

Remediation of Cadmium Toxicity on Alfalfa (*Medicago sativa* L.) Using Biochar as a Bioadsorbent, *Rhizobium meliloti* and Arbuscular Mycorrhizal Fungi as Biofertilizers

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Rec date:

HfU'WfVc\XFUhgWbhhkUga YUg fYXVrhYa YhcXXYgM\VX
VnBi Vc]gYhiU"QSQ

A]bYFU'cbgWbhhkUga YUg fYXUhiC]ZK Uhf'UbX9bj]fcbA Ybh
FYgUfW=bg]h h'fCK '9'F"=Z5 [f]W/h fU'FYgUfW7YbfYZ9[nali

B]fc[Yb' kUg Xhfa]bYX i gbl' hY a cX] YX A]Mc!?' YXU'`
a YhcXQ%Q

D\cgl\cfi gkUgXhfa]bYXVmi gbl' j UbUXU'a c`nXU'Y'a YhcX
Q&Q

DcHgg] a' kUg a YUg fYX i gbl' Ua Y d\cra Yhf' UWWX]b['lc
A Yfch UbX7Y]UffUQ' Q

7UV'a UbXa U]bYgi a 'kYfYg]a UYXi gbl' =bX Wj Ymi7ci d`YX
GdYMc'a YfnDUga Uf#7DLA cXYI 'ha U&cV]bM]cb"

YhUbgcW]cb ZMcf fH LZcf 7Xk]h]b Ud'UbhikUgXhfa]bYX
lc' g'ck 7XhfUbgcW]cb dfcdMh]gZca 'fcclg'lc' gYXgQ(Q=hkUg
YdfYgXUg

H 1a YU'f]b'gYXg#a YU'f]b'fcclg"

GHg]W' UbUng]g kUg Wff]YX ci h UWWX]b['lc' hY a YhcX cZ
Wa d'Yf' fUbXca]nX VcWg Xg]b' f77F6G" 6UG]i gbl']kc!kUm
UbUng]g cZ j Uf]UbW 5BCJ5' Z`ckYX Vm 8i bWb]g Ai]hdY
7ca dU]gcb Hghi gbl' =6A 'GHg]W'DfcX WUbXGfj]WGe i HcbgZ
GGG' GHg]W'Zcf' K]bXckgZ JYfgcb' &" D 'S'S) 'UbX D 'S'S%kYfY
XfchXUgV]b['gUhg]W'mg]b] WbhZcf hYa YUbg'Wa dUfYzi gbl'
YUhg]b] WbhX] YfYW f'cS 'U) 'UbX% E.UWWX]b['lc' GbYXWf
UbX7cWfUbQ) Q

Physical Properties				Soil texture	pH	EC* Ms/cm	SP*(%)	Cations and anions (mg/Kg)							
Sand (%)	Silt (%)	Clay (%)	Coarse sand (%)					Na+	K+	Ca ⁺⁺	Mg ⁺⁺	Cl-	HCO ⁻	CO ₃ ⁻	SO ₄ ⁻
37.9	17.2	9.4	35.5	Sandy loams.	8	3.2	28	18.5	0.3	7.7	3.5	27.7	0.8	--	3.5

Results and Discussion

67 UbUnglffHUVY%Lg ck YX`lhYWbhhbhcZ< A g]b UvgnbWcZ7X' D`ngjW'UbXWYa]W' dfcdYfhYgcZh Yg:]`fHUVY&L]bX]WbXUgUbXm`cLá fC@:gfi Wí fyk]h` Ub`Y WUb[YU`Y7Uz? zA [`UbXBU

7cbWfb]b[`lc` [fckh`cZUZUZžh Yfyg`lg]bX]WbXUXY`mf]ci g]a dUWicZ%a A`7Xcb ZYg` UbXf`nkY[\hcZg`cclgUbXfclgffHUVY`E`]gfYX Wjcb`a] \hVYX Ylc`7Xi dH`Ydf]a Uf]`mhfci [\`fcclg Q*QCbYcZh Yj]HU`Wí gYcZd`Uhh[fckh`fYX Wjcb`i bXf`7X]gfYgg`lg`h`Y UhfUjcb`cZ`d`clcg`bh`Y]WY WbWñ UbX Wbg`ei Ybhñ U XWUgY]b`7C`&Ug]a]Ujcb`UbX`d`clcg`bh`Uhg`UWw`a`Ujcb`Q+Q CbYcZh Ych`Y`a`cgl]a`dcf]Uhhf`Y]g`bg`V\]bXh`Y`Ufa`Z`n]YXcZ UZUZ]cb`UZUZ] [fckh`lg`h`Y`X]a]b]g`]b[`cZYgg`bh]U`a]bYUg` Yfyg`lg]bX]WbXh`U`Yj`Yg`UbXfclg`WbhhbhcZBzDz? z7UUbXA [&

