

# Bio-organic Microbial Consortia with Soil Conditioner Promotes Drought Tolerance to Improve Tuber Yield of Potato

Abdullah Al Mamun, Günter Neumann, Uwe Ludewig, Markus Weinmann, Tim Tenbohlen, Fahim Nawaz, Aneesh Ahmed and Narges Moradtabal  
Institute of Crop Science, Nutritional Crop Physiology (340h), University of Hohenheim, D-70593 Stuttgart, Germany, abdullahal.mamun@uni-hohenheim.de

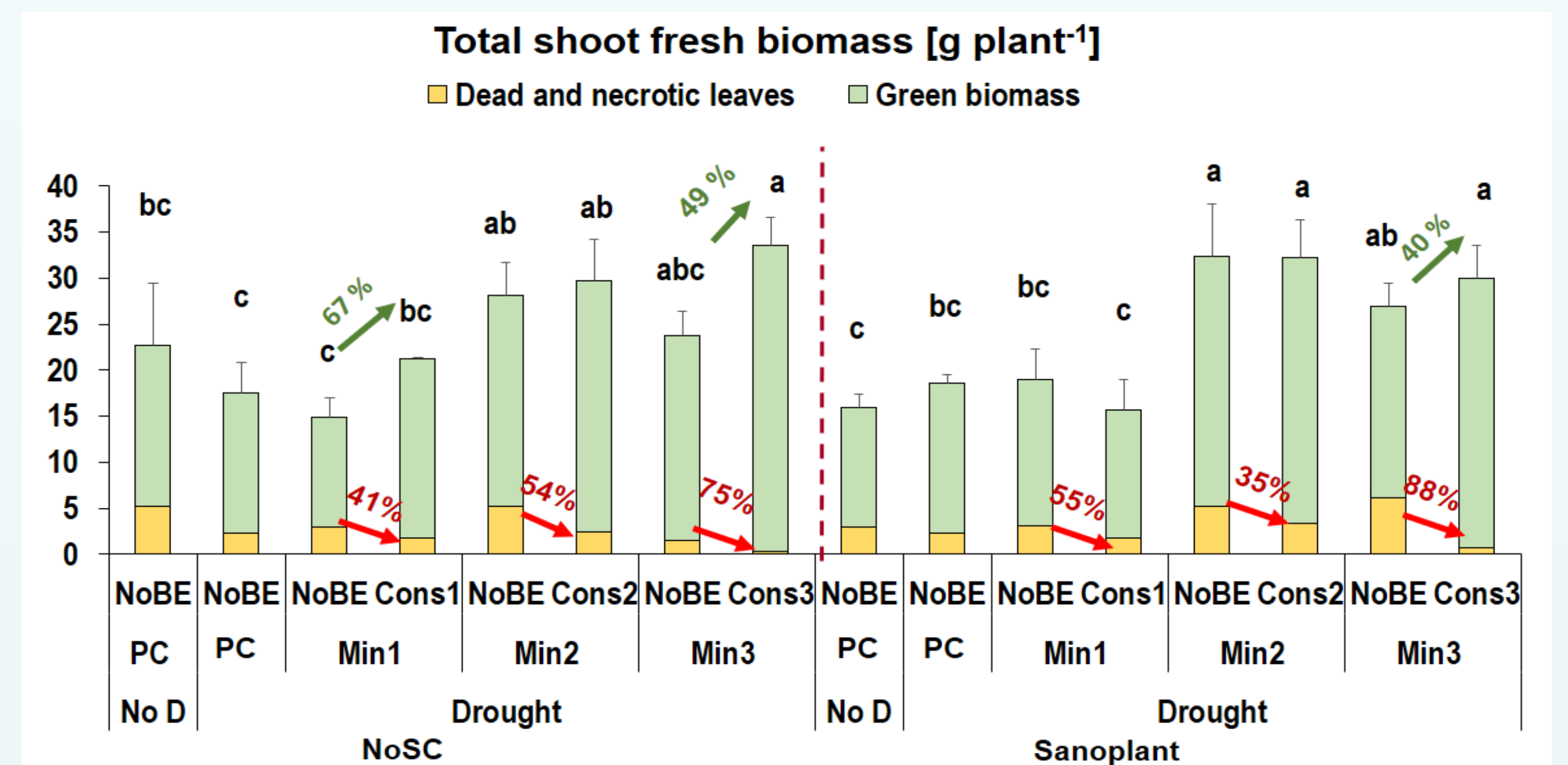
## Introduction

Application of silicatic soil conditioners to improve soil water relationships under drought stress may be strategy to support rhizosphere establishment of beneficial microbial inoculants with drought-protective potential. In this study, we investigated drought-protective effects of plant-beneficial microbial consortia based on selected strains of *Pseudomonas* (Cons1), *Burkholderia* (Cons2) and *Burkholderia* + *Trichoderma* (Cons3) in combination with arbuscular mycorrhizal fungi (AMF *Rhizophagus irregularis*) applied in protective organic fertilizer formulations (Minigran®1-3) with or without application of a silicatic organic soil conditioner (Sanoplant®) on plant performance and tuber formation of potato under controlled conditions in greenhouse experiments.

