APPENDIX 4:
PROGRESS REPORT
THE PROMOTION OF CONSERVATION AGRICULTURE IN THE NORTH-EASTERN FREE STATE – PHASE 1 (TWO STUDY AREAS)

For the period:
October 2017 to September 2018

Compiled by:
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In collaboration with:
Riemland (Reitz) and Ascent (Vrede) study groups

September 2018

GRAIN SA
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The Maize Trust

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1. Introduction

This progress report covers the period of October 2017 to September 2018 of the implementation of a project funded by The Maize Trust (MT)**,** which will assist to scale out Conservation Agriculture (CA) to grain farmers in the north-eastern Free State Province. The north-eastern and eastern parts of the Free State are seen as key grain producing areas and have very suitable conditions (soil and climate) to practice CA, however, the area still has a very low adoption percentage of farmers practising CA. Consequently, this area has been identified by Grain SA's CA Farmer Innovation Programme (CA-FIP) as a target area to promote CA among farmers in order to improve their sustainability and profitability. The Grain SA CA-FIP uses innovative, well organised and interested farmers and/or their structures (e.g. study groups, clubs, associations, etc.) as platform to launch projects and scale out CA to the surrounding farming communities. In this respect two active study groups, namely Ascent (Vrede district) and Riemland (Reitz district) have agreed to serve as platforms to launch projects in these two study areas. The study groups have consequently been engaged in various planning and implementation activities for the 2015/16 season, which have all been included in various work packages that serve as the framework for this proposal.

2. Description of the targeted study area(s)

The two study areas identified (listed below) were described in detail (Grain SA, March 2015).

The Frankfort-Vrede Plain occupies most of the northern half of the study area, south of the Vaal River. The underlying geology is mainly mudstone and sandstone of the Adelaide Formation, Beaufort Group with, in the north-east, shale of the Volksrust formation, Ecca Group. Dolerite intrusions occur frequently. The soils are mainly dark, swelling clays of the Arcadia form along with duplex soils (sandy, often bleached topsoil abruptly overlying gleyed clay) of the Estcourt and Kroonstad forms, especially in the north-west.

The Bethlehem-Reitz Basin, in the west of the area, is underlain mainly by mudstone and sandstone of the Tarkastad Formation, Beaufort Group. The soils here are mainly grey and yellow, sandy loam to sandy clay loam soils with grey, mottled plinthic subsoils, belonging to the Avalon, Westleigh and Longlands forms. Duplex soils, as well as shallow, rocky soils of the Mispah form, are also present.

3. Targeted beneficiaries or key project participants

Two separate farmer-centred Innovation Platforms (IP's) or project study areas have been established around the Ascent and Riemland farmer study groups, which will target farming communities in the following Grain SA regions (and districts): Region 15 (Heilbron, Frankfort and Vrede) and Region 18 (Reitz and Lindley). Each of these two regions constitute fairly homogeneous agro-ecological conditions, which will facilitate the scaling out of CA practices from the representative project sites and trials on selected (or volunteering) farmers' fields (in the Vrede and Reitz districts).

It is envisaged that the IP's will be able to create a general awareness and innovation capacity among the farming communities in these regions and even beyond their borders. A small percentage of grain producers (<5%) follow CA practices, although a substantial (but unknown) percentage do follow some form of reduced tillage practice. The reasons for the poor adoption of CA is not well-understood, but are most probably and primarily due to a lack of information and awareness of the principles, practices and long term benefits of CA on farming. It is of utmost importance to break this cycle of ignorance and empower farmers with a truly sustainable farming system.

4. Project aim

The aim of the project is:
To promote conservation agriculture in key grain producing areas of the North-eastern Free State through a farmer-centred innovation process.

4.1. Objectives

The following short-term objectives will assist the project in achieving its aim:
a) To establish and facilitate on-farm trials around two local farmer structures (i.e. the Ascent and Riemland study groups)
b) To monitor and analyse a series of on-farm, farmer-led trials on selected farmers' fields
c) To create wider awareness and innovation capacity in local farming communities on the practices and benefits of locally adapted CA systems.
d) To support farmer facilitation, administration and reporting processes.

In order to effectively implement the above short-term objectives, a number of cross-cutting **work packages** were designed with each having a designated person or institution to implement and manage the specific activities and budget (see Section 11 below for detailed discussion of work packages). **Table 1** shows the different work packages and responsible champions in each project:

Table 1: Work packages and lead partners in Riemland and Ascent projects

Work Package	Lead partner - Riemland	Lead partner - Ascent
1. Coordination and management	Danie Slabbert (Riemland study group)	Paul Zietsman (Ascent study group)
2. Assessment of soil quality under CA systems	Lientjie Visser (ARC); Willie Pretorius (Soil Health Solutions)	Paula Lourens (Vermi Solutions), Willie Pretorius (Soil Health Solutions)
3. Assessment of cover crop adaptability and suitability	Gerrie Trytsman (ARC-API)	Gerrie Trytsman (ARC-API)
4. Agronomic field trial planning, analyses and reporting	Willem Killian (ARC-SG)	Willem Killian (ARC-SG)
5. Coordination and facilitation of project activities among farmer participants	Jacques van Zyl (VKB)	Jacques van Zyl (VKB)

5. Project approach and rationale

In the original Grain SA proposal submitted in March 2015, the development and implementation of *Innovation Systems (IS)* to adapt CA principles to local (farmer) conditions has been well motivated and approved. Accordingly, and at the very least, the emphasis has to be on on-farm research and the inescapable experiential learning that this generates; both of which critically place the farmer in the central role.

Since the commencement of the implementation process in 2015, several 'actors' that influence the 'working' of the innovation process around the two project study areas, *have been 'formally' and effectively integrated with the IP's in the form of work packages and related responsibilities*. The CA FIP is confident that these two local IP's have their focus on **farmer empowerment**, i.e.

ensuring that farmers are recognised, accepted, rewarded and used as independent innovators (or researchers). Proper facilitation and coordination of this farmer-led innovation process and its various activities is crucial and in the light of this IS philosophy, local resources (people) took up these responsibilities quite effectively. The CA facilitator at Grain SA (Dr Hendrik Smith), who manages and implements the CA-FIP, fulfils an overarching role in this respect. Another prominent local stakeholder, namely VKB, is playing a vital role at both sites as project or farmer facilitators, as well as implementing and monitoring field trials and other activities.

The key elements of the CA-FIP project approach are as follows:

5.1. Farmer-centred Innovation Systems Research

CA is defined by three key principles that have to be applied simultaneously and adapted to each farm ecosystem, namely minimal mechanical soil disturbance, permanent organic soil cover and crop diversity. The inescapable consequence of this is that farmers have to function as applied ecologists who have to fine-tune (adapt) universal principles to their own social, economic and ecological circumstances. As mentioned above, farmers are the adopters, the adapters and often the innovators of new farming techniques through an **on-farm, farmer-led research** process.

A series of selected on-farm, farmer-led trials, where farmers are lead or equal partners (in identifying research needs, designing, implementing and evaluating experiments), will give farmers independence, ownership and control. Experiments were well designed with appropriate treatments and sufficient replications spread over the entire agro-ecological zone and/or on a sufficient number of farms (see trial designs and layouts attached). Data from properly designed experiments will provide a much stronger starting point for discussion and investigation of a farmer's claims or problems. Hence, scientifically valid data are being generated and strengthened through the involvement of agricultural scientists in group problem solving and on-farm research (through the different work packages).

5.2. Participatory monitoring, evaluation and adaptive management

There are several purposes in the use of PM&E within the CA FIP, for example to enhance shared understandings (i.e. to offer a forum that allows different stakeholders to articulate their perspectives); to increase participants' engagement, sense of ownership, and self-determination; to strengthen organizations and promote institutional learning; to encourage institutional reform towards more participatory structures; etc. In this context PM&E is regarded less as an instrument of reporting and auditing, and more as a means of *enabling organizations and groups to keep track of their progress, build on their successes, and enhance their capacities for self-reflection, learning, and responsiveness (or adaptability)*. Thus, PM&E is used in a more transformative / empowerment way to support learning and adaptive management among those involved.

The following indicators were identified and are being measured and monitored by and through the different work packages:

INDICATOR	YES / NO	MEASUREMENT	WHO (Ascent)	WHO (Riemland)
Compaction	Y	Root evaluation; bulk density; penetration resistance	Facilitator	Facilitator
Wind erosion	Y	Ground cover after plant (per Monitoring form)	Farmers & Facilitator	Farmers & Facilitator

Soil fertility	Y	Haney soil health test	Vermi Solutions	Agrisol
Soil biology / Soil structure	Y	Haney soil health test PLFA tests for soil health	Vermi Solutions	Soil Health Solutions
Rainfall	Y	Per event / 24 hour	Rain gauge	Rain gauge
Pests	Y	Monitoring form	Farmers & Facilitator	Farmers & Facilitator
Diseases (soil-borne)	N	Root rot counts	ARC	ARC
Nematodes	N	Nematode counts	NA	NA
Biodiversity	Y	Dung beetles, etc	ARC	ARC
Production	Y	Yield; kg/mm; kg/kg NPK; biomass	Farmers & Facilitator	Farmers & Facilitator
Weeds	Y	Weed counts; keep plots clear of weeds; weed control / herbicide programme	Farmers & Facilitator	Farmers & Facilitator
Mico-toxins	N			
Economy	Y	Gross margin / savings of treatments / systems economy	Farmers & Facilitator	Farmers & Facilitator
Grain quality	Y	Grading	VKB	VKB
Record keeping	Y	Description of all physical and chemical practices on treatments	Farmers	Farmers
Water content	Y	Soil moisture probes	Facilitator	Facilitator

5.3. Reference Group

A Reference Group will be coordinated for the project by Grain SA. The Reference Group (comprising key, concerned and capable persons) is tasked to provide the project team with guidance and to assist the CA-FIP in monitoring progress and evaluating deliverables. The Reference Group is only required to act in an advisory capacity. At this stage the Grain SA CA working group or CA forum fulfils this role.

Reference Group (or CA working group) meetings are scheduled at least once a year (February and August). Progress reports for the preceding period and work programmes for the following cycle are tabled and discussed at these meetings.

5.4. Awareness and marketing

General awareness (or sensitisation) has been experienced as particularly important to stimulate farmers getting involved with further learning activities, such as experimentation. The whole CA farmer innovation process usually needs an 'impulse' or an injection of energy (knowledge) to start or to speed-up the momentum and mostly it is a specific awareness event or sensitisation that achieves that. The CA-FIP sees three distinct awareness raising activities as key events during the entire CA innovation process:

- Organise cross-visits or Look & Learn visits to other successful CA communities or farmers
- Develop/distribute posters, pamphlets, videos/dvd's and other material to support the awareness raising events/campaign.
- Organise/support major or annual information days, workshops or conferences.

6. Work packages

As discussed above, a number of key stakeholders, who could play a role in the implementation of the project, were identified and involved at the start of the project. These stakeholders were invited to a planning workshop where they took part in a participatory brainstorm, identifying and prioritizing problems and solutions, consequently leading to the design of a number of Work Packages (WPs) to be implemented by selected stakeholders who were identified through these meetings. The project budget was consequently developed around these WPs, linked to various activities and deliverables. The implementation of these WPs is collectively monitored and managed through the project team, especially during site visits and monthly meetings. The on-farm trials form the basis of all the other activities in the project and will run through a number of seasons. Emphasis will be placed on data collection, interpretation, reporting and awareness.

7. Implementation of work plan from October 2017 to September 2018 – summary

KEY ACTIVITY	TIMELINE	INDICATOR OF SUCCESS	PROGRESS TO DATE (for interim period Jul-Sep'15)
Objective 1: To establish and facilitate on-farm trials around two local farmer structures (i.e. study groups)			
a) Prepare, establish and manage on-farm trials on selected sites (farms)	Continuous	Statistically designed trials established and managed on selected trial sites	Statistically designed trials were designed, established and managed on selected trial sites. ARC SG helped the Riemland group to measure and prepare the trial sites. Assistance was also given with the planting of the row width trial. – see trial layouts attached
Objective 2: To monitor and analyse a series of on-farm, farmer-led trials on selected (volunteering) farmers' fields			
a) Participatory monitoring / data collection	January to June	Collection of a range of selected indicators from trials, especially soil samples	Collection of a range of selected indicators from trials, especially soil samples. VKB and ARC-SG sampled soil at all the trials to measure moisture at planting time. A new monitoring system has been developed.
b) Farmer participatory M&E and discovery learning	January to June	Completion of Field monitoring form with farmers	Completion of Field monitoring form with farmers.
c) Data Analysis and Evaluation	June to August	Analysis of data collected from on-farm trials and field forms	Analysis of data collected from on-farm trials and field forms.
Objective 3: To create wider awareness and innovation capacity in local farming communities on the practices and benefits of locally adapted CA systems.			
a) Annual farmers day or conference	February to March	A well organised and -attended awareness event	A CA conference was successfully held in Reitz on 19-20 March, which was attended by 680 participants. A successful farmers' day was also held at Ascent on 28 May with 50 people attending.
b) Exposing on-farm trials to interested farmers and other	Continuous	Trial visits by interested people	A number of interested people (mostly farmers) have been visiting the on-farm trials through the season and had

			discussions with participating farmers.
Objective 4: To support social learning, farmer facilitation, administration and reporting processes.			
a) Project meetings	Bi-monthly meetings	At least 4 project meetings per year	A number of project meetings were held at each of the project sites to monitor and manage planned activities.
b) Farmer facilitation	Continuous	Effective deployment of a local farmer facilitation to assist implementation and M&E with farmers	Jacques van Zyl (VKB) took over the role of farmer facilitator to facilitate and coordinate activities with and between the farmer co-workers.
c) Reference Group	August	A well organised annual reference group meeting	Feedback and planning meetings were held in August 2018.
d) Reporting	March and September	Six-monthly and annual reports according to specifications	Completed annual reports for period October 2016 to September 2017.

8. Implementation of work packages from October 2017 to September 2018

8.1. Coordination and management

Work Package title	**Coordination and management**
Work Package period	October 2017 to September 2018
Lead partner	Riemland and Ascent study groups
Involved partners	All
Objectives	Coordinate activities among all partners Ensure timely reporting to Grain SA Promote synergy among project activities
Justification	Project size, complexity and level of integration/interdependency among different project actions require strict delivery and adherence to project timelines as essential. Partners must often work together to achieve specific project outputs.
Description of work	**Project inception workshop**. A one-day project planning and inception workshop was held at the beginning of the project to enable all project partners

	to define work packages and procedures to achieve the project outputs and objectives. These WP's are used for the financial control and payment of the project and for the monitoring of the agreed tasks and deliverables. Work package managers were identified at this meeting and will present/follow strategies and protocols which are frequently monitored by all partners. **Frequent coordination meetings**. The purpose of these monthly or bi-monthly meetings is to establish and manage an Innovation Platform (IP) for improved communication, integration and sharing. The essence or key action in these meetings will be social learning, characterised by feedback, reflection, planning and coordination between different work packages and stakeholders. A secondary activity is the creation of a wider network in support of communication, sharing, learning and scaling out. **Annual Reference Group Meetings.** Formal reference group meetings will be organised each year with representation from each work package. In order to provide the project with independent monitoring, advice and support and to ensure communication with key stakeholders, a group of experts and end users (reference group) will be formed and invited to participate. Presentations from each work package leader will summarise achievements. Discussions about progress, potential deviations from the work plan and forward planning will be standing items at each meeting. **Activity reporting.** Partners will prepare a two-page activity report *every six months*. The lead applicant and work package managers will use these to assess whether work progresses to plan and take action to minimise the effects of delays on other project activities. **Annual progress reports.** Annual reports will be made following Maize Trust / CA-FIP instructions. Work package managers will be responsible for collating information and making a single work page report. The lead applicant will be responsible for integrating these into a single full report. A similar approach will be used to prepare the final project report covering information from all project years.

Deliverables	• Project actions and reporting delivered on time

Risks	None anticipated

8.2. Assessment of soil quality under CA systems

Work Package title	**Assessment of soil quality under Conservation Agriculture (CA) systems**
Work Package period	October 2015 to September 2017

Lead partners	Lientjie Visser (Mr. GP Schoeman), VermiSolutions (Ms. Paula Lourens) and Soil Health Solutions (Mr Willie Pretorius)
Involved partners	Riemland & Ascent study groups, ARC-SGI, Grain SA,

Objectives	• To characterize the soil types and soil physical & chemical parameters, such as particle distribution, pH, Soil Organic Matter (SOM), macro-, micro-nutrients, and soil biology • To compare the effect of different CA treatments on soil quality • To establish relationships between different soil parameters, yield and atmospheric elements

Justification	A number of studies suggest that a soil and nutrient management strategy based on a broader range of ecosystems processes is worth further investigation. The approach shifts the emphasis of soil nutrient (fertility) management away from soluble, inorganic plant-available pools to organic and mineral reservoirs that can be accessed through microbial and plant mediated processes. However, a relatively poor understanding and capacity exist among the local research fraternity to investigate these crucially important subjects.

Description of work	Characterise the effects of different CA practices (treatments) on soil nutrient and physical dynamics as well as crop growth and yield, will involve regular field visits, sampling of soil on selected transects / sites and time intervals, laboratory analyses of the samples, data processing, statistical analyses and report writing.

Activities	1. Monitoring and Sampling 2. Lab Analyses 3. Monthly meetings (project team) 4. Annual reference group meeting (advisory committee) 5. Annual report and admin (technical data) 6. Participate in Awareness events

Risks	• Being a dryland experiment, low and erratic rainfall may compromise crop yields; • Wild animals and birds may jeopardise crop performance and yields; • Instrumental failure can result in incomplete data results

ACTIVITIES AND DELIVERABLES

Activities	**Deliverables**
1. Monitoring and Sampling	Identification of representative ecotopes on different farms Identify sampling points on different treatments in each ecotope; Take composite samples at each sampling point
2. Lab Analyses	Haney soil health test PLFA Nematode indicator test
3. Monthly meetings (project team) & Training	Participate in monthly forum meetings, discussing problems and possible solutions to that.
4. Annual reference group meeting (advisory committee)	Report progress and findings to advisory committee; Discussion and evaluation of data. Learning from each other.

5. Annual report and admin (technical data)	Written technical report covering trial procedures, results and progress.
6. Participate in Awareness events	Trial visits with stakeholders; participate in awareness events, such as information day and/or cross-visits

DELIVERABLES, PROGRESS AND RESULTS ACHIEVED PER ACTIVITY

Activities	**Progress and Results achieved**
1. Monitoring and Sampling (Done with activity 3 above)	Monitoring done in September 2018
2. Lab Analyses	Submitted samples and waiting for analysis.
3. Monthly meetings (project team) & Training	Participated in planning meetings.
4. Annual reference group meeting (advisory committee)	Held in August and September.
5. Annual report and admin	Submitted 6-monthly report in March 2018 Contributed to comprehensive annual report in September 2018.
6. Participate in Awareness events	Participated in conference (Reitz) on 19-20 March and farmers' day (Ascent) on 28 May.

8.3. Assessment of cover crop adaptability and suitability

Work Package title	**Assessment of cover crop adaptability and suitability**

Work Package period	October 2017 to September 2018
Lead partner	ARC-AP (Mr. Gerrie Trytsman)
Involved partners	Grain SA, Riemland & Ascent study groups / IP's

Objectives	• To establish and maintain an on-farm screening trials • Determining the biological production of different cover crops • Measuring the production of crop residues of each cover cropping system • Measure the adaptability of cover crops in different agro-ecological regions

Justification	Cover crops offer many benefits for agriculture productivity and sustainability while reducing off farm environmental effects. For agricultural productivity, sustainability and soil health these include: erosion control, compaction remediation, increased water infiltration and storage, improved soil biodiversity, increased organic matter, nitrogen fixation, and improved nutrient recycling and retention of macro and micro nutrients. Environmental benefits include: reduced

	nutrient leaching, reduced sediment and phosphorus deposition, reduced runoff, and increased carbon sequestration; while suppression of weeds, diseases and nematodes and improved beneficial insect habitat results in reduced pesticide use. Other conservation benefits include: pollinator enhancement, wildlife enhancement as well as aesthetic value (Stivers-Young and Tucker, 1999; and Snapp *et al.,* 2005). The use of no-tillage systems greatly increases the benefits of cover crops and vice versa. No-till systems increases water conservation by maintaining cover crop residues on the surface. No-till systems reduce the disruption of the soil reducing: soil erosion, water runoff, organic matter oxidation and increases; infiltration and all of the benefits of improved organic matter accumulation. Stratification of the soil profile as result of no-till is important for macro invertebrates and soil micro-organisms. Tillage leads to unfavorable effects such as: soil erosion, soil compaction, loss of organic matter, degradation of soil aggregates, death or disruption of soil microbes and other organisms including; mycorrhizae, arthropods, and earthworms. Continuous no-till needs to be managed very differently in order to maintain or increase crop yields. Residue, weeds, equipment, crop rotations, water, disease, pests, and fertilizer management are just some of the many details of farming that change when switching to no-till. Tillage generally increases the amount and speed of nitrogen mineralization of soil organic matter which may increase or decrease synchrony of nitrogen release depending on the timing of the subsequent crop's nitrogen needs.

