



INTERNATIONAL INSTITUTE  
OF SUGAR BEET RESEARCH

# ABSTRACTS OF PAPERS

79<sup>TH</sup> IIRB CONGRESS

**Innovation: our driver for a profitable  
and ecologically balanced  
sugar beet production**

**27 – 28 February 2024**

**Hotel Le Plaza**

**Brussels, Belgium**

**Table of Contents****Oral presentations****Session 1: Reviewing innovative weed control approaches**

- 1.1 Peter Risser, Horst Stauffer-Bescher: Digitalisation in weed control using AI and robotics – results from an integrated field trial design in sugar beet ..... 1
- 1.2 Oliver Schmittmann *et al.*: Development of a method for testing weeding-technologies in field, using the quality determination of spot-sprayer as an example ..... 2
- 1.3 Olga Fishkis: Holistic assessment of sustainability, procedural and economic efficiency of conventional and novel weed control techniques..... 3

**Session 2: Leaf disease forecast and management**

- 2.1 Nathan A. Wyatt *et al.*: Understanding the complete disease cycle of *Cercospora beticola*, progress towards a comprehensive Cercospora leaf spot forecasting model..... 4
- 2.2 François Joudelat *et al.*: CERCOCAP: Managing cercospora with modeling and IoT cameras ..... 5
- 2.3 Bram Hanse, Arjen Buijze: Innovation for a profitable and ecologically balanced management of foliar diseases in sugar beet..... 6
- 2.4 Abel Barreto *et al.*: Site-specific leaf disease management in sugar beet fields based on high resolution multispectral UAV imagery..... 7

**Session 3: Managing insect-related threats**

- 3.1 Bojan Duduk *et al.*: Phytoplasmas infecting sugar beet in central Europe. 8
- 3.2 Pierre Longerstay *et al.*: Stolbur – An additional challenge in sugar beet growing associated to syndrome basses richesses (SBR) ..... 9
- 3.3 Svenja Bänsch, Maria Köhler: Presence, life cycles and monitoring of soil insect pests to better understand possibilities for control ..... 10
- 3.4 Linda Geenen-Frijters *et al.*: The efficacy of new seed treatments to control *Atomaria linearis* and other soil pests in sugar beet ..... 11
- 3.5 Corentin Sochard: New insights on the sugar beet weevil *Lixus juncii*..... 12

**Session 4: Alternative pest control / IPM**

- 4.1 Nika Jachowicz *et al.*: Conservation biological control potential in sugar beet fields in Denmark ..... 13
- 4.2 Chloé Dufrane *et al.*: Companion plants to control pests in sugar beets .. 14
- 4.3 Benedict Wieters *et al.*: FlowerBeet: biological control of aphids by beneficial insects through integrated flowering strips..... 15
- 4.4 Sharella Schop: Mature plant resistance in sugar beet..... 16

**Session 5: Breeding approaches for virus yellows control**

- 5.1 Mario Schumann *et al.*: European wide monitoring of yellowing viruses and its implications for testing new virus yellows control strategies..... 17
- 5.2 Jan Sels *et al.*: Flavie – a collective, multi-stakeholder effort to propose varietal solutions against virus yellows ..... 18
- 5.3 Michael Stange *et al.*: The breeding challenge of our time: yellowing viruses..... 19
- 5.4 Julia Bengtsson *et al.*: Research and breeding for resistance and tolerance to virus yellows ..... 20
- 5.5 Suzannah Harder: Strain variation in virus yellows and consequences for future virus resistant/tolerant varieties ..... 21

**Session 6: Resistance potential of beet genetic sources**

- 6.1 Felix L. Sandell *et al.*: Genomic analysis of wild and cultivated beets ..... 22
- 6.2 Kevin Dorn: Beet crop wild relative germplasm mining uncovers new sources of disease resistance..... 23
- 6.3 Lukas Rollwage *et al.*: Virus yellows disease in sugar beet – resistance mechanism for the future ..... 24
- 6.4 Rajtilak Majumdar *et al.*: Genome, transcriptome, and metabolome analyses reveal distinct metabolic alterations in the ethyl methanesulfonate (EMS) mutant sugar beet breeding lines resistant to rhizomania ..... 25

