Training on technological aspects of walnut cultivation

Tbilisi, Georgia, October 2019

Agenda

01

Before the beginning of the walnut orchard planting

The technical project for planting authorization. The soil analysis. Planting scheme.The water source for irrigation.

02

The planting preparations

Soil preparation. Deep soil aeration. Mycorryzae and other microorganisms.
Checking the healty of walnut roots. The hydratation of walnut trees before planting.

03

Pruning of the lateral bearing walnut varieties

The principles of the pruning of the lateral bearing walnut trees.

04

Succes stories and the failure of some european walnut orchards

Before the beginning of the walnut orchard planting

The technical project for planting authorization is mandatory in the EU for all new orchards larger than 2 hectares

The Main Chapters:

The soil analysis and agrochemical composition.

Recomended species and varieties.

The type of the new orchard: conventional, ecological or integrated system?

The technology used for planting , pruning and phytosanitary treatments

Planting scheme.

The water source for irrigation.

The schedule of the planting works

Fertilizers consumption for biomass production (wood, leafs and fruits)

(I. Kiss, 2017, after Epstein 1972, cited by DAVID & VELICICA DAVIDESCU, 1981)

Production	*Dry matter -tons*	*1 to*	*2 to*	*3 to*	*4 To*	*5 to*	*6 to*	*7 to*	*8 to*	*9 to*	*10 to*
Active substance	**Content kg/ D M**	**kg**	**kg**	**kg**	**kg**	**kg**	**kg**	**kg**	**kg**	**kg**	**kg**
Molibden	0,0000001	0,0001	0,0002	0,0003	0,0004	0,0005	0,0006	0,0007	0,0008	0,0009	0,001
Coper	0,0000060	0,006	0,012	0,018	0,024	0,03	0,036	0,042	0,048	0,054	0,06
Zinc	0,0000200	0,02	0,04	0,06	0,08	0,1	0,12	0,14	0,16	0,18	0,2
Manganese	0,0000500	0,05	0,1	0,15	0,2	0,25	0,3	0,35	0,4	0,45	0,5
Boron	0,0000200	0,02	0,04	0,06	0,08	0,1	0,12	0,14	0,16	0,18	0,2
Iron	0,0001000	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1
Chlorine	0,0001000	0,1	0,2	0,3	0,4	0,5	0,6	0,7	0,8	0,9	1
Sulfur	0,0010000	1	2	3	4	5	6	7	8	9	10
Phosphorus	0,0020000	2	4	6	8	10	12	14	16	18	20
Magnesium	0,0020000	2	4	6	8	10	12	14	16	18	20
Calcium	0,0050000	5	10	15	20	25	30	35	40	45	50
Potassium	0,0100000	10	20	30	40	50	60	70	80	90	100
Azote	0,0150000	15	30	45	60	75	90	105	120	135	150
Oxygen	0,4500000	450	900	1350	1800	2250	2700	3150	3600	4050	4500
Carbon	0,4500000	450	900	1350	1800	2250	2700	3150	3600	4050	4500
Hydrogen	0,0600000	60	120	180	240	300	360	420	480	540	600

Q: How will calculate the necessary of the fertilizers related with the soil composition?
A: Step 1: Calculate the content of the first 60 cm of soil in macro and micro elements
Step 2: Calculate the biomass quantity desired to be produced by the orchard.
Step 3: Compare the results of soil content substances with the values included in the previous table for biomass desired production. If the calculated chemical content of soil is lower than the consuption of fertilizers to produce the desired biomass quantity in the orchard, we need to apply fertilizers substances.

The soil profile . Chile , 2017
Sand, stones and volcanic ash (30%)

When is the first crop of the walnut orchard?

- After how many years?
- **After a wrong question is possible just the next answer: depend on trunk cross sectional area (TCSA**) of the walnut trees! Under 150 square centimeters of the TCSA, we can't talk about commercial yields of the walnut orchards.

- The TCSA will be calculated following measuring the trunk circumferences circa 30 centimeters above the bottom of the crown.

Important!

The TCSA can grow at 150 square centimeters in 3 years after planting or in 10 years or in 20 years, depending on availability of the irrigation and fertilizers for the nutrition of the walnut trees!

Ups... Sometime is good to remember the water and fertilizers! ☺

How will choose the planting distances?

