



EVALUATION OF INDIAN POTATO (*SOLANUM TUBEROSUM* L.) GERMPLASMS AGAINST COMMON SCAB CAUSED BY *STREPTOMYCES SCABIES*

KAPURIA MANTHAN¹, DHARAJIYA DARSHAN^{2*}, KHATRANI TARUN², JASANI HITESH², CHAUDHARI S.M.³ AND CHAUHAN R.M.⁴

¹Shree P. M. Patel Institute of Integrated M.Sc. in Biotechnology, Anand-388001, Gujarat, India

²Department of Plant Molecular Biology and Biotechnology, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar-385506, Gujarat, India

³Department of Plant pathology, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar-385506, Gujarat, India

⁴Centre of Seed Technology, S. D. Agricultural University, Sardarkrushinagar-385506, Gujarat, India

*Corresponding Author: Email-darshanbiotech1@gmail.com

Received: March 16, 2016; Revised: March 29, 2016; Accepted: March 30, 2016

Abstract- Potato (*Solanum tuberosum* L.) is an important non-cereal crop all over the world and is remarkably recommended for ensuring global food security. Potato being a vegetatively propagated crop provides an ample opportunity for the pathogen to perpetuate from one generation to another through tubers and because of its succulence; it prevents desiccation of the pathogens. Among many diseases, common scab caused by *Streptomyces scabies* is a serious disease in India where the yield loss on account of the disease is not much but it drastically reduces the market value of the produce due to inferior quality. In the present investigation, a set of fifteen germplasms of potato was screened against common scab caused by *S. scabies* under natural and controlled conditions during 2012-13 to locate sources of resistance. As a result, out of fifteen germplasms/cultivars of potato screened against common scab, none of the germplasm was proven to be resistant to common scab. Whereas, four potato germplasms were categorized as moderately resistant; three genotypes were categorized as moderately susceptible; six potato germplasms were proven to be susceptible and two genotypes were found to be highly susceptible to common scab caused by *S. scabies*. Use of resistant cultivars for the management of common scab disease of potato is the best and most economic method. Hence, moderately resistant germplasms like MF-1, MS/95-1307, DSP-287 and Kufri Sutlaj should be cultivated to deal with the common scab of potato.

Keywords- Common scab, Potato (*Solanum tuberosum*), *Streptomyces scabies*, Field evaluation

Citation: Kapuria Manthan, et al., (2016) Evaluation of Indian Potato (*Solanum tuberosum* L.) Germplasms against Common Scab Caused By *Streptomyces scabies*. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 8, Issue 19, pp.-1336-1338.

Copyright: Copyright©2016 Kapuria Manthan, et al., This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

Introduction

Potato (*Solanum tuberosum* L.) is a native of South America. It is one of the major vegetable crops of the world and the fourth most important food crop worldwide after wheat, rice and maize [1]. In India, this crop was introduced in early seventeenth century probably by the Portuguese or by the British missionaries [2]. Potato is one of the most important vegetable crops in India, for both local consumption and exportation. Since this crop provides a source of low cost energy to the human diet, it is considered an economy food [3]. It is widely cultivated and could contribute to reducing worldwide food shortages.

The disease common scab is caused by *Streptomyces scabies* (ex. Thaxter) Lambert & Loria. It is a gram-positive actinomycetes belonging to the order *Actinomycetales* and family *Streptomycetaceae* [4,5]. Common scab is one of the most destructive diseases of potato throughout the world [6, 7]. Various species are found associated with common scab but two species *S. scabies* and *S. acidiscabies* have been reported to cause superficial, erumpent or pitted lesion types but erumpent lesions were the most common and most of the lesions had a raised, rough and corky appearance [8]. Common scab, an important disease of potato, was previously considered to be a minor disease, has now started posing serious threat to commercial as well as seed production programs due to increasing incidence year after year.

Potato being a vegetatively propagated crop provides ample opportunity for the pathogen to perpetuate from one generation to another through tubers and because of its succulence it prevents desiccation of the pathogens. The tubers also provide them food material in the form of readily utilizable carbohydrates, proteins and minerals to subsist. Common scab did not destroy tubers but

blemishes the surface and there by decrease market value [5].

In the North Gujarat region of India since two decades the occurrence of this disease in varying intensities has become a common cause of deterioration of the marketing quality of the tubers. The disease has been observed in almost all the potato growing districts of Gujarat at a range of 1.5 to 34.6 %. Common scab incidence was the highest in Banaskantha district (34.06%) [9]. At present, the common scab is a serious disease in Gujarat where the yield loss on account of the disease is not much but it drastically reduces the market value of the produce due to inferior quality.