**Session 7: Advances in agronomy**

- 7.1 Dennis Grunwald *et al.*: Soil carbon dynamics under sugar beet cultivation – what do we really know? ..... 26
- 7.2 Marisol Campoverde, Remy Duval: How can sugar beet crop management contribute to improve the field cropping systems carbon footprint? ..... 27
- 7.3 Jens Loel *et al.*: Innovative seed treatment solutions for future-proof sugar beet growing ..... 28
- 7.4 Thomas Leborgne: PREVIBEST: Apprehend the risk of soil compaction during beet harvest ..... 29
- 7.5 William English *et al.*: Modelling sugar beet clamp temperature ..... 30

**Poster abstracts****1 Agronomy****Fertiliser use and optimisation**

- 1.1 Ivana Bajić *et al.*: Effect of nitrogen mineral nutrition in extreme climatic conditions on sugar beet production ..... 32
- 1.2 Przemysław Barłóg *et al.*: Content and accumulation of nutrients by sugar beet varieties differing in yield potential and tolerance to pathogen pressure ..... 33
- 1.3 Dirk Hyndriks *et al.*: Nitrogen and energy use in sugar beet ..... 34
- 1.4 André van Valen: Effects of different nitrogen fertilisation strategies on sugar beet growth and yield..... 35
- 1.5 André van Valen: Effects of sodium fertilisation in sugar beet on sandy soils in the Netherlands..... 36
- 1.6 Gereon Heller *et al.*: CULTAN – An alternative fertilisation method in sugar beet in the face of sustainable change? ..... 37
- 1.7 Olivera Popov *et al.*: Application of mealworm FRASS fertiliser in sugar beet production: Step towards profitable and ecologically balanced sugar beet production ..... 38
- 1.8 Dietmar Horn *et al.*: Development of humus-C, EUF extractable organic nitrogen (N<sub>org</sub>) and EUF dissolved organic carbon (DOC) in long-term field trial with different precrops and N-, P-, K-fertilisation strategy ..... 39
- 1.9 Ruska Kaipainen: New methods of increasing carbon sequestration on sugar beet fields in Finland ..... 40
- 1.10 Susanna Muurinen: LASSO – use the Nitrogen and bind the Carbon..... 41
- 1.11 Georgina Barratt: Optimising sugar beet management practices to reduce greenhouse gas emissions ..... 42

**Irrigation and drought tolerance**

- 1.12 Asa Olsson Nyström, Lars Persson: Long-term effects of liming in crop rotations with sugar beet ..... 43
- 1.13 Rachel P. Naegele *et al.*: Seedling drought tolerance in sugar beet is predicted by leaf water vapor and stomatal conductance ..... 44
- 1.14 Juliette Adrian *et al.*: Description of the dynamics of water stress in sugar beet crops ..... 45
- 1.15 Paul Tauvel *et al.*: Evaluating and optimizing strategies to irrigate sugar beet ..... 46
- 1.16 Kibrom B. Abreha *et al.*: Drought tolerance screening of sugar beet lines under greenhouse and field conditions ..... 47



|  |    |
|--|----|
| 1.17 Dirk Hyndriks <i>et al.</i> : Robust trialling under climate change .....   | 48 |
| <b>Root analysis</b>   |    |
| 1.18 Ludmilla Dahl <i>et al.</i> : Sugar beet fine root distribution: root imaging analysis platform for sugar beet root system measurement .....                              | 49 |
| 1.19 Jessica Arnhold <i>et al.</i> : A deeper look – root growth observations with the minirhizotron technique .....   | 50 |
| <b>2 Storage</b>   |    |
| 2.1 Agnieszka Andrusiak <i>et al.</i> : Quality Parameters of sugar beet roots depending on the method of harvesting and length of storage .....                               | 51 |
| 2.2 Gerardus Croonen: AI-based detection and quantification of soil adhesion, excess vegetation, damage and rot on sugar beets .....   | 52 |
| 2.3 Martijn Leijdekkers <i>et al.</i> : Effect of different virus yellows infection timepoints on storability .....  | 53 |
| 2.4 Shyam L. Kandel <i>et al.</i> : Use of low concentration chlorine dioxide gas to manage storage disease in sugar beets .....   | 54 |
| 2.5 Joakim Ekelöf, André Wauters: Quick tests for sugar beet respiration ....  | 55 |
| 2.6 Karen Fugate <i>et al.</i> : Transcriptional and metabolomic changes in postharvest sugar beet roots identify genes potentially involved in respiratory sucrose loss ..... | 56 |
| 2.7 Daria Ilina <i>et al.</i> : Disentangling factors related to storability in sugar beet from different (molecular) angles .....   | 57 |
| <b>3 Breeding</b>  |    |
| <b>Breeding methods</b>  |    |
| 3.1 Carolina Diller <i>et al.</i> : Improving emasculation success in sugar beet .....   | 58 |
| 3.2 Bettina Müller <i>et al.</i> : Phenomic selection using Near-Infrared (NIR) wavelengths: a new tool to predict sugar yield .....   | 59 |
| 3.3 Rachel P. Naegele, Linda E. Hanson: The USDA ARS East Lansing sugar beet breeding programme: adapting to meet the needs of a changing industry .....                       | 60 |
| 3.4 Fernando Finger, Karen Fugate: Expression of SWEET and TST sugar transporters during sugar beet growth and taproot storage .....   | 61 |
| 3.5 Torben Erichsen <i>et al.</i> : The challenge to produce a representative sugar beet sample .....  | 62 |
| <b>Bolting resistance</b>  |    |
| 3.6 Giovanni Campagna, Tommaso Iaboli: Varieties with a reduced degree of induction to early flowering for autumn sowing in the beet growing areas of COPROB (Italy) .....     | 63 |