... using the *ti* coefficients for production based on trunk cross sectional area and planting distance, determined by Hassani et all, 2013.

	Coefficients *(ti)*								
	Planting space (m^2) devoted to each walnut tree								
TCSA (cm^2)	<9	9-25	25-64	64-122	122-169	169-225	225-289	289-324	>324
>5100	0,010	0,072	0,148	0,316	0,624	1,038	1,198	1,223	1,297
5100-4101	0,024	0,099	0,204	0,557	0,993	1,216	1,315	1,359	1,359
4100-3201	0,048	0,136	0,281	0,886	1,163	1,335	1,461	1,461	1,461
3200-2501	0,096	0,188	0,387	1,038	1,276	1,483	1,483	1,483	1,483
2500-1801	0,192	0,259	0,534	1,139	1,418	1,418	1,418	1,418	1,418
1800-1201	0,277	0,357	0,737	1,266	1,266	1,266	1,266	1,266	1,266
1200-701	0,349	0,493	1,016	1,016	1,016	1,016	1,016	1,016	1,016
700-351	0,421	0,680	0,680	0,680	0,680	0,680	0,680	0,680	0,680
350-150	0,481	0,481	0,481	0,481	0,481	0,481	0,481	0,481	0,481
<150	0	0	0	0	0	0	0	0	0

Diameter of the trunk (cm)	14	22	30	40	48	56	64	72	80	88
TCSA (cm^2)	153,86	379,94	706,5	1256	1808,64	2461,76	3215,36	4069,44	5024	6079,04

With other words....

... The planting distance between the walnut trees and rows isn't a real problem until the value of *ti* coefficient decrease to the next value. Then is the moment when is necessary to reduce the number of walnut trees /hectare!

Q: How many walnut trees can be planted/hectare in a commercial walnut orchard?
A: Minimum 156 trees (8 x 8 m), Maximum 2272 trees (4 m x 1.1m)

Q: How to decrease/ to modify the number of trees/hectare?
A: Remove the trees from the walnut orchard.
Example: From 4 m x 1.1 m, when the diameter of trunk is 30 cm(or TCSA is 700 square centimeters) the next distances can be 4 m x 2.2 m (ratio 1:2) or 4m x 3,3 m (ratio 2:3). After that the next modify of distance between the trees can be done when the diameter of trunk is 40 cm(or TCSA is 1200 square centimeters), from 4 m x2.2m (1136 trees/ha) to 8 m x 4,4 m (284 trees/ha)

Experimental field, Chile, 2017
Planting distances: 4 m x 1.1 m= 2272 trees/ha

Young walnut orchard prepared for the 3rd winter, China, 2012
Planting distances: 4 m x 2 m= 1250 trees/ha

Commercial walnut orchard, Chile 2017
7 m x 3.5 m, Chandler

Hyper-intensive walnut orchard, Chile ,2017,
Chandler, 4 m x 2 m 1250 trees/ha, yr.4

Hyper-intensive walnut orchard, Chile, 2013,
9 tons/hectare from 6th year

Q: Can we estimate the potential tree/orchard yield?
A: Yes, using the model for estimation of nuts per tree based on characteristics which cold be evaluated in the dormant period . The matematichal formula of this model is:

TY=TCSA(ti(1+pr)(1+(db+ci+om))w)

Where
TY= Prediction of potential tree yield= the number of fruits/tree
TCSA = our old friend (trunk cross-sectional area)
ti = is a coefficient for production based on TCSA and planting distance
pr = a coefficient for type of bearing and growing habit
db = a coefficient related to the observed rateof dried shots inside canopy of walnut tree
ci = the density of fruiting shots inside of canopy in relation with TCSA
om = is a coefficient related to annual growt and orchard management
w = is a coefficient related to soiland water status in walnut tree

	Coefficients *(ti)*								
	Planting space (m²) devoted to each walnut tree								
TCSA (cm²)	<9	9-25	25-64	64-122	122-169	169-225	225-289	289-324	>324
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3200-2501	0,096	0,188	0,387	1,038	1,276	1,483	1,483	1,483	1,483
2500-1801	0,192	0,259	0,534	1,139	1,418	1,418	1,418	1,418	1,418
1800-1201	0,277	0,357	0,737	1,266	1,266	1,266	1,266	1,266	1,266
1200-701	0,349	0,493	1,016	1,016	1,016	1,016	1,016	1,016	1,016
700-351	0,421	0,680	0,680	0,680	0,680	0,680	0,680	0,680	0,680
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<150	0	0	0	0	0	0	0	0	0

