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Culture System of Trees Fruit Production Efficiency in Relation to Light as an Output Influencing Factor

Valerian BALAN, Gheorghe CIMPOIES

Faculty of Horticulture, The Agrarian State University of Moldova, MD-2049,
42 Mircesti St., Chisinau, Republic of Moldova; v.balan@uasm.md

Abstract. The training systems in orchards depending on the desired objectives. Along with the parameters of biological, ecological and technological resources that govern the productivity, the orchard, to the extent possible to satisfy more envisaged objectives. Without doubt the scientific value of these objectives will mention their decisive character in the choice of culture. Several objectives have been proposed recently with such an approach. We present here a bibliographical review of some of the elements which constitute the ground of their conception such as potential of biological production, optical system, light utilisation, plant density, and latitude of the locality.

Keywords: geographic latitude, plant density, foliar area, orchard system

INTRODUCTION

By introducing advanced technologies and high economic efficiency in well meet the fruit producers' requirements and interest in culture. A large fruit production can be achieved in favourable conditions of ongoing processes of photosynthesis. One of the main functions of the fruit-growing facility is maximum efficiency of converting solar energy into chemical energy bound in the fruit. That is why the light energy coefficient of conversion of trees at a significant extent determines the performance of orchards.

MATERIAL AND METHODS

The researches for study and development of optimum parameters structure of the fruit plantings of leading sorts of apple (the *Slava peremojtiam, Kalvili snow, Renet Simirenko, Richared Delicious, Winter Banana, Golden Delicious, Mantuaner, Jonathan, Idared, Wagener prize, Starkrimson, Florina, Pinova, Gala Must, King Jonagold, Cempion*), grafted on rootstocks M 4, MM 106, M 26 and M 9 at the Department Fruit growing State Agrarian University of the Moldova, were started since 1973.

The following parameters of the plantings structure were studied in different combination: distance between rows - 3,5; 4,0; 4,5; 5,0; 5,5 m and between trees in a row – 1,2; 2; 2,5; 3,0; 3,5; 4,0; 4,5 m; the width in the crown - 1,0; 1,5; 2,0; 2,5; 3,0 m; the height of the crown - 2,0; 2,5; 3,0; 3,5; 4,0 m. The experiences were repeated three times. The direction of the rows from north to south. The numbers of registered trees in each variant are 24. The trees are formed on type of liberally rising fan-shaped espalier (palmetto), liberally rising spindle of the bush and Slanke spil.

The evidence and estimation of apple tree biological characters were done casing the method of constant research. Accumulation, structure and balance of phytomass were studied at different periods of age.

RESULTS AND DISCUSION

The inquiries made by Jackson (1980), Agafonov (1983), Balan (2003) showed that trees plantations represent imperfect biological systems for an effective use of solar energy. The less densely are the tree planted, the more solar energy is lost and the slower is their pace of growth and land cover. In the case it flatten crowns of the apple harvest in a great quantity of light energy (19%) is lost to till the appearance of leaves. Of the remaining active radiation available to the trees of 498x107 kcal / ha, when planting distances are 4x3, 5 m, 2.5 m crown height and width - 1.5 m, a huge quantity (54%) is not intercepted by foliage. Of incident light radiation over vegetative canopy of 20% is reflected by the foliage outside, 10% is inactive photosynthetic, 20% of radiation crosses all lines of trees due to improper parameters of plantation (Budan and Amzar, 1992). Another criterion that determines the photosynthetic productivity the crown is the light regime inside them. Only the upper and outer parts of a depth of 1-1,2 m have the advantage of light for over 30% of total solar light, which assures the level of production. The leaves of the crown have a low photosynthetic intensity due to light deficiency.

The structuring of simple, natural, well lit crown and planting trees at optimal distance, reduces largely the effect of mutual shading increasing the efficiency of using solar energy (Balan, 1994, 1996, 2004). The crown of lighting changes depending on the geographic latitude and the orientation of lines according to cardinal points. The sunlight in the northern hemisphere during vegetation, gets on the crown at an angle equal to the latitude between 8h-8h 30 a.m. and 15h 30-16h p.m. (Turmanidze, 1981; Agafonov, 1983). That is why the distance between rows will be calculated depending on the angle of incidence of sunlight between 8h 30 a.m. and 15h 30 p.m. This fact shows that the orientation of rows within the meaning of the crown NS in the East is in direct sunlight more than 3 hours in the first half of the day and in the West in the afternoon.

