

'HYHORSPHQW RI %LRORJLFDO 6XOIXU)HUWLOLW\ ,PSURYHPPHFW RI 'HVHUV 6RLO)HUWLOLW\ L

4DGHU\DK \$KPDG \$DPPWDZDQL ,EUDKLP \$O 6XUUDV .XZDLW ,QVWLWXWH IRU 6FLHQWLILF 5HVHDFK (QYLURQPHQW 3 2 %R[6DIDW .XZDLW

5HVHDFK \$UWLFOH

<p>5HFHLYHG GDWH \$FFHSWHG GDWH 3XEOLVKHG GDWH)RU &RUUHVSRRGHQFH .XZDLW ,QVWLWXWH IRU 6FLHQWLILF 5HVHDFK (QYLURQPHQW DQG /LIH 6FLHQWIF 5HVHDFK & HQWHU 3 2 %R[6DIDW .XZDLW (PDLDPXWDZD#NLVU HGX NZ .H\ZRUGV DONDOL VRLO (OHPHQWDO HWKXVH KRXXVH VVXOIXU R[LGL]LQJ PLFUREHV DPHQGPHQW %LRIHUWLOL]HU HQYLURQPHQW DQG EDFWHULD</p>	<p style="text-align: right;">\$%675\$&7</p> <p>3XUSRVKH DONDOLQH QDWXUH RI WKH .XZDLW GLVWXUEHG RI SODQW JHUPLQDWLRQ DEGXULQJ JURZWK OHDGLQJ WR DQ HQYLURQ JURZQ 7KH ORFDO VRLO LV DONDOLQH ZLWK WRKLPK IRVH DQK SODQW VSHFLHV :LWV HQWHUHQPHQW VVXOIXU DQG VXOIXU LV K\SRWKHVL]HG WKDW VRLO LV DPHSURYLQJ VRLO SURSHUW\ DQG WKXV LQ FURS SURGXFWLYLW\</p> <p>5HVXQW JHQHUDO LQFUHDVLQJ DSSOLFDEOH VLJQLILFDQWO\ WR S+ GHFUHDVH DQG \$OIRXQG GHU JUHHQKRXXVH FRQGLWLRQV 7KH KLONJ KDV FDXVHG WZR XQLW UHGXFWRQV LQ ZLWKLQ GD\ 2Q WKH RWKHU KDQG ELRIHUWLOL]HU SURGXFWHG KDV VOLJKWO\ JUHHQKRXXVH S+ UHGXFWRQ</p> <p>&RQFOXVLRQV RI WKH ELRORJLFDO VXOIXU SRVLWLYH UHVSRRQVHV LQ WHUPV RI FKDQJHU JUHHQKRXXVH DQG ILHOG WHVW DV ZHOOD FURS XVHG LQ WKLV LQYHVWLJDWRQ</p>
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,1752'8&7,21

6XVWDLQDEOH IDUPLQJ KDV EHHQ LGHQWLILHG ELR IHUWLOL]HU DV DQ DQG FURS SURGXFWLRQ \$V ELR IHUWLOL]HUV EHQHILFLDO PLFUREHV KDV WKHLU SRWHQWLDO UROH LQ IRRG YDPHWRIDQV VVXOIXU DSSOLFDEOH ZDWHU XSWDNH SODQW JURZWK DQG SODQW WROHUDQFH WR DELRWLF UROH LQ WKH SURGXFWLYLW\ DQG VXVWDLQDELOLW\ RI VRLO DQG LQ SURLQSXWV IRU WKH IDUPHUV

,Q VRLO PLFURRUJDQLVPV SOD\ D PDMRU UROH LQ VXOIXU R[LGDWLRQ
IHUWLWLW\ FDXVLQJ WKH IRUPDWLRQ RI VXOIDWH WKH PDMRU 6 LRQ X
HOHPHQW FDQ EH XVHG WR P^{SS}BYGHKLSKOWDNDROLPLFVRROVDQLVPV LV
HQYLURQPHQW LQFOXGLQ^{Thiobacillus} DUH XPIEWKHRUHKHXWHURWURSKV SKRWRV
FRORUOHVV ILODPHQWRXV VXOIXU EDFWHULD 2I WKHVH RQO\ WKH WKLI
DJULFXOWX^UDUH SRMLRQV DUH IORRGHG VRLOV LQ ZKLFK WKH PLFURRUJD
H ^{Beggiatoa} EXW WKDW FDQ EH LVRODWHG IURP ERWK DJULFXOWXUDO DQGG

