Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences
Institutionen för växtproduktionsekologi

Delredovisning av EkoForsk-projektet

Balanserad gödsling i ekologisk tomatodling

Jag erhöll 2010 medel från Ekoforsk för att genomföra projektet *Balanced fertilisation in organic tomato production* (bilaga 1). Våren 2011 påbörjade jag delprojekt 1 med målsättningen att undersöka avkastning och upptag av fosfor (P) i tomatplantan vid tillförsel av citronsyra med bevattningsvattnet till ett pH värde motsvarande 3.5, 5 eller 6.5. Jord till växthusförsöket som var planerat att pågå under 10 veckor, hämtades från en kommersiell odling. Jord från denna odlare hade använts i ett tidigare försök och då visat lovande resultat, som inom kort publiceras i Acta Agriculturae. Tyvärr visade det sig att jorden var infekterad med ett komplex av Fusarium/Verticillium vilket resulterade i att plantorna vissnade och försöket fick avbrytas.

Mot bakgrund av att symptom inte observerats i odlingen och tanken att plantorna inte skulle vara lika utsatta för svampangrepp när de växte i en större jordvolym sjösatte jag våren 2012 ett försök på plats i odlingen. Relativt snart upptäckte jag dock symptom även i detta försök som då liksom försöket 2011 fick avslutas. Denna vår (2013) genomför jag för tredje gången försöket med tillförsel av citronsyra med bevattningsvattnet men denna gång med andra jordar. Försöket kommer att avslutas och analyseras under maj/juni.

Delprojekt II kommer inte att kunna genomföras som planerat på grund av brist på pengar. Jag planerar därför att följande vår (2014) göra ett enklare försöksupplägg med tillförsel av citronsyra med bevattningsvattnet i kombination med olika gödslingsstrategier. Samma år planerar jag också att genomföra delprojekt III i den ursprungliga försöksplanen. I detta försök jämförs pH utvecklingen i jord vid tillsatts av kalksalpeter + torv, blodmjöl, stallgödsel, färsk grönmassa och ensilage. Försöket kommer att genomföras med och utan växt. Budget och tidsplanering för 2013 och 2014 återfinns i bilaga 2.

Ultuna 2013-05-24
Birgitta Båth

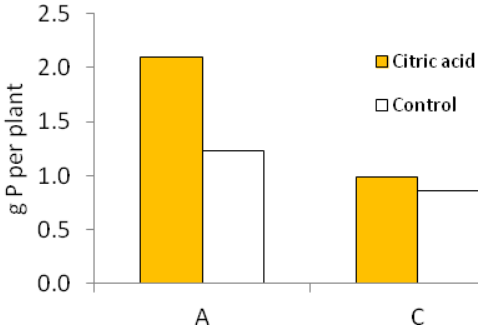
BALANCED FERTILISATION IN ORGANIC TOMATO PRODUCTION

Introduction

For the past ten years, a participatory research group in central Sweden has been working on issues relating to organic growing of greenhouse tomatoes. An important issue for the growers in the group is how to design their fertilisation strategy so as to prevent nutrient deficiency developing in the crop. Analyses of plant sap from existing commercial crops show that the levels of phosphorus (P) are low (Magnusson *et al*., 2010). The nutrient deficiency in the plant is probably not primarily the result of deficiency in the soil, but rather of low nutrient release rate in relation to crop requirements. Uptake of P in the plants is low despite the fact that soil analyses reveal the P status in the soil to be very good.

In greenhouse beds with high amounts of organic material added, the pH value gradually increases (Bertrand *et al*., 2007; Narambuye & Haynes, 2006). The reason for this pH increase is that plants (particularly legumes) and farmyard manure have an excess of base cations (Persson, 2003). At high pH values the availability of P is decreased because P is bound in insoluble calcium compounds (Tisdale *et al*., 1999). In turn, phosphorus deficiency can give rise to N deficiency through disruption of protein synthesis in the plant (de Groot *et al*., 2003; Jeschke *et al*., 1997). A strategy to increase P availability for the tomato plant is to add a fertiliser or soil improver that lowers the pH of the soil. Another is to add an organic acid, e.g. citric acid. Organic acids increase P availability primarily by chelating ions associated with phosphate (Hariprasad & Niranjana, 2009). A complication of increased P availability is that high P levels can cause deficiency of zinc (Zn), copper (Cu), iron (Fe) and manganese (Mn) through antagonism during uptake in the plant (Epstein & Bloom, 2005). On the other hand, a decrease in pH increase uptake of these ions (Sarkar & Jones, 1982)

a)



