 1% tuber area affected; 2 = 1-10% tuber area affected; 3 = 11-20% tuber area affected; 4 = 21-50% tuber area affected and 5 = 51% or more potato tuber area affected.

Results

The survey was carried out during the period of over three years (2001-2004). During this period, 525 potato tuber samples from 176 locations scattered in 32 districts were collected from eight potato production agro-ecological zones of Pakistan. Ninety potato tuber samples were collected during 1st year (2001-2002), 298 during 2nd year (2002-2003) and 137 during 3rd year (2003-2004).

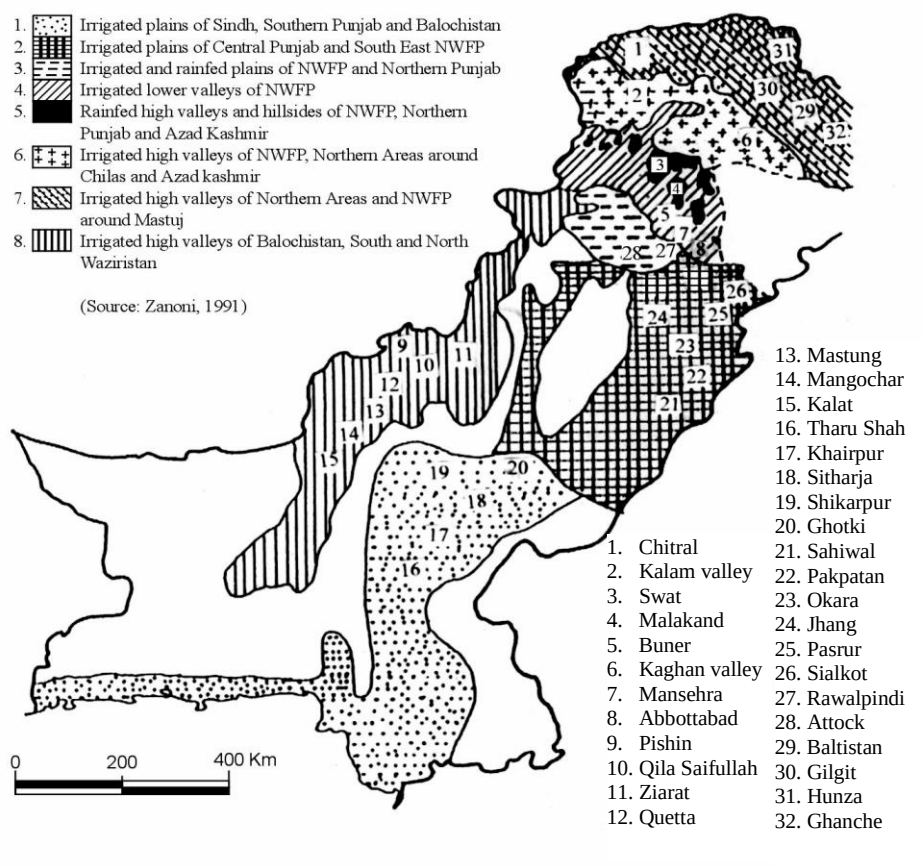

Fig. 1. Major potato production areas of Pakistan surveyed during 2001-04. Potato production agro-ecological zones based on Zanoni, 1991.

Disease prevalence: Locality-wise, none of the locations was found disease free in zone 1, 2, 3, 4, 5, 6, and 8. Ten locations in zone 7 viz., Booni, Mastuj, Laspur, Shahidaas, Chinar, Garam Chashma, Roi, Narcoraite, Kajal and Murdan were found disease free (Table 2). For an individual location, the lowest mean disease prevalence of 16.66% was found in Chitral (zone 7). In rest of the locations, mean disease prevalence ranged from 25-100%. Agro-ecological zone-wise, black scurf was the most prevalent with 99.50% mean disease prevalence in agro-ecological zone 2 (Table 3), comprising of Punjab province followed by 96.66% in zone 1 (Sindh province), and 95.23% in zone 8 (Balochistan province). The lowest mean disease prevalence of 59.19% was found in zone 7, Northern Areas of Pakistan.

