

EVALUATION OF POTATO “*SOLANUM TUBEROSUM* L.” ACCESSIONS OVER WIDE RANGE OF ENVIRONMENTS

Syed Ijaz ul Hassan*, Muhammad Iqbal, Mudassar Iqbal**, Aftab Iqbal,
Mudassar Hussain and Muhammad Shahbaz *

ABSTRACT

Eleven potato strains namely FD70-1, SH-704, SH-701, FD 61-3, FD 51-5, N 2002-1, SH-692, FD 69-1, FD 63-1, Asterix and Sante were tested at four locations of Punjab, Pakistan at Potato Research Institute, Sahiwal during 2010-11. On the basis of emergence, the genotype SH-704 (88.9%) exceeded all other strains. Maximum resistance/tolerance was also shown by this strain against scab and cracking diseases. Maximum and minimum percentage of *Rhizoctonia* was 3 and 0% on the strains sante and FD-631. On an average SH-701 showed the minimum % age (11.6) of small size tubers, and FD 63-1 showed maximum % age (14.1) of ration size tubers. Regarding tuber yield FD-70-1 (32.2 t/ha), FD 69-1(31.2 t/ha), SH-701 (28.1 t/ha), SH-692 and FD 63-1 each gave significantly higher yield (27.6 t/ha) than standard strains Asterix and Sante.

KEYWORDS: *Solanum tuberosum*; potato; genotypes; strains; performance; environments; tuber size; scab; cracking; *Rhizoctonia*; yield; Pakistan.

INTRODUCTION

The genus *Solanum* contains over 2000 species, of which only 150 are tuber bearing (9). Potato (*Solanum tuberosum* L.) is the fourth most important crop by volume of production, having a high nutritive value and gives high returns to farmers (3). It is the world's fourth major food crop (7) and one of the main staple foods (4). Potato having its origin in Peru and Bolivia (South America) spreaded to other parts of the world successfully and became a staple crop of Europe. It is generally believed that the Portuguese introduced potato in Indo-Pak sub-continent and the British encouraged its cultivation during 19th century. Potato is an annual herbaceous plant, which is vegetatively propagated by the tuber. Over the years, potato has become an important crop for both farmers and consumers in Pakistan.

*Potato Research Institute, Sahiwal, **Vegetable Research Institute, AARI, Faisalabad, Pakistan.

In Pakistan potatoes are grown on 138.5 thousand hectares with a production of 3141.4 thousand tons (2). The average yield is 22.7 tons/ha which is of course lower than available potential. Ayub *et al.*, (3) concluded that sowing potato with whole tubers improves growth and yield. Potato yield is affected by some major diseases, lack of improved, locally adapted potato cultivars, limited access to chemical fertilizers and shortage of high quality planting material. Olanya *et al.* (10) reported that Supplemental irrigation can improve potato growth and tuber yield under deficit rainfall conditions, but may also impact potato tuber diseases. Black scurf (*Rhizoctonia solani*), black dot (*Colletotricchum coccodes*), silver scurf (*Helminthosporium solani*) and common scab (*Streptomyces scabei*) diseases were quantified on potato tubers randomly sampled at harvest and stored at 7.2°C. Bugarcic *et al.*, (4) studied variability and productive properties in potato strains under different agro-ecological conditions. He observed for yield, tuber size and number of tubers per plant. Chaudhary *et al.* (5) observed that strains 384640-3, 386029-18, 382021-9 and 382134-21 showed good germination, best tuber grades, tuber yield, tolerance to *Rhizoctonia* and cracking.

Masarirambi (8) reported that parameters measured included shoot emergence (germination), haulm growth and yield. There were significant differences in mean percentage germination at 9, 10, 11 and 12 days after planting across the four seed sizes. Plants from larger seed potato tubers exhibited greater physiological growth and yield (kg/ha) compared to smaller seed tubers when the experiment was terminated at 95 days after emergence. Large and very large seed potato tubers exhibited greater overall resource use efficiency of allocation of metabolites as measured by growth components and yield at all plant density levels compared to small and medium sized seed tubers. Finally Masarirambi (8) concluded from the study that the final size and number of tubers produced per plant was governed by seed size. Sowing potato with whole tubers improves growth and yield.

Soil-borne and tuber diseases are diverse and ubiquitous in potato growing regions of the world. Tuber black scurf (*Rhizoctonia solani*), black dot (*Colletotricchum coccodes*), silver scurf (*Helminthosporium solani*) and common scab (*Streptomyces scabei*) are the most important potato tuber diseases in some potato producing areas. Research has been conducted on soil-borne and tuber diseases such as black scurf, silver scurf, black dot, and common scab with emphasis on their prevalence, disease management and potential impacts reported by Olanya *et al.* (10). In our research the effect of Scab, *Rhizoctonia* and Cracking diseases was almost low. Most of the strains showed resistance against different diseases and some of them showed susceptibility.

