Adaptability and storability of CIP potato clones under long-day conditions of Central Asia

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Abstract

After the breakdown of the USSR, potato seed and production systems collapsed in all central Asian republics resulting in a loss of valuable Russian and local varieties and consequent import of poorly adapted cultivars. In an effort to assist NARS of Central Asia, CIP supplied advanced potato clones for evaluation of their varietal potential under long day conditions as a means to support local farm-based and formal seed systems, among them some germplasm materials from the Lowland Tropic Virus Resistant (LTVR) population. In Uzbekistan, the most promising clones identified in three years' multilocation trials were as follows: 390478.9, early bulking, 388676.1, 397073.16, 391180.6, mid-early and 397077.16, medium maturing, with multilocation adaptability, while 388615.22 was early bulking and 392797.22 (UNICA) was mid-early maturing. The latter two clones showed the best performance in the lowlands during the first and second growing season, respectively. Storability was assessed under traditional and controlled atmospheric conditions and clones classified according to their dormancy period. Clone 397073.16 had the most noticeable apical dominance and the longest sprout length in both storage methods. A positive correlation existed between weight loss and the length of the longest sprout for all the clones, under the traditional storage method. The highest weight losses were reported for clone 397069.11 (8.84%) under controlled storage conditions and 397073.16 (8.03%) under traditional store conditions at 53 and 45 days from dormancy release, respectively. The study indicated that under traditional storage conditions, varieties with longer dormancy period and slower rate of sprout growth have limited weight loss during storage and, therefore, better keeping quality.

Keywords: Potato, Seed systems, Dormancy, Apical dominance, Weight loss.

Introduction

Uzbekistan was part of the USSR until it became independent in 1991. It is located approximately between 37-45° N and 55-72° E. The country has a total area of 44.8 million hectares with only 4.5 million hectares arable, out of which 4 million are irrigated (FAOSTAT, 2007). A vast area is covered by deserts, mountains and steppes. Climate is strongly continental and subject to extremes of temperature during winter and summer with abrupt changes even during the day; factors that limit cropping options. Rainfall is variable and uncertain, with periodic droughts. Most rains come during the spring, but these are generally scarce with less than 40 mm per month. After wheat and rice, potato is the most important food crop in Uzbekistan, cultivated on an area of about 52 000 ha. It is estimated that the double-cropping system of the lowlands covers about seventy percent of the total potato area with the second growing season (mid-July to October) prevailing as far as cultivated area is concerned. The remaining potato area is cultivated in the single-cropping season of the highlands, with planting in May and harvest in September-October. This cropping pattern is spread all over central Asian countries. Before independence, the Uzbek population consumed potatoes partially produced locally and partially imported from other Soviet Republics. Further to the disintegration of the USSR and consequent collapse of the potato research and development system, stocks of valuable Russian and local varieties got lost, while conventional potato seed tubers started to be imported from abroad and then fed into the formal and informal potato seed systems. To assist local NARS in their breeding and rehabilitation efforts, the International Potato Center (CIP) supplied a set of 34 advanced breeding clones and varieties with potential or demonstrated adaptation to long day conditions in the form of in-vitro plantlets in April 2005. The introductions included advanced selections of previously released varieties from CIP's Lowland Tropic Virus Resistant (LTVR) population, and varieties (e.g. Yagana-INIA, Achirana-INTA) from intervarietal crosses or collaborating institutions' population improvement programs (Chile, Argentina). Achirana-INTA, for instance, was introduced because of its successful performance in northern China. Main traits desired by local breeders are earliness for lowlands and medium-late maturing cycle for the highlands (up to 120-130 days from planting), red skin color, resistance to viruses and main abiotic stresses (heat, drought), and marketability. Minitubers produced under screenhouse conditions in Tashkent were planted at a mid-elevation site in 2006, for further increase and preliminary clonal observations. In collaboration with local NARS, 22 clones selected for characters such as tuber shape, tuber eye depth, plant height, length of stolons, susceptibility to early blight (*Alternaria solani*) and viruses, were then entered in multilocation trials in 2007, 2008 and 2009. The present study seeks to provide useful guidance for potato breeding and selection programs, and the results may be valuable for recommending new varieties for specific uses. The study documents field performance of CIP clones under the long day conditions of Central Asia, and provides practical indications concerning storability.

