Effective Microorganisms (EM®) Technology® as an ecological solution for infertile river bank – Sorek River, Israel

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***Abstract*— River banks made infertile by residues of herbicides are a common problem for all coastal rivers in Israel. Sorek River, collecting rain water from Jerusalem Mountains out to the Mediterranean Sea, is one of them. After a neglect of many years, the relevant authorities have decided to go on and restore it. Local soil tests were performed and have shown very low germination rate. So, the authorities instigate a pilot project for the restoration of the unfertile banks of the Sorek River. In it, EM® was taking a major part; it was tested as a bio-remediation approach for clearing out chemical residues and for re-creating a living topsoil, for the prosperity of the different local wild plants that were planted. The pilot was maintained for one growing season (summer), while different growth parameters were measured and collected. The results led to a clear conclusion that the usage of EM Technology® was found to be improving and hastening the establishment of the plants, their roots system and the vegetative growth, and also increasing the development of different species from the local seed bank.**

Keywords: EM, Effective Microorganisms, environment, Sorek River, bio-remediation, chemical residues, riparian

I. BACKGROUND

The general approach for using microbial inoculants for agriculture and soil is presented clearly in [1] as an old-new approach for sustainable farming systems and the environment. Low agricultural production efficiency is closely related to a poor coordination of energy conversion which, in turn, is influenced by crop physiological factors, the environment, and other biological factors including soil microorganisms. The soil and rhizosphere microflora can accelerate the growth of plants and enhance their resistance to disease and harmful insects, by producing bioactive substances. These microorganisms maintain the growth environment of plants, and may have primary effects on both soil quality and crop quality. A wide range of results are possible, depending on their predominance and activities at any one time.

The concept and technology of EM® was originally developed by Teruo Higa (then, at University of the Ryukyu, Okinawa, Japan) in 1980s [2]. EM® consists of mixed cultures of beneficial microorganisms such as lactic acid bacteria, photosynthetic bacteria and yeast. Originally, EM® technology was developed as microbial inoculants to increase the microbial diversity and improve the quality of the soil in agriculture [3].

Along the years, a variety of EM® bioremediation projects and experiments were performed around the world. It is concluded that the anaerobic fermentation with organic matter, Effective Microorganisms resources, is very effective for remedying the contaminated soil with hexavalent chromium [4]. It is also found that Bioremediation of lindane by effective microorganisms (EM) removed 90% of the lindane initial concentration after 60 days of treatment. It is also stated that bioremediation with effective microorganisms can be regarded as safe and effective remediation technology for lindane in soil [5]. The application of EM® material also promoted degradation of the oils in polluted soil. In a pilot scale experiment, it especially promoted decomposition of kerosene [6].

For many years, the Sorek River has been neglected, having sewers flowing in it as a natural thing. Due to large number of complaints from citizens of near-by cities about mosquitoes, anti-mosquito spraying procedures have been taken. Those, required spraying the banks with herbicides for the sake of accessibility. This repetitive chemical treatment had continued along 30-40 years, when its severe devastating results were realized in 2012. Then it was decided to start the river's rehabilitation, and to plant local and natural fauna on the banks. Planting tests were performed, resulting in the fact that seedlings are having great difficulty to establish and to prosper.

Adding this to a history of personal experience with EM® has brought us (Moran Advising and Development, restoration and management, experts in the field of aqua-hydrology) to offer trying EM Technology® in this specific project.

The challenges faced at the Sorek River project:

Soil is polluted and infertile due to a very long period of using herbicides with long-term residual affect –

- We examine different methods for dealing with infertile soil;
- Face the limited time for plant establishment, due to winter time that can bring flooding in the river (from end of March until the end of October);
- Need to establish a strong root-stock that spreads enough, in order to enable the river bank to withstand the strong cutting forces of the tides;
- Need to encourage plant growth in a stressful, dry situation so the plants can prosper, establish themselves to hold soil, before the arrival of winter floods;

Fig. 1: Sorek River, trees are falling into the river when winter floods are coming

Fig. 2: Infertile and barren river banks, Sorek River, pilot location

Fig. 3: Pilot project location

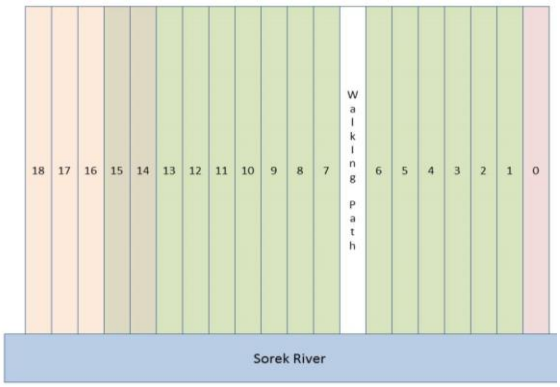

Fig. 4: Plots location diagram

- Need to handle the bad draining of the local soil, due to layering of soils with low drainage formation of high redox levels in the depth of the river bank, due to few layers of nazaz* soil.

* Nazaz soil is a red sandy soil including in its profile a horizontal layer of clay soil - blocking water percolation and root penetration. This is caused by watering mountain slopes crop fields (in intensive agriculture) for long periods of time and the drifting of clay to plain areas.

II. MATERIALS AND METHODS

A. Project description

In April 2013, an experiment to purify and revive sections along the banks of Sorek River started. The experiment included plots with different application methods of EM®, active carbon applications, chemical fertilization and untreated control.