Thiobacillus LV WKH EHVW NQRZQ JHQXV^{7KH}FDORUHXVXVDOEDFSWHXIGRPRQDG OI
JHQXV DOVR FRQWDLQV QRQPRWLOH URGV DQG FRFFRLG RUJDQLVPV 7K
R[LGDWLRQ RI UHGXFHG VXOIXU FRPSRXQGV :LWKLQ WKH JHQXV WKHUH
JDLQ HQHUJ\ IURP WKH R[LGDWLRQLRIPDDQFDUVRQZVRXUFH DQG WKH
WKDW FDQ JURZ DXWRWURSKLFDQO\ @PL[RWURSKLFDQO\ RU DV KHWHURW

+RZHYHU 6 R[LGGL]LQJ PLFURRUJDQLVPV OLYH LQ VRLOV LQ FRQVRUWLD
D VXFFHVVLRQ RI JURXS^V@R[LGGL]LQJ PLFURRUJDQLVPV DONDOLQH VRLOV KHWHURWU

Thiobacillus thioparus WKHQ WDNH^{Thiobacillus}UEHDFRPHV GRPLQDQW EHORZ S+ & R
VXOIDWH UHGXFHUV DQG VXOILGH R[LGGL]LQJ EDFWHULD ZDV IRXQG WK
PXOWLFHOOXO^DDLRUCDQOVKHHWHURWURSKLF EDFWHUL^UDRKXWH LVRHOOWRHXQ
FRDO V^KOHZDV VXJJHVWHG "W^{EDM}ORLJHGLVRFDD^{HEG}QHILFLDO WR WKH
VXFK DV DFHWDWH DQG SUXYDWH ZKLFK PD\ LQKLELW FKHPROLWKRWU
ZLWK QLWULPLQ^WEDF^WVRDLQWHUHVWLQJ WKDW WKH GHVXOIXUL]DWLRQ
PL[HG FXOWXUH LQFOXGLQ^GQHWHULVR^USRZH^UDRKXWH LVRHOOWRHXQ

,Q FDOFDUHRXV VRLOV SRRU DYDLODELWLW\ RI QXWULHQWV UDWKHU W
GHILFLHQF\ LQFLGHQW 1XPHURXV VRLO IDFWRUV DUH JRYHUQHGF^QQWHIL
DUH WKH PDLQ IDFWRUV UHVSRQVLEOH^IR^US^SSKLFRZLRQDRDDEBOLQCHRIS
WKH QXWULHQW GHILFLHQF\ XQGHU XQIDYRUDEOH VRLO FRQGLWLRQV ZLV

7KH DONDOLQH QDWXUH RI WKH .XZDLW GHVHUW VRLO UHVXOWV LQ WKH
JURZWK OHDGLQJ WR DQ HQYLURQPHQW ZKHUH SODQWV FDQ KDUGO\ EH
DONDOLQH FRPSRQHQWV LQ WKH VRLO 2QH DSSURDFK IRU QHXWUDOL]DV
R[LGGL]LQJ EDFWHULD DV D VRLO DPHQGPHQW 6XOIXU PDWHULDOV DUH R
LRQ DQG WKHQ WKH DONDOLQH FRPSRQHQWV DUH QHXWUDOL]HG DW WK
FDQ EH VXSSOLHG 7KH DLP RI WKH SUHVHQW VWXG\ ZDV WR GHYHORS
K\GURGHVXOSKXUL]DWLRQ SURFHVVHV DQG VXOIXU R[LGGL]LQJ EDFWHUL
DONDOLQH VRLO

$$0\$7(5, \$/6 \$1' 0(7+2'6$$

6FUHHQLQJ RI 6XOIXU 2[LGGL]LQJ %DFWHULD

)LIW\ RQH VRLO VDP SOHV ZHUH VFUHHQH G IRU VXOIXU R[LGGL]LQJ EDFWH
IRU WKHVH VDP SOHV ZDV GHWHUPLQH G DQG ZDV XVHG IRU WKH+^BQRFXOD
J/ 0J62 +2 J/1+ 62 J&D&O J)H62 J1D0R2 +2 J/6 J/
EURPRWK\PRO EOXH S+ 7KH VDP SOHV ZHUH VFUHHQH G IRU VXOIXU R[LG