Materials and methods

In 2007, 2008 and 2009, multilocation trials were planned under the varied agro-climatic conditions and growing seasons of Uzbekistan. Trials in the lowlands were carried out in Termez (302 m asl, 37° N, 67° E), on the bank of the Amu Darya river on the border with Afghanistan, during the first growing season, with planting in February and harvest in June, and in Tashkent (476 m asl, 41° N, 69° E), either in the first or second growing season with planting in March and July, respectively. Other trials were carried out at Pskem (1 236 m asl, 42° N, 70° E) during the highlands' single cropping season, with planting in May-June and harvest in September. In Central Asia day length and temperature vary in the course of each growing season, from short to long days and mild to high temperatures during the first growing season, and the opposite in the second growing season of the lowlands. On the other hand, in the highlands, temperature may be high during the day, especially in June, July and August, but it sensibly decreases during the night. .In each one of the three sites the choice of clones to test was made according to results obtained in 2006 after measuring earliness and bulking-based maturity of CIP advanced clones (Carli et al., 2008). Between 5 and 20 selected clones were planted in a randomized complete block design with three replications at a spacing of 70 cm between rows and 25 cm between plants in the row (57 100 plants/ha). The plot size was 2.8 x 5.0 m in all the locations. Fertilizers were applied at the rate of 117 N - 138 P_2O_5 – 225 K_2O units per hectare. Crops were dehaulmed 100 days after planting and harvested approximately ten days later to record tuber yield (t/ha). On each site, especially from April till October, furrow irrigation was provided every two-three weeks. The insecticide Confidor (imidacloprid: 200 g/l) was sprayed three times at a commercial formulation rate of 0.16 kg/ha to control Colorado potato beetle (*Leptinotarsa decemlineata,* Say). Dutch var. Sante, class Elite, was used as a control check.

Storability of the selected clones was assessed both in a cellar in a traditional farm house and a cold store in the town of Tashkent, where potato tubers are kept at a temperature of 2-4°C from February till June. In the traditional cellar, mean maximum ambient temperature ranged from 14.1°C in November 2008 to 10.5°C in January 2009, while mean minimum temperature varied from 6.5°C in November 2008 to 3.6°C in January 2009. The traditional cellar is normally used for seed tubers planted at the beginning of March; it is, in fact, problematic under those conditions to keep the seed viable till June-July because of the high temperatures that occur from March onward. Therefore, in this case, pre-sprouting starts towards mid-January, that is about three to three and a half months after harvest. On the other hand, poorly maintained cold stores of a capacity of about 5 000 tons are used to keep seed tubers that are planted towards mid-May in the highlands, or mid-July in the lowlands. As a consequence, pre-sprouting should start towards mid-April or mid-June, five and a half and seven and a half months after harvesting, respectively. In both stores, seed tubers of a calibre ranging from 35 to 55 mm were kept in trays containing 30 tubers each. The trial was replicated three times. Observations were made once a month in the case of the cold store tubers, and more regularly in the case of those stored traditionally. Observations concerned: (i) percent weight losses, (ii) dormancy period measured as number of days from haulm cutting to sprouting of 80% of the tubers with at least one sprout longer than 2 mm (van Ittersum and Scholte, 1992), (iii) dormancy status of the clones as percentage of tubers that were dormant at the end of storage, (iv) number of sprouts per tuber counted every fifteen days after release of dormancy in the traditional store, and (v) length of the longest sprout measured in the traditional store at 10 day intervals and in the cold store at the end of storage. Tubers were stored on October 24, 2008. Haulm killing occurred on October 01, 2008, at 100 days after planting, followed by harvest, 10 days later, and a two-week curing period. Storage observations were completed by February 16 (traditional store) and April 13 (cold store).

The obtained data were statistically processed using MSTATC (1993). The statistical analysis covers the following indicators: mean value (x), and Coefficient of Variation (CV). A two-way analysis of variance (ANOVA-2) was then computed as well as an LSD test for the level of significance of α=0.05. Correlations between different storability parameters were computed on the basis of mean value of one year (2008-2009).

