ABSTRACT

Tomato (*Lycopersicon esculentum* Mill.) is an important commercial crop. High quality tomatoes for the local and export markets are grown hydroponically. In this study, the effect of electrically activated sodium bicarbonate and non-ionized sodium bicarbonate solutions on productivity and postharvest quality of hydroponically grown tomatoes was tested. Sodium bicarbonate is a ready source of bicarbonate. By using a novel technique obtained from Radical Waters (Pty) Ltd., ionized bicarbonate (anolyte) can be produced from sodium bicarbonate and applied to plants to stimulate photosynthesis, and improve yield and postharvest quality. The effect of ionized and non-ionized bicarbonate solutions on productivity and postharvest quality was studied by measuring the following: (1) Preharvest growth rate (leaf length, stem height and diameter); total yield; starch concentration in leaves; fruit count; leaf chlorophyll content; CO_2-uptake; soluble solids and concentration of K^+, Na^+ and NO_3^- in leaves. (2) Postharvest rate of respiration and transpiration; ethylene production; total soluble solids content; ascorbic acid content; pH; fruit firmness; fruit mass; fruit diameter; longevity; concentration of K^+, Na^+ and NO_3^- at one-third towards maturity, two-thirds towards maturity, at maturity and during ripening, and rate of ripening at 12 and 23°C. During the preharvest period, plants treated with anolyte showed increased growth rate, starch concentration, chlorophyll content, soluble solids content and improved yield. During the growth period, the concentration of K^+ and NO_3^- was higher in plants treated with anolyte than in plants treated with non-ionized sodium bicarbonate. The concentration of Na^+ during the preharvest period was higher in plants treated with non-ionized sodium bicarbonate than in plants treated with anolyte. After harvest, fruits from plants treated with anolyte had a reduced rate of ethylene production, rate of respiration and transpiration, total increased soluble solids and ascorbic acid content than fruits from plants treated with non-ionized sodium bicarbonate. Fruits from plants treated with anolyte had reduced rate of ripening and were larger and heavier than fruits from plants treated with non-ionized sodium bicarbonate. Anatomical and ultrastructural studies revealed that treatment with anolyte stimulated cell growth and photosynthesis. These results were confirmed by comparing the CO_2-uptake of treated and untreated plants. Application of anolyte stimulated photosynthesis, thus improving yield and fruit quality. Treatment with non-ionized

sodium bicarbonate resulted in salt- stress and calcium deficiency. Some of the fruits on plants treated with non-ionized sodium bicarbonate suffered from blossom-end rot due to salt-stress.

UITTREKSEL

Die tamatie (*Lycopersicon esculentum* Mill.) is ‘n balangrike kommersiële vars produk. Goeie gehalte tamaties wat in die plaaslike en internasionale markte verkoop kan word, word baie keer hidroponies gegroei. Hierdie projek konsentreer op die invloed van elektries-geaktiveerde natriumbikarbonaat (anoliet) en ongeïoniseerde natrium-bikarbonaat oplossings op die produktiwiteit en na-oeskwaliteiet van hidroponies gekweekte tamaties. Natriumbikarbonaat is ‘n baie goeie bron van bikarbonaat. Radical Waters (Pty) Ltd. het ‘n tegniek ontwikkel wat geïoniseerde bikarbonaat (anoliet) kan maak uit natriumbikarbonaat. Die aanwending van anoliete stimuleer fotosintese, bevorder opbrengs en verbeter na-oeskwaliteit. Geïoniseerde en ongeïoniseerde bikarbonaatoplossings se invloed op produktiwiteit en na-oeskwaliteit is bestudeer deur die volgende te meet: (1) Voor-oesgroeitempo (blaarlengte, stingelhoogte en -diameter); totale opbrengs; styselinhoud van die blare; chlorofilinhoud van die blare; aantal vrugte per plant; CO_2-opname; totale opgeloste stowwe en die konsentrasies van K^+, Na^+ en NO_3^- in die blare. (2) Na-oes respirasie- en transpirasietempo’s; etileenproduksie; totale opgeloste stowwe; askorbiensuurinhoud; pH; vrugfermheid; vrugmassa; vrugomtrek; langlewendheid; en die konsentrasies van K^+, Na^+ en NO_3^- wanneer die vrugte twee-derdes volgroeid was, volgroeid was en tydens die rypwordingsproses van die vrugte is getoets. Die tempo waarteen die vrugte by 12 en 23°C ryp word is ook geanaliseer. Voor die vrugte geoes is, het die plante wat met anoliete behandel is verbeterde groei, stysel inhoud, chlorofilinhoud, opgeloste stowwe en opbrengs getoon. Gedurende die groei tydperk het die K^+ en NO_3^- konsentrasies ook beter vertoon in die anolietbehandelde plante, in vergelyking met onbehandelde plante. Die Na^+ konsentrasies was hoër in plante wat met ongeïoniseerde natriumbikarbonaat behandel was as wat dit was in plante wat met anoliet behandel is. Tamaties wat geoes is van plante wat met anoliet behandel is het minder etileen geproduseer, laer respirasie en transpirasie gehad en het meer opgeloste stowwe en askorbiensuur bevat as tamaties van plante wat behandel is met ongeïoniseerde natriumbikarbonaat. Die anoliet tamaties het ook stadiger ryp geword en was groter en swaarder. Anatomiese en ultrastrukturele analise het gewys dat anolietbehandeling selgroei en fotosintese gestimuleer het. Hierdie

resultate is bevestig deur die CO_2-opname van behandelde en onbehandelde plante te vergelyk. Anolietbehandeling stimuleer fotosintese en bevorder sodoende opbrengs en vrugkwaliteit. Ongeïoniseerde natriumbikarbonaatbehandeling het gelei tot soutstres en kalsiumtekorte. Party van die plante wat met ongeïoniseerde natriumbikarbonaat behandel is se vrugte het bloeiselpunt verrotting ontwikkel as gevolg van die soutstres wat die plante ervaar het, waardeur kalsium uit die selwande verplaas is.

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ABBREVIATIONS AND SYMBOLS

ADP	-	adenosine diphosphate
ATP	-	adenosine triphosphate
C_2H_4	-	ethylene
°C	-	degrees Celsius
cm	-	centimetres
CO_2	-	carbon dioxide
dH_2O	-	distilled water
EFE	-	ethylene forming enzyme
g	-	grams
h	-	hour
HCO_3^-	-	bicarbonate ion
H_2O	-	water
K^+	-	potassium ion
kg	-	kilograms
L	-	litres
mg	-	milligrams
mL	-	millilitres
mm	-	millimeters
mol	-	mole
Na^+	-	sodium ion
nm	-	nanometres
NO_3^-	-	nitrate ion
$NaHCO_3$	-	sodium bicarbonate
NAD	-	nicotinamide adenine dinucleotide
$NADH_2$	-	reduced NAD
ORP	-	oxidation-reduction potential
O_2	-	oxygen
PCR	-	polymerase chain reaction
pH	-	hydrogen ion concentration

ppm	-	parts per million
RNA	-	ribonucleic acid
SS	-	sucrose synthase
SPS	-	sucrose phosphate synthase
TDS	-	total dissolved solids
µ	-	micro
µg	-	micrograms
µL	-	microlitres