MATERIALS AND METHODS

Eleven potato strains/lines namely FD70-1, SH-704, SH-701, FD61-3, FD 51-5, N 2002-1, SH-692, FD 69-1, FD 63-1, Asterix and Sante were tested at four locations, those are Potato Research Institute, Sahiwal, Vegetable Research Institute, Faisalabad, Potato Research Station, Sialkot and Farmer Field, Chiniot. The material was planted on 18.10.10, 20.10.10, 21.10.10 and 28.10.10, respectively keeping plant to plant and row-to-row distances 20 cm & 75 cm, respectively. The plot size was maintained as 6 x 2.25 m. The trial was laid out in RCBD with three replications. Normal agronomic and plant protection measures were carried out for proper crop development. The harvesting was done on 05.02.11, 10.02.11, 11.02.11 and 24.03.11 respectively. The data regarding emergence percentage, tuber grades/diseases and yield were recorded. The results were statistically analyzed according to Steel and Torrie (12).

RESULTS AND DISCUSSION

Plant emergence percentage

Data on different growth parameter and diseases attack was recorded i.e., emergence percentage, tuber size, tuber yield, scab, *Rhizactonia* and cracking in potato. Maximum (88.9%) and minimum (78.3%) average emergence percentage was obtained in strain SH-704 and N 2002-1, respectively (Table 1). All the strains were statistically similar and had no significant difference except strain N 2002-1 (78.3%). This difference in emergence can be attributed to the tuber dormancy controlling factor. The given emergence percentage trends are similar to the emergence percentage results reported by Abbasi *et al.* (1).

Table 1. Emergence percentage of strains at different locations.

Rank	Strains	PRI Sahiwal	PRS, Sialkot	Farmer's field Chiniot	VRI, Faisalabad	Average
1	SH-704	91.9	96.3	82.2	85.2	88.9
2	FD 69-1	89.7	94.8	78.5	91.1	88.5
3	FD 70-1	87.2	95.6	84.1	83.7	87.7
4	Asterix	96.9	94.5	76.3	78.7	86.6
5	SH-692	94.4	94.4	85.5	66.7	85.3
6	FD 61-3	88.6	94.8	70.0	86.7	85.0
7	Sante	78.3	87.2	90.7	81.8	84.5
8	SH-701	82.7	95.6	74.4	83.0	83.9
9	FD 51-5	85.2	95.9	74.4	71.9	81.9
10	FD 63-1	62.2	95.6	91.8	74.4	81.0
11	N 2002-1	78.3	94.4	74.4	65.9	78.3
	LSD 5%	8.8	2.7	14.6	11.1	

Abbreviations: PRI = Potato Research Institute, PRS = Potato Research Station, FF = Farmer's field, VRI = Vegetable Research Institute.

Tuber size

Potato tuber size variation data was also showed that Percentage of small tuber size was normal in all strains at all locations except at PRS, Sialkot. Overall maximum and minimum average percentage of small sized tubers (<35mm) was observed in strain SH-704 (19.5%) and in SH-701 (11.6%), respectively (Table 2a). After small sized potato data the trend was different, when data on medium sized potato (35-55 mm) was recorded (Table 2b). Average percentage of medium sized tubers was more than 70 percent. At PRS Sialkot medium sized potato percentage was low as compared to other locations. Maximum and minimum average percentage of medium sized potato tubers was 84.3 percent (Asterix) and 71.9 percent (FD 69-1), respectively (Table 2b). In large tuber size the strains Sante and Asterix went down in average percentage while strain FD 63-1 got top position followed by FD 70-1. Here in terms of large size tubers (>55mm) the maximum and minimum average percentage was 14.1 percent (Asterix) and 4.9 percent (Sante) respectively (Table 2c).

Table 2(a). Grading of potato tubers according to small size (<35mm).