## Experimental Setup

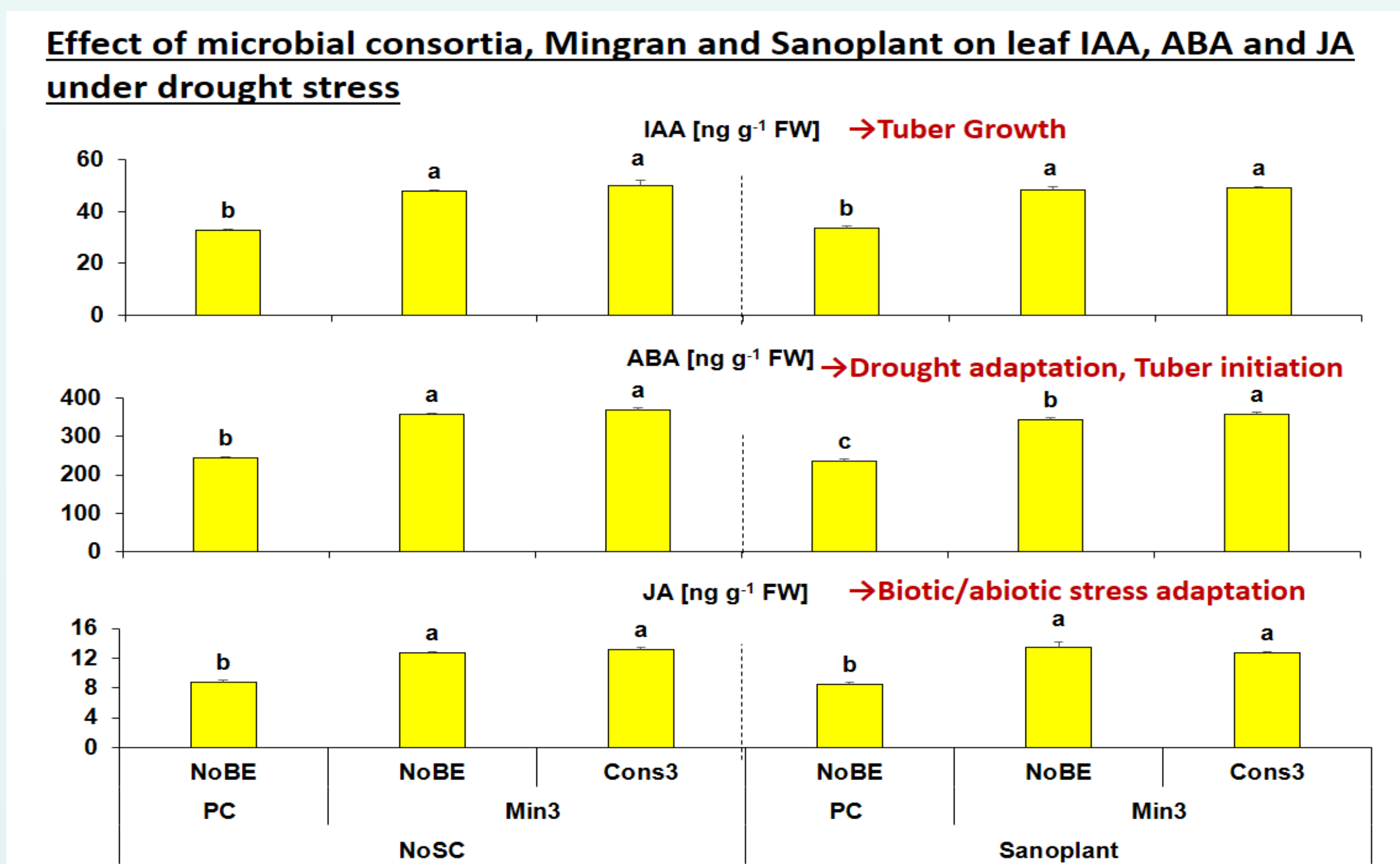
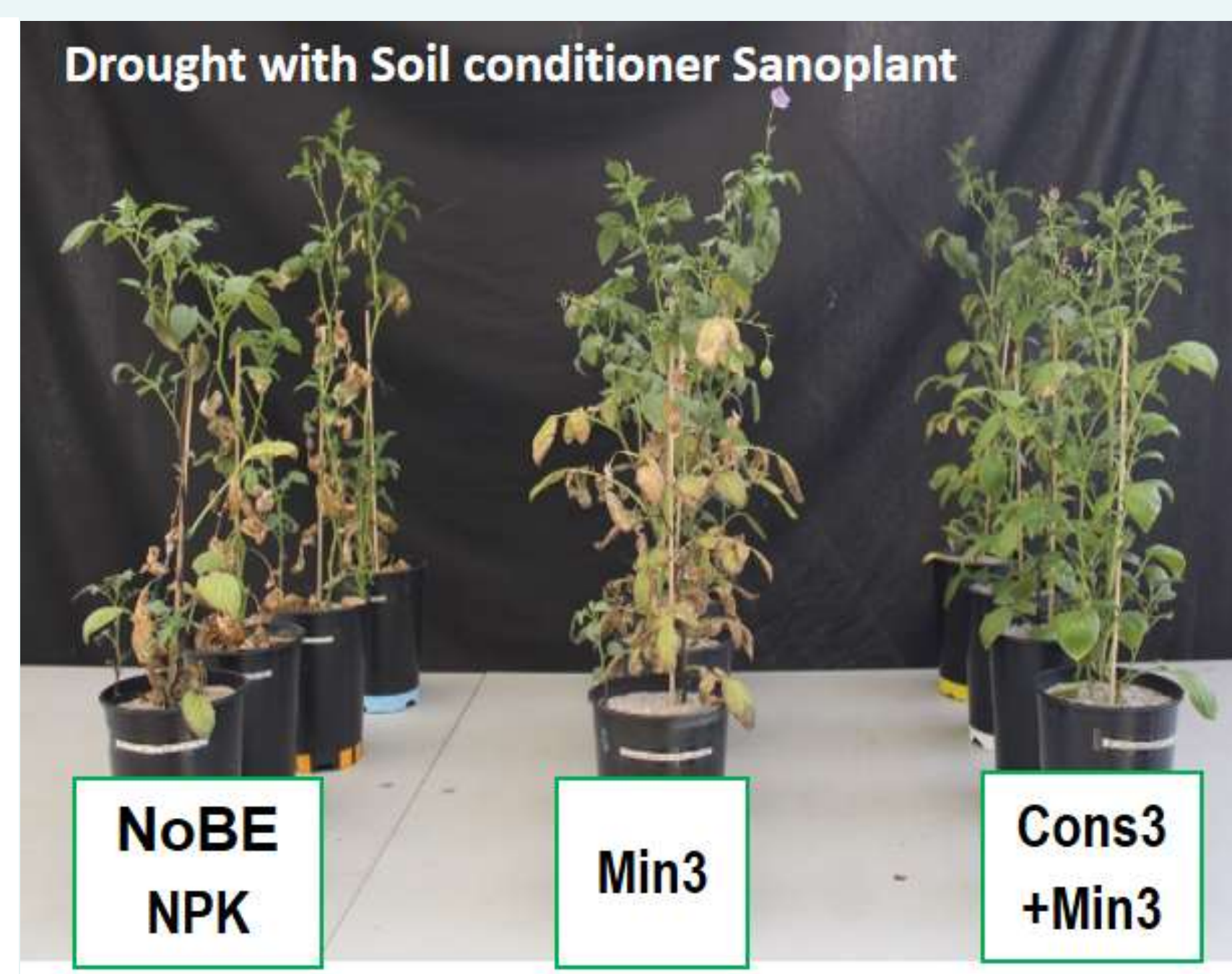
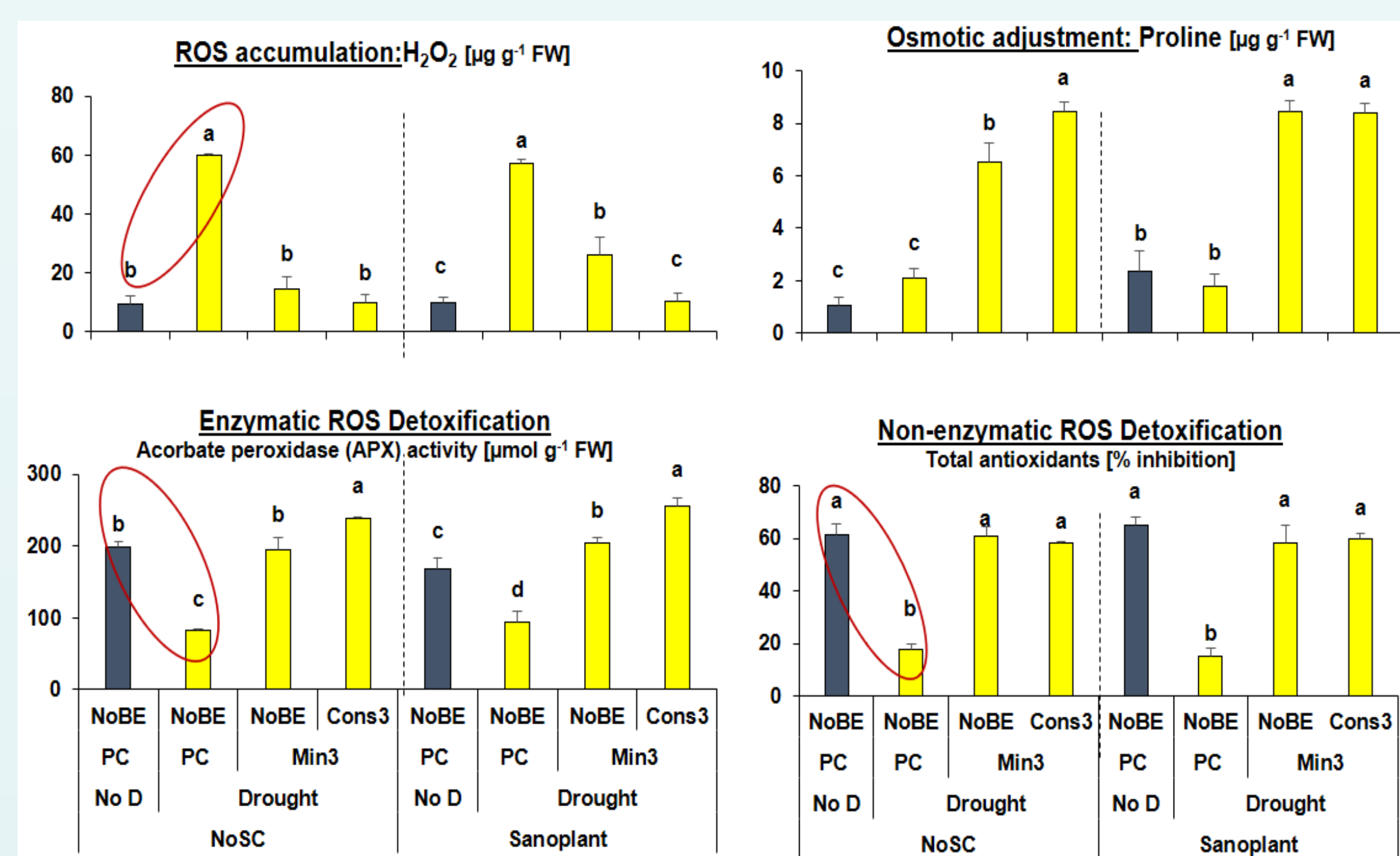
**Test Plant:** Seed-grown potato (*Solanum tuberosum*, hybrid B464, Solynta Netherlands)  
**Culture substrate:** 50 % w/w, fine quartz sand, 50 % w/w silty loam pH 6.2, P-CAL 34 mg kg<sup>-1</sup>.  
**Fertilization:** Minigran® (DCM, Belgium) fertilizer granulates (based on N rich plant-based materials) with and without microbial consortia [3g plant<sup>-1</sup>] applied twice in the nursery and during transplanting to drought screening. Positive control plants fertilized with mineral fertilization according to the nutrient content of the Minigran formulations (N=132 mg kg<sup>-1</sup>, P= 8 mg kg<sup>-1</sup>, K = 67 mg kg<sup>-1</sup> and Mg =20 mg kg<sup>-1</sup>. A commercial silicatic soil conditioner (Sanoplant®; Sanoway, Dornbirn, Austria) was applied at a recommended rate of 4 g kg<sup>-1</sup> substrate.  
**Microbial consortia:** Minigran 1, 2 and 3 formulations optimized for survival of consortia 1, 2 and 3:  
 1. AMF (*Rhizophagus irregularis* MUCL 41833 + *Pseudomonas brassicacearum* (3Re27))  
 2. AMF + *Paraburkholderia phytofirmans* PsJN  
 3. AMF + PsJN + *Trichoderma asperelloides* A  
**Culture conditions:** After 8 weeks seedling in nursery, 3 weeks establishment at 60% soil water holding capacity (WHC), 6 weeks drought (20-25% WHC), 2 weeks recovery (60% WHC).

