EFFECTS OF SUBSOILING ON ALFISOL SOIL PHYSICAL PROPERTIES IN COLOMBIA

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KEYWORDS: Subsoiler, Tillage,
Physical Properties, Cane Sugar, Soil.

Abstract

A STUDY was conducted to evaluate the effects of subsoiling on the soil physical properties in the Providencia Sugar Mill S.A. in Colombia. A Steiger tractor of 225 HP and parabolic subsoiler were used with different velocities (3.0 to 4.2 km/h) and spacing between shanks (1.1 to 1.4 m). The soil studied was an Alfisol of the Argelia series with clay texture. The soil properties, namely available water capacity, breaking area, moisture content and lower limit of plasticity, were measured to a depth of 80 cm. Average soil moisture content at the time of the test (13.0%) was below the lower plastic limits (18.10%) in the 0–30 cm layer. When the spacing between shanks was decreased and velocity increased, breaking area increased from 1.4 m^2 to 1.6 m^2 and available water content was increased from 16.64% to 20.13%. In conclusion, the subsoiling tillage increased the breaking area and available water content when spacing between shanks was 1.1 m and velocity was 4.2 km/h and decreased soil compaction in an Alfisol soil.

Introduction

Soil compaction is generated by machinery traffic during harvest and agricultural operations. This compaction is related to the moisture content in the soil. Compaction modifies the soil physical properties such as bulk density, penetration resistance, infiltration, available water capacity and can create problems of crop development and decreased production.

To reduce soil compaction, subsoiling is used during soil preparation and also in ratoons. The soil preparation is carried out before planting by two passes to increase the broken area and by one pass between the rows in ratoons.

Factors influencing the soil breaking of the subsoiler are: moisture content, velocity of the tillage, depth and spacing between shanks, design of the implement. This study evaluated the subsoiler use in tillage of sugarcane crops and its effect on soil physical properties such as available water capacity and breaking area.

Material and methods

The trial was carried out in Topacio farm near to Providencia sugar mill in Colombia. The soil is Argelia (Alfisol) with clay texture. A 225 HP tractor was used with parabolic shaped subsoiler. Distances between shanks were: S1=1.1 m, S2=1.3 m and S3=1.4 m, working at a depth of 0.60 m. The working velocity varied between V1=3.20, V2=3.7 and V3=4.15 km/h. The trial plots had an average area of 2 ha.

A hole with dimensions 3x0.80 m and depth 0.80 m was built. A cone penetrometer was used to measure the compaction every 0.20 m and the effect on the soil in the breaking area was determined. The moisture content was measured with pressure plates and rings by the Casagrande method (Gonzales, 1979). The soil samples were evaluated at 0–30 and 30–60 m layers.

The parameters assessed were: penetration resistance, moisture content, available water capacity, plastic limits and the area of breaking by the subsoiler. A 5% probability level was used to test the significance of differences between treatments. The soil samples were evaluated in the soil laboratory of the National University of Colombia.

Results and discussion

Moisture content

Table 1 shows that, in the 0–60 cm layer in the different trials, the moisture content (MC) was lower than the lower plastic limit (LPL). The subsoiling was in the friable range at the 0–60 cm layer, according to the study by Asae (1971), Bukhari (1990), Girón (1992), Gavande (1987) and Chancellor (1971).

Table 1—Moisture content (%).

TEST	Layer	
	0–30	30–60
L.P.L.	18.10	31.78
V1–S1	13.93	11.12
V2–S1	15.88	11.70
V3–S1	12.44	11.20
V1–S2	13.95	10.96
V2–S2	10.52	10.66
V3–S2	11.02	11.32
V1–S3	13.61	14.53
V2–S3	13.84	14.18
V3–S3	11.74	11.09

Penetration resistance

The values decreased in general with respect to initial values (Table 2). These values were 12.41 kg/cm^2 in the 0–20 cm layer and decreased to 0.27 kg/cm^2 in 0–20 cm layer in V1-S1. This shows that subsoiling is beneficial for breaking the soil and agrees with Adeoye (1982), Asae (1971) and Chancellor (1971).

Table 2—Penetration resistance (kg/cm^2).

Test	Layer–cm			
	0–20	20–40	40–60	60–80
Initial	12.41	3.20	0.76	0.76
V1-S1	0.27	0.59	0.28	0.69
V2-S1	0.41	0.70	0.94	0.70
V3-S1	1.70	0.97	1.65	0.67
V1-S2	0.76	1.23	1.61	1.15
V2-S2	0.47	1.24	1.73	1.18
V3-S2	1.26	1.46	2.09	1.18
V1-S3	1.56	1.07	0.79	1.44
V2-S3	1.39	0.70	1.04	1.44
V3-S3	1.85	0.81	1.37	1.44

Breaking area

Table 3 shows values of the breaking area in different trials. The breaking area decreased when distance between shanks of 1.56 m^2 in V3-S1 to 1.17 m^2 in V3-S3 increased. With increased velocity, the breaking area increased from 1.47 m^2 in V1-S1 trial to 1.56 m^2 in V3-S1. The breaking area increased with a lower spacing between shanks and higher velocity. Similar data were found by Hendrick and Gill (1973), Ide *et al.* (1987) and Rodriguez (2008).

