AN EVALUATION OF AMENDMENTS TO REDUCE HARDSETTING IN A SODIC DUPLEX SOIL UNDER SUGARCANE PRODUCTION

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Abstract

Sodic duplex soils are widely distributed on the Australian east coast and 15% of canelands are sodic. The objective of this project was to identify potential treatments for reducing hardsetting in such soils, which could be reasonably implemented at the farm level. Surface soil (0–25 cm) was treated with a range of calcium, horizon modification, organic matter (OM) and soil conditioner treatments. Ameliorated soils were wet to field capacity and incubated, followed by measurement of the soil strength characteristic as they dried. Sand, filterpress and polyacrylamide (PAM) treatments markedly reduced strength development and were recommended for further trials at farm level. Treatments which mixed surface and subsurface soil, or which were puddled to simulate wet cultivation, developed strength rapidly and to a greater degree than the control and should be avoided in farm practice.

Introduction

Sodic duplex soils are widely distributed in eastern Australia, and intensified land use has led to increased use of such marginal soils for sugar production. The productivity of these soils is naturally limited, while poor industry returns currently constrain corrective expenditure. The objective of this study was to identify potential treatments that reduce hardsetting on these soils and which could reasonably be implemented by farmers.

Materials and methods

Site description

The sample soil was a duplex/sodosol obtained from a sugarcane farm near Bundaberg, Queensland. The site was affected by waterlogging, cultivation was difficult, and crop yield reduced. Soil sodium (3.9 meq/100 g) and ECse (0.2 S/m) levels were high and increased with depth, while calcium:magnesium ratio (0.99) and soil OM (1.3%) were low.

Characterising hardsetting behaviour of soils

Surface soil (0–25 cm) was subjected to a range of calcium, horizon modification, OM addition and soil conditioner treatments simulating the effects of potentially useful management practices in three experiments (Table 1). Treatments were applied at field rates to sieved soil in small containers, and incubated at field capacity under constant temperature and evaporative conditions for 21 d. Duplicate OM treatments were saturated and stirred with a glass rod for 60 s before incubation to simulate the effect of wet cultivation on soil hardsetting properties. Following incubation, soil strength development was measured for 6 d as the soil dried using the method proposed by Daquiado (1998).

Contrary to field experience, soil strength was not reduced by gypsum application in Experiment 1, so the effect of gypsum on hydraulic conductivity (K) of the soil was also investigated.

Results

Experiments 1–3 identified the filterpress, sand and PAM treatments, in that order, as the most effective ameliorants in reducing hardsetting (Figure 1(a)). Although calcium treatments had little effect on soil strength in any soil texture combination (data not presented), K improved approximately 40-fold in surface and subsurface soil treated with saturated gypsum solution (Figure 1(b)).

| Table 1—Treatments applied to simulate management practices. |
|---------------------------------|---------|--------|---------|
| Texture¹ | Rate (7.5 t/ha) | OM² | Rate | Soil conditioner³ | Rate |
| 100% A | Gypsum | Soybean | 4 t/ha DW | AgriSC | 600 mL/ha |
| 100% B | Lime | Sorghum | 10 t/ha DW | Molasses | 3 t/ha |
| 50%A:50%B | | Fprs | 160 t/ha FW | PVA | 0.05% w/w |
| 75%A:25% sand | | | | PAMs | 10–30 kg/ha |

¹A, surface soil; B, subsurface soil.
²OM, organic matter; DW, dry weight of tops; FW, fresh weight; Fprs, filterpress.
³AgriSC, commercial soil conditioner; PVA, polyvinyl alcohol; PAM, polyacrylamide applied with gypsum 5 t/ha.

KEYWORDS: Hardsetting, Sugarcane, Polyacrylamide, Filterpress.
hence soil strength was lowered by diluting A horizon soil with coarse sand. Further management of soil texture to limit hardsetting due to sodicity was possible by minimising mixing between surface and subsurface horizons. Raising the proportion of subsurface soil was also undesirable due to high EC and low pH of this soil.

