Gimnazija Petra Preradovića Virovitica

Comparison of the amount of absorbed CO_2 in old and young lime trees

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Project „5 do 12 za Dvorac”

- Old trees were cut down and new ones were planted.
- Historically significant trees that are over 200 years old, but were not suffering disease or tree rot were preserved.

Lime (*Tilia cordata*)

- deciduous tree with a wide and regular crown
- heart-shaped leaves, yellow and bisexual flowers

Photosynthesis

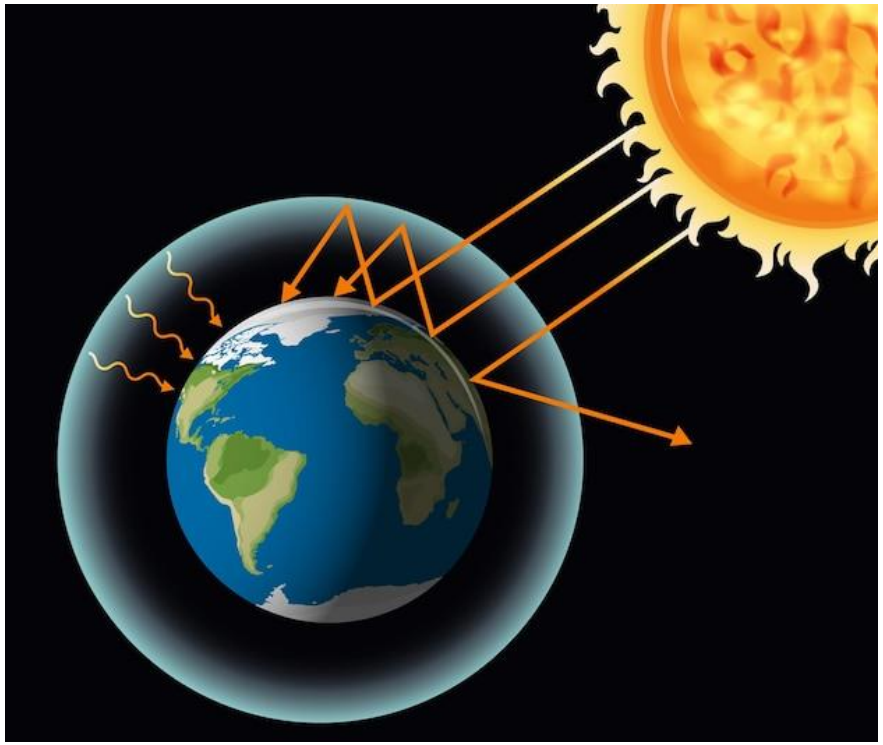
- carried out by photoautotrophic organisms (algae, cyanobacteria, plants)
- takes place in chloroplasts

THE GREATER THE GREEN BIOMASS OF THE LIME, THE GREATER THE INTENSITY OF PHOTOSYNTHESIS

Food chain

lime → firebug → sparrow

Global warming



schematic representation of the greenhouse effect

combustion of fossil fuels in factories

Research questions

Is there a measurable increase in the biomass of old and young lime trees during six months?

Which trees, young or old, absorb more **CO_2** over six months?

Is there and how large is the difference in the percentage increase of absorbed **CO_2** in old and young lime trees during six months?

Hypotheses

1

Both old and young lime trees will have a measurable increase in biomass after six months.

2

Old lime trees will absorb a larger amount of **CO_2** during six months.

3

Young lime trees will have a higher percentage increase in absorbed **CO_2** during six months.

