



5HVHDFK \$UWLFOH 2SHQ \$F

)HDVLELOLW\ RI D %LRUHPHGLDWLRQ 3URFHVV 1XWULHQW 13. IRU +\GURFDUERQ &RQWDPLQDW

\$EGHOGSDELGLDRXWKHU =SDEGRXZDKHE ,PDE 0DQDGD %HQ +DVVHQ &RDEEHVQMDVQRXGRNWDU +DPGL
/DERUDWRU\ RI 0LFURELDO (FRORJ\ DQG 7HFKQRORJ\ 'HSDUWPHQW RI %LRORJLFDO DQG &KHPLFDO (QJL
7XQLV 8QLYHUVLV\ RI &DUWKDJH 7XQLVLD

1DWLRQDO 6FKRRO RI (QJLQHUV RI 6ID[%3 6ID[8QLYHUVLV\ RI 6ID[7XQLVLD
&HQWUH GH UHFKHUFKH HW GH WHFKQRORJLH GH O pQUJLH 7HFKQRS{OH GH %RUM &pGULD %3 1 f
/DERUDWRU\ RI 3ODQW %LRWHFKQRORJ\ 1DWLRQDO ,QVWLWXWH RI \$SSOLHG 6FLHQFH DQG 7HFKQRORJ\
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\$SSOLHG 6FLHQFH DQG 7HFKQRORJ\ ,16\$ 7XQLV 8QLYHUVLV\ RI &DUWKDJH 7XQLVLD #JPDLO@F
5HF GDWH \$\$U \$SSLFODG3XHE GDWH 0D\ > @)UDQNHQEHUJHU HW DO > @ UH
&RSULJKW \$ELG \$ HW DO 7KLW LV DQ RSHQ DFFHVV DUWLFLPHQW RI &DUWKDJH 7XQLVLD
GLVWULEXWLRQ DQG UHSURGXFWRQ LQ DQ\ PHGLXP SURYLGHG WKH PULJLDO DDXWKRU DQG VRXUFH D
QLWURJHQ DQG SKRVSKRUXV DQG K

\$EVWUDFW

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GLHVHO FRQWDPLQDWHG VRLO XQGHU QDWXUDO ERQGWLWLRQV %LRGHJUDGDWLRQ
13"@
73+ LQ VS!D@ p0 SURGXFWLRQ RI RLO WUDGXFWLRQ DLRQLOV PLFURFRUHV
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VXFK DV KXPDQ KHDOWK DQG HQYLURQPHQW SDFWRYLFZKHQ 7KH KYXGELDGEVGH K P
VSUHDGV KRUL]RQWDOO\ RQ WKH JURXQG ZLWKLXWULHQW DQG RLO SDFWRYLFZKHQ RQ WY
JURXQG ZDWHU DLU VSDFH DQG WR WKH VXUWHWRRQV LQ SDFWRYLFZKHQ RQ WY
WKLW SDUWLWLRQ K\GURFDUERQ DUH GHJUDGHG LQ VRLO PDLQO\ E\ EDFWHULD
RI WKH WRWDO RI KHWURWURSKLODWHUHLDOV DQG RSHWKRGV
IXQJL > @

0LFURELDO FRPPXQLW\ VWUXFWXUH LQ K\GURFDUERQ FRQWDPLQDWHG VRLO
DUH LQIOXHQFHG E\ D QXPEHU RI IDFWRUV VXFK DV VRLO VSHXV FRFHQWUDWLRQ
DQG ELRDYDLODELOLW\ RI WKH FRQWDPLQDWHG VRLO QXWULHQW RQWULHQW
WHPSHUDWXUH R\JHQ FRQWHQW DQG S+ > 72\$/ 6DQG 2, / , % < \$Q6\$ULDQD JF
%LRUHPHGLDWLRQ ZKLFK LV GHILQHG RQ UHSHUWV WUHQV LXLV)LJXUH
PLFURRUJDQLVPV SODQWV RU HQJ\PHV SRORXWLRQV SRO\ SRO\ E\ K\G
FRQWDPLQDQWV LQ D OHVV WR\LF VSHFLHV RLO D QDQWUBFDUERQ WUHQV WUHQV
LWV FRVWV DQG EHQHILWV WKDW UHVXOW IURP WKH SRORXWLRQV OHYHOWLF
9DULRXV IRUPV RI WUHDWPHQW WHFKQRORJ\ RSHUHQV XQGHUHQV LQ WKHU DQD
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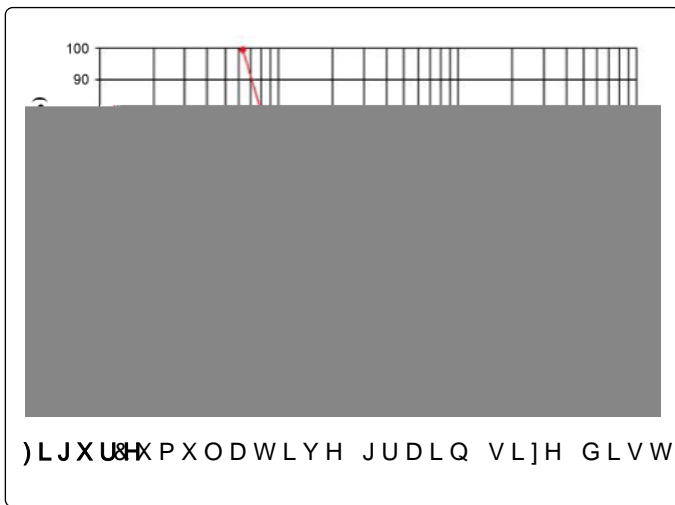
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WKH VDPH FRPSRVLWLRQ VXSSOHPHQWHG ZLWK J O RI \$JDU

