

**USE OF WASTE PRODUCTS TO ENHANCE PLANT PRODUCTIVITY ON
ACIDIC AND INFERTILE SUBSTRATES**

by

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TABLE OF CONTENTS

Acknowledgments	i
Declaration	ii
List of Tables	iii
List of Figures	v
Abstract	ix
Uitrekksel	xii
CHAPTER 1	
A review on soil acidification, soil nutrient depletion and the need for soil amelioration using coal combustion byproducts and organic wastes	1
Introduction	1
Nature and extent of acidification and soil nutrient depletion	4
Causes and effects of acidification	8
Purpose of amelioration	10
Methods and mechanisms of amelioration	16
The use of fly ash as a soil amendment	22
Effect of fly ash on soil properties.....	26
The effects fly ash have on plant growth.....	32
Agricultural utilization of biosolids	40
Heavy metal bioavailability in biosolid amended soils.....	48
The co-utilization of waste products to ameliorate acidic and nutrient depleted soils	53
References	71
CHAPTER 2	
Multiple cropping on soils treated with a mixture of sewage sludge, lime and class F fly ash (SLASH)	107

Abstract	107
Introduction	108
Materials and Methods	109
3 rd cropping cycle.....	110
4 th cropping cycle.....	110
5 th cropping cycle.....	111
6 th cropping cycle.....	111
Statistical analyses.....	111
Results and Discussion	112
Sunflower (<i>Helianthus sp. cv. ORIT</i>).....	112
Buffalo grass (<i>Cenchrus ciliaris cv. CPI 71914</i>).....	114
Sorghum (<i>Sorghum sp. cv. Hypergraze</i>).....	115
Rye (<i>Rye sp. cv. SSR 729</i>).....	117
Conclusion	119
References	120
CHAPTER 3	
The influence of a mixture of sewage sludge, fly ash and lime (SLASH) on the biomass production of two grasses and two legumes	122
Abstract	122
Introduction	123
Materials and Methods	125
Statistical analyses.....	127
Results and Discussion	127
White sweet clover (<i>Melilotus alba</i>).....	127
Kentucky bluegrass (<i>Poa pratensis</i>).....	131
Tall fescue (<i>Festuca arundinaceae</i>).....	133
Crown vetch (<i>Coronilla varia</i>).....	134

Conclusion	137
References	138

CHAPTER 4

Comparative study on the influence of SLASH and its individual components on the production of maize (<i>Zea mays</i>) and heavy metal accumulation	140
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Abstract	140
Introduction	141
Fly ash.....	142
Biosolids.....	143
Alkaline biosolids.....	144
Materials and Methods	145
Statistical analyses.....	147
Results and Discussion	147
Conclusion	152
References	154

CHAPTER 5

Forage production from cereal and grain crops, on fly ash – biosolid amended soil	160
--	------------

Abstract	160
Introduction	161
Materials and Methods	163
Statistical analyses.....	165
Results and Discussion	165
Conclusion	171
References	172



CHAPTER 6

Influence of a fly ash – biosolid mixtures on soil chemical

properties.....	174
Abstract.....	174
Introduction.....	175
Fly ash.....	175
Biosolids.....	176
Biosolid-fly ash mixtures.....	177
Experimental procedures.....	179
Results and Discussion.....	181
pH (H ₂ O).....	181
Phosphorus (P).....	185
Calcium (Ca).....	186
Potassium (K).....	188
Magnesium (Mg).....	189
% C and CEC.....	190
Conclusion.....	190
References.....	191

CHAPTER 7

General conclusions and recommendations.....	198
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DECLARATION

I, Wayne Frederick Truter, hereby declare that this dissertation for the degree M.Sc.Agric. (Pasture Science) at the University of Pretoria, is my own work and has never been submitted by myself at any other university.

A handwritten signature in black ink, appearing to read 'W.F. Truter', written over a horizontal line.

W.F.Truter

May 2002

LIST OF TABLES

CHAPTER 2

Table 1 : The mean dry matter production (g/pot) of sunflower (<i>Helianthus sp. cv. ORIT</i>) in response to various SLASH treatments.....	114
Table 2 : The mean dry matter production (g/pot) of buffelgrass (<i>Cenchrus ciliaris cv. CPI 71914</i>) on soils amended with different levels of SLASH.....	115
Table 3 : The mean dry matter production (g/pot) of sorghum (<i>Sorghum sp. cv. Hypergraze</i>) in response to different SLASH treatments.....	117
Table 4 : The mean dry matter production (g/pot) of rye (<i>Secale cereala cv. SSR729</i>) on soils treated with various levels of SLASH.....	118

