SLU
ALNARP

LTV-fakultetens faktablad
2018:6

Fakta från SLU Partnerskap Alnarp

Biobased binding material for plant growth substrates

William R. Newson and Eva Johansson

Summary

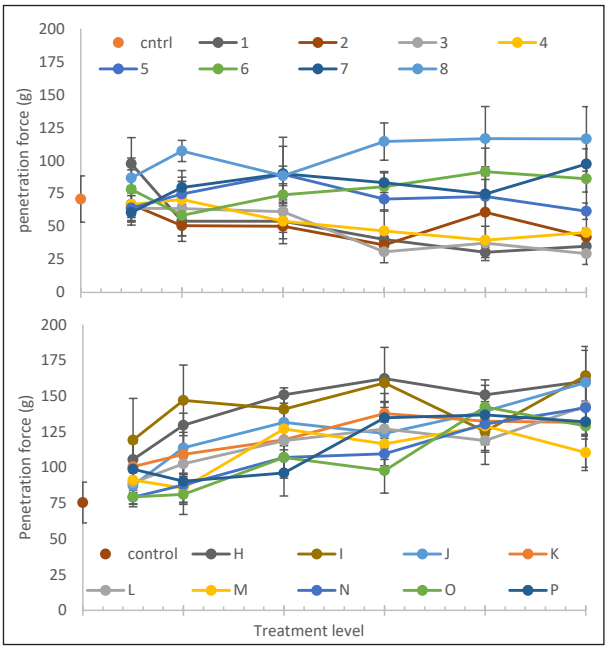
Ornamental flower producers call for a more sustainable solution for growing small plants, where fossil based 'glued plugs' are currently used. We produced biobased and biodegradable plugs of similar strength as current fossil based 'glued plugs'. The intention was to use these plugs for growing ornamental plants, such as geraniums and pansies, in greenhouses for later transplanting to larger pots. Strong or so called glued plugs are a prerequisite for successful transplanting of some plants since these species do not grow strong roots. Unfortunately, our strong biobased and biodegradable plugs negatively influenced the root growth of the ornamental plants, and thus are not yet an alternative for ornamental flower production. More work is needed before a commercially interesting sustainable plug is available with enough strength that allows plant root growth for the ornamental flower production industry.

Why do we need biobased plant substrate binders?

Some ornamental plants do not develop a strong root system early in their development. When these plants are grown on a large scale in trays, the root systems cannot hold the growth substrate or "plug" together when they are transplanted to larger containers. The breakdown of the plug can damage the roots and negatively affect the growth after transplanting. The current solution is to use "glued plugs" where fossil based "glue" is used to hold the substrate together, reducing the chance of damage during transplantation. The glued plugs have disadvantages; they require additional handling since they are from an outside producer, are expensive and not environmentally friendly since the glue is fossil based. The preferred solution to this problem is a biobased binder material that meets 5 main criteria: 1) strong enough to not fall into pieces when transplanted, 2) able to support plant growth, 3) be environmentally friendly, i.e., biobased and biodegradable by composting, 4) readily available in significant quantities with consistent quality and low cost, and 5) can be integrated into the current production systems.

Wishes of the ornamental flower production industry

The ornamental flower production industry (i.e. Syngenta AG) wanted a biobased and biodegradable alternative to their current fossil based glued plugs that could fit into their present production system and did not require additional handling. To fulfil these requirements, we aimed at the development of a plug with the following characteristics; i) made of biobased materials, ii) biodegradable, iii) similar strength as commercial glued plugs, iv) having an easy flow in the existing tray filling machines, v) being friendly to the seeds, vi) having similar water holding capacity as current plugs to maintain seed growth by supporting proper root aeration and drainage, and vii) not negatively impact the development and growth of the plants of interest.



Effect of protein binder on penetration strength of plant substrate.

Options for biobased plant substrate binders

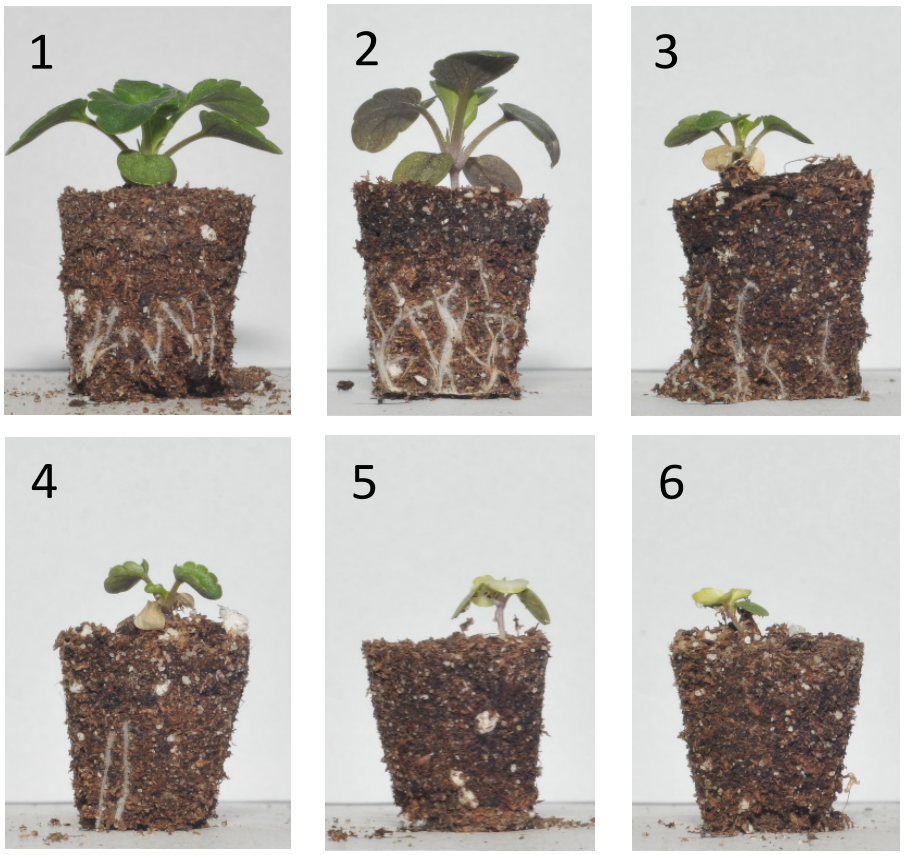
By building on results from previous Partnerskap Alnarp projects (Johansson et al. 2016, 2017), in which plant proteins have been used as binders in seed pelleting, we were able to develop biobased and biodegradable plugs of similar strength as commercially glued plugs.