7KH S+ RI WKH PHGLXP ZDV DGMXVWHG WR DOO PHGLD DQG VROXWLRQ
ZHUH SUHSDUHG ZLWK /LWHU GLVWLOOHG ZDWHU DQG DXWRFODYHG DW r & IR
PLQ \$IWHU LVRODWLRQ DQG IRU WKH ZRUNLQJ FHOO EDQNV WKH PLFURELDO
VXVSHQVLRQ ZDV UHVXVSHQGHG LQ IUHVK 0LQLPDO 0HGLXP 00
FRQWDLQLQJ RI JO\FHURO DQG VWRUHG LQ FU\R YLDOV r &

5HVXOWV DQG 'LVFXVVLRQV

6RLO DQDO\VLV

\$FFRUGLQJ WR WKH UHVXOWV RI WKH VRLO WH[WUXH DQDO\VLV WKH VDPH V
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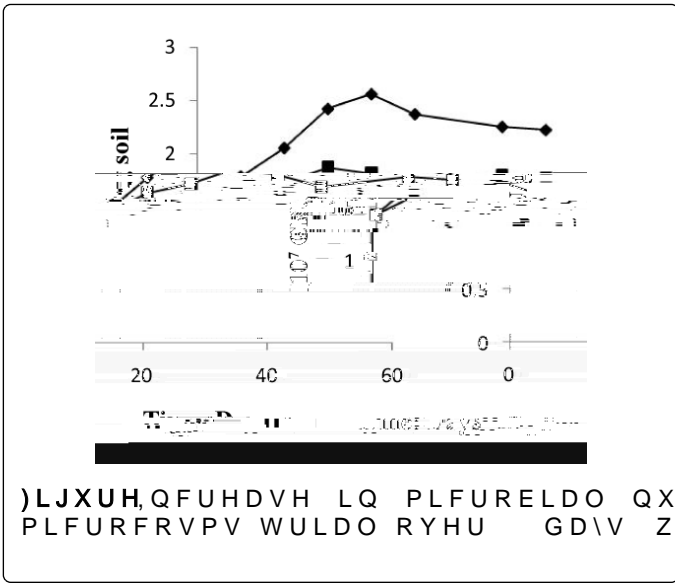