Description of work	**On-farm, farmer-led screening trials: around 10 potential cover crops**

Activities	7. Land preparation (finding a suitable location, sourcing materials) 8. Purchase Materials & Equipment 9. Establishing and Planting of trials 10. Seasonal management and maintenance of trials 11. Monitoring and Sampling (including harvesting, biomass and yield determination, nutrient analysis) 12. Lab Analyses 13. Monthly meetings (project team) & Training 14. Annual reference group meeting (advisory committee) 15. Harvesting, biomass and yield determination, nutrient analysis 16. Annual report and admin (production & technical data) 17. Participate in Awareness events

Risks	Finding a suitable site for a trial of this magnitude Getting the right equipment and seed to do the job well Acts of God (drought, hail, etc.) Labour (weed control, harvesting, etc.)

Progress with activities

Activities	**Deliverables**	**Progress and results achieve**
7. Land preparation	Weeding and management of cover crops prior to planting.	At present chemical land preparation is done by all farmers. If a broadleaf is part of the mixture then spraying a round-up, 2-4D mixture is recommended. Grazing vetch would

		not easy be killed using Round-up alone. Grasses are, however, easily killed.
8. Purchase Materials & Equipment	Acquisition of seed, inoculum, stickers, implements, chemical inputs.	Seeds of summer and late summer mixtures for research purposes were given to farmers at Riemland and Ascent.
9. Establishing and Planting of trials	Establish trial according to the field plan.	Mostly farmers use commercial planters. Both vacuum and finger planters are used. If not available fertilizer spreader can also used for broadcasting. Good seed to soil contact will increase sucsess.
10. Seasonal management and maintenance of trials	Regular visits to the trial site for inspection of weeds and insect damage and control if needed. Top dressing of grass cover crops. Treatment of cover crop at appropriate time (usually before seed set) using appropriate equipment. Submission of technical report after each visit. Photos from trial during visits	Trials at Izak was visited on 11/09. Proposals were made how to improve system etc. All researcers visited Skulpspuit on the 10/1/2018 and also visted Danie Slabbert, Abe and Callie on the 29/1/2018. A survey was done at Danie which will be included into the report on Mob grazing veld. Photo's were taken when visiting the trials to monitor progress.
11. Monitoring and Sampling	Completed data sheets for 1. Input cost 2. Germination 3. Cover % 4. Height of cover of each addition 5. Biological productivity t/ha^{-1}	DM will be determined at a later stage. At the same time cover %, height of the cover and actual stand will be determine.
12. Lab Analyses	C:N content of plant material	Veld samples were dried to detemine DM for the veld grazing at Danie.
13. Monthly meetings (project team) & Training	Partake in monthly forum meetings, discussing problems and possible solutions to that.	On 11/09 a report back meeting was attended and ideas exchanged. A meeting was held at the Riemland study group with Landbouweekblad and the involvement of the different rollplayer were discussed. Also involved in a teleconference on the 30/01/2018. Attend the conference at Reitz with valuable contributions from Jay Fuhrer.
14. Annual reference group	Report progress and findings to advisory committee.	A presentation was given during a farmer's day at I. Dreyer's farm.

meeting (advisory committee)	Discussion and evaluation of trials. Learning from previous mistakes.	Two articles were written for the Grain SA magazine. Also helped Mr Dreyer with his fertilizer rate of maize.
15. Annual report and admin (production & technical data)	Written a technical report covering trial procedures, results and progress.	Technical progress report was submitted by middle March. Technical progress report will be submitted in September
16. Participate in Awareness events	Trial visits with stakeholders; participate in awareness events, such as information day and/or cross-visits.	Will be present at the conference late March.

Background

Suzette Smallberger was appointed by VKB to replace Dr Robert Steynberg who went on early retirement. She also found greener pastures in the meantime, which left a void in farmer innovation project team. Lucky for us, Mr Jacques van Zyl (VKB) joined the team and assisted this work package in distributing seed to farmers as well as monitoring progress.

Cover crop mixtures being used for various purposes on three individual farms.

Callie Meintjies, Reitz

Callie Meintjies' farm Driefontein is situated in the Reitz area. He plants different mixtures of cover crops to achieve sustainability in his soya bean practices. The summer mixture was planted to enhance his SOC content (see Photo 8.3.1). The mixture was terminated with a roller in March 2018. He planted a winter mixture after rolling, using this for sheep and cattle grazing. He entered into a 50/50 agreement with a partner that supply the livestock. He is responsible for feeding the animals.

Photo 8.3.1: Summer cover crop mixture, terminated (1)

The cattle herd grazing the cover crops consist of 37 cows and 113 weaners. The summer mixture was planted for feeding the livestock. He employs a Mob grazing system, or ultra-high density grazing. Animals are moved 6-8 times daily and have excess to fodder the whole day. Electric fencing was used to create temporary camps. Water was supplied at a central point on the contour, next to the CC. At present he is not satisfied with the animal's growth rate and would like to increase his daily gain (Photo 8.3.2).

Photo 8.3.2: Summer cover crop mixture grazed

The intercropping mixture is established with maize. The idea is to keep living roots in the soil for as long as possible. He chose a mixture that contain broadleaves because grasses do not grow in shade. Presently he is still experimenting, with the ultimate goal to lower input cost and to diversify his farm enterprise. He recently also established 10 ha of pecan trees as a priority to stabilize the soil. He wants to establish a more permanent mixture between the trees for the aforementioned purpose. Table 8.3.1 is an example of the different crop and mixture combinations that Callie uses to promote CA practises.

Table 8.3 1: Cover crop mixtures on the farm Driefontein, Reitz

Summer mixture 1	**Summer mixture 2**	**Inter-cropping mixture for maize**
• 6 kg/ha fodder sorghum • 6 kg/ha Babala • 0,5 kg/ha Teff cultivar SA Bruin • 4 kg/ha Black oats • 8 kg/ha Cowpea cultivar Betswit • 3 kg/ha Sunnhemp • 2 kg/ha Sweet clover • 0,5 kg/ha Turnip • 0,75 kg/ha Jap radish	• 8 kg/ha sweet sorghum • 4 kg/ha Black oats • 6 kg/ha grazing vetch • 4 kg/ha Sunnhemp • 0,75 kg/ha Jap Radish • 0,5 kg Interval rape	• 5 kg/ha Crimson clover • 5 kg/ha MPT turnip (seed density increase because seed is broadcasted)

Danie Slabbert, Reitz

Danie farms in the Reitz area on the farm Vanrooyenswoning.

Resources: arable land, centre pivots and veld

Danie divided his arable land in three equal 300 ha plots. He uses a 3-year rotation which consist of maize > soybeans > wheat > sunflower rotation. He intensifies by planting wheat after soybeans. The wheat acts as a cover crop to him, thus any wheat harvest is a bonus.

He also has four centre pivots on his farm of equal size. He plants potatoes every 4th year. After harvesting the potatoes, he plants a CC mixture in February. The mixture consists of cool season grasses, legumes and brassicas. Other crops planted are cash crops such as maize, soybeans and sunflower in rotation for 3 years before returning to potatoes.

Danie bought 340 Drakensbergers as a nucleus herd of cattle. He uses this herd to harvest the CC as can be seen in Photo 8.3.3.

Photo 8.3.3: Drakensbergers on multi-specie cover crops under pivots

Danie wants to increase the herds' size in the future. His aim is to diversify his farming enterprise and increase soil heath. He sees the livestock as a tool to meet his objectives faster. Future plans using CC also includes the withdrawal of 100 ha of sunflower planting to establish mixtures to feed his growing herd.

His grazing strategy consists of ultra-high density grazing. To implement this, he makes use of electric fencing moving the herd to new pasture every 20 minutes (Photo 8.3.4).

Photo 8.3.4: Electric fencing equipment

In summer the herd is on natural pastures during the active growing season with similar utilization strategies, i.e. grazing is intense but with low frequency. He feels this will give ample time for the pastures (CC and Veld) to recover. He hopes that in future the species competition will contain more palatable grasses (Plate 8.3.5). A preliminary survey (6-month report) confirmed that his natural grazing was previously underutilized. This coming season a more in depth survey is planned. To do this we have requested the assistance of Fritz van Oudtshoorn, an ecologist.

Photo 8.3.5: Grazing degrades veld

Intercropping maize with brassicas

Maize intercropped with radish is still in an experimental phase but looked promising when visited in May (Plate 8.3.6). After harvesting the maize, the radish will be utilized by livestock. The impact on soil health and livestock production will be monitored in the future. Radish is renowned for scavenging nitrogen and uplift compaction layer deep in the soil. Keeping living roots in the soil will also feed microbes and lessen the impact of nematodes through the fumigation of soil.

Photo 8.3.6: Intercropped radish in maize

Izak Dreyer, Vrede

Izak Dreyer farms near Vrede and do CA on his farm Skulpspruit. He owns livestock that consists of a commercial herd as well as a Bonsmara stud and sheep. He implements an array of CA practices on his farm such as.

- No-till
- Crop rotation; maize and soya bean
- Mulch retention
- Intercropping; double cropping and delayed inter-cropping with maize
- Stacked crop rotations; planting maize consecutive year to get a mulch
- Cool season cover crop mixtures
- Warm season cover crop mixtures
- Livestock Integration with ultra-high density grazing

Tabel 8.3.2 is an example of cover crop mixtures he used in his quest to get healthier soil and feed his growing herds. He sees a difference in soil life where earthworms and dung beetles returned and saprophytic fungi breaks down the fibrous residues.

Table 8.3.2: Cover crop mixtures planted for feed and mulch on the farm Skulpspruit, Vrede

Spring mixture	**Fallow spring mixture**	**Summer mixture**	**Mixture for sheep**
• 30 kg/ha Oats • 10 kg/ha Saia Oats • 10 kg/ha Fodder peas • 1 kg/ha Sweet clover • 0,5 kg/ha Interval Rape	• 6 kg/ha Barsweet Sweet sorghum • 1 kg/ha MPT @ R52,50/kg • 20 kg/ha Outback Oats • 6 kg/ha Vetch	• 5 kg/ha Bargrazer Fodder sorghum • 4 kg/ha Babala • 4 kg/ha Saia oats • 6 kg/ha Cowpea • 3 kg/ha Sunnhemp	• 5 kg/ha Pearler 0,5kg/ha MPT @ R52,50/kg • 6 kg/ha Dolichos var Rongai • 0,5 kg/ha Inteval rape

• 0,5 kg/ha Barkant Turnip		• 0,3 kg/ha Interval rape • 0,5 kg/ha Barkant turnip • 0,2 kg/ha Kale	

Livestock Integration

Izak used cool season crops to feed his livestock during winter time. Photo 8.3.7 shows livestock grazing an early spring planting of cool-season CC mixture. Previously, he used a mixture containing summer annuals such as sorghum and cowpea, but it did not establish well due to low minimum temperatures. Making use of electric fencing means that he can move the herd every half hour without problems. He is encouraged by a ADG (average daily gain) of 1,2 kg/day and the fact that for the first time he noticed dung beetles on a regular basis. His weaners weighs 80 kg more after the winter after grazing CC than those over-wintering on veld with a winter lick. This is a significant improvement since he now can breed his heifers earlier.

He had some sheep losses due to nitrate poisoning. His advise to other farmers is to never allow hungry sheep into a new pasture full of succulent new growth.

Photo 8.3.7: Grazing spring mixture

He planted 30% of his land to cover crops and he would like to increase the amount this coming season. He believes to make the system work for him and eventually he will end up with a cash crop and cover crops in a 50-50 rotation.

Cash crops

Izak plants soybean and maize. He has tried intercropping his maize at a 4-6 leave stage with cool season mixtures. The practise works, but he is convinced after attending a CA conference in Stellenbosch that we should look at ways to make use of biannual and hard seediness of legume crops to come up with a rotation that can last longer than just a year.

His maize and soybean yield increased the past couple of years. Soybeans seem to do well when planted green into wheat. Soybean also seems to thrive after a summer annual grass such as babala. He also has maize and soya strip trials where different treatments of fertilizer and plant density are studied. This year showed that 80 kg N/ha was the most economical treatment for fertilizer applied at planting (40 kg) and top dressing (40 kg) for maize. This is about 30% less of what was applied in the past. Photo 8.3.8 shows Izak standing in front of an 80 kg N/ha treatment at the reproduction phase.

Photo 8.3.8: Izak Dreyer standing in front of maize, Skulpspruit, Vrede

Conclusion

All farmers want to manage soil in a way it was designed to function. Soil health, including building SOC in the transitional phase, remains important. Cover crops play a role in getting positive results much faster than other systems. Bringing livestock back is also encouraging and spread the risk of crop failure. Even if conditions are not a 100%, some components within a mixture will thrive and produce.

Gaps identified and way forward

There is a need to look at individual crops and the genetic diversity within species. For the 2018/19 season a decision by the different role players were taken to investigate a principal cover crop, such as sorghum. Sorghum (sweet and general), sorghum crosses, sudan grass, sudan grass crosses with BMR mutation genes, as well as babala and hybrid babala will be researched. This decision was taken on the basis that most of the summer mixtures used as cover crops contain various amounts of summer annual grasses. The difference in cost of these cultivars are huge. Ordinary sorghum prices range from below R10/kg to sweet sorghum that is above R50/kg. The focus of the study will include the regrowth potential, biomass, cyanide poisoning potential of the different treatments.

Four mayor seed companies were approached to include accessions of sorghum and babala and a total of sixteen cultivars will be evaluated.

To stimulate cover crops interest, we also requested the same companies to supply a summer mixture for evaluation. This as an activity previously done at Ottosdal with great success. These mixtures will be grazed by ruminants and evaluated in terms of nutrient content and biomass.

There is a growing concern amongst researchers that farmers that use high input CA cash crop systems, doesn't benefit from the role that surface residues play on enhancing soil water processes, especially water runoff and soil erosion control. Yields remain high but the soil health progress seems to stagnate. Soil samples confirm that soil organic carbon content (SOC) of the soil remains low, the biomass of microorganisms is poor and a trophic level that represent the predators (protozoa and nematodes) in the soil food web do not function.

Using mixtures, livestock integration and low levels of input can stimulate plants to supply the soil food web with a steady supply of liquid carbon and regain some of the lost trophic levels that are missing. In low-input systems, the role of mulching lies probably more in enhancing soil fertility through maintaining or increasing SOC levels. It is hoped that the above mentioned research activities will open this debate and will positively influence soil health as a vital part of CA systems.

According to Kristine Nichols, a soil ecologist from the USA, grain crops do not produce that much photosynthetic exudates, also called liquid carbon, to feed soil microbes. When grain crops become reproductive, root exudates shut off as the plant shunts resources into seed production. There is thus only a four to five-week period when plants push exudates into the soil. This is not sufficient time enough and thus grain production don't contribute much to the build-up of soil carbon.

By using high-density, low frequency grazing on the summer mixture, we are trying to restore soil carbon stock in the soil. The above ground chewing, tearing and trampling actions by grazers creates wounds that the plants must heal, however, the plants can't do this alone. They need micronutrients and microbial metabolites and this they achieve by pumping a steady supply of carbon rich exudates from their roots to recruit microbial assistants.

By letting livestock graze half of the crop biomass available, the diverse sward will regrow. Livestock manure also contains more humic substances than plant residues. Dung beetles and saprophytic fungi can feed on this nutrient rich matter and help recycle elements back into the soil. This carbon will eventually become part of the more resistant, stable carbon pool, also called humus or "the very dead" SOM. By planting fodder crops, nutrients deep in the soil is returned (recycled) to the surface and placed back into biological circulation. The mulch left on the surface will upon decaying release plant accessible nutrients back to the soil to be used by subsequent crops. By not using excessive amounts of agrochemicals, soil can recuperate with microorganisms breaking down unwanted chemical substances.

8.4. Agronomic field trial results in Riemland study area

Work period	October 2016 to September 2017
Lead partners	ARC-SG (W Killian, L Visser) and VKB (P de Wet, S Smalberger)
Involved partners	Riemland study group and other Innovation Platform (IP) partners

Objectives	• To plan and design the on-farm maize plant population density trials • To plan and design the on farm crop rotation trials • To (statistically) analyse and report the results of the maize plant population density trials • To (statistically) analyse and report on the results of the crop rotation trials

Justification	Plant population density is one of relatively few variables that farmers can manage easily. Current recommendations for maize plant population were derived from trials under conventional tillage. Physically, the soil is very different in no-tillage than in tilled soil. This might require an adjustment in the plant population density of crops. Recommendations from elsewhere in the world is that plant population densities should be increased and row width should be decreased for no-till cropping. Crop rotation, another easily manageable variable, is one of the principles of conservation agriculture. No information on how crops respond to rotation in conservation agriculture systems in this semi-arid environment is available. Crop responses to changes in management and the environment is usually liable to interactions resulting in variation of the results, which might lead to wrong conclusions and recommendations. In order to generate scientifically sound recommendations on these two agronomical variables, proper planning and analyses of the results is needed.

Description of work	**Planning and designing of trials in collaboration with participating farmers and partners. Analyses of farmer collected results and reporting of findings.**

Activities	Planning of trials through the attendance of the frequent coordination meetings where aims and procedures will be discussed with farmers. Planning of trial layout and compiling of data sheets to be completed by participating farmers. Collection of data from farmers at the after harvest of the trials. Statistical analyses, interpretation, discussion and drawing of conclusions from the results. Presentation and reporting of the results to participants and MT as required.

Deliverables	• Annual trial plans and analysis report • Regular attendance of meetings • Reporting as required • Popular article once enough results have been acquired.

Risks	Adequate involvement and participation of farmers

DELIVERABLES, PROGRESS AND RESULTS ACHIEVED PER ACTIVITY

Activities *(as specified in Work Package or project proposal)*	**Deliverables or Milestones***(as specified in Work Package or project proposal)*	**Progress and Results achieved;** and/or **Problems and Milestones <u>not</u> achieved**(in report period)
1. Planning of trials	Farmer participation in meetings.	A meeting was held on <u>18 October 2017</u> to discuss the new planting season with Abé Visser and Danie Slabbert. Armand Muller withdraw from the project. The crop rotation trial will continue only on Danie Slabbert's farm. The long-term trial of the study group, which is planted on Abé Visser's farm, will be included in the project. The initial purpose of the trial was to compare no-till with conventional tillage. The aim was however changed and no-till, with two crop rotation treatments will be applied in future. The Study Group held a meeting on <u>20 July 2018</u> to discuss the challenging problems that threatened the success of the trials. The conclusion was that the small trial areas were difficult to manage and maintain, which also had a huge impact on the outcome of results. It was decided that it would be more realistic to monitor larger areas within existing conservation agriculture (CA) fields. Mr Abé Visser wihtdraw from the Grain SA project. However, he will continue with the trial on his farm for the Study Group. Planning of new format of trials were done on 6 August 2018 with Mr Danie Slabbert and on 24 August 2018 with Mr Callie Meintjies.
2. Land preparation and planting of trials	Trials were planted as planned during October-December 2017 period	Assisted with planting of the trials on Mr Slabbert's farm.
3. Seasonal management and monitoring	* Trial visits	29 January 2018. With VKB and Grain SA and 30 June 2018 with VKB and Grain SA.

	* Yields will be measured after harvesting. * Soil probe data are monitored on a continuous basis. *Soil sampling	Yields were measured and captured as agreed Soil probe data were captured as agreed. Soils were sampled on 30 August and 3 September 2018.
4. Monthly meetings (project team) & Training	Participate in monthly forum meetings, discussing problems and possible solutions to that.	Active discussions on a Whats App group. Farmer visits. Project team meetings and discussion sessions between farmer co-workers.
5. Awareness events	Create awareness of CA farming practices through events and reporting.	* The row width & plant population trial was used as demontration during the Landbou Weekblad CA Conference (19-20 March 2018).
Reporting	Reporting as required and popular article once enough results have been acquired.	* A popular article published in the February 2018 SA Grain.