Table 3—Breaking area (m^2).

Test	m^2
V1–S1	1.473
V2–S1	1.505
V3–S1	1.561
V1–S2	0.903
V2–S2	1.050
V3–S2	1.185
V1–S3	0.876
V2–S3	0.954
V3–S3	1.173

Available water capacity

The initial value was 11.11% in the 0–30 cm layer (Table 4). The available water capacity (AWC) increased when the separation between shanks of the subsoiler decreased and with an increase in the velocity. This value ranged from 16.64% in V1-S1 to 20.13% in V3-S1 trial, in the 0–30 cm layer. Studies by Asae (1971) and Girón found increases in AWC.

Table 4—Available water capacity (%).

Test	Layer (cm)	
	0–30	30–60
Initial	11.11	12.55
V1-S1	16.64	6.37
V2-S1	18.72	8.62
V3-S1	20.13	11.18
V1-S2	9.18	10.03
V2-S2	9.57	11.60
V3-S2	15.03	13.46
V1-S3	7.62	10.73
V2-S3	9.40	11.52
V3-S3	13.08	12.54

Conclusions

The subsoiling in soil preparation reduces the compaction of the soils.

High velocity tillage and lower spacing between shanks increases the breaking area and available water capacity.

The moisture content in soil should be lower than the lower plastic limit for good performance of the subsoiler.

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EFFETS DU SOUS-SOLAGE SUR LES PROPRIETES PHYSIQUES D'UN ALFISOL EN COLOMBIE

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**MOTFS CLES: Sous-Soleur, Travail du Sol,
Propriétés Physiques, Canne à Sucre, Sol.**

Résumé

AFIN D'ÉVALUER les effets du sous-solage sur les propriétés physiques du sol, une étude a été réalisée sur le site de la Providencia Sugar Mill S.A. en Colombia. Un sous-soleur parabolique tracté par un tracteur Steiger de 225 HP a été utilisé à différentes vitesses (3.0 et 4.2 km/h) et espacements (1.1 et 1.4 m) entre étançons. Le sol étudié était un Alfisol à texture argileuse de la série Argélia. Les propriétés du sol, c'est-à-dire la capacité en eau disponible, la surface de cassure, la teneur en eau et la limite inférieure de plasticité ont été mesurées jusqu'à une profondeur de 80 cm. La teneur en eau moyenne au moment du test (13%) était inférieure à la limite inférieure de plasticité (18%) dans la couche 0–30cm. La diminution de l'espacement et l'augmentation de la vitesse ont entraîné des augmentations de la surface de cassure de 1 .4 m^2 à 1.6 m^2 et de la teneur en eau disponible de 16.4% à 20.13%. En conclusion, le sous-solage en diminuant l'écartement et en augmentant la vitesse, augmente la surface de cassure, la teneur en eau disponible du sol et diminue la compaction d'un Alfisol.

EFECTOS DEL SUBSOLADO SOBRE LAS PROPIEDADES FISICAS DE UN SUELO ALFISOL EN COLOMBIA

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Resumen

SE REALIZO un estudio para evaluar los efectos del subsolado sobre las propiedades físicas del suelo en el ingenio Providencia S.A. en Colombia. Se utilizó un tractor Steiger de 225 HP y un subsolador parabólico, a distintas velocidades (3.0–4.2 km/h) y diversos espacios entre brazos (1.1 a 1.4 m). El suelo bajo estudio fue un Alfisol de la serie Argelia con textura arcillosa. Las propiedades del suelo, tales como capacidad de retención de agua, área de ruptura, contenido de humedad y límite mínimo de plasticidad se midieron a una profundidad de 80 cm. El contenido de humedad promedio en el suelo al momento de la evaluación (13.0%) estaba debajo de los límites mínimos de plasticidad (18.10%) en la capa de 0–30 cm. Cuando se redujo el espacio entre los brazos del subsolador y se aumentó la velocidad, se incrementó el área de ruptura de 1.4 m^2 a 1.6 m^2 y el contenido de agua disponible se incrementó de 16.64% a 20.13%. En conclusión, el subsolado incrementó el área de ruptura y el contenido de agua cuando se dejó un espacio entre los brazos del implemento de 1.1 m y se trabajó a una velocidad de 4.2 km/h, y se redujo la compactación de un suelo Alfisol.