|  |    |
|--|----|
| 3.7 Chenggen Chu: Genetic analysis of genes controlling annual and biennial growth habit in sugar beet germplasm .....   | 64 |
| <b>Remote sensing for breeding and precision farming</b>   |    |
| 3.8 David Eyland <i>et al.</i> : Remote sensing technologies for data-driven plant breeding .....  | 65 |
| 3.9 Simon Jeppson: The use of unmanned aerial vehicles (UAVs) in sugar beet cultivation .....  | 66 |
| 3.10 Francois Joudelat, S. Soubreyrand: Satellite imagery use-cases for sugar beet monitoring .....  | 67 |
| 3.11 Otto Nielsen, Casper Szilas: Quantification of soil parameters and agricultural product interactions using field mapping, precision farming technologies and vegetation indexes – a GIS-based alternative to classical field trials ..... | 68 |
| <b>4 Phytopathology</b>  |    |
| <b>Fungal leaf diseases</b>  |    |
| 4.1 Quentin Tilloy: Cristal Cerc'OAD®: a cercospora forecasting model used by farmers .....  | 69 |
| 4.2 Klara Pavlu <i>et al.</i> : 3 years of experience with the upgraded signalling system of <i>Cercospora beticola</i> .....  | 70 |
| 4.3 Alix Hubaux, André Wauters: Efficacy of foliar fungicides to control <i>Cercospora beticola</i> .....  | 71 |
| 4.4 Agnieszka Kiniec, Jacek Piszczek: The in vitro activity determination of essential oils against <i>Cercospora beticola</i> .....   | 72 |
| 4.5 Friedrich Kempf, Marion Seiter: Control of resistant <i>Cercospora</i> leaf spot by fungicides and tolerant varieties .....  | 73 |
| 4.6 Austin K. Lien <i>et al.</i> : DMI fungicide sensitivity in <i>Cercospora beticola</i> following forced selection from repeated application and tank-mixing ...  | 74 |
| 4.7 Ashok K. Chanda, Austin K. Lien: Management of rhizoctonia root rot and <i>Cercospora</i> leaf spot in sugar beet .....  | 75 |
| 4.8 Annabelle Buckley: The sweet side of fungicides – physiological effects of fungicides on sugar beet growth and yield .....   | 76 |
| 4.9 János Kimmel <i>et al.</i> : Optimisation of fungicide control with copper against <i>Cercospora beticola</i> .....  | 77 |
| 4.10 László Potyondi <i>et al.</i> : Change in copper content in beet leaves by using various copper compounds and adjuvants under the influence of precipitation .....  | 78 |
| 4.11 Yixuan Yang <i>et al.</i> : Impact of cultivar resistance on <i>Cercospora beticola</i> epidemiology on sugar beet .....  | 79 |