8.4.1 Introduction to field trials in the Reitz study area

In 2015, the Riemland Study Group identified two projects for on-farm trials, namely the influence of row width and plant population on yield, as well as crop rotation. Planting of the trials started in December 2015 under immense dry conditions, which resulted in low yields. Weather conditions improved over the next two seasons, but several other problems such as weed control, cattle in the trials and availability of equipment demanded a change in strategy. The Study Group held a meeting on 20 July 2018 to discuss the challenging problems that threatened the success of the trials. The conclusion was that the small trial areas were difficult to manage and maintain, which also had a huge impact on the outcome of results. It was decided that it would be more realistic to monitor larger areas (ecotopes) within existing conservation agriculture (CA) fields.

This report summarises the trial results of the last three seasons. A short overview of the planned measurements in the 2018/2019 growing season will also be presented.

8.4.2. Background and results of trials

8.4.2.1 Trial 1 - The influence of row width and plant population on maize and soybean yield in the Eastern Free State

Mr Danie Slabbert was responsible for the trial site on his farm Van Rooyenswoning, in the Reitz area. The objective of the trial was to measure the influence of the interaction between three row widths (50 cm, 75 cm and 100 cm) and four plant populations on maize (20 000, 40 000 60 000 and 80 000 plants/ha) and soybean (105 000, 2050 000, 350 000 and 450 000 plants/ha) yields. Both crops in the trial were planted in a factorial design with three replicates. The crops rotated annually.

Weather conditions had a huge impact on crop yield. Figure 8.4.1 shows the monthly rainfall recorded during the three summer crop growing seasons from 2015 to 2018.

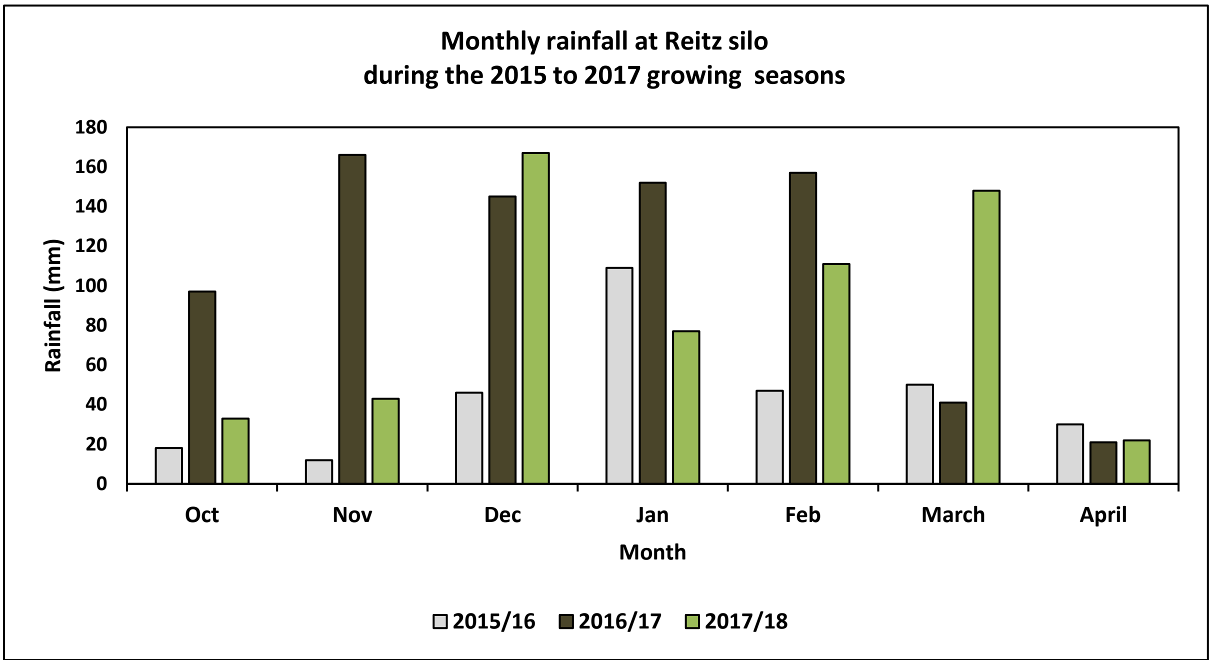


Figure 8.4.1: Monthly rainfall recorded at the Reitz silo during the 2015 to 2017 growing season of summer crops in the district

The total rainfall measured from October 2015 to April 2016, was 312 mm, in comparison with the 779 mm recorded from October 2016 to April 2017 and the 601 mm measured from October 2017 to April 2018. The average trial yields recorded for these three growing seasons were 4.64 ton/ha (2015), 7.53 ton/ha (2016) and 6.37 ton/ha (2017) for maize, with 2.92 ton/ha (2016) and 2.32 ton/ha (2017) for soybean. The 2015 drought resulted in a very low soybean plant emergence and no data were obtained.

Maize

Due to planter restrictions, the 20 000-plant population was replaced in 2017 with a 100 000-plant population. Therefore, discussions will include only the 40 000-, 60 000- and 80 000-plant population treatments. In Table 8.4.1 the effect of plant population on maize yield from the 2015 to the 2017 season are presented. The three year average yield (5.30 ton/ha) of the 40 000-plant population was significantly lower than the yields of the other two plant populations, which indicates that it is not a viable practise. The fact that the average yield between the 60 000 (6.54

ton/ha) and 80 000 (6.70 ton/ha) plant populations did not differ significantly, was proof that a farmer can obtain a competitive yield with less input cost on seed with a plant population of 60 000 plants per hectare.

Table 8.4.1: The effect of plant population on maize yield during the 2015 to 2017 seasons

Plant season	Row width (cm)	Plant population (plants/ha)			Average row width per year
		40 000	60 000	80 000	
2015/2016	50	3.46[g]	5.84[cdef]	5.48[defg]	4.93[c]
	76	3.93[fg]	4.29[efg]	4.97[defg]	4.40[c]
	100	3.48[g]	5.14[defg]	5.15[defg]	4.59[c]
2016/2017	50	7.84[abc]	8.03[abc]	9.25[a]	8.37[a]
	76	7.42[abc]	8.09[abc]	7.44[abc]	7.65[ab]
	100	6.15[cdef]	6.99[abcd]	6.57[bcde]	6.57[bc]
2017/2018	50	5.82[cdef]	7.02[abcd]	8.06[abc]	6.93[b]
	76	4.85[defg]	6.53[bcde]	4.83[defg]	5.40[c]
	100	4.75[defg]	6.94[bcd]	8.50[ab]	6.73b[c]
Average yield per plant population		5.30[b]	6.54[a]	6.70[a]	6.18
$LSD_{(year \times row\ width \times plant\ pop.\ (0.05))}$ = 2.31; $LSD_{(year \times row\ width\ (0.05))}$ = 1.33; $LSD_{(plant\ pop.\ (0.05))}$ = 0.77; CV = 22.8 %					

Table 8.4.2 indicates the effect of the three row widths on maize yield, which was recorded during the 2015 to 2017 seasons. The 6.76 ton/ha yield of the 50 cm row widths was significant higher than the 5.82 ton/ha and 5.96 ton/ha yields obtained with the 76 cm and 100 cm row widths. Conventional farmers in the region use 76 cm row widths, but the data indicates that a 50 cm row width × 60 000 maize plant population will produce the highest yield in a CA system.

Table 8.4.2: The effect of row width on maize yield during the 2015 to 2017 seasons

Plant season	Plant population (plants/ha)	Row width (cm)			Average plant pop. per year
		50	76	100	
2015/2016	40 000	3.46[g]	3.93[fg]	3.48[g]	3.62[c]
	60 000	5.84[cdef]	4.29[efg]	5.14[defg]	5.09[b]
	80 000	5.48[defg]	4.97[defg]	5.15[defg]	5.20[b]
2016/2017	40 000	7.84[abc]	7.42[abc]	6.15[cdef]	7.14[a]
	60 000	8.03[abc]	8.09[abc]	6.99[abcd]	7.70[a]
	80 000	9.25[a]	7.44[abc]	6.57[bcde]	7.75[a]

2017/2018	40 000	5.82[cdef]	4.85[defg]	4.75[defg]	5.14[b]
	60 000	7.02[abcd]	6.53[bcde]	6.94[bcd]	6.83[a]
	80 000	8.06[abc]	4.83[defg]	8.50[ab]	7.13[a]
Average yield/row width		6.76[a]	5.82[b]	5.96[b]	6.18
$LSD_{(year \times row\ width \times plant\ pop.\ (0.05))}$ = 2.31 ; $LSD_{(year \times plant\ pop.(0.05))}$ = 1.33; $LSD_{(row\ width(0.05))}$ = 0.77; CV = 22.8 %					

Soybean

Only two years' data are available on the soybean, which makes it difficult to draw final conclusions. Plant population had no effect on soybean yield (Table 8.4.3), as the yields of the four different plant populations, 2.47 ton/ha, 2.56 ton/ha, 2.67 ton/ha and 2.79 ton/ha, did not differ significantly from each other.

Table 8.4.3: The effect of plant population on soybean yield during the 2015 to 2017 seasons

Plant Season	Row width (cm)	Plant population (plants/ha)				Average row width per year
		150 000	250 000	350 000	450 000	
2016/2017	50	2.53[abcd]	3.13[abc]	2.47[abcd]	3.11[abc]	2.81[a]
	76	2.36[abcd]	2.97[abcd]	3.02[abc]	3.35[abc]	2.93[a]
	100	3.46[ab]	2.75[abcd]	3.60[a]	2.32[abcd]	3.03[a]
2017/2018	50	3.40[ab]	3.37[ab]	3.57[a]	3.20[abc]	3.39[a]
	76	2.44[abcd]	1.14[e]	1.94[cd]	2.47[abcd]	2.00[b]
	100	1.18[d]	1.45[d]	2.13[bcd]	1.56[d]	1.58[b]
Average yield per plant population		2.56[a]	2.47[a]	2.79[a]	2.67[a]	2.62
$LSD_{(year \times row\ width \times plant\ pop.\ (0.05))}$ = 1.42 ; $LSD_{(year \times row\ width\ (0.05))}$ = 0.71; $LSD_{(plant\ pop.\ (0.05))}$ = 0.58; CV = 33 %						

However, Table 8.4.4 indicates that the 3.10 ton/ha yield of the 50 cm rows were significantly higher than the 2.46 ton/ha and 2.31 ton/ha measured respectively on the 76 cm and 100 cm row widths. The row width data correlates with the row width data of maize as previously discussed.

Table 8.4.4: The effect of row width on soybean yield during the 2015 to 2017 seasons

Plant season	Plant population (plants/ha)	Row width (cm)			Average plant pop. per year
		50	76	100	
2016/2017	150 000	2.53[abcd]	2.36[abcd]	3.46[ab]	2.78[a]
	250 000	3.13[abc]	2.97[abcd]	2.75[abcd]	2.95[a]
	350 000	2.47[abcd]	3.02[abc]	3.60[a]	3.03[a]

	450 000	3.11^{abc}	3.35^{abc}	2.32^{abcd}	2.93^{a}
2017/2018	150 000	3.40^{ab}	2.44^{abcd}	1.18^{d}	2.34^{b}
	250 000	3.37^{ab}	1.14^{e}	1.45^{d}	1.98^{b}
	350 000	3.57^{a}	1.94^{de}	2.13^{bcd}	2.55^{a}
	450 000	3.20^{abc}	2.47^{abcd}	1.56^{d}	2.41^{b}
Average yield per row width		3.10^{a}	2.46^{b}	2.31^{b}	2.62
$LSD_{(year \times row\ width \times plant\ pop.\ (0.05))}$ =1.42 ; $LSD_{(year \times plant\ pop.(0.05))}$ = 0.82; $LSD_{(row\ width(0.05))}$ = 0.50; CV = 22.8 %					

Conclusion

The research confirmed that the 50 cm row widths produced significantly higher maize and soybean yields than the 76 cm and 100 cm row widths. A significantly higher maize yield was obtained with 60 000 and 80 000 maize plant populations, compared to a plant population of 40 000. However, the 50 cm row width × 60 000 maize plant population combination will ensure almost the same income at a lower input cost. Therefore it will be the first choice for maize production in a CA system.

8.4.2.2 Trial 2 - An evaluation of different crop rotations in the Eastern Free State

The trial commenced in 2015 on two localities in the Reitz district, namely the farms of Mr Danie Slabbert and Mr Armand Muller. Due to changes in equipment, only Mr Slabbert continued with the trial in 2017. Table 8.4.5 indicates the planting times and crops in the six rotation systems. The trial format was a randomised block with four replicates of the six crop rotation treatments. Each of the six rotations were planted on the same plots to measure the effect of the crop sequences.

Table 8.4.5: Annual planting times and crops in the six rotation systems

Year	Month	Rotation 1	Rotation 2	Rotation 3	Rotation 4	Rotation 5	Rotation 6
2015	Nov	Soybean	Soybean	Soybean	Soybean	Soybean	Soybean
	Dec	Soybean	Soybean	Soybean	Soybean	Soybean	Soybean
2016	Jan	Soybean	Soybean	Soybean	Soybean	Soybean	Soybean
	Feb	Soybean	Soybean	Soybean	Soybean	Soybean	Soybean
	Mar	Soybean	Soybean	Soybean	Soybean	Soybean	Soybean
	Apr	Soybean	Soybean	Soybean	Soybean	Soybean	Soybean
	3 May	Soybean	Soybean	Soybean	Soybean	Soybean	Soybean
	Jun		Wheat	Wheat		Cover crop (W)	Wheat
	Jul		Wheat	Wheat		Cover crop (W)	Wheat
	Aug		Wheat	Wheat		Cover crop (W)	Wheat
	Sep		Wheat	Wheat		Cover crop (W)	Wheat
	Oct		Wheat	Wheat			Wheat
	Nov	Maize	Wheat	Wheat	Sunflower	Maize	Wheat
	Dec	Maize	Wheat	Wheat	Sunflower	Maize	Wheat
2017	Jan	Maize	Sunflower		Sunflower	Maize	Sugar bean
	Feb	Maize	Sunflower		Sunflower	Maize	Sugar bean
	Mar	Maize	Sunflower		Sunflower	Maize	Sugar bean
	Apr	Maize	Sunflower		Sunflower	Maize	Sugar bean
	May	Maize	Sunflower		Sunflower	Maize	Sugar bean
	Jun	Maize	Sunflower		Sunflower	Maize	
	Jul						
	Aug						
	Sep						
	Oct	Soybean	Maize	Maize	Maize	Soybean	Maize
	Nov	Soybean	Maize	Maize	Maize	Soybean	Maize
	Dec	Soybean	Maize	Maize	Maize	Soybean	Maize
2018	Jan	Soybean	Maize	Maize	Maize	Soybean	Maize
	Feb	Soybean	Maize	Maize	Maize	Soybean	Maize
	Mar	Soybean	Maize	Maize	Maize	Soybean	Maize
	Apr	Soybean	Maize	Maize	Maize	Soybean	Maize
	May	Soybean	Maize	Maize	Maize	Soybean	Maize
	Jun		Maize	Maize	Maize	Cover crop (W)	Maize
	Jul					Cover crop (W)	
	Aug					Cover crop (W)	
	Sep					Cover crop (W)	
	Oct	Maize	Soybean	Soybean	Soybean	Maize	Soybean
	Nov	Maize	Soybean	Soybean	Soybean	Maize	Soybean
	Dec	Maize	Soybean	Soybean	Soybean	Maize	Soybean

The 2017 season was extremely difficult due to weed control problems, as well as cattle damage to maize in the trial. Table 8.4.6 summarises the average annual yields of the crop in the six rotation systems planted from the 2015 to the 2017 season on Mr Slabbert's farm. Only one of four maize replicates in rotations two and three, and two of four maize replicates in rotation six could be harvested at the end of the 2017 season, while all the maize replicates of rotation four were written off. All four soybean replicates of rotations one and five were harvested.

Table 8.4.6: A summary of average the yields of crop sequences in the six rotation systems

Growing season	Rotation 1	Rotation 2	Rotation 3	Rotation 4	Rotation 5	Rotation 6
2015/2016	Soybean 0.94 ton/ha	Soybean 1.03 ton/ha	Soybean 1.02 ton/ha	Soybean 0.01 ton/ha	Soybean 1.02 ton/ha	Soybean 0.93 ton/ha
2016/2017	-	Wheat 0.76 ton/ha	Wheat 0.83 ton/ha	-	* Cover crop 2.10 ton/ha	Wheat 0.82 ton/ha
	Maize 8.53 ton/ha	Sunflower 0.63 ton/ha	-	Sunflower 1.68 ton/ha	Maize 8.96 ton/ha	Sugar bean 0.28 ton/ha
2017/2018	Soybean 2.62 ton/ha	Maize 5.73 ton/ha	Maize 6.11 ton/ha	Maize No yield	Soybean 2.48 ton/ha	Maize 4.20 ton/ha

* Dry plant mass yield

The 2017 season soybean yields of 2.62 ton/ha and 2.48 ton/ha harvested respectively in rotation systems one and five correlated with the average on-farm yield of 2.3 ton/ha harvested by Mr Slabbert on the rest of his fields. Although not one of the maize yields on rotation systems two (5.73 ton/ha), three (6.11 ton/ha) and six (4.20 ton/ha) had four replicates, only rotation six had a lower yield than the average maize yield of 5.3 ton/ha, that was harvested on the rest of the farm.

2.2.2 Conclusion

Due to unfortunate circumstances, only two of the six rotation systems were completed successfully. Therefore it was impossible to identify any effects of crop sequences within the different rotation systems. Although the final yields of soybean compared well with the average on-farm soybean yield, none of the rotation systems proofed to be more successful than the other.

3. Way forward

The two trials will be replaced with annual, long-term measurements on nine GPS monitoring points to evaluate changes in soil health, biodiversity, soil water and production under CA and CT practises in the Reitz district. Currently Mr Danie Slabbert uses an ultra-high density grazing system with veld in the summer and maize stubble with cover crops (including intercropping) in the winter, as food for his cattle. The six sampling points (different ecotopes) on his farm include the following:

- a sandy soil under cultivation,
- a clay soil under cultivation,
- a high potential soil under cultivation,
- veld not grazed,

- veld under ultra-high density grazing,
- veld under conventional grazing.

Mr Callie Meintjies wants to improve the soil health of the sandy soil on his farm. His crop rotation system includes soybean in combination with winter and summer cover crops. The cover crops and veld are utilised for cattle grazing in an ultra-high grazing system. Three sampling points were identified, namely:

- a fallowed sandy soil, planted with cover crops in 2017,
- a poor sandy soil planted with cover crops in 2017,
- veld, which was conventionally grazed in the 2017 summer season.

The nine points were sampled on 31 August and 3 September 2018. Soil samples will be analysed with the Haney soil health test, PFLA for soil biodiversity and soil fertility. Weather conditions will be recorded on both farms and probes will be installed at each point for recording of soil water conditions. Monitoring of dung beetle activity will be done on a two month basis from October 2018.

8.5. Agronomic field trial results in Ascent study area

Work period	October 2017 to September 2018

Lead partner	Local facilitators (Jacques van Zyl (VKB))
Involved partners	Ascent study groups and other Innovation Platform (IP) partners Willem Killian, Lientjie Visser (ARC), Gerrie Trytsman (ARC), Paula Lourens (Vermi Solutions), Hendrik Smith (Grain SA)

Objectives	• Coordinate on-farm experimentation activities among all participating farmers • Ensure timely and correct implementation of relevant activities and treatments • Assist with the use of specialised implements for trial purposes • Promote synergy among farmer participants • Monitor selected indicators (through field form, sampling & visits) and report on project activities and progress related to farmer involvement.

Justification	On-farm experimentation involving farmers as 'researchers' are seen as central to research projects under the banner of the CA-Farmer Innovation Programme at Grain SA. This implies that trial treatments or replications are implemented on the farm by the respective farmer participants. A range of support measures are needed to ensure the success and quality of these farmer-led actions, including the engagement of relevant research and technical team members around these farmers. **A particular role and function identified by the project team is that of a local farmer facilitator, primarily assisting, guiding, calibrating and coordinating the participating farmers to implement the experimental designs (treatments) correctly.** This person also has to manage and move specific specialised implements (e.g. a no-till planter) between the farmers, allowing timely and correct use of it. The person selected should be locally based and should have an intimate knowledge of the local natural resources and stakeholders, especially the farmers. Expected result of this function is the

	elimination of undesirable variables and the increased quality of the trials and data.