19 plots were designed, 1 meter wide each, 20 meters long:

- Plot 0: Chemical fertilizer
- Plots 1-13: EM® treatments
- Plots 14-15: Untreated control
- Plots 16-18: Active carbon

(See project location and diagram – Fig. 3, Fig. 4).

B. Materials used and way of application

- Chemical fertilizer: N:P:K - 12:2:6.
- Activated EM1® solution (EMa) – was prepared according to common guidelines, from EM1 mother culture – mixed at 5% ratio from general water volume (i.e. 5 liters EM1® + 5 liters sugar cane molasses at a 100 liters container, filled with de-chlorinated water).
- Bokashi – made according to common protocol guidelines, using wheat bran as the medium.
- EM super sera C (EM-X-Ceramic powder - EMXC) – grey-clay powder – product promoted by EM Research Organization (EMRO).
- Cow-Dung-Bokashi (CDB) – prepared by layering 2/3 of 3 months old dry cow dung with 1/3 green and chopped urban gardening clippings, watered with EMa solution at 5 liters / 1 m^3, diluted with water to create 40% moisture ratio, put in a sealed and air-proof container for 3 weeks before usage.
- Molasses – sugar cane molasses, 80 brix**, a by-product of the sugar manufacturing industry, available as a feed supplement for animal husbandry and also for humans.
- Active carbon applications: CP2 powder and PK-1-3 granulates.

** Brix represents the sugar content of an aqueous solution. One degree Brix is 1 gram of sucrose in 100 grams of solution and represents the strength of the solution as percentage by mass.

Our application approach for EM was to check different materials available, in order to see which combination will give the best results. This was done by adding different organic matter materials, which serve as base and medium for the bacteria in EM®, by testing EMa pre-plant application at different quantities and by creating an artificial semi-sealed environment for encouraging the un-aerobic fermentation EM® generates. This was done by covering the plots with a nylon sheet.

(This process – EM Biological Soil 'Pasteurization', EM-BSP, was advised by Mr. John Phillips, AZ USA, who was a student of Dr. Higa for many years, and one of the EM® pioneers in the USA. The process was developed by Dr, Higa

himself for the sake of fermenting all organic matter present in the soil – including pathogens, fungi spores, old roots etc).

Post-planting foliar feed and EMa maintenance applications by drip-line along the summer were also examined. The option of avoiding any post-planting treatment was also tested, for simplicity of large scale applications from economic reasons. Anaerobic and aerobic fermentations are also described and compared in [2].

Application details and description per plot can be seen in Table 1.

C. Application methods

- Chemical fertilizer - applied manually once a week (in ppm, related to the total water quantity applied).
- EMa – pre-plant dripline application was applied 3 weeks before planting, with a fertilizing pump, diluted with water in order for bacteria solution to go 30cm deep (300 m^3/ha)
- EMa post-plant dripline application was applied via fertilization pump, added to the watering sessions.
- EMa post-plant foliar application was applied, diluted with water and sprayed manually on all above-ground parts of the plants.
- Bokashi – was sprinkled on the plot and tilled in, 3 weeks before planting.
- EMXC - was sprinkled on the plot and tilled in, 3 weeks before planting.
- CDB - was sprinkled on the plot and tilled in, 3 weeks before planting.
- Molasses – was poured on the plot and tilled in, 3 weeks before planting.
- Active carbon applications: CP2 powder – was applied by dipping the seedlings. PK-1-3 granulates – applied into the plant pit.
- Nylon sheet – grey/black common farming nylon – was layered on top of the plots, after tilling all materials in. Nylon perimeters were sealed with dirt and were removed after 3 weeks of semi-fermentation. Soil was let to aerate for 3 days before planting was performed.
- All plots, besides 4,10,13 (receiving CDB) were supplied with common gardening compost at 50 m^2/ha.

D. Planting protocol

Each plot was divided into 6 stripes, according to distance from the flowing river. 24 species of local wild plants were planted according to cross-sections, in respect to the distance from the flowing river (the seeds were collected from the wild and germinated in leading nurseries).

Plants species and location in perspective to the flowing river can be seen in Fig. 11.

Planting date – May 13'th 2013

Plot	Pre-planting	Post-planting	Remarks
0		12:2:6 chemical fertilizer once a week	starting at 50ppm and increasing gradually to 150ppm
1	EMa - 50 liter/ha Bokashi - 1000kg/ha	EMa driplines - 50 liter/ha/week	
2	EMa - 50 liter/ha Bokashi - 1000kg/ha EMXC - 100 kg/ha	EMa driplines - 50 liter/ha/week	
3	EMa - 50 liter/Ha Bokashi - 1000kg/ha EMXC - 100 kg/ha	EMa driplines - 50 liter/ha/week EMa foliar – 30 liter/ha/week	
4	EMa - 50 liter/ha CDB – 100m^3/ha EMXC - 100 kg/ha	EMa driplines - 50 liter/ha/week	
5	EMa - 50 liter/ha Bokashi - 1000kg/ha		
6	EMa - 3500 liter/ha Bokashi - 1000kg/ha	EMa driplines - 50 liter/ha/week	Covered with nylon
7	EMa - 3500 liter/ha Bokashi - 1000kg/ha EMXC - 100 kg/ha	EMa driplines - 50 liter/ha/week	Covered with nylon
8	EMa - 3500 liter/ha Bokashi - 1000kg/ha EMXC - 100 kg/ha	EMa driplines - 50 liter/ha/week EMa foliar – 30 liter/ha/week	Covered with nylon
9	EMa - 3500 liter/ha Bokashi - 1000kg/ha EMXC - 100 kg/ha Molasses – 1 liter/m^2	EMa driplines - 50 liter/ha/week	Covered with nylon
10	EMa - 3500 liter/ha CDB – 100m^3/ha EMXC - 100 kg/ha	EMa driplines - 50 liter/ha/week	Covered with nylon
11	EMa - 3500 liter/ha Bokashi - 1000kg/ha		Covered with nylon
12	EMa - 3500 liter/ha Bokashi - 1000kg/ha		
13	EMa - 3500 liter/ha CDB – 100m^3/ha EMXC - 100 kg/ha		
14	Untreated control		
15	Untreated control		
16	16% concentrate dip of active carbon CP2 powder		
17	100cc PK-1-3 granules + 400cc soil mix		
18	100cc PK-1-3 granules + 10cc CP2 powder mix		

