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A simplified process of biological fertilization by seed coating with mycorrhizal fungal spores and PGPR bacteria in maize and sorghum

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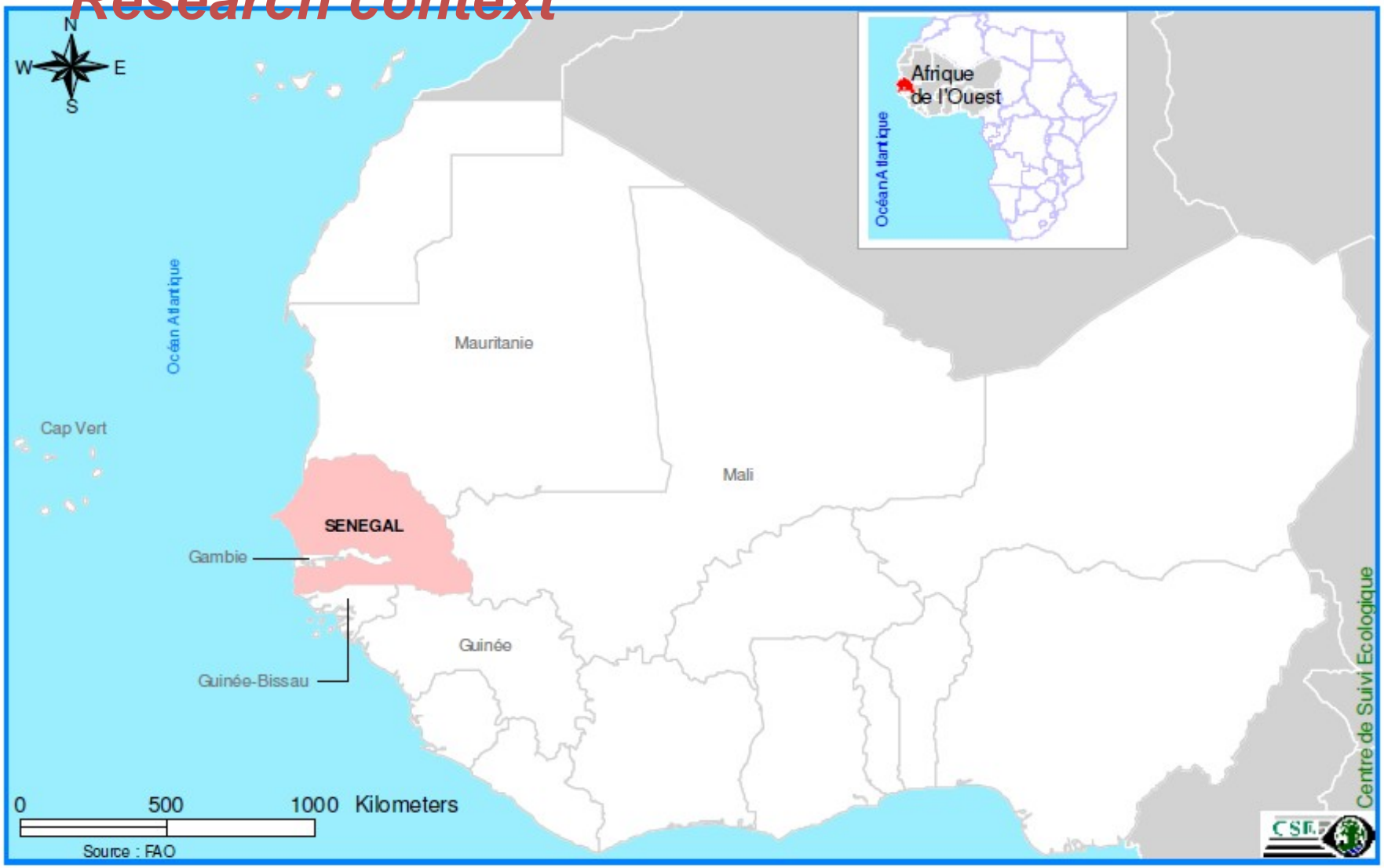
Research context

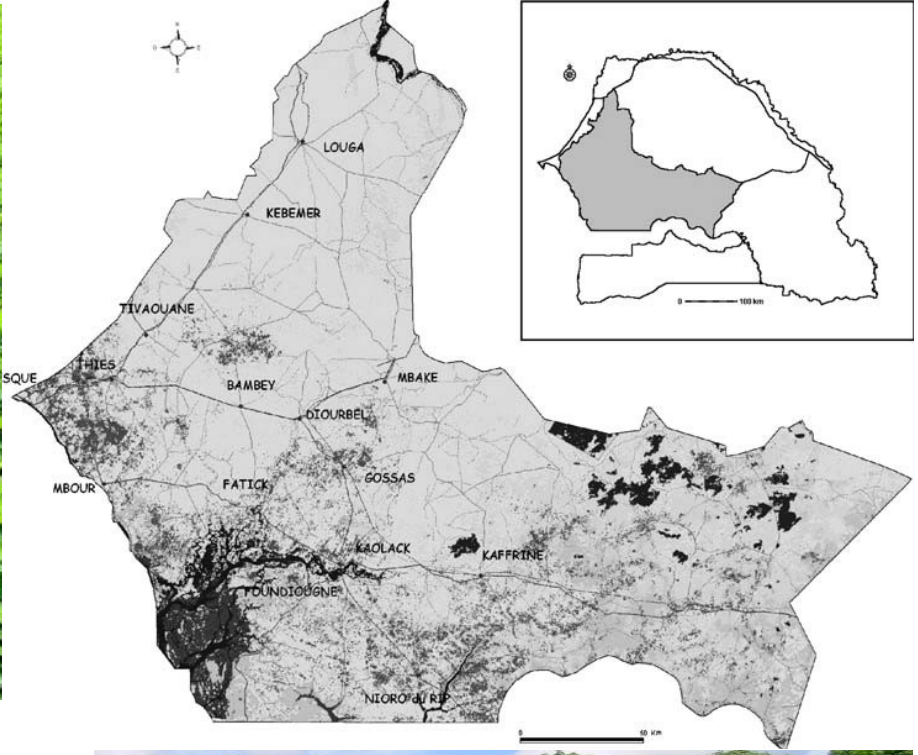


Superficie : 196 720 km^2
Population : 17 215 428 habitants

The climate is typical of semi-arid lands of West Africa characterized by a short rainy season from July to September-October. Average annual rainfall is oscillating between 400 and 600 mm with temperature ranging from 23.7 to 37.7°C.