|   |    |
|---|----|
| 4.12 Angharad Compton <i>et al.</i> : Integrated fungal foliar disease management of sugar beet .....   | 80 |
| 4.13 Anne Lisbet Hansen, Philipp Trénel: Interactions between crop biomass and development of leaf diseases in sugar beet with the potential to graduate fungicide applications ..... | 81 |
| 4.14 Jinquan Li <i>et al.</i> : QTL mapping for a monogenic resistance of powdery mildew in sugar beet .....  | 82 |
| 4.15 Dirk Hyndrixx <i>et al.</i> : Breeding for robust and durable leaf disease tolerance – doing more with less? .....   | 83 |
| 4.16 Emma Thorell, Valentina Rossi: Breeding as a mitigation tool to reduce reliance on chemicals.....  | 84 |
| 4.17 Emma Thorell, Linda Ripa: Multigenic resistance leads the way on sustainable <i>Cercospora</i> leaf spot control .....   | 85 |
| 4.18 Henning Ebmeyer <i>et al.</i> : CR+ Management Goal: GREEN LEAVES UNTIL HARVEST – An integrated management concept for <i>Cercospora</i> control in sugar beet.....              | 86 |
| 4.19 Jens Christoph Lein <i>et al.</i> : Gaining ground against <i>Cercospora</i> – sustainable disease control with CR+.....   | 87 |
| <b>Rhizomania / Soilborne diseases</b>  |    |
| 4.20 Maria Fattori, Britt-Louise Lennefors: Survey of Rhizomania <i>Rz1</i> resistance break-down in North Africa and Middle East.....  | 88 |
| 4.21 Vanitharani Ramachandran <i>et al.</i> : Molecular characterisation of rhizomania resistance-breaking isolates of beet necrotic yellow vein virus in the United States .....     | 89 |
| 4.22 Armin Shahpari, Julie Lissens: Apha.Bio's APEX platform: screening for biocontrol microorganisms against soilborne diseases in sugar beet ....                                   | 90 |
| 4.23 Bradley Dotson <i>et al.</i> : Breeding for better biocontrol symbiosis of <i>Trichoderma</i> against <i>Aphanomyces</i> .....   | 91 |
| <b>Virus yellows monitoring and control</b>   |    |
| 4.24 Michael Stange <i>et al.</i> : MODEFY – MONitoring and DEFence measures against Yellowing virus diseases in sugar beet .....   | 92 |
| 4.25 Alistair JD Wright, Mark Stevens: Optimising the use of UAV-remote sensing to phenotype varietal tolerance to virus yellows .....  | 93 |
| 4.26 Levine de Zinger <i>et al.</i> : National variety list admission criteria for varieties with virus yellows tolerance in the Netherlands .....                                    | 94 |
| 4.27 Nils Klingemann <i>et al.</i> : Managing virus yellows in sugar beet – an integrated approach .....  | 95 |

|  |     |
|--|-----|
| 4.28 Valérie Cadot <i>et al.</i> : A new protocol to assess tolerance/ resistance for sugar beet varieties to virus yellows .....  | 96  |
| 4.29 Marine Delsaux, Eric Dubert: Resistance and tolerance to virus yellows in hybrids from DLF Beet Seed .....  | 97  |
| 4.30 Vinitha Puthanveed <i>et al.</i> : Transcriptomic study on responses of sugar beet to beet mild yellowing virus .....   | 98  |
| 4.31 Jung Lin Ni <i>et al.</i> : Efficient and high-throughput identification of viruses in sugar beet.....  | 99  |
| 4.32 Sharella Schop: Multiplex and Luminex assay for the detection of yellowing viruses.....   | 100 |
| 4.33 Pierre Hellin <i>et al.</i> : Monitoring of beet yellows-associated viruses in Wallonia, Belgium .....  | 101 |
| 4.34 Isabelle Stockmans <i>et al.</i> : The VirBiCon project: Towards sustainable management of viral yellowing in sugar beet .....  | 102 |
| 4.35 N. Rojas-Preciado <i>et al.</i> : Forecasting the incidence of viral yellowing in sugar beet: Identification of risk factors .....                                    | 103 |
| 4.36 Ellen Everaert <i>et al.</i> : Prevalence and virulence of yellowing viruses .....  | 104 |
| 4.37 Stephanie Coenen <i>et al.</i> : First attempt to map progress of virus yellows patches in different varieties .....  | 105 |
| 4.38 Margot Beelaert <i>et al.</i> : Understanding the beet yellows drivers in divers landscape contexts .....   | 106 |
| 4.39 Beelaert Margot <i>et al.</i> : Virobett – Understanding the spread of sugar beet yellows viruses to improve integrated pest management strategies .....              | 107 |
| <b>Pest control</b>  |     |
| 4.40 Sophia Czaja <i>et al.</i> : Aphid monitoring in sugar beet – an important component in integrated pest management.....   | 108 |
| 4.41 Juliane Schmitt <i>et al.</i> : SIMAphid – a simulation model for the first occurrence of <i>Myzus persicae</i> in spring, a vector of viruses in sugar beet .....    | 109 |
| 4.42 Marie Gilard, André Wauters: Observation and warning network for insect pests .....   | 110 |
| 4.43 Chloé Dufrane <i>et al.</i> : Intercropping beet-barley to reduce aphid populations in sugar beet fields in Belgium .....   | 111 |
| 4.44 Olivera Popov <i>et al.</i> : Transmission risks of Beet Yellows Virus by <i>Myzus persicae</i> and <i>Aphis fabae</i> aphids in diverse experimental conditions .... | 112 |
| 4.45 Amélie Monteiro: Assessments of solutions against <i>Myzus persicae</i> to prevent Sugar beet Yellows .....   | 113 |