CHAPTER 3

Table 1 : The mean dry matter production (g/pot) of white sweet clover (<i>Melilotus alba</i>) on soil amended with different levels of SLASH.....	128
Table 2 : The mean dry matter production (g/pot) of Kentucky bluegrass (<i>Poa pratensis</i>) as influenced by SLASH.	132
Table 3 : The mean dry matter production (g/pot) Tall fescue (<i>Festuca arundinaceae</i>) in response to various SLASH treatments.....	134
Table 4 : The mean dry matter production (g/pot) of Crown vetch (<i>Coronilla varia</i>), in two consecutive winter growing seasons, as influenced by SLASH.....	136

Table 5 : Dry matter production (g/pot) of Crown vetch (<i>Coronilla varia</i>), in two consecutive summer growing seasons, as influenced by SLASH.....	136
--	------------

CHAPTER 4

Table 1 : Dry matter production (g/plant) of maize (<i>Zea mays</i>) at different stages on soils treated with SLASH (T2-T5), sewage sludge (T6), fly ash (T7) and lime.....	148
Table 2 : The mean elemental concentration of maize leaves (mg kg^{-1}) grown on SLASH (T2-T5), sewage sludge (T6), fly ash (T7) and lime (T8) treated soils.....	151
Table 3 : The mean elemental concentration of maize grain (mg kg^{-1}) grown on SLASH (T2-T5), sewage sludge(T6), fly ash (T7) and lime (T8) treated soils.....	152

CHAPTER 5

Table 1 : Influence of sewage sludge, lime and fly ash individually and in combination (SLASH) on the mean dry matter production (g/net plot) of the cereal crop Triticale (<i>Triticale hexaploid</i>) ~ 350 days after the treatment application and preceded by two cropping cycles,	166
Table 2 : Influence of sewage sludge, lime and fly ash individually and in combination (SLASH) on the mean dry matter production (g/net plot) of sorghum (<i>Sorghum sp. cv Hypergraze</i>).....	168

Table 3 : Influence of sewage sludge, lime and fly ash individually and in combination (SLASH) on the mean dry matter production (g/net plot) of winter rye (<i>Secale cereale</i> cv. SSR729).....	169
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LIST OF FIGURES

CHAPTER 2

Figure 1 : Response of sunflower (<i>Helianthus sp.</i> cv. ORIT) to SLASH treated soils.....	112
Figure 2 : Influence of SLASH on the mean number of inflorescences of sunflower (<i>Helianthus sp.</i> cv. ORIT).....	113
Figure 3 : The mean length measurements (cm) of sunflower (<i>Helianthus sp.</i> cv. ORIT) in response to different SLASH levels.....	114
Figure 4 : Root development of buffelgrass (<i>Cenchrus ciliaris</i> cv. CPI 71914) in soils treated with SLASH.....	116
Figure 5 : Root development (g/pot) of sorghum (<i>Sorghum sp.</i> cv. Hypergraze) in SLASH treated soils.....	117

CHAPTER 3

Figure 1 : Influence of SLASH on sweet clover (<i>Melilotus alba</i>) seedling survival.....	128
Figure 2 : Sweet clover (<i>Melilotus alba</i>) response to SLASH treated soils relative to the control.....	129
Figure 3 : Root development (g/pot) of sweet clover (<i>Melilotus alba</i>) as influenced by SLASH.....	130

Figure 4 : Sweet clover (<i>Melilotus alba</i>) root development on SLASH treated soils.....	130
Figure 5 : The influence of SLASH on the density rating of Kentucky bluegrass (<i>Poa pratensis</i>).....	131
Figure 6: Root development (g/pot) of Kentucky bluegrass (<i>Poa pratensis</i>) as influenced by different levels of SLASH.....	133
Figure 7 : Crown vetch (<i>Coronilla varia</i> cv. Penngift) growth on SLASH treated soils relative to the control.....	135

CHAPTER 4

Figure 1 : Illustration of the raised beds planted to maize (<i>Zea mays</i>).....	146
Figure 2 : Maize grain production (g/plant) on soils treated with SLASH (T2-T5), sewage sludge (T6), fly ash (T7), and lime (T8) relative to the control.....	149
Figure 3 : % N in leaf and grain material of maize (<i>Zea mays</i>) produced on soils ameliorated with different levels of SLASH (T2-T5), sewage sludge (T6), fly ash (T7) and lime (T8).....	149
Figure 4 : % P in leaf and grain material of maize (<i>Zea mays</i>) produced on soils ameliorated with different levels of SLASH (T2-T5), sewage sludge (T6), fly ash (T7) and lime (T8).....	150