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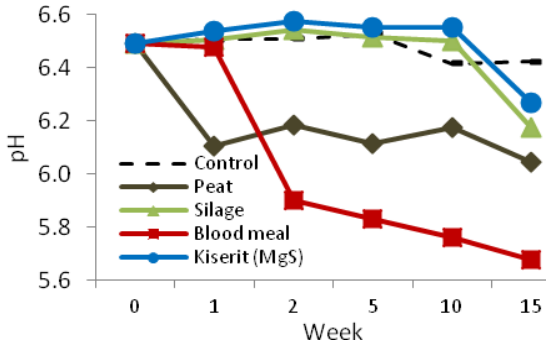

Figure 1. a) Uptake of P in tomato plants after 10 weeks, greenhouse experiments in boxes.
b) Change in pH in soil from culture A, incubation experiment without plants.

The experiments carried out by the participatory research group have investigated issues such as the effect on pH of adding four different fertilisers/soil improvers; and whether addition of citric acid together with irrigation water increases P availability (Figure 1). The results are promising. Addition of citric acid with the irrigation water (pH 3.6) was shown to increase P uptake, while the fertilisers/soil improvers tested lowered the pH by between 0.5 and 1.0 units. However, the observed effects on pH of adding blood meal and silage were probably greater than would have been the case if the system studied had included plants to take up all the N as it was being mineralised. Furthermore, we do not know the effects of applying citric acid with the irrigation water in combination with fertilisation on P uptake by plants.

The work to date has resulted in greater precision in plant nutrition. The disadvantage with this practice is that the fertilisers used, *e.g.* blood meal, contain large amounts of sulphur (S) in relation to potassium (K). High concentrations of sulphur accumulate in the greenhouse soil and disrupt nutrient uptake by plants. This has led to a suggestion to increase fertilisation with farmyard manure and green manure, which have a better S:K balance.

Against this background and based on the experiments carried out to date, the other members of the group and I want to continue with the task of drawing up a balanced fertilisation strategy for organic tomato production.

Research issues

Sub-project I
Can the effect of adding citric acid with the irrigation water be achieved at pH values higher than 3.6?

Sub-project II
Can the fertiliser dose be decreased when citric acid is added with the irrigation water?

Sub-project III
How is the pH in the soil affected by addition of fertiliser and soil improver to cultivation systems with and without plants?

Materials and methods

The proposed project will be based on the conditions in one of the commercial greenhouses included in the participatory research group. All sub-projects will use soil from this greenhouse.

Sub-project I
Uptake of P by the tomato plant and yield will be studied for 10 weeks in the greenhouse at pH values of 3.5, 5.0 and 6.5. The effects will be studied in a pot experiment with soil placed in pots (4 x 4 x 5 dm^3), with a system for easily recirculating the drainage water. One tomato plant will be planted in each pot. The comparison will be carried out without addition of fertiliser.

Samples for analysis of plant uptake of P, N, Mn, Zn, Fe and Cu will be taken at harvest. N will be analysed using a Leco analyser according to the Dumas method (Bremner & Hauk, 1982) and other plant nutrients using inductively coupled plasma spectrometer after extraction with HNO_3. Three plant fractions (stem, leaf and fruits) will be analysed.

Sub-project II

This study will be carried out on-site in the commercial greenhouse during the period from planting of the tomato plants to completion of harvest from the 7th truss. In the two experiments included in the study, yield will be monitored and availability of P, N, Mn, Zn, Fe and Cu will be determined every second week by plant sap analyses. When the study is terminated, leaf analyses will be performed.

A.

This preliminary study will investigate the effects of adding citric acid with the irrigation water. In one of the greenhouse beds, a double row of 10 plants (20 tops) will receive citric acid with the irrigation water. The pH lowering in the drainage water will be adjusted according to the results from *sub-project I*. Yield and nutrient uptake will be compared with those of similar plants receiving no citric acid with the irrigation water. The study will be performed without fertiliser input.

B.

