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SCREENING OF POTATO GERMPLASM FOR FROST TOLERANCE

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Abstract

Punjab shares about 90% in potato area and production of Pakistan. Out of this, about 75% area is planted during autumn season. Severe frost during winter months of the crop life some times results into crop failure as happened during winter 2005-06. Development of frost tolerant varieties is one of the options to avert the colossal loss caused by frost. The extra-ordinary frost received during the year 2005-06 provided an opportunity to screen potato germplasm planted at the Vegetable Research Institute, Faisalabad for finding some genotypes which could withstand heavy frost situation. Forty three entries planted during 2nd week of October 2005 were studied and the results showed that the strains FD 3-9 and FD 3-15 were the most tolerant.

Key words: Potato, frost tolerance, Pakistan, Punjab

INTRODUCTION

Potato is an important staple food crop through out the world. It is also becoming more popular in the farming community due to its increasing demand for processing industry in Pakistan. It was grown in Pakistan on an area of 117.4 thousand hectares during 2005-06, out of which 104.5 thousand hectares (89%) were planted in Punjab. About 75% of this area is planted during autumn season and the crop passes through the winter months when it is in tuber formation stage. During some years, severe frost in these months poses a risk of crop failure or severe reduction in crop yields. The crop season of 2005-06 was one such year in which the potato crop yield was reduced by about 26% due to severe frost during the months of December and January. This reduction of 26% in yield resulted into a loss of about 5.5 billion rupees to the national economy.

Development of frost tolerant varieties is one of the options to avert this colossal loss. The availability of germplasm with ability to withstand frost is the key for the development of such varieties. References are available that some wild potato species have high levels of frost tolerance (Li, 1977; Estrada, 1982; Barrientos et al., 1994; Vega & Bamberg, 1995) but their utilization in breeding programmes is not an easy job in countries like Pakistan where research facilities are meager. The availability of frost tolerant genotypes in cultivated species could be a short cut method in breeding frost tolerant potato varieties.

The onslaught of severe frost during 2005-06 was taken as an opportunity to screen the germplasm for frost tolerance. Forty three strains developed by the Vegetable Research Institute, Faisalabad were screened for their tolerance to the severe frost conditions.

MATERIALS AND METHOD

Forty three new strains including four standard varieties were planted at Vegetable Research Institute, Faisalabad during autumn season 2005-06. The material was sown on October 12, 2005, keeping plant to plant and row to row distances of 20 cm and 75 cm, respectively. The plot size was 6 × 1.5 m. The material was sown according to the Randomized complete block design with three replications. Normal agronomic and plant protection measures were carried out to maintain the crop. Emergence data were recorded after 45 days of planting to note the plant population. There was severe frost during the months of December and January. The meteorological data for this period is presented in Table 1. Data on frost damage was recorded during 2nd week of January after severe frost on the scale given in Table 2. The harvesting was done on February 07, 2006 and yield data were also recorded.

Table 1: Meteorological data of frosty nights

Date*	Temperature (°C)		Date	Temperature (°C)	
	Maximum	Minimum		Maximum	Minimum
December 01, 2005	21.8	2.5	December 18, 2005	23.3	0.2
December 02, 2005	22.0	2.7	December 19, 2005	22.3	0.4
December 03, 2005	22.5	1.5	December 20, 2005	21.1	1.8
December 04, 2005	22.7	2.0	December 21, 2005	20.0	1.8
December 05, 2005	24.8	2.5	December 23, 2005	21.4	2.0
December 10, 2005	23.5	2.3	December 24, 2005	21.5	0.0
December 11, 2005	22.5	1.5	December 25, 2005	22.0	0.0
December 12, 2005	23.0	1.0	January 03, 2006	14.0	1.3
December 13, 2005	21.7	0.7	January 04, 2006	16.1	1.3
December 14, 2005	21.8	0.8	January 05, 2006	18.0	-1.0
December 15, 2005	22.0	1.1	January 06, 2006	18.0	-1.6
December 16, 2005	21.0	1.1	January 07, 2006	19.0	-1.7
December 17, 2005	23.2	0.0	January 08, 2006	20.2	-1.5

Table 2: Scale to record frost damage

Scale	Extent of Frost damage
1	Nil
2	10%
3	20%
4	30%
5	40%
6	50%
7	60%
8	80%
9	100%

RESULTS AND DISCUSSION

Emergence Percentage

Plant emergence was recorded after 45 days of planting. Plant population was recorded from the experimental plot and then emergence percentage was calculated. According to data presented in Table 3 it is evident that most of the strains showed more than 75% emergence and strains FD 48-4 and FD 49-28 gave maximum percentage of emergence (98.9%) followed by FD 3-10 with emergence percentage 97.8% whereas minimum percentage was recorded in strain FD

44-43 (30%). Emergence percentage has direct effect on tuber yield as greater the plant population the more will be the tuber yield. The strains with less emergence percentage will reduce the yield.