Table 1: Plots application description

Fig. 5: Experiment area

Fig. 6: EMXC sprinkling work (the right plot has CDB on it)

Fig. 7: Tilling in organic inputs (plot-9, with molasses)

Fig. 8: Active carbon granules

Fig. 9: Nylon cover, plots 6-11

Fig. 10: Planting

E. Data collection

2 sampling sessions were performed along the growing season: July 1'st and September 2'nd 2013. Collected data was determined according to the plant specifications: plant height, foliar diameter and number of branches. A "Growth Index" was calculated, in order to show the plant biomass according the specifications of each and each plant, for the different plots and stripes:

Growth Index = sum of the averages of (

plant height (for protrusive plants like *Cyperus alopecuroides Rottb*) |

plant diameter (for sprawling plants like *Trifolium fragiferum*) |

plant height * number of branches (for thick plants like *Pluchea dioscoridis*)

Divided by sampling section area (1 m^2).

"Total Growth Area" – data was collected at the end of the growing season. Roots were exposed and their spread was also measured. Index is calculated by adding the growth area of above-ground parts + growth area of roots.

Due to the labor and efforts required for exposing the root-stock on all its spread, this was performed for 2 species only, in selected stripes.

F. Supplementary experiment

Since the Sorek River pilot is a pioneering project, many academics were invited to give their opinion, including University Professors, botanical specialists and others. Some suggested that experiment should be performed in pots too (In vitro) – in order to support our thesis, and also to show that the EM solution carrier (molasses) is not the reason for the changes we see. We went on and designed a supplementary potted-plants experiment that approved by restoration manager, and executed by AgroCity.

1) *Experiment protocol*

- 2 different species (*Plantago lanceolata L.* and *Rumex pulcher L.*)
- 14 different settings
- 10 replicated of each setting (total of 280 pots)
- Plants were sampled twice along the season, collecting "General Growth Index"
- Specific application details can be supplied upon request

2) *Experiment design*

- T0 – soil only
- T1 – soil + compost
- T2 – soil + molasses
- T3 – soil + compost + molasses
- T4-13 – different combinations of:
  - EMa pre-plant doses – low, high
  - With / without nylon incubation
  - With / without Bokashi
  - Molasses as a pre-plant application
  - With / without Post-plant EMa application

3) *Data collection*

"General Growth Index" was calculated as: number of leaves * plant height. Data was sampled two times.

III. RESULTS AND DISCUSSION

Remark: Along this pilot, vast amount of data was collected. Analyzing it all the way through was far too much for the budget available for that project. Following results and analysis will describe the general tendencies found.

A. Growth Index

Growth Index results are shown in the next 6 graphs (Fig. 12-17). For each stripe, according to distance from the flowing water: A1, A2, B1, B2, B3, C (following the planting sketch in Fig. 11).

Sample-1, July 1'st 2013 – in Grey

Sample-2, September 2'nd 2013 – in Black

These charts are the summary of entire data collected on the stripes and test plots. Further analysis and comparison according to the variables tested, is presented in next sections.