***URZWK &RQGLWLRQ 2SWLPL]DWLRQ**

7KH RSWLPDO FRQGLWLRQ IRU ELRPDVV SURGXFWLRQ IRXU WZR VHOH
HOHPHQWDO VXOIXU WR \HDVW H[WUDFW WR GLIIHUHQW
PHGLD

6RLO 6XOIXU %LRIHUWLWLW]HU 3URGXFWLRQ

6RLO ELRIHUWLWLW]HU ZDV SURGXFHG E\ PL[LQJ VXOIXU VHZDJH VOXG
%HQWRQLWH +LURVKLPD :DNR &R /WG 7KH VKDSH RI WKH VXOIXU ELR
P)LJXUHDNLQJ WKH XVDJH LQWR DFFRXQW 7KH WDUJHW RI WKH FRPS
NJIFP



) L J X U Sulfur biofertilizer pellet with a diameter of 5 m to 10 m.

'HYHORSPHQW RI 6RLO %LRIHUWLLOL]HU DQG (YDOXDWLRQ

7KH VRLO ELRIHUWLLOL]HU SURGXFWLRQ ZDV FDUULHG RXW ZLWK WZR N SURGXFWHG E\ WKH .QHDGHU DQG WKH 3XVKLQJ 7\SH &DVWLQJ PDFKLQH , E\ WKH 0L]HU ZLWK D UROOHU DQG WKH %ULTXHWLQJ 0DFKLQH)LUVW GU\ IRUP DQG WKHQ WKH\ ZHUH PL]HG DJDLQ DIWHU WKH DGGLWLRQ RI PDFKLQH RU %ULTXHWLQJ PDFKLQH WR PDNH WKH SHOOHW &RPSUHVV KDOIWLPH IRU WKH VRLO ELRIHUWLLOL]HU LQ ZDWHU ZDV PHDVXUHG DV DPHQGPHQW DQG PO RI ZDWHU ZHUH XVHG

*UHHQKRXVH ([SHULPHQW

7KH H[SHULPHQW ZDV FDUULHG RXW LQ D + î : î / P ILEHUJODVV PRYHDEOH EHQFKHV IRU VSDFH VDYLQJ DQG FRROHG WKURXJK DQ HYDSR JUHHQKRXVH KDYH EHHQ LQ WKH UDQJH f& WR f& 7KH VRLO ELRIHUWLLOL]HU VOXGJH EHQWRQLWH VDQG DQG EDFWHULD .D 3 0 1 QDVQ G U 3 &) RLO DWWDSXOJLWH 7KH SURGXFW ZDV LQFRUSRUDWHG LQWR ILQHO\ VLHYHG RI Y Y WR LPSURYH WKH SK\VLFDQ SURSHUW\ RI WKH URRW PHGLXP ZLWK D S+ RI DURXQG 7KH H[SHULPHQW ZDV ODLG RXW LQ D UDQD DQG JORJDO VRLO DQG HLJKW UHSOLFDWLRQV SHU VRLO WUHDWPHQW \$ J RI \$OIDOID VHHGV ZHUH SODQWHG LQ FP GLDPHWHU SRWV 1HFHV FRPSRVHG RI WKH IROORZLQJ FKHPLFDQV ZLWK FRQFHQWUDWLRQV XVH &D12 +2 P0 SRWDVVLXP QLPVUDWLRQ HYLXP V*2IDWH P00JSRWDVVLXP .+32 P0 DQG LURQ DV ('\$ FRPSRVHG FRQVWUJHQWV +RDJODQG PLFUR +%2 PJ/PDQJDQHVH FKORULGH OFU&]LQF VXOIDWH =Q6PJ/FRSSHU VXOIDWH &X62 PJ/DQG PROVERGDAZH + PJ/7KH FKDQJHV LQ S+ ZHUH PR EDVLV DQG SODQW WLVVXH VDP SOHV ZHUH WDNHQ IRU GU\ PDWWHU ZHLJ