These experiments were performed with 2 commercially available plant protein types, one with 6 modifications and the other with 8 and 6 addition levels for each. Most of the experimental conditions showed similar or better strength compared with the commercially glued plugs using a penetration test. However, a strength plateau existed in dosage level and differences were observed between protein type and applied modifications indicating potential candidates for plant growth tests.

The promising formulas were further explored with up to 8 modifications and multiple dosing levels, resulting in over 90 different protein-based binder conditions for greenhouse trials. In addition to protein-based binders we also explored starches, but they showed increased adhesion to the planting tray making their use unsuccessful. Natural fibres were added to the plugs at 3 levels to improve mechanical binding in the substrate. The particle distribution in the standard substrate was modified to examine its effect on the ability of the substrate to hold together on plant transfer. Biobased release agents were applied to the surface of the plant trays to decrease the force required for plant removal, to reduce young plant damage.

Results of greenhouse trials

Seeds of the ornamental plants of interest were sown in the selected formulations, standard commercial substrate and glued plugs. Plant



Effect of protein binder on root development: 1. Current "glued plug", 2. Standard substrate, 3-6 increasing protein binder level.

growth was studied for 4 weeks. The general conclusion from these trials is that our biobased and biodegradable plugs impacted the plant growth negatively i.e. among the conditions tried, no successful combination was found. Increasing protein levels had a detrimental effect on root development and plant growth. At the lowest addition levels there was less of an effect on plant growth, but then the plug strength was not comparable to the glued plugs.

Another negative effect observed in some of our biobased and biodegradable plugs was increased mould growth during seed germination which might have an impact on plant development. If biobased plugs should be used in the future they may have to be modified or additives used to protect against mould growth, such solutions are available as shown in our previous work (Wu et al. 2016). Furthermore, issues such as substrate stuck to the container surface and poor root penetration are other factors needing a solution. Weak root growth might be the reason for decreased plant growth observed in our biobased plugs. In the cases where plant fibres were added to the substrate the fibres had a previously unobserved negative effect on root growth, resulting in underdeveloped plants, outweighing any reinforcing effect.

Conclusions

We found that for the biobased plugs developed, any positive plug strengthening effect was offset by decreased root growth. In principal, growth of the plants own roots must be seen as the most effective way to hold the substrate together. Any treatment that reduced root development thereby contributed a negative effect on plug performance. The current commercial solution, 'glued plugs', showed the best root development indicating that their performance may be due to improved root structure more than the substrates strength.

In order to find a solution to the problem of non-sustainable plugs for ornamental flower production, the focus should be on the improvement of young plant root development. Biobased additions must be found that not only bind the substrate together but support root growth. Encouraging the roots themselves will improve substrate binding while maintaining healthy plant growth.

References

Johansson E, Newson WR, Kuktaite R, Fredlund K, Malik AH (2016) Biobaserad utsädespelletering – gynnsamt för miljön och för utveckling och tillväxt hos den unga sockerbetan. LTV-fakultetens faktablad 2016:4

Johansson E, Newson WR, Fredlund K, Malik AH (2017) Proteinbaserad utsädespelletering – för ökad avkastning hos sockerbeta? LTV-fakultetens faktablad 2017:8

Wu Q, Shun S, Kollert M, Mtimet M, Roth SV, Gedde UW, Johansson E, Olsson RT, Hedenqvist MS. (2016) Highly absorbing antimicrobial biofoams based on wheat gluten and its biohybrids. ACS Sustainable Chemistry & Engineering. 4:2395-2404

- Participating researchers: William R. Newson and Eva Johansson, Swedish University of Agricultural Sciences; Department of Plant Breeding; Piet van Marrewijk and Marten Denekamp, Syngenta AG

- Faktabladet är utarbetat inom LTV-Fakultetens Instutionen av Växtförädling, www.slu.se/institutioner/vaxtforadling/
- Projektet är samfinansierat av Partnerskap Alnarp och Syngenta AG

- Projektansvarig Eva Johansson, huvudförfattare till detta faktablad är William R Newson och Eva Johansson, eva.johansson@slu.se, www.slu.se/institutioner/vaxtforadling/personal/

- På webbadressen http://epsilon.slu.se kan detta faktablad hämtas elektroniskt