Results and discussion

Last developments of the LTVR population of CIP

The development and orientation of the LTVR population of CIP in the last thirty years was documented by several authors (Cubillos and Plaisted, 1976; Plaisted, 1987; Mendoza, 1990; Mendoza et al., 1996; Mihovilovich et al., 2007). About nine years ago, CIP's breeding program intensified efforts to improve the adaptation of LTVR population to northern temperate regions including parts of China, Central Asia and the Caucasus. Controlled-cross families were evaluated for tuberization and yield in a series of surrogate environments including extended day length in the warm summer of La Molina (12° 06' S) and the coastal desert site of Majes (16.5° S) in Peru and natural long day conditions in Osorno, Chile (41° S). This enabled the identification of superior progenitors for adaptation to long days which were in turn tested in the form of progeny in 3 locations from Central to North China. Information on stability of performance among lowland and highland sites in Peru and progeny performance under extended day length or natural long day conditions was used to identify clones and design crosses for provision to Central Asian and Caucasus countries as in vitro clones and true seed families, respectively. The high solar radiation and temperatures of short to moderate day length locations such as Majes and Huancayo (11° 09' S) seems to have played an important role in identification of genotypes with adaptation to higher latitudes.

Field performance

CIP advanced clones tested on the mid-elevation site of Pskem showed that the yield obtained in 2008 was largely higher than that obtained in 2007 for almost all the entries due to improved irrigation facilities that increased water availability to the potato crop (Table 1). Clones 388676.1 and 390478.9 performed the best, yielding 71.7 and 43.9 t/ha in 2008 and 2007, respectively. While in 2008, the yield of 388676.1 was significantly higher than that of the other entries except for 720090 (62.0 t/ha), in 2007, 390478.9 did not perform better than 391180.6 (42.3 t/ha) and 397077.16 (41.9 t/ha) at $\alpha \leq 0.05$. Clones 391180.6, 390478.9, 392780.1 and 397077.16 had, however, the most stable yield during two consecutive years of trials with the lowest variation in percentage (5.7, 14.6, 37.8 and 38.4, respectively) reported among the tested clones (Table 1).

Table 1. Yield performance at mid-elevation (1,236 m asl), Pskem, May-September. Means of 3 reps

Entries	Yield (t/ha)		Mean yield (t/ha)	Variation 2007/ 2008
	2007 17.05-05.09	2008 06.06-24.09		(%)
388611.22	14.4 m	47.0 fgh	30.7	226.39
388615.22	29.6 efgh	51.9 cdefg	40.7	75.34
388676.1	33.1 defg	71.7 a	52.4	116.62
388972.22	27.6 fghij	60.0 bcd	43.8	117.39
390478.9	43.9 a	50.3 defg	47.1	14.58
391180.6	42.3 ab	44.7 fgh	43.5	5.67
392780.1	30.7 defg	42.3 gh	36.5	37.79
397029.21	23.0 hij	42.4 gh	32.7	84.35
397030.31	37.2 bcd	21.8 i	29.5	-41.4
397035.26	35.2 cde	61.0 bc	48.1	73.3
397073.16	33.9 def	52.5 bcdef	43.2	54.87
397077.16	41.9 abc	58.0 bcde	49.9	38.42
397099.4	22.2 ijk	46.2 fgh	34.2	108.11
397099.6	26.9 ghij	25.0 i	25.9	-7.06
397054.3	28.7 efghi	61.4 bc	45.0	113.94
720089	21.9 jkl	48.7 efgh	35.3	122.37
720090	31.8 defg	62.0 ab	46.9	94.97
720140	16.3 klm	44.7 fgh	30.5	174.23
720139	15.4 lm	45.3 fgh	30.3	194.16
720189	22.3 ijk	39.7 h	20.7	78.03
Sante	27.8 fghij	48.0 fgh	37.9	72.66
Mean	28.9	48.8	38.8	68.86
CV (%)	13.98	12.22	----	----
LSD (0.05)	6.6	9.8	----	----

In Termez, the favorable results obtained for clone 388615.22 in 2008 were confirmed in 2009. However, its yield was not significantly higher than that of Sante, 391180.6 (25.3 t/ha), 388676.1 (25.0 t/ha) and 397073.16 (24.0 t/ha) in 2007, and 397073.16 (38.9 t/ha) and 391180.6 (33.0 t/ha) in 2008. Only clones 388615.22, 391180.6 and 397073.16 performed better than the others in both years (Table 2).

Table 2. Yield performance in the lowlands (first growing season, Termez). Means of 3 reps.

