Investigation of the effect of soil replacement and fertilization on the improvement of calcareous mining spoils productivity in mountain Ghiona-Central Greece

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Site description

Ghiona mountain - Central Greece

- Altitude: 850 m
- Piles of calcareous spoils derived from bauxite mining
- Bioclimatic zones of the deciduous oaks and *Abies cephalonica*
- Climate mild Mediterranean with cold winters
- Annual rainfall: 1200 mm

Experimental Design

Fully Randomized Blocks

3 Replications

4 Treatments:

A=control

B= 40kg/ha NPK: 12-8-16 (MgO+B+Fe+Zn) Complesal supra

C= 40kg/ha NPK: 11-15-15

D= 40kg/ha NPK: 12-12-12+15(S) + 10% organic matter

Experimental Design

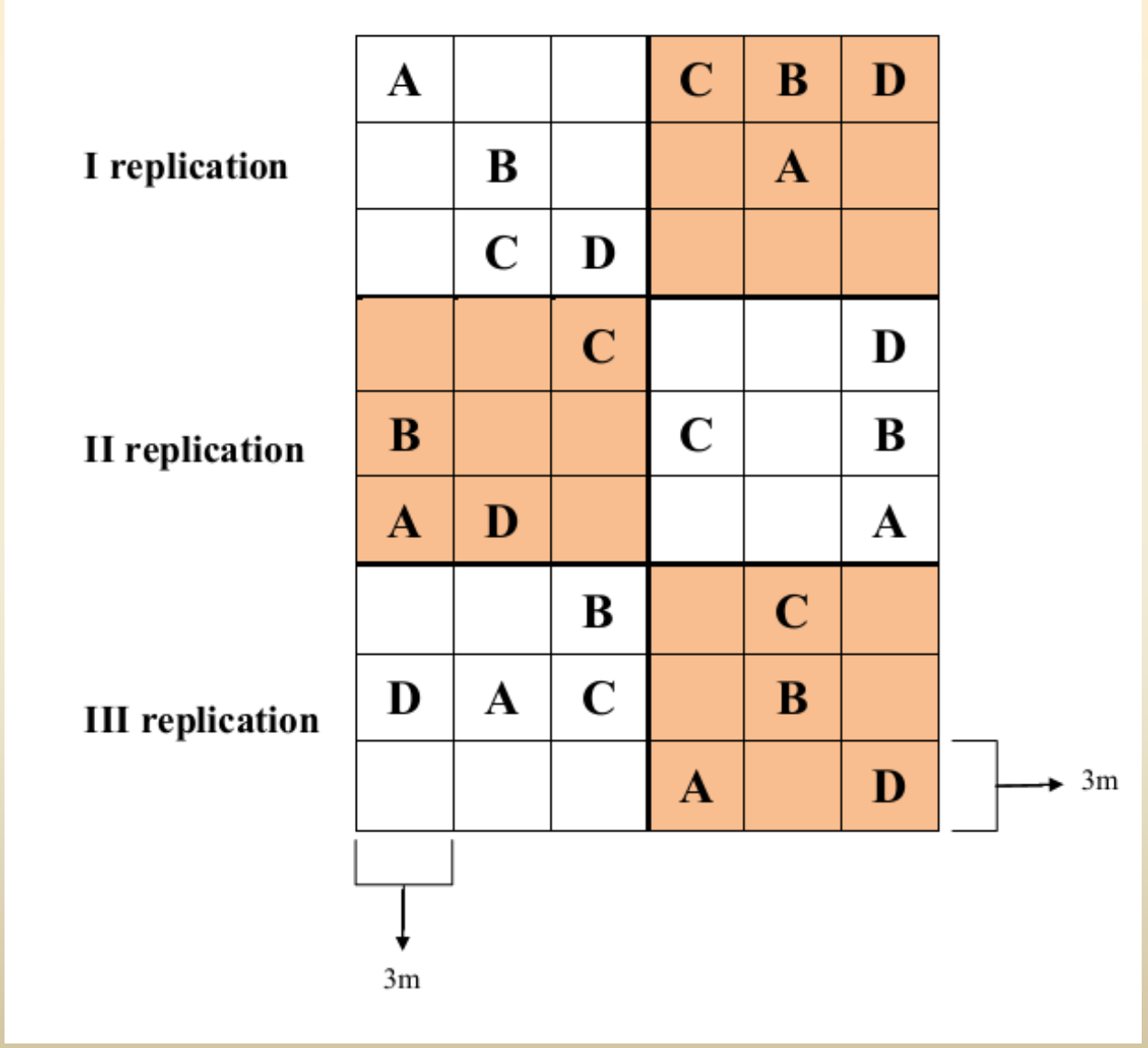
- On **bare spoils** and
- On spoils **covered with a layer** of soil (fine earth) about 15 cm deep
- Fertilization, 20kg/ha, twice