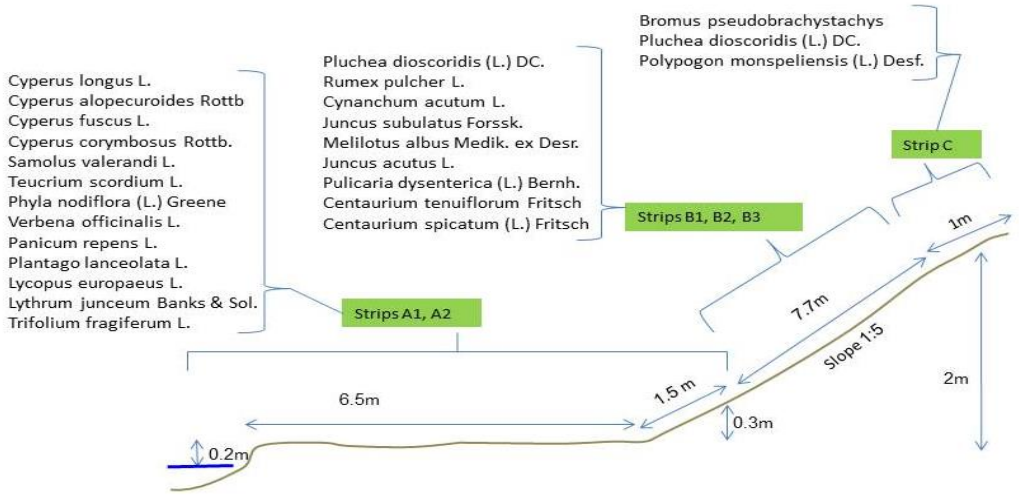

Fig. 11: River slope sketch

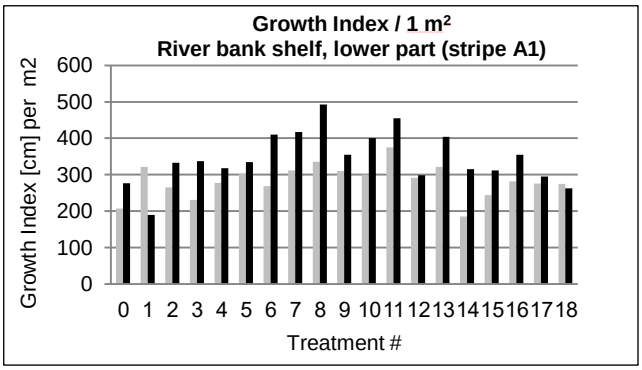

Fig. 12: Results – growth index/1 m^2, stripe A1

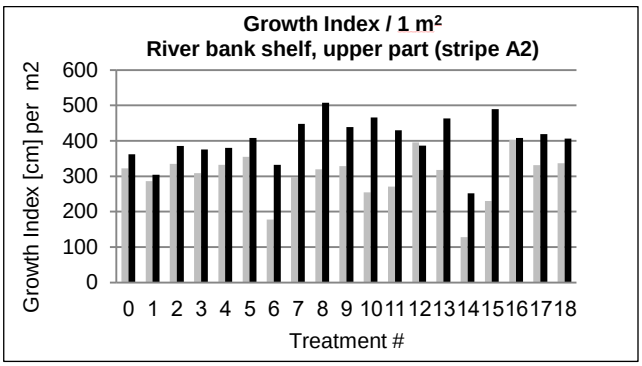

Fig. 13: Results – growth index/1 m^2, stripe A2

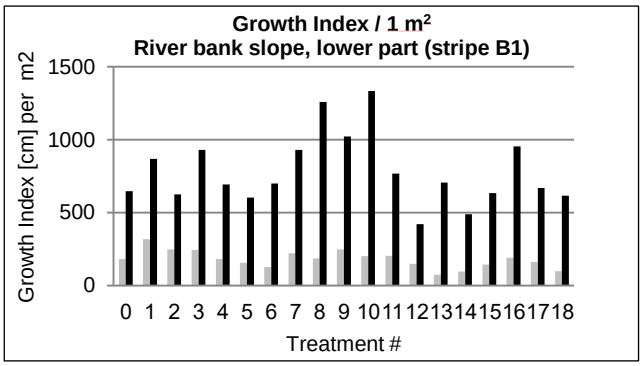

Fig. 14: Results – growth index/1 m^2, stripe B1

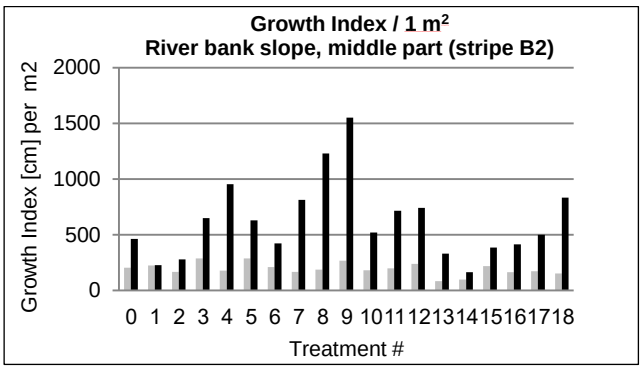

Fig. 15: Results – growth index/1 m^2, stripe B2

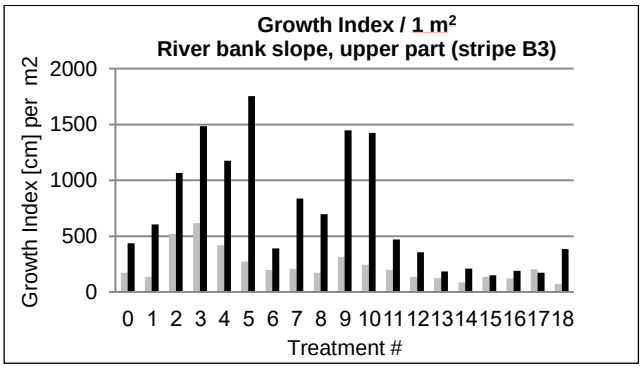

Fig. 16: Results – growth index/1 m^2, stripe B3

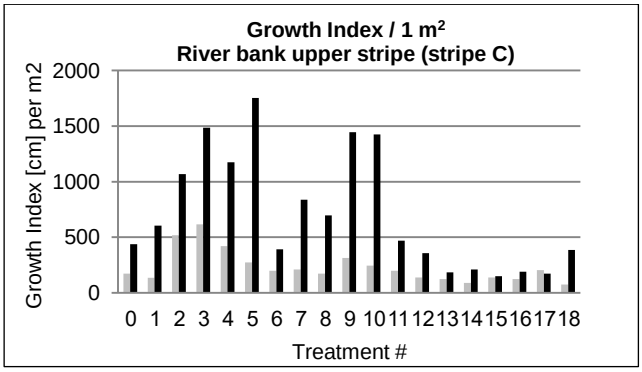

Fig. 17: Results – growth index/1 m^2, stripe C

B. Total Growth Area

The total biomass (both above ground and underground parts) is presented:

Fig. 18, *Pulicaria dysenterica (L.) Bernh* in stripe B2, shows a clear difference between the selected treatments: EM (4=933, 9=1231, 12=1174), chemical fertilization (0=615), control (14=308) and active carbon (18=480).

