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Research Concerning the Influence of Photoperiod Upon Potato Stolonization and Tuberization

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Abstract. A study regarding stolon and tuber development of three potato varieties (Christian, Cumidava and Tresor) bedded in three photoperiods (14.5, 15, 15.5 light hours) was conducted. The aim was to keep trace of stolons and tubers formed at 5, 10 and 30 days from the initiation of tuber development on four measures (5-10 mm, 10-20 mm, 20-30 mm and over 30 mm). Stolon and tuber number/plant is presented in dynamics, and the total number of formed tubers at 30 days from tuber development initiation is considered as total tuber number/plant.

Keywords: potato, photoperiod, stolonization, tuberization, number of tubers.

INTODUCTION

Among biologic processes, stolon and tuber development in potato is an essential aspect of its yield potential expression. Stolons begin their development at 1 to 3 weeks after springing, following a forming order from the most basal stem nodes and then progressively at higher nodes (Brown, 2007). Tuber initiation takes place at 3 to 4 weeks from plant springing and implies tuber formation at the first inter-loop placed under the apical shoot of the stolon. In practice, this stage is reached when tuber diameter is double in comparison with the carrier stolon diameter (Rouseelle *et al*.1996). Tuber growth takes place through reserve substances accumulation in tissues, these being synthesized by leaves. Tuber distribution on measure fractions within crop is influenced both by tuber formation period and stolon number that form tubers on plant and is also the key factor to yield destination, either for consumption or seed. (Neag, 2009)

MATERIALS AND METHODS

Three potato varieties, from three different ripening groups were studied: Christian (semi-early), Cumidava (semi-late) and Tresor (early). Researches were conducted in vegetation vases, in UASVM Cluj-Napoca vegetation house, year 2011. Seed tubers from the three experimental varieties were sorted and calibrated on the same measures keeping count of the correlation between tuber size and the number of sprouts rose through shooting. Tubers were shot in darkness, afterwards exposed to light and then three shoots were left on each one as to reach uniformity of the factors in the study. They were planted in vegetation vases, in a substratum of 60% virgin soil, 30% peat and 10% sand.

In order to mark out the influence of light period (photoperiod) upon stolon number and formed tubers, plantings were made at April first, April 15th and May first, aiming to have natural daylight for 14.5, 15.0 and 15.5 hours during tuber development period.

Tuber development determinations expressed through the number of formed tubers on measure fractions 5-10 mm, 10-20 mm, 20-30 mm and over 30 mm and through stolons number, were cuatified at 5, 10 and 30 days from tuber development initiation, as to judiciously appreciate the experimental factors.

The irrigation norm was of 143 ml/vegetation vase and total water input was brought up to 80% from active humidity interval.

Experimental technique was used for bi-factorial experiences. Calculations were realized using variance analysis method, with two factors, and results were interpreted through difference significance by Student and Duncan tests. Moreover, charts were used after the histogram method.

RESULTS AND DISCUSSION

In variety and light length interaction, at 5 days from tuberization initiation, a great influence of daylight is detected upon formed stolon number, in different photoperiods (Tab. 1). Although the length of light hour number differs only with 0.5 hours/day, stolon number differences appear at all experimental varieties. Of all three tested varieties, Christian is less influenced; the stolon number difference in comparison with the variety that develops it's stolons in the shortest day length, is small but determinable and repeatable. For Cumidava and Tresor, there are great differences, negatively very significant, these varieties being plainly influenced by photoperiod where the number of formed stolons is concerned. The differences that appear under the influence of photoperiod upon stolonization are also highlighted through the Duncan test, these being significant up against 14.5 day light at 15.0 and 15.5 hours of light/day. The number of tubers identified on plant is lessened than the stolon one, which means that not all stolons generate tubers, but the influence of light period upon tuber number becomes more and more obvious, as in the case of the influence upon stolon number. Duncan test calculation can confirm these assertions. Nevertheless, some varieties are not so strictly influences by day light length, as in the case of Christian variety, but the influence still exists upon stolon and tuber number. If until the 5th- 6th of May daylight length reaches 14.5 hours, the importance of early planting becomes obvious. This way, potatoes will develop tubers at the beginning of May, when daylight does not exceed 14.5 hours (Tab. 1).

