



Samson Huni (Autor)

# Gas exchange, evapotranspiration efficiency, morphophysiology and productivity of cowpeas under water deficit

Samson Huni

Gas exchange, evapotranspiration  
efficiency, morphophysiology and  
productivity of cowpeas under water deficit



Cuvillier Verlag Göttingen

Internationaler wissenschaftlicher Fachverlag

<https://cuvillier.de/de/shop/publications/509>

## Copyright:

Cuvillier Verlag, Inhaberin Annette Jentzsch-Cuvillier, Nonnenstieg 8, 37075 Göttingen,  
Germany

Telefon: +49 (0)551 54724-0, E-Mail: [info@cuvillier.de](mailto:info@cuvillier.de), Website: <https://cuvillier.de>

## Table of contents

Summary	iii
Zusammenfassung	iv
Dedication	vii
Acknowledgements	vii
List of Tables	xi
List of Figures	xvi
Abbreviations	xviii
<b>1. INTRODUCTION</b>	<b>1</b>
1.1. Aims and objectives of these studies	1
<b>2. LITERATURE REVIEW</b>	<b>3</b>
2.1. Drought: Definition, importance/perspective	3
2.2. Gas exchange, evapotranspiration efficiency, biomass accumulation and allocation	3
2.3. Cowpeas	6
2.3.1. Ecophysiology of cowpeas, production and importance, constraints and drought research	6
<b>3. MATERIALS AND METHODS</b>	<b>9</b>
3.1. Plant material	9
3.2. Pots, growth substrate and planting	10
3.3. Conditions of culture	11
3.3.1. Irrigation system	11
3.3.2. Light, temperature and relative humidity	12
3.4. Gas exchange measurements	13
3.5. Leaf relative water content and leaf electrolyte leakage	13
3.6. Biomass, leaf area, leaf temperature and stem length	14
<b>4. RESULTS</b>	<b>16</b>
4.1. Growth conditions	16
4.1.1. Greenhouse temperature (T) and relative humidity (rH)	16
4.1.2. Soil water potential (SWP) and soil water content (SWC)	17
4.2. Gas exchange	19
4.2.1. Net photosynthetic rate ( $P_N$ )	19
4.2.2. Transpiration rate (E)	20

4.2.3. Stomatal conductance ( $g_s$ )	21
4.2.4. Intrinsic transpiration efficiency ( $TE_i$ )	22
4.2.5. Ratio of photosynthetic rate to stomatal conductance ( $P_N/g_s$ )	24
4.3. Plant water status and water use	25
4.3.1. Leaf relative water content (RWC)	25
4.3.2. Water use (WU)	26
4.3.3. Evapotranspiration efficiency (ETE)	29
4.3.3.1. Evapotranspiration efficiency (ETE) during stress intervals	31
4.3.4. Water-use efficiency (WUE)	33
4.4. Growth and biomass allocation	34
4.4.1. Relative growth rate (RGR)	34
4.4.2. Net assimilation rate (NAR)	35
4.4.3. Main stem length and stem mass to length ratio	36
4.4.3.1. Main stem length	36
4.4.3.2. Main stem mass to length ratio (SMLR)	37
4.4.4. Biomass (DM)	39
4.4.4.1. DM accumulation during stress intervals	39
4.4.4.2. DM stress index	41
4.4.5. Leaf area and specific leaf area	42
4.4.5.1. Leaf area (LA)	42
4.4.5.2. Specific leaf area (SLA)	43
4.4.6. Stem mass ratio and leaf mass ratio	44
4.4.6.1. Stem mass ratio (SMR)	44
4.4.6.2. Leaf mass ratio (LMR)	45
4.4.6.3. Leaf shedding	45
4.5. Electrolyte leakage and leaf temperature	47
4.5.1. Cell membrane stability (CMS)	47
4.5.2. Leaf temperature	48
4.6. Yield and yield components	49
4.6.1. Number of pods and seeds	49
4.6.1.1. Number of pods	49
4.6.1.2. Number of seeds	50
4.6.2. Seed yield	51

4.6.2.1. Seed yield stress index	52
4.6.3. Pod yield	53
4.6.4. Single grain mass (SGM)	53
4.6.5. Harvest index (HI)	54
4.6.6. Shelling out-turn	55
4.7. Relationships among traits	56
4.7.1. Relationships among gas exchange traits	56
4.7.2. Relationships among gas exchange, evapotranspiration efficiency, biomass traits, leaf temperature and yield	56
<b>5. DISCUSSION</b>	<b>59</b>
5.1. Gas exchange	59
5.2. Water use, evapotranspiration efficiency and water-use efficiency	63
5.3. Growth and biomass allocation	63
5.4. Other morphophysiological traits	66
5.4.1. Leaf relative water content and leaf cell membrane stability	66
5.4.2. Leaf senescence and abscission	67
5.4.3. Leaf temperature	69
5.5. Yield and yield components	70
<b>6. CONCLUSION</b>	<b>76</b>
<b>7. LITERATURE CITED</b>	<b>78</b>
<b>APPENDIX</b>	<b>97</b>