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Laboratory screening of CIP-bred potato clones for abiotic stress tolerance

Institute of Botany, Plant Physiology and Genetics (AS RT), Dushanbe,
in collaboration with the International Potato Center (CIP)

**“Enhanced food and income security in SWCA
through potato varieties with improved
tolerance to abiotic stress” (a project funded by BMZ/GTZ)**



- Tajikistan is situated in the south-eastern part of Central Asia and has borders with Afghanistan, Uzbekistan, Kyrgyzstan and China.
- It is closely located to India, Pakistan, Turkmenistan, Kazakhstan and Iran.
- Country area: 143 100 km²
- Population: 7 millions.



- Agricultural land occupies only 28% of Tajikistan, since a large portion of the territory is mountainous (93%)
- Abiotic stress factors are of increasing importance in the country and are represented by: heat, strong winds, dust storms, soil salinization and drought
- Annual losses of agricultural production due to the above abiotic factors are estimated to be approx. 35-45%
- Average statistical data show that in recent years additional 110 thousand hectares of irrigated land have been affected by soil salinization with losses corresponding to approx. 17% of the gross harvest of cereals and potatoes

- The main crops in Tajikistan are wheat, cotton, potatoes and fruits
- Potato consumption in recent years has grown significantly and is now of 80-90 kg per capita/year
- Average annual gross harvest of potatoes is 760 thousand tons (2010)
- There have been sharp increases in the area under potato cultivation and in the production by the private sector

- **Our Institute has carried out activities in the framework of the BMZ/GTZ-funded project, assisted by CIP: «Enhanced Food and Income security in the South-West and Central Asia (SWCA) through potato varieties with improved tolerance to abiotic stress»**
- **Research Objectives:** Screening potato clones for tolerance to salinity and drought under *in vitro* conditions
- **Study materials:** *in-vitro* potato plants of advanced clones supplied by CIP



Details of the facilities for tissue culture and minituber production at the Institute



Exp. No.1: In-vitro screening of CIP clones vis-à-vis of salinity

- *In vitro* plants of 37 clones were transplanted into MS nutrient media with additional application of sodium chloride (NaCl) at concentration levels of 0.5%; 1.0% and 1.5 %. In-vitro plants of the Dutch var. Picasso and CIP-bred clone 397077.16 were used as controls.
- Experiments were carried out in 5 replications and statistically analyzed by CropStat 7.2.
- After 5-6 weeks from sub-culturing in-vitro we determined:
 - the percentage of viability
 - fresh weight of plants (g)
 - height of plants (cm)
 - number of roots
 - fresh weight of roots (g)
 - chlorophyll content (a+b)

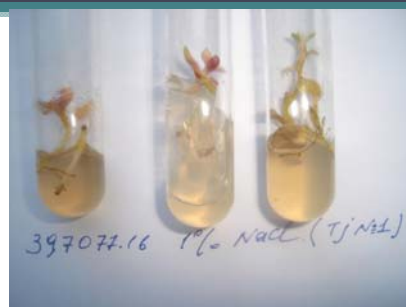
- According to the obtained data, the concentration of 1.5% NaCl showed to be sub-lethal for most clones; the growth and development of tested plants were much distinct from the control, and root formation was not observed.
- LOW RESISTANCE (at 1,5% NaCl)
(viability of 0-20%): **301040.63, 376181.5, 380506.10, 380506.6, 382171.10, 394034.7, 399101.1**
- HIGH RESISTANCE (at 1,5% NaCl)
(viability of 80-100%): **397077.16, 301029.18, 370120, 370121, 380583.8, 394034.7**

(The in-vitro plantlets are considered viable when they have ability to regenerate once placed in a medium without NaCl).

- Our experiments showed that CIP-bred clones № **397077.16, 301029.18, 370120, 370121, 380583.8, 394034.7** had a high viability at the concentration of 1,5% NaCl under *in vitro* conditions. Further sub-culturing into the normal medium gives normal, healthy plants
- Clone **397077.16**, after 60 days sub-culturing at 1% NaCl, once sub-cultured into normal medium showed a reddish color of plants due to high concentration of anthocyanins and carotenoids, as plant response to stress. Stress factors, as high concentration of NaCl lead to accumulation of active form of O₂. Anthocyanins and carotenoids participate in reducing oxidative damage caused by stress factors.