CHAPTER 5

Figure 1 : Raised bed illustration.....	164
--	------------

Figure 2 : The total dry matter production (g/net plot) in the winter growing season of Triticale (<i>Triticale hexaploid</i>) in response to SLASH and it's individual components.....	167
Figure 3 : The total dry matter production (g/net plot) in the summer growing season of sorghum (<i>Sorghum sp. cv. Hypergraze</i>) in response to SLASH and it's individual components.....	169
Figure 4 : The total dry matter production (g/net plot) in the winter growing season of rye (<i>Secale cereala cv. SSR729</i>) in response to SLASH and it's individual components.....	170

CHAPTER 6

Figure 1 : Increase/decrease of pH (H ₂ O) units of soils treated with a mixture of sewage sludge, fly ash and lime in combination (SLASH) and separately, relative to the control, 180 days after treatment application.....	181
Figure 2: Increase/decrease of pH (H ₂ O) units of soils treated with a mixture of sewage sludge, fly ash and lime in combination (SLASH) and separately, relative to the control, 360 days after treatment application.....	182
Figure 3 : Increase/decrease of pH (H ₂ O) units of soils treated with a mixture of sewage sludge, fly ash and lime in combination (SLASH) and separately, relative to the control, 540 days after treatment application.....	183

Figure 4 : Increase/decrease of pH (H ₂ O) units of soils treated with a mixture of sewage sludge, fly ash and lime in combination (SLASH) and separately, relative to the control, 750 days after treatment application.....	184
Figure 5 : Increase/decrease of pH (H ₂ O) units of soils treated with a mixture of sewage sludge, fly ash and lime in combination (SLASH) and separately, relative to the control, 930 days after treatment application.....	184
Figure 6 : Influence of SLASH, sewage sludge, fly ash and lime on the P content (mg kg ⁻¹) of soils relative to the control, over time.....	185
Figure 7 : Influence of SLASH, sewage sludge, fly ash and lime on the Ca content (mg kg ⁻¹) of soils relative to the control, over time.....	187
Figure 8 : Influence of SLASH, sewage sludge, fly ash and lime on the K content (mg kg ⁻¹) of soils relative to the control, over time.....	188
Figure 9 : Influence of SLASH, sewage sludge, fly ash and lime on the Mg content (mg kg ⁻¹) of soils relative to the control, over time.....	190

ABSTRACT

Use of waste products to enhance plant productivity on acidic and infertile substrates

by

Wayne Frederick Truter

Supervisor: Prof. Norman F.G. Rethman

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in the Department of Plant Production and Soil Science

Excessive soil acidity and soil infertility is a continuing problem in many agricultural areas of South Africa, and is becoming an increasingly important limiting factor. Although liming is usually an effective counter to soil acidification and inorganic fertilizers a method to correct infertile soils, liming and intensive fertilization does not always make economic sense, when there are alternatives. Many low-input agricultural systems (e.g. subsistence farming practices, extensive grazing lands and many recreational management practices) cannot use large amounts of lime and fertilizer and remain economically viable. Practices, which focus on reducing inputs, provide an important link between the

needs of commercial farmers and those involved in recreational services or subsistence agriculture. With commercial systems, the aim is to reduce inputs for economic/environmental reasons. Subsistence farmers have similar aims, but, in this case, it is often because they have restricted access to inputs.

Coal combustion by-products (CCB's) and organic wastes are produced annually in vast amounts and are disposed of in various environmentally hazardous ways. Increased cost and new environmental legislation have prompted research into alternative methods of safe disposal or utilization of these waste materials. It is, therefore, a significant challenge to address these scenarios to the benefit of all parties involved. Coal combustion by-products, particularly fly ash, and organic wastes such as sewage sludge, or animal manures have been widely used as cost effective amendments for acid and infertile soils.

Both fly ash and sewage sludge have limitations as solitary amendments. The use of fly ash as a soil amendment is hindered by a lack of macro-nutrients in the ash and concerns about high B levels causing toxicity, while land application of sewage sludge is restricted due to it's pathogenicity and often high heavy metal content.

Technology has been developed to combine sewage sludge and fly ash to provide a soil ameliorant, which is termed SLASH. SLASH has definite agricultural potential. This ameliorant has enhanced yields of various crop species including ornamental sunflowers, various grasses, legumes, forage crops, and even grain crops, dramatically. It has improved soil chemical properties including pH levels, higher macronutrient and micronutrient levels, improved microbial populations, increased soil organic matter, and has resulted in improved physical soil properties. All these factors contribute to a better soil environment for essential root development to ensure good quality, high yielding crop production. Various studies were conducted in this SLASH programme to identify optimal application rates, tolerances and sensitivities to the waste product mixture, expected yield index values, as well as comparisons with the

individual waste products used in the SLASH mixture. Conclusions from these studies have identified gaps in our knowledge and raised further questions regarding the use of SLASH in agricultural practices necessitating ongoing research. However, based on the results obtained from this study it is concluded that SLASH is a recommended soil ameliorant for acidic and infertile soils with good management.