Diameter of the trunk (cm)	14	22	30	40	48	56	64	72	80	88
TCSA (cm²)	153,86	379,94	706,5	1256	1808,64	2461,76	3215,36	4069,44	5024	6079,04

$$TY=TCSA(ti(1+pr)(1+(db+ci+om))w)$$

pr = The coefficient for type of bearing and growing habit

	Coefficients (pr)				
	Bearing type				
		A few or less than 50% of terminal buds	Terminal bearing	Intermediate	Lateral bearing
Growing habit	Rank	1	2	3	4
Upright	1	-0,72	-0,34	0,03	0,41
Intermediate	2	-0,66	-0,22	0,22	0,66
Spreading	3	-0,59	-0,09	0,41	0,91

TY=TCSA(ti(1+pr)(1+(db+ci+om))w)

db = The coefficient related to the observed rateof dried shots inside canopy of walnut tree

Coefficients related to the observed of dried shoots inside the canopy of walnut tree		
Dry shoots in canopy	Rank	Coefficient (db)
High (>50%)	1	-0,32
Intermediate (10 - 50%	2	-0,07
low (under 10%)	3	0,38

TY=TCSA(ti(1+pr)(1+(db+ci+om))w)

ci = The density of fruiting shots inside of canopy in relation with TCSA

TCSA	Rank	Coefficients (ci) Density of fruiting shots: No or a few percent (<20% respect to outside) of shoots inside canopy	Intermediate percent (20-50% respect to outside) of shoots inside of canopy	High percent (>50% respect to outside) of shoots inside canopy
>5100	9	-0,47	-0,18	0,29
5100-4101	8	-0,46	-0,17	0,29
4100-3201	7	-0,44	-0,16	0,29
3200-2501	6	-0,42	-0,14	0,29
2500-1801	5	-0,38	-0,12	0,30
1800-1201	4	-0,33	-0,08	0,30
1200-701	3	-0,20	0,00	0,31
700-351	2	-0,03	0,11	0,33
350-150	1	-0,03	0,11	0,33
<150	0	0,12	0,21	0,35

TY=TCSA(ti(1+pr)(1+(db+ci+om))w)