Description of work	Prepare farmers and implement on-farm trials. Manage, maintain and move specialised implements to be used by the various farmers involved in the trials. Making sure that farmers understand the treatments and what is expected from them. Calibrate or train farmers on specific implements / practices where necessary. Conduct regular field/farm visits, monitor and coordinate relevant activities, assist with sampling of soil where necessary. Attend regular project meetings and assist with report writing.

Activities	1. Land preparation 2. Planting 3. Seasonal management 4. Monitoring and Sampling 5. Monthly meetings (project team) 6. Annual reference group meeting (advisory committee) 7. Annual report and admin 8. Participate in Awareness events

Risks	• Being a dryland experiment, low and erratic rainfall may compromise crop yields; • Wild animals and birds may jeopardise crop performance and yields; • Instrumental and logistical failure can result in incomplete activities and results

ACTIVITIES AND DELIVERABLES

Activities	**Deliverables**
7. Land preparation	Assist farmers to lay out their trial plots Prepare (calibrate and train) farmers on the trial treatments Make sure land preparation (e.g. weeding) is done according to specifications Make sure the correct type and quantity of production inputs are ready and used
8. Planting	Prepare planter for planting Move planter between farmers for timely planting, where necessary Make sure farmers plant according to standard treatment specifications
9. Seasonal management	Assist farmers in weeding and pest/disease management
10. Monitoring and Sampling (Done with activity 3 above)	Assist farmers to complete field forms Assist to collect soil samples Monitor the farmer-led actions
11. Monthly meetings (project team) & Training	Participate in monthly forum meetings, discussing problems and possible solutions to that.

12. Annual reference group meeting (advisory committee)	Report progress and findings to advisory committee; Discussion and evaluation of data. Learning from each other.
13. Annual report and admin	Written report covering trial implementation, results and progress.
14. Participate in Awareness events	Trial visits with stakeholders; participate in awareness events, such as information day and/or cross-visits

DELIVERABLES, PROGRESS AND RESULTS ACHIEVED PER ACTIVITY

Activities *(as specified in Work Package or project proposal)*	**Deliverables or Milestones** *(as specified in Work Package or project proposal)*	**Progress and Results achieved;** and/or **Problems and Milestones <u>not</u> achieved** (in report period)
1. Planning of trials.	Farmer participation in meetings.	Reporting and planning meetings were held at Ascent on 12 September 2017 where farmer participants were confirmed.
2. Land preparation and planting of trials.	Trials were planted as planned during October-November 2017 period.	Assistance was given with the planting of trials where possible. Trials had established very satisfactory.
3. Seasonal management and monitoring.	* Yields and yield components will be measured after harvesting. * Soil probe data are monitored on a continuous basis.	Proper reporting follows in the technical annual reports below. Trails were montored weekly
4. Awareness events.	Create awareness of CA farming practices through events and publications.	A CA farmers' day was organised on 28 May 2018.
5. Statistically analyse and report the results	Annual report Reporting as required and popular article once enough results have been acquired	Trial data was analysed and reported to farmers – 25 August 2017 and included in the annual report (see technical annual reports below)

A. MAIZE TRIALS

GENERAL PROCEDURES

Plant population strip trials were planted; the co-worker used his own farming equipment and followed his own standard agronomic practices regarding fertilization, cultivar selection, crop protection, etc. The plant populations range between 40 000 and 120 000 plants/ha.

Five fertilizer trials were done. The specific experimental details will be supplied below.

Trial 1: Izak Dreyer (Skulpspruit)

Row width: 0.76 m

Fertilization: Plant with 40N 3:2:1(25)

Cultivar: DKC 78 87

Plant population: 55 000 plants/ha

Planting date: 2nd week of October 2017

Harvesting date: May 2018

Treatments:

N level- 40, 60, 80, 100, 120N kg/ha LAN topdressing

Trial 2: Izak Dreyer

Row width: 0.76 m

Fertilization: Plant with 40N 3:2:1(25)

Cultivar: DKC 78 87

Plant population: 55 000 plants/ha

Planting date: 2nd week of October 2017

Harvesting date: June 2018

Treatments:

N level- 60, 80, 100, 120N kg/ha LAN topdressing

Trial 3: Izak Dreyer

Row width: 0.76 m

Fertilization: Plant with 40N 3:2:1(25)

Cultivar: DKC 78 87

Plant population: 55 000 plants/ha

Planting date: 2nd week of October 2017

Harvesting date: June 2018

<u>Treatments:</u>

N level- 40, 60, 80, 100, 120N kg/ha

<u>Trial 4: Izak Dreyer</u>

Row width: 0.76 m

Fertilization: Plant with variable 3:2:1(25)

Cultivar: DKC 78 87

Plant population: 55 000 plants/ha

Planting date: 2nd week of October 2017

Harvesting date: June 2018

<u>Treatments:</u>

N level- 0, 248, 327, 458, 537, 582 kg/ha 3:2:1(25)

<u>Trial 5: Izak Dreyer</u>

Row width: 0.76 m

Fertilization: Plant with variable 3:2:1(25)

Cultivar: DKC 78 87

Plant population: 55 000 plants/ha

Planting date: 2nd week of October 2017

Harvesting date: June 2018

<u>Treatments:</u>

N level- 0, 248, 327, 458, 537 kg/ha 3:2:1(25)

<u>Trial 6: Izak Dreyer</u>

Row width: 0.76 m

Fertilization: Plant with 40 3:2:1(25), 60N LAN topdressing

Cultivar: DKC 78 87

Planting date: 2nd week of October

Harvesting date: June 2018

<u>Treatments:</u>

Plant population: 40k, 55k, 60k, 80k, 120k plants/ha

TRIAL RRSULTS FOR THE 2017/2018 SEASON

Rainfall

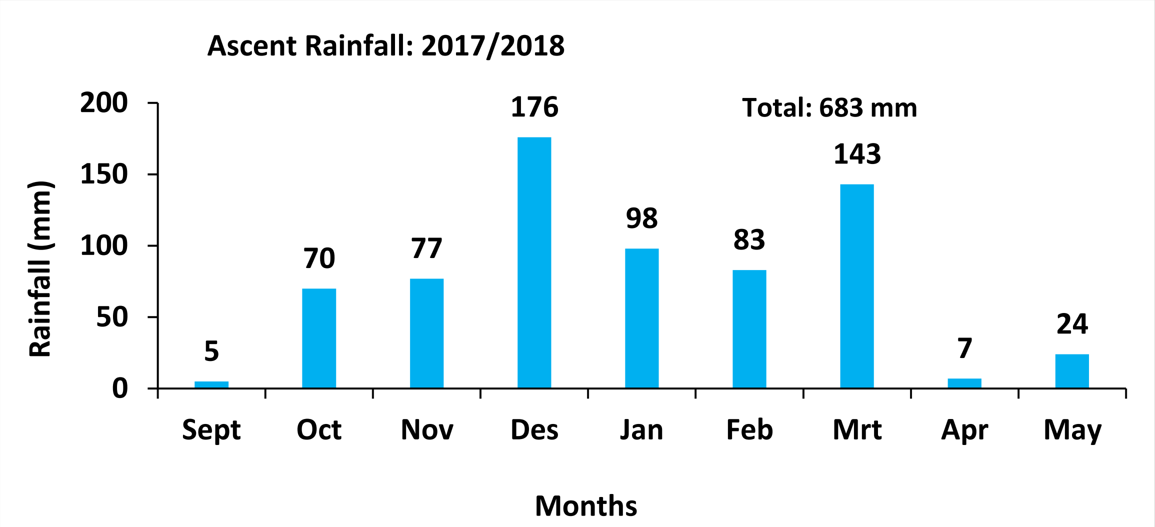


Figure 8.5.1. Monthly rainfall data for Ascent 2017/2018.

Figure 8.5.1 shows good rainfall in terms of total rainfall for the growing season. From September to November rainfall was low and the planting period was shortened and delayed. December received good rainfall. From the last week of December till the last week of January is was very dry. The last few days of January received rainfall. This season saw above average rainfall for March to May.

CA and fertilization: Yield

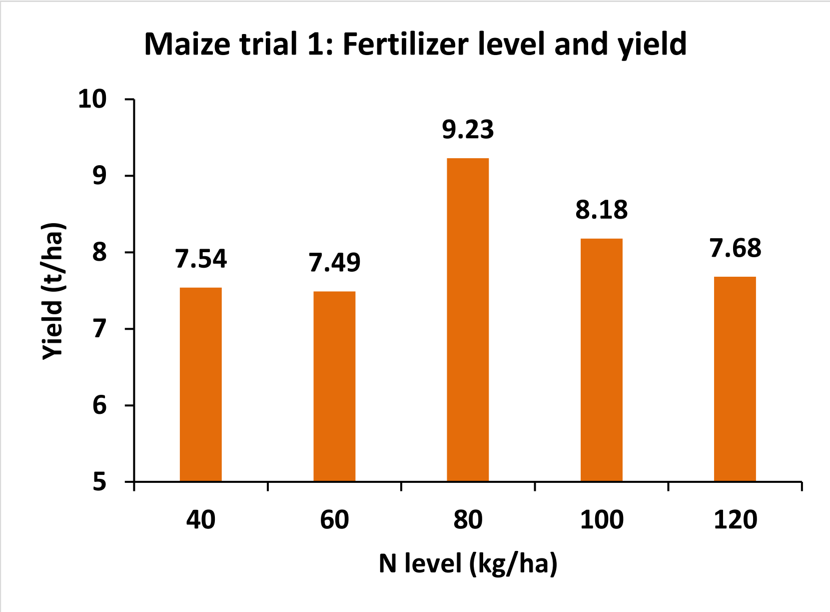


Figure 8.5.2. Effect of N level on maize yield produced under no till conditions.

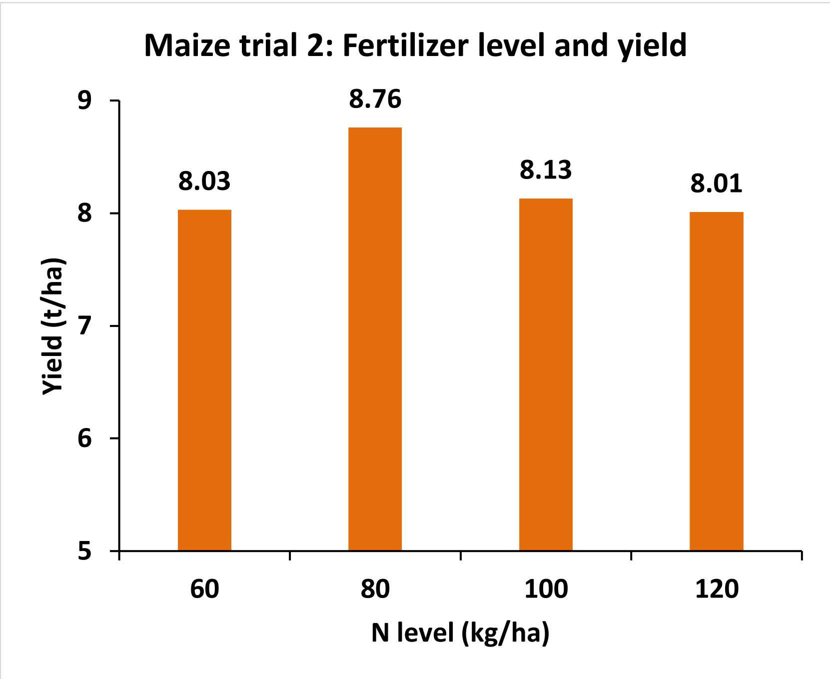


Figure 8.5.3. Effect of N level on maize yield produced under no till conditions.

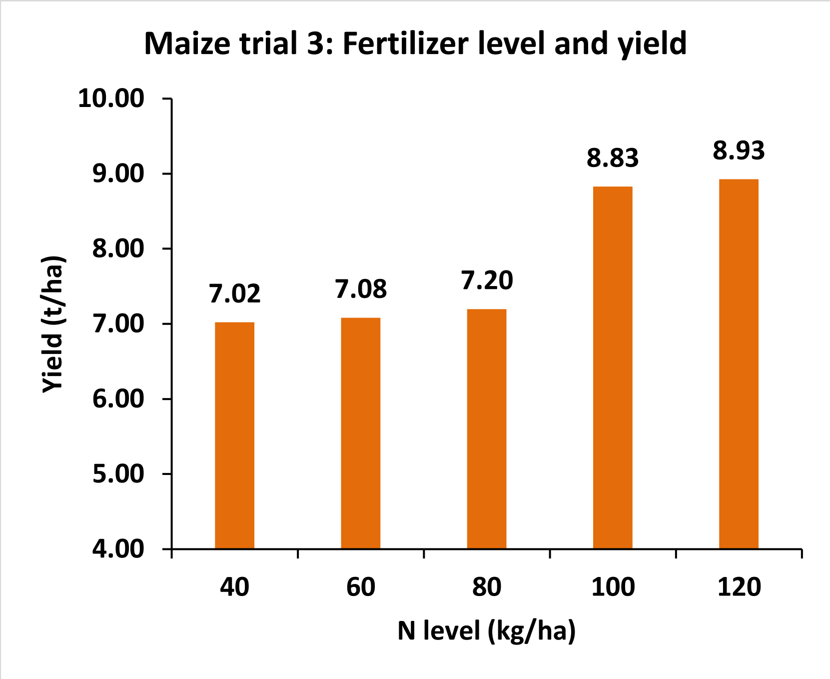


Figure 8.5.4. Effect of N level on maize yield produced under no till conditions.

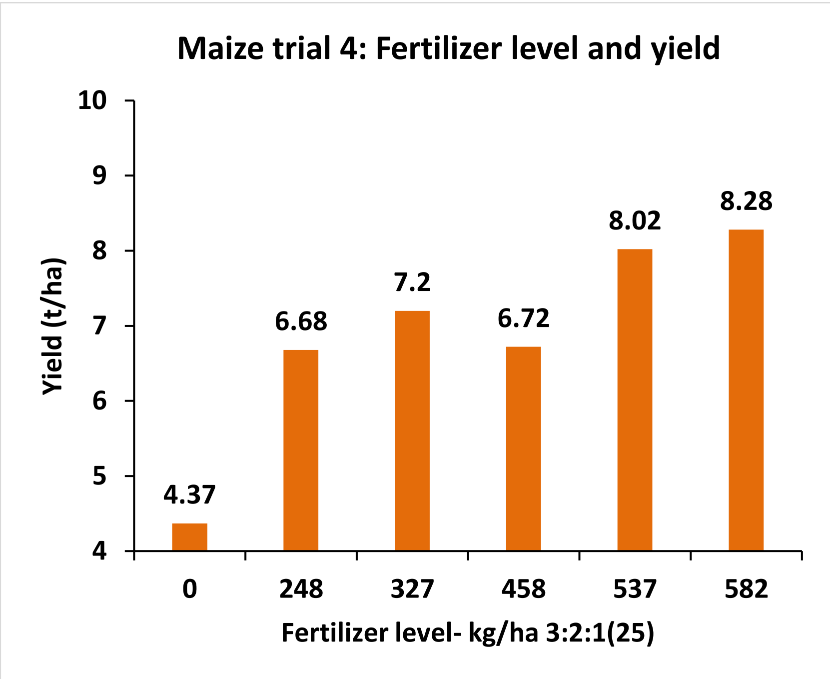


Figure 8.5.5. Effect of fertilizer level on maize yield produced under no till conditions.

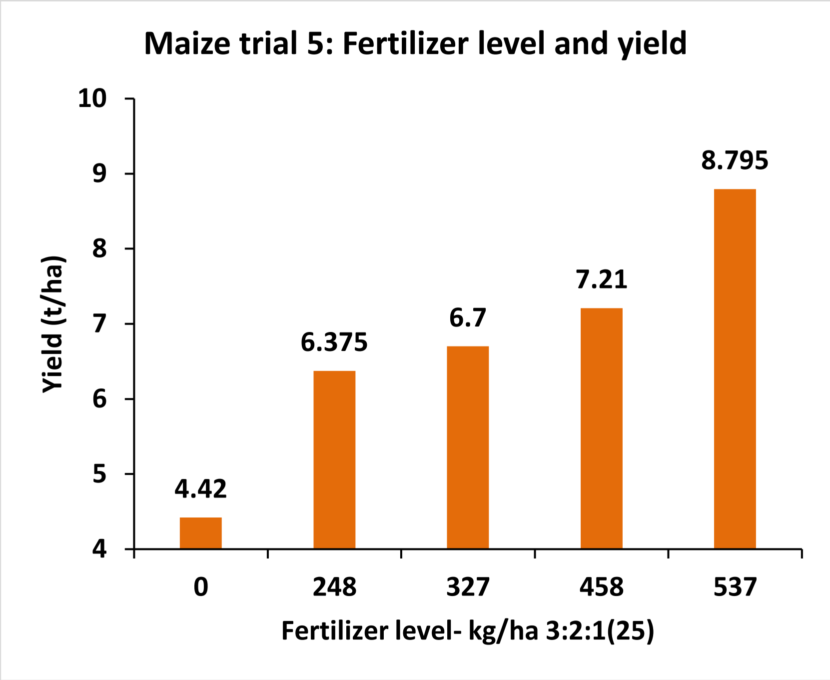


Figure 8.5.6. Effect of fertilizer level on maize yield produced under no till conditions.

CA and Plant population: yield

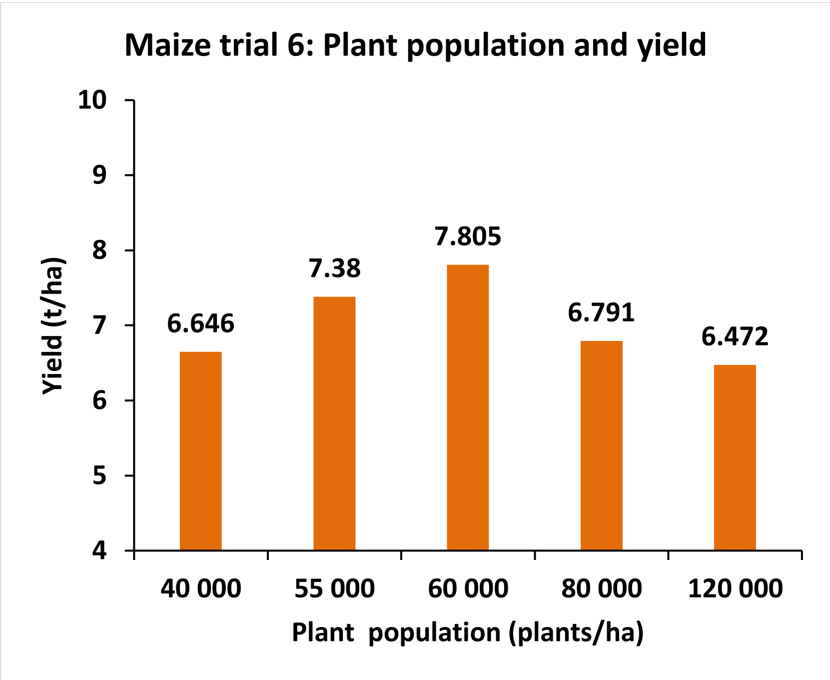


Figure 8.5.7. Effect of plant population on maize yield produced under no till conditions.

CONCLUSIONS AND RECCOMENDATIONS

Maize fertilization

Fertilizer trials was only done under no till conditions this year. Trial 1 and 2, where only N levels varied, shown that with less N (than the standard recommendations), higher yields can be produced. The trials showed that the 80N treatment produced the highest yield, with 40N and 60N producing the same yields than 120N. In trials 4 and 5 the fertilizer mixes varied. These trials showed that yield increases with increasing the fertiliser mix levels.

Maize plant population

This season only one plant population trial was done under no till conditions. The results show that yield increased with increased plant population up until 60 000 plants/ha, where after yield decreased. This year a 20 000 plants/ha treatment was not planted, because such low plant populations tend to limit yield, especially during favourable rainfall.

SOYA BEAN TRIALS

GENERAL PROCEDURES

Detailed information will be given on the results pages whilst general procedures will be presented here.

I Dreyer: Trial 1

A 4x4x2 factorial experiment (maturity class x plant population x row width) with 4 replicates was planted at Ascent, North of Vrede. A 36-row planter was used to plant rows of 0.38 m width. Wide rows of 0.76 m were created by pulling out every second 0.38 m row unit. Plants were thinned by hand to achieve correct plant populations. Hand thinning was chosen as a technique to increase randomization and to manipulate plant populations better than what is normally achieved when using planter gears to vary plant density.