Research context

Peanut **1 421 288 T**



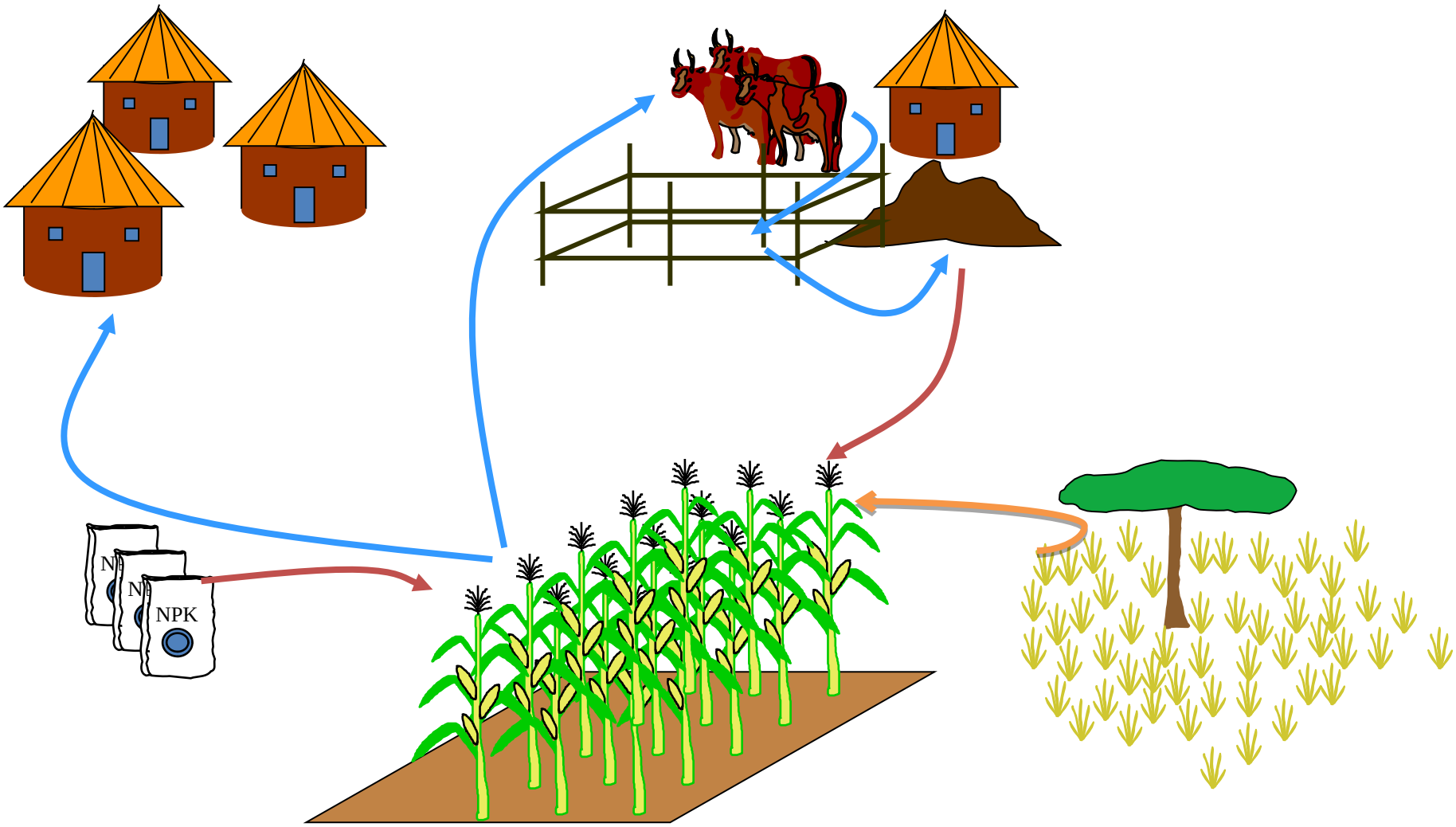
Cotton **16 511 T**

Cowpea **63 000 T**

Research context

Crop yields are continuously decreasing mainly due to a loss of soil fertility.

Among strategies to counteract this problem, the used of symbiotic microorganisms is a promising approach for restoring poor soils and increasing crop yields.



Research context

N2 fixing bacterial symbioses

N_2

Mycorrhizal symbioses

P, H_2O

1. There is an inadequacy of the mode of application of microbial fertilizers in relation to cultivation practices.

2. Seed attacks by insects can seriously reduce the cereal grain stocks and their performance. Losses by the insects can reach 40% within 6 months of storage.

Aim of the study

Our paradigm: to intensify the use of microbial fertilizers, to adjust application modes suitable for smallholder farmer cultivation systems and to increase the seed quality and the production of nutritious and healthy food.

The objectives of the action were:

(i) to use microbial consortium (AM fungi and bacteria) as coating products (biofertilizers) to develop a seed coating technology for the maize and sorghum cultivars;

(ii) to assess whether the coated products can be stored without losing viability for guaranteed period and;

(iii) to assess whether the coatings can reduce the damages caused by the insect bioaggressors.

