Plants for Plants 4-Terra: a novel biostimulant for improved yield and quality in fruits in phosphorus deficiency



Sudiro Cristina1*, Zind Zahi2, Čabilovski Ranko3, Popović Brigita4, Kurjacov Aleksandar2, Altissimo Adriano1 1 LANDLAB srl, Via Quintarello 12/A, 36050 Quinto Vicentino (VI) - ITALY 2 Van Iperen International BV, Smidsweg 24, 3273 LK Westmaas - NETHERLANDS 3 University of Novi Sad, Faculty Of Agriculture, Department of Field and Vegetable Crops, Trg Dositeja Obradovića 8, Novi Sad, - SERBIA. 4 Josip Juraj Strossmayer University of Osijek, Faculty of Agrobiotechnical Sciences, Vladimira Preloga 1, Osijek - CROATIA *correspondant author: c.sudiro@landlab.net

Phosphorus is an essential nutrient in fertilisers. Yet the world's farmers depend on phosphorus sourced from finite phosphate rock, which are becoming more scarce, expensive and are concentrated in few countries.

The Project Plants for Plants (P4P) aims to improve resource efficiency of crops by introducing a new category of biostimulants. In actual practice, waste materials and by products are often seen as potential source of biostimulants, therefore the discovery of functional active ingredients is rather casual. P4P reverses this approach: first the problem is identified and then tailored compounds, based on specific Standardized Metabolites Phytocomplexes (SMPs) physically extracted from suitable organically grown plants, are produced and tested.

Among the products developed in this Project, and thanks also to the co-funding of the EU's LIFE Program (LIFE18 ENV/NL/000043), Plants for Plants 4-Terra is based on a synergistic combination of specific heterosides and organic acids that is aimed to increase Phosphorus Use Efficiency (PUE).

Trials were performed in different crops families: the ones on apples, in 3/4 climatic conditions, showed that application of Plants for Plants 4-Terra in both comfort and sub-comfort conditions increased fruits yield and/or quality, as colour, 'Brix and firmness. Moreover a trial on strawberries showed that at the end of the trial more available phosphorus could be found in the soil, compared to the soil of the untreated plants.

To conclude, Plants for Plants 4-Terra proved to be an effective biostimulant both in stressed and in the so-called comfort environment, demonstrating that even plants grown in optimal conditions are far from exploiting their whole genetic potential.



Plants for Plants 4-Terra increases yield and quality of fruits as well as increases available P in the soil



Plants for Plants 4-Terra was applied on strawberry (cv Joly) grown in soil, in 3 times with 7 days interval starting from flowering.

P4P - Terra,

dosage 1



Untreated





The application of Plants for Plants 4-Terra improved strawberry yield by more than 20% at the higher dosage. The effect was particularly evident in the first pickings.

ond lved?

Ō

Ň

N L



As the average berry size was not in influenced by the application of the product, the effect of Plants for Plants 4-Terra was probably in the increase in fruit setting. Moreover, the berries of the best size (10-30 g) were more abundant in the treated entries, in total: 2113 g in the untreated, 2349 g in the low dosage, 2733 g in the high dosage.

Effect on P availability in the soil

The application of Plants for Plants 4-Terra increased the amount of available P in the soil at the end of the trial by 13% for the higher dosage.



4%

36%



Plants for Plants 4-Terra was applied on apple trees (cv Gala), in 3 applications with 7 days interval, after buds burst till full flowering. Phosphorus was reduced in fertigation. Total P reduction (considering also basal dressing) was -30% in the negative control (UTC, -30%P) and in the treated entries.

Effect on the fruit quality

Entry	Firmness	TSS	TA	Over colour	Anthocyanins
UTC, 100%P	7,06 a	10,93 a	0,31 a	48 a	6,6 a
UTC, -30%P	7,26 b	11,03 a	0,33 a	49,5 b	6,52 a
P4P - Terra, dosage 1, -30%P	7,95 d	10,58 a	0,33 a	64,5 c	7,53 b
P4P - Terra, dosage 2, -30%P	7,69 c	10,58 a	0,31 a	77 d	7,89 c

No effect on the average weight of the fruits was found. However, the quality parameters were indeed influenced. Treatments with Plants for Plants 4-Terra in fact, slightly increased fruits firmness, and dramatically increased over color and anthocyanins content compared to both the negative and the positive control. The correlation between the over color evaluation (visual evaluation) and the anthocyanins content (biochemical measurement) was very high (R2=0,9448).