SW Graaff: Trial 2 and 3

Two 4x4x2 factorial experiments (maturity class x plant population x row width) with 4 replicates were planted at Jim Fouche/Frankfort. Trial 2 was planted early November, while Trial 3 was planted late during the first week of December. Trial 3 was planted right next to the previously planted trial where a strip was left unplanted the first-time round. A 14-row planter was used to plant the 0.6 m wide rows. A GPS system enabled the tractor to double plant very effectively to form rows of 0.3 m width. Plant populations in the wide rows were manipulated by the planter gears whilst hand thinning was used in the narrow rows.

J van Dyk: Trial 4

A 4x4 factorial experiment (maturity class x plant population) with 3 replicates was planted at Memel/Vrede. The elevation above sea level of this area North of Vrede is generally 150 m higher than the rest of VKB’s production area. It is also almost 2°C cooler than the rest of VKB’s area. A 12-row planter was used, and planting density was varied using the planter gears.

The following Sensako cultivars provided a range of maturity classes:

Cultivar SSS 4945 – Maturity class 4.5

Cultivar SSS 5449 - Maturity class 5

Cultivar SSS 5202- Maturity class 5.2

Cultivar SSS 6560 - Maturity class 6

The cultivar 5202 was included this season as a fourth cultivar.

Net plots consisted of two 5 m rows that were harvested by pulling out whole plants and transporting them in bags to a store for threshing. A small-scale threshing machine was used, and small samples were taken for determining moisture contents afterwards. Yields are comparable on a 12,5% moisture content basis.

Harvesting dates differed according to the requirements of the different maturity classes. It was generally done about two weeks after physiological maturity had been reached for a specific maturity class.

Pod heights were determined just before harvesting was done. A measurement was made after subjectively determining which plants were most representative of the treatment combination.

Pod numbers per plant were determined during harvesting. Plants were pulled from the ground by hand and put in bundles of 10 to assist with counting the plant population. One of these bundles was selected and all the pods counted to determine the mean number of pods per plant.

Morphological development could only be monitored once a week. Crude differences could be demonstrated but finer differences would require finer measurements than what weekly observations could provide.

Trial 1

Tillage practice: No Till

Fertilizer: 8kg/ha N; 16kg/ha P + gypsum + "green granules"

Planting date: 07 November 2017

Harvesting time: Differentially (two weeks after physiological maturity)

Treatments

Plant population – 100k, 200k, 270k and 400k per ha

Row width- 0.38 m and 0.76 m

Maturity class-

- 4.5 (Cultivar SSS 4945)

- 5 (Cultivar SSS 5449)

- 5.2 (Cultivar SSS 5202)

- 6 (Cultivar SSS 6560)

Trial 2

Tillage practice: Conventional

Fertilizer applied: 6kg/ha N; 12kg/ha P; 24 kg/ha K

Planting date: 16 November 2017

Harvest date: Differentially (two weeks after physiological maturity)

Treatments:

Plant population – 150k, 300k, 400k and 600k per ha

Row width – 0.30 m and 0.60 m

Maturity class

- 4.5 (Cultivar SSS 4945)
- 5 (Cultivar SSS 5449)
- 5.2 (Cultivar SSS 5202)
- 6 (Cultivar SSS 6560)

Trial 3

Tillage practice: Conventional

Fertilizer applied: 6kg/ha N; 12kg/ha P; 24 kg/ha K

Planting date: 04 December 2017

Harvest date: Differentially (two weeks after physiological maturity)

Treatments:

Plant population – 150k, 300k, 400k and 600k per ha

Row width – 0.30 m and 0.60 m

Maturity class

- 4.5 (Cultivar SSS 4945)
- 5 (Cultivar SSS 5449)
- 6 (Cultivar SSS 6560)

Trial 4

Tillage practice: No Till

Fertilizer applied: 9kg/ha N; 9kg/ha P; 18kg/ha K

Row width: 0.76 m

Planting date: 29 November 2017

Harvest date: Differentially (two weeks after physiological maturity)

<u>Treatments</u>:

Plant population – 200k, 300k, 400k and 500k per ha

Maturity class

- 4.4 (Cultivar Patrys 100)

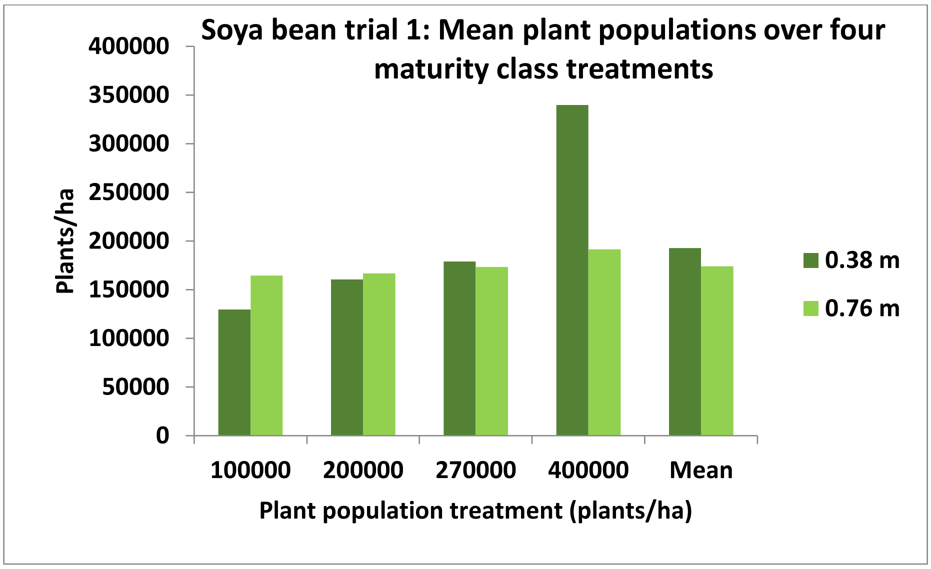
- 5 (Cultivar SSS 5449)

- 5.2 (Cultivar SSS 5202)

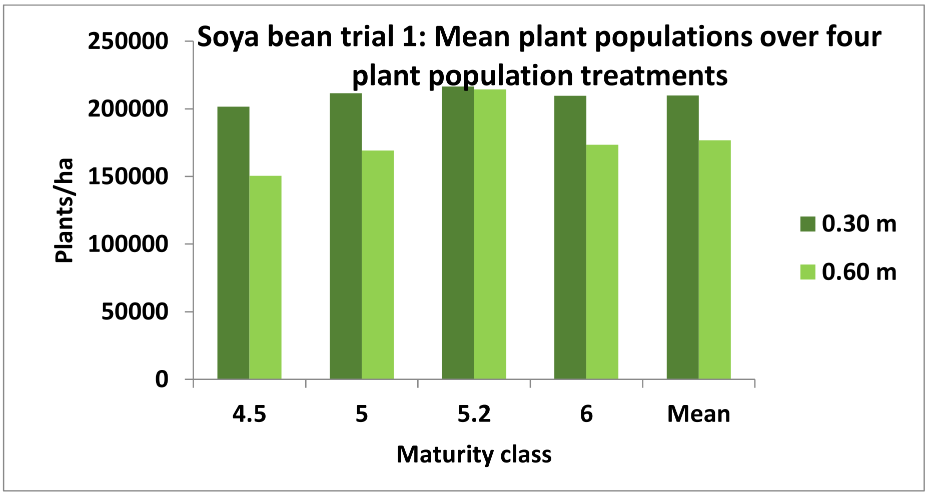
- 6 (Cultivar SSS 6560)

<u>Results</u>

The final plant populations that were determined at harvesting will be provided first. It is very important to keep these results in mind. Sometimes it is only practical to provide the planned plant population for a graph when certain results are illustrated. It can thus be misleading to link an effect to a certain plant population that was in reality not achieved.

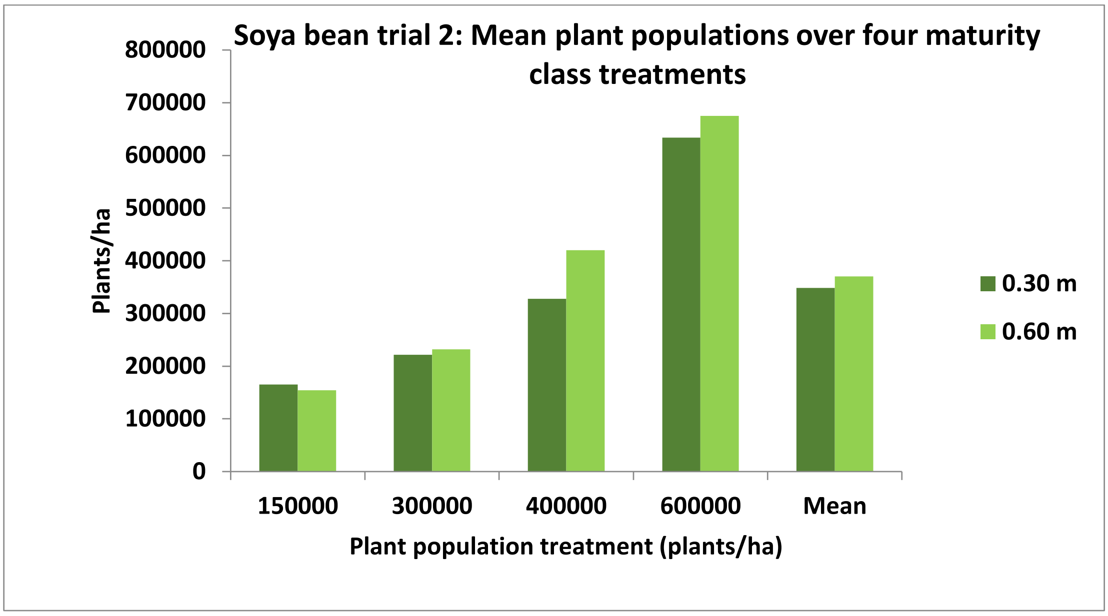


a



b

Figure 8.5.8. Mean final plant populations for a) plant population treatments and b) maturity class treatments.

a


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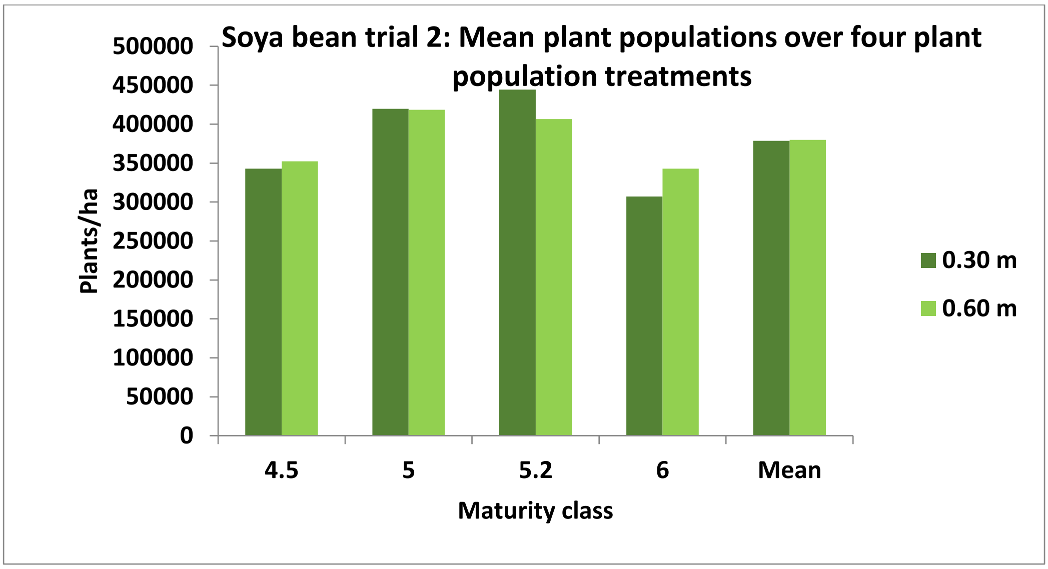
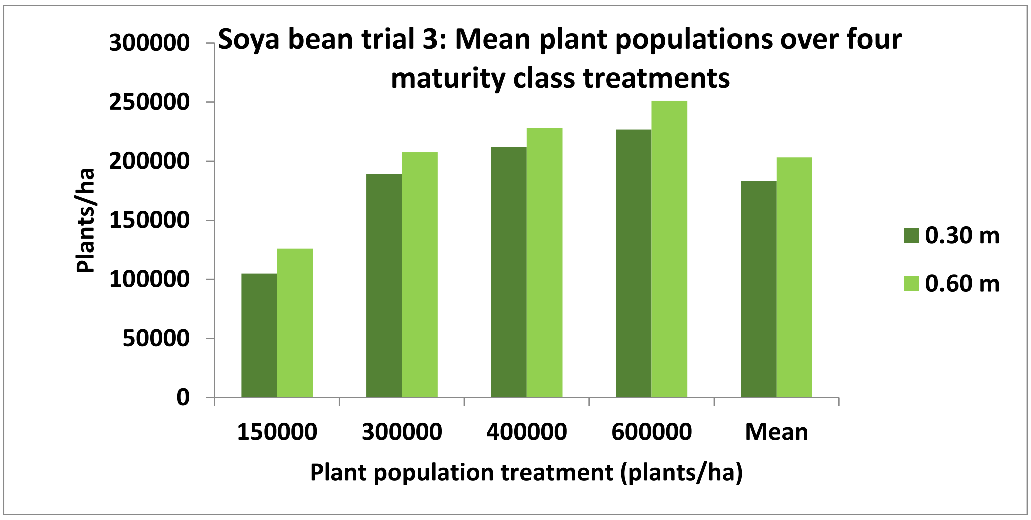
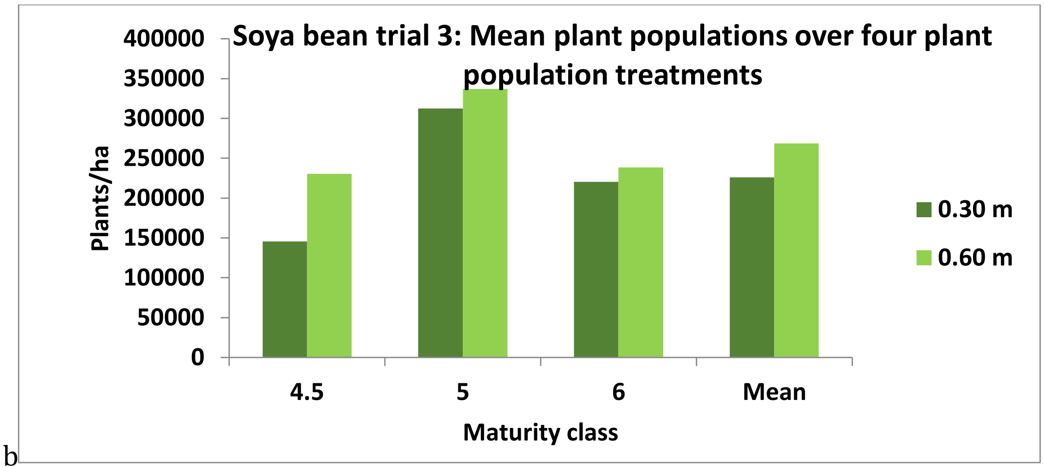


Figure 8.5.9. Mean final plant populations for a) plant population treatments and b) maturity class treatments.

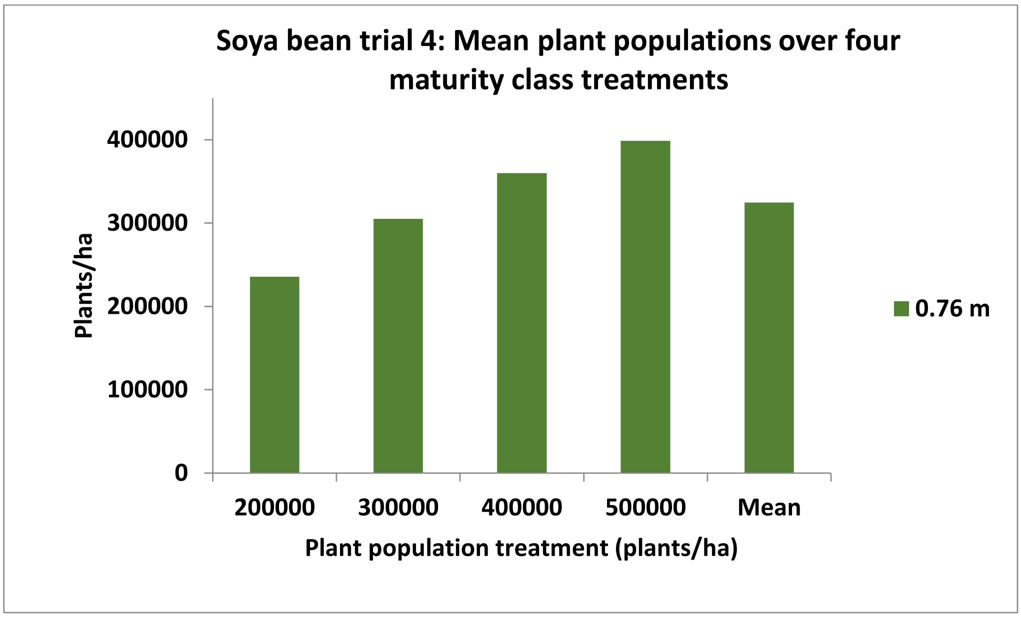


a

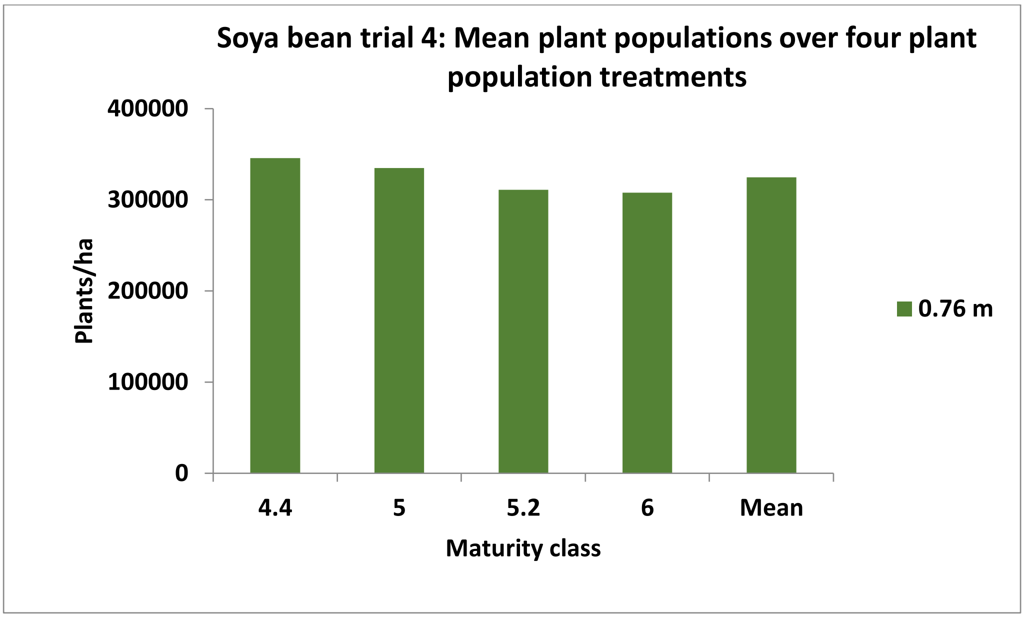


b

Figure 8.5.10. Mean final plant populations for a) plant population treatments and b) maturity class treatments.