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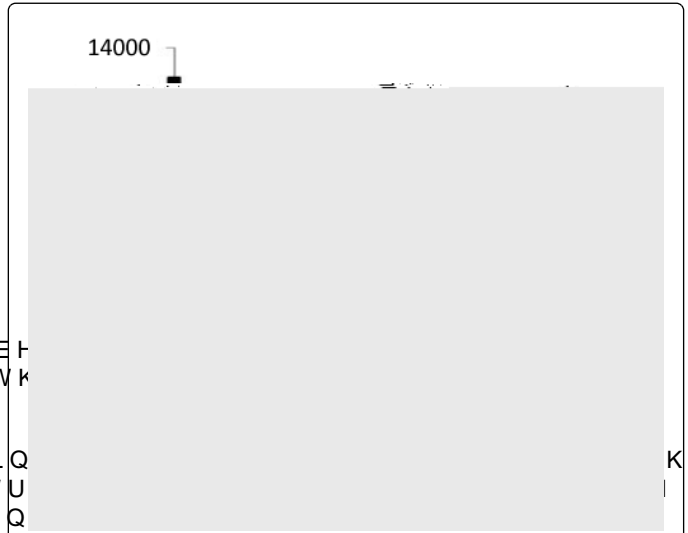
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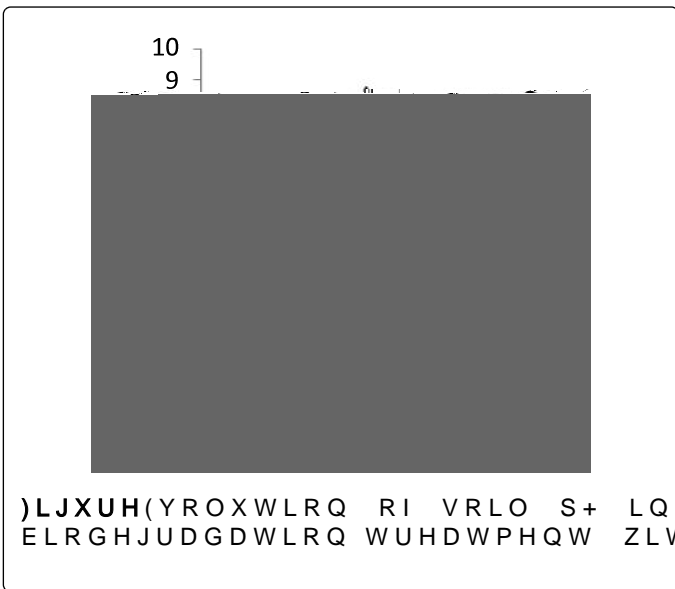


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 K\GURFDUERQV VROXELOLW\ SROOXWDQW
 OLFURFRVPV ZHUH NHSW DW URRP WHPSH
 ODERUDWRU\ LQFXEDWRU LQ RUGHU WR ID
 DQG PDVV WUDQVIHU



)LJXUH,QFUHDVH LQ PLFURELDO QXPEH
 PLFURFRVPV WULDO RYHU GD\V ZLWK

7KH S+ YDOXHV ZHUH VLPLODU ZLWKLQ KDG DO
 DYHUDJH RI LQ WZR PLFURFRVPV WU ILUVW
 GD\V RI WUHDWPHQW S+ VKRZHG DQ
 IURP WR LQ WZR V\WHPV UHVSHFWLYHO\ \$W WKH HQG RI WKLV SHULRG
 GD\V WKH S+ UDQJHG IURP WR)LJXUH DQG GHSHQGHG 73+ 3HWUROHX
 LQFUHDVHV LQ WKH WUHDWHG V\WHP \$W WKH HQG RI SURILOH FURURFURFRVP
 LQFUHDVH IURP WR \$IWHU GD\V RI WUHDWPHQW ZLWK QXKH S+ YDOXHV WKRXW
 GHFUHDVHG SURJUHVVLYHO\ IRU WKH WZR V\WHP DQG WKH DEDWHPHQW YDOXH
 UHDFKHG DQG UHVSHFWLYHO\)LJXUH 7KH DYHUDJH RI
 S+ FKDQJLQJ REVHUYHG ZDV FRQILUPHG 7KH VDPH UHYXOW RI UHHU HW DO
 > @ WKDW PLFURELDO FRPPXQLW\ LQ WKH WUHDWHG SURLOH FURURFURVP PJ NJ
 FRQWDPDQDWHG VRLO DUH LQIOXHQHGH LQ WKH WUHDWHG SURLOH FURURFURVP GD\
 ELRGHJUDGDWLRQ V\WHP WKH VDPH SURILOH FKDQJLQJ Z
 FRQFHQWUDWLRQ YDOXH UDQJHG IURP
 ILUVW V\WHP WKH 73+ FRQFHQWUDWLRQ
 WKH HQG RI WUHDWPHQW LW LV UHODWLY
 V\WHP ZKLFK KDYH DQ DYHUDJH RI
 VLPXODWLRQ SURFHVV LV VLJQLILFDQWO\
 > @ DQG > @ 8QH\SHFWHGO\ WKH G
 ELRGHJUDGDWLRQ EHWZHHQ WKH WUHDWH
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 OHYHO RI i aUHSURFHQWLQJ a2+ VWUHW
 JURXS DQG DOVR UHSURFHQWLQJ VWUHW
 JURXS ZHUH REVHUYHG 7KH HDN REPHUYHO
 ZDV LQGLFDWLYH RI WKH &a+ JURXS &RPS
 WZR V\WHPV)LJXUH DQG LW IRXQG
 + ERQGV DUH PDLQO\ GHJUDGHG LQ FF
 K\GURFDUERQV ERQGV GXH WR ERQGHG 2
 WKH WUHDWPHQW 7KLV FRXOG EH H\SO
 DURPDWLF IUDFWLRQ DUH GHJUDGHG LQ
 PULFRRE @ GXULQJ WKH €p d a Q SURFHV
 WK QXWULHQW ZLWKRXW QXWULHQW