MATERIAL and METHODS: the selected cultivars

"Early thaï" cultivar for *Zea mays*

"Nganda" cultivar for *Sorghum bicolor*

MATERIAL and METHODS: the selected inoculants

Rhizophagus aggregatus

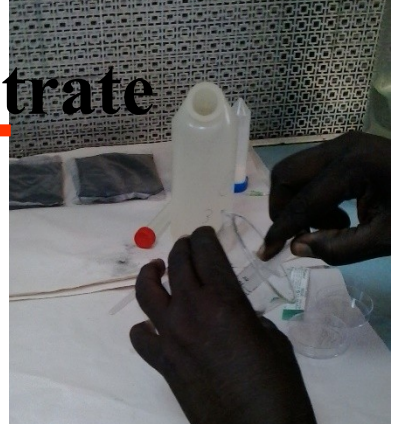
Rhizophagus fasciculatus

AMF inoculum

Leifsonia sp. ORS 3454

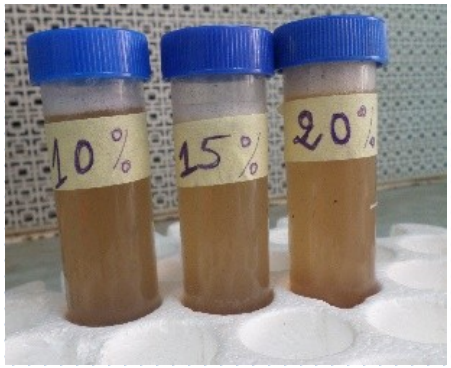
MATERIAL and METHODS: the coating substrate

Peat substrate, pH adjusted at 6.8



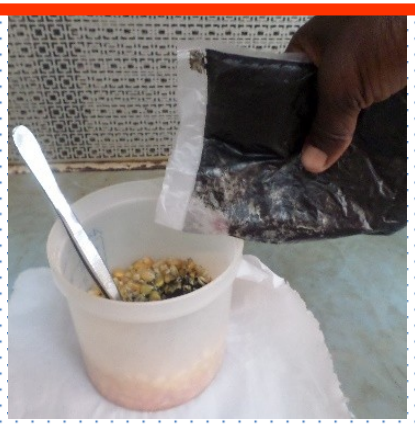
Arabic gum exudate used as the glue material

MATERIAL and METHODS: seed coatings



Three solutions of arabic gum 10, 15 and 20%

Seeds + arabic gum



Peat substrate containing the microbial consortium was gradually added

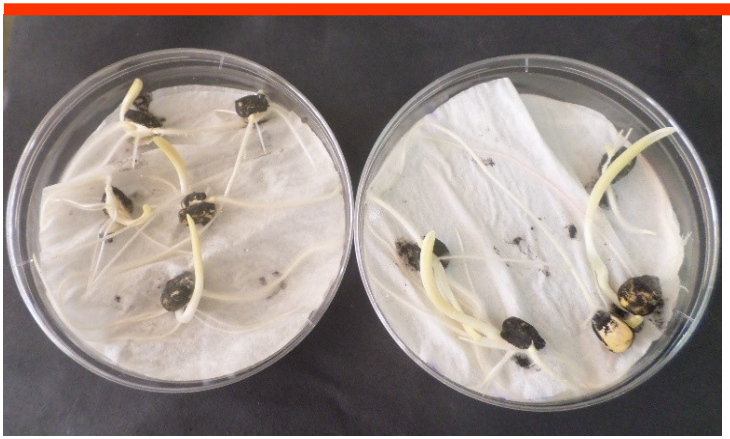
Peat was stirred thoroughly to ensure each seed was wrapped with a uniform layer of coated materials

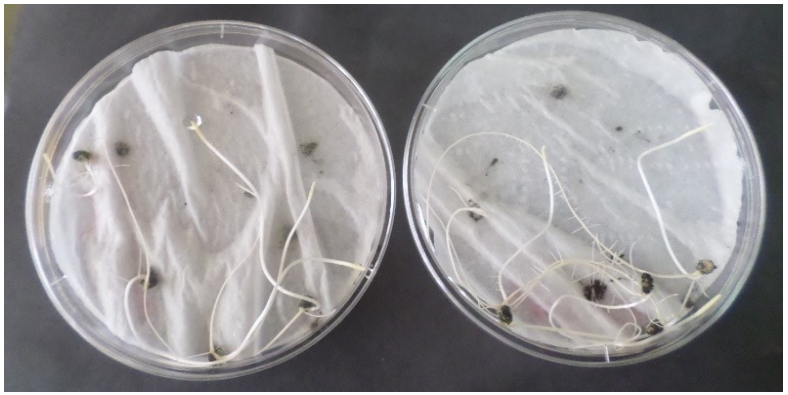
Coated seeds of *Zea mays*

Coated seeds of *Sorghum bicolor*

The coated seeds were dried and stored

MATERIAL and METHODS: Seed germination tests





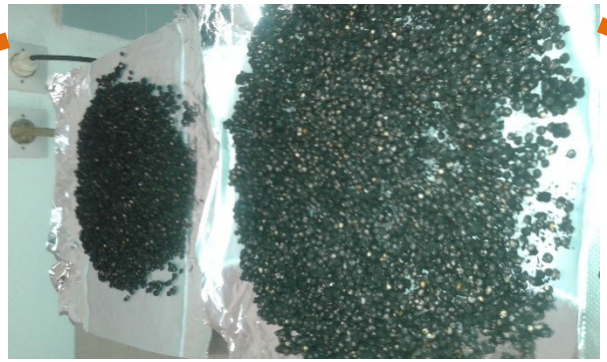
Seed germination rates and inoculants germination capacities were determined just after coating.

The remaining coated and uncoated seeds were divided into two lots.