0 1998

XWUgX`Vñh`YY`WicZ%a A`7X7`&fHUVY(E`]ga] \hVYX Ylc`Wá d]h]jcb`Wk`Yb`7X`UbX`ch`Y`a`]bYUg`Zf`V]bX]b[`ghg`cf`HfUg`c`f`Hf`g`h`lg`YX`lc`a`]bYU`XY`WbWñ`cf`]a`VUUbW`UbX`Xdf`Ygg]cb`cZUZUZ] [fckh`"

-b`UX]hcbzh`Y`XWUgY`cZa`]Wicbi`H]Yblg`Wbhhbha`UnVYX`Ylc`h`Y`]bh`f`Z`f`Yb`WcZ7Xk]h`h`Yf`a`cj`]b[`dUk`UnZca`f`cclg`lc`gYXg`YfYX`Wjcb`]b`?`Z`i`dH`Y]b`Yj`Yg`UbXfclg`i`bXf`7X]gfYgg`a] \h`VYX`Ylc`h`Y`UbH]`cb]ga`Wk`Yb`7X`UbX`?`Z`]cbg`8`WUg]b[`cZa [`UbXB`Wbhhbhi`bXf`7X]gfYgg`^`UXUbY]`Uj`YY`Wicb`d`clcg`bh`Ygg`Wbg`ei`Ybhñ`d`Uhh[fckh`"K` \`Yb`d`Ublg`Ugc`f`V` \] \ `Lá`ci`bhicZ7Xž`h`Y`a`YU`Wí`gYc`cl`XUj`Y]b1`fm]c`h`Y`d`Uga`Ua`Ya`VUby`Q,`QUbX`fYX`WgB`i`dH`Y`Zhi`g`YXlc`X]gi`fV]b]h`Yb]f]c[`Yb`a`YUvc`]ga`i`bXf`7X]gfYgg`h`Uu`Y`Wd`Uhh[fckh`"

18

Treatments Cd (1 mM) Nitrogenase

hYUa Ybi]g' Ygn'lc' Uid'nā WYUd' UbX' gZY' cb' d'Ublz' g:]` UbX
Ybj]fcbA Ybl']g'kci' Xa UblUj'g:]`Zfj']hmUbX'd'Ublz'Ug'kY`Ug
UbjA U'UbX'i a Ub^YUh"

References

% :i':zK Ub['E'f88%L'FYa cjU'cZ\Yj'nia YU']cbg'Zca 'kUg'kUMg'>
9bj]fcb'A UbUj'Y- &'(S+!(%"
&' =fU'Yā '5GZ'G'Yā '55z'9!QhX'A:z<Ua UX'6<'f88%L'Qb['Y'cf
Wā V]bYXWZa]i a 'UbXUi a]bi a]blel]W]cb'cZa]W'j'f'UbX_]XbYm
k]h'dcg]VYY YM

(' " A Y fch`GE 7Y[UffU>f%- &L:7\Ya]W`Y HfUMU]lmcZ\Uj mia YUg
X f]b[UbXU Y`cb[Hfa`Udd]M]cbgcZgk U Ygi X| Ylc:gc]">Gc]"GW
(. ' %!' &%

((" Gc`ln9z; fY`Y`A`f88&L:5Wwa i`Ujcb`dfcdYf]YgcZ5g7Xz7i zDVUbX
Nb`VniZi f`k`YiUbX`d`UbhgY]Wg[fck]b[`cb`g`Va`Y[YX`a`]bYHU]b[g`

F\]rcVUMf]U fD, DF: UbX]lg=a dUMi cb' GcfU]Y Df]cX" A]XXY 9Ugh
xi fbU'cZ5dd]YXG]bVg*." +!', +"
, (" B]Yg 8< f%-)E YWVUz n]bV]UbX Wka]i a `Y i l`gg]a `7n567
Zca `5`W]]bYg Yi fcd\i g Z bW]cbg Ug U W]cb!dfcbb`Ub]dcf]f`]b