Fig. 19, *Pluchea dioscoridis (L.) DC* in stripe C, shows a clear difference between the selected treatments: EM (4=1001, 9=776), chemical fertilization (0=635), control (14=512) and active carbon (18=334).

C. Local seed bank species

Along the growing season, foreign species were starting to emerge – species from local seed bank, meaning – plant species that were not planted as a part of that project, but germinated from seeds that were in the soil for many years. Those were counted and this data is presented in Fig. 20.

Here we could see 2 emerging plants for chemical fertilization, average of 2 for control and 1 emerging plant for active carbon, compare to average of 2.9 for EM plots. (Data of other stripes is also available).

D.Analysis according to the tested variables

In order to analyze the effect of a specific input discussed, a further analysis was made (sample-2 is presented):

1) EM treated plots Vs plots with no EM:

4 groups of data have been created: Chemical treatment (plot-0), EM treatment (average of plots 1-13), un-treated control (plots 14-15) and active carbon treatment (16-18).

Results in Fig. 21 are showing a clear advantage to the EM plots in the different stripes. Active carbon treatments are second, chemical fertilization is third and un-treated control fourth.

2) Pre-plant dose of EM - large Vs small dose:

In this case, plot-5 (small dose) is compared to plot-12 (large dose).

Results are presented in Fig. 22.

Here, in overall, we could not see a clear difference between the selected plots. Stripes B2 and C are getting a better results with the higher dose, compare to stripes B1 and A1 showing the opposite. A2 is showing no difference, and B3 is showing a very steep decline due to the large pre-plant application, which might indicate an analysis failure or a specific reaction in that stripe.

3) The effect of molasses:

In this case, plot-9 (with molasses) is compared to plot-7 (without molasses).

Results are presented in Fig. 23.

Molasses application is not showing here a clear tendency. Stripes C and A1 are showing a decrease by the molasses input. Stripes B1, B2 and B3 are showing benefits due the molasses application, and A2 is showing stability.

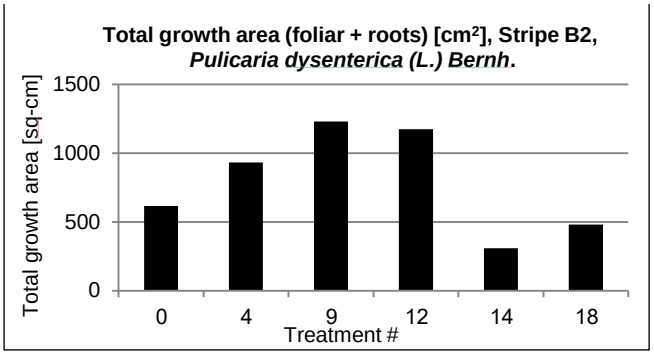

Fig. 18: Results – Total growth area, stripe B2, *Pulicaria dysenterica (L.) Bernh*

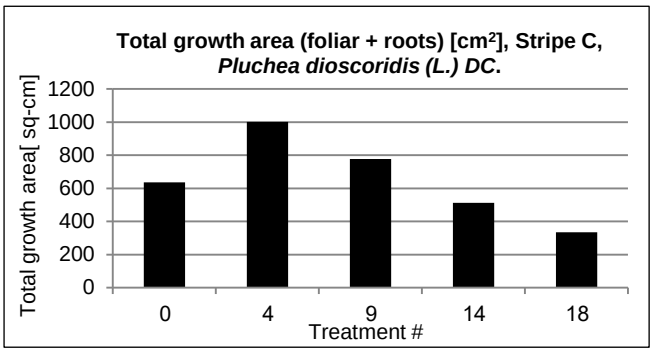

Fig. 19: Results – Total growth area, stripe C, *Pluchea dioscoridis (L.) DC*

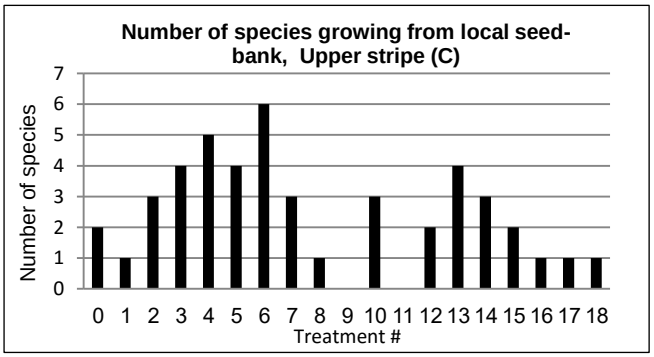

Fig. 20: Results – Number of species growing from local seed bank

4) The effect of CDB:

In this case, plot-4 (with CDB) is compared to plot-2 (without CDB)

Results are presented in Fig. 24.

CDB application is not showing a clear tendency. Stripes B3, B1, A2, A1 are showing no difference in growth, stripe B2 is showing a benefit from that application and stripe C is showing a very steep decline from it, which might be due to analysis failure, or a specific tendency in that stripe.

5) The effect of EMXC:

In this case, plot-7 (with EMXC) is compared to plot-6 (without EMXC).

Results are presented in Fig. 25.

EMXC application is showing a beneficial difference compare to a similar plot with same characteristics, excluding

EMXC. This is clearly shown for almost all stripes, besides A1 showing no effect at all.

6) The effect of covering the plots with nylon:

In this case, plot-11 (covered with nylon) is compared to plot-12 (not covered).

Results are presented in Fig. 26.

It can be seen in the graph that in all stripes but B2, nylon cover over the plots has been showing a benefit for the growth of the plants. In all stripes, but B1, the change is modest (this will be further discussed in the conclusions section).