Disease incidence and severity: In individual localities, the highest mean disease incidence of 87% was found at Bunga Hayat (Table 2) followed by 82.18% in Gogaira and 81.26% in Slara (zone 2). The lowest mean disease incidence of 0.5% was found in Hazratabad (zone 7). At individual farms, the highest disease incidence of 97% was found in Pakpatan followed by 96.55% in Slara (zone 2) and 95% in Naran (zone 6), whereas, the lowest disease incidence of 3% was found each at Malam Jabba (zone 5),

Table 3. Mean prevalence, incidence and severity of black scurf disease in potato production agro-ecological zones of Pakistan (2001-2004).

Agro-ecological zone	Number of areas surveyed	Number of locations surveyed	Number of farms surveyed	Prevalence* (%)	Incidence** (%)	Severity*** (0-5 rating)
1	5	5	32	96.66	23.35	2.34
2	6	35	82	99.50	65.55	2.95
3	3	16	16	87.77	20.60	1.31
4	4	9	46	92.39	30.35	1.46
5	2	13	36	87.15	15.37	1.21
6	2	20	60	85.52	17.93	1.29
7	4	67	227	59.19	12.81	1.19
8	6	11	26	95.23	25.75	1.37
Total	**32**	**176**	**525**			

*Mean percentage of surveyed farms having black scurf, **Mean percentage of potatoes infected with black scurf, ***Mean percentage of tubers surface showing disease symptoms assessed on a visual 0-5 rating scale.

Mataltan (zone 6) and Nagar (zone 7). The maximum disease incidence range of 0-95% was found at Naran (zone 6) followed by 0-82.14% at Jowar (zone 4), and 0-81% at Sialkot (zone 2). The minimum disease incidence range of 0-2% was found at Hazratabad (zone 7). Overall, samples of zone 2 were having the highest disease incidence, whereas, the samples of zone 7 were having the lowest disease incidence. Potato production zone-wise, the highest mean disease incidence of 65.55% was found in zone 2 followed by 30.35% in zone 4 and 25.75% in zone 8 (Table 3). The lowest mean disease incidence of 12.81% was found in zone 7.

At individual farms, the highest disease severity of 5 was found each at Ghotki (zone 1), Pakpatan (zone 2) and Naran (zone 6). Locality-wise, the highest mean disease severity of 3.6 was found each at Punjab Seed Corporation farm and Arifwala followed by 3.5 each in village 112/9L and 11 SP (Table 2) and 3.33 each in village 100/9L and Bunga Hayat (zone 2). The lowest mean disease severity of 0.16 was found in Chitral (zone 7). The maximum disease severity range of 1-5 was found at Depalpur (zone 2) and 0-4 at Jowar (zone 4), Miandam (zone 5), Gilgit, Hunza and Bughusht Seegain (zone 7) followed by 1-4 at Malam Jabba (zone 5), Ainabad, and Naltar Bala (zone 7). The lowest disease severity range of 0-1 was recorded at Ghazi (zone 3), Kishwera, Dand (zone 5) and Mandik, Surmo, Pali Saltoro, Chapurson, Sost, Chitral, Bamburet, Hazratabad, Wahat (zone 7). No difference in disease severity rating 1-1 of samples collected from Thana (zone 4), Gulabad, Binori (zone 5), Ashuren (zone 6), Alchuri, Nagar (zone 7) and 3-3 of samples collected from Gogaira and Slara (zone 2) were found. The highest mean disease severity for an agro-ecological zone was 2.95 recorded in zone 2 followed by 2.34 in zone 1, whereas, the lowest mean disease severity of 1.19 was found in zone 7 (Table 3). Overall, samples of zone 2 were having more disease incidence and severity as compared to other zones.