Rank	Strains	PRI, Sahiwal	PRS, Sialkot	Farmer's field Chiniot	VRI, Faisalabad	Average
1	SH-704	14.7	26.0	16.7	20.7	19.5
2	FD 69-1	14.0	30.0	13.7	19.3	19.3
3	FD 61-3	10.0	29.3	16.3	16.7	18.1
4	SH-692	11.3	25.7	17.3	16.0	17.6
5	Sante	16.3	16.8	18.7	18.2	17.5
6	FD 70-1	7.0	26.0	14.0	8.7	13.9
7	FD 51-5	7.3	17.3	13.3	16.7	13.7
8	FD 63-1	5.3	17.7	12.0	14.0	12.3
9	Asterix	8.0	14.3	15.7	9.5	11.9
10	N 2002-1	7.0	20.0	9.3	10.3	11.7
11	SH-701	5.3	18.7	12.3	10.0	11.6
LSD 5%		4.2	4.3	6.9	4.2	

Table 2 (b). Grading of potato tubers according to medium size (35-55 mm).

Rank	Strain	PRI, Sahiwal	PRS, Sialkot	Farmer's field Chiniot	VRI, Faisalabad	Average
1	Asterix	85.3	83.4	81.0	87.8	84.3
2	Sante	80.0	80.7	75.3	79.4	78.8
3	FD 51-5	85.7	61.0	81.0	80.7	77.1
4	N 2002-1	85.3	56.0	81.0	82.4	76.2
5	SH-701	84.7	58.0	80.0	81.0	75.9
6	SH-692	82.0	55.7	77.7	80.3	73.9
7	FD 61-3	83.7	54.0	79.0	78.6	73.8
8	FD 63-1	81.0	52.7	82.3	78.7	73.7
9	FD 70-1	82.3	44.7	80.7	83.3	72.8
10	SH-704	80.7	56.3	76.0	75.3	72.1
11	FD 69-1	81.3	46.3	82.7	77.4	71.9
LSD 5%		5.2	5.4	6.3	5.2	

Table 2 (c). Grading of potato tubers according to large size (>55 mm).

Rank	Strain	PRI Sahiwal	PRS, Sialkot	Farmer's field Chiniot	VRI, Faisalabad	Average
1	FD 63-1	13.7	29.7	5.7	7.3	14.1
2	FD 70-1	10.6	29.3	5.3	8.0	13.3
3	SH-701	10.0	23.3	7.7	9.0	12.5
4	N 2002-1	7.7	24.0	9.7	7.3	12.2
5	FD 51-5	7.0	21.7	5.7	2.3	9.2
6	FD 69-1	4.7	23.7	3.7	3.3	8.9
7	SH-692	6.7	18.7	5.0	3.7	8.5
8	SH-704	4.7	17.7	7.3	4.0	8.4
9	FD 61-3	6.3	16.7	4.7	4.7	8.1
10	Asterix	6.7	2.3	3.3	2.7	5.0
11	Sante	3.7	2.5	6.0	2.4	4.9
LSD 5%		2.7	4.9	1.6	2.2	

Diseases percentage

Data collected on diseases showed that accessions in cadence of different diseases Scab Rhizations and cracking in potato strain was not same. The results are in line with Olanya *et al.* (10) who detected variation in average incidence of tuber diseases among cultivars. The ranking of cultivars in terms of tuber susceptibility to various diseases was not consistent. Maximum and minimum scab percentage was recorded in Sante (9.5%) and SH-704 (3.1%). In Asterix scab percentage was also 3.1%. It means that SH-704 and Asterix strains were more resistant to scab (Table 3). Resistace against *Rhizoctonia* was shown by all strains but FD 63-1 showed complete resistance. Maximum and minimum average percentage of *Rhizoctonia* was 3% and 0% in Sante and FD 63-1, respectively (Table 4). Cracking percentage recorded at different locations of Pakistan was totally different in eleven tested potato strains. Maximum and minimum resistance against cracking was shown by SH-704 and SH-701 respectively. So percentage of cracking was highest in SH-701 and lowest in SH-704 followed by FD 69-1 (Table 5).

Tuber yield

In the eleven tested strains of potato the yield of potato tubers was maximum in strain FD 70-1. It gave maximum production (40.5 t/ha) at Farmer's Field, Chiniot out of all other strains cultivated at same location. Maximum and minimum potato tuber yield was shown by FD 70-1 and N 2002-1, respectively. Average yield produced by FD 70-1 and N 2002-1 were 33.2 and 22.8 tons per hectare, respectively, (Table 6).

The data (Table 1) shows that emergence of all the strains was comparatively low at all the locations as compared to previous year except at Sialkot (96.3%) which is due to temperature difference.

The data presented in (Table 2a) shows that the percentage of small size tuber (<35mm) of all the strains was normal and below 20% at all the locations except PRS, Sialkot where small size tubers percentage remained higher as compare to other locations, where maximum (30%) small size tubers percentage was recorded in strain FD 69-1 and minimum (18.7%) in SH-701.