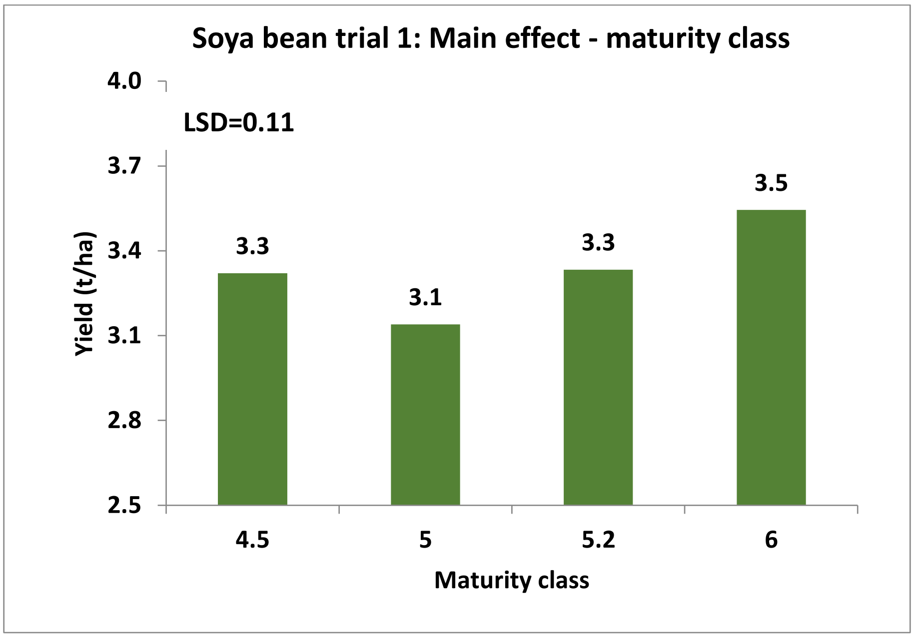
a



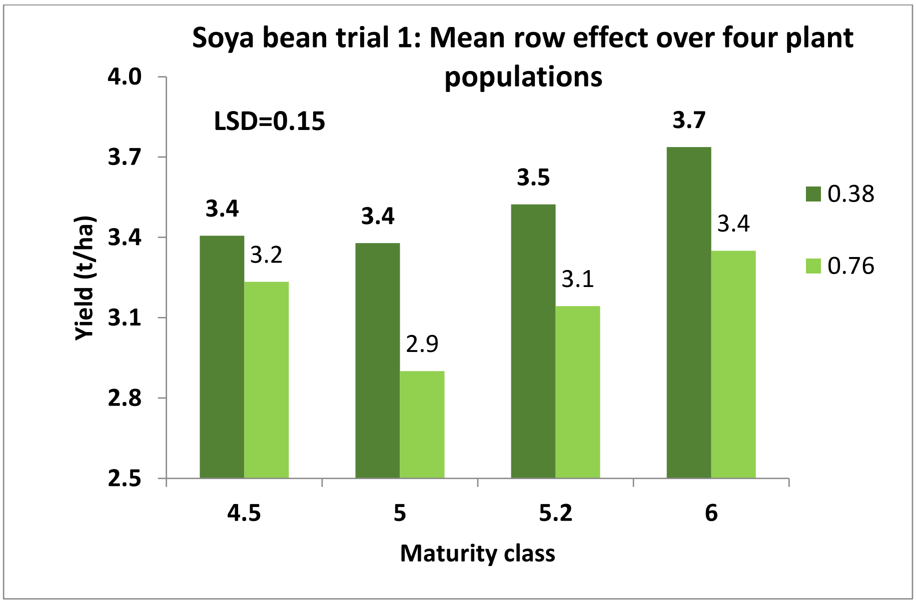
b

Figure 8.5.11. Mean final plant populations for a) plant population treatments and b) maturity class treatments.

YIELD- MAIN EFFECTS FOR MATURITY CLASSES

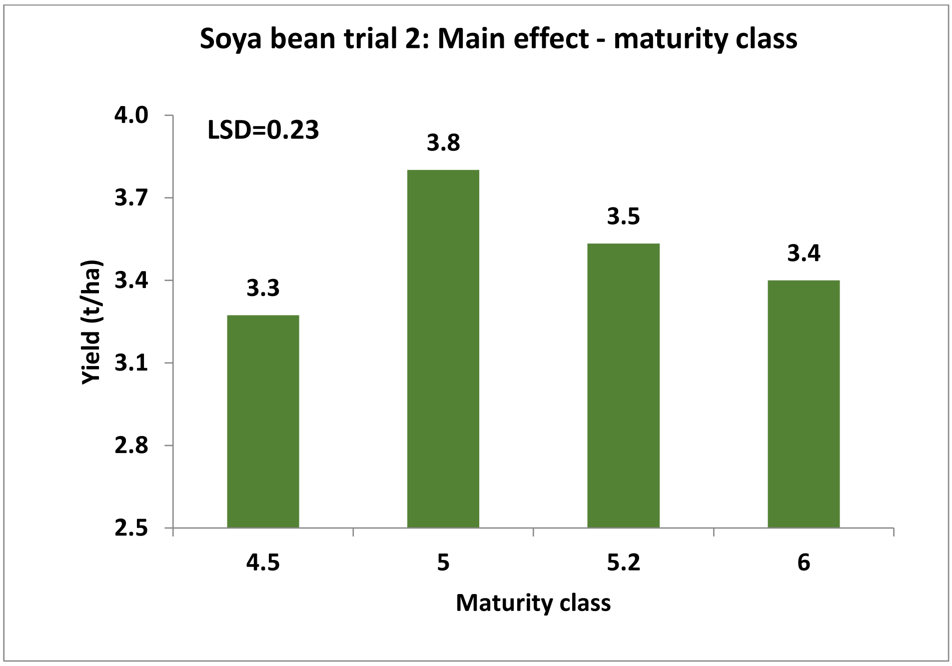


a



b

Figure 8.5.12. Main effect for maturity class (a) and b) maturity class x row width interaction for soya bean yield in Trial 1.

a


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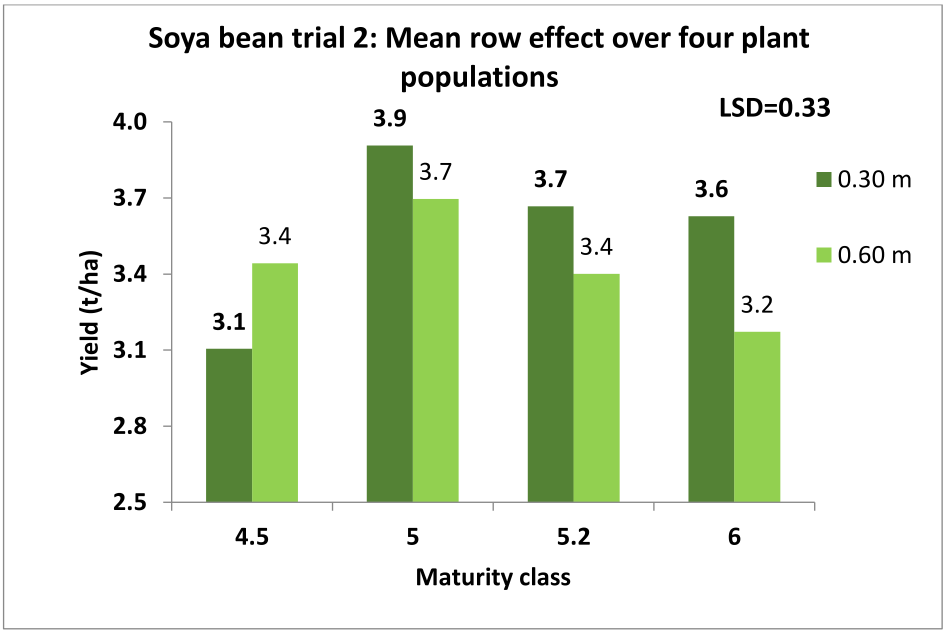
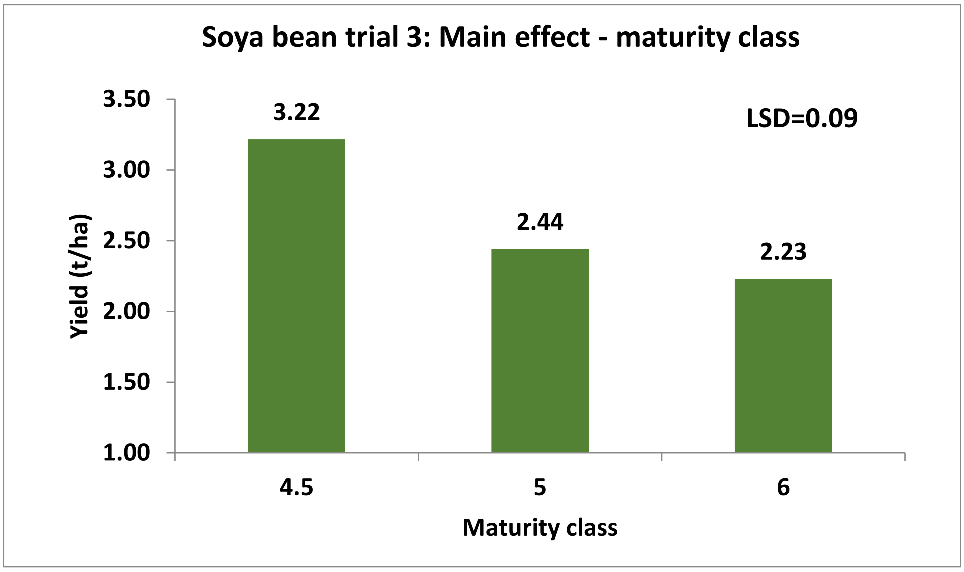


Figure 8.5.13. Main effect for maturity class (a) and b) maturity class x row width interaction for soya bean yield in Trial 2.

a 

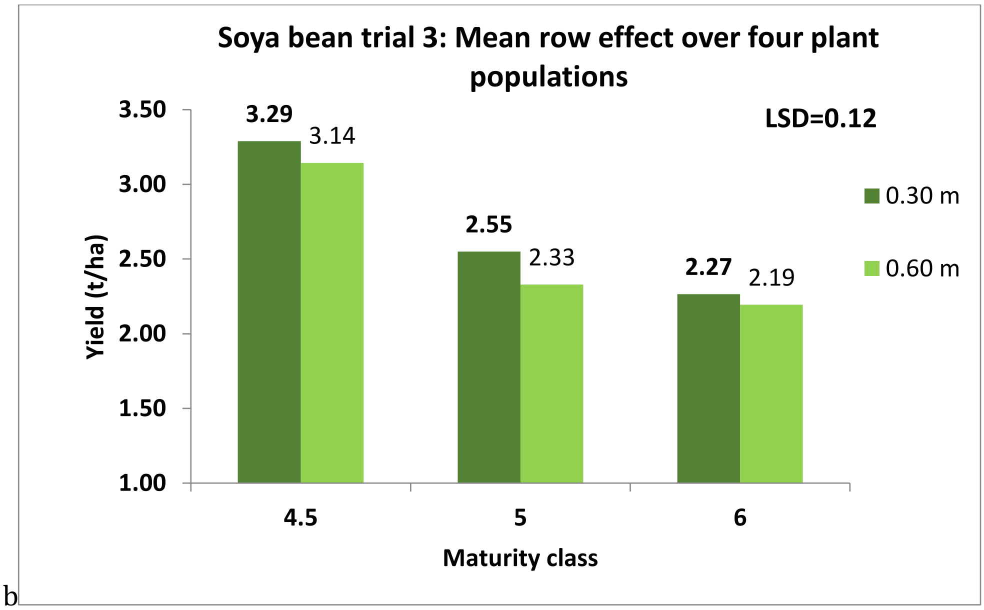
b 

Figure 8.5.14. Main effect for maturity class (a) and b) maturity class x row width interaction for soya bean yield in Trial 3.

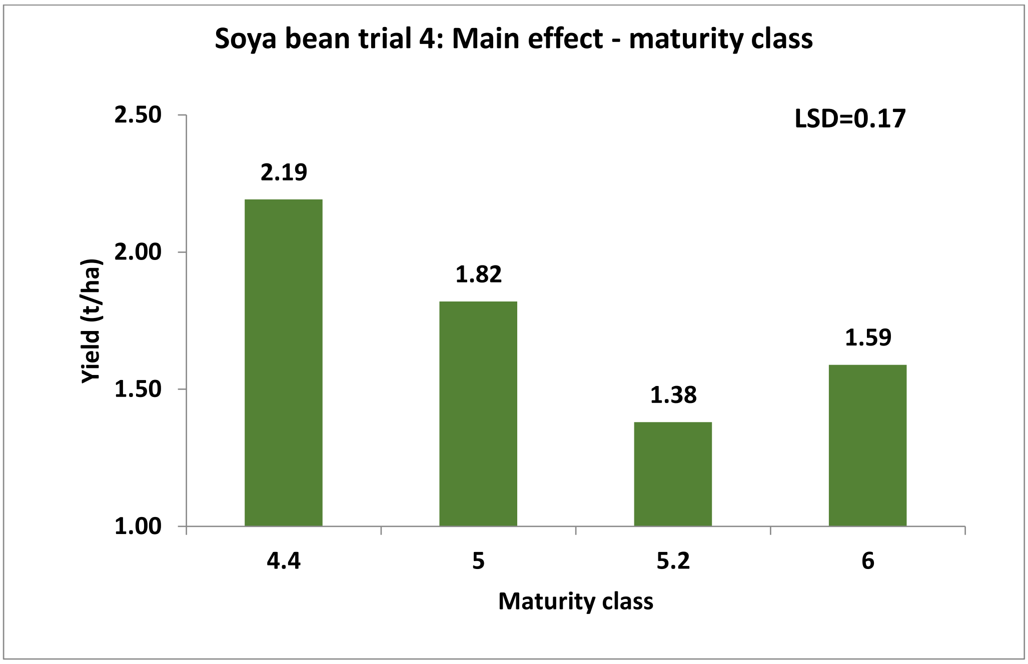
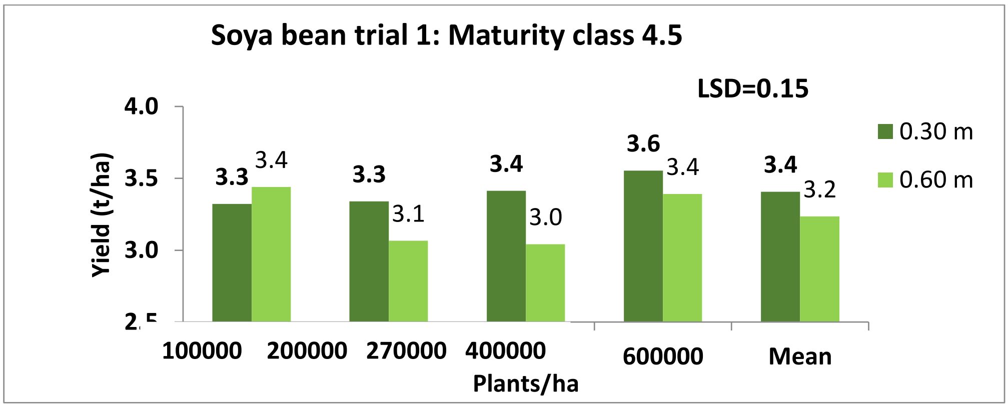
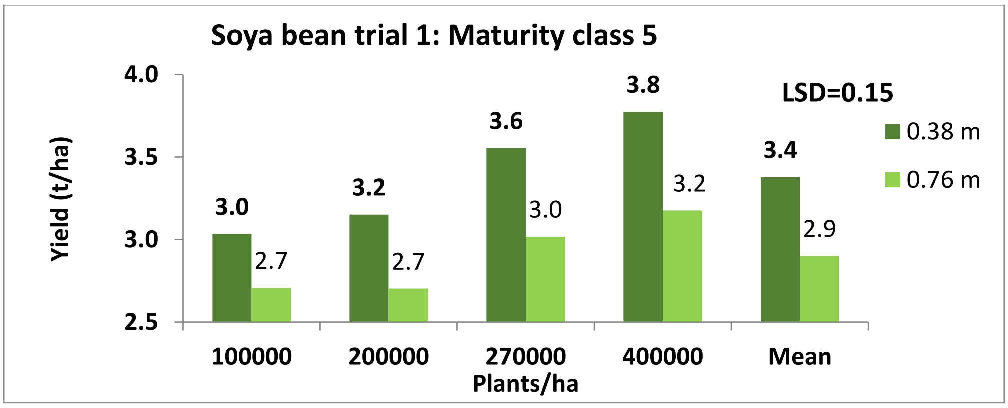


Figure 8.5.15. Main effect for maturity class for soya bean yield in Trial 4.

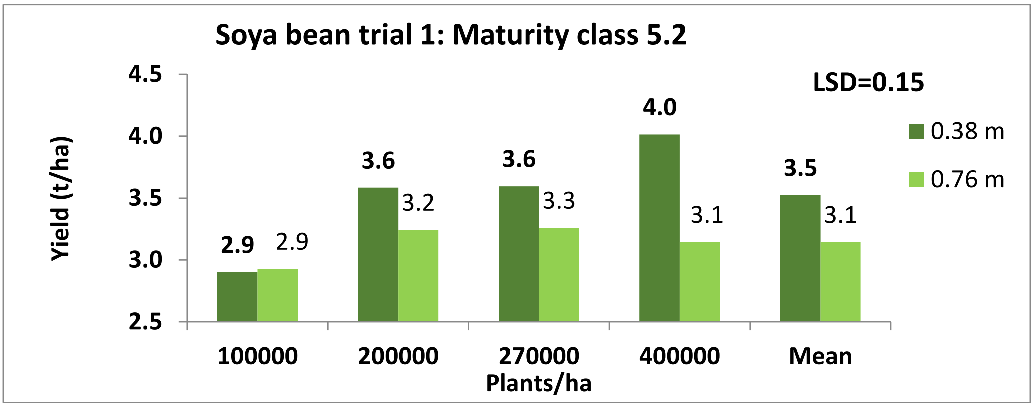
YIELD- PLANT POPULATION X ROW WIDTH X MATURITY CLASS INTER ACTION



a



b



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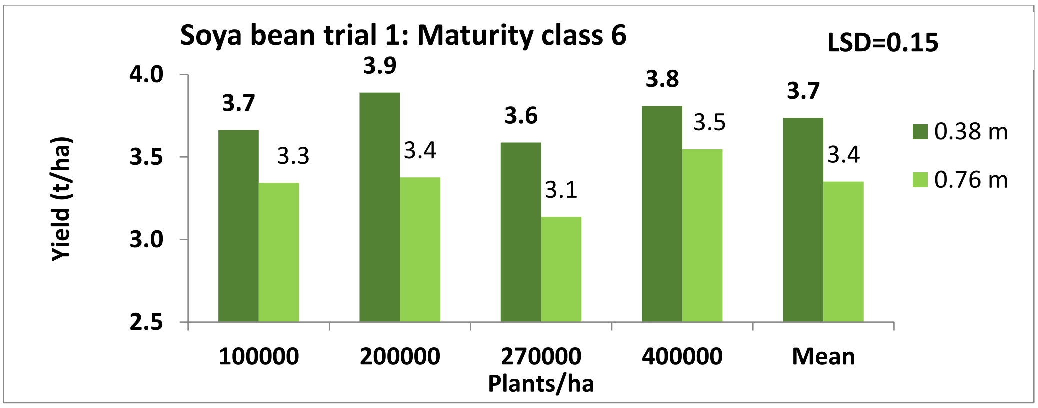


d

Figure 8.5.16. Soya bean yield for different maturity class x plant population x row width treatment combinations in Trial 1.

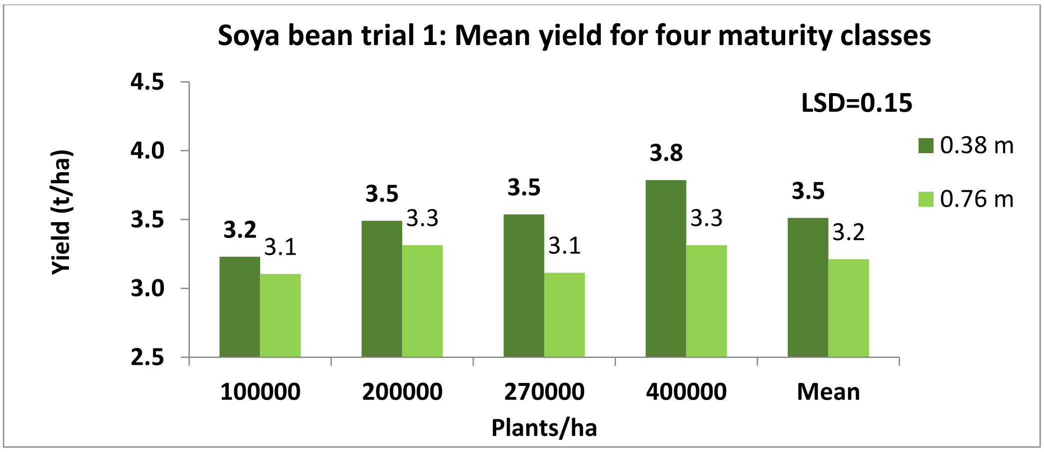


Figure 8.5.17. Mean yield for four soya bean maturity classes planted in two row widths at four plant populations in Trial 1.