Entries	Yield (t/ha) 2008 28.02-18.06	Yield (t/ha) 2009 12.02-02.06	Mean Yield (t/ha)	2008/ 2009 (%)
388615.22	36.0 a	41.8 a	38.9	16.11
388676.1	25.0 ab	27.6 b	26.3	10.4
391180.6	25.3 ab	33.0 ab	29.1	30.43
397035.26	19.1 b	27.9 b	23.5	46.07
397073.16	24.0 ab	38.9 ab	31.4	62.08
Sante	25.3 ab	20.7 bc	23.0	-18.18
Mean	25.8	31.6	28.7	22.48
CV (%)	26.37	22.1	----	----
LSD (0.05)	12.38	12.43	----	----

Table 3. Yield performance in the lowlands (first growing season, Tashkent). Means of 3 reps.

Entries	Yield (t/ha) 2008 07/03–26/06	Yield (t/ha) 2009 12/03-26/06	Mean Yield (t/ha)	2008/ 2009 %
388611.22	17.3 b	32.8 ab	25.0	89.6
388615.22	29.8 a	31.2 ab	30.5	4.7
388676.1	24.9 ab	35.1 a	30.0	40.9
391180.6	24.6 ab	29.5 b	27.0	19.9
397073.16	20.5 b	33.8 ab	27.1	64.9
397077.16	29.3 a	38.2 a	33.7	30.4
397099.4	28.5 a	33.3 ab	30.9	16.8
390478.9	24.5 ab	37.2 a	30.8	51.8
Sante	31.8 a	22.5 bc	27.1	-29.2
Mean	25.7	32.6	29.1	26.8
CV (%)	17.55	4.5	----	----
LSD (0.05)	7.8	7.7	----	----

Table 4. Yield performance in the lowlands (second growing season, Tashkent). Means of 3 reps.

Entries	Yield (t/ha) 2007 09/07–30/10	Yield (t/ha) 2008 19/07-13/11	Mean Yield (t/ha)	2008/ 2009 %
388676.1	32.6 a	21.6 d	27.1	-33.7
388972.22	23.8 e	22.1 d	22.9	-7.1
391180.6	19.5 g	13.9 e	16.7	-28.7
392797.22	33.1 a	31.7 ab	32.4	-4.2
397035.26	31.4 b	25.0 cd	28.2	-20.4
397065.28	14.1 h	28.8 bc	21.4	104.3
397073.16	24.7 d	33.8 ab	29.2	36.8
397077.16	28.9 c	34.4 a	31.6	19.0
397054.3	23.0 f	31.8 ab	27.4	38.3
Sante	23.1 f	24.2 cd	23.6	4.8
Mean	25.4	26.7	26.0	5.1
CV (%)	12.03	10.95	----	----
LSD (0.05)	0.53	5.02	----	----

In the Tashkent region's first growing season, Sante had the highest yield in 2008 (31.8 t/ha) although there were only two clones that yielded significantly less, 388611.22 and 397073.16. On the contrary, in the first growing season of 2009, 397077.16 (38.2 t/ha) was the best clone with a yield significantly higher than 391180.6 and Sante. Clone 388615.22 not only showed the most stable yield during the two-year trials with the lowest yield variation (4.7%), but it was also among the best performing entries. In the second growing season, clones 392797.22 (33.1 t/ha) and 397077.16 (34.4 t/ha) performed better in 2007 and 2008, respectively, although their yield was not significantly higher than 388676.1 (32.6 t/ha) in 2207, and than 397073.16 (33.8 t/ha), 397054.3

(31.8 t/ha) and 392797.22 (31.7 t/ha) in 2008 (Table 4). Among them, 392797.22 and 397077.16 had the highest average yield in the two years. Interestingly, all the above clones performed better than Sante.

Some negative phenological and pathologic characteristics

Among the clones tested in Pskem (Table 1), 391180.6, 392780.1, 397035.26 and 720189 showed symptoms referring to potato stolbur Phytoplasma disease, with aerial tubers and reddish, rolled leaflets on the top of plants (De Bokx et al., 1987). As reported by local scientists, this disease is occurring increasingly in Central Asia. Clones 720089, 397029.21 and 397099.6 had somewhat unattractive shape, characterized by moderately deep eyes. Finally, on all the sites, including the one at mid-elevation, seven clones, namely 388972.22, 397029.21, 397030.31, 397065.28, 397099.6, 397054.3 and 720189 developed long stolons, a characteristic which is not appreciated locally as the crop is not suitable for mechanical or semi-mechanical harvest.

