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THE GROWTH CHARACTERISTICS OF SIX PEAR CULTIVARS UNDER THE "TRIDENT" TRAINING SYSTEM IN SOUTH-EAST OF ROMANIA

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Abstract

New orchards are heading to increase the planting density per hectare or to create an increased number of productive structures (scaffolds, axes, etc.) per surface unit. One way to accomplish the second task is to divide the growth vigor over more branches. This goal can be achieved by new tree training systems asthree-axis shape called "Trident" "Candelabro", "Chandelier" or "Candlestick". A replicated trial was established in the orchard of the University of Agronomic Sciences and Veterinary Medicine of Bucharest to evaluate the behavior of some self-rooted pear cultivars on "Trident" training system. The orchard spacing was 4 X 2.0 m and studied varieties were Abbé Fétel, Conference, Clapp's Favorite, Max Red Bartlett, Beurré Bosc and Alexander Lucas. The trunk diameter, total annual shoot length and shoot number, tree height and other growth parameters were measured annually at the beginning of growing season. The obtained results indicate differences between varieties. The greatest values for height tree were registered in Abbé Fétel variety in both season and the lowest values for Clapp's Favorite variety in 2011 and Max Red Bartlett variety in 2012.The data referring to trunk cross section pointed out very significant positive differences at Abbé Fétel and significant positive differences in case of "Conference" variety from average used as control in 2011. In 2012, two varieties showed significant positive differences from the average experience, respectively Conference and Max Red Bartlett.In 2011 varieties Conference, Abbé Fétel and Max Red Bartlett produced more long shoots than the average of trial and in 2012 the varieties mentioned above and Beurré Bosc" formed long shoots more thanthe average.

Key words: *orchard system, self-rooted trees, tree growth.*

INTRODUCTION

Tree architecture is an important aspect for the breeders having regard that growth vigour and specific type of growth and fructification affects directly the number of trees/unit of area. The need to reduce both pruning costs and the use of growth regulators changed the objectives of researches mainly in optimization of training methods based on natural tree habit (Lauri et. al., 2000). There are numerous technical and organizational innovations (cultivars, rootstocks, cropping techniques and defense techniques) that affect the whole life of an orchard (Galli et al., 2011). Two aspects, trees cultivated on their own roots and "Trident" training system were the subject of our study.

The use of self-rooted cultivars has had a great success in pear in the last decade. It offers the possibility to obtain high quality yields and it is good technique that can be extend in pear orchard (Stanica et al., 2000). It also could provide some tolerance to disease, especially fire blight (*Erwinia amylovora*) (Spornberger et. al., 2008).

The "Trident" system proposes a central leader and two side branches that are trained vertically that means finally the tree present three leaders (Vercammen, 2011). Distributing vegetation over three axes induces less vigour since tree sends nutrients responsible with growth in three axes instead of one. As bi-axis system "Trident" system is based on the same concept and the same effects, such as: a good exposure of fruit to sunlight, reducing tree height, reduction of cultural practices, less use of growth regulators, considerable speeding of harvest and pruning should appear (Dorigoni, 2008). The aim of the present work was to study the behavior of six self-rooted pear varieties in terms of vegetative growth of the trees.

MATERIALS AND METHODS

The study was conducted between 2011-2012 in a modern pear orchard located in Bucharest

area of latitude 26.5 degree East and longitude 44.3 degree North. The altitude is about 90 m above the sea level.
The plant material used in this study included self-rooted cultivars "Abbé Fétel", "Max Red Bartlett", "Conference", "Beurré Bosc", "Alexander Lucas", "Clapp's Favorite". Spacing between rows was 4 m and in the row 2 m, the trees being leaded as "Trident" leading form. A randomized block design for each cultivar in tree replications with three trees per plot was set-up.
There were used two support systems, one namely T 4- wire with galvanized wire (figure 1) and the other with two wire and three bamboo tutors/tree (figure 2).

Figure 1. T-4 wire support system

To assure stability of system in ground was used classical anchorage system and on the row every 10 meters, concrete espaliers were placed.
The alleyways were cultivated with perennials and were mowed mechanical in the growing season. On tree row the soil was maintained clean of weed by hand and mechanical cultivation.

Figure 2. Two wire and three bamboo tutors

The existing drip irrigation system on each rows provides 2l/hour water. It consist of continuous dripping line and individual drippers every 0.5.m.
The soil is typical brown-reddish with 40% clay content in the surface layer.
The average annual temperature is 10.6C and annual sum of precipitation is 574.3 mm.
Measurements were carried out at the beginning of each season, early in the spring, with roulette and caliper and results were expressed in cm.
The trunk thickness was measured at 50 cm above ground and was used to calculate the trunk cross sectional area. Also were measured: tree height, the total length and/or number of vegetative shoots. Total shoots were measured or counted and classified as vegetative shoots or flowering shoots. Some data were processed with variance analysis and t-test was applied.