7) The effect of post-planting EM foliar feed:

In this case, plot-8 (with foliar feed) is compared to plot-7 (without foliar feed).

Results are presented in Fig. 27.

This figure is showing that post-planting foliar feed with EM along the summer had no effect on stripe C, caused a growth decline for stripe B3, caused a stronger growth for stripes A1 and A2, and created a strong prosperity change in stripes B1 and B2.

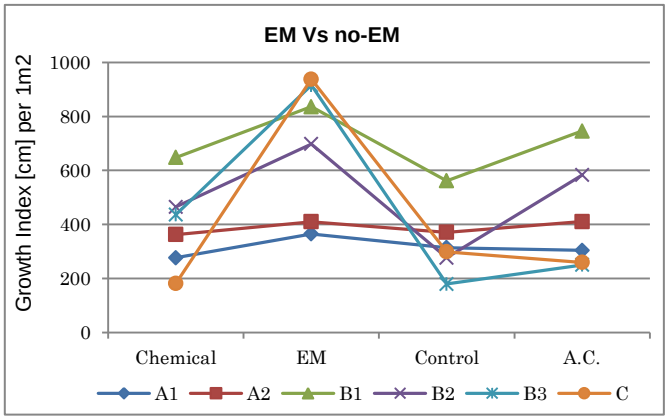

Fig 21: EM treated plots Vs plots with no EM

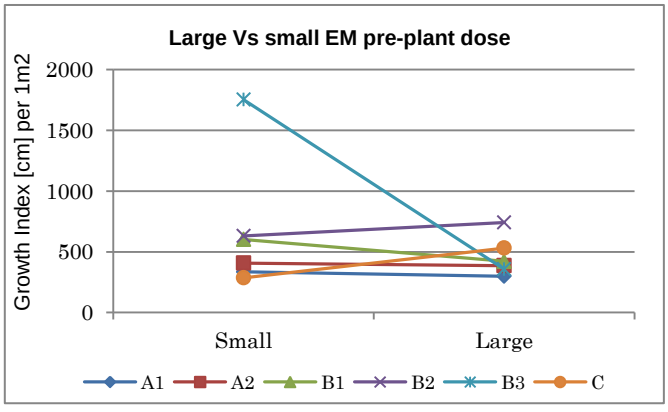

Fig 22: Large Vs small EM pre-plant dose

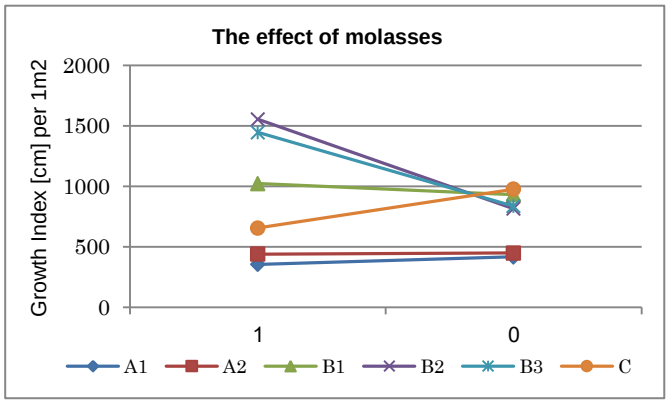

Fig. 23: The effect of molasses

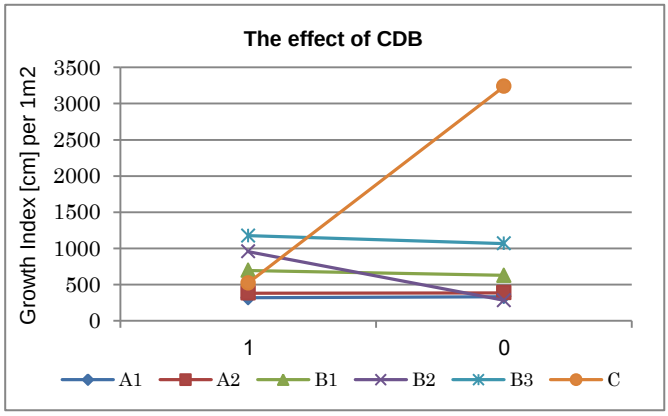

Fig. 24: The effect of CDB

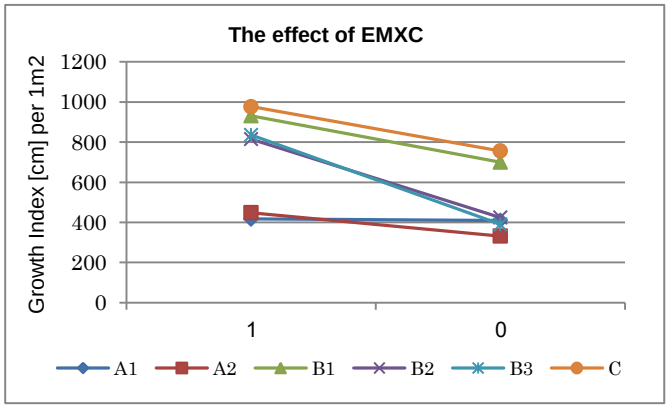

Fig. 25: The effect of EMXC

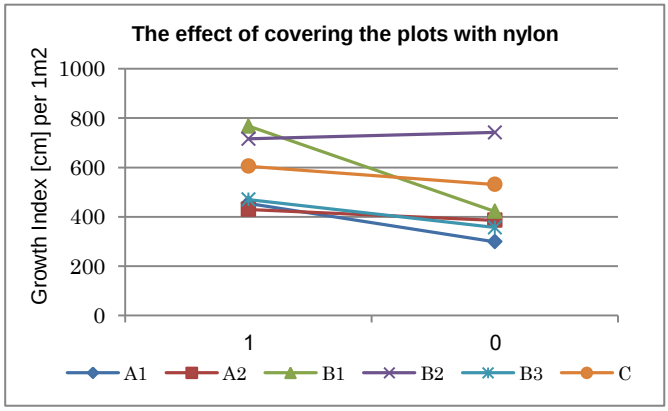

Fig. 26: The effect of covering the plots with nylon

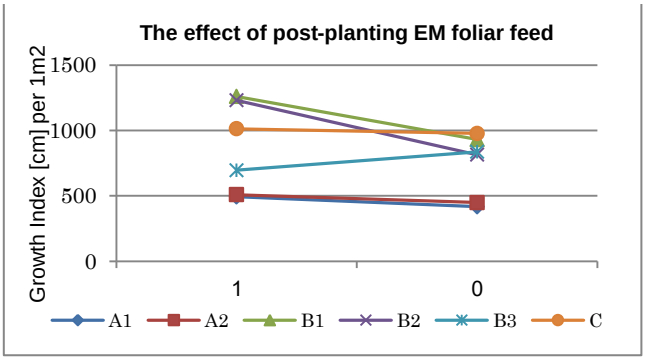

Fig. 27: The effect of post-planting EM foliar feed

E. Pluchea dioscoridis analysis

Pluchea dioscoridis is a typical riverbank plant, representing well the overall tendency that we could see for other plants measured.

This analysis is made for stripe-B2 only, due to the fact that it was found as a representing stripe – placed at the center of the slope, where plants are not growing in open water (like stripes A1 and A2, which are also continuously diluted with the flowing water), and where soil is saturated enough for capillary irrigation. Soil analysis has also shown that B2 stripe has uniform soil structure all along the pilot region.

Data is presented in Fig. 28: Growth Index, calculated by plant height * number of branches (only sample-2 data is presented – for showing the latest results).

For that specific plant, in that specific stripe, the figure is showing a clear difference between EM plots (average (1:13) = 392) to control plots (average (14:15) =86) and chemical fertilization plot (0=138). 2 Active carbon plots (17=455) and 18=624) are showing high results too (average (16:18) = 383), though, plots 4=828 and 9=836 are showing the best Growth Index results. That specific plant has not been successful in plots 1 and 10, and it is not clear why.