## Results: Vegetative plant development



Microbial consortia were able to reduce irreversible drought-induced leaf damage with best performance of Cons3. No additional effects of the soil conditioner.

## Results: Oxidative stress defence and hormonal status



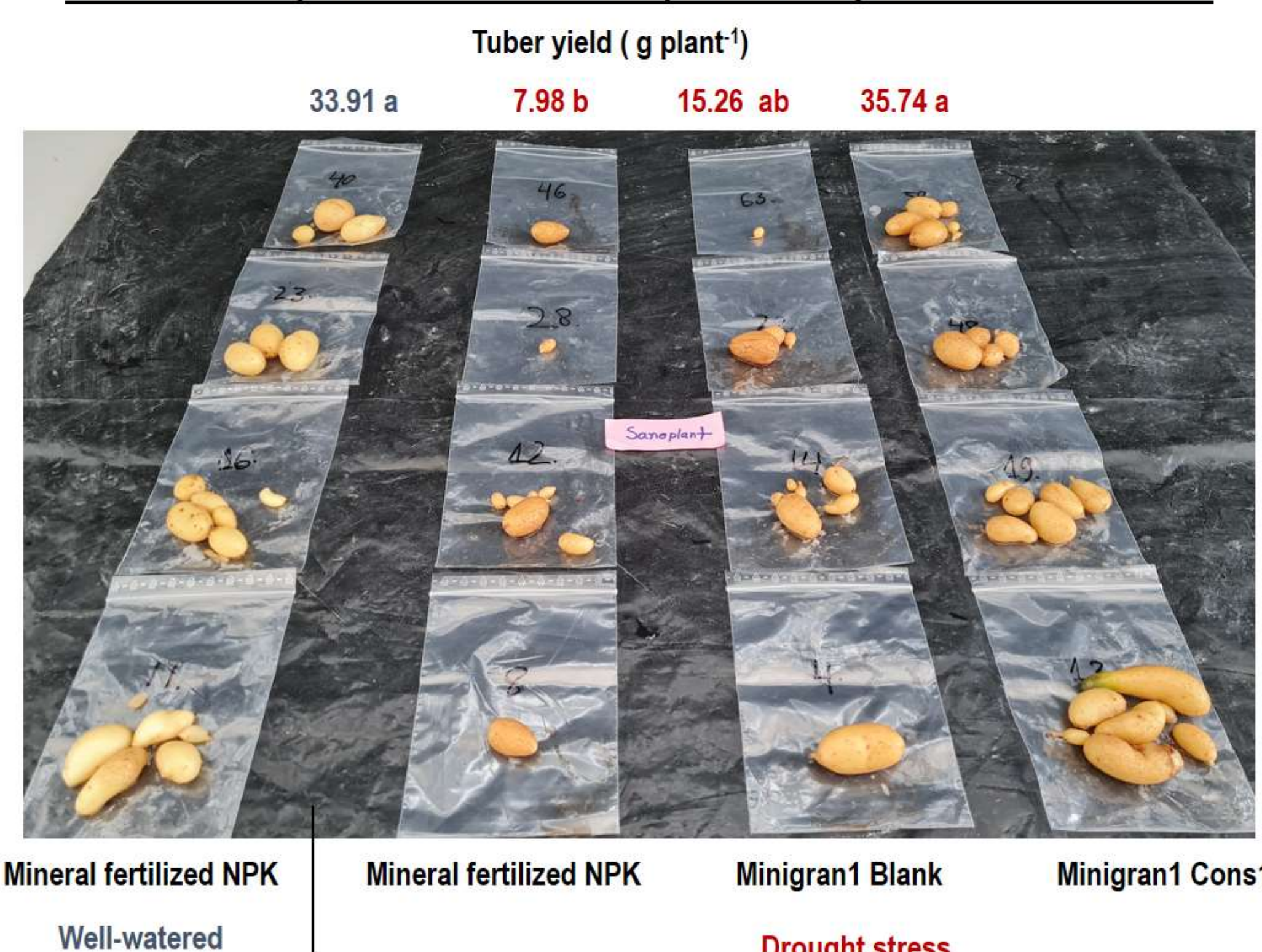
Protective effects on leaf damage were related with increased accumulation of osmoprotectants (proline) and improved ROS (H<sub>2</sub>O<sub>2</sub>) detoxification (APX, antioxidants) induced by the consortia and to a lesser extent by the Minigran blank formulation. No additional effects of soil conditioner.

The Minigran blank formulation increased shoot accumulation of hormones involved in drought adaptation (ABA, jamic acid, JA) and tuber formation (ABA, IAA).