Clone № 397077.16



Clone № 397077.16



Clone № 301029.18



Clone № 397077.16

Micro tuber formation in 1% NaCl concentration

- *In vitro* plants for micro-tuber formation were grown in MS media with NaCl at the concentration of 1%. After 5-6 weeks from sub-culturing we determined:
- the percentage of viability (%)
- number of micro-tubers
- weight of 1 micro-tuber (mg)

- Clones that had a high resistance to NaCl (1.5%) in the previous experiment showed good formation of micro-tubers under *in vitro* conditions, but not all resistant clones (from previous trial) showed micro-tuber formation in presence of salt (1 % NaCl).



Some physiological parameters at 1.5% NaCl concentration

Tajik No.	CIP No.	Viability (%)	Plant height (cm)		Fresh weight (mg)		Root length (cm)		Ch. Cont., %
			C	E	C	E	C	E	
1	397077.16	100	12.2	2.0	460	136	9	0	11
40	301024.14	80	11.1	1.7	203	101	10.2	0	16
41	301029.18	100	11.9	2.1	345	112	8.4	0	28
45	370120	100	11.9	2.1	336	138	7.0	0	16
46	370121	100	11.6	2.3	193	178	7.1	0	14
48	380389.1	80	11.4	1.4	229	130	8.5	0	15
50	380583.8	100	12.5	1.2	385	104	4.2	6.3	10
59	391580.30	100	13.2	1.8	385	146	5.7	0	17
62	393381.4	80	12.0	1.3	252	86	6.7	0	14
63	393536.13	80	12.3	1.7	480	132	6.7	0	24
65	393708.31	100	12.3	2.4	353	152	7.2	0	10
67	394881.8	80	11.9	1.5	435	96	7.3	0	11
74	393708.31	100	14.3	2.2	187	261	8.3	0	14
79	709004	100	12	2.2	200	66	5.0	0	21
80	720118	100	8.8	1.8	142	75	7.5	0	17
LSD (0.05) Clone		29.6	1.76		186.1		4.2		15.6
CIP*TR			2.19		263.3		5.98		

2nd experiment:

In-vitro screening of CIP-bred clones vis-à-vis of drought

- *In vitro* plants of 37 CIP-bred clones were transplanted into MS nutrient media with additional application of polyethyleneglycol (15.0 %, PEG - 6000). In-vitro plants of the Dutch var. Picasso together with CIP-bred clone 397077.16 were used as controls.
- Experiments were carried out in 5 replications and statistically analyzed by CropStat 7.2.
- After 5-6 weeks from sub-culturing we determined:
 - the percentage of viability (%)
 - fresh weight of plants (g)
 - height of plants (cm)
 - number of roots
 - fresh weight of roots (g)
 - chlorophyll content (a+b)

Some physiological parameters of drought resistant potato clones
(mean of 5 replications)

Taj. №	CIP №	Height of plants (cm)	Fresh weight (g)	Number of roots	Length of roots (cm)
40	301024.14	2,44	0,0482	-	-
47	376181.5	2,30	0,0378	2,6	0,2
48	380389.1	1,97	0,0645	1,6	0,3
50	380583.8	2,06	0,0584	3,3	0,5
56	386292.3	3,35	0,0515	2,1	0,4
57	389429.31	1,52	0,0800	2,1	0,7
60	392785.15	2,30	0,0786	1,5	0,2
62	393381.4	1,80	0,0430	2,8	0,1
66	394034.7	2,30	0,0660	2,0	0,2
67	394881.8	2,60	0,0534	1,2	0,3
69	395186.6	2,12	0,0492	1,7	0,2
78	709003	1,57	0,0260	3,2	0,2
80	720118	2,6	100	3,1	0,4

Micro-tuber formation under drought stress conditions

Taj. №	CIP	Number of micro-tubers	Weight of micro-tubers (mg/pl)
47	376181.5	1,1	146,5
48	380389.1	0,4	15,4
50	380583.8	1,8	120,6
56	386292.3	0,6	49,2
57	389429.31	2,3	216,3
60	392785.15	0	0
62	393381.4	2,1	130,2
66	394034.7	2,3	164,5
67	394881.8	1,7	150,3
69	395186.6	1,3	150,3
78	709003	1,2	48,0
80	720118	0	0

Potato CIP-bred clones showing resistance to salinity and drought under in-vitro conditions

- 397077.16
- 380389.1
- 380583.8
- 393381.4
- 394881.8
- 720118

CONCLUSIONS

Testing *in vitro* potato clones under various concentrations of NaCl and PEG can be profitably used for a first screening of large amount of potato clones/varieties.

Of course, these test need confirmation under field conditions. In fact, while in vitro plants grow under artificial and sterile conditions, in the field they are subjected to a wider range of biotic and abiotic stresses.



Thank You