RESULTS AND DISCUSSIONS

The growing vigour of the trees cultivated in high density system shows us that between the pear varieties have appeared differences regarding the trunk thickness growth, the height of trees and transversal cross section.
The trunk is an important element which characterizes the tree vigour and it is analyzed and correlated with a series of other biometrical process and indices (Comanescu et al., 2012). The analysis of tree height values among the varieties showed that tree height was lowest in

"Clapp's Favorite" in 2011 where the height of the tree constituted 170 cm and "Max Red Bartlett" in 2012 with the height of the tree constituted 200 cm. The highest values for this parameter was registered in "Abbé Fétel" in both seasons, with the height of the tree constituted 250 cm in 2011 and 280 cm in 2012 whereas in other varieties the recorded values were intermediate (table 1).

Values of the trunk thickness comprised between 2.10 and 2.93 cm in 2011 registered the pear tree varieties: "Max Red Bartlett: (2.70 cm), "Clapp's Favorite" (2.10 cm), "Beurré Bosc" (2.62 cm), "Alexander Lucas" (2.50 cm), "Abbé Fétel" (2.93 cm) and "Conference" (2.88 cm). In 2012 the recorded values were placed between 2.80-3.82 cm with lowest values at "Clapp's Favorite" (2.80 cm) and highest at "Conference" variety (3.82 cm).

Growth of trees, expressed as a trunk cross section area registers extreme values, comprised between 3.5 cm^2 at "Clapp's Favorite" variety and 6.7 cm^2 at "Abbé Fétel" variety in 2011. In the next year the values comprised between 6.2 cm^2 at "Clapp's Favorite" variety and 11.6 cm^2 at "Max Red Bartlett". The data from 2011 were statistically processed as compared to the average of the trial, used as control and pointed out very significant positive differences at "Abbé Fétel" and significant positive differences in case of "Conference" variety. In 2012 two varieties showed significant positive differences from the average of experience, respectively "Conference" and "Max Red Bartlett". Significant negative differences, as compared with average, taken as control, registered the "Clapp's Favorite" variety. Vigour with insignificant differences, as compared with average had the varieties "Beurré Bosc", "Clapp's Favorite", "Alexander Lucas", "Max Red Bartlett" in 2011 and "Abbé Fétel", "Beurré Bosc" and "Alexander Lucas" in 2012.

The average of annual vegetative shoot growth in 2011 was 147.8 cm/tree in "Clapp's Favorite", 257.8 cm/tree in "Beurré Bosc", 288.2 cm/tree in "Alexander Lucas", 320.1 cm/tree in "Conference", 327.7 cm/tree in "Max Red Bartlett" and the highest value (413.5 cm/tree) in "Abbé Fétel". In 2012 the registered values were as follows: 346.5 cm/tree in "Alexander Lucas", 360.1 cm/tree in "Clapp's Favorite", 386.8 cm/tree in "Abbé Fétel", 405.6 cm/tree in "Conference" and 411 cm/tree in "Beurré Bosc" varieties (fig. 3). In 2011 trees from "Conference", "Abbé Fétel" and "Max Red Bartlett" produced more long shoots than the average of trial (292.5 cm/tree). In 2012 the varieties mentioned above and additional "Beurré Bosc" produced long shoots more than the average (384 cm/tree).

In 2011, a large number of vegetative spurs produced "Conference" (68) and "Beurré Bosc" (45) while "Max Red Bartlett" and "Clapp's Favorite" formed the fewest number of spurs (39 and 38).

Table 1. Vegetative growth in 2011 and 2012

Pear variety	Tree height (cm)		Trunk thickness (cm)		Transversal cross section (cm^2)		Differences as to average (cm^2)		Significance	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Abbé Fétel	250	280	2.93	3.48	6.7	9.5	+1.3	+0.35		N
Conference	210	250	2.88	3.82	6.5	11.4	+1.1	+2.25		
Beurré Bosc	190	250	2.62	3.28	5.4	8.5	0	-0.65	N	N
Clapp's Favorite	170	220	2.10	2.80	3.5	6.2	-1.9	-2.95	N	
Alexander Lucas	180	210	2.50	3.14	4.9	7.7	-0.5	-1.45	N	N
Max Red Bartlett	180	200	2.70	3.84	5.7	11.6	+0.3	+2.45	N	
Average	196.6	235	2.62	3.39	5.4	9.15	-	-	-	-

DL 5 %=0.80 cm^2 (2011) N= not significant DL 5%=1.8 cm^2 (2012)

DL 1%=1.14 cm^2 *= significant difference DL1%=2.5 cm^2

DL 0.1%=1.65 cm^2 **= distinctive significant difference DL 0.1%=3.7 cm^2

In 2012 "Alexander Lucas" produce the largest number of vegetative spurs (122), followed by Beurré Bosc" (80) and the lowest number was registered in "Clapp's Favorite" (table 3).