Discussion

The survey for sampling was carried out irrespective of the potato crop season i.e., spring, autumn and winter because it was not possible to move around in all the potato production zones of Pakistan during a single season. Survey indicated that black scurf was a common and a major potato disease in all the zones. The highest mean disease

prevalence, incidence and severity of 99.50%, 65.55% and 2.95 rating, respectively, were recorded in agro-ecological zone 2 (Punjab province) followed by disease prevalence of 96.66%, incidence of 23.35%, and severity of 2.34 rating in zone 1 (Sindh province). The least mean disease prevalence, incidence and severity of 59.19%, 12.81% and 1.19 rating, respectively, was found in zone 7, Northern Areas of Pakistan Sahiwal, Okara, Pakpatan, Jhang, Pasrur and Sialkot are the major potato growing areas in zone 2 with three cropping seasons. Soils of this region are calcareous sandy to silty loam having less than 1% organic matter and with pH 7.5 to 8.5. Irrigation is by tube wells and channels. Deficiency of Zn is a problem in this area (Khan & Webb, 1984). About 80% potato crop of Pakistan is produced in this zone. Production is intense in the region of towns, near cold stores and bazaars (Geddes *et al.,* 1985). There are many causes of high prevalence, incidence and severity of black scurf disease in this zone. These include favourable climatic conditions, mono-cropping, chiefly, of cv. *Desiree,* the most susceptible to black scurf disease of potato, lack of crop rotations, unsafe seed flow and lack of quarantine procedures for the disease. Environmental conditions conducive for *R. solani* are low soil temperatures and high moisture levels in soils. Populations of *R. solani* boost in fields where slight or no rotation is applied (Hooker 1981). These conditions together with zinc deficiency are predisposing factors for black scurf and are favouring the development of *R. solani* in soils of zone 2. Zn function in root rot disease of cereals/bare patch disease incited by *R. solani* AG 8 has been reported by Thongbai *et al.,* (1993). They reported an inverse relationship between zinc status in wheat plants and seriousness of *Rhizoctonia* root rot and found Zn deficiency increasing the disease. Potato is a money crop of zone 2. Farmers are cautious, knowledgeable, progressive and wealthy. Monocropping in zone 2 is usual; therefore, its cropping intensity is very high. *R. solani* is encouraged by lack of crop rotations (Hooker, 1981). Potatoes grown without proper rotation may lead to an encouragement in soil-borne diseases (Zanoni, 1991). *Desiree* is the most admired variety cultivated here (Khan & Naumann-Etienne, 1989). These circumstances are leading to continuous build up of inocula of *R. solani* in the fields. Ahmad *et al.,* (1995c) also reported that potato monocropping appears to be one of the key factors for more disease in this zone. Introduction of seed potatoes from abroad by progressive farmers without right quarantine measures appears to be another factor of more disease. Many unapproved exotic varieties e.g. Raja, Sante, Syphonia, Santana, Adora, Dragha, Cleopatra, Kondor, and Murillo in addition to approved varieties e.g., Desiree, Diamant, Ultimus, Faisalabad White, Faisalabad Red, Ajax, Patrones, and Spunta which appears to be susceptible to black scurf are under cultivation (K. Farooq, 2005, personal communication).

Zone 1 (Sindh province) is the second most affected zone by black scurf. It occupies little area in potato cultivation. The major potato growing areas in this zone are Khairpur, Ghotki, Satharja, Tharu Shah and Shikarpur. Diamant and Patronse are the most commonly grown cultivars followed by Desiree. Diamant is susceptible and Patronse is highly susceptible to black scurf disease (Zanoni, 1991). It has waterlogging and salinity problems, which make the soils poorly drained, thus conducive for disease. The major constraints to potato production appears to be quality of seed. Mostly the seed is obtained from zone 2, Sahiwal area (Nanumann-Etienne, 1990), where black scurf is a problem. Moveover, cultivation of susceptible varieties is increasing populations of *R. solani* in this zone.