Analysis according to tested variables:

- EM pre-plant dose - comparing plots 5 (360, small dose) and 12 (660, large dose) shows a clear advantage for the large dose.
- Molasses – comparing plots 9 (836, with) and 7 (500, without) is showing an advantage for using molasses.
- CDB – comparing plots 4 (828, with) and 2 (103, without) is showing a strong benefit for the use of CDB.
- EMXC- comparing plots 7 (500, with) and 6 (211, without) is showing a benefit for the use of EMXC.
- Nylon cover – comparing plots 11 (294, covered) and 12 (660, not covered) is showing an advantage for no cover of nylon.
- Foliar feed – comparing plots 8 (564, with) and 7 (500, without) is showing a slight benefit for the foliar feed.

F. Supplementary experiment

Results are shown in Fig. 29-30.

Sample-1, November 29'th 2013 – in Grey

Sample-2, December 26'th 2013 – in Black

Plants in pots can be seen in Fig. 31-32.

Over all supplementary experiment results are showing the expected – that the different EM inputs are beneficial for the growth of the selected plants (in both figure s, a clear difference can be seen between treatment 0-3 and 4-13).

One of the initial purposes of this experiment was to show that the carrier of EM (sugar cane molasses, which is the medium EM solution brew, is on) has no effect of its own on the growth of plants.

Treatment 2 and 3, with molasses and molasses + compost, respectively, are clearly showing a lower Growth Index compare to treatment 9, having molasses and pre-plant low dose of EM, and also compare to treatment 13, which has molasses and pre-plant high dose of EM.

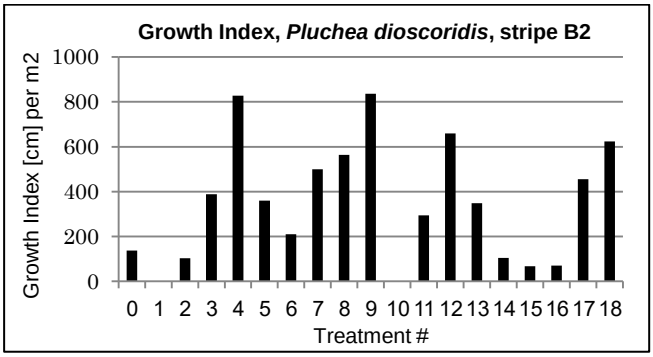

Fig 28: *Pluchea dioscoridis* analysis, stripe B2

Supplementary experiment Results:

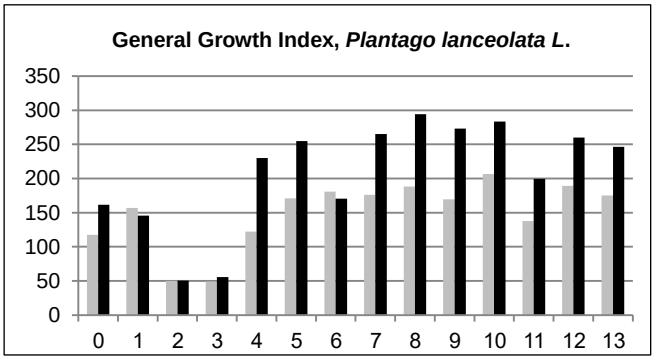

Fig. 29: Supplementary experiment Results – General Growth Index, *Plantago lanceolata L.*