The data (Table 2b) shows that on average basis all the strains have medium size tubers (35-55mm) above 70%. At PRS, Sialkot the medium size tuber percentage remained low as compared to other locations. The strain FD 70-1 produced minimum percentage of medium size tubers (44.7%) whereas FD 51-5 produced the maximum percentage (61%) of medium size tubers at PRS, Sialkot.

The data (Table 2c) shows that all the strains have ration size tubers (>55mm) in range of 4-15 percent but Potato Research Stations (PRS), Sialkot remained at top in producing large size tubers. The maximum percentage of large size tubers (29.7%) was recorded in FD 63-1 at PRS Sialkot. Similarly the minimum percentage (16.7%) of large size tuber from Sialkot location was obtained from the strain FD 61-3.

The data presented in Table 3 shows that no severe attack of scab was observed on all strains at all the locations. The maximum attack of scab (14.3%) was recorded at farmer's field on the standard strain FD 69-1 followed by Sante (11.3%) whereas the maximum resistance/tolerance was shown by SH-704 (3.1%) against scab. The incidence of scab was slightly higher at Farmer's field, Chiniot.

Table 3. Attack of scab (%) on potato strains at different locations.

Rank	Strain	PRI Sahiwal	PRS, Sialkot	Farmer's field Chiniot	VRI, Faisalabad	Average
1	SH-704	2.7	2.3	6.3	1.0	3.1
2	Asterix	3.7	2.1	4.3	2.3	3.1
3	FD 63-1	3.3	3.7	6.7	0.0	3.4
4	FD 51-5	5.0	2.0	4.0	3.0	3.5
5	FD 61-3	2.3	2.7	5.7	5.0	3.9
6	SH-701	5.0	3.0	7.3	1.0	4.1
7	FD 70-1	1.3	3.3	7.0	5.0	4.2
8	N 2002-1	3.3	3.7	8.0	3.3	4.6
9	SH-692	4.3	4.3	7.7	5.3	5.4
10	FD 69-1	4.0	5.3	14.3	5.7	7.3
11	Sante	8.3	10.3	11.3	7.9	9.5
LSD 5%		3.4	1.6	2.6	4.4	

The data (Table 4) showed less attack of *Rhizoctonia* at all the locations. On an average no attack was observed on FD 63-1 showing complete resistance

against *Rhizoctonia*. Maximum attack of *Rhizoctonia* was observed on the standard strain Sante (3%) whereas the same strain showed maximum infection (11%) at Potato Research Institute Sahiwal.

Table 4. Attack of *Rhizoctonia* (%) on potato strains at different locations.

Rank	Strain	PRI Sahiwal	PRS, Sialkot	Farmer's field Chiniot	VRI, Faisalabad	Average
1	FD 63-1	0.0	0.0	0.0	0.0	0.0
2	FD 61-3	1.0	0.3	0.0	0.0	0.3
3	FD 70-1	0.3	0.0	0.7	0.0	0.3
4	SH-704	1.0	0.0	0.0	0.3	0.3
5	SH-701	1.7	0.7	0.0	0.0	0.6
6	FD 69-1	2.3	1.7	0.0	0.0	1.0
7	Asterix	3.7	0.0	0.0	0.0	1.0
8	SH-692	0.3	2.0	3.0	0.3	1.4
9	FD 51-5	3.7	0.0	1.7	0.0	1.4
10	N 2002-1	2.7	1.0	3.0	0.0	1.7
11	Sante	11.0	0.0	1.0	0.0	3.0
LSD 5%		3.1	0.8	1.9	0.4	

The data (Table 5) shows that the minimum cracking was observed from all the strains. The maximum percentage of cracking (2.7%) was observed on SH-701 whereas on SH-704 it was minimum (0.2%). The strain SH-701 showed maximum (4.3%) cracking at PRI, Sahiwal.

On average basis the strain FD 70-1 produced the maximum tuber yield (33.2 t/ha) followed by FD 69-1 (31.2 t/ha) (Table 6). Minimum tuber yield (22.8 t/ha) on an average basis was recorded in strain N 2002-1. Location wise, minimum tuber yield (9.1 t/ha) was obtained at VRI, Faisalabad, where maximum tuber yield (23 t/ha) was obtained from the strain FD 63-1.

Table 5. Cracking %age of potato tubers at different locations.

