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**Growth, photosynthetic capacity and yield potential
of sweet potato (*Ipomoea batatas* L. (Lam.))
as affected by irrigation levels**



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Institut für Obstbau und Gemüsebau
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zu Bonn

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of sweet potato (*Ipomoea batatas* L. (Lam.))
as affected by irrigation levels**

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It is He Who sendeth down rain from the skies: with it We produce vegetation of all kinds: from some We produce green (crops), out of which We produce grain, heaped up (at harvest); out of the date-palm and its sheaths (or spathes) (come) clusters of dates hanging low and near: and (then there are) gardens of grapes, and olives, and pomegranates, each similar (in kind) yet different (in variety): when they begin to bear fruit, feast your eyes with the fruit and the ripeness thereof. Behold! in these things there are signs for people who believe. (Al-An'aam: 99)

Dedicated for my family

Einfluss von Bewässerungstufen auf Wachstum, Photosynthesekapazität und Ertragsbildung der Süßkartoffel

In der vorliegenden Studie wurde der Einfluss von fünf unterschiedlichen Bewässerungstufen auf die Wachstums- und Ertragsbildung der Süßkartoffel, Kohlenhydratgehalt der Knollen sowie Chlorophyll- und Carotingehalte der Blätter untersucht. Zusätzlich wurden die Süßkartoffelsorten hinsichtlich der photosynthetischen Kapazität der jungen und vollständig entwickelten Blätter charakterisiert. Mit Hilfe des kurzlebigen ^{11}C -Radioisotops wurde das Potential der Blätter bestimmt, Photoassimilate zu exportieren.

Wasser erhöhte das vegetative Wachstum der Süßkartoffel. Mehr Wasser steigerte die Trockenmasse der Blätter, Blattzahl, Trockenmasse der Stengel und die Länge der längsten Stengel der Süßkartoffelklone. Die drei Klone, AB94001.8, AB94078.1 und Eland produzierten den höchsten Knollenertrag, aber weniger Blättern, Stengeln und Wurzeln. Zum letzten Erntetermin war Trockenmasse der Knollen positiv mit der Knollenzahl, dem Frischgewicht pro Knolle, der Trockenmasse der Gesamtpflanze, der Effizienz der Trockenmasseproduktion und dem Verhältnis zwischen (Wurzel+Knollen)/Sproß korreliert. Im Gegensatz dazu war das Trockengewicht der Knolle negativ mit der Trockenmasse der Blätter, Stengeln und Wurzeln korreliert. Außerdem war die Trockenmasse der Gesamtpflanze positiv mit der Trockenmasse der Blätter und negativ mit dem Verhältnis Trockenmasse der Blätter korreliert.

Der Gehalt an löslichen Zuckern stieg im Jahresverlauf, Trockenstress steigerte den Gehalt an löslichen Zuckern insbesondere in den Knollen. Zum Erntezeitpunkt bestand eine negative Korrelation ($r = -0,671$) zwischen dem Gehalt an löslichen Zuckern und dem Stärkegehalt in den Knollen. Der Gesamtchlorophyll- und Carotingehalt der Blätter variierte in Abhängigkeit von den Klonen. Der höchste Chlorophyllgehalt wurde in der Kontrollbehandlung erreicht. Trockenstress und temporäre Staunässe verringern den Chlorophyllgehalt. Die Varianten mit temporärer Staunässe enthielten mehr Carotin in den Blättern als solche mit Trockenstress.

Bei sechs untersuchten Süßkartoffelklonen AB94001.8, Eland, CIP-1, AB94065.4, Klon A und AB94078.1 bestand eine positive Korrelation der Netto-Photosyntheserate (A) mit der Gesamtproduktion an Pflanzentrockenmasse, nicht aber mit der Knollenproduktion. Netto-Photosyntheseraten der vollständig entwickelten Blätter waren positiv mit der effektiven Quantenausbeute ($\Delta F/Fm'$) korreliert. Eine negative Korrelation zwischen qN und g'_m wurde festgestellt. Eine Zunahme der Verhältnisse zwischen Knollen Trockenmasse pro Pflanze und Blattflächen für die Sorten AB94001.8, Eland, CIP-1, AB94065.4 und Klon A war mit einem niedrigen qN korreliert.

