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SOIL COMPACTION AND CROP ROTATION EFFECTS ON SOIL PARAMETERS AND SOYBEAN YIELD IN DIRECT DRILLING SYSTEMS

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The objective of this work was to evaluate soil compaction and crop rotation effects on soil parameters and soybean yield in grain fields managed under direct drilling systems. Five no-tillage soil management situations were studied to evaluate soil compaction degree and other related soil physical properties, in fields located at four sites on the Chacopampeana Plains, province of Tucumán, Argentina. The assessed situations were: (N): 'new soils', planted with soybean for less than 5 years under no tillage management; (SS): continuously planted with soybean for over 10 years, under no tillage management; (SC): soybean/corn rotation for over 10 years, under no tillage; (SS+DVT): planted with soybean for over 10 years, under no tillage and under deep vertical tillage before sowing and (SC+DVT): soybean/corn rotation for over 10 years, under no tillage and under deep vertical tillage. The parameters evaluated before sowing were: bulk density (BD), maximum bulk density (BDmax), macroporosity, penetration resistance (PR), crop residues, rate infiltration (I), organic matter (OM), and soybean yield.

In topsoil, OM was significantly higher in N than in SS and SS+DVT, while SC and SC+DVT showed intermediate values at all sites. DVT showed a significantly lower crop residue amount than treatments without DVT. Nonetheless, despite the use of DVT, SC had higher crop residue levels than SS in all locations. The upper 20 cm BD was higher in all situations without DVT except in N, probably because the land had been cultivated only for a few years. In most situations, relative apparent density did not exceed the value of 90%, considered critical for normal soybean root growth. PR was significantly lower in SS+DVT and SM+DVT than in SS and SM, respectively. Infiltration rates (I) were significantly higher in DVT than in those situations without tillage. However, N had the highest (I), probably due to the conservation of the soil porous system. Average soybean yields were 18% higher in SC than in SS, and 23% higher in SC+DVT than in SS+DVT. However, no significant differences between treatments with and without DVP and with the same sequence or crop rotation were found. It is advisable to quantify the parameters mentioned in this study before deciding whether or not deep tillage equipment should be used.

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Soil compaction and crop rotation effects on soil parameters and soybean yield in direct drilling systems

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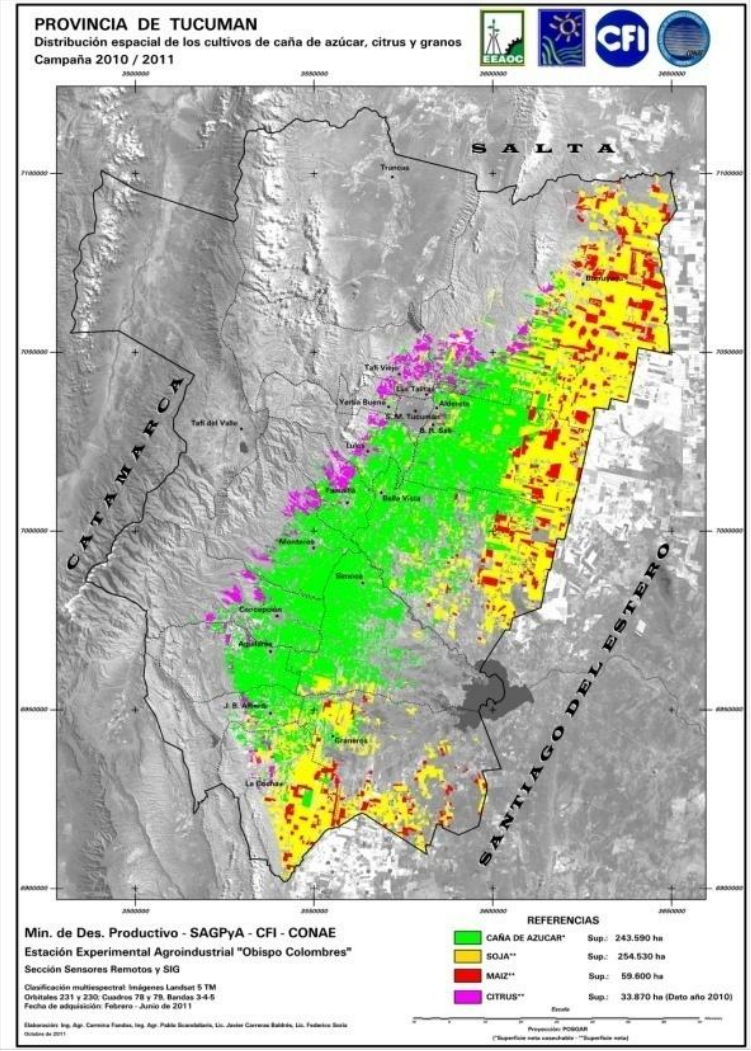
Tucumán province