Research methods

- select lime trees
- measure the height and diameter of the limes
- make calculations
- display data graphically

Making calculations

$$t = \tan\alpha \cdot d + o$$

t – tree height [m]
α – elevation angle
d – distance from the tree [m]
h – observers height [cm]

$$d = \frac{O}{\pi}$$

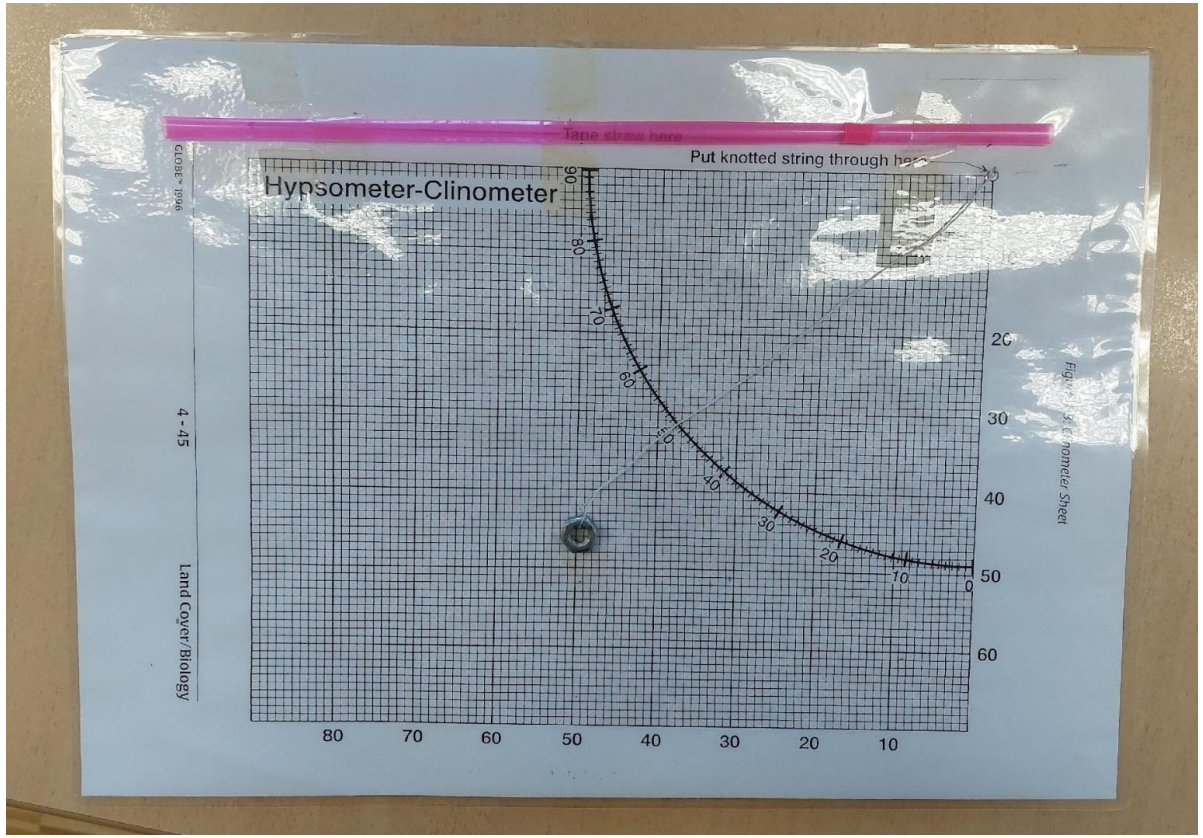
d – diameter [cm]
O – circumference [cm]

$$GW = a \cdot d \cdot t$$

a = 0,0346 (if d > 28 cm)
a = 0,0577 (if d < 28 cm)
GW – green weight / green biomass [kg]
d – diameter [cm]
t – tree height [m]

$$DW = \frac{GW}{2}$$

DW – dry tree weight [kg]



$$C = \frac{DW}{2}$$

C – amount of stored carbon [kg]

$$aps\ CO_2 = C \cdot \frac{Mr\,(CO_2)}{Ar\,(C)}$$

$aps\ CO_2$ – absorbed CO_2 [kg]

Using GLOBE protocols

Values of height, circumference, diameter, biomass, dry tree mass, amount of absorbed carbon and amount of absorbed CO_2 measured in December 2021 for young trees