Scab disease cannot currently be controlled with pesticide application and the effects of cultural control methods, such as irrigation management or crop rotation differ for netted and common scab [10]. Hence, selection of the resistant cultivar is one of the key management practice used to reduce the brunt of this disease because of the existence of wide variability in resistance of potato germplasm against common scab disease [11]. However, specific factors associated with disease resistance are not well defined [12]. Physical features of tuber such as thickened skin, skin russetting and density, aperture and structure of stomata/lenticels are likely to play some important role in expression of disease resistance [6, 13]. Various factors like age of plant, type and time of infection, soil and climatic factors, type of strain of the pathogen and genetic make-up of host plant, influence the disease development in potato crop [14].

Many bacterial diseases hamper successful potato crop production in India among which common scab disease is the most destructive. Use of susceptible potato cultivars/varieties, favourable soil conditions and presence of diverse virulence of

the pathogen contribute towards the outbreak of this disease. A number of management strategies are available but the most adequate, economical and durable method is the use of potato germplasms/cultivars resistant against common scab. Hence, the present investigation was carried out to find out the disease reactions of fifteen potato germplasms of India against common scab under field as well as controlled conditions.

Materials and Methods

Screening of potato germplasms under field condition

For the screening of fifteen potato germplasms for common scab diseases, the experimental material was provided by the Potato Research Centre, SDAU, Deesa. Potatoes from fifteen diverse germplasms (DSP-7, Kufri chipsona-1, JX-249, MF-1, MS/95-1307, DSP-287, Kufri Pushkar, Kufri Jyoti, Kufri Sutlaj, Kufri Badshah, Kufri Kundan, Kufri Khyati, Kufri Bahar, Kufri Anand and KCM) were sown under the field condition in Rabi, 2012-13. The presence of disease symptoms was checked out from the harvested tubers of each germplasm and disease rating was recorded if there was presence of disease symptoms. The germplasms were categorized in different disease reactions according to the disease scale described earlier [9] as given in [Table-1]. The disease index and disease incidence (%) was calculated according to the equations given below.

$$\text{Disease index} = \frac{\text{Total no. of infected tubers} \times \text{Disease rating}}{\text{Total no. of tubers}}$$

$$\text{Disease incidence(\%)} = \frac{\text{Total no. of infected tubers}}{\text{Total no. of tubers}} \times 100$$

Table-1 Disease rating scale for common scab of potato suggested by [9]

Rating	Description of symptoms	Disease Reaction
0.0	Healthy tubers	Resistant (R)
1.0	1-10 per cent tuber surface was affected	Moderately Resistant (MR)
2.0	11-25 per cent tuber surface was affected	Moderately Susceptible (MS)
3.0	26-50 per cent tuber surface was affected	Susceptible (S)
4.0	Above 50 per cent tuber surface was affected	Highly susceptible (HS)

Screening of potato germplasms under controlled condition

Potatoes from diverse germplasms were grown in the pots and were sterilized by dipping them in 2% formaldehyde solution for one minute. The mixture containing soil,

sand and FYM in the ratio of 50:25:25 were filled in sterilized pot and after autoclaving, it was kept for 10 days to expel harmful gases. The inoculum of each isolate of *S. scabies* isolated from the infected tubers in the previous study [15] was thoroughly mixed with the autoclaved soil mixture in pots and moistured with water before one week of planting for uniform spread of the inoculum. One pot was kept as control in which the inoculum was not mixed. Potato tubers were surface sterilized with 2.5% Sodium hypochlorite solution for 5 min prior to sowing. Pots were irrigated regularly. During harvesting time, the presence of disease symptoms was checked and if there was presence of disease, than disease rating was recorded.

Results and Discussion

The use of resistant varieties is the cheapest and the best means of controlling any disease. Therefore, in the present investigation, a set of fifteen germplasms of potato was screened against common scab caused by *Streptomyces scabies* under natural and controlled conditions to locate sources of resistance. During field evaluation, the highest disease incidence (79.78 %) was observed in JX-249 and lowest disease incidence (19.75 %) was observed in DSP-287. The range of disease index among fifteen potato germplasms was 3.19 (in JX-249) to 0.20 (in DSP-287) during field study. In the controlled condition, maximum and minimum per cent disease incidences were recorded for Kufri Pushkar (84.21 %) and DSP-287 (22.73 %), respectively. The disease index ranged between 0.23 and 3.37 in potato germplasms under controlled condition. The results of per cent disease incidence and disease index of fifteen potato germplasms against common scab recorded under field and controlled conditions are given in [Table-2].