)LJXUH(YROXWLRQ RI VRLO S+ LQ
 ELRGHJUDGDWLRQ WUHDWPHQW ZLWK

FRQFHQWUDWLRQ YDOXH UDQJHG IURP
 ILUVW V\WHP WKH 73+ FRQFHQWUDWLRQ
 WKH HQG RI WUHDWPHQW LW LV UHODWLY
 V\WHP ZKLFK KDYH DQ DYHUDJH RI
 VLPXODWLRQ SURFHVV LV VLJQLILFDQWO\
 > @ DQG > @ 8QH\SHFWHGO\ WKH G
 ELRGHJUDGDWLRQ EHWZHHQ WKH WUHDWH
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 KDQG 7KH)7,5 VSHFWUXP)LJXUH RI VK
 OHYHO RI i aUHSURFHQWLQJ a2+ VWUHW
 JURXS DQG DOVR UHSURFHQWLQJ VWUHW
 JURXS ZHUH REVHUYHG 7KH HDN REPHUYHO
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 WZR V\WHPV)LJXUH DQG LW IRXQG
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 WKH WUHDWPHQW 7KLV FRXOG EH H\SO
 DURPDWLF IUDFWLRQ DUH GHJUDGHG LQ
 PULFRRE @ GXULQJ WKH €p d a Q SURFHV
 WK QXWULHQW ZLWKRXW QXWULHQW

,Q RWKHU KDQG VRLO WHPSHUDWXUH DQG VRLO PRLVWXUH DIIHFV WKH NLQHW
 RI K\GURFDUERQ VRLO UHDFWLRQV GXULQJ WKH ELRUHPHGLDWLRQ SURFHVV
 OLFURELDO DFWLYLWLHV LQ VRLO LQYROYH HQ\PDWLF DQG ELRFKHPLFDO
 SURFHVVHV UHODWHG WR WHPSHUDWXUH VHQLWLHV

ORUHRYHU WKH DHURELF ELRGHJUDGDWLRQ RI K\GURFDUERQ FRPSRXQG LV
WKH PRGLILFDWLRQ DQG GHFRPSRVLWLRQ RI WKH FRPSRXQG E\ VRLO EDFWHULDO
WR SURGXFH XOWLPDWHO\ FHOZVWFWLQERQ GLR[LGH &2
PRGLILFDWLRQ LV FDUULHG RXW HQWLUHO\ E\ HQ]\PHV ORFDWHG ZLWKLQ WKH
PLFURELDO FHOOV 7KLV K\GURFDUERQ ELRGHJUDGDWLRQ LV D ELRORJLFDOO\

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PDMRU GHFRQWDPLQDWLRQ DERXW DSSUR[LDPDWLHQZRISSOQLFQV
VRLO UDWL RI KIGURFDUERQ UHPRYDO GULUDXOXDUEXHV RI 1WRPPDWPHQWJODQG
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HYDOXDWLRQ RI WKH LQ VLWX H[SHULPHQWDO SHUIRUPDQFHV DV IDFWRUV
DIIHFWLQJ WKH DELOLW\ RI WKH PLFURFHV IRU GHWRILDFWLRQ DQG 6RLO
UHKDELOLDWLRQ WKH KIGURFDUERQV LQ HQYLURQPHQW (FRORJ)

5HIHUUHQFHV

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RLO LQ ZDWHU \$FWD &KLPLFD 6ORYHQLFD GHWHUPLQDQJ SKRVSKRUXV LQ ZDWHU DQG
/HDK\ -* &ROZHOO 55 0LFURELDO GHJUDGLDWRQ RI KIGURFDUERQV LQ
WKH HQYLURQPHQW 0LFURELRO 5HY 3DUW &KPLFD DQG PLFURELRORJLFD SU
:ROLFND %LRGHJUDGDWLRQ 7KH 1DWXUDQ 0HWKRGLU/LTXLGDWLRQ
(QYLURQPHQWDO 3ROOXWHG E\ 3HWUROHXP PDWWHU 0HWKRGLU 6RLO \$QDQV 3DUV
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%LRGHJUDGDWLRQ
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RI VRLO RUJDQLF PDWWHU DQG EDFWHULDO FRPPXQLW\ VKLIW RQ ELRUHPHGLDWRQ
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%LRGHJUDGDWLRQ
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FRQWDPLQDWHG VHGLPHQWV LQ WKH 6XOWDQDWH RI 2PDQ DQG HYDOXDWLRQ RI
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