Measurments completed in December 2021							
Lime number	Height / m	Circumference/ cm	Diameter/cm	Biomass/kg	Dry tree mass/kg	Amount of stored carbon/kg	Apsorbed CO_2/kg
m6	5.7	42	13.4	59.0	29.5	14.8	54.2
m1	5.7	43	13.7	61.9	30.9	15.5	56.8
m5	5.5	43.8	13.9	62.0	31.0	15.5	56.9
m8	5.4	47	14.9	70.1	35.0	17.5	64.3
m3	5.7	46	14.6	70.8	35.4	17.7	65.0
m2	5.6	46.5	14.8	71.1	35.5	17.8	65.2
m4	6.0	46	14.6	73.4	36.7	18.4	67.3
m10	5.1	50	15.9	74.9	37.5	18.7	68.7
m9	5.7	53	16.8	94.0	47.0	23.5	86.2
m7	5.5	58	18.4	108.7	54.3	27.2	99.7

Values of height,circumference, diameter, biomass,dry tree mass, amount of absorbed carbon and amount of absorbed CO_2 measured in June 2022 for young trees

Measurments completed in June 2022							
Lime number	Height / m	Circumference/ cm	Diameter/cm	Biomass/kg	Dry tree mass/kg	Amount of stored carbon/kg	Apsorbed CO_2/kg
m6	7.3	46.7	14.8	92.8	46.4	23.2	85.2
m1	7.8	45.6	14.5	94.0	47.0	23.5	86.2
m5	6.8	46.9	14.9	87.2	43.6	21.8	80.0
m8	7.3	48.5	15.4	100.1	50.1	25.0	91.9
m3	7.5	50.5	16.1	111.5	55.8	27.9	102.3
m2	7.0	49.5	15.7	100.6	50.3	25.1	92.3
m4	6.8	50.1	15.9	99.5	49.8	24.9	91.3
m10	5.7	51.9	16.5	89.5	44.8	22.4	82.1
m9	6.0	55.7	17.7	107.7	53.8	26.9	98.8
m7	6.8	59.5	18.9	140.4	70.2	35.1	128.8

Values of height,circumference, diameter, biomass,dry tree mass, amount of absorbed carbon and amount of absorbed CO_2 measured in December 2021 for old trees