This study will investigate the possibility of decreasing the fertilisation intensity when citric acid is added with the irrigation water. The study will include four treatments, with treatment 1 corresponding to the ordinary fertilisation strategy in the greenhouse:

1. Fertilisation with silage and blood meal.

2. Addition of citric acid with the irrigation water – Fertilisation with silage and blood meal.

3. Addition of citric acid with the irrigation water – Fertilisation with silage.

4. Addition of citric acid with the irrigation water – No extra addition of plant nutrients.

guard plants		*path*	*Row 1 Ordinary*		*path*	*Row 2 Citric acid*		*path*	*Row 3 Citric acid*		*path*	*Row 4 Citric acid*		*path*	*guard plants*	
plant	plant		Guard plants			Guard plants			Guard plants			Guard plants			plant	plant
plant	plant		Guard plants			Guard plants			Guard plants			Guard plants			plant	plant
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plant	plant		plant	plant		plant	plant		plant	plant		plant	plant		plant	plant
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plant	plant		Guard plants			Guard plants			Guard plants			Guard plants			plant	plant
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plant	plant		plant	plant		plant	plant		plant	plant		plant	plant		plant	plant
plant	plant		Guard plants			Guard plants			Guard plants			Guard plants			plant	plant
plant	plant		Guard plants			Guard plants			Guard plants			Guard plants			plant	plant
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plant	plant		plant	plant		plant	plant		plant	plant		plant	plant		plant	plant
plant	plant		Guard plants			Guard plants			Guard plants			Guard plants			plant	plant
plant	plant		Guard plants			Guard plants			Guard plants			Guard plants			plant	plant

Figure 2. The 12 plots (4 treatments x 3 replicates) in *sub-project II* B. The three treatments with citric acid in the irrigation water will be randomised among the nine plots in row 2-4. The three replications within the treatment with the ordinary fertilisation strategy will, out of practical reasons, be placed in row 1.

As a measure of tomato plant growth and development including flowering, fruiting, number of fruits, number of leaves, stem growth and stem thickness will be monitored. The study will include three replicates, with each replicate comprising a double row of 10 plants (20 tops).

Sub-project III

This study will investigate the changes in pH on addition of peat+blood meal, farmyard manure, fresh green biomass and silage to 1-L plots with and without plants. In the cultivation system with plants, one tomato seed will be placed in each pot together with fertiliser and soil improver to cover the N requirement for five weeks. After five weeks the tomato plants will be cut off level with the soil surface and the pH in the soil will be determined. The soil will then be mixed in the pot with a new batch of fertiliser and soil improver and a new tomato plant will be established. This procedure will be repeated two further times, i.e. the experiment will run for 20 weeks. The experiments will be carried out with four replicates in the greenhouse.

Organisation and deliverables

The person responsible for the project will be Assoc. Prof. Birgitta Båth, Dept. of Crop Production Ecology, SLU. Dr Båth has expertise in the use of organic manures in vegetable production systems.

Timetable

	February-March	April-June	July-August	December
2011		*Sub-project I*		
2012	*Sub-project III*	*Sub-project III* *Sub-project IIA*	*Sub-project IIA*	Part-reporting
2013		*Sub-project IIB*	*Sub-project IIB*	Final reporting

Reference group
A reference group comprising skilled practitioners will be affiliated with the project to act as discussion partners regarding the design of experiments and results (expertise):

- Extension officer E. Ögren, Province Administration of Västmanland (organic vegetable production)
- Extension officer K. Homman, Province Administration of Dalarna (organic vegetable production)

Deliverables:
The project will deliver international peer-reviewed papers and the results will be presented at international and national conferences. Research results will be communicated to the horticultural sector through *e.g*. excursions, participation in courses and articles directed at the farming community and the advisory services. The close collaboration with commercial growers and extension officers is a guarantee that the results from the project will be spread in a wider circle.

Budget

	2011	*2012*	*2013*
Labour incl. LKP and OH	275 000 SEK	300 000 SEK	325 000 SEK
Analyses etc	50 000 SEK	25 000 SEK	50 000 SEK
Premises etc	25 000 SEK	25 000 SEK	
Farm trial (access compensation and yield losses)		25 000 SEK	50 000 SEK
Travel etc		25 000 SEK	25 000 SEK
Total	*350 000 SEK*	*400 000 SEK*	*450 000 SEK*

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Budget och tidsplanering för 2013 och 2014

Budget

Totalt tilldelades projektet 1 200 000 kr av dem återstår 665 000 kr.

	2013	*2014*
Lön 15 %	185 000	190 000
Analyser	80 000	45 000
Hyra växthus	60 000	60 000
Material	25 000	20 000
Resor	5 000	5 000
Total	*345 000*	*320 000*

Tidsplanering

	Februari-Mars	April-Juni	Juli-Augusti	December
2013		*Del-projekt I*		Delrapportering
2014	*Del-projekt II*	*Del-projekt II* *Del-projekt III*	*Del-projekt II*	Slut redovisning