UITTREKSEL

Gebruik van afvalprodukte om plant produktiwiteit op suur en onvrugbare substrate te verbeter.

deur

Wayne Frederick Truter

Leier: Prof. Norman F.G. Rethman

Voorgelê ter vervulling van 'n deel van die vereistes vir die graad

M.Sc. (Agric) Weidingkunde

in die Departement Plant Produksie en Grondkunde

Oormatige grond versuring en grond onvrugbaarheid is 'n voortdurende probleem in verskeie landbou areas van Suid-Afrika, en is besig om 'n groter beperkende faktor te word. Alhoewel kalk gewoonlik 'n effektiewe teenwerking vir versuurde grond is en anorganiese bemesting 'n metode om onvrugbare grond reg te stel is, maak bekalking en intensiewe bemesting nie altyd ekonomies sin nie, veral wanneer daar alternatiewe is. Baie lae-inset landbou sisteme, (bv. selfversorgende boerderye, oormatig beweiende lande en verskeie ander ontspannings bestuurs praktyke), kan nie groot hoeveelhede kalk en kunsmis gebruik en steeds ekonomies lewensvatbaar bly nie. Praktyke wat daarop gefokus is om insette te verminder, verskaf 'n belangrike skakel tussen die

behoefte van die kommersiële boer en dié betrokke by ontspannings dienste of selfversorgende landbou. Die doel van kommersiële sisteme is om die insette te verminder, vir ekonomiese of omgewings redes. Selfversorgende boere het soortgelyke doelwitte, maar in dié geval is dit dikwels weens beperkte toegang tot insette.

Steenkool verbrandings neweprodukte en organiese afvalstowwe word jaarliks in groot hoeveelhede geproduseer en word weggedoen op verskeie omgewings-onvriendelike/gevaarlike maniere. Alternatiewe metodes van veilige wegdoening, of verbruik, van hierdie afval produkte word aangemoedig deur verhoogde kostes en nuwe omgewings wetgewing. Dit is daarom 'n betekenisvolle uitdaging om hierdie scenarios aan te spreek tot voordeel van al die betrokke partye. Steenkool verbrandings neweprodukte, meer spesifiek vliegass, en organiese afval materiaal soos rioolslyk of dierlike misstowwe, is reeds wyd gebruik as koste effektiewe herstelmiddele vir suur en onvrugbare grond.

Beide vliegass en rioolslyk het sekere beperkinge as alleenstaande herstelmiddele. Die gebruik van vliegass as 'n grond herstelmiddel word ingeperk deur 'n tekort aan makro-nutriënte in die ass en 'n bemoeidheid met hoë B vlakke wat toksisiteit kan/mag veroorsaak. Die landelike toediening van rioolslyk word dikwels deur die patogenisiteit en hoë swaar metaal inhoud daarvan beperk.

Tegnologie is ontwikkel wat rioolslyk en vliegass kombineer om sodoende 'n grond herstelmiddel, naamlik SLASH, te verskaf. SLASH het besliste landou potensiaal. Hierdie herstelmiddel het die opbrengs van verskeie gewasse dramaties verbeter, insluitend ornamentele sonneblomme, verskeie grasse, peulplante, voergewasse, en selfs graan gewasse. Dit het die chemiese eienskappe van grond verbeter, insluitend die pH vlakke, makro- en mikro-nutriënt vlakke, mikrobiële populasies en organiese materiaal. Dit het selfs die fisiese eienskappe van grond verbeter. Al hierdie faktore dra by tot 'n beter grond omgewing vir essensiële wortelontwikkeling om sodoende goeie kwaliteit, hoë opbrengs gewasse te verseker. Verskeie studies is aangevoer in hierdie SLASH program om sodoende die optimale toedieningsvlakke, toleransies en



sensitiwiteit vir die afval produk mengsel, verwagte opbrengs indeks waardes, asook vergelykings met individuele afvalprodukte gebruik in die SLASH mengsel, vas te stel. Gevolgtrekkings van hierdie studies het gapings in ons kennis geïdentifiseer en verdere vrae gelig aangaande die gebruik van SLASH in landbou praktyke, wat dus verdere navorsing nodig maak. Op grond van die resultate verkry uit hierdie studie, word daar egter tot die slotsom gekom dat SLASH met goeie bestuur 'n aanbevole grond herstmiddel is vir suur en onvrugbare gronde.