Chlorophyll fluorescence-derived photosynthetic parameters and yield of Common bean (phaseolus vulgaris L.) under multiple stress and Drought

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Definitions: Definitions: PhiI, the yield of photochemistry (measures photosynthetic efficiency); PhiNPQ, the yield for dissipation by downregulation (measures energy loss via downregulation of photochemistry); PhiNO, the yield of other non-photochemical losses (unregulated losses that reflect non-light induced or dark quenching processes).

INTRODUCTION

Drought and intermittent drought stress are increasing and therefore affecting common bean (*Phaseolus vulgaris L.*) production. Such changes in climate therefore require new approaches to plant improvement. Hence, a new device called a MultispeQ was used in this study to collect various parameters for phenotyping common bean under multiple stress, drought stress and non-stress. The objectives of the study were to assess plant response to PhiII, PhiNPQ, and PhiNO (photosynthetic parameters); and to evaluate 13 genotypes (2 Andean lines, 10 Middle American lines and 1 non-nodulating check, R99) for drought tolerance, Carbon isotope discrimination (CID), Nitrogen derived from the atmosphere (Ndfa), and grain yield. Hence this research aims to identify genotypes tolerant to drought.

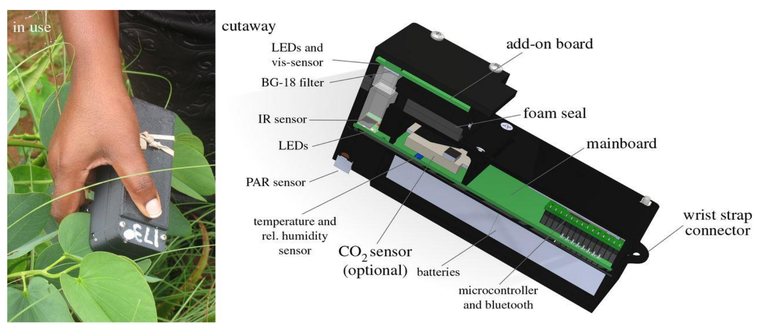

Figure 1. MulitspeQ device in use

METHODS

A total of 13 genotypes were grown under varying conditions in 3 sites: Othello with Drought stress (DS) and Non-stress (NS) treatments; Paterson with Low Nitrogen (Low N) treatment but fully irrigated; and Roza with Multiple Stress(MS) treatment of compact soil, poor fertility and intermittent drought. Hence, the design was a split-plot for Othello and a randomized complete block design (RCBD) for Paterson and Roza. Data was collected on photosynthetic parameters using the MultispeQ, Carbon Isotope Discrimination (CID), Nitrogen derived from the atmosphere (Ndfa) and yield. GenStat 17th Ed was the statistical package used to analyze data at 95% confidence interval.

RESULTS

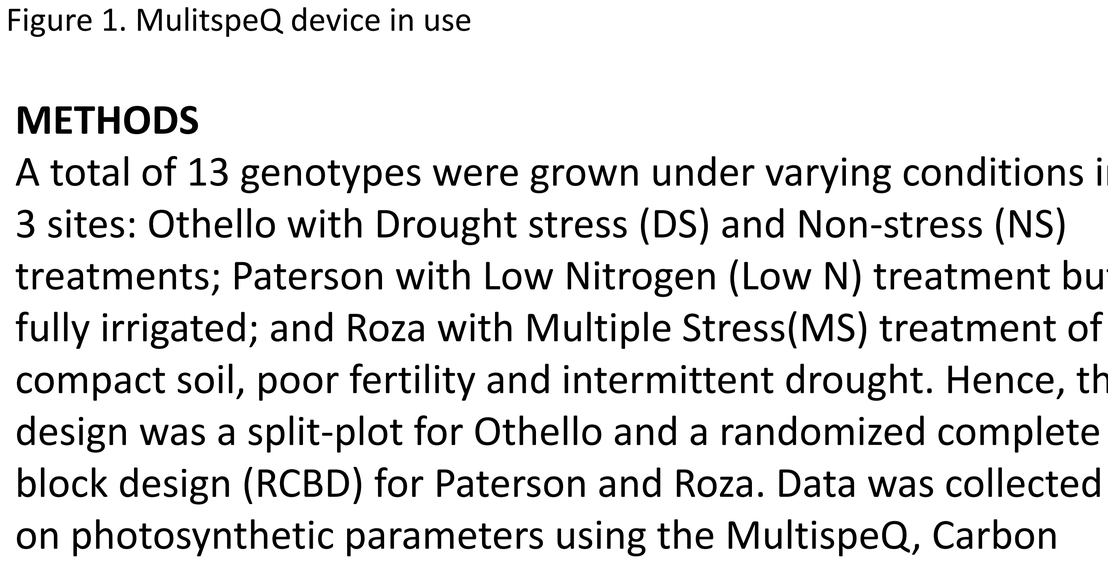

Figure 2. Seed Nitrogen derived from the atmosphere (Ndfa) of 13 genotypes planted in the field in Othello (DS & NS), Paterson (Low N) and Roza (MS). Red circle Ndfa >20% under both DS & MS, yellow circle Ndfa >20% under MS

- Seed Ndfa and CID was significantly different for genotypes in all 3 locations, unlike plant Ndfa and CID, with high Ndfa values under NS and Low N while low values under DS and MS.
- DS significantly reduced Δ13C while genotypes Δ13C varied significantly under Low N and MS.
- Highest GY was under Low N (with full irrigation) and lowest under DS.
- PhiI under DS and MS was high at 60DAP and low at 75DAP.