|   |     |
|---|-----|
| 4.46 Kévin Tougeron: Agro-ecological infrastructures to help control aphids .....   | 114 |
| 4.47 Tarek Dardouri <i>et al.</i> : Control of sugar beet yellows viruses by behavioural manipulation of aphid vectors in the field via volatiles .....   | 115 |
| 4.48 Mark Stevens <i>et al.</i> : Beet moth monitoring in the north-west of Europe  | 116 |
| 4.49 Elma Raaijmakers: Row application of insecticides and the use of green insecticides to achieve goals of the farm to fork strategy .....  | 117 |
| 4.50 Suzanne Gunter <i>et al.</i> : Beet the future; different approaches .....   | 118 |
| 4.51 Christel A. Roß, Nicol Stockfisch: Appropriate indicators for monitoring chemical plant protection use in sugar beet cultivation .....   | 119 |
| 4.52 Giovanni Campagna, Tommaso Iaboli: <i>Lixus junci</i> diffusion on sugar beet in Po Valley and control strategy .....  | 120 |
| 4.53 Darija Lemic <i>et al.</i> : Evaluating sugar beet varieties and seed treatments for enhanced pest control .....   | 121 |
| 4.54 Martina Dokal, Marion Seiter: Efficacy of a new Active ingredient in sugar beet coating .....  | 122 |
| 4.55 Zdzisław Klukowski, Jacek Piszczek: Modeling the spring migration timing of Beet Root Weevil ( <i>Asproparthenis punctiventris</i> (Germ.)) based on the sum of effective temperatures .....               | 123 |
| 4.56 Azra Kurtovic <i>et al.</i> : Data- and model-based prediction of the sugar beet weevil occurrence .....   | 124 |
| 4.57 Katharina Sielemann <i>et al.</i> : Characterisation of a nematode tolerance locus in sugar beet .....   | 125 |
| <b>RTD and SBR</b>  |     |
| 4.58 Živko Ćurčić <i>et al.</i> : Field trial evaluation to RTD susceptibility/tolerance to RTD in Serbia: Is there a tolerance to RTD in current varieties? .....  | 126 |
| 4.59 Britt-Louise Lennefors <i>et al.</i> : Syndrome basses richesses, stolbur and Macrophomina; experiences shared by DLF Beet Seed .....  | 127 |
| 4.60 Olaf Czarnecki <i>et al.</i> : Deploying wild beet resistance sources for breeding SBR and RTD tolerant sugar beet varieties .....   | 128 |
| 4.61 Helen Pfitzner <i>et al.</i> : Understanding the threat: the planthopper <i>Pentastiridius leporinus</i> and its impact on sugar beet cultivation in Southwest Germany .....                               | 129 |
| 4.62 Christian Lang <i>et al.</i> : Bacterial Tuber Wilt in potato ( <i>Solanum tuberosum</i> ) and its implications for sugar beet ( <i>Beta vulgaris</i> subsp. <i>vulgaris</i> ) cultivation in Europe ..... | 130 |