Effect on P content in the plant

Entry	Ν	(%)	P	(%)	K	(%)
UTC, 100%P	3,31	а	0,32	b	1,64	ab
UTC, -30%P	3,32	а	0,27	а	1,54	а
P4P - Terra, dosage 1, -30%P	3,19	а	0,31	b	1,57	ab
P4P - Terra, dosage 2, -30%P	3,18	а	0,34	b	1,66	b

Effect on P availability in the soil



The application of Plants for Plants 4-Terra increased the amount of available P in the soil at the end of the trial reaching values even higher than the full P, in particular at the higher dosage.

The level of P in the strawberries leaves was not improved instead, however, considering the higher biomass produced, the total P uptaken is higher in the treated entries compared to the untreated one (no dilution effect).

Treatment with Plants for Plants 4-Terra increased P levels in the leaves, reaching values comparable to the full P. Also K levels were increased in the treated plants

Plants for Plants 4-Terra induced the expression of a phosphate transporter: PHT2;1

The sugar beet plants were grown in pots of 7 x 7 x 20 cm filled with perlite.

All the treated plants were grown under P deficiency (33% P) achieved through fertigation. Plants for Plants for Plants 4-Terra was applied at roots level in 2 applications. with 7 days of interval, on seedlings of about 3 weeks. For each treatment, 30 plants were used. 72 h from the second treatment, plants were harvested and analysed.

Effect on the shoot and root biomass

ý	FB shoot (g)		Entry	FB shoot (g)
reated, low P	2,17 a		Untreated, low P	0,49 a
- Terra, low, low P	2,94 b	+35%	P4P - Terra, low, low P	0,59 a
reated, high P	4,36 c	+101%	Untreated, high P	1,27 c
				•

The application of Plants for Plants 4-Terra partially restored P deficient plants 10 days after first application (+35% shoot biomass compared to untreated plants at the same level of P).

Effect on the expression of PHT2:1

Bg_PHT2;1: Low affinity H+/Pi chloroplastic cotransporter. Involved in inorganic phosphate (orthophosphate, Pi) uptake in green parts of plants in Pi-sufficient conditions. Required for Pi retranslocation during Pi deprivation. The investigation of the null mutant pht2;1-1 made by Versaw and Harrison* (2002) revealed that. PHT2;1 function affects the accumulation of Pi in leaves and the allocation of Pi throughout the plant. In fact, under high-Pi growth conditions, the reduction in leaf Pi content and the overall reduction in growth are consistent with Pi limitation of photosynthesis. The application of Plants for Plants 4-Terra increased the expression of the chloroplastic ortophosphate transporter PHT2;1.

*Versaw, W. K., & Harrison, M. J. (2002). A chloroplast phosphate transporter, PHT2;1, influences allocation of phosphate within the plant and phosphate-starvation responses. The Plant cell, 14(8), 1751-1766.



CONCLUSIONS: Plants for Plants 4-Terra improves yield and quality of plants, in particular of fruits. This effect may be caused by an induced increase in P availability in the soil, of P uptake in the plants (seen either as an increase of P in absolute value in the

plant or as a lack of a dilution effect) and/or a general improved nutrient use efficiency. The increase of P uptake by the plant may be due to an indirect activation of the microbioma of the soil (i.e. P solubilizing bacteria – currently under evaluation) and/or by the increased expression of specific P transporters (i.e. PHT2;1).



Plants for Plants Life Project | Project Start: 07-01-2019 | Project End: 31-01-2022. This project is co-funded by the European Union's LIFE Programme under Grant Agreement LIFE18 ENV/NL/000043

www.plantsforplants.com