Between 26 and 28
South latitude and 64 30'
and 66 West longitude



Geographical distribution of main crops in Tucumán

The main features of the Chacopampeana region are the following:

✓ The area planted with soybean is 250.000 ha.

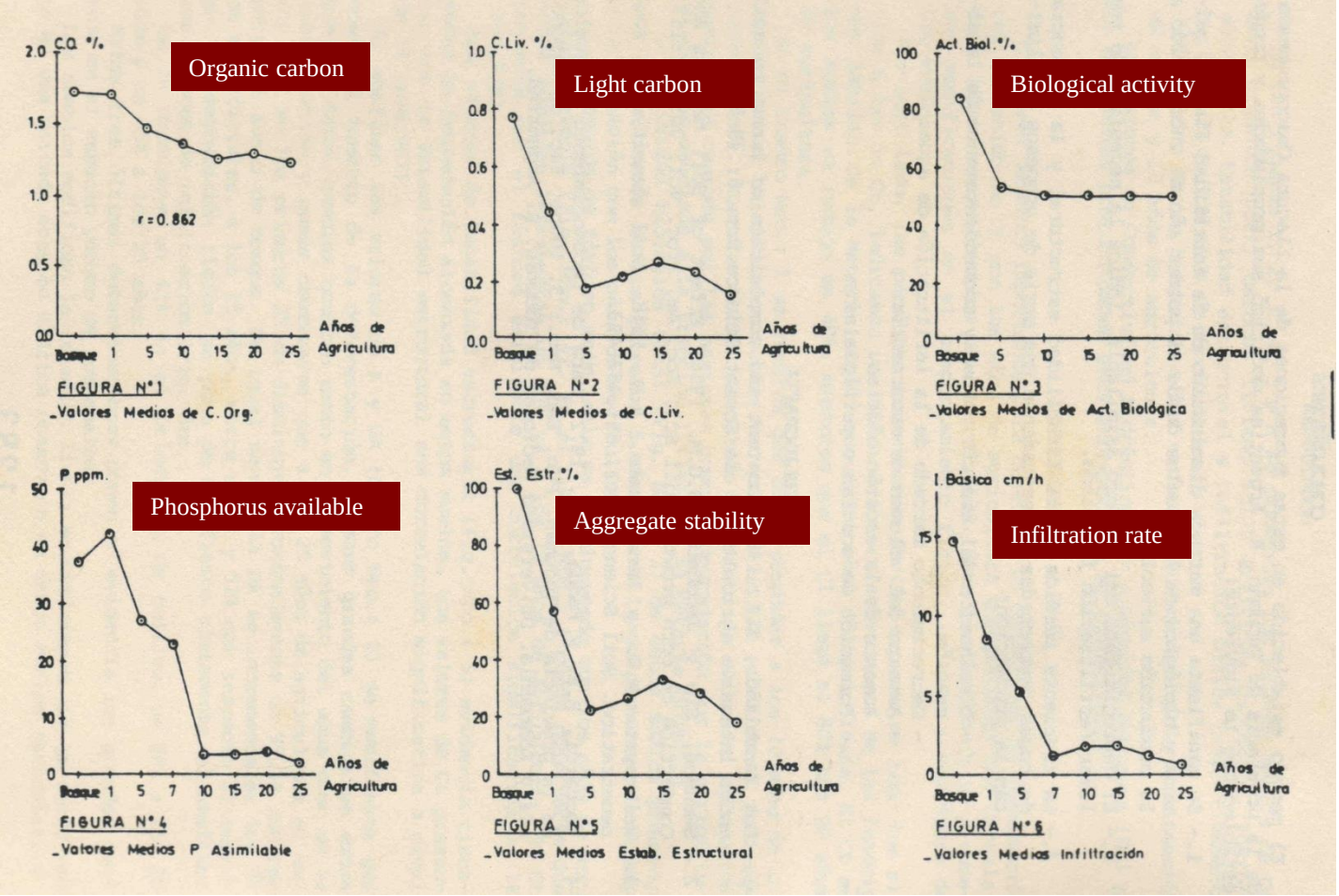
✓ The climate is warm dry subhumid to warm semiarid. Average annual rainfall ranges from 650 to 850 mm, and is concentrated between October and April, with arid conditions occurring the other six months.