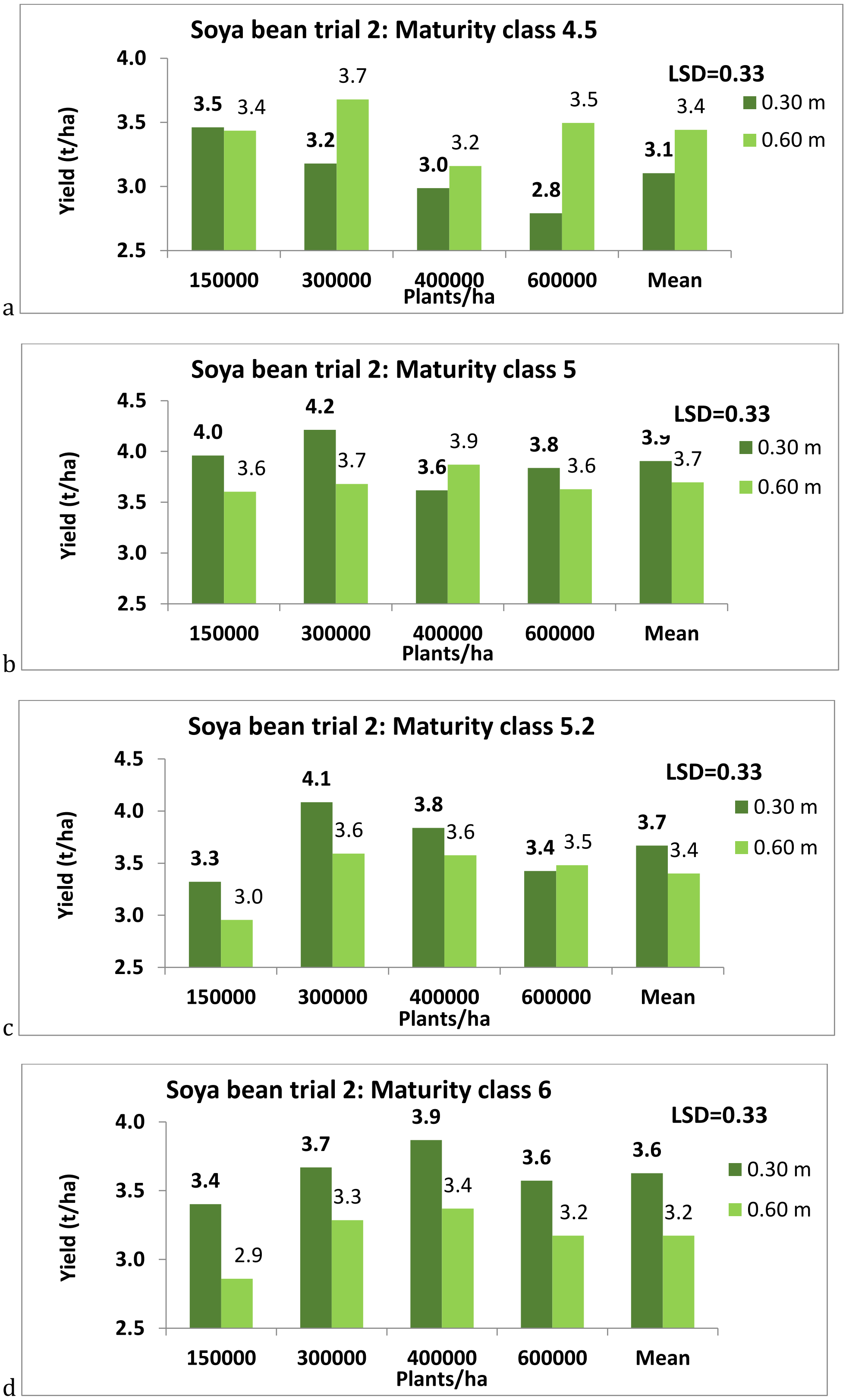


Figure 8.5.18. Soya bean yield for different maturity class x plant population x row width treatment combinations in Trial 2.

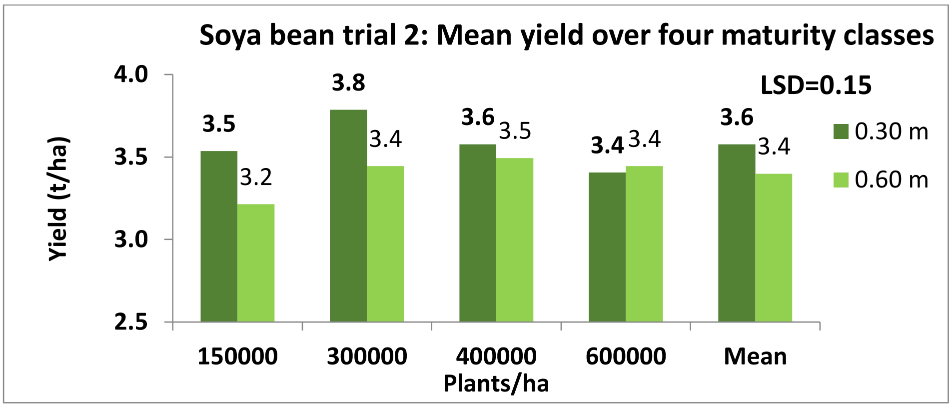
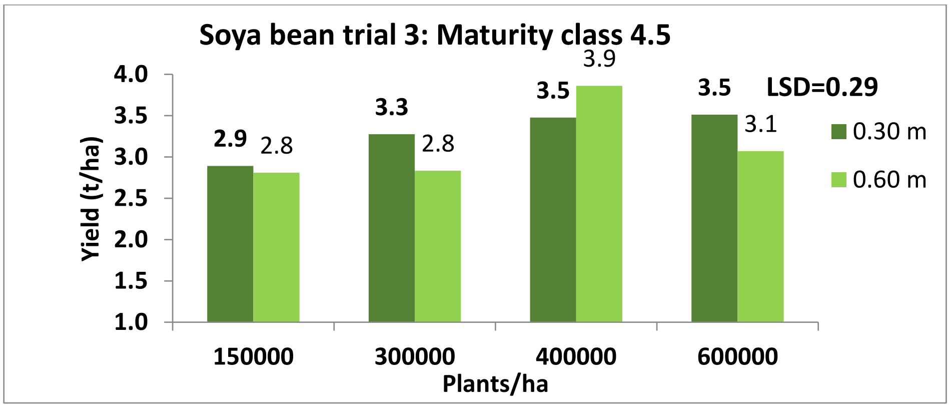


Figure 8.5.19. Mean yield for four soya bean maturity classes planted in two row widths at four plant populations in Trial 2.

a



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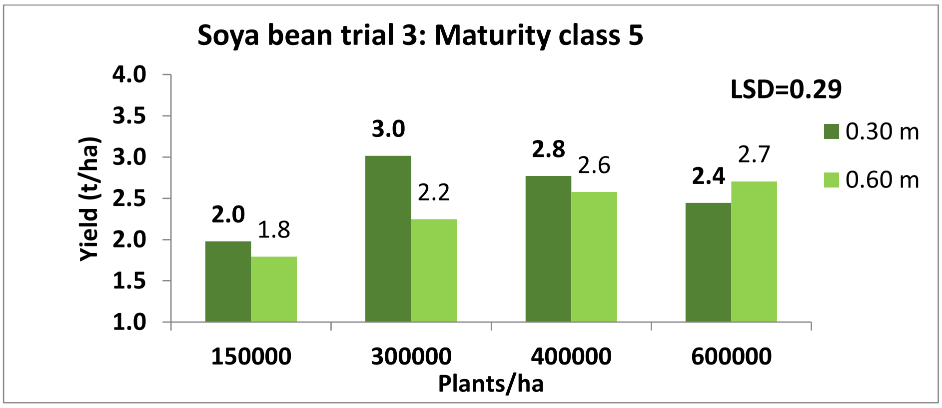


c

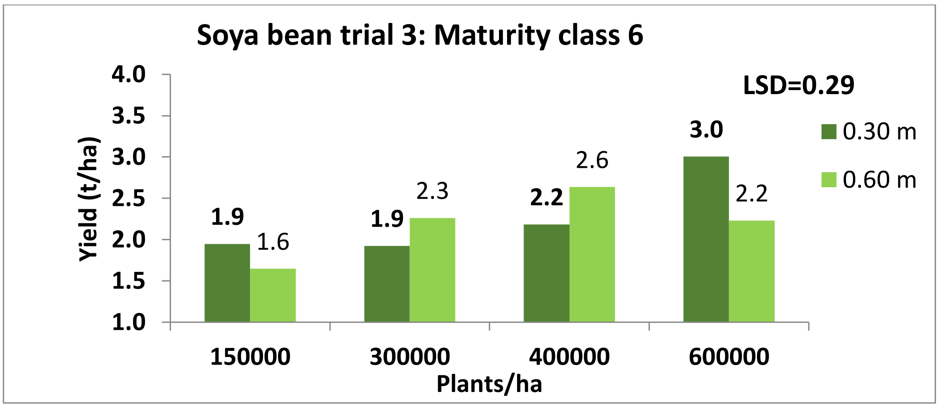


Figure 8.5.20. Soya bean yield for different maturity class x plant population x row width treatment combinations in Trial 3.

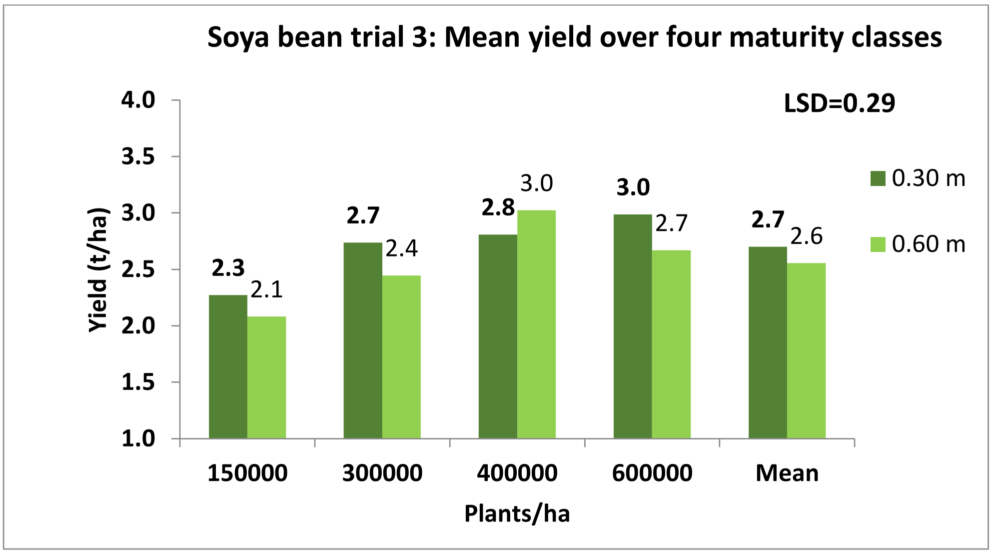
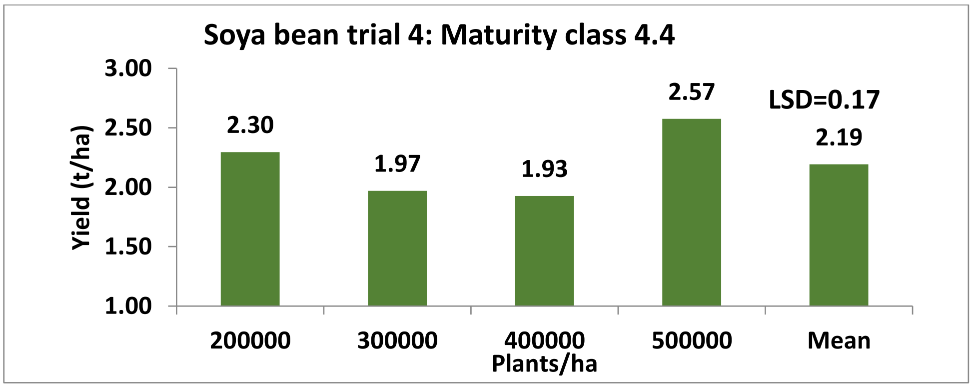
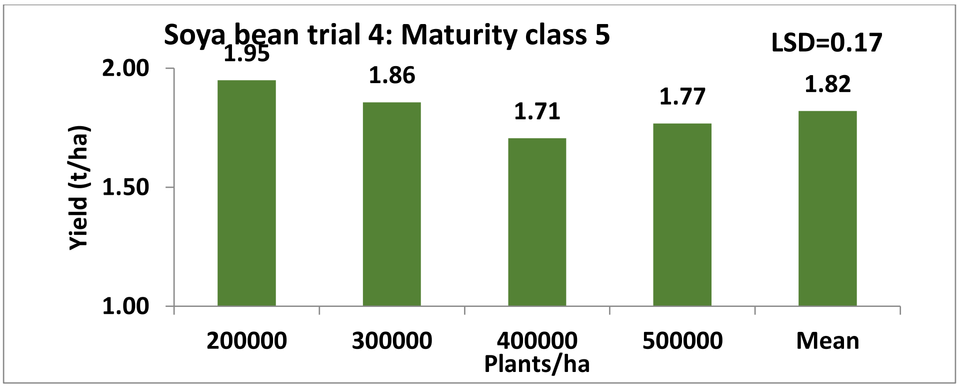


Figure 8.5.21. Mean yield for four soya bean maturity classes planted in two row widths at four plant populations in Trial 3.



a



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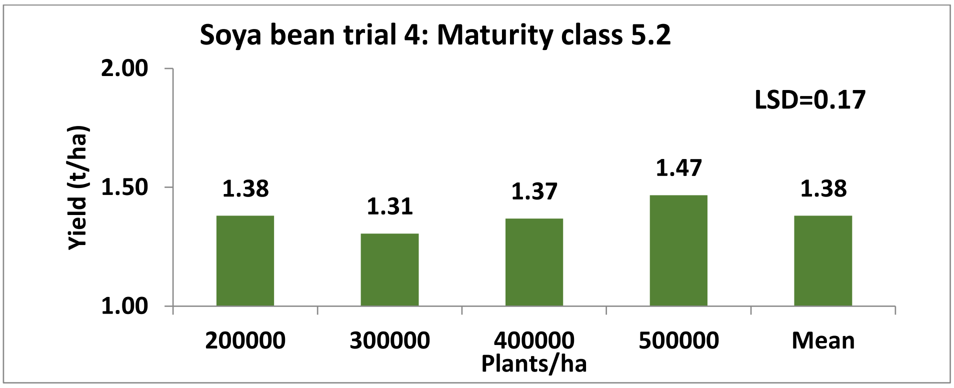


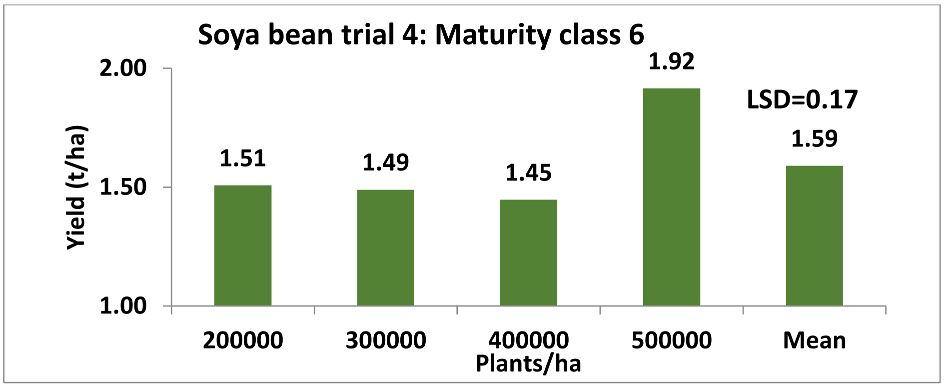
d


Figure 8.5.22. Soya bean yield for different maturity class x plant population x row width treatment combinations in Trial 4.

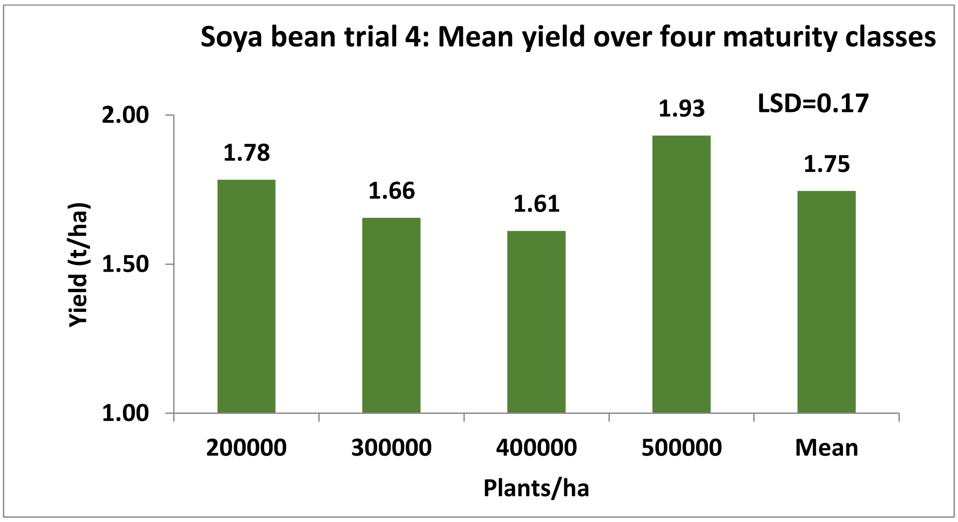
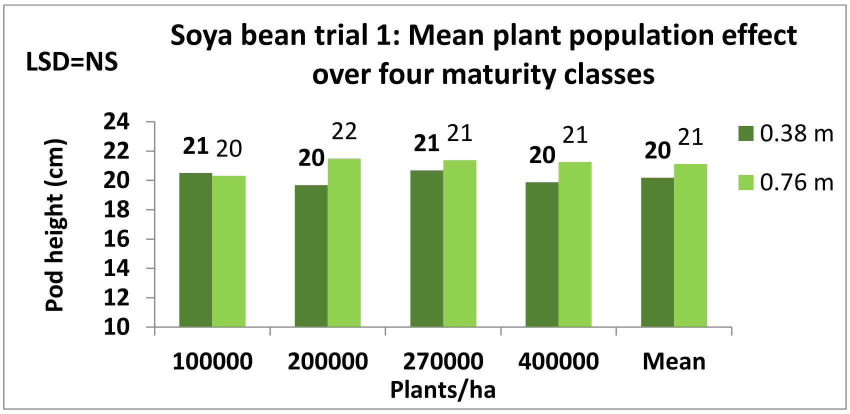
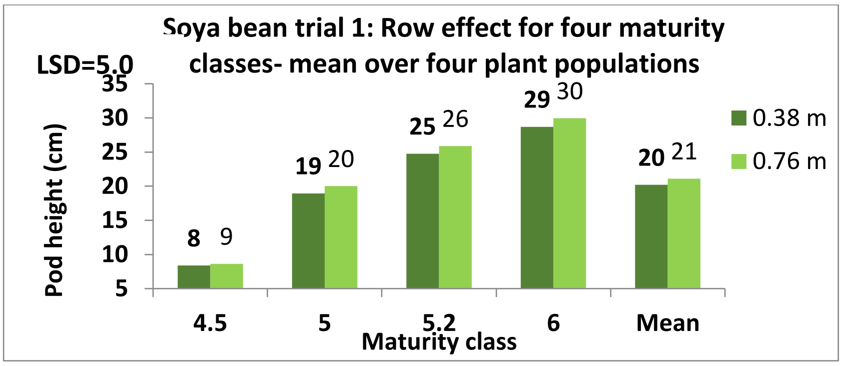


Figure 8.5.23. Mean yield for four soya bean maturity classes planted in two row widths at four plant populations in Trial 4.