One batch was stored in a cold room (6 °C) and the other batch was kept at room temperature (on average 25 °C).

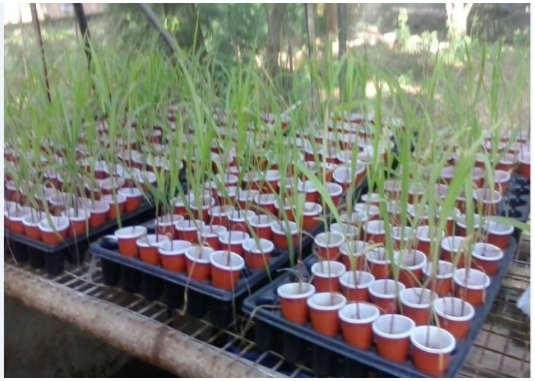
These batches of seeds were stored for 4 months and the germination capacities of seeds and coated inoculants were tested every two months.

MATERIAL and METHODS: Effect of coated seeds storage on the viabilities of seeds and microbial biofertilizers



Seeds kept at room temperature (25°C)

Seeds kept at a temperature of 6°C



Germination tests each two months during six months of storage

Determination of mycorrhizal colonization every two weeks during six weeks of culture

Determination of mycorrhizal colonization every two weeks during six weeks of culture

MATERIAL and METHODS: determination of the effect of the coating on the protection of seeds against bioagressors

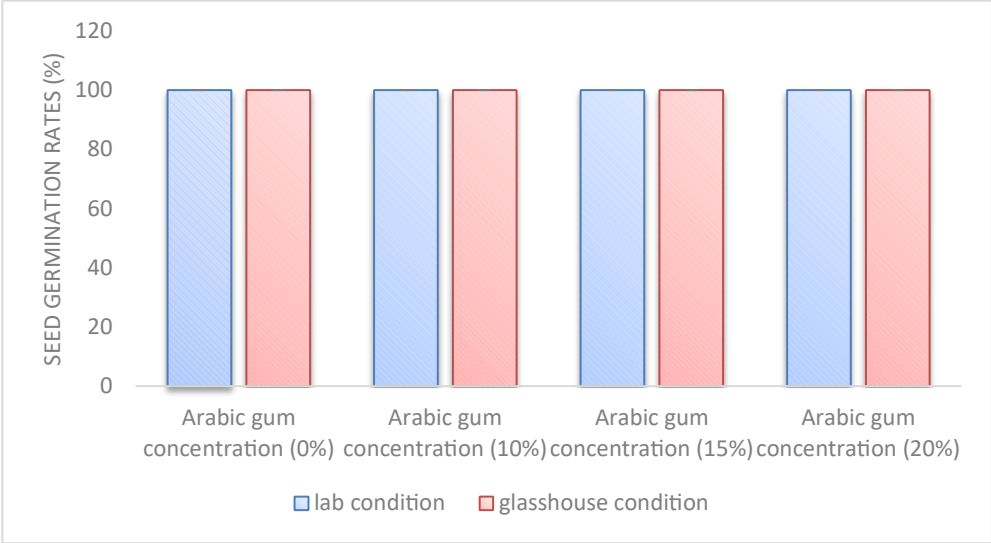
Sitophilus zeamais

Rhyzopertha dominica

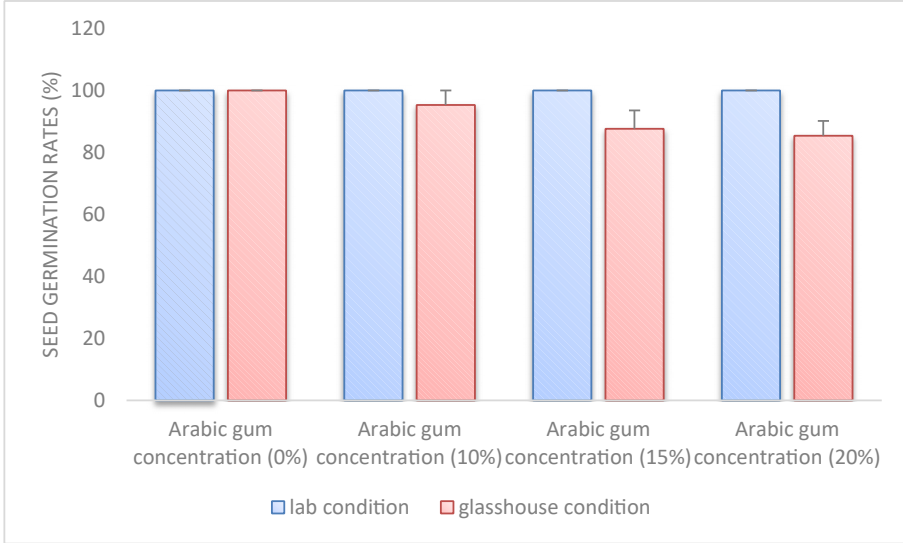
Breeding in masse of *Sitophilus zeamais* and *Rhyzopertha dominica*

Measured parameters: emergence of insects, rate of fertility, sex-ratio, percentage of attacks and weight losses.