✓ Soils are typic and entic Haplustolls and typic Argiustolls developed on eolic parent materials (loess). The surface texture is mainly silty loam, with low aggregate stability and a trend to surface crusting.

Expansion of the Argentine agricultural frontier

Expansion of the Argentine agricultural frontier

Effect of agricultural use on soil parameters



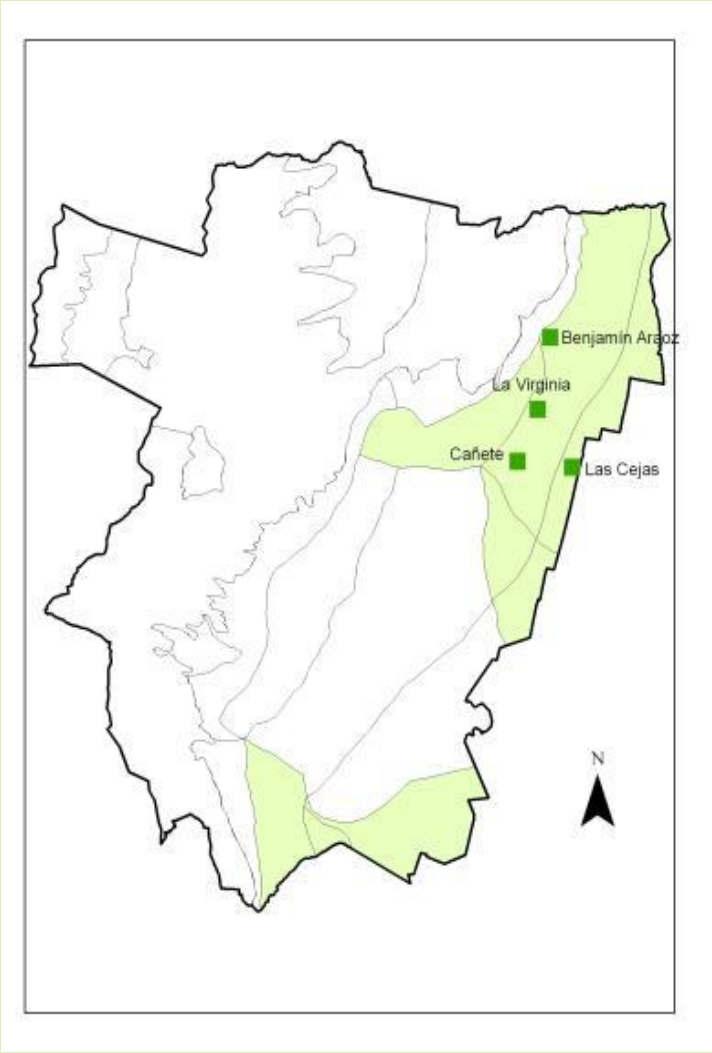
Objective

the objective of this work was to evaluate soil compaction and crop rotation effects on soil parameters and soybean yield in grain fields under no tillage systems.