Rank	Strain	PRI Sahiwal	PRS, Sialkot	Farmer's field Chiniot	VRI, Faisalabad	Average
1	SH-704	0.3	0.0	0.0	0.3	0.2
2	FD 69-1	0.7	0.0	0.0	0.3	0.3
3	Asterix	1.7	0.0	0.7	0.0	0.6
4	FD 51-5	2.3	0.0	0.7	0.0	0.8
5	FD 61-3	1.0	0.0	0.7	1.7	0.9
6	FD 63-1	1.3	2.0	1.3	0.0	1.2
7	N 2002-1	1.3	1.3	1.3	2.3	1.6
8	Sante	4.0	0.0	3.0	0.0	1.8
9	FD 70-1	0.3	1.0	1.0	5.3	1.9
10	SH-692	1.3	1.7	2.0	3.0	2.0
11	SH-701	4.3	1.7	4.3	0.3	2.7
LSD 5%		2.0	1.5	1.6	2.5	

Table 6. Tuber yield (t/ha) at different locations.

Rank	Strain	PRI Sahiwal	PRS, Sialkot	Farmer's field Chiniot	VRI, Faisalabad	Average
1	FD 70-1	38.0	35.1	40.5	19.0	33.2
2	FD 69-1	34.8	35.3	31.8	22.7	31.2
3	SH-701	31.9	21.7	37.8	21.0	28.1
4	SH-692	30.0	27.2	37.5	15.8	27.6
5	FD 63-1	25.7	28.9	32.6	23.0	27.6
6	FD 61-3	27.8	27.7	29.3	19.0	26.0
7	Asterix	30.2	26.1	28.9	18.4	25.9
8	SH-704	29.8	18.8	37.8	14.3	25.2
9	FD 51-5	29.3	23.5	31.3	13.1	24.3
10	Sante	23.0	21.0	28.9	19.1	23.0
11	N 2002-1	26.9	22.7	32.6	9.1	22.8
LSD 5%		4.0	6.3	7.8	5.2	

CONCLUSION

It is concluded that behavior of different potato strains changed with climate. A locally developed line SH-704 showed maximum tolerance against scab and cracking diseases at different locations, so this line could be used in future breeding projects for the development of disease free lines of potato with high yield.

REFERENCES

1. Abbasi, N. A., I. A. Hafiz and B. Fazal. 2004. Evaluation of exotic potato varieties in ecological conditions of Islamabad during autumn season. *Int. J. Agri. Biol.* 6(3):479-82.
2. Anon. 2010. Economic Survey of Pakistan. 2009-10. Govt. of Pakistan, Finance Division, Economic Advisory Wing, Islamabad.
3. Auyb, C. M., M. W. Haider, M. A. Pervez, M. A. Baloch and Y. Masih. 2012. Growth and yield of potato (*Solanum tuberosum* L.) grown from whole and cut tubers. *Pak. J. Agri., Agri. Engg., Vet. Sci.* 28(1):15-19.
4. Bugarcic, Z., V. Susics, A. Dokic, S. Jevtic and B. Lazic. 1977. Phenotype values variability and productive properties of IRI dutch potato strains under different agro-ecological conditions. *Proc. First Balkem Symposium on Vegetables and Potato, Belgarde, Yugoslavia.* *Acta Horticulture.* 2 (462):921-27.
5. Chaudhary, M. S., F. Hameed, A. H. Tariq, M. Iqbal and M. S. Alam. 1997. Studies on white skinned potato germplasm to evolve high yielding and disease resistant varieties. *J. Agric. Res.* 35(1-2):49-56.
6. Hoque, M.E., 2010. In vitro tuberization in potato (*Solanum tuberosum* L.). *POJ.* 3(1):7-11

7. Jadhav, S. J. and S. S. Kadam. 1998. Potato. *In: Handbook of Vegetable Science and Technology*. D. K. Salunkhe S.S. Kadam and Marcel Dekker (eds.), Inc. New York, USA. p. 11–37.
8. Masarirambi, M. T., F. C. Mandisodza, A.B. Mashingaidze and E. Bhebhe. 2012. Influence of plant population and seed tuber size on growth and yield components of potato (*Solanum tuberosum*). *Int. J. Agric. Biol.* 14:545-54.
9. Muthoni, J., H. Shimelis, R. Melis and J. Kabira. 2012. Reproductive biology and early generations selection in conventional potato breeding. *AJCS*. 6(3):488-97.
10. Olanya, O. M., G. A. Porter and D.H. Lambert. 2010. Supplemental irrigation and cultivar effects on potato tuber diseases. *AJCS* 4(1):29-36.
11. Sonnewald, U. 2001. Control of potato tuber sprouting. *Trends in Plant Science*. 6:333-35.
12. Steel, R. G. D. and J. H. Torrie. 1980. *Principles and Procedures of Statistics*. McGraw Hill Book Co., New York. Pp. 560.

Received: August 19, 2013 Accepted: January 11, 2014