Crop duration

Among the clones studied, one was early maturing, five were early bulking, six were mid-early and five were medium maturing (Tables 5 and 6).

Storability

Potato storability or keeping quality is an important feature too often forgotten in potato breeding and selection. Storability attributes studied in the potatoes stored under traditional conditions included duration of dormancy, sprouting patterns and weight loss. Table 5 shows that dormancy period ranged between 77 and 115 days, the shortest being in clone 392797.22 and the longest in clone 720150. Dormancy is considered to be a varietal character that might be affected by both preharvest and postharvest conditions (Ezekiel and Singh, 2003). In accordance with the variation in dormancy observed for the clones evaluated, those with less than 80 days duration were classified as having short dormancy, those with between 80 and 90 days as having medium, and, those with more than 90 days as having long dormancy (Table 5). There were significant differences in the dormancy period between and within different maturity classes (i.e. early, mid-early, and medium). The early maturing clone 397099.4 had a dormancy period of as long as 102 days (long dormancy) and medium maturing clone 720150 had long dormancy of 115 days (long dormancy). Hence no correlation was found between maturity class and dormancy duration as also reported by Burton (1989) and others (Roztropowicz and Wardzynska, 1974). The number of sprouts (>2 mm) per tuber also varied among the clones within and between different maturity groups (Table 5). Apical dominance was prevalent in clones 388676.1, 397073.16 and 720150, whereas clones 390663.8 and 720141 had the highest significant number of sprouts (6.3 vs. 5.7) 45 days after dormancy release. The number of sprouts per tuber is known to be a varietal characteristic (Sunoschi, 1981). The length of the longest sprout showed significant variation among the clones; 132 days after haulm killing the variation ranged from 0.8 cm (720148, 720150) to 2.3 cm (397073.16). The clones which showed greater sprout length up to 16 Feb., 2009, included 397073.16 (2.3 cm), 388676.1 (2.1 cm), 390663.8 (2.0 cm), whereas significantly lower sprout length was observed in clones 720150, 720148, 720139 and 392797.22, with less than 1 cm. The length of the longest sprout has been shown to be one of the most useful measurements to estimate sprout development in potato tubers (Wurr, 1978). The variability observed in the growth rate of the longest sprout in this study confirms earlier studies (Burton, 1989; Singh and Ezekiel, 2003) who reported that in the case of varieties with prevalent apical dominance, the length of the longest sprout was found to be the highest in comparison to the varieties where several sprouts grew simultaneously, thereby showing significant negative correlation between number of sprouts and length of the longest sprout (Singh and Ezekiel, 2003). In this study as well, 397073.16, which had prominent apical dominance, showed significantly faster growth rate of the longest sprout (Table 5). However, the correlation between the number of sprouts and length of the longest sprout was non significant ($r = -0.007$) in the present study. On the other hand there was significant negative correlation between length of sprouts and the dormancy period ($r = -0.51$) indicating that the shorter the dormancy period, the longer the length of apical sprout and *vice-versa*. Weight loss, which is an indicator of storage longevity and keeping quality of potato (Pande et al., 2007) showed significant differences among clones with 397073.16 having the highest weight loss (8.03%), while 720148 and 391180.6 had the lowest loss (5.0 and 5.07%, respectively) 116 days after the beginning of storage or 45 days after release of dormancy. The highest significant weight loss was observed in a mid-early maturity clone, while the lowest weight loss was in an early bulking and mid-early clone. The weight loss of 17 entries was positively correlated with the length of the longest sprout ($r = 0.46$), while there was no correlation between weight loss and number of sprouts per tuber ($r = -0.04$). With respect to dormancy period, the weight loss showed significant negative correlation ($r = -0.58$), in accordance with results obtained in India (Pande et al., 2007).