Materials and methods

This study was carried out in grain fields located at four sites in the Chacopampeana Plain, province of Tucumán, Argentina.

Five no-tillage soil management situations were studied at each site to evaluate soil compaction degree and other related soil physical properties.



Treatments studied in the trial were the following:

N: 'new soils', planted with soybean (immediately after clearing) for less than 5 years under no tillage management.

SS: soybean monoculture for over 10 years, under no tillage management.

SC: soybean/corn rotation for over 10 years (at least 3:1), under no tillage management.

SS+DVT: soybean monoculture for over 10 years, under no tillage interrupted with a deep vertical tillage before sowing.

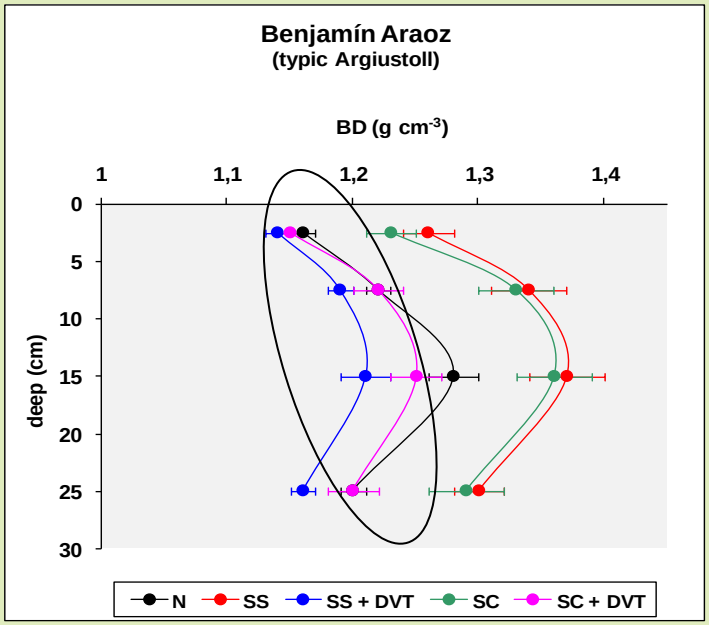
SC+DVT: soybean/corn rotation for over 10 years (at least 3:1), under no tillage interrupted with a deep vertical tillage before sowing.

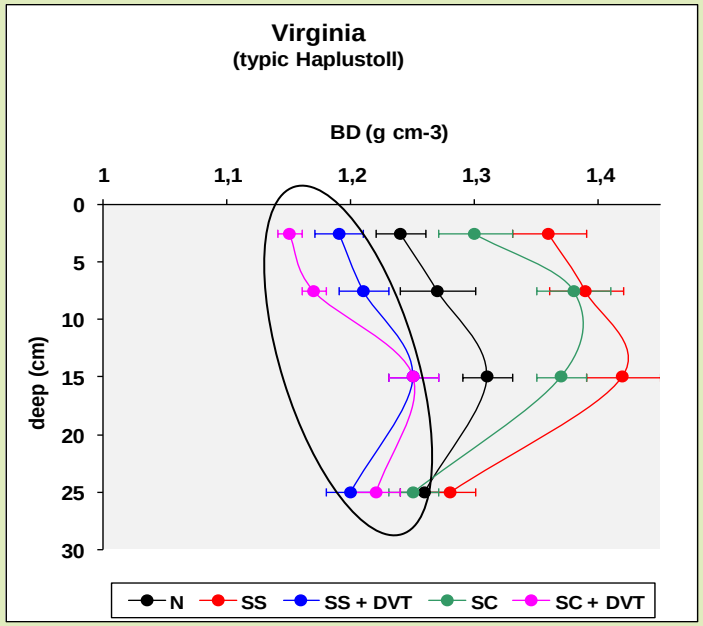
The parameters evaluated were:

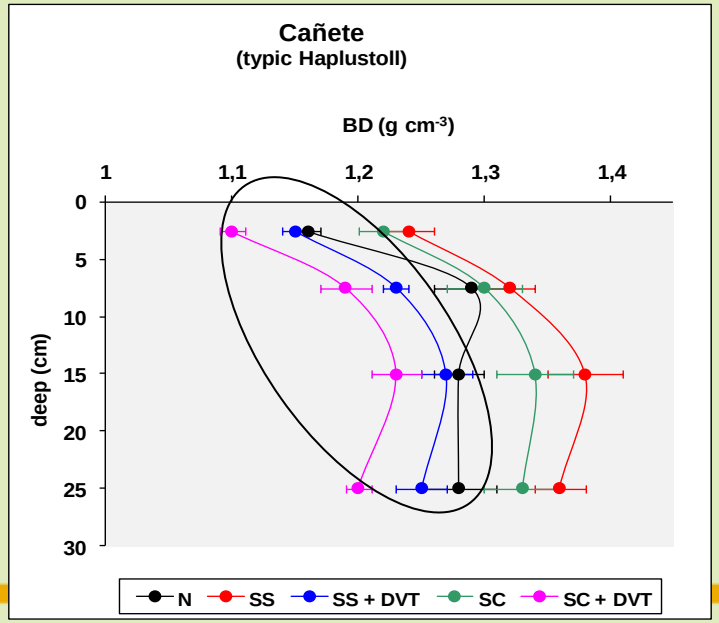
bulk density (with the cylinder method); maximum bulk density (with the Proctor test); macroporosity (with tensium infiltrometer); penetration resistance (using a cone penetrometer); residue cover (assessed by cord intersection); rate infiltration (evaluated with a ring infiltrometer); organic matter (through Walkley and Black) and soybean yield.