To use the solar energy with maximum efficiency to the surface a number of ways to optimize the relationship between height, crown width and shape, and distance between rows of trees which can adjust light interception and reception have appeared (Odier, 1978; Balan, 2005, 2007). In determining the distance between rows of fruit trees it is necessary to determine the crown height (H), width at the bottom of the crown (B), the angle of inclination of the surface side of the crown from vertical (α) and geographical latitude of the locality (φ) and the values obtained by calculating the distance between lines using the formula:

$$L = H \operatorname{tg} \varphi - H \operatorname{tg} \alpha + B$$

Method described by Balan (1996) allows determination of the distance among the fruit trees in relation to changes in various parameters crown geographic conditions (Tab.1).

Production potential was calculated according to the coefficient of volumetric density of lateral surface of the crown and the coefficient of effectiveness of plantation (Agafonov, 1983). The results showed that value of relative production potential is in the reverse, dependence to the crown size. Thus, the greatest production potential is formed in the plantations were the crown thickness not exceed 2 m.

In plantations with equal thickness of the crown at the basis, the production potential increases gradually at the same time with decreasing of crown height. This is happens because with the decreasing of crown height increase the width at its peak and the rate increases at the last over side of the crown, less illuminated. Thus, with the decreasing of crown height improvers the regime of lighting which can be definitive in the development of productive organs and fructification of trees.

Tab. 1

The optimal productive potential of plantation according to the crown structure on geographic latitude 47°

The distance between rows, cm	Crown height, cm	Angle of inclination of the crown, degrees	Crown width, cm		Level of soil cover,%	Crown area, thousands m^2/ha	Crown volume, thousands m^3/ha	Potential of production, %
			on the basis	at the top				
400	230	12	200	102	50	14300	8682	69,2
400	200	4	200	172	50	14350	9300	78,0
400	190	0	200	200	50	14500	9500	83,0
400	250	12	200	94	50	15150	9187	72,4
450	250	4	200	165	44,4	14820	10137	77,4
465	250	0	200	200	43,0	15050	10750	81,2
400	250	12	200	94	50	15150	9187	72,4
400	250	4	150	115	37,5	16300	8281	77,0
400	250	0	140	140	35,0	16300	8750	82,1
322	200	12	150	65	46,5	14687	6675	76,3
350	200	4	150	122	42,8	14970	7771	83,9
365	200	0	150	150	41,1	15064	8217	87,3
272	200	12	100	15	36,8	15623	4227	73,0
300	200	4	100	72	33,3	15798	5732	83,1
315	200	0	100	100	31,7	15870	6348	87,4

The penetration of light inside the crown of trees is influenced by the orientation of rows of sloping land and location. In orchards with continue crowns best illuminated on plane land are lines oriented to NS direction followed by the interim guidelines such as NW-SE and NE-SW. The land with south location, south-east and south-west receive 2-3 times more light, while the western and eastern 1,2-1,5 times in comparison with northern exposition. Insulation in the south is directly proportional to the degree of slope land, and in the north index is inversely proportional to the size of slopes (Amzar and Manughevici, 1977).

Solar energy use efficiency also depends on the size and spatial location of the foliar surface at the land unity occupied by it. From the research undertaken resulted that in many cases the foliar surface recorded values of 20-30 thousand m^2 / ha (Balan, 1997; Babuc end Croitoru, 2008).

The continuous increase of the foliar area decreases the amount of light inside the crown and at the determination of photosynthetic efficiency (Deviatov, 1989). Although the foliar surface is an important indicator characterizing the production potential of plantations, besides its value of the information about the location of the foliar area and its illumination is important (Cimpoieş, 2000).

For a start decipher of foliar area in fruit trees plantations it is proposed to indicate at the size of Foliar index (Fi) on the line of trees and between rows, is the area covered (F_1) and uncovered (F_2) of all vegetative projection. For example, the expressions Fi = 2, F1=4, F_2 = 0 show that the plantation Foliar index is equal to 2, the area covered is 4 and 0 for the surface not covered by the projection of crowns. Although the index of foliar plantation is optimal, the foliage is not uniformly located within the orchard. So photosynthetic productivity of trees depends on the distribution of active foliar surface that receive light energy, and at the unit of land, crop quantity and quality is directly correlated with to the foliar surface performed on this unit.