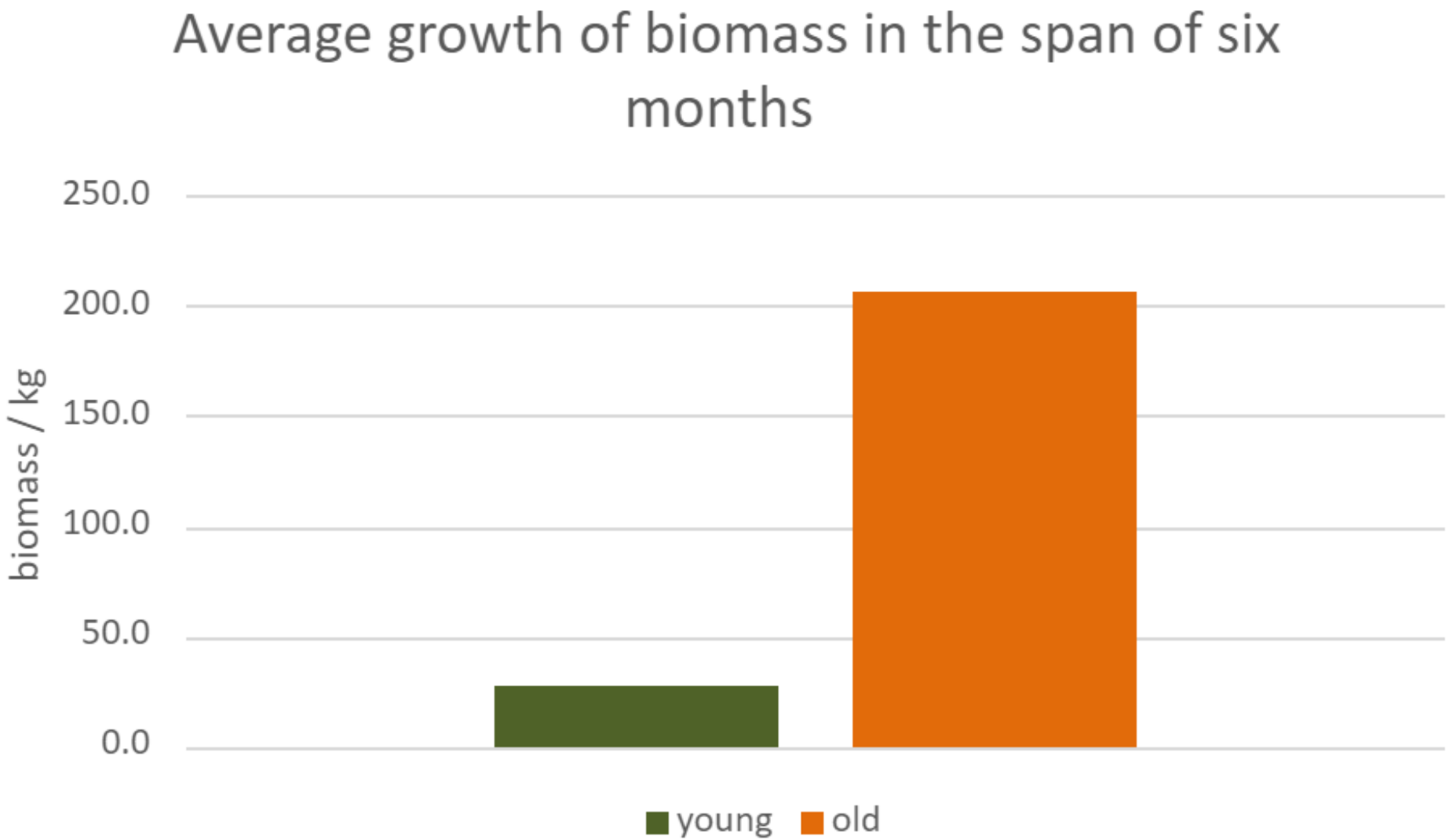
Measurments completed in December 2021							
Lime number	Height / m	Circumference/ cm	Diameter/cm	Biomass/kg	Dry tree mass/kg	Amount of stored carbon/kg	Apsorbed CO_2/kg
v4	23.3	140	45	1597	798	399	1465
v9	27.5	129.5	41	1612	806	403	1479
v5	23.3	147.1	47	1763	881	441	1617
v6	24.1	147	47	1821	910	455	1670
v7	22.3	155.2	49	1878	939	469	1723
v8	23.3	169	54	2327	1163	582	2135
v2	24.1	173	55	2522	1261	630	2314
v3	31.4	177.2	56	3447	1723	862	3163
v10	38.3	226.3	72	6857	3429	1714	6291
v1	27.5	286	91	7864	3932	1966	7215

Values of height,circumference, diameter, biomass,dry tree mass, amount of absorbed carbon and amount of absorbed CO_2 measured in June 2022 for old trees

Measurments completed in June 2022							
Lime number	Height / m	Circumference/ cm	Diameter/cm	Biomass/kg	Dry tree mass/kg	Amount of stored carbon/kg	Apsorbed CO_2/kg
v4	24.1	140.3	45	1658	829	415	1522
v9	29.4	130.5	41	1750	875	438	1606
v5	24.3	147.8	47	1856	928	464	1703
v6	24.9	147.4	47	1891	946	473	1735
v7	24.7	156.5	50	2115	1057	529	1940
v8	25.9	169.1	54	2589	1295	647	2376
v2	24.6	173	55	2574	1287	643	2362
v3	32.5	177.8	57	3592	1796	898	3296
v10	41.5	227	72	7476	3738	1869	6859
v1	28.6	287.3	91	8253	4127	2063	7572

Comparison in the amount of absorbed CO_2 in old and young lime trees

GLOBE, 2024.