  i)on 04.11.2010 &

  ii)on 30.03.2011

- Size plot 2X2=4 m^2
- 24 plots

Experimental Design



Experimental plots in Mt. Ghiona

Experimental plots in Mt. Ghiona

Establishment

Autumn 2010 (4 November)

Seed mixture		
Species	**Participation (%)**	**Germination rates**
Festuca rubra	10	16.67%
Medicago sativa	20	85.83%
Sanguisorba minor	15	100.00%
Phacelia tanacetifolia	15	69.78%
Onobrychis sativa	25	62.92%
Lolium rigidum	10	96.25%
Festuca ovina	5	35.00%

Results for physical and chemical properties

	Spoil material	Fine earth
pH	7.53	6.78
N (%)	**0.012**	**0.017**
P (mg kg-1)	1.2	1.4
Mg2+ (cmolc kg-1)	0.66	4.7
K+ (cmolc kg-1)	**0.05**	**0.11**
Ca2+ (cmolc kg-1)	35.11	26.83
Clay (%)	10	46
Silt (%)	4	32
Sand (%)	86	22

Results

Biomass Production

Mean Value per plot

Least Significant Difference (LSD) for the comparison of the means

Mean biomass production Kg/ha

Treatments	Spoil	Spoil + fine earth
A	201.33a	533.67b
B	1,071.67e	1,392.33de
C	897.67e	1,426.67d
D	780.00e	1,533.33de

Results

Dry biomass

All fertilization treatments > control,

- No differences statistically significant

  between the fertilized treatments

- **Total dry biomass 65.6% higher in the treatment with soil cover.**

- Difference between:

  ı) control &

  ıı) fertilized plots with NPK with & without soil cover

Discussion

Soil Replacement **significantly increased (X 2.5) biomass production but not reached a satisfactory level**

The un satisfactory production seems to be related to the **similarity for the major nutrients** between the **soil used** and to those of **spoil materials**

The improvement reached is due to

- best texture and
- the lack or minor presence of skeletal material (>2mm)

OTHER REASONS

- topsoil is minimal or non-existent
- large amounts of B horizon soil
- crumbly bedrock

Discussion

Fertilization significantly increased the Production of Dry Biomass

- **very low level of main nutrient elements** with and without soil cover
- that mineral fertilization (**N, P**) of **mined land** substantially **increases** plant production & promotes herbaceous vegetation establishment
- The **lack** of statistically significant **differences** between the different fertilizers used it appears that differences in their composition are **not sufficient to influence** the production of dry biomass.

Composition of the vegetation

Lolium rigidum survive & growth

-all other species failure-perhaps due to

i) delayed sowing (04-11-2009) &

ii) low temperatures during and after germination, which destroyed the germinated seedlings of the other species.

Sanguisorba minor scattered appearance

Why Lolium rigidum escaped damage?

- in a **more advanced stage** of growth and **withstood better** the low temperatures
- to its possible **better resistance** in low temperatures

Annual *plants have faster germination & better growth rates* ***than perennial***

Hypothesis for the failed species

- Grains even with **high germination in laboratory conditions** may produce **inferior** or very inferior results **in natural conditions**

- Seeds of various plant species **require different germination conditions** that may be not suited for other species in a period

- Some leguminous species are harmed by the **fertilizer added simultaneously** with their sowing

Conclusions

- The used soil **improves the conditions** of the mentioned spoil materials, **but** by itself **cannot ensure** adequate **vegetation establishment**
- **Fertilization** is **essential** for the **vegetation establishment** and **satisfactory growth**
- Regarding the **quantity and repetition of fertilisation** further investigation is needed as appropriate to particular site conditions