)LHOG 7ULDOV

3ORWV VL]H RI îZHWH LURJLDWHG E\ D VSULQNOHU LUULJDWLRQ V\VV VFKHGXOH DQG GRVDJHV SURYLGHG ZHUH DSSOLHG DFFRUGLQJ WR WKH ELRIHUWLLOL]HU SHOOHWV FRQVLVWHG RI 6f GU\ VOXGJH VDQG FP WR FP RI VRLO 6XOIXU ELRIHUWLLOL]HU UDWHV DSSOLHG ZHUHTXL WR RU 7KH H[SHULPHQW ZDV ODLG RXW LQ D UDQGRPL]HG FRPSO

&KHPLFDQ \$QDO\VLV

7KH HOHPHQWDO FRPSRVLWLRQV RI RUJDQLF PDWWHU LQ WKH VRLO & HOHPHQWDO DQDO\]HU 7KHUPR)ODVK & (\$ 7KH WRWDO FRQWHQV SODQW WLVVXH DQG VRLO VDP SOHV ZHUH GHWHUPLQHG E\ ,QGXFWLYHO\ \$XVWUDOLD PHWKRQ & ; UD\ GLIUDFWLRQ ;5' SDWWHUQV ZHUH PH -DSDQ

6FUHHQLQJ RI 6XOIXU 2[LGL]LQJ %DFWHULD DQG *URZWK &RQGLWLRQ 2SW

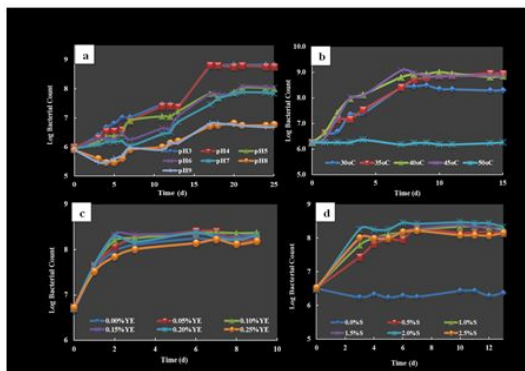
)RUW\ ILYH JUDQDobactin]EVEWHULD ZHUH LVRODWHG LVRODWHV DW f& ORZHVW LQFXEDWLRQ WLPH EHWZHHQ WKUHH WR VHYHQ LQFXEDWLQJ G FXUYHV ZHUH VWXGLHG 0D[LXP JURZWK DQG SDEGHS ZHHPDHLWKPURJUR IRXQG ZLWK LVRODWH DIWHU IRXU LQFXEDWLRQ GD\ ZLWK D PD[LXP S PD[LXP GURS LQ S+ DW f& ZDV IRXQG ZLWK LVRODWH &S+ DIWHZLWK LQFXEDWLRQ GD\ ,VRODWHV DQG PD[P] JURZWK i ZHUH VHOHFWH RSWLPL]DWLRQ DW f& DQG f& UHVSHFWLYHO\ ,VRODWH ZDV ODEHO

7DEOMaximum growth and maximum pH drop for the selected isolates.

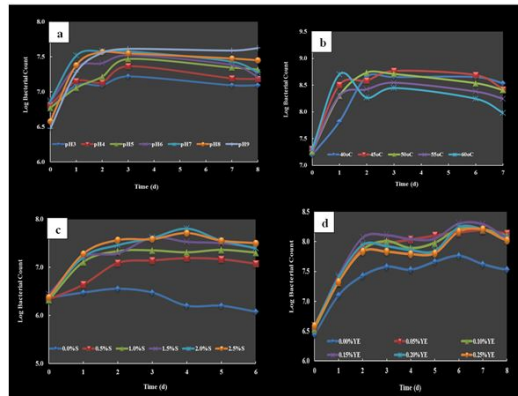
,VRODWH ,6RLO S+	0D[&)8 ;	0D[S+ GURS	,QFXEDWLRQ 7HPSHQLFXEDWLRQ 'D\	7L
			f&	
			f&	
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			f&	
			f&	
			f&	