The light through the canopy may be endlessly changed in an orchard to intercept the light radiation absorbed actively photo synthetically. From research undertaken to use and

light interception in orchards were separated different ways of optimizing the relationship between the recovery area of nutrition, production volume and the crown area of all lateral vegetative which can adjust production potential of fruit growing plantations. It was established that the parameters of all vegetative plantings in full production and the internal structure of the canopy must allow the interception of at least 70% of incident light radiation. The best coverage of the soil with the projection of the canopy trees is in full production proved to be 65-70% of the total area (Stefan et al, 1983; Babuc, 1985). Using solar energy and land in orchards in time achieved by the evolution of the crown geometric structure is an essential objective in determining the distance of planting, size and internal structure of the crown.

The utilization of solar energy carried out by a canopy parameters major indicator, usually considered characteristic for each culture system. From the research conducted at the Institute of Piteşti fruit-growing the result that if the iron crowns apple, apple production is 41.7 - 56.3 t / ha and the rate of conversion of light energy into chemical energy incorporated in fruit 1,69 - 2,92%. Analyzing the presented data in that case height of 2.5 m width and 1.5 m a canopy have been the highest values of agroproductivity (56.3 t / ha) and the coefficient of conversion into radiation of fruit biomass available (0.92%) and lowest values in a height of 2.5 m width and 0.75 m a crown (Budan and Amzar, 1992).

Although the rate of conversion into chemical energy incorporated in fruit (2.92%) compared to radiation is absorbed mostly in the case with the height of 2.5 m and width 0.75 m, canopy uses very low (0.65%) radiation available. So trees behind cuts should not be exaggerated dimensions, nor fall below a certain limit. As a result, the photosynthetic productivity of the canopy is in line with the foliar active obtaining light energy and dynamics of leaf area formation in the ontogenesis and trees during the growing season is correlated with the intensity of shoot growth and leaf rosettes.

The maximum foliar area where trees of moderate growth and leaf formation, mainly on the rosettes, was reached in the second half of June and, if more severe shortening of the industries highest foliar mainly shoot was obtained in October (Palmer, 1988).

The research undertaken has led to the conclusion that the leaf that falls from a tree changes depending on the phenophase of the vegetation, age and productivity of trees (Table 2). During the growing majority of leaf area, 2.1 m^2/tree (64.42%), is formed on the shoot and only 1.16 m^2/tree (35.58%) - a pinch, spears and scholarships. In the following period the age of the trees of leaves on a tree below the values recorded on shoot and higher pinch, spears and scholarships. Thus in the fruit-bearing trees of the leaf on the twig is 20.74% (6.2 m^2/tree), and branches of fruit - 79.26% (23.7 m^2/tree).

So, two plantations characterized by the same amount of foliar surface will not have the same agronomic performance if this value is reached in phenophase different vegetation. If prevailing formation of rosettes on the foliar surface will reach maximum values in June, the age is going floral induction. So, the necessity to form an early foliar surface cutting through the trees balanced.

Tab. 2

Evolution of the development area on foliar shoot rosettes and the variety of *Golden Delicious* apple, grafted on rootstock M4. (Planting distance of 5 x 3 m)

Nr crt	Specification	Units of measurement	Period age of trees			
			Growth	Growth and fruit-bearing	Fruit-bearing and growth	Fruit-bearing
1	Foliar area on the annual tree branches	m^2/tree	2,10	10,92	7,95	6,20
2	Share foliar area on the annual tree branches	%	64,42	51,95	30,69	20,74
3	Foliar surface of rosettes	m^2/tree	1,16	10,1	17,95	23,7
4	Share rosettes of foliar area per tree	%	35,58	41,95	69,31	79,26
5	Foliar area per tree	m^2/tree	3,26	21,02	25,9	29,9

CONCLUSIONS

The subject on the culture is enough controversial in literature and in fruit-growing practice. That is why, it is necessary that of the study basis to establish a direct link between the methods, technology and the biological material used for the purpose of expressing an optimum potential of biological production.

In determining the distance between rows of fruit trees it is necessary to determine the crown height (H), width at the bottom of the crown (B), the angle of inclination of the surface side of the crown from vertical (α) and geographical latitude of the locality (φ) and the values obtained by calculating the distance between lines using the formula:

$$L = H \operatorname{tg} \varphi - H \operatorname{tg} \alpha + B$$

The calculations showed that the value of the potential production of the canopy, calculated according to the coefficient of volumetric density of lateral surface of the crown (Agafonov, 1983), gradually increases with decreasing crown height. This is ripening because with decreasing crown height increased width at its peak and the rate increases last over the side of the crown, less illuminated. So there fore once, with the decreasing height crown, it improves the lighting that can be characteristic in the development of productive trees and fructification.

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