Table 3: Performance of strains regarding yield and frost tolerance

Sr. No.	Variety	Emergence (%)	Tuber yield (tonnes/ha)	Frost damage scale (1-9)
1	FD 3-9	70.7	15.1	4.0
2	FD 3-15	91.1	23.6	6.0
3	FD 32-2	91.7	20.5	6.0
4	NARC 13	90.0	26.7	6.0
5	FD 8-1	81.1	13.3	6.0
6	NARC 4	73.3	26.7	6.0
7	FD 35-25	71.5	13.1	6.0
8	FD 37-13	62.6	13.3	6.0
9	FSD White	97.2	15.5	6.5
10	FD 48-54	37.0	11.2	6.5
11	FD 48-4	98.9	19.9	7.0
12	FD 19-2	96.7	20.1	7.0
13	FD 49-13	96.7	14.9	7.0
14	FD 65-8	96.7	26.7	7.0
15	NARC 11	96.7	24.4	7.0
16	NARC 43	90.0	20.0	7.0
17	SH-5	86.7	21.3	7.0
18	NARC 18	86.7	20.0	7.0
19	FD 40-10	82.8	16.2	7.0
20	NARC 16	80.0	24.9	7.0
21	NARC 6	76.7	22.2	7.0
22	NARC 34	76.7	20.0	7.0
23	FD 8-3	74.0	11.1	7.0
24	NARC 21	63.3	35.6	7.0
25	9803	60.0	13.0	7.0
26	FD 65-5	60.0	22.2	7.0
27	FD 7-2	48.5	10.8	7.0
28	FD 15-2	95.6	13.5	7.5
29	FD 1-3	89.4	18.6	7.5
30	FD 49-28	98.9	10.9	8.0
31	FD 3-10	97.8	18.6	8.0
32	NARC 8	96.7	25.6	8.0
33	Cardinal	94.4	15.3	8.0
34	FD 53-1	93.3	20.0	8.0
35	FD 61-3	93.3	20.0	8.0
36	FD 65-6	90.0	24.4	8.0
37	Diamant	85.6	11.8	8.0
38	NARC 15	63.3	22.2	8.0
39	FD 49-62	84.4	15.6	9.0
40	Desiree	78.3	7.7	9.0
41	FD 35-36	75.9	12.3	9.0
42	FSD-Red	45.6	7.1	9.0
43	FD 44-43	30.0	4.7	9.0

Tuber Yield (Tonnes/ha)

The ultimate objective of the farmers is to get more tuber yield. The present study is to screen frost tolerant strains; it would be more useful if a strain have tolerance against frost along with more yield potential. Perusal of Table 3 depicted that maximum tuber yield of 35.6 tonnes/ha was recorded from the strain NARC 21 followed by FD 65-8, NARC 13 and NARC 4 with yield value of 26.7 tonnes/ha, but none of these strains showed tolerance against frost. The strain which exhibited maximum tolerance against frost produced 15.1 tonnes/ha tuber yield. Minimum tuber yield (4.7 tonnes/ha) was recorded from FD 44-43, which may be due to very low percentage of emergence. During this particular year overall yields remained low due to severe incidence of frost during the months of December and January.

Frost Tolerance

Frost has severe effects on the potato crop which reduce the yield even up to 40%. A minimum temperature below 2°C was recorded on several dates in the month of December and even below °C was also recorded for four days during 2nd week of January, the most crucial time for the growth and development of potato crop. It is likely that less frost effect was experienced in seedlings that had not yet emerged during frosts. This was the ideal situation for the breeders to evaluate the clones to frost tolerance/damage. Notable tolerance for the frosts was observed in FD 3-9. The 2005 autumn season offered good opportunities to evaluate potato response to serious frosts in early and late development stages. Differences in frost tolerance were evident among the clones evaluated. This study will help in incorporation of the required character in to the existing lines as the identified line tolerant to frost has low tuber yield.

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