Die Sorte Thai, die mit einer sich entwickelnden Knollen exportierte einen beträchtlich größeren Prozentsatz an vor kurzem fixierten Photoassimilaten (70% - 75% = Exportbruch + Dunkelatmung) als die Sorten AB95001.4 und Dayak ohne Knollen (32% - 50%). Nur die Sorte Kwarangwana wies einen geringeren Export von ^{11}C aus behandelten Blättern auf. Die Ernte der Sorte Thai, 75 Minuten nach einer $^{11}\text{CO}_2$ - Applikation und anschließender Analyse der Verteilung des Radioisotops innerhalb der Pflanze, zeigte, dass fast 60% der Radioaktivität, die vom Blatt exportiert wurde, innerhalb der wachsenden Knollen gespeichert wurden. Dies belegt eine starke Sink-Kapazität dieses Organs.

Die Photosynthesekapazität der Klone wurde auch von ihrer Sink-Kapazität geprägt. Dabei ist der Stengel als sekundärer Sink und als ein möglicher Regulator für die Translokation anzusehen. Weitere Studien sind jedoch notwendig, diese Hypothese zu prüfen.

Growth, photosynthetic capacity and yield potential of sweet potato as affected by irrigation levels

Characterisation of sweet potato (*Ipomoea batatas* L. (Lam.) to different water regimes was the main topic of the present study. Six sweet potato clones were submitted to five different irrigation levels in order to study growth and yield, carbohydrate content in tubers as well as the chlorophyll and carotene contents in leaves. Furthermore, sweet potato clones were characterised with regard to their photosynthetic capacity of young and fully expanded leaves and their potential to export photoassimilates from leaves using the short-lived radioisotope ^{11}C .

Irrigation increased the vegetative growth of sweet potato. More irrigation increased dry matter of leaves, leaf number, dry matter of vines and length of the longest vines of sweet potato clones. On the other hand, irrigation decreased the root-tuber/shoot ratio and dry weight of tuber of the sweet potato clones. Three clones AB94001.8, AB94078.1 and Eland had the highest production of tubers but lowest production of leaves, vines and roots. At final harvest, dry weight of tubers correlated significantly with tuber number, fresh weight per tuber, plant dry biomass, dry matter production efficiency and (roots + tubers) / shoots ratio. Dry weight of tubers correlated negatively to leaf dry weight ratio, vine dry weight ratio and root dry weight ratio. Furthermore, plant dry biomass correlated positively to dry weight of leaves and negatively to leaf dry weight ratio.

Total soluble sugar increased with time, whereas drought treatments increased total soluble sugar in sweet potato tubers. At final harvest, there was a significant negative correlation ($r = -0.671$) between total soluble sugar and starch content in tubers. Total chlorophyll and carotene contents of leaves varied with clones. The highest chlorophyll content was reached by the control treatment and decreased in the treatments drought and temporary water logging. Water logging treatments decreased carotene content in leaves more than the drought treatments.

Net photosynthesis rates (A) of the investigated sweet potato clones, AB94001.8, Eland, CIP-1, AB94065.4, Klon A, and AB94078.1 were correlated with plant dry mass production, but not with tuber production. Net photosynthesis rate of fully expanded leaves was positively correlated with effective quantum yield ($\Delta F/F_m'$) of the investigated sweet potato clones. A significant negative correlation between qN (non-photochemical quenching) and g'_m (carboxylation efficiency) was recorded. An increase of the ratio tuber dry matter per plant's leaf area for the clones AB94001.8, Eland, CIP-1, AB94065.4, and Klon A was also correlated with a low qN .

In the ^{11}C experiment, clone Thai with a developing tuber exported a considerable greater percentage of the recently fixed photoassimilates (70% - 75% = export fraction + respiration) than clones AB95001.4 and Dayak (32% - 50%) without tubers. Only clone Kwarangwana was characterised by an even smaller loss of ^{11}C from the application leaf. The harvest of clone Thai, 75 min after $^{11}\text{CO}_2$ -application and subsequent analysis of the distribution of the radioactive tracer within the plant indicated that nearly 60% of the radioactivity exported from the leaf was stored within the growing tuber, proving the strong sink capacity of that organ.

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