10 day after tuberization onset (Tab. 2) both stolons and tubers are still forming. Although, early varieties, like Tresor, have a slight tendency of caching up with the stolon and tuber number, differences are still great when compared with the shortest length day and are also statistically assured or with an obvious tendency of a stolon number decrease. Differences between the shortest daylight and Cumidava and Christian varieties are negatively highly significant, for both stolon and tuber number formed at over 14.5 hours of light/day (Tab. 2).

The same tendency of forming a smaller stolon and tuber number at a length day of 15, 15.5 hours respectively is detected after 30 days from tuberization inception for all three varieties. For Cumidava and Tresor varieties, a 15.5 hours photoperiod during tuberization initiation period, stolon number/plant differences are negatively highly significant and tuber number/plant differences are distinguishable significant. The same photoperiod applied for Christian variety, determines distinguishable significant differences in stolon and tuber number/plant.

Analyzing the average of the three studied varieties, 30 days after tuberization inception, it can be noticed that prior differences are pronounced. When having a longer photoperiod of 15 and 15.5 hours, the stolon and tuber number/plant differs in a negatively highly significant way from the number obtained at a 14.5 hours photoperiod. Interpreting data through Duncan test, stolon and tuber number differences that appear between a 15 and a 15.5 hours photoperiod are not significant, but the ones between these two and the 14.5 hours are. This means that 14.5 hours of light/day threshold should not be crossed by plants during stolonization and tuberization stage (Tab. 3).

It has been noticed that stolon and tuber number is higher for shorter photoperiods, at all three time intervals considered for determinations.

Fig. 1 presents the evolution of tuber number divided in four measure fractions: 5-10 mm, 10-20 mm, 20-30 mm and over 30 mm, under the influence of experimental factors, in a time spread of 5-10-30 days from tuberization onset at experimented varieties. It can be observed that all experimented varieties form a higher number of tubers/plant at shorter light period during tuberization onset. For all three experimented varieties, the presence of tubers that are bigger than 30 mm, which represent commercial yield, is noticed after 10 days from tuberization onset, at 14.5 hours photoperiod and only after 30 days at 15 and 15.5 hours photoperiod. At 30 days from tuberization initiation, the number of tubers/plant that are bigger than 30 mm is compassed between 3 and 6 at a light period of 14.5 hours, between 2 and 3 at a light period of 15 hours and between 1 and 2 at a light period of 15.5 hours.

CONCLUSIONS

- For all three time intervals that were considered for determinations regarding stolon and tuber number, it was noticed that this number grows in short photoperiod conditions.
- A proper stolonization and tuberization under our country's latitude conditions happens at 14.5 hours of light which is reached during the first decade of May, this implying an early planting at the beginning of April as to assure the most favourable photoperiod for potato.
- The stolons and tubers of the potato plant are in a direct relationship and determinant for the potato production during the whole potato vegetation period in all cultivars and in all maturity categories
- The number of formed tubers is always smaller than that of stolons and it is generally directly influenced by day length.

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Tab. 1

Influence of the photoperiod and variety interaction upon stolon and tuber number at 5 days from tuberization onset

Cultivar	Photoperiod	N^0 of stolons/pl.	Percentage	Dif./Signif.	Duncan test	N^0 of tubers/pl	Percentage	Dif./Signif	Duncan test
Christian	14,5 hours	17,00	100	Mt.	B	11,33	100	Mt.	B
	15 hours	13,67	80	$-3,33^{-}$	B	8,00	71	$-3,33^{-}$	AB
	15,5 hours	14,00	82	$-3,00^{-}$	B	4,00	35	$-7,33^{00}$	A
Cumidava	14,5 hours	13,33	100	Mt.	B	10,67	100	Mt.	B
	15 hours	4,33	33	$-9,00^{000}$	A	3,00	28	$-7,67^{000}$	A
	15,5 hours	6,00	45	$-7,33^{00}$	A	3,67	34	$-7,00^{0}$	A
Tresor	14,5 hours	17,67	100	Mt.	B	12,67	100	Mt.	B
	15 hours	7,67	43	$-10,00^{000}$	A	3,33	26,3	$-9,33^{00}$	A
	15,5 hours	8,00	45	$-9,67^{000}$	A	4,67	37	$-8,00^{00}$	A
Cultivar average	14,5 hours	16,00	100	Mt.	B	11,56	100	Mt.	B
	15 hours	8,56	54	$-7,44^{000}$	A	4,78	41	$-6,78^{000}$	A
	15,5 hours	9,33	58	$-6,67^{000}$	A	4,11	36	$-7,44^{000}$	A
DL (p 5%) cultivar x photoperiod				4,32				5,00	
DL (p 1%) cultivar x photoperiod				6,06				7,02	
DL (p 0,1%) cultivar x photoperiod				8,56				9,91	
DS 5% cultivar x photoperiod					4,32-4,86				4,99-5,63
DL (p 5%) photoperiod				2,49				2,89	
DL (p 1%) photoperiod				3,50				4,05	
DL (p 0,1%) photoperiod				4,94				5,72	
DS 5% photoperiod					2,49-2,61				2,88-3,02