The total length of the flowering shoots registered the highest value in both years for "Max Red Bartlett" (119.4 cm/tree in 2011 and 395.8 cm/tree in 2012) and the lowest value for "Beurré Bosc" (16.8 cm/tree in 2011 and 293.2 cm/tree in 2012) (table 2). The varieties "Max Red Bartlett", "Conference" and "Abbé Fétel" produced over than 300 cm/tree of flowering brindles in 2012 (table 2).

The values of offshoots length varied between 0 and 26.1 cm/tree in 2011 and 7.8 -107.8 cm/tree in 2012 with the highest value registered in "Max Red Bartlett" variety in 2011 (26.1 cm/tree) and "Alexander Lucas" variety in 2012 (107.8 cm/tree) (table 2).

"Alexander Lucas" variety formed the largest number of flowering dards in 2011 (67) and "Abbé Fétel" variety in 2012 (33) (table 3).

Trees formed also fruit bourses, one of them remained undeveloped others are formed by different shoots as spurs, dards or spurs and dards. "Abbé Fétel" and "Conference" formed constantly spurs, dards and bourses but the highest number of bourses with dards was registered in 2011 for "Alexander Lucas" variety (99) followed by "Clapp's Favorite" variety with 54 bourses with dards (table 3).

Table 2. Flowering shoots (cm/tree) registered between 2011-2012

Pear variety	Flowering shoots (cm/tree)					
	Brindles		Offshoots		Total length	
	'11	'12	'11	'12	'11	'12
A. Fétel	33.1	302.2	11.8	61.8	44.9	364
Conf.	27.5	321.7	15.3	14.5	42.8	336.2
Beurré Bosc	16.8	213.5	0	7.8	16.8	221.3
Clapp Fav.	17.6	271.2	0	22	17.6	293.2
Al. Lucas	103.8	250	8.6	107.8	112.4	357.8
Max Red Bart.	93.3	363.1	26.1	32.7	119.4	395.8

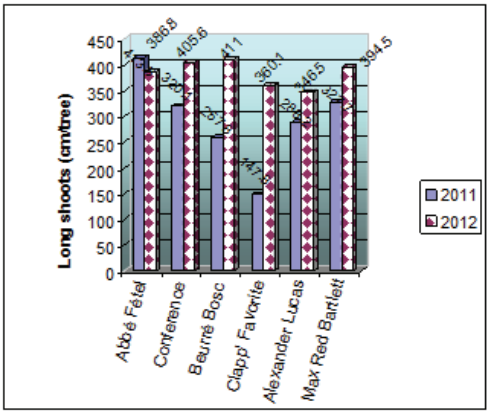

Figure 3. Long shoots registered (cm/tree) between 2011-2012

Table 3. Average number/tree and type of vegetative and flowering shoots

Pear variety	Vegetative shoots (no/tree)		Flowering shoots (no/tree)									
	Spurs		Dards		Fruit bourses							
					undeveloped		with spurs		with dards		with spurs&dards	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Abbé Fétel	49	51	24	33	3	5	57	6	5	1	4	0
Conference	68	54	25	10	0	16	10	61	0	0	0	0
Beurré Bosc	54	83	9	5	0	0	0	8	0	0	0	0
Clapp's Favorite	38	50	14	3	0	3	5	2	54	0	0	0
Alexander Lucas	45	122	67	24	0	3	5	11	99	0	0	0
Max Red Bartlett	39	60	11	22	7	0	54	57	1	8	0	0

CONCLUSIONS

The results showed that the studied pear varieties have capability to growth in Bucharest area.

In term of tree height we registered insignificant differences between self rooted varieties that could be interpreted as a uniformity of growth of studied cultivars.

In 2011 trunk cross section area showed differences allowing cultivars to be ranked in order of decreasing vigor: "Abbé Fétel", "Conference", "Max Red Bartlett", "Beurré Bosc", "Alexander Lucas" and "Clapp's Favorite". In

2012 the order was "Conference", "Max Red Bartlett", "Abbé Fétel" "Alexander Lucas" and "Clapp's Favorite".

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