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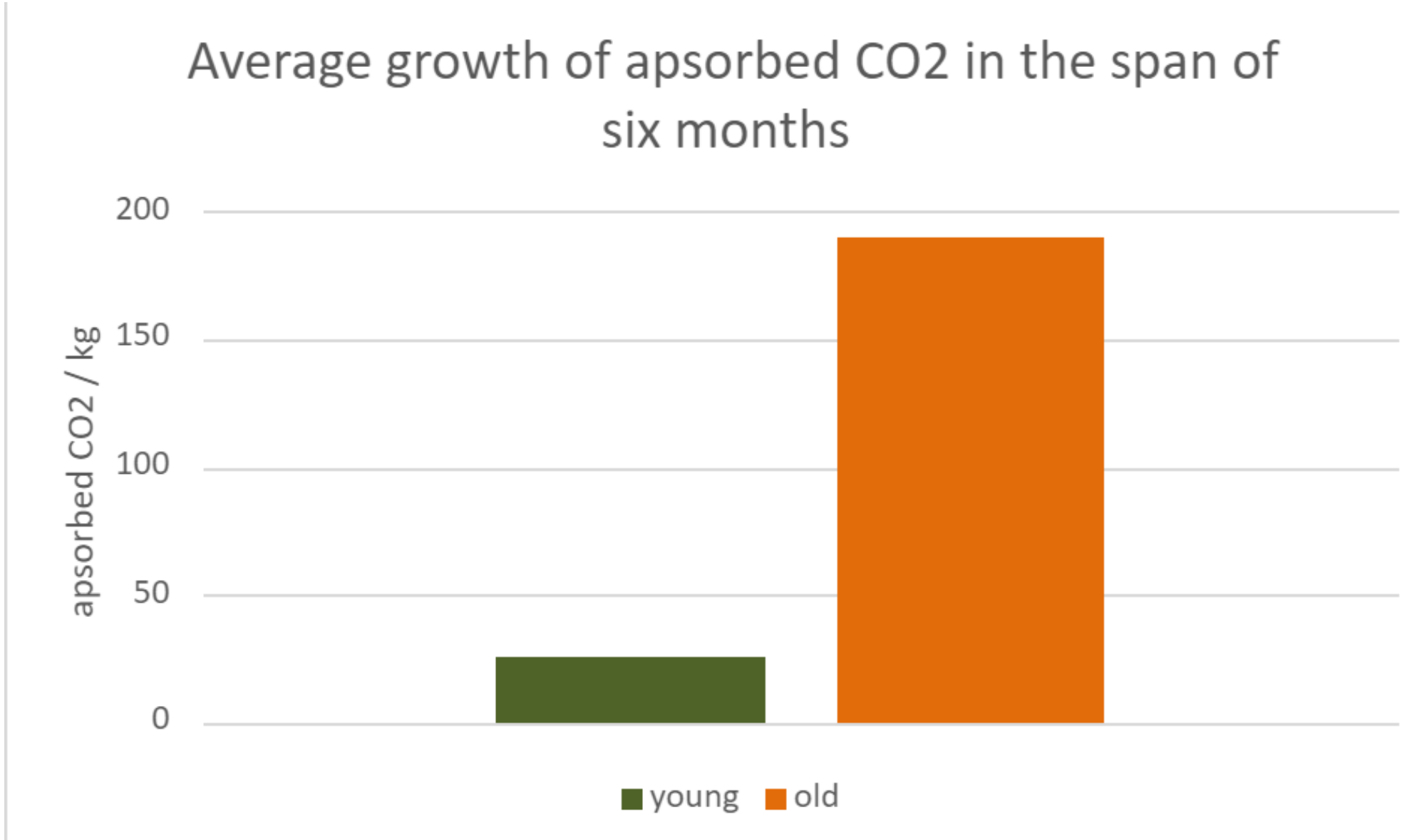

Percentage increase in amount of absorbed CO_2 during the span of six months

1. Calculate the average amount of absorbed CO_2 in ten observed trees at the beginning.
2. Calculate the average amount of absorbed CO_2 after six months.
3. Substract the first value from the second one to get the average growth of absorbed CO_2.
4. Divide the difference by the value in the beginning to see how much the amount of absorbed CO_2 changed in relation to the first value.