2SWLPL]HG &RQGLWLRQ IRU ,VRODWHV .13&) DQG .13&1

7KH JURZWK FRQGLWLRQ IRU ELRPHOSURJRYWLDV VRRUSWLRQ]HG DW f UHVSHFWLYHO\ %RWK VWUDLQV KDG WKH VDPH RSWLPDO WHPSHUDWXUH +RZHYHU WKH\ KDYH D GLIIHUHQW RSWLPDO JURZWK S+ RSWLPDO ZHUH JURZQ XQGHU WKH RSWLPL]HG FRQGLWLRQ PL]HG LQ Acidithiobacillus thiooxidans .13&) DQG 7KLREDFLOOXV VS .13&1 E\ 0,' /DEV ODERUDWRULHV & ZKLFK ZDV SHUIRUPHG XVLQJ D 3HUNLQ (OPHU \$SSOLHG %LRV\WHP V 0 VHTXHGFH GHWHUPLQH IRU WKH V U51\$ JHQH UHVXOWHG L Thiobacillus VS UHVSHFWLYHO\ *HQH%DQN DFFHVVRQ QR 0. DQG 0. UHVSHF



) L J X U B Growth condition optimization for biomass production for KNPCF. (a): pH; (b): Temperature; (c): Yeast extract; (d): Elemental Sulfur.



B Growth condition optimization for biomass production for KNPCN. (a): pH; (b): Temperature; (c): Yeast extract; (d): Elemental Sulfur.

6XOIXU %LRIHUWLLOLJHU 3URGXFWLRQ 'HYHORSPHQW DQG (YDOXDWLQRQ

7DEOMKRZV WKH FKHPLFDO DQDO\VLV UHVXOW IRU WKH PDWHULDOV XV
FRQWDLQ RUJDQLF FRPSRXQGV DQG WKH LPSRUWDQW FRPSRQHQWV WRIOXO & D \$O₂
& D \$O₂ %HQWRQLWH DOVR GRHV QRW FRQWDLQ RUJDQLF FRPSRXQ
. \$O₂ 2+ 2 DQG 4XDUW]KHGLU\ VOXGJH FRQWDLQV RI RUJDQLF FD
RI SKRVSKR\LF 7KHLEDBQ FRPSRQH DQG GW4XDUW]UHL 2R FUI\ VWDOOLQH

7DEO Chemical analysis result of the materials used in the sulfur biofertilizer.

0DWHULDOV		.XZDLW VRLO%HQWRQLWH6XOIXU	'U\ VOXGJH
2UJDQLF PDWWHU ZW	&		
	6		
	1		
,QRUJDQLF PDWWHU ZW	6L2		
	\$O ₂		
	&D ₂		
)H ₂		
	. ₂		
	0J ₂		
	1D ₂		
	3 ₂		
7L ₂			
; UD\ GLIIUDFWLRQ 5HVXOWV	4XDUW]	5HFWRULWH	4XDUW]
	0DLQ	0DLQ	DV PLQHDO
	&DOFLWH	4XDUW]	
	\$QRUWKLWH	0DLQ	

7DEOMKRZV WKH UHVXOWV IRU WKH HIIHFW RI XVLQJ .XZDLW VRLO DQG
VWDELOLW\ LQ WKH VPDOO VFDOH VXOIXU ELRIHUWLLOLJHU SURGXFWG \$V
ELRIHUWLLOLJHU SURGXFWLRQ ,Q WKH SUHVHQFH RI WKH VDPH DPRXQW R
WKH VWDELOLW\ LQ WKH ZDWHU ZDV DOVR LQFUHDVHG &RPSUHVVLQRQ VW

5HV 5HY - (FRO (QYLURQ _ 9ROXPH _ ,VXXH _ -XQH

7 D E O Effect of Kuwait soil and Bentonite on the compression strength and water stability for the small-scale sulfur biofertilizer produced in the presence of organic compounds (PVA).