Agro-ecological zone 7, Northern Areas of Pakistan embrace the valleys of Chitral, Gilgit, Sost, Naltar, Skardu, Shigar and Khaplu.. There is only one cropping season i.e summer and potato is a main crop. Mostly, desi (local) white coat varieties derived from varieties launched many years ago (Whiteman, 1985) in addition to recent varieties, are under cultivation. The local varieties, during survey, appeared to be resistant to *R. solani*. Farmers sow mostly own kept seed in pits of prior season potato crops (Zanoni, 1991). Cropping intensity is the minimum and there is a gap of eight months amid the two potato crops. Prevalence of such conditions in zone 7 are not favouring the disease, therefore, build up of inocula of *R. solani* is slow and less, consequently, zone 7 is least affected. Frank (1978) reported that variation in the incidence of stem canker and black scurf can be ascribed to differences in the quantity of soil-borne inocula of *R. solani*. Few locations in zone 7 viz., Booni, Mastuj, Laspur, Shahidaas, Chinar, Garam Chashma, Roi, Narcoraite, Kajal and Murdan were found disease free, therefore, can be used for disease free seed production.

Agro-ecological zones 3, 4, 5 and 6 also occupy little area in potato production. Zone 3 comprises of parts of Punjab and North West Frontier Province (NWFP), whereas, zone 4 comprises of lower valleys including Abbottabad, Malakand and Buner of NWFP. Swat and parts of Mansehra district fall under zone 5, whereas, Kalam and Kaghan valleys are placed in zone 6. The origin of seed potatoes for these zones is mostly zone 2. Most of the conditions conducive for disease are not present in these zones. Therefore, black scurf disease was found with varying degree of severity.

Disease prevalence and incidence-wise, zone 8 (Balochistan province) was found to be the third most affected area. Quetta, Mastung, Kalat, Qila Saifullah, Pishin and Ziarat are the major potato growing areas. Potato crop is irrigated by tube wells, and streams or Karazes. Most of the seed for cultivation comes from Sahiwal and Okara (zone 2) and is contributing in the constant build up of inocula of black scurf. According to the farmers, the disease has become a problem during the last five years. Moreover, zinc deficiency in Balochistan province soils could also be a favourable factor for the development of black scurf (T.Aqil, 2005, personal communications).

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References

Ahmad, I. 1998. Emergence of diseases and their impact on seed potato production. Research paper presented at workshop on disease free seed potato in Northern Areas. Agriculture Department Northern Areas, Gilgit.

Ahmad, I., M.H. Soomro, S. Iftikhar and M. Aslam. 1991. Investigation on powdery scab of potato in Pakistan. CDRI-PSPDP, PARC, Islamabad, Pakistan. pp. 1-2.

Ahmad, I., M.H. Soomro, S. Khalid, S. Iftikhar, A. Munir and K. Burney. 1995d. Recent distributional trends of potato diseases in Pakistan. National Seminar on Research and Development of Potato Production in Pakistan, April 23-25, NARC, PSPDP, PARC, Islamabad, Pakistan.

Ahmad, I., S. Iftikhar, M.H. Soomro, S. Hameed and S. Khalid. 1995. Diseases of potato in Sindh, Pakistan during 1994. CDRI-PSPDP, PARC, Islamabad, Pakistan. Pp. 35.

Ahmad, I., S. Iftikhar, M.H. Soomro, S. Khalid and A. Munir. 1995a. Diseases of potato in Northern Areas during 1992. CDRI-PSPDP, PARC, Islamabad, Pakistan. Pp. 38.

Ahmad, I., S. Iftikhar, M.H. Soomro, S. Khalid, and S. Hameed. 1995b. Diseases of potato in Ahmad, I., S. Iftikhar, M.H. Soomro and A. Munir. 1995c. Diseases of potato in 1993 Crop in Pak-Swiss Potato Development Project Pilot Area of Miandam, NWFP, Pakistan. CDRI-PSPDP, PARC, Islamabad, Pakistan. pp. 29.