$$\%\,(aps\ CO_2) = \frac{\overline{aps\ CO_2\,(_{end})} - \overline{aps\ CO_2\,(_{beginning})}}{aps\ CO_2\,(_{beginning})}$$

Comparison in the amount of absorbed CO_2 in old and young lime trees

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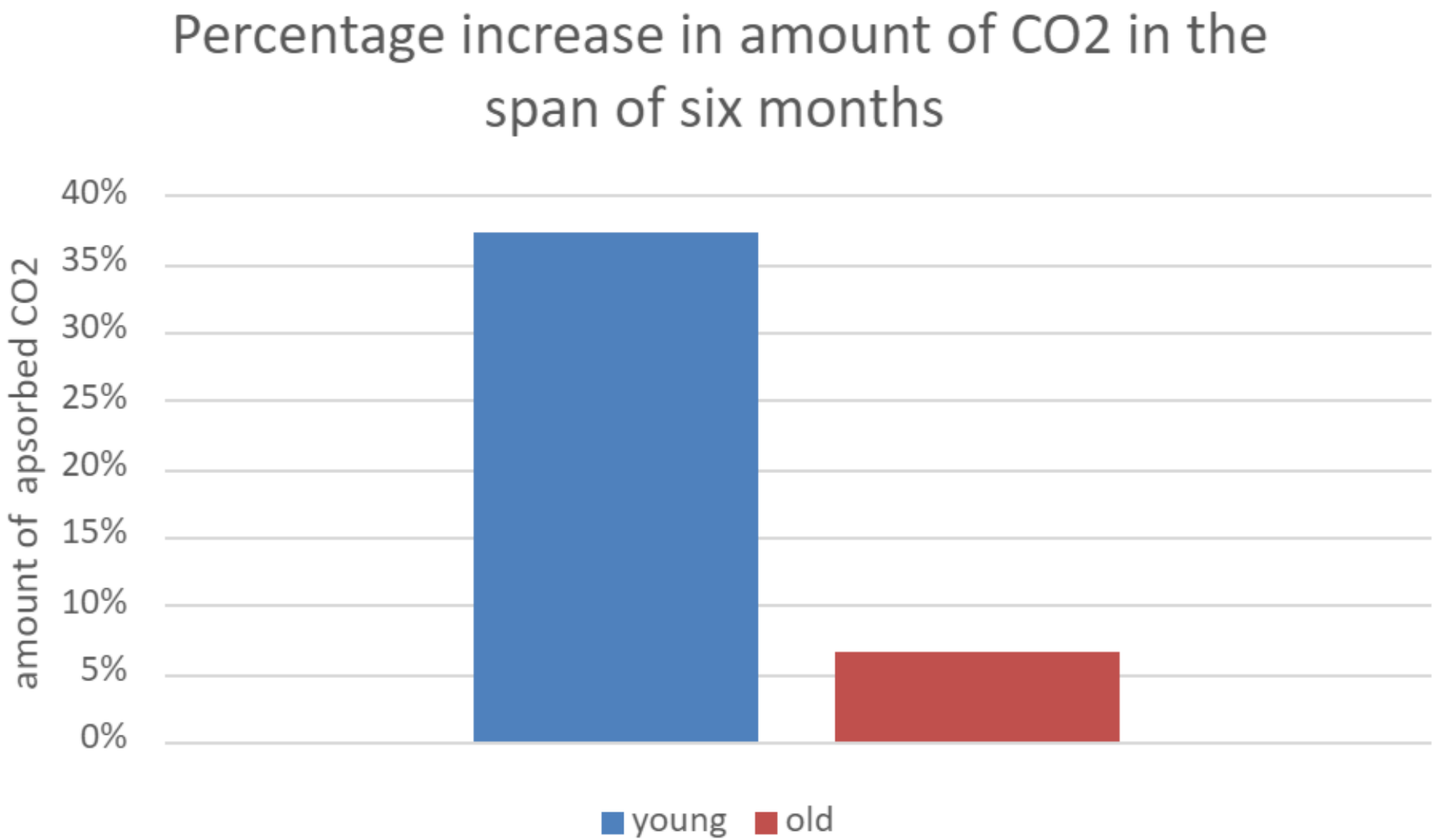
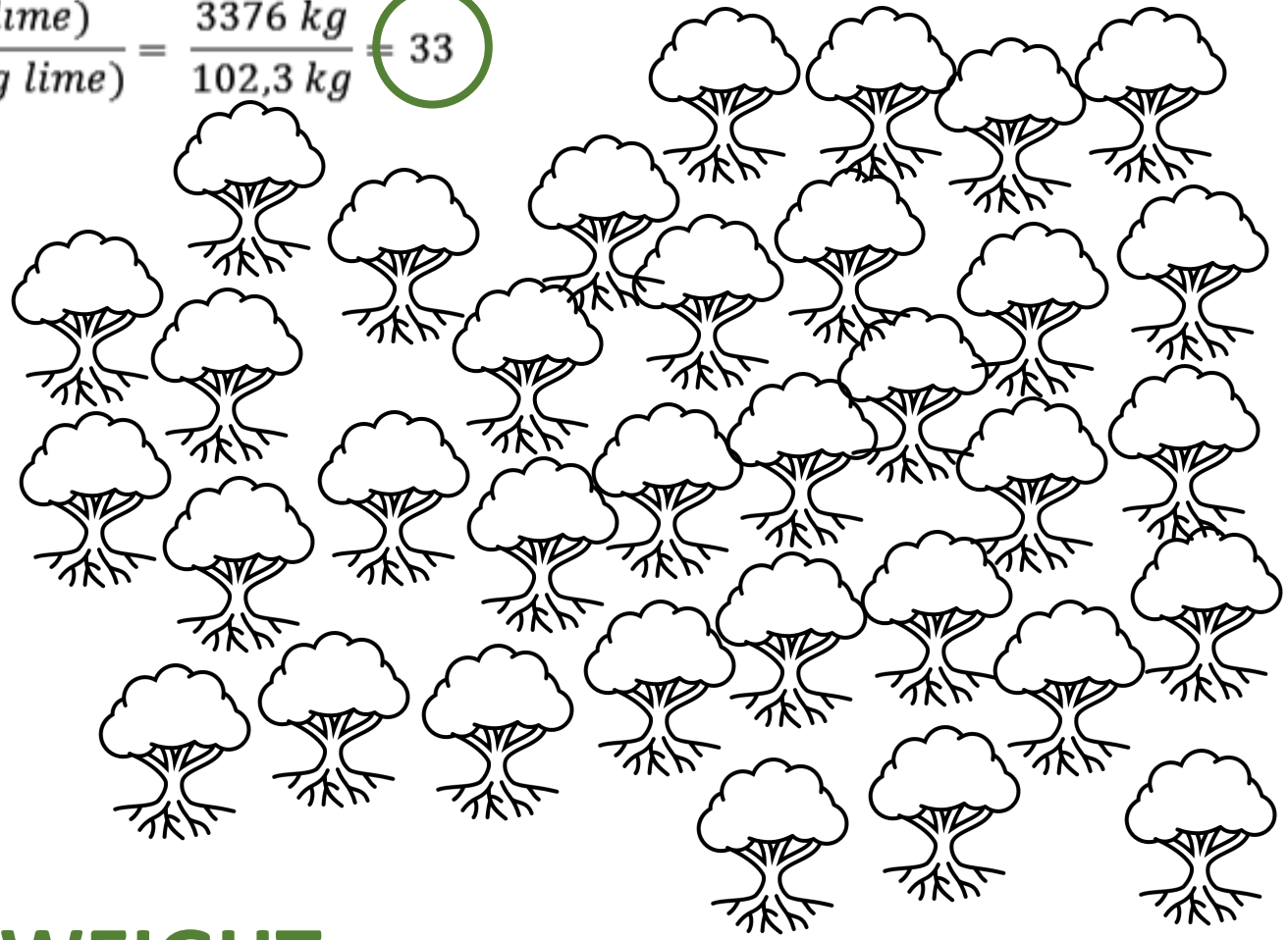


- How many young lime trees have the same biomass as an old lime tree?