\$PHQGPHQW 1R	&RPSRQHQQWV ZW				&RPSUHVVLQRQ 6WUHQJWK	D\WUHQJWK LQW\ GD\
	6XOIXU	6OXGJH	6RLO	%HQWRQLWH39\$		
/						
/						
/						

7DEO Effect of Kuwait soil and Bentonite on the compression strength and water stability for the large-scale sulfur biofertilizer produced in the absence of organic compounds.

7 D E O Effect of Kuwait soil and Bentonite on the compression strength for the large-scale sulfur biofertilizer produced in the absence of organic compounds.

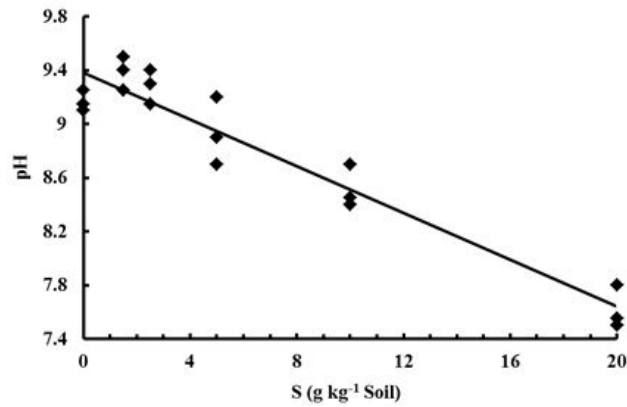
\$PHQGPHQW 1R	&RPSRQHQQWV ZW				&RPSUHVVLQRQ 6WUHQJWK
	6XOIXU	'U\ VOXGJH6RLO	%HQWRQLWH		
/					
/					
/					
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6XOIXU %LRIHUWLQJHU 3HOOHW 7HVW LQ WKH *UHHQKRXVH

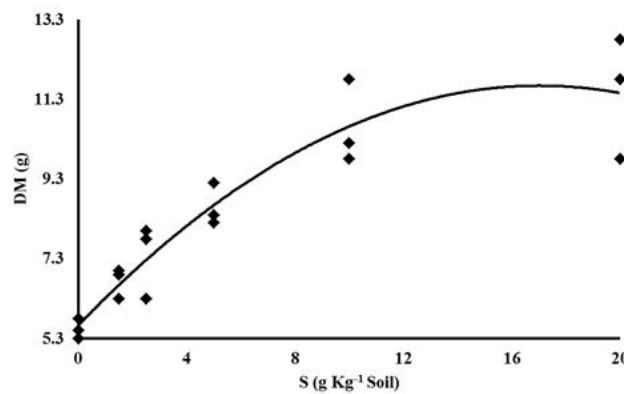
7KH JURZWK RI \$OIDOID SODQW DW GLIIHUHQW VXOIXU ELRIHUWLQJHU J6NJ J DQG J6NJ) LJXUH7KH GLIIHUHQFH PD\ EH GXH WR WKH FKDQJH DPRXQWLQJ RI \$OIDOID \$SSOLFDFWLRQ DW HIJH RWLYH LQ UHGXFHQJ S+ E\ DSSU LQ WKH SUHVHQW RI SUW KH ZHUW R HQW HVXOWV RI ILWWLQJ D VHFRRG RUGHU EHWZHHQ 'U\ ODWWHU '0 SURGXFWLRQ RI DWR HQW IDW HQW IDW HQW IDW HQW EHWZHHQ '0 DWR HQW VLJQLILFDQFH OHYHO ZLWK WKH DWR HQW SRO\QRPLDO U UHODWLRQV KLS EHWZHHQ '0 SURGXFWLRQ RI \$OIDOID SODQW DQG S+ RI PHGLXP WKH KLJLKHU\U\ \LHOG



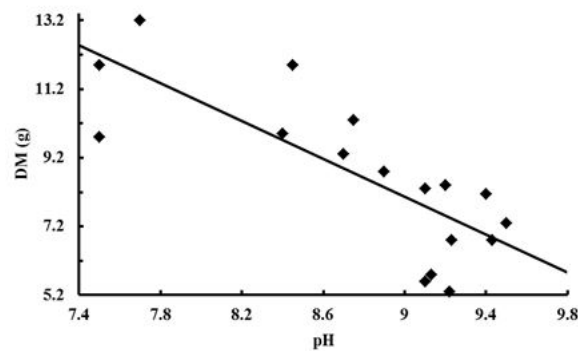
) L J X U Effect of increasing sulfur biofertilizer application rate on Alfalfa plant growth.