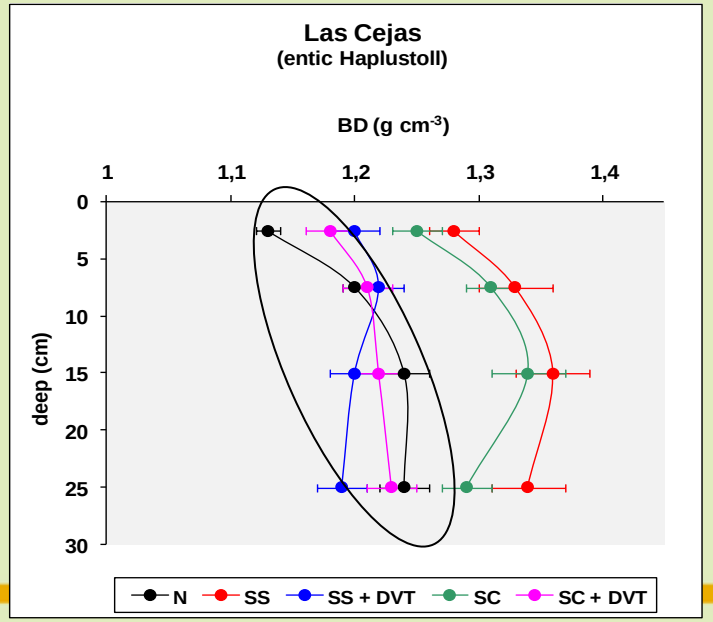
Results

Bulk Density

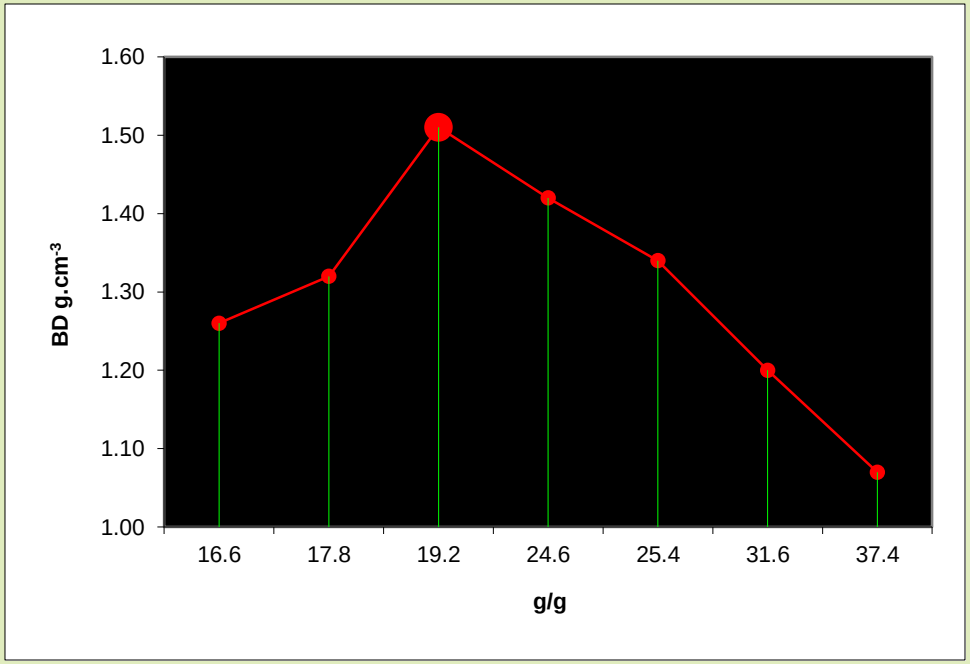








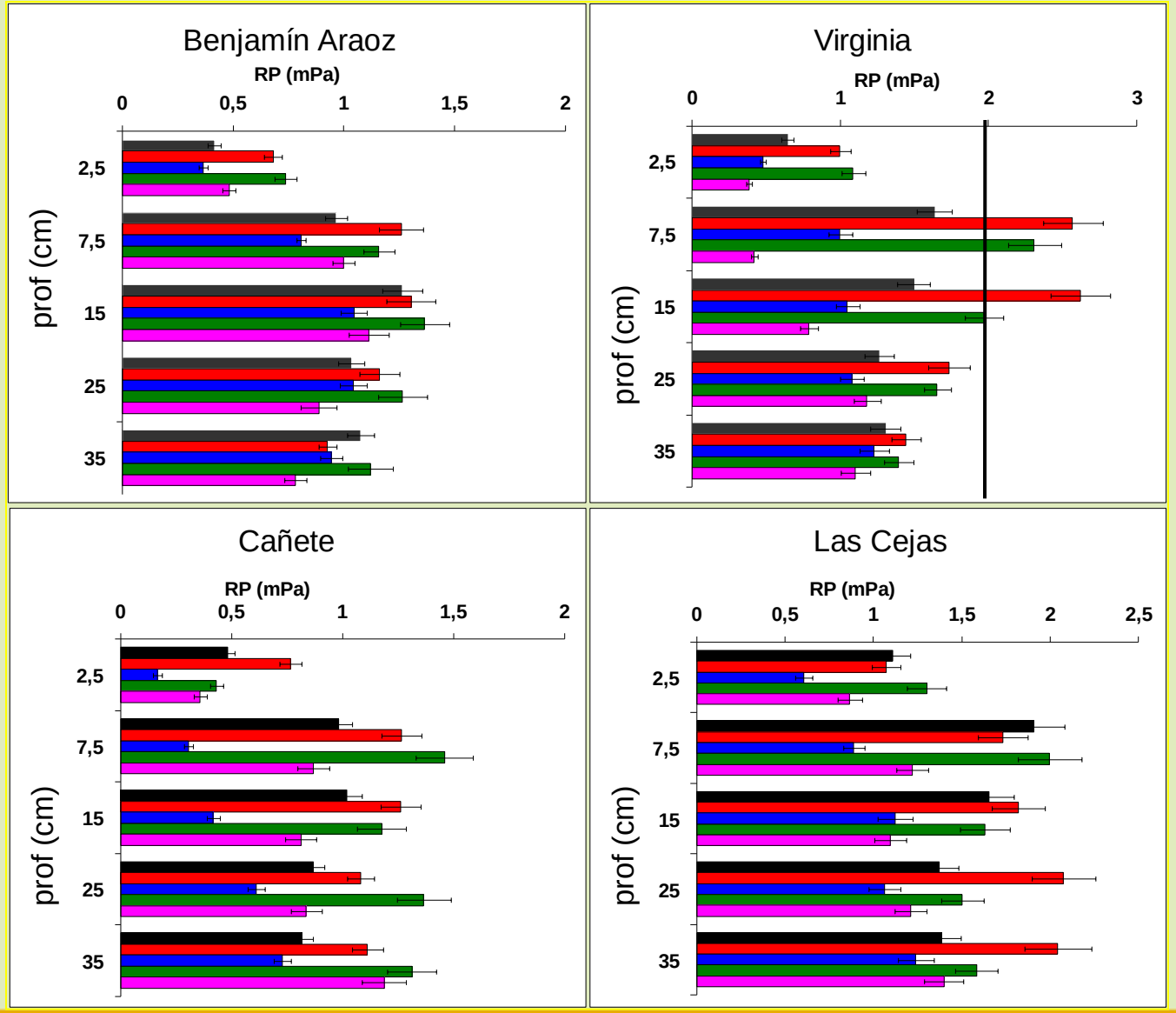
Maximum Bulk Density (Proctor test)