According to the results of the study carried out under the field and controlled conditions shown in [Table-2], potato germplasms were categorized under different disease categories, which are given in [Table-3]. All the fifteen potato germplasms were categorized in the same categories in both conditions namely, field and controlled conditions. None of the germplasm was proven to be resistant to common scab. Four potato germplasms viz., MF-1, MS/95-1307, DSP-287 and Kufri Sutlaj were categorized as moderately resistant. Three genotypes namely Kufri Chip 1, Kufri Khyati and KCM were categorized as moderately susceptible. A set of six potato germplasms including DSP-7, Kufri Jyoti, Kufri Badshah, Kufri Kundan, Kufri Bahar and Kufri Anand were proven as susceptible to common scab. Two genotypes namely, JX-249 and Kufri Pushkar were found to be highly susceptible to common scab caused by *S. scabies*. Different disease category wise distribution of fifteen potato germplasms is shown in [Fig-1].

Table-2 Disease incidence (%) and disease index of common scab on potato germplasms under field and controlled conditions

Sr. no.	Potato Germplasm	Field Condition			Controlled Condition		
		Disease Incidence (%)	Diseases Index	Disease Reaction	Disease Incidence (%)	Diseases Index	Disease Reaction
1	DSP-7	71.43	2.14	S	75.00	2.25	S
2	Kufri Chipsona-1	55.37	1.11	MS	59.09	1.18	MS
3	JX-249	79.78	3.19	HS	80.95	3.24	HS
4	MF-1	37.11	0.37	MR	40.00	0.40	MR
5	MS/95-1307	35.96	0.36	MR	47.06	0.47	MR
6	DSP-287	19.75	0.20	MR	22.73	0.23	MR
7	Kufri Pushkar	77.60	3.10	HS	84.21	3.37	HS
8	Kufri Jyoti	71.79	2.15	S	76.00	2.28	S
9	Kufri Sutlaj	24.71	0.25	MR	45.45	0.45	MR
10	Kufri Badshah	71.21	2.14	S	77.27	2.32	S
11	Kufri Kundan	70.53	2.12	S	75.00	2.25	S
12	Kufri Khyati	56.57	1.13	MS	70.59	1.41	MS
13	Kufri Bahar	70.21	2.11	S	78.57	2.36	S
14	Kufri Anand	73.74	2.21	S	82.61	2.48	S
15	KCM	55.36	1.11	MS	57.14	1.14	MS

R: Resistant, MR: Moderately Resistant, MS: Moderately Susceptible, S: Susceptible, HS: Higher Susceptible

Like most bacterial diseases, common scab of potato would be best controlled by using resistant cultivars. Repeated experiments with soil artificially infested with different isolates of three species representative of the three pathogenicity groups exhibited the level and stability of cultivar resistance, as well as the existence of a range of aggressiveness among different isolates [16]. The distribution of scab severity indexes recorded on a collection of sixteen potato cultivars and twenty seven breeding clones grown in soil infested with isolates of common scab pathogen was continuous and

suggesting isolate non-specific quantitative resistance [16].

In an earlier study in India, twenty seven cultivars of potato were evaluated against common scab grown in a commercial field in two consecutive years (1996-97 and 1997-98) among which eight cultivars were least susceptible and the others ranged from medium susceptible to very highly susceptible whereas none of the cultivars was resistant [17]. In another study conducted in north Gujarat region, out of ninety five varieties/entries screened against common scab, none was found resistant but twenty

three were moderately resistant, twenty four found moderately susceptible while the rest were either susceptible or highly susceptible to the disease [18].

Table-3 Distribution of potato germplasms in various disease categories of common scab

Category	Disease Index (Rating)	Potato Germplasms	
		Field Condition	Controlled Condition
Resistant (R)	0.00	-	-
Moderately resistant (MR)	0.1-1.0	MF-1, MS/95-1307, DSP-287, Kufri Sutlaj	MF-1, MS/95-1307, DSP-287, Kufri Sutlaj
Moderately susceptible (MS)	1.1-2.0	Kufri Chipsona-1, Kufri Khyati, KCM	Kufri Chipsona-1, Kufri Khyati, KCM
Susceptible (S)	2.1-3.0	DSP-7, Kufri Jyoti, Kufri Badshah, Kufri Kundan, Kufri Bahar, Kufri Anand	DSP-7, Kufri Jyoti, Kufri Badshah, Kufri Kundan, Kufri Bahar, Kufri Anand
Highly Susceptible (HS)	3.1-4.0	JX-249 and Kufri Pushkar	JX-249 and Kufri Pushkar