Low organic matter

Raising the low soil OM levels in this farming system was difficult due to frequent cultivation, and rapid development of the soil strength in all stirred OM treatments reinforced the importance of avoiding wet cultivation. OM appeared to be more effective when applied in large quantities, although similar effects of filterpress and sand indicated that a trade-off between duration of benefits and ease of application existed. However, repeated filterpress application has been associated with heavy metal accumulation, so fallow break crops should be further investigated at the field level.

Waterlogging

Waterlogging was a limitation of the soil due to its duplex structure, occurring regardless of sodicity. The lack of opportunity to increase depth by mixing with subsoil indicated that irrigations of lower volume and higher frequency were desirable. Where this is not possible, improved drainage should be sought by gypsum application or use of PAM. Lack of response of soil strength to gypsum in this experiment was atypical, possibly due to a lack of drainage to leach sodium from ameliorated soils. However, soil K increased substantially in response to gypsum, indicating that improved drainage should result in the field where gypsum applications to the row extend to drains.

Conclusion

Potentially useful practices identified for the management of hardsetting in sodic duplex soils in this region include (a) avoidance of cultivation or laser levelling which mixes surface with subsurface soil, (b) cultivation at appropriate water content, (c) the application of filterpress and (d) the application of other ameliorants such as PAM and gypsum (Meier, 2001). Field trials are recommended to evaluate these treatments.

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REFERENCES


UNE EVALUATION DES AMENDEMENTS POUR REDUIRE LE DURCISSEMENT DES SOLS SODIQUES SOUS CULTURE DE LA CANNE A SUCRE

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Résumé
Les sols sodiques duplex sont très répandus sur la côte ouest australienne et 15% des terres sous canne sont sodiques. Ce projet fut entrepris afin d’identifier des traitements potentiels pour réduire le durcissement de ces terres. Ces traitements devraient aussi être à la portée des fermiers. La couche arable de ces terres (0-25 cm) fut amendée avec une gamme de produits calciques, de la matière organique et de conditionneurs chimiques et finalement par une modification du profil du sol. Les sols traités furent humidifiés à un taux correspondant à la capacité au champ pour être ensuite incubés. Les caractères de résistance du sol sont constamment mesurés durant le dessèchement. Les apports de sables, des écumes (filterpress) et de polyacrylamide (PAM) ont nettement réduit le durcissement des sols déshydratés. Cependant le mélange de la couche arable au sous-sol, et les sols soumis au puddlage simulant le travail d’un sol très humide durcissaient plus rapidement et furent à un certain degré supérieurs au témoin. Donc ces pratiques devraient être abandonnées.

Mots clés: Durcissement, canne à sucre, polyacrylamide, écumes.

ENMIENDAS PARA REDUCIR EL ENDURECIMIENTO EN SUELOS SÓDICOS EN PRODUCCIÓN DE CAÑA

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Resumen
Los suelos duplex y sódicos tienen una amplia distribución en la costa este de Australia en donde el 15% de los suelos son sódicos. El objetivo del presente proyecto consistió en identificar los tratamientos potenciales para reducir el endurecimiento de estos suelos, lo cual se puede realizar de manera razonable en la finca. La superficie del suelo (0-25 cm) fue tratada con calcio, materia orgánica y con acondicionadores del suelo. Los suelos recuperados fueron humedecidos a capacidad de campo y luego incubados; posteriormente se realizaron lecturas de dureza en la medida en que el suelo se secó. A Los tratamientos con arena, cachaza y poliacrilamida (PAM) redujeron de manera marcada la resistencia y fueron recomendados para ensayos posteriores en las fincas. Los tratamientos en los que se mezcló el suelo superficial y subsuperficial, o los que fueron amasados simulando el cultivo en condiciones húmedas, se endurecieron rápidamente y en mayor escala que el testigo, razón por la cual se debe evitar esta práctica.