Results: Effect of coatings on seed germination rates



Maize seed germination rates just after coating

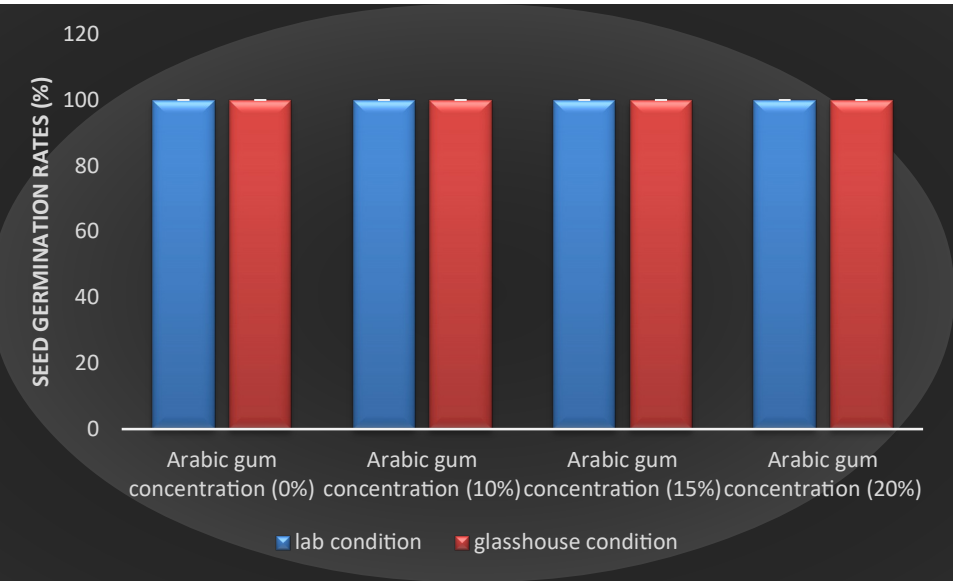


Sorghum seed germination rates just after coating

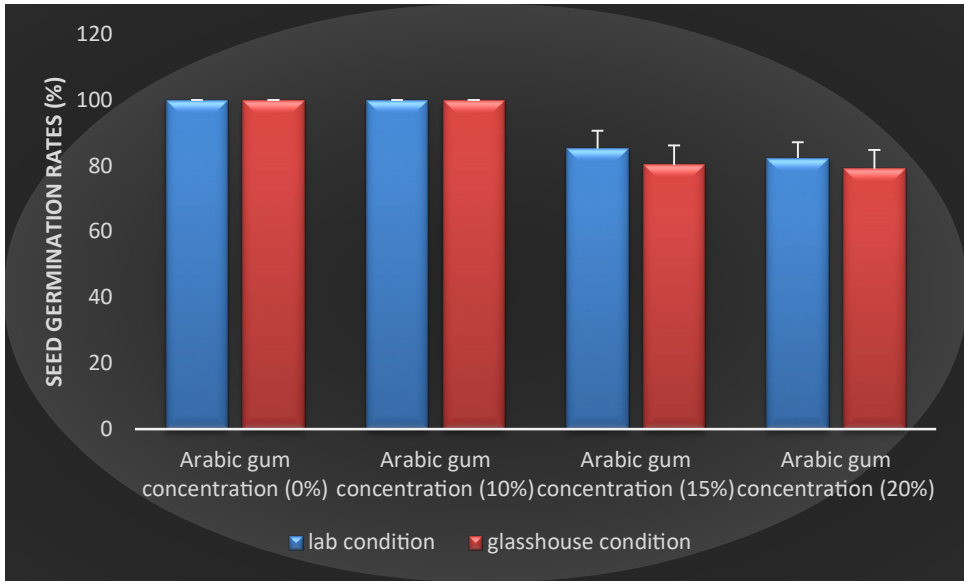
The coating process did not influence *Z. mays* seed germination.

For *Sorghum bicolor* seeds, coated seeds with 15% and 20% Arabic gum decreased the seed germination rates at both laboratory and glasshouse conditions.

Results: *Effect of coatings on seed germination rates*



Maize seed germination rates after 4 months of seed storage in cold room (6°C)

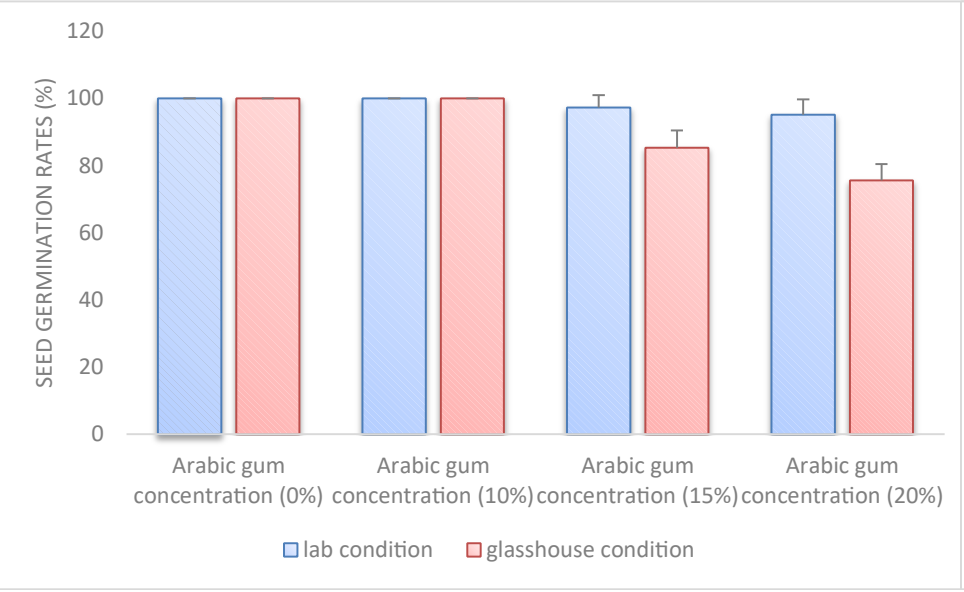


Sorghum seed germination rates after 4 months of seed storage in cold room (6°C)