POD HEIGHT

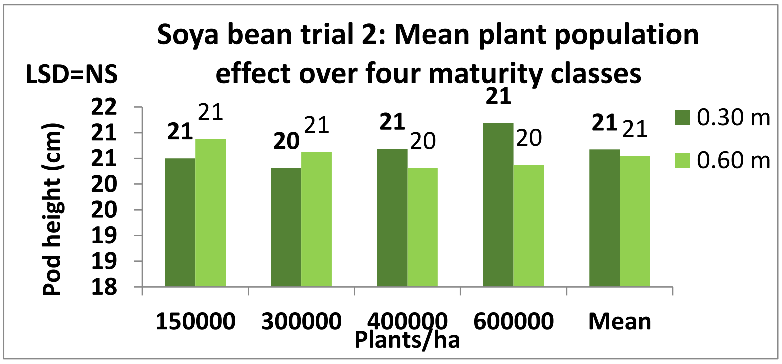


a

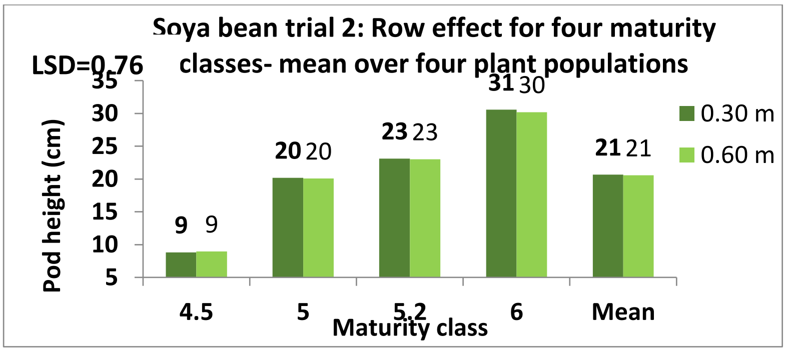


b

Figure 8.5.24. Mean pod height for a) four plant populations and b) four soya bean maturity classes in Trial 1.

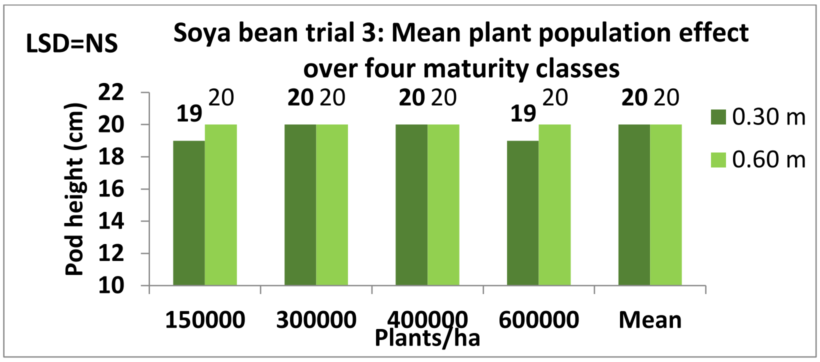


a

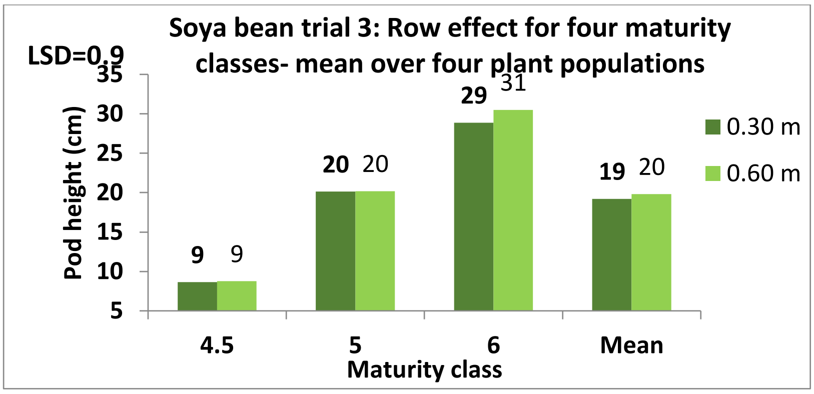


b

Figure 8.5.25. Mean pod height for a) four plant populations and b) four soya bean maturity classes in Trial 2.

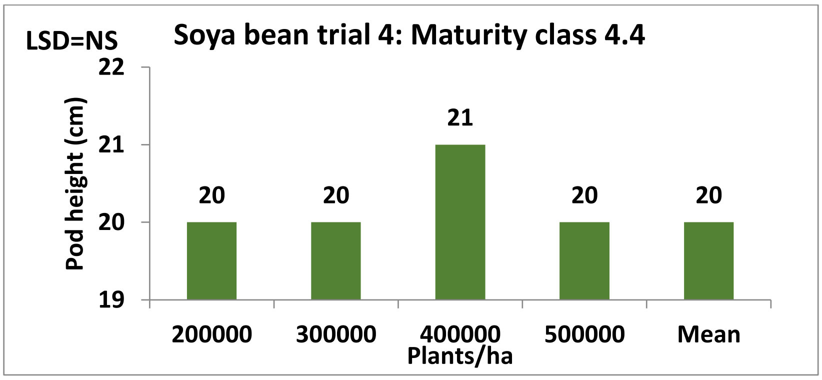


a

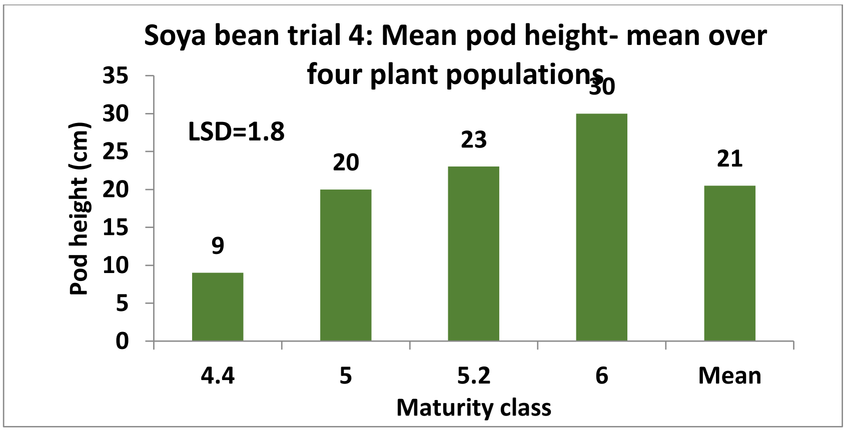


b

Figure 8.5.26. Mean pod height for a) four plant populations and b) four soya bean maturity classes in Trial 3.



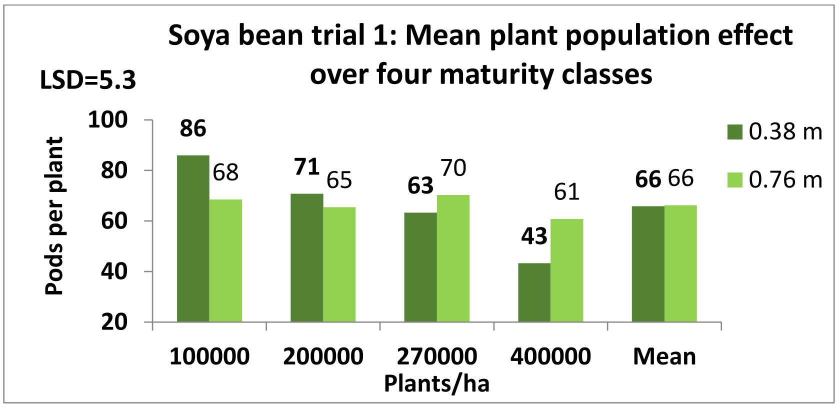
a



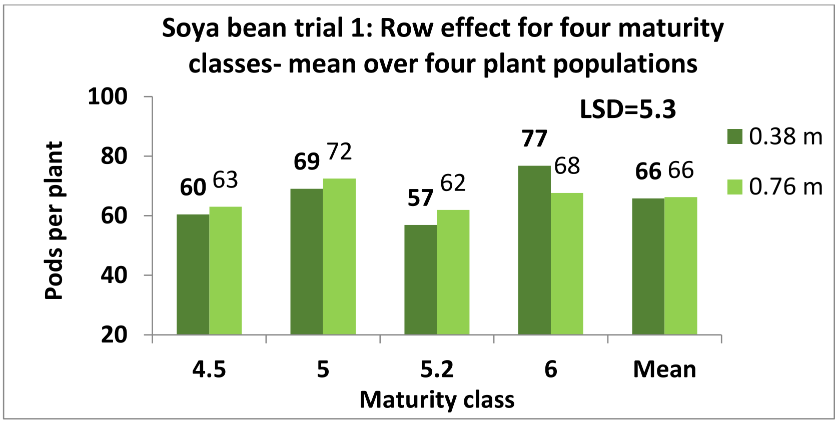
b

Figure 8.5.27. Mean pod height for a) four plant populations and b) four soya bean maturity classes in Trial 4.

POD NUMBER PER PLANT

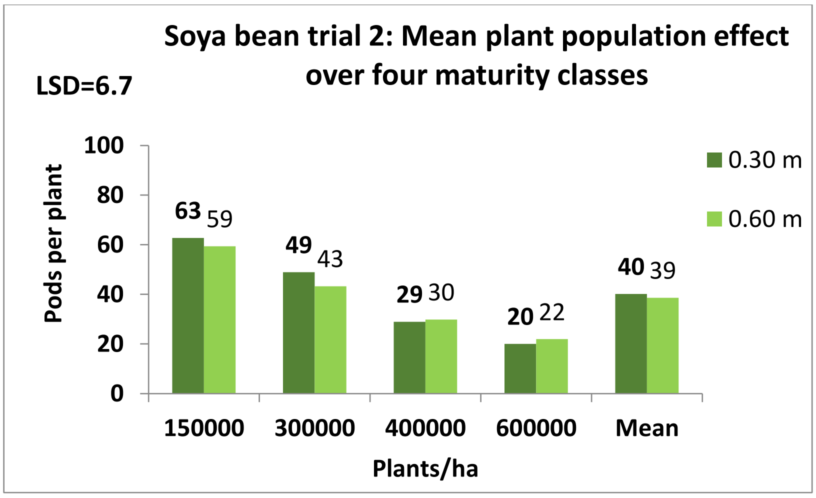


a

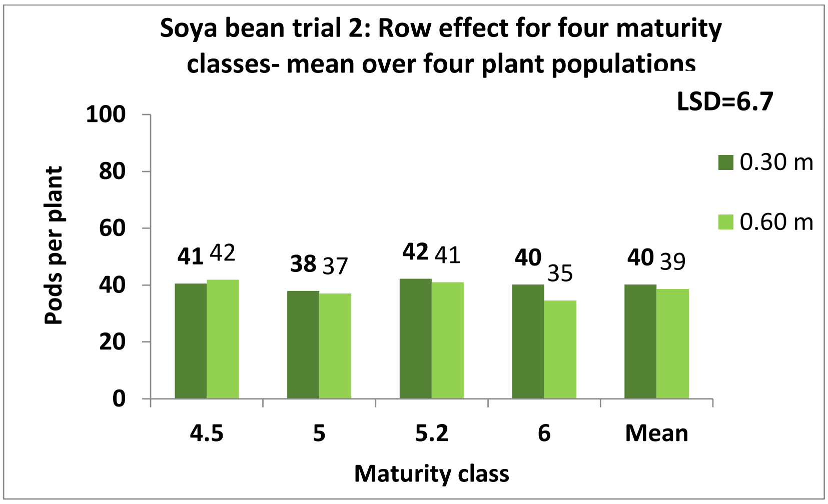


b

Figure 8.5.28. Mean pod number per plant for a) four plant populations and b) four soya bean maturity classes in Trial 1.

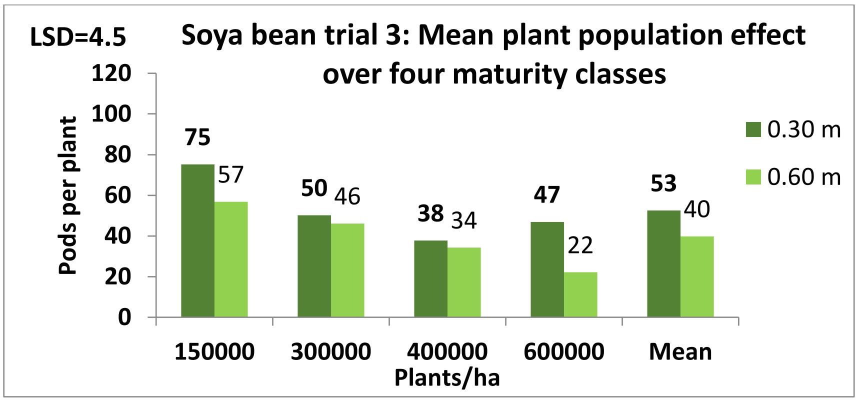


a

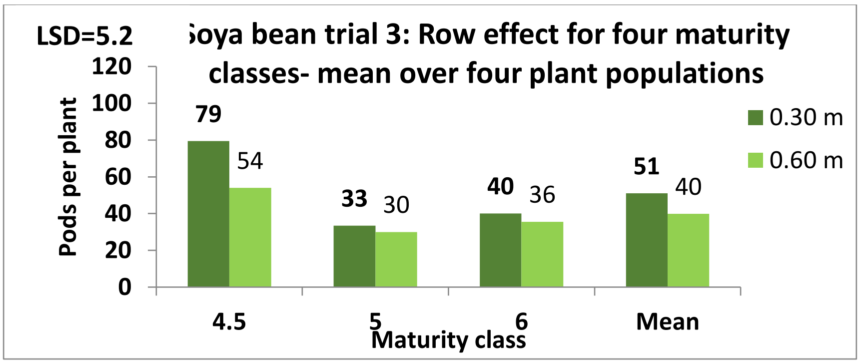


b

Figure 8.5.29. Mean pod number per plant for a) four plant populations and b) four soya bean maturity classes in Trial 2.



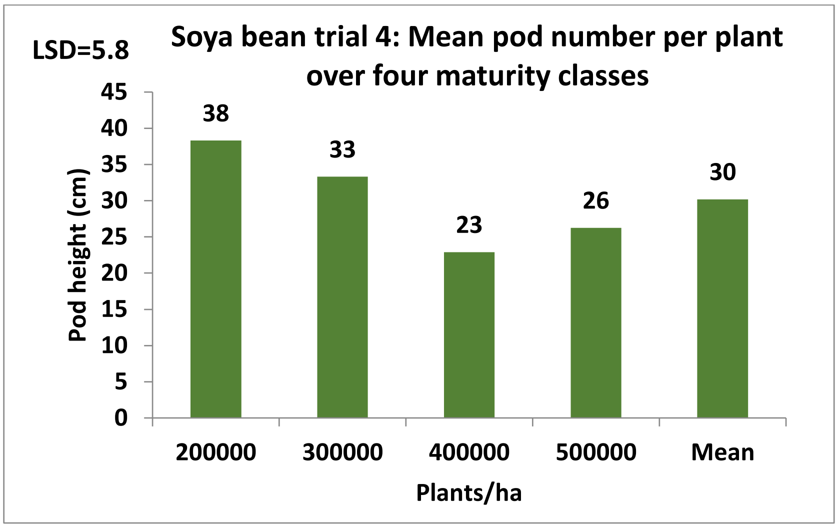
a



b

Figure 8.5.30. Mean pod number per plant for a) four plant populations and b) four soya bean maturity classes in Trial 3.

a



b

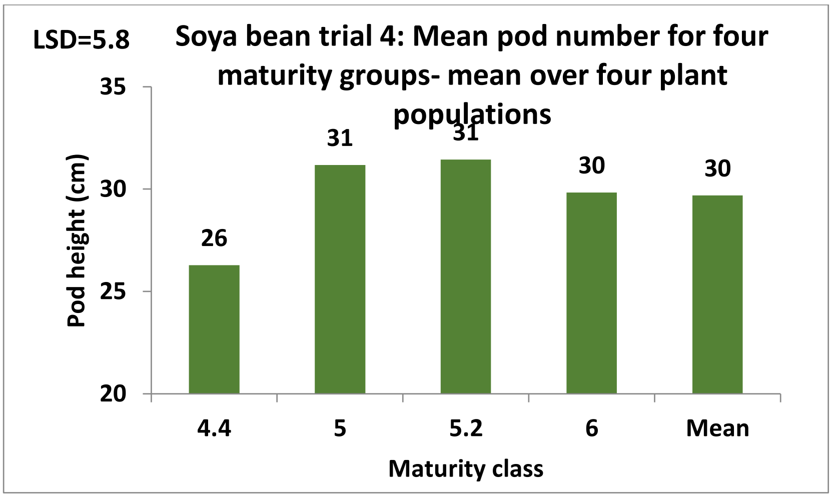


Figure 8.5.31. Mean pod number per plant for a) four plant populations and b) four soya bean maturity classes in Trial 4.

MORPHOLOGICAL DEVELOPMENT

Table 8.5.1 to 8.5.4 show the total growing period in weeks, divided into critical development periods. There were clear differences between maturity groups in terms of reaching certain morphological periods. Looking specifically at trial 2 and 3, which had two planting dates, it is clear that later planting reduces the growing season. A two-and-a-half-week delay in planting resulted in a shorten growing season of 3 weeks for maturity group 4.5 and 2 weeks for maturity group 5 and 6. Also looking at yield, it is clear that later maturing groups tend to produce lower yields than early maturing groups for late planting dates. After two years of results one can conclude that maturity groups of 4.5 and shorter can still be planted during the first week of December and still have enough time to complete their growing cycles before a normal first date of middle April.

Table 8.5.1. Trial 1 - Soya bean morphological development for four maturity classes.

	Maturity class			
	4.5	5	5.2	6
Morphological period	Weeks			
Planting- R1	9	12	13	13
R1- R5	6	6	5	5
R5- R8	5	5	6	6
Total growing period	20	23	24	24

Table 8.5.2. Trial 2 - Soya bean morphological development for four maturity classes.

	Maturity class			
	4.5	5	5.2	6
Morphological period	Weeks			
Planting- R1	7	11	11	11
R1- R5	6	5	5	5
R5- R8	6	5	6	6
Total growing period	19	21	22	22

Table 8.5.3. Trial 3 - Soya bean morphological development for four maturity classes.

	Maturity class		
	4.5	5	6
Morphological period	Weeks		
Planting- R1	6	8	9
R1- R5	5	6	5
R5- R8	5	5	6
Total growing period	16	19	20

Table 8.5.4. Trial 4 - Soya bean morphological development for four maturity classes.

	Maturity class			
	4.4	5	5.2	6
Morphological period	Weeks			
Planting- R1	9	13	13	13
R1- R5	4	5	5	5
R5- R8	6	4	6	6
Total growing period	19	22	24	24

CONCLUSUINS AND RECOMMENDATIONS

PLANT POPULATION – SOYA BEAN

As seen in the 2016/2017 season, soya bean plant populations as low as 100 000 or 150 000 plants/ha can produce yields close to plant populations of 250 000 to 400 000 plants/ha. Plant populations of lower than 150 000 plants/ha are not recommended, because the occurrence of hail is possible and can have a very negative impact on final plant population. Low plant populations can also lead to gaps in the row and especially with narrower rows. Increased plant population resulted in an increase in yield, especially for the late planting date. Before deciding on higher plant populations, one should consider the economic impact. The sum must be made to see if the increase in yield obtained from higher plant populations justify the increases seed cost. Results also show that an increase in plant population above the current general plant populations of about 350 000 plants/ha have a small advantage on yield. For pod height difference in plant population did not have significant differences. Number of pods per plant were significantly affected by plant population. Number of pods per plant decreased with increasing plant population in most of the trials.

ROW WIDTH – SOYA BEAN

The results of the 2017-18 season, as the previous season, showed that narrow rows have significant greater yields than wider rows; the effect is much greater that increasing plant populations. Even when narrow rows of 0.6 m were further narrowed to 0.3 m, higher yields were harvested. This year's planting techniques also did not favour narrow rows, yet narrow rows produced higher yields. There were no significant differences between row widths regarding pod height. Narrow rows produced a higher number of pods per plant than wide rows in general.

PLANTING DATE AND MATURITY GROUP

Planting date and maturity group interacts with one another and cannot be considered separately. Planting date had a great influence on yield. Early or normal planting dates resulted in higher yields than late planting dates. For the early planting trial all the maturity groups produced satisfactory yields. Late planting dates resulted in significant lower yields for maturity group 5 and 6.

It is clear that delayed planting effects yields of all maturity groups negatively. When early planting can be realized, longer maturity groups must be planted firstly, to utilize the growing season optimally. Shorter maturity groups can be planted in December, but longer maturity groups must be avoided when planting late.

9. Summary of expenses on August 2018

Description	Total Actual YTD Aug 18	Total Budget YTD Sept18	Available to use
Reitz Soil	-	83 200	83 200
Vrede: Soil	-	76 800	76 800
Cover crops	7 760	141 600	133 840
Reitz: Agronomy	41 120	84 800	43 680
Vrede: Agronomy	27 324	53 920	26 596
Reitz: Grain SA	38 527	145 000	106 473
Vrede: Grain SA	14 224	68 000	53 776
Total	**128 955**	**653 320**	**524 365**