Tab. 2

Influence of the photoperiod and variety interaction upon stolon and tuber number at 10 days from tuberization onset

Cultivar	Photoperiod	N^0 of stolons/pl.	Percentage	Dif./Signif.	Duncan test	N^0 of tubers/pl	Percentage	Dif./Signif	Duncan test
Christian	14,5 hours	21,00	100	Mt.	F	18,33	100	Mt.	C
	15 hours	13,33	64	$-7,67^{00}$	DE	11,33	62	$-7,00^{000}$	B
	15,5 hours	10,00	48	$-11,00^{000}$	BCD	7,33	40	$-11,00^{000}$	A
Cumidava	14,5 hours	14,67	100	Mt.	E	13,67	100	Mt.	B
	15 hours	5,00	34	$-9,67^{000}$	A	4,33	32	$-9,33^{000}$	A
	15,5 hours	8,00	55	$-6,67^{00}$	ABC	7,33	54	$-6,33^{000}$	A
Tresor	14,5 hours	12,33	100	Mt.	CDE	10,67	100	Mt.	B
	15 hours	10,33	84	$-2,00^{-}$	BCDE	7,33	69	$-3,33^{0}$	A
	15,5 hours	6,33	51	$-6,00^{00}$	AB	5,33	50	$-5,33^{00}$	A
Cultivar average	14,5 hours	16,00	100	Mt.	B	14,22	100	Mt.	B
	15 hours	9,56	60	$-6,44^{000}$	A	7,67	54	$-6,56^{000}$	A
	15,5 hours	8,11	51	$-7,89^{000}$	A	6,67	47	$-7,56^{000}$	A
DL (p 5%) cultivar x photoperiod				4,18				3,01	
DL (p 1%) cultivar x photoperiod				5,87				4,22	
DL (p 0,1%) cultivar x photoperiod				8,29				5,96	
DS 5% cultivar x photoperiod					4,18-4,71				3,00-3,38
DL (p 5%) photoperiod				2,41				1,74	
DL (p 1%) photoperiod				3,39				2,44	
DL (p 0,1%) photoperiod				4,78				3,44	
DS 5% photoperiod					2,41-2,53				1,73-1,82

Tab. 3

Influence of the photoperiod and variety interaction upon stolon and tuber number at 30 days from tuberization onset

Cultivar	Photoperiod	N^0 of stolons/pl.	Percentage	Dif./Signif.	Duncan test	N^0 of tubers/pl	Percentage	Dif./Signif	Duncan test
Christian	14,5 hours	16,00	100	Mt.	CD	14,33	100	Mt.	D
	15 hours	13,33	83	$-2,67^{-}$	CD	9,33	65	$-5,00^{-}$	BCD
	15,5 hours	8,00	50	$-8,00^{00}$	AB	6,00	42	$-8,33^{00}$	AB
Cumidava	14,5 hours	16,33	100	Mt.	D	15,00	100	Mt.	D
	15 hours	4,00	25	$-12,33^{000}$	A	3,00	20	$-12,00^{000}$	A
	15,5 hours	6,00	37	$-10,33^{000}$	AB	5,00	33	$-10,00^{00}$	AB
Tresor	14,5 hours	14,33	100	Mt.	CD	13,33	100	Mt.	CD
	15 hours	10,67	74	$-3,67^{-}$	BC	7,67	58	$-5,67^{0}$	ABC
	15,5 hours	3,67	26	$-10,67^{000}$	A	3,00	26	$-10,33^{00}$	A
Cultivar average	14,5 hours	15,56	100	Mt.	B	14,22	100	Mt.	B
	15 hours	9,33	60	$-6,22^{000}$	A	6,67	47	$-7,56^{000}$	A
	15,5 hours	5,89	38	$-9,67^{000}$	A	4,67	33	$-9,56^{000}$	A
DL (p 5%) cultivar x photoperiod				5,03				5,42	
DL (p 1%) cultivar x photoperiod				7,07				7,60	
DL (p 0,1%) cultivar x photoperiod				9,98				10,73	
DS 5% cultivar x photoperiod					5,03-5,67				5,41-6,10
DL (p 5%) photoperiod				2,91				3,13	
DL (p 1%) photoperiod				4,08				4,39	
DL (p 0,1%) photoperiod				5,76				6,20	
DS 5% photoperiod					2,90-3,05				3,12-3,28