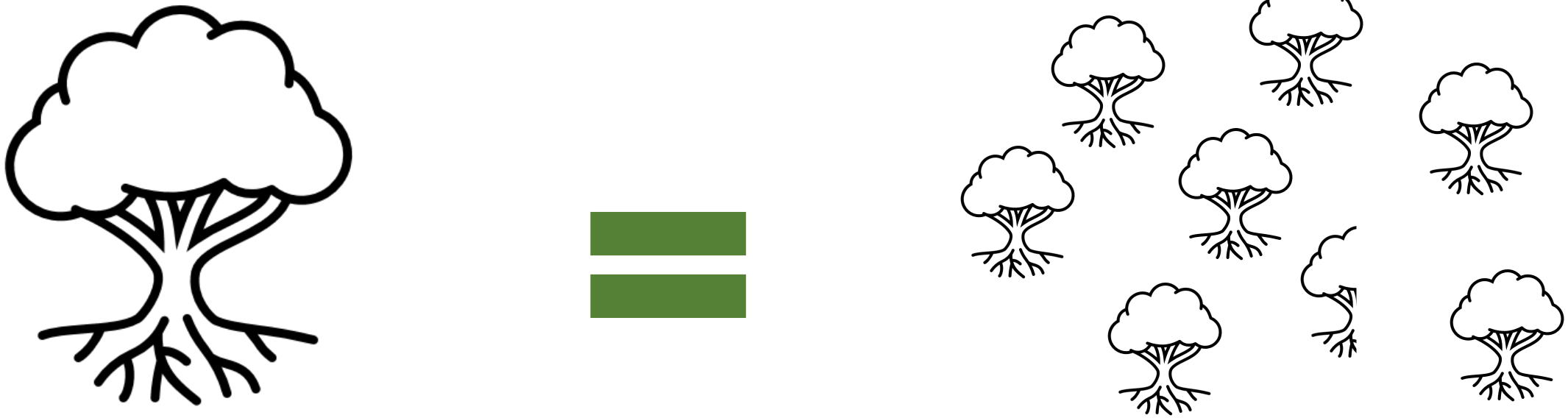
$$N = \frac{\overline{biomass\,(old\ lime)}}{biomass\ (young\ lime)} = \frac{3376\ kg}{102{,}3\ kg} = 33$$



SAME WEIGHT

- How many young lime trees can replace a singular old lime tree in terms of the amount of absorbed CO_2 during six months?

$$\frac{\overline{aps\ CO_2(_{old\ lime})}}{\overline{aps\ CO_2(_{old\ lime})}} = \frac{\overline{aps\ CO_2(_{june}) - aps\ CO_2(_{december})}}{\overline{aps\ CO_2(_{june}) - aps\ CO_2(_{december})}} = \frac{190\ kg}{25{,}5\ kg} = 7{,}45$$



SAME amount of absorbed CO2

Conclusion

Over the course of six months, there was a measurable increase in biomass in old and young lime trees.

Old trees, which have a higher biomass, store a larger amount of CO_2 over six months than young trees, which have a lower biomass.

The percentage increase in stored CO_2 over six months is higher in young lime trees compared to old lime trees.

ALL OUR HYPOTHESES HAVE BEEN CONFIRMED!

Additional conclusion

The same total biomass of old and young lime trees does not absorb the same amount of CO_2 during six months. A specific biomass of young trees will absorb 4.5 times more CO_2 than that same biomass of old trees.

Revitalization of the park includes rejuvenation of the plant population. Although revitalization reduces the total biomass, the amount of absorbed CO_2 decreases to a much lesser extent.

Thank you for your attention!