The role of mycorrhization in sustainable fruit production

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What is mycorrhiza ?

Phenomenon of symbiotic association between particular fungi and roots of the plants is named mycorrhiza

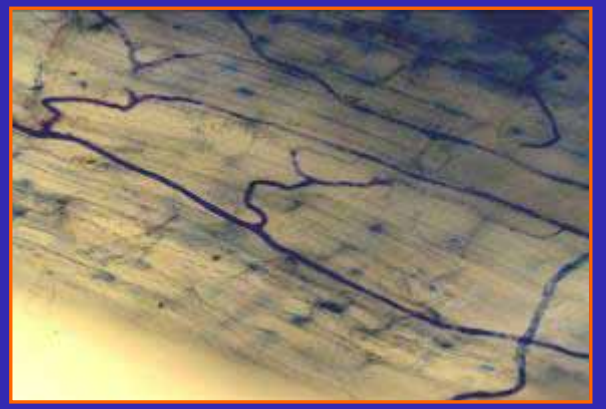
types of mycorrhiza:

- endo - **AMF**
- ecto - **EMF**
- ericoid - **ERM**
- others – highly specific

Endomycorrhizae (AMF)

***arbuscular mycorrhizal fungi, vesicular-arbuscular (VA or VAM)-* until 80 % of plant kingdom**

- *Glomales*
- *Glomaceae*
  - *G. intraradices*
  - *G. mosseae*
  - *G. fasciculatum*
  - *G. etunicatum*
  - *G. macrocarpum*
  - *G. microcarpum*
  - *G. versiforme*



Ericoid mycorrhizae (ERM) -

Fungi: ***Hymenoscyphus spp.; Oidiodendrum spp.***

Vaccinium, Calluna, Erica, Rhododendron

External hyphae plays a role of hair roots

Expression of mycorrhizal symbiosis

Between plant and fungi develops “dialog”, which express in:

- form of plants (morphological effect)
- nutritional status (trofic effect)
- water relations (water potential, water content)
- photosynthetic activity
- tolerance to unfavourable conditions (abiotic and biotic)

Effectiveness of symbiosis depends on kind of inoculum, methods of application and plant management (FERTILIZATION !)

Meaning of mycorrhizal symbiosis

- for micropropagated plants
- growing in soilless system
- having special requirements

Also in:

- decreasing of fertilizers and pesticides
- possibility to decrease water requirements
- improve relation between green part and roots of the plants

Endomycorrhiza (AMF) –

Micropropagated strawberry

Mycorrhization simultaneously with rhizogenesis

+M -M

- M + M

Ready for plantation into the field

Endomycorrhiza (AMF) –

Apple rootstock – M9

- M + M (1x) + M (2x)

1x – pojedyncza dawka ~ 400 mg/roślinę
2x – podwójna dawka

Peach rootstock - Cadaman

-M +M +M (+bact) +M 506

Why mycorrhiza for *Vaccinium spp.?*

- In agriculture management is difficult to ensure conditions comparable to those existing in natural systems.
- Fungi forming ericoid mycorrhiza are not spread everywhere, thus spontaneous inoculaction has a little chance to exist.
- Cultivars of blueberry and cranberry cultivated in Europe were originated in North America.
- Thus question is: do fungi from European ecosystems are able to develop the functional symbiosis with cultivars originated in North America?

Blueberry cv. **'Bluecrop'** and **Cranberry** cv. **'Pilgrim'**

Plant Material

Propagation:

- multiplication - *in vitro*;
- rooting - *ex vitro*

Mycorrhization:

- at time of planting into pots

Evaluation:

- morphological
- physiological

- M + M

The plants - source of inoculum

Vaccinium myrtillus

Vaccinium vitis idaea

Arctostaphylos uva-ursi

Calluna vulgaris

Ledum palustre

Blueberry - morphological effects

- M + M

Inoculum from *V. vitis-idea* – first year of growth

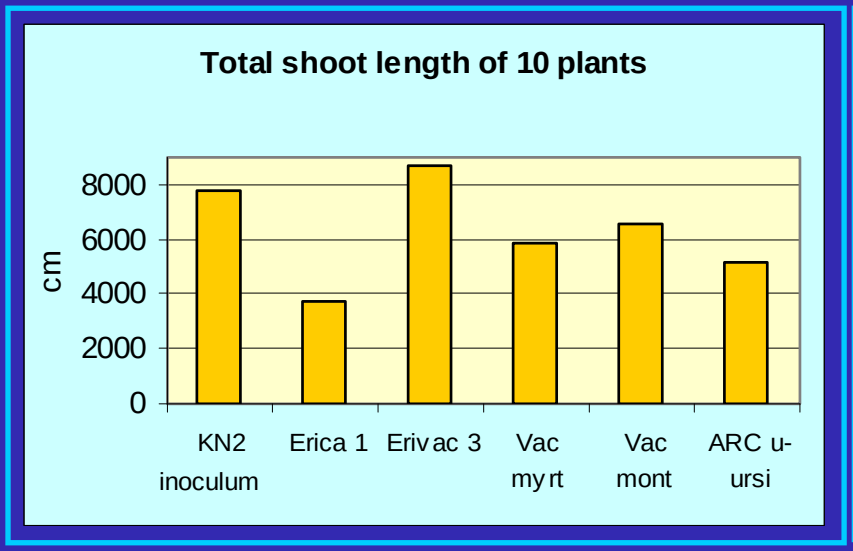
Control Erivac

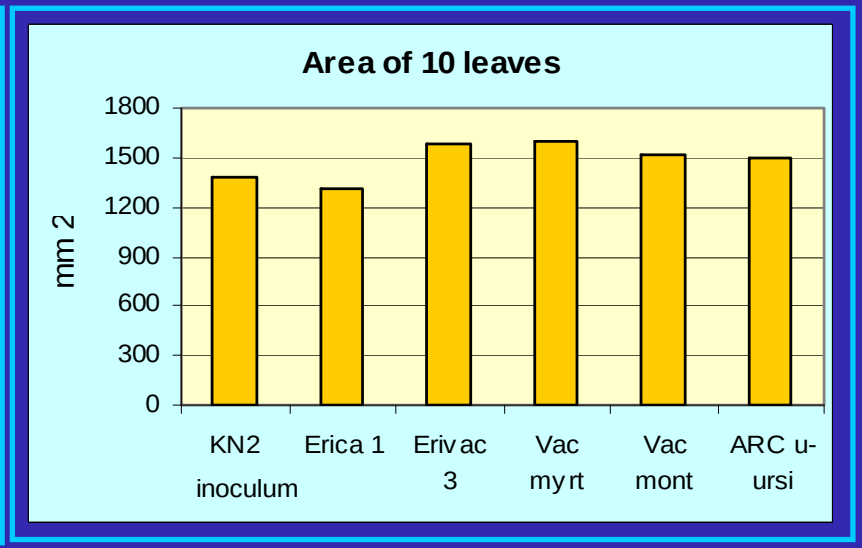
Third year of growth – first year in the field

GROWTH STIMULATION – the most active ERIVAC

Cranberry – morphololological effects

Shoots and leaves





Growth of the shoots is inhibited. Area of leaves is slightly stimulated This stimulation can be physiologically significant (increase of total photosynthetic area)

Cranberry – morphololological effects

Fresh and dry weight of roots

inokulum	FW – g (%)	DW – g	% DW
KN	6.751 (100)	**2.922**	**43.3**
Calluna vulgaris	6.372 (94)	2.102	33.0
V. myrtillus	**7.974 (118)**	2.476	31.0
V. vitis idea	6.504 (96)	2.071	31.8
Arctost. uva-ursi	**8.164 (121)**	2.804	34.3
Erivac (mix)	**7.548 (112)**	2.428	32.2

Fresh weight of roots mycorrhized with inocula *V. myrtillus* and *Arctostaphylos uva-ursi* and mixed (Erivac) - higher than in other treatments

Dry weight always lower

Role of mycorrhiza in drought stress

Strawberry, cv. ‘Senga Sengana’

Mycorrhization delayed wilting of the plants

+ M - M

The plants were not watered for 5 days

Role of mycorrhiza in pH stress –

cranberry cv. 'Pilgrim'

Substrate:

- standard: peat – perlite – sand (5:1:1)
- mineral wood (Grodan) instead of perlite

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pH of substrate:

Before experiment:

- standard: 4,0
- with mineral wool: 5,5

At the end:

- standard: 4,5
- with mineral wool: 6,5

Role of mycorrhiza in pH stress –

cranberry cv. ‘Pilgrim’

Total shoot length of 15 plants - cm

pH of substrate	Contr - M	*Calluna vulgaris*	*Caluna*+ bacteria	Erica 1	*V. oxyccocus*
4,5 (standard)	2443	2465	2394	2051	2294
6,5 (with mineral wool)	2009	**2834**	2256	2468	2268

Mycorrhization was ineffective, when pH of substrate was optimal.

Mycorrhization was highly effective in alleviation of pH stress.