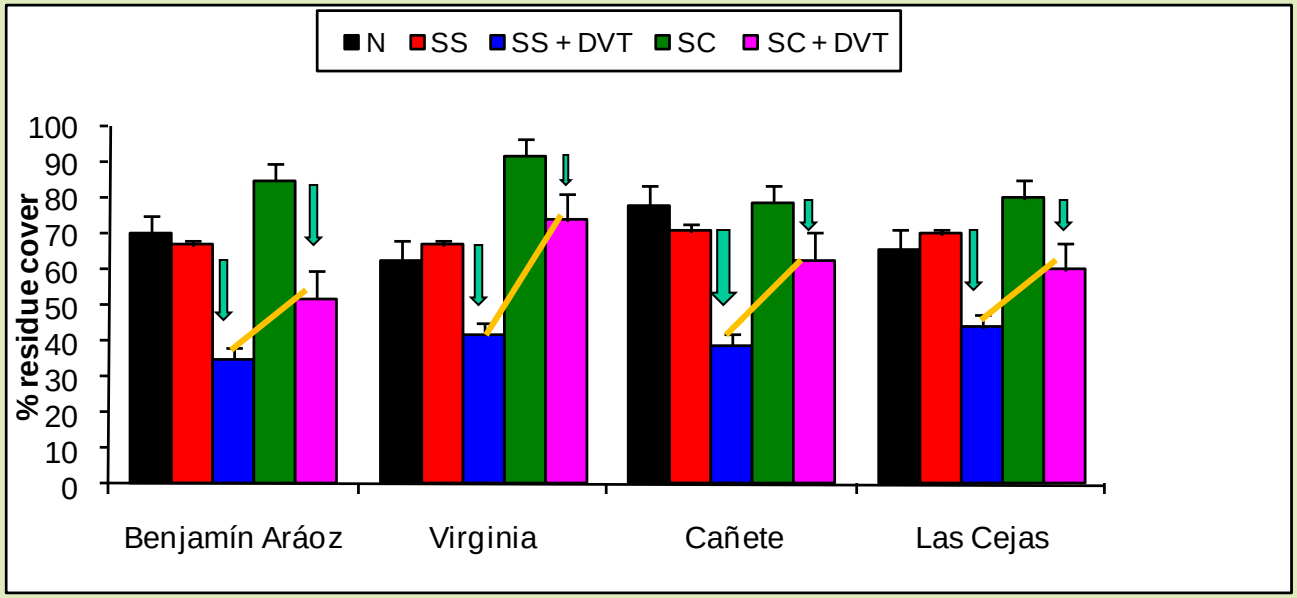
Relative Bulk Density (BD/BD max)

	Benjamín Araoz		Virginia		Cañete		Las Cejas	
BD máx.	1,53 gr cm^{-3}		1,51 gr cm^{-3}		1,52 gr cm^{-3}		1,50 gr cm^{-3}	
crop rotation	SS	SC	SS	SC	SS	SC	SS	SC
BD rel. 7,5 cm	87%	87%	92%	91%	86%	85%	89%	87%
BD rel. 15 cm	89%	89%	94%	90%	89%	88%	89%	89%