On the other hand, in the cold store, dormancy varied both among maturity groups and within each group (Table 6), ranging from 99 (391180.6, 397035.26, 397073.16, 397077.16) to 174 days (388615.22). The majority of clones had dormancy longer than 120 days. It is reported that within the range of 3 to 20°C, tubers stored at a lower temperature have a longer period of innate dormancy than those stored at a higher temperature (Wiltshire and Cobb, 1996). This was confirmed by the present study because clone 720150, for instance, showed longer dormancy under cold store conditions than in the store under traditional conditions (174 vs. 115 days). At the end of the storage period, that is 196 days from haulm killing, 397073.16 had the longest sprout, measuring 28.3 mm, which was significantly the longest measurement among the different clones. At the end of storage, clone 720148 showed the strongest dormancy (100%), followed by 720150 and 720141 with, respectively, 90 and 75.5% of the tubers affected. Apical dominance at the end of storage was particularly noticeable in clone 397073.16. Weight loss showed considerable variation between clones on all the study's observation dates (Table 6). After 53 days of dormancy release the range of weight loss varied from as low as 4.6% (388676.1) to as high as 8.84% (397069.11). The highest significant weight loss was observed in a medium maturity clone, while the lowest weight loss was in three mid-early clones. The weight loss of 17 CIP potato advanced clones was negatively correlated with the length of the longest sprout (r = -0.23). With respect to dormancy period, the weight loss showed very low correlation (r = 0.25).

Conclusions

The study compared advanced clones and varieties with the most popular and imported variety, Sante, under Uzbekistan's different environmental conditions. Except for one case (Table 3), where performance of the standard check matched those of some CIP clones, the latter performed significantly better than var. Sante. Results demonstrated that potato yields in the dual-cropping system of the lowlands and the single cropping system of the highlands are strongly influenced by water availability under the arid conditions of Central Asia. In spite of these stressful conditions, some advanced clones from CIP showed good adaptability and performance and can be recommended for further release as varieties. Specifically, while 390478.9, early bulking, 388676.1, 391180.6, mid-early, and 397077.16, medium maturing, show good adaptation to different environments, clone 388615.22, early bulking, and 392797.22 (UNICA), mid-early maturing, perform better in the lowlands during the first and second growing season, respectively. Clone 397073.16, when apical dominance is broken in a timely manner, shows good adaptation both in the lowlands and the highlands. The only exceptions are represented by clones 388972.22, 397029.21, 397030.31, 397065.28, 397054.3, 397099.6 and 720189 that have long stolon development. Furthermore, three clones, in particular, 397065.28, 397054.3 and 720139 have too high a plant height to be accepted by the local State Committee for Variety Testing. The study concluded that among the traits sought and evaluated, in varietal assessment, storability should be regarded as equally important as yield, disease resistance and quality. In the study the sprouting attributes of 17 CIP advanced clones previously selected for agronomic and quality characteristics, revealed abundant variability in terms of dormancy period, number of sprouts, length of the longest sprout and weight loss. For instance, 397073.16 had prominent apical dominance and significantly faster growth rate of the longest sprout, thus explaining the highest weight loss recorded when potatoes are stored under traditional conditions. It is expected that the investigation results will help CIP's breeders to improve potato adaptability to long day and storing conditions of Central Asia.

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Table 5. Potatoes stored under traditional conditions: dormancy and sprouting behaviour of CIP clones. Tashkent, Uzbekistan (October 2008-February 2009). Means of three reps.