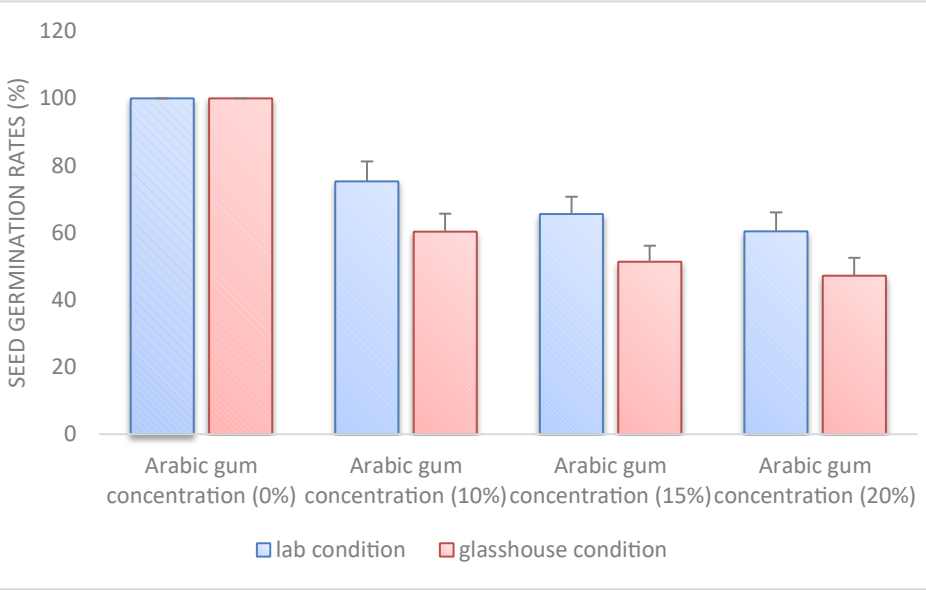
Decreased seed germination characteristics were observed for the 15 and 20% Arabic gum concentrations when seeds were stored at 6°C temperature.

Only seeds coated at 10% Arabic gum and uncoated seeds showed germination rates reaching 100%.

Results: Effect of coatings on seed germination rates



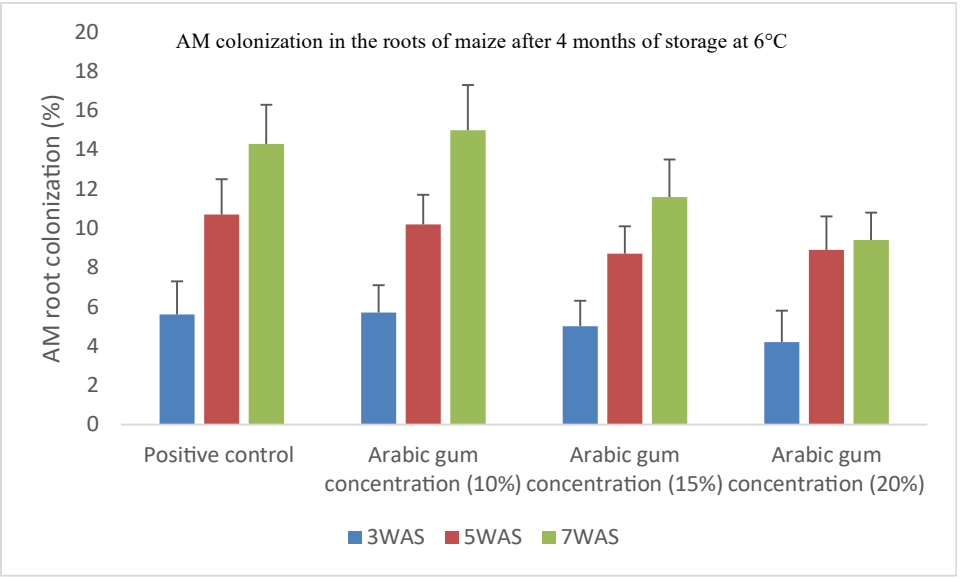
Maize seed germination rates after 4 months of seed storage at room temperature (25°C)