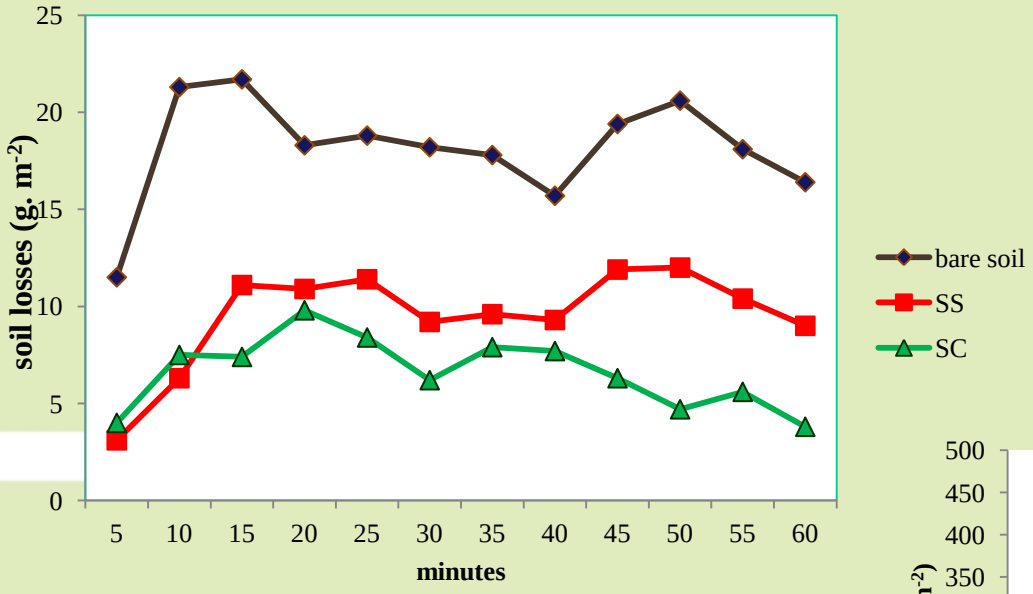
Penetration Resistance

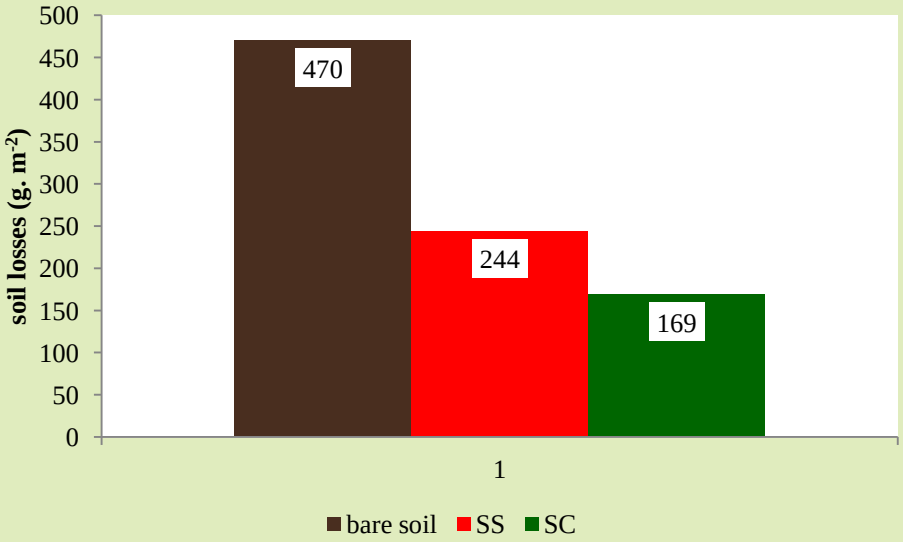


Residue cover



Soil losses under simulated rainfall condition