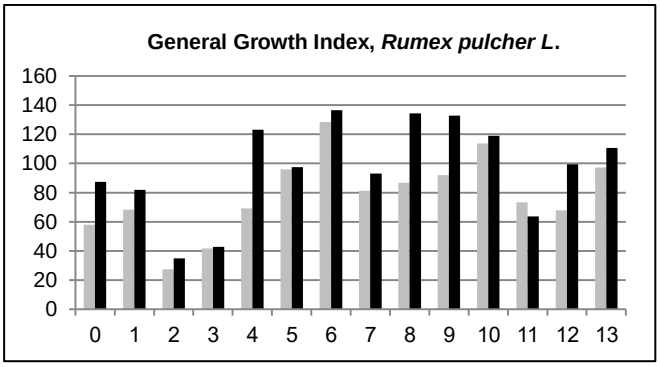

Fig. 30: Supplementary experiment Results – General Growth Index, *Rumex pulcher L.*

Fig. 31: Supplementary experiment results - control

Fig. 32: Supplementary experiment results - EM

IV. SUMMARY AND CONCLUSIONS

1. Different growth can be seen in different sections, with a clear advantage for the EM plots, compare to the active carbon and untreated control plots (see Fig. 22).

   EM application Vs no EM is also supported by the supplementary experiment (see Fig. 29, 30), and by and *Pluchea dioscoridis* analysis.

2. We couldn't see a clear advantage for the high dose of EM pre-plant application (see Fig. 23). The supplementary experiment hasn't also supported us with this variable. This can be seen in T4-T9 which are with a low dose of EM pre-plant, compare to T10-T13, which are with high EM pre-plant dose. *Pluchea dioscoridis* analysis shows a benefit for the large dose. Further study should be performed on this subject.

3. Molasses pre-plant application didn't show an overall clear difference (see Fig. 24). Checking the results for this variable in the supplementary experiment hasn't shown a clear difference as well (comparing T8 Vs T9, and T12 Vs T13). *Pluchea dioscoridis* analysis did show a clear advantage for the molasses application. This requires further study.

4. CDB (Cow-Dung-Bokashi) hasn't been showing an overall clear effect (See Fig. 25). It might be that the constraints on the compared plots are already supplying enough available organic matter, so no additional effect is possible. *Pluchea dioscoridis* analysis did show a clear advantage for the CDB application. This requires further study

5. EMXC (EM-X-Ceramic powder) application has shown a clear benefit, with the constraints of the specific plots. Further study should be initiated in order to test this input (see Fig. 26). This was not tested in the supplementary experiment. *Pluchea dioscoridis* analysis also supports the benefit for applying EM-X-Ceramic powder as a pre-plant application.

6. Fig. 27 shows that covering the plots with nylon for a semi-anaerobic fermentation is giving better growth results. This was tested only with high EM pre-plant dose, and should be further studied with low dose. *Pluchea dioscoridis* analysis supports the opposite, which might be due to a specific sensitivity of that specific plant to the substances created in this process described.

   Growth benefits should also be valued and estimated, in order to see if the cost of this application (the nylon + labor for covering and removing + 3 weeks incubation period) is worthwhile. Using a nylon cover also requires barren land, without any branches or rocks standing out, so the nylon won't tear. This is making this application expensive and not practical for large scale areas.

   Examining these parameters at the supplementary experiment hasn't shown a clear direction (comparing T6 Vs T8, and T10 Vs T12). It should be noted that application of nylon was different, and was creating a 100% seal of the soil, compare to the Sorek pilot, which was semi-anaerobic.

7. Foliar feed with EM had a positive effect on the growth of plants. This can be seen in most stripes in Fig. 28. *Pluchea dioscoridis* analysis shows a slight benefit for the continuous foliar feed. This should be further tested, to see the effect of foliar feed according to the specific species growing in the respected stripes.

8. Due to budget and time limitations - project was not planed with all variables clearly independent, so conclusions for some of the inputs were hard to be made. From the same

reasons we had no replicates for the stripes – one stripe for each treatment – this was also limiting the analysis and conclusion making.

9. Sampling was done by a Master degree student for environmental studies.
10. All seeds were collected locally by experts, and germinated by experts, according to each and each specie
11. Local seeds bank germination was a very strong proof for us that EM® really helps bringing life back to the soil.

All project details, including pre-work tests, land management, planting protocol and EM usage are available in the project summary document that was published and submitted to the relevant authorities involved (a 220 pages booklet describing into details the entire project scenario), where it is also stated that EM® was a big factor in the success of this pilot, adding our recommendation that it will be used in the expected project to come. As a result, EM® is also in-cooperated in 2 other projects supervised and managed by us.

V. FINAL CONCLUSION

EM® was found as a very beneficial technology for the rehabilitation and revival of lands in a short period of time.

As a result - EM Technology® was chosen to be part of the rehabilitation of the riparian areas of the Sorek River, and project is currently under design and in approval state.

Other photos from the project can be seen in Fig. 33-35:

Fig. 33 – Project area at winter floods (14/12/2013) - river bank is withstanding flood surges, and vegetation is prospering.

Fig. 34 - Project area after irrigation was stopped (beginning of November 2013).

Fig. 33: Project area at winter floods

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Fig. 34: Entire project plots at the end of summer