Role of mycorrhiza in light stress

strawberry, cv. ‘Elsanta’

Characterization of plants growing under standard greenhouse conditions and in shade

Light conditions	mycorrhiza	leaves (mg DW)	roots (mg DW)
standard	-	535 (100)	1075 (100)
	+	588 (110)	1328 (123)
shade	-	241 (100)	306 (100)
	+	**306** (**127**)	**393** (**128**)

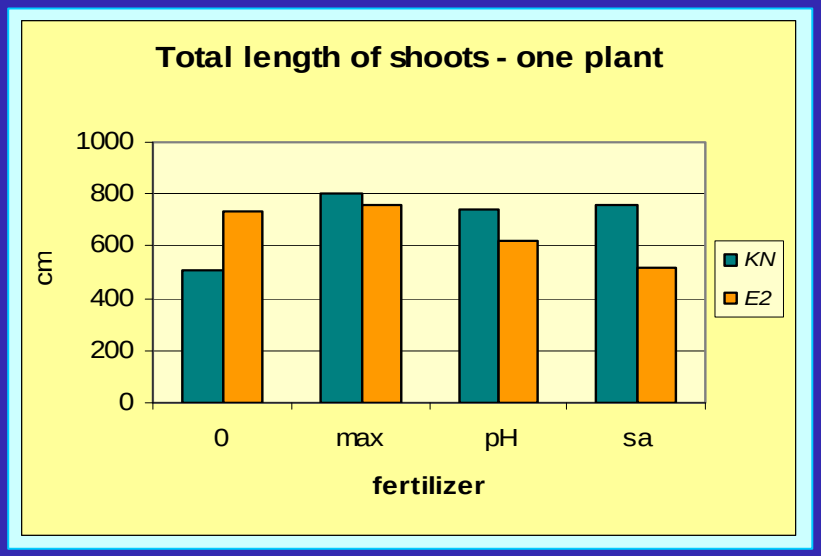
Mycorrhization increased DW of leaves and roots, much more under shade conditions .

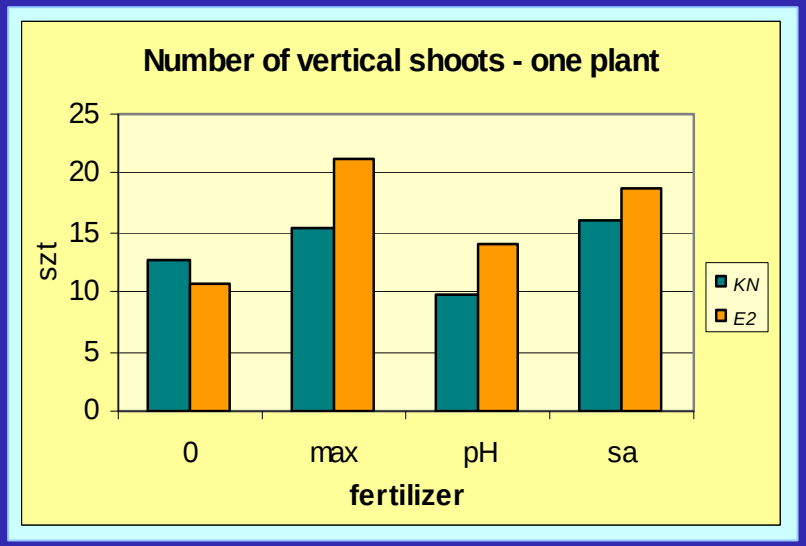
Effectiveness of mycorrhiza under different fertilization

cranberry cv. ‘Pilgrim’

Planted 04.IV.2006; inok. – 04.IV.2006

Measured August 2007





Effectiveness of mycorrhization depended on kind of fertilizer. Growth of shoots stimulated when plants were unfertilized. Fertilizer *Max* the most effective in stimulation of number of the vertical shoots.

Other effects of mycorrhizal association

Increase tolerance/resistance to biotic stress

- soil pathogens: *Verticillium, Phytophtora……*
- leaf pathogens: *Botritis, Phytophtora* (tomatos)…..
- nematoda
- flys (?)

Cooperation with:

- Ildiko Balla and Endre Szucs – Hungary (experiments with rootstocks for peaches)
- Joanna Jagla – Experimental Station, Brzezna, Poland (experiments with rootstocks for cherries)
- The Center for the Elite Nursery Stock, Prusy. Poland
- Owners of blueberry plantations
- Members of Polish Mycorrhizal Society
- Firm Mycoflor – Poland (producer of inoculum)
- Firm Biorize – France (producer of inoculum)

THANK YOU FOR YOUR ATTENTION

Ectomycorrhiza

Saprophytic fungi –
are wonderful