) L J X U Effect of sulfur biofertilizer application rate on pH of growth medium.



) L J X U Effect of sulfur biofertilizer application rate on dry matter yield of Alfalfa.



) L J X U Effect of soil pH alteration on DM of Alfalfa (45 days after planting).

\$ O I D O I D S O D Q W W L V V X H V D P S O H V Z H U H D Q D O \} J H G I R U D W E O H 2 F R S C F U H Q W F U L P S R U W D Q F H Z D V V F R I Q F H L Q W L I D F D L Q W 6 Q S O D Q W W L V V X H V L F R Q W F H Q W W E W L 6 R C S O D Q W W L V V X H V J U R Z Q L Q W K H S U H V H Q F H R I V X O I X U R [L G L] L Q J E D F W H U E D F W H U L D & R P S D U L V R Q V R I \$ O I D O I D S O D Q W J U R Z W K L Q S R W V J U R Z Q L Q J 6 N J W U H D W P H Q W Y V V F R I Q W U R I W H U J 6 N D J Q G G D \ V V H H G L Q J L Q S R W V L Q J U R Z W K L Q W K H S U H V H Q F H R I E D F W H U L D Z D V J U H D W H U W K D Q W K D W L Q W

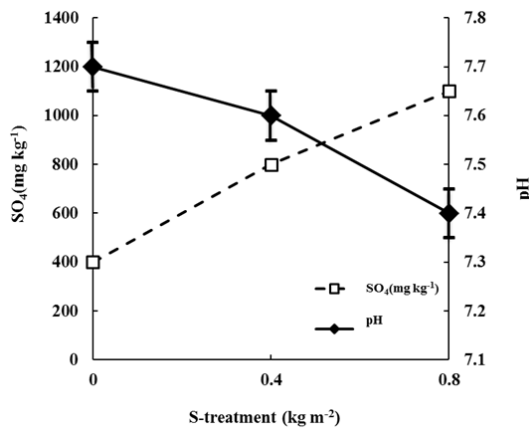
7 D E O Macro and micro-elements^a in Alfalfa plant tissues grown at different concentrations of sulfur in the biofertilizer in the presence (P) or absence (A) of sulfur-oxidizing bacteria (B).

6 ^R E	%	0 J	3	& D	.	6 2	& X) H	0 R	= Q
	\$									

	3									
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	3									
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	3									
D PJ NFJ 6 NJVRL0										

6XOIXU %LRIHUWL0L]HU 3H00HW 7HVW LQ WKH)LHOG

,Q ILHOG HYDOXDWLRQ VXOIXU ELRIHUWL0L]HU SH00HW VKRZH G VOLJK RI WKH VRLO LQ WKH H[SHULPHQWDO VLWH FDQG HGHPSMUKH WKH WJHWLWV LQ VXQIORZHU SORVV H[SHULPHQW WKH VRLO S+ GHFUHDVH ZLW WKH VSO LQFUHDVH RQ WKH WJHWLWV LQ WKH VRLO S+ GHFUHDVH ZLW WKH VSO VLPL0DU0 6LPL0DU UHVXOWV ZHUH DOVR REWDLQH G IRU FRP DQG VSO SK\VLRRJLFDO S+ UDQJH DQG ORQJ GLVWDQFH WUDQVSRUW RI VXOIDW VXOIDWH LV QHFHVVDU\ WR LQFRUSRUDWH VXOIXU LQWR DPLQR DFLGV S



) L J X U Effect of sulfur biofertilizer on pH and SO₄ concentration of soil at sunflower harvest.