om = The coefficient related to annual growt and orchard management

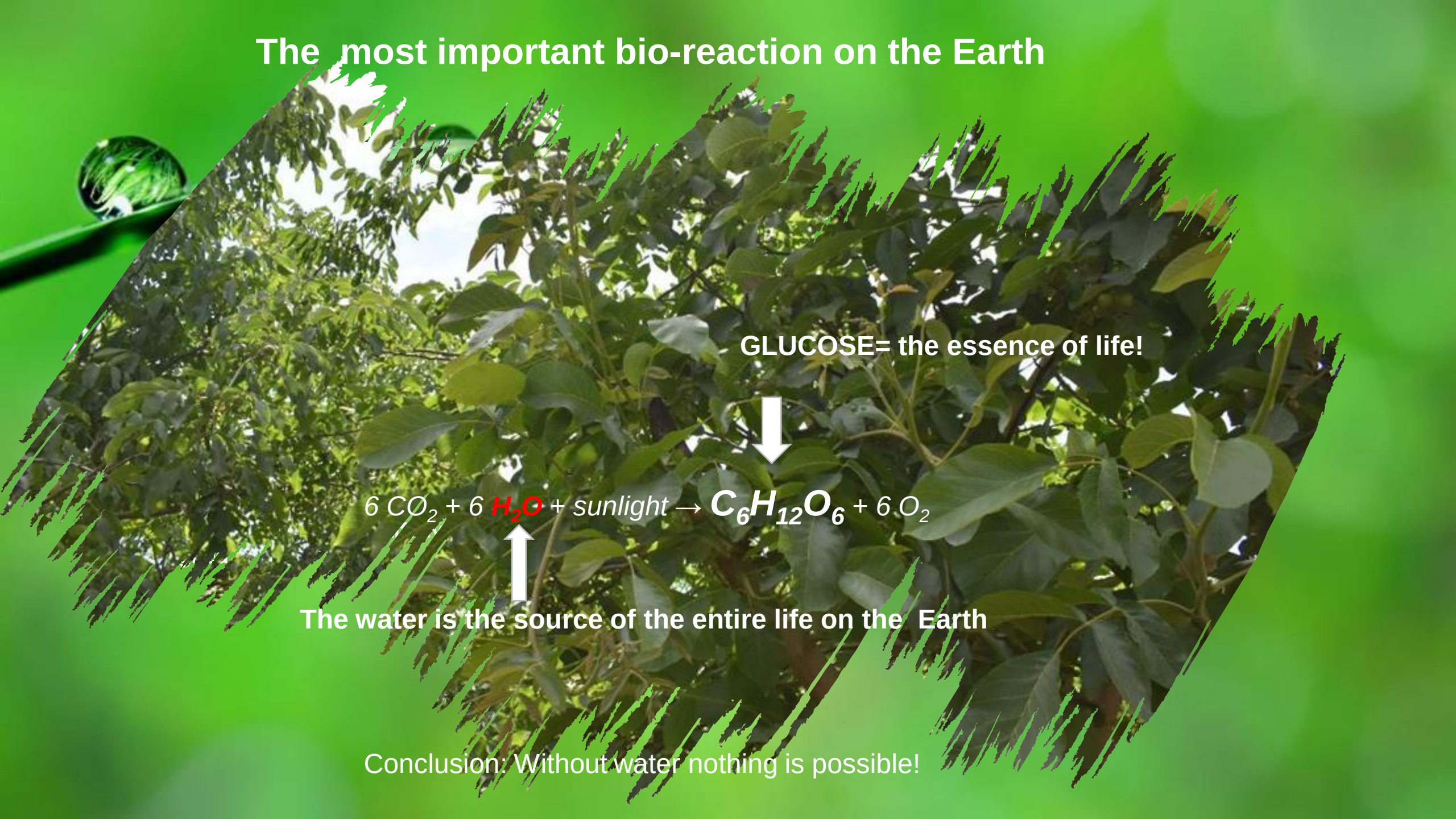
Orchard Management	Coefficients (om)		
	Annual growth of shoots		
		Undesirable	Desirable
	Rang	1	2
Undesirable	1	-0,2375	-0,0875
Desirable	2	0,0625	0,2625

w = The coefficient related to soil and water status in walnut tree

Water limitation	Coefficients (w)		
	Soil Status		
		Undesirable	Desirable
	Rank	1	2
More frequent water deficit	1	0,07	0,1
Frequent water deficit	2	0,21	0,3
Somewhat water deficit	3	0,53	0,75
No water deficit	4	0,7	1

TY=TCSA(ti(1+pr)(1+(db+ci+om))W)

The most important bio-reaction on the Earth



GLUCOSE= the essence of life!

$$6\,CO_2 + 6\,H_2O + sunlight \rightarrow C_6H_{12}O_6 + 6\,O_2$$

The water is the source of the entire life on the Earth

Conclusion: Without water nothing is possible!

Evaluating potential yield of the young lateral bearing walnut orchard– The worst scenario without irrigation system, water deficit and undesirable orchard management

TY=TCSA(ti(1+pr)(1+(db+ci+om))w)

Where
TY= Prediction of potential tree yield= the number of fruits/tree
TCSA = our old friend (trunk cross-sectional area)= 350 cm^2
ti = The coefficient for production based on TCSA and planting distance = 0.481 (5 m x 2 m= 1000 trees/ha)
pr = The coefficient for type of bearing and growing habit= 0.91
db = The coefficient related to the observed rateof dried shots inside canopy of walnut tree= 0.38 (low dry shoots rate in canopy)
ci = the density of fruiting shots inside of canopy in relation with TCSA= 0.33 (High percent (>50% respect to outside) of shoots inside canopy)
om = the coefficient related to annual growt and orchard management = -0.2375
w = the coefficient related to soil -and water status in walnut tree= 0.21