CIP clones	Maturity	Dormancy period (days)	Length of the longest sprout (cm)					Av. No. of sprouts per tuber (days after sprout initiation)			Weight loss (%)		
			05.01. 2009	15.01. 2009	25.01. 2009	05.02. 2009	16.02. 2009	15	30	45	05.01. 2009	25.01. 2009	16.02. 2009
397099.4	Early	102	0.3	0.8	0.8	1.1	1.2	1.7	2.0	2.3	4.06	5.08	5.83
388615.22	Early bulking	98	0.3	0.6	0.9	1.3	1.4	1.7	2.0	2.0	4.15	5.66	6.46
390478.9	Early bulking	98	0.7	0.9	1.4	1.6	1.8	2.7	2.7	3.3	4.05	5.22	5.85
720087	Early bulking	107	0.1	0.4	0.5	0.8	1.0	2.7	2.7	2.7	4.29	4.87	5.59
720141	Early bulking	107	0.2	0.3	0.5	0.9	1.2	3.3	5.7	5.7	4.10	5.18	5.91
720148	Early bulking	108	0.0	0.1	0.2	0.5	0.8	0.0	1.0	2.3	3.14	4.23	5.00
388676.1	Mid-early	91	0.9	1.6	1.8	1.9	2.1	1.7	1.7	1.7	4.91	5.50	6.51
390663.8	Mid-early	95	0.7	1.0	1.4	1.8	2.0	5.3	6.3	6.3	4.13	5.04	6.14
391180.6	Mid-early	98	0.5	0.7	0.8	1.1	1.5	1.3	2.3	2.3	3.20	4.26	5.07
392797.22	Mid-early	77	0.1	0.2	0.4	0.7	0.9	2.3	4.7	4.7	5.26	6.13	6.97
397035.26	Mid-early	95	0.7	1.0	1.3	1.4	1.6	2.7	3.3	3.3	4.14	5.30	6.14
397073.16	Mid-early	87	0.9	1.3	1.8	2.0	2.3	1.7	1.7	1.7	5.60	6.64	8.03
397069.11	Medium	95	0.9	1.2	1.4	1.5	1.6	1.7	2.0	2.0	4.00	5.12	6.11
397077.16	Medium	89	0.8	1.1	1.2	1.4	1.4	2.3	3.7	3.7	3.77	4.84	5.92
388611.22	Medium	91	0.7	1.0	1.2	1.4	1.6	3.3	3.3	3.3	5.23	6.18	7.11
720139	Medium	107	0.1	0.4	0.5	0.7	0.9	2.0	3.0	3.0	4.68	5.38	6.13
720150	Medium	115	0.1	0.2	0.3	0.6	0.8	1.0	1.7	1.7	4.51	5.34	6.26
	Mean	97.6	0.47	0.75	0.96	1.22	1.42	2.2	2.93	3.06	4.31	5.29	6.18
	CV (%)	1.0	20.8	16.7	12.4	8.9	7.7	23.9	18.6	17.1	4.4	4.0	3.0
	LSD (0.05)	1.6	0.16	0.20	0.19	0.17	0.18	0.86	0.89	0.86	0.31	0.34	0.31

Table 6. Potatoes kept in the cold store: dormancy, sprouting behaviour and weight loss of CIP clones. Tashkent, Uzbekistan (October 2008-April 2009. Means of three reps.

CIP clones	Maturity	Dormancy period (days)	Length of the longest sprout at the end of storage (mm)	Dormancy (% of tubers dormant at the end of storage)	Apical dominance of tubers (%)	Weight loss (%)		
						15 days after sprout initiation (22 Jan. 2009	30 days after sprout initiation (19 Feb. 2009)	53 days after sprout initiation (13 April 2009)
397099.4	Early	139	1.0	5.5	---	3.55	4.57	5.99
388615.22	Early bulking	174	2.7	---	---	3.50	4.38	7.45
390478.9	Early bulking	104	16.0	---	---	3.52	4.93	6.87
720087	Early bulking	174	0.7	50.0	---	3.90	4.88	6.15
720141	Early bulking	174	0.5	75.5	---	4.19	4.89	6.29
720148	Early bulking	174	0.0	100.0	---	3.84	4.94	5.82
388676.1	Mid-early	109	13.3	---	---	2.85	2.86	4.60
390663.8	Mid-early	174	0.8	53.3	---	4.31	5.03	6.91
391180.6	Mid-early	99	11.3	---	---	3.12	3.13	4.76
392797.22	Mid-early	114	19.3	---	---	2.66	3.33	4.80
397035.26	Mid-early	99	13.7	---	---	4.96	5.59	7.45
397073.16	Mid-early	99	28.3	---	76.7	3.59	4.10	5.86
388611.22	Medium	104	11.7	---	---	5.06	5.52	6.73
397069.11	Medium	129	7.0	10.0	3.3	5.77	7.05	8.84
397077.16	Medium	99	10.3	---	---	3.37	4.49	5.84
720139	Medium	124	1.3	---	---	3.05	3.82	5.57
720150	Medium	174	0.5	90.0	---	4.79	5.39	6.83
	Mean	133.1	8.1	22.6	---	3.88	4.64	6.28
	CV (%)	3.5	48.8	20.4	---	5.5	2.5	2.6
	LSD (0.05)	7.79	6.59	7.66	---	0.35	0.19	0.27

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