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\$ONDOL VRLOV IRUPHG DV D UHVXOW RI FDUERQDWH DQG EEF0,WE R0D WEH FKDUDFWHUL]HG E\ KLJK S+ ! KLJK H[FKDQJHDEOH VRGLXP SHUFHQWDO DOO RI ZKLFK DUH GHWULPHQWDO WR WKH SK\VLFRFKHPLFDQD S+ H[SHULPHQW \HDUV DV VRLO S+ GHFUHDVH LQ WKH VRLO S+ GHFUHDVH ZLW WKH VSO LQFUHDVH RQ WKH WJHWLWV LQ WKH VRLO S+ GHFUHDVH ZLW WKH VSO VLPL0DU0 6LPL0DU UHVXOWV ZHUH DOVR REWDLQH G IRU FRP DQG VSO SK\VLRRJLFDO S+ UDQJH DQG ORQJ GLVWDQFH WUDQVSRUW RI VXOIDW VXOIDWH LV QHFHVVDU\ WR LQFRUSRUDWH VXOIXU LQWR DPLQR DFLGV S

%LRORJLFDOO ETR0ba0Ls]H0G0i0ans WR62 XQGHU DHURELF FRQGLWLRQV LV IUHT DQG GLVVROYH LQVROXE0,0 PLFUR QIXVVWHQRL0 EDQV S+ QHXWUD0L]LQJ DQ QDWLYH VRLO S+ GHFUHDVH LQ WKH VRLO S+ GHFUHDVH ZLW WKH VSO LQFUHDVH RQ WKH WJHWLWV LQ WKH VRLO S+ GHFUHDVH ZLW WKH VSO VLPL0DU0 6LPL0DU UHVXOWV ZHUH DOVR REWDLQH G IRU FRP DQG VSO SK\VLRRJLFDO S+ UDQJH DQG ORQJ GLVWDQFH WUDQVSRUW RI VXOIDW VXOIDWH LV QHFHVVDU\ WR LQFRUSRUDWH VXOIXU LQWR DPLQR DFLGV S

.D\D 0 HW DO (IIHFW RI HOHPHQWDO VXOIXU DQG VXOIXU FRQWDLQ
FRUQ SODQWV JURZQ RQ D FDOF DUHRXV VRLO \$IULFD - %LRWHFKQRO
.RYGD 9\$ \$ONDOLQH VRGD VDOLQH VRLOV \$JURNpPLD HV 7DODMWDQ
\$EURO ,3 HW DO &URS UHVS RQVHV WR GLIIHUHQWLDO J\SVXP DSSOL
H[FKDQJHDEOH VRGLXP XQGHU ILHOG FRQGLWLRQV 6RLO 6FL
*DUFLD 0(HW DO 7KH HIIHFW RI VXOSKXU RQ WKH VROXELOLW\ DQG
)DOLK \$0\$ 6XOSKXU R[LGDWLRQ LQ 6DXGL \$UDELDQ DJULFXOWXUDO
6ODWRQ 1\$ 7KH LQIOXHQH RI HOHPHQWDO VXOIXU DPHQGPHQWV R
\$UNDQVDV
0F&UHS*G\ HW DO 6XOIXU LVRWRSH IUDFWLRQDWLRQ R[LGDWLRQV
VRLO &DQ - 6RLO 6FL
+LQDO HW DO (IIHFW RI &D&2 DQG FOD\ FRQWHQW RORSSKULF V
\$ER 5DG\ HW DO (IIHFW RORSSKULF RORSSKULF RORSSKULF RI FDOF DUHRXV
VHHGOLQJV \$ULG 6RLO 5HV 5HKDELO
0RGDL\$V KH HW DO (IIHFW RORSSKULF RORSSKULF DO FKDQJHV DQG QXWULHQW D
6RLO
/LQGHPDQQ :& HW DO (IIHFW RI VXOIXU VRXUFH RQ VXOIXU R[LGDWL
&RZHOO /(HW DO 6WLPXODWLRQ RI HOHPHQWDO VXOSKXU R[LGDWL
%HV K+UHW DO (IIHFW RORSSKULF RORSSKULF RORSSKULF RORSSKULF
6RLO :DWHU 6FL
-DQJHQ ++ HW DO 7KH HIIHFW RI WHPSHUDWXUH DQG ZDWHU SRWHQ