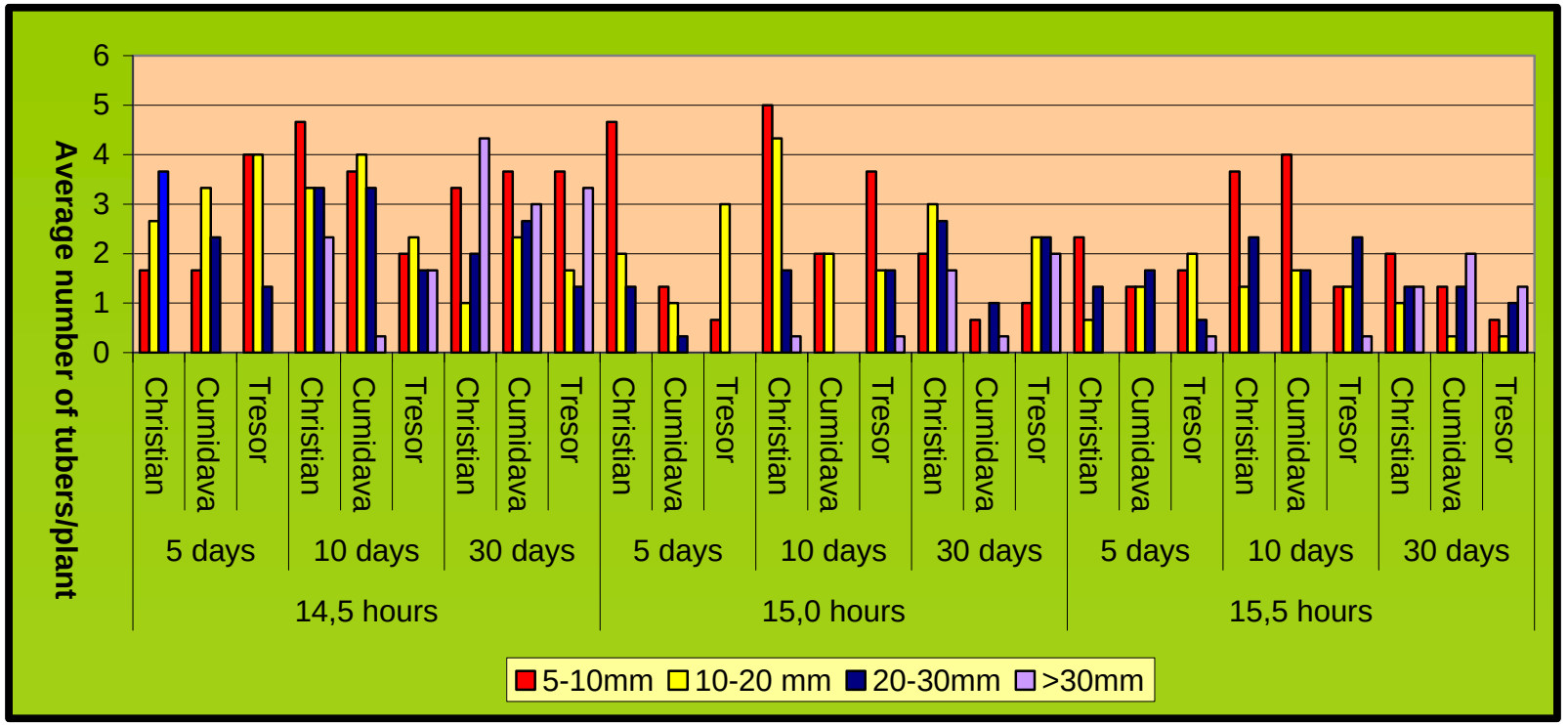

Fig. 1. Average number of tubers/plant at three time intervals in different photoperiod