|  |     |
|--|-----|
| 4.63 Manuela Schieler <i>et al.</i> : SIMPenta – a simulation model for the population dynamics of <i>Pentastiridius leporinus</i> , a vector of phytopathogenes in sugar beet ..... | 131 |
| 4.64 Jonas Bömer <i>et al.</i> : Three-dimensional examination of the tap root of SBR affected sugar beet .....  | 132 |
| 4.65 Justus Detring <i>et al.</i> : Optical properties of SBR-diseased sugar beet and development of automated phenotyping routines .....  | 133 |
| 4.66 B. Kais <i>et al.</i> : Influence of SBR on phloem sap composition of sugar beet and the behavior of its vector <i>Pentastiridius leporinus</i> .....                           | 134 |
| <b>5 Weed Control</b>  |     |
| 5.1 Jakob Berg, Heinz Bernhardt: Herbicide reduction in sugar beet cultivation by band spraying and mechanical weed control .....  | 135 |
| 5.2 Mikkel Nilars, Otto Nielsen: Optimal use of herbicides in combination with mechanical weed control .....   | 136 |
| 5.3 Thomas Leborgne: Overview of the latest spot spraying technologies in beet .....   | 137 |
| 5.4 Susanna Muurinen: FarmDroid FD20 robot on the sugar beet and winter rapeseed rows in Finland .....   | 138 |
| 5.5 Sjef van der Heijden: Effectiveness of various herbicides pre-emergence in sugar beet .....  | 139 |
| 5.6 Sjef van der Heijden: Resistant ryegrass in sugar beet .....   | 140 |
| 5.7 Maik Gertz <i>et al.</i> : CONVISO® SMART: driving innovation in sugar beet weed control .....   | 141 |
| 5.8 Max Lucas Wilhelm: CONVISO® SMART launch Germany – customer satisfaction and stewardship management hand in hand .....   | 142 |
| 5.9 Christina Wellhausen <i>et al.</i> : Control of groundkeepers from ALS-tolerant sugar beet in following crops .....  | 143 |
| 5.10 Giovanni Campagna, Tommaso Iaboli: Experience of weed control strategy Conviso One on sugar beet in Po Valley .....   | 144 |
| 5.11 Giovanni Campagna, Tommaso Iaboli: Experience of weed control strategy groundkeeper sugar beet in Po Valley .....   | 145 |
| 5.12 Marion Seiter <i>et al.</i> : To get most out of Conviso Smart varieties .....  | 146 |



1.7 OLIVERA POPOV<sup>1</sup>, IVANA BAJIĆ<sup>1</sup>, MATIJA MILKOVIĆ<sup>2</sup>, ŽIVKO ĆURČIĆ<sup>1</sup>

<sup>1</sup> Institute of Field and Vegetable Crops, 30 Maksima Gorkog, SR – 21000 Novi Sad

<sup>2</sup> Faculty of Agriculture, University of Belgrade, 6 Nemanjina, SR – 11080 Beograd

**APPLICATION OF MEALWORM FRASS FERTILISER IN SUGAR BEET  
PRODUCTION: STEP TOWARDS PROFITABLE AND ECOLOGICALLY  
BALANCED SUGAR BEET PRODUCTION**

To address the growing demand for sugar, sugar beet production must be increased. However, conventional chemical fertilisers, essential for root growth and yield quality, are environmentally harmful due to factors like greenhouse gas emissions and organic pollution. To address this issue, we need to consider eco-friendly organic alternatives, such as FRASS, which is the residue from mealworm larval excrement. FRASS is rich in essential nutrients (ESN), including nitrogen (N), phosphorus (P), and potassium (K). In our study, we aim to explore the potential of FRASS as an environmentally innovative fertiliser for sugar beet production, given the increasing popularity of mealworm farming. In a field experiment, we compared the efficacy of pre-sowing fertilisation on two sugar beet varieties using three different models of two fertiliser concentrations (N:P:K 80:60:40 & N:P:K 40:30:20 ): pure mealworm FRASS, a combination of FRASS and mineral fertiliser, and pure mineral fertiliser (NPK). Our goal was to maintain the same level of ESN between NPK fertilisers and FRASS. To achieve this, we calculated that 2 t/ha of FRASS are required to match the N:P:K 80:60:40 ratio, while 1 t/ha of FRASS suffice for N:P:K 40:30:20. For trials involving combined fertilisers, we adjusted the FRASS quantity to maintain consistent ESN levels with pure FRASS/NPK, halving the FRASS amount previously used. In NPK fertilisers, the same nutrient sources were used:  $\text{CO}(\text{NH}_2)_2$  for N,  $(\text{NH}_4)(\text{H}_2\text{PO}_4)$  (MAP) for P, and KCl for K. Results indicated no significant difference in sugar content between the treatment groups and the control. However, there were significant variations in sugar yield and root yield. The most effective treatment for sugar yield was the combination of NPK in N:P:K 80:60:40 concentration and FRASS. In contrast, for root yield, both combinations of N:P:K 40:30:20 and FRASS, and N:P:K 80:60:40 with FRASS, were equally effective. These findings suggest that FRASS has potential as a partial or complete alternative to NPK fertilisers.