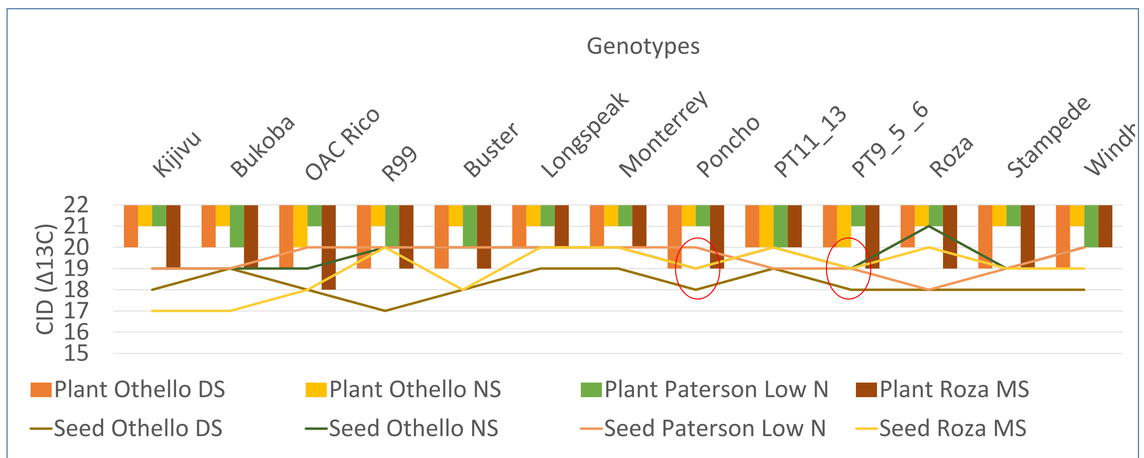

Figure 3. Plant and Seed Carbon Isotope Discrimination, CID (Δ13C) of 13 genotypes planted in the field in Othello (DS & NS), Paterson (Low N) and Roza (MS); Red circles CID low for seed under DS and MS

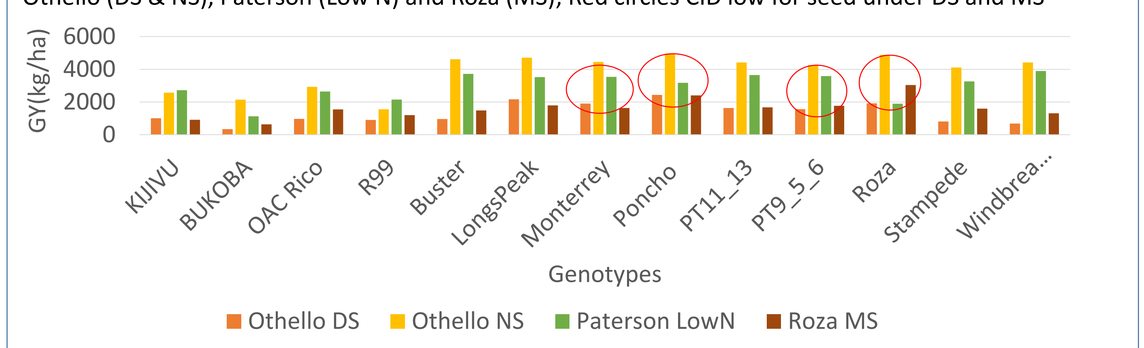

Figure 4. Grain Yield, GY (kg/ha) of 13 genotypes planted in the field in Othello (DS & NS), Paterson (Low N) and Roza (MS); Red circles GY >1500 kg/ha under DS and MS

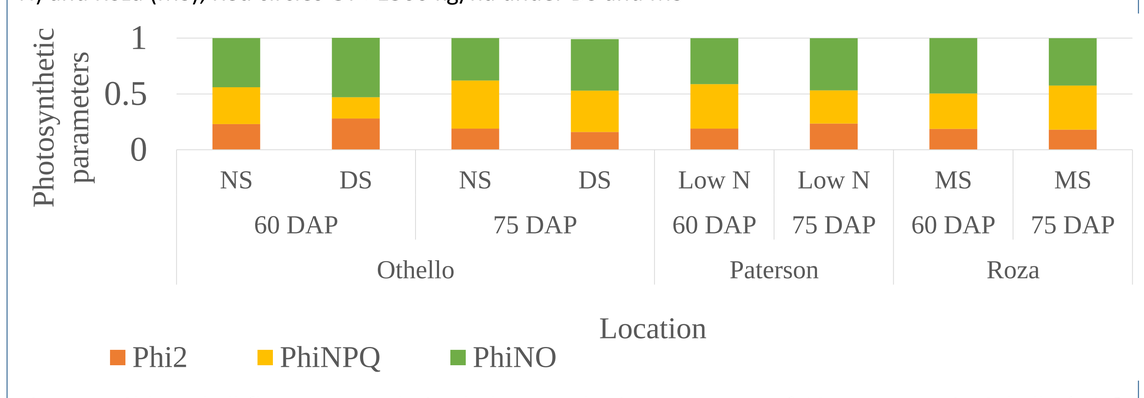

Figure 5. Chlorophyll fluorescence-derived photosynthetic parameters of 13 genotypes in Othello (DS & NS), Paterson (Low N) and Roza (MS)

CONCLUSION

- Genotypic variation was noted for Ndfa and CID in seed than in plant tissue.
- There were no significant differences among genotypes for CID under DS in plant tissue.
- PhiII, productive photochemistry declines during pod filling under DS and MS.
- Poncho and PT9_5_6 had lower Δ13C values hence positively related to Transpiration Efficiency (TE); relatively high yield, >1500kg/ha; but relatively greater Ndfa, >20% under MS only.
- Therefore, these two Middle American genotypes have the potential to tolerate drought, yield better and fix moderate amounts of nitrogen through symbiosis.

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