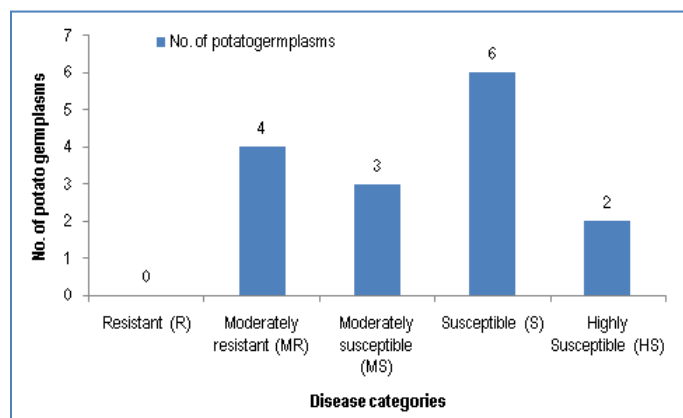


Fig-1 Distribution of potato germplasms in different disease categories of common scab

In one of the previous studies, twelve potato cultivars were screened against common scab disease caused by *Streptomyces scabies* at Faisalabad, Pakistan during 2011-12 under randomized complete block design (RCBD). Among the twelve potato cultivars, SH-692, SH-704 and Cardinal were the least susceptible whereas highly susceptible cultivars were FD-96-1, FD-63-1, FD-70-1, FD-8-3, FD-8-1 and Astrax [7].

In the present study, Kufri Sutlaj, a red skinned type was found to be moderately susceptible to common scab. Similarly, it was proven in a previous study that red skinned cultivars were the least susceptible to common scab disease as compared to white skinned potatoes [7]. In general, disease severity was more in white skinned high yielding varieties being cultivated on large scale and continuously over the years [19].

A larger set of germplasms should be screened to identify the source of resistance against common scab of potato. Further morphological study of potato tubers should be carried out to correlate the morphological characters with disease severity. Molecular breeding might be helpful to identify the source of resistance against different strains of *S. scabies* to develop new resistant cultivars.

Conclusion

Adoption of resistant cultivars for management of common scab of potato is the best and most economic method. So, least susceptible (moderately resistant) varieties like MF-1, MS/95-1307, DSP-287 and Kufri Sutlaj should be cultivated to uplift the production of potato. There is need of identification and development of new resistant cultivars against multiple strains of *S. scabies*.

Conflict of Interest: None declared

References

- [1] Andre C.M., Ghislain M., Bertin P., Oufir M., del Rosario Herrera M., Hoffmann L., Hausman J.F., Larondelle Y. and Evers D. (2007) *Journal of Agricultural and Food Chemistry*, 55(2), 366-378.
- [2] Pal B.P. and Pushkarnath (1951) *Indian Council Agricultural Research Bulletin*, 62, 63.
- [3] Pandey S.K. and Sarkar D. (2005) *Potato Journal*, 32(3-4), 93-104.
- [4] Kutzner H.J. (1981) *The prokaryotes*, 2, 2028-2090.
- [5] Wanner L.A. (2006) *Phytopathology*, 96(12), 1363-1371.

- [6] Loria R., Kers J. and Joshi M. (2006) *Annual Review of Phytopathology*, 44, 469-487.
- [7] Atiq M., Khalid A.R., Hussian W., Nawaz A., Asad S. and Ahmad T.M. (2013) *Pakistan Journal of Phytopathology*, 25(1), 27-30.
- [8] Loria R., Bukhalid R.A., Fry B.A. and King R.R. (1997) *Plant Disease*, 81(8), 836-846.
- [9] Patel R.L. (1991) Ph.D. thesis (unpublished) submitted to Gujarat Agricultural University, Sardarkrushinagar, Gujarat.
- [10] Scholte K. and Labruyère R.E. (1985) *Potato Research*, 28(4), 443-448.
- [11] Park Y.B., Kim S.Y. and Cho J.L. (2002) *Journal-Korean Society for Horticultural Science*, 43(5), 607-612.
- [12] Goth R.W., Haynes K.G., Young R.J., Wilson D.R. and Lauer F.I. (1995) *American Potato Journal*, 72(9), 505-511.
- [13] Tegg R.S., Gill W.M., Thompson H.K., Davies N.W., Ross J.J. and Wilson C.R. (2008) *Plant Disease*, 92(9), 1321-1328.
- [14] Agrios G.N. (2005) *Plant Pathology*, Academic press, San Diego, USA.
- [15] Kapuria M.N., Chaudhari S.M., Kanbi V.H. and Chauhan R.M. (2015) *Trends in Biosciences*, 8(12), 3177-3180.
- [16] Pasco C., Jouan B. and Andrivon D. (2005) *Plant Pathology*, 54(3), 383-392.
- [17] Mishra K.K. and Srivastava J.S. (2001) *Potato Research*, 44(1), 19-24.
- [18] Chaudhari S.M. (2005) Ph.D. thesis (unpublished) submitted to Sardarkrushnagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat.
- [19] Mishra K.K. and Srivastava J.S. (1999) *Journal of the Indian Potato Association*, 26 (3-4), 143-144.