## Results: Tuber formation and AMF colonization

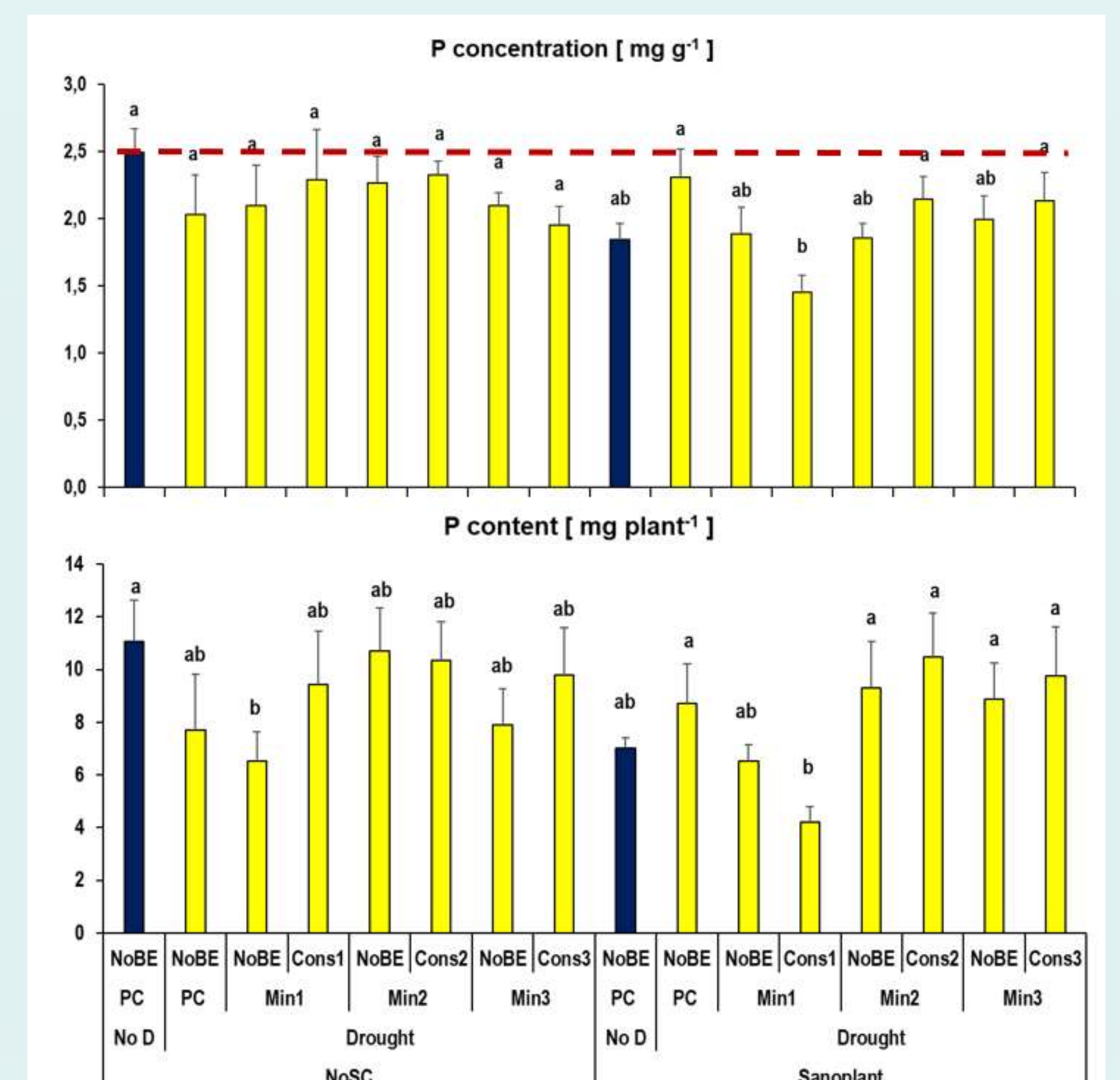
Treatments	Tuber yield [g plant <sup>-1</sup> ]	AMF colonization [%]
Well-watered	23.7	19.8
Well-watered+SC	33.9	34.0
Drought	13.0	10.5
Drought+SC	8.0	18.3
Drought+Cons1	16.8	64.0
Drought+Cons1+SC	35.7*	72.8
Drought+Cons3	12.9	60.8
Drought+Cons3+SC	21.8*	66.3
Drought+Cons2	5.7	47.8
Drought+Cons2+SC	6.4	59.5

Tuber yield with mineral fertilizer, Minigran1 blank or Minigran1 with Consortium1 (AMF + *Pseudomonas*) with Sanoplant soil conditioner



Drought stress reduced tuber yield. The soil conditioner increased tuber yield in combination with microbial inoculants, associated with increased AMF root colonization.

## P- nutritional status



Increased AMF root colonization induced by application of soil conditioners did not affect the P-nutritional status,

## Conclusions:

- The Minigran blank formulation reduced drought-induced oxidative damage via improved ROS detoxification, further improved by co-application of microbial consortia.
- Reduced drought-induced leaf damage leads to improved assimilate supply for tuber formation.
- Soil conditioners further improved tuber formation in combination with inoculants, related with improved AMF colonization independent of P-nutritional effects but most likely related with improved ROS detoxification documented for AMF associations.