Anonymous. 2005. *Agricultural Statistics of Pakistan*. Govt. of Pakistan. Ministry of Food, Agriculture, and Livestock. Food, Agriculture & Livestock Division (Economic Wing), Islamabad.

Balochistan during 1993. CDRI-PSPDP, PARC, Islamabad, Pakistan. Pp. 39.

Carling, D.E., and R. H. Leiner. 1986. Isolation and characterization of *Rhizoctonia solani* and binucleate *R. solani* – like fungi from aerial stems and subterranean organs of potato plants. *Phytopathology* 76: 725-729.

Dillard, H.R., T.J. Wicks and B. Philip. 1993. A grower survey of disease, invertebrate pests and pesticide use on potatoes grown in South Australia. *Australian Journal of Experimental Agriculture*, 33:653-61.

Frank, J.A. 1978. The *Rhizoctonia* disease of potatoes in Maine. *American Potato Journal*. 55: 59.

Frank, J.A. 1981. *Rhizoctonia* canker (black scurf), In: *Compendium of potato diseases*. (Eds.): W.J. Hooker. St. Paul, MN. USA: The American Phytopathological Society Press, 52-54.

Geddes, A.M.W., M. Banaras, M.B. Khan and K. Farooq. 1985. Yield survey of autumn potato crop in Punjab plains, 1983/4. PSPDP/PARC, Islamabad.

Hooker, W.J.1981. *Compendium of Potato Diseases*. American Phytopathological Society, Saint Paul, Minnesota, USA.

Khan, M.B. and K. Nauman-Etienne. 1989. A study on the mechanization of the Punjab potato crop in relation to seed production and multiplication. PSPDP/PARC, Islamabad.

Khan, R.A., S. Iftikhar, A. Rafi, S. Riaz and I. Ahmad. 1995. Distribution and incidence of tuber diseases of potato in Swat valley. National Seminar on Research and Development of Potato Production in Pakistan, April 23-25. 1995, NARC, PSPDP, PARC, Islamabad.

Khan, S.A. and R.E. Webb. 1984. Potato germplasm screening for resistance to major viruses leaf blight, cold tolerance and qualities tests. 3rd Annual Report Project No.PK-SSA-168, Vegetable Research Institute, Faisalabad, Pakistan.

Leach, S.S. and R.E. Webb. 1993. Evaluation of potato cultivars, clones and a true seed population for resistance to *Rhizoctonia solani*. *American Potato Journal*, 70: 317-28.

Munir, A., S. Iftikhar, I. Ahmad, M.H. Soomro and M. Aslam. 1994. Tuber diseases of potato in autumn 1992-93 Crop in Pak-Swiss Potato Development Project Pilot Areas of Irrigated Plains of Central Punjab (Zone 2), Pakistan. CDRI-PSPDP/PARC, Islamabad, Pakistan. Pp. 8.

Naumann-Etienne, K. 1990. Current situation and future strategy in seed potato production for Pakistan. A discussion paper. Report B 1990/1, PSPDP/PARC, Islamabad.

Thongbai, P., R.J. Hannam, R.D. Graham and M.J. Webb. 1993. Interaction between zinc nutritional status of cereal and *Rhizoctonia* root rot severity. *Plant and Soil*, 153: 207-214.

Turkensteen, L.J. 1988. Survey of bacterial and fungal diseases of potato in Balochistan province of Pakistan, August 16-21, 1987. PSPDP/PARC, Islamabad.

Whiteman, P. 1985. Mountain oases. A technical report of agricultural studies in the Hunza, Ishkoman and Yasin valley of Gilgit district, Integrated Rural Development Project, Pak/80/009 FAO/UNDP.

Zanoni, U. 1991. *Potato Atlas and Compendium of Pakistan*. PSPDP/PARC, Islamabad, Pakistan.

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