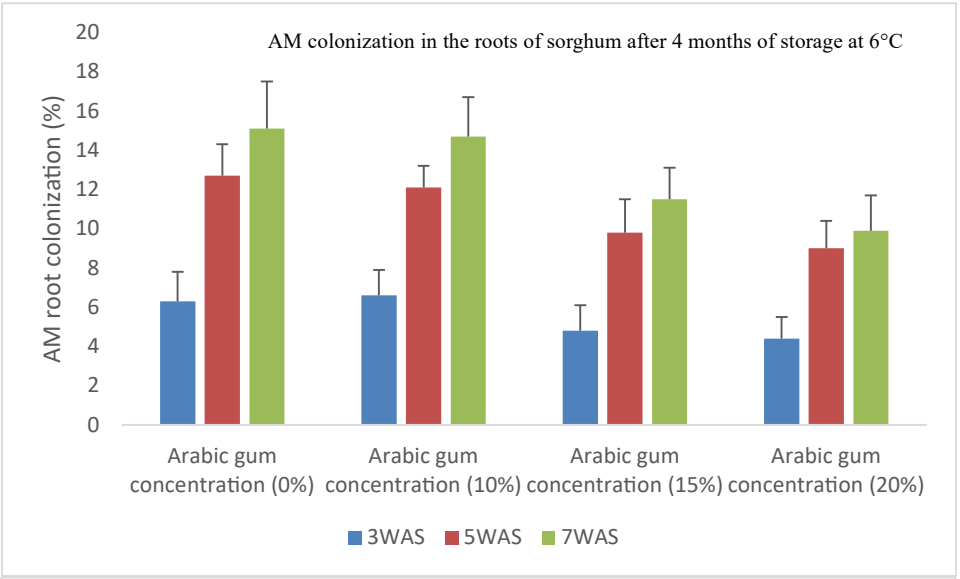


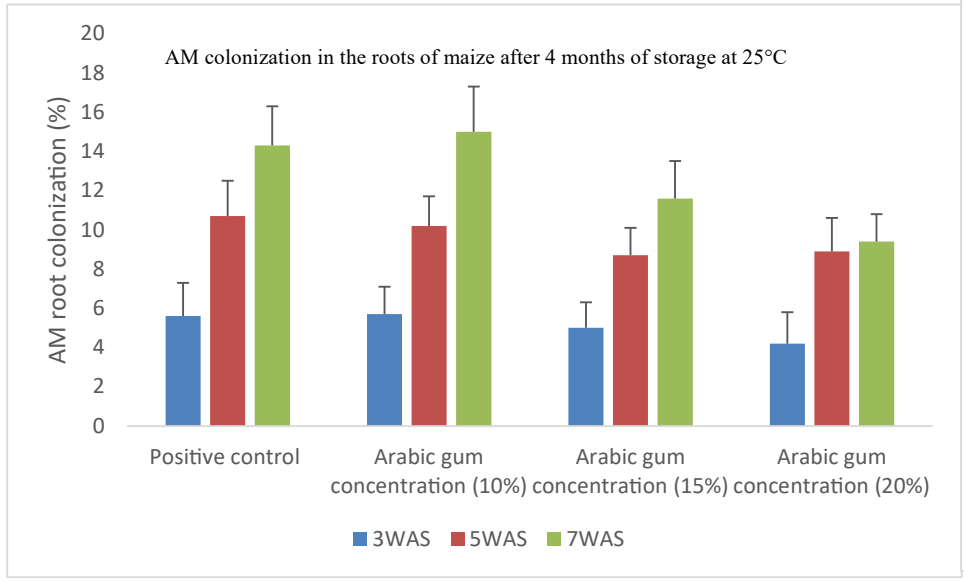
Sorghum seed germination rates after 4 months of seed storage at room temperature (25°C)

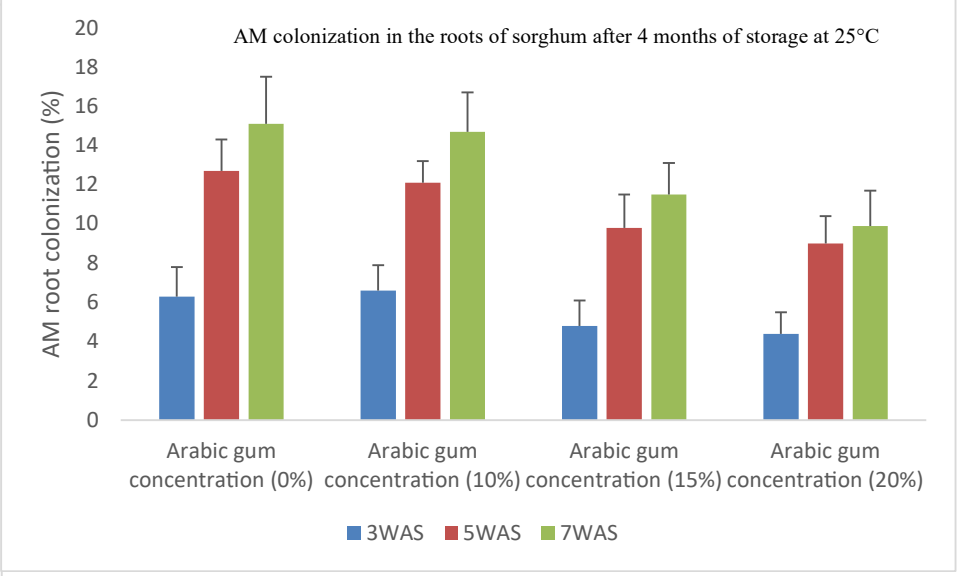
The germinating characteristics decreased for seeds coated with 15 and 20% Arabic gum and stored for 4 months at room temperature (on average 25°C) in both laboratory and glasshouse test conditions.

Results: Effect of coatings on AM spore colonization





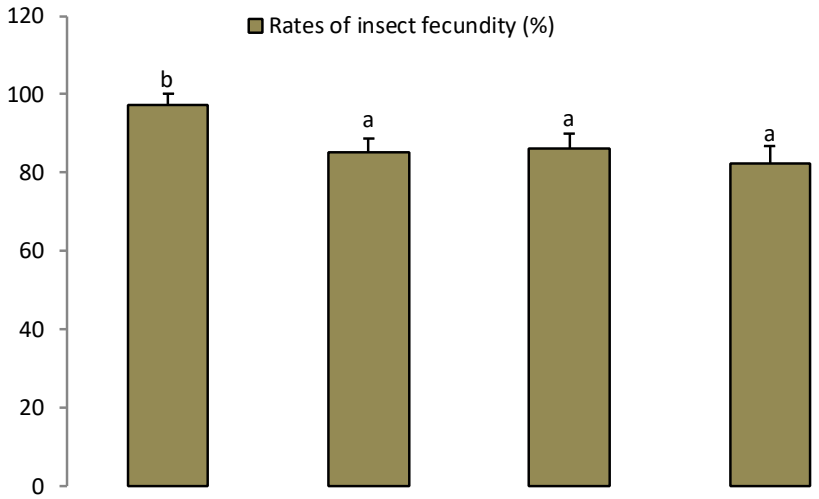


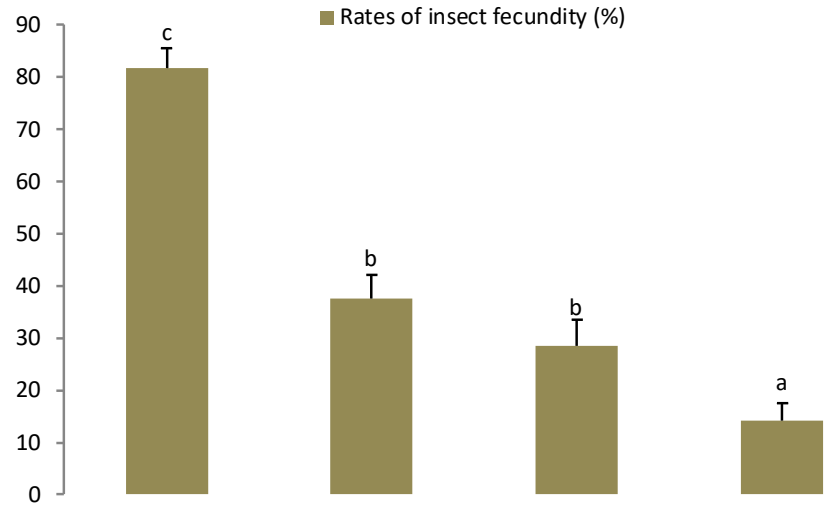


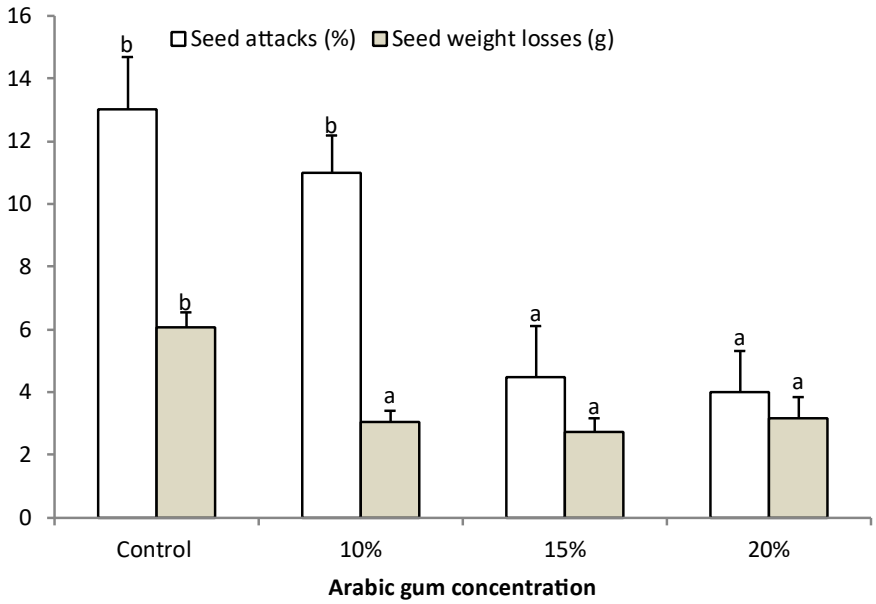
All coated seeds and positive controls formed root mycorrhizal colonization whatever the Arabic gum concentration and seed storage conditions.

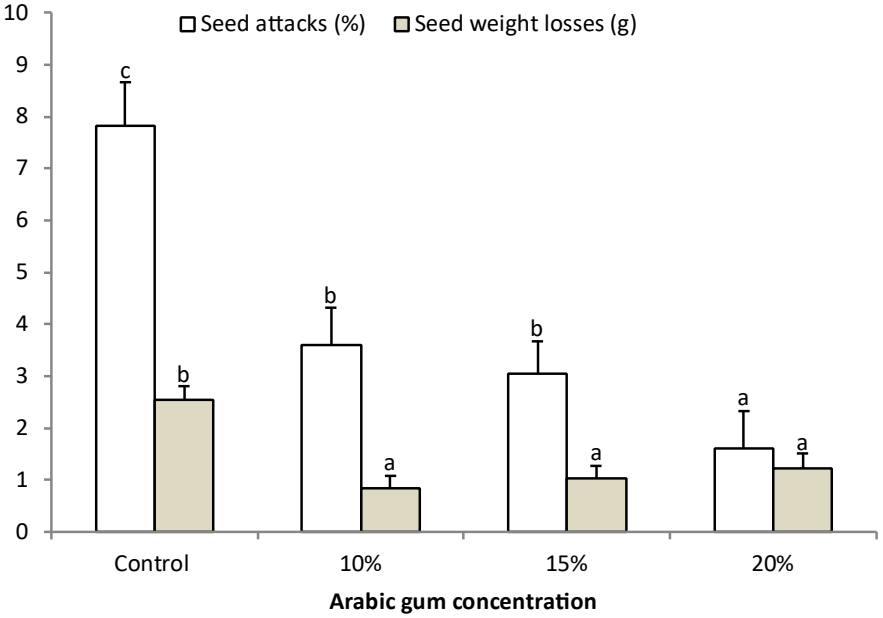
The overall trend was that root mycorrhizal colonization decreased with increasing the concentration of Arabic gum.

Results: Effect of coatings on seed protection against bioaggressors









Uncoated seeds recorded more insect emergences compared to the coated ones with more seed attacks and more seed weight losses. Moreover, insect emergences and seed damages decreased with augmenting the concentration of Arabic gum solution.

Conclusion and further directions

This work demonstrated that maize and sorghum seed coating with arbuscular mycorrhizal spores and Plant Growth Promoting Rhizobacteria fertilizers is feasible using a 10% Arabic gum solution without obscuring the seed and mycorrhizal fungal germination capacities.

Moreover, the results indicated that the coated seeds can be stored for up to 4 months at 6°C conditions, without losing the seed germinability and coated microbial inoculant efficacy.

Meanwhile, beyond a certain threshold, the gum dose acted negatively on the germinating characteristics of sorghum seeds and fungal spores.

Lastly, the results showed that the coating reduced significantly the damage caused on the seeds by *Sitophilus zeamais* and *Rhyzopertha dominica* insects.

Further studies are needed to explain potential science mechanisms of seed protection through coatings and assess the benefits of seed coatings under a wide range of soil and climatic conditions.

THANK YOU FOR YOUR ATTENTION