Prediction of potential number of walnuts/tree (TY)	
Coefficients	**Value**
TCSA (cm^2)	150,0375
ti coefficient	0,4810
pr coefficient	0,9100
db coefficient	0,3800
ci coefficient	0,3300
om coefficient	-0,2375
w coefficient	0,2100

Calculated TY	gr/fruit	Prognosed Yield/tree kg	Prognosed Yield/ha kg
43	10	0,426	426,239
43	11	0,469	468,863
43	12	0,511	511,487
43	13	0,554	554,110
43	14	0,597	596,734

Evaluating potential yield of the young lateral bearing walnut orchard– The best scenario, with irrigation system, no water deficit and desirable orchard management

TY=TCSA(ti(1+pr)(1+(db+ci+om))w)

Where
TY= Prediction of potential tree yield= the number of fruits/tree
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ci = the density of fruiting shots inside of canopy in relation with TCSA= 0.33 (High percent (>50% respect to outside) of shoots inside canopy)
om = the coefficient related to annual growt and orchard management = 0.2625
w = the coefficient related to soil -and water status in walnut tree= 1

Prediction of potential number of walnuts/tree (TY)	
Coefficients	**Value**
TCSA (cm^2)	150,0375
ti coefficient	0,4810
pr coefficient	0,9100
db coefficient	0,3800
ci coefficient	0,3300
om coefficient	0,2625
w coefficient	1,0000

Calculated TY	gr/fruit	Prognosed Yield/tree kg	Prognosed Yield/ha kg
272	10	2,719	2718,914
272	11	2,991	2990,805
272	12	3,263	3262,696
272	13	3,535	3534,588
272	14	3,806	3806,479

Comparison between the worst and the best scenarios

Prediction of potential number of walnuts/tree (TY)	
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272	14	3,806	3806,479

Conclusion: The orchard management and the soil and water status can do the diference between profit and loses. What can we do about this things? The LEARNING must be the main our activity!

The same comparison between the worst and the best scenarios in different planting scheme

Prediction of potential number of walnuts/tree (TY)	
Coefficients	**Value**
TCSA (cm²)	150,0375
ti coefficient	0,4810
pr coefficient	0,9100
db coefficient	0,3800
ci coefficient	0,3300
om coefficient	-0,2375
w coefficient	0,2100

			156 trees/ha	312 trees/ha	408 trees/ha	1000 trees/ha
Calculated TY	gr/fruit	Prognosed Yield/tree kg	Prognosed Yield/ha kg	Prognosed Yield/ha kg	Prognosed Yield/ha kg	Prognosed Yield/ha kg
43	10	0,426	66,493	132,987	173,905	426,239
43	11	0,469	73,143	146,285	191,296	468,863
43	12	0,511	79,792	159,584	208,687	511,487
43	13	0,554	86,441	172,882	226,077	554,110
43	14	0,597	93,091	186,181	243,468	596,734
43	15	0,639	99,740	199,480	260,858	639,358
43	16	0,682	106,389	212,778	278,249	681,982
43	17	0,725	113,039	226,077	295,639	724,606

Prediction of potential number of walnuts/tree (TY)	
Coefficients	**Value**
TCSA (cm²)	150,0375
ti coefficient	0,4810
pr coefficient	0,9100
db coefficient	0,3800
ci coefficient	0,3300
om coefficient	0,2625
w coefficient	1,0000

			156 trees/ha	312 trees/ha	408 trees/ha	1000 trees/ha
Calculated TY	gr/fruit	Prognosed Yield/tree kg	Prognosed Yield/ha kg	Prognosed Yield/ha kg	Prognosed Yield/ha kg	Prognosed Yield/ha kg
272	10	2,719	424,151	848,301	1109,317	2718,914
272	11	2,991	466,566	933,131	1220,248	2990,805
272	12	3,263	508,981	1017,961	1331,180	3262,696
272	13	3,535	551,396	1102,791	1442,112	3534,588
272	14	3,806	593,811	1187,621	1553,043	3806,479
272	15	4,078	636,226	1272,452	1663,975	4078,370
272	16	4,350	678,641	1357,282	1774,907	4350,262
272	17	4,622	721,056	1442,112	1885,838	4622,153

Conclusion: The orchard management and the soil and water status can do the diference between profit and loses. What can we do about this things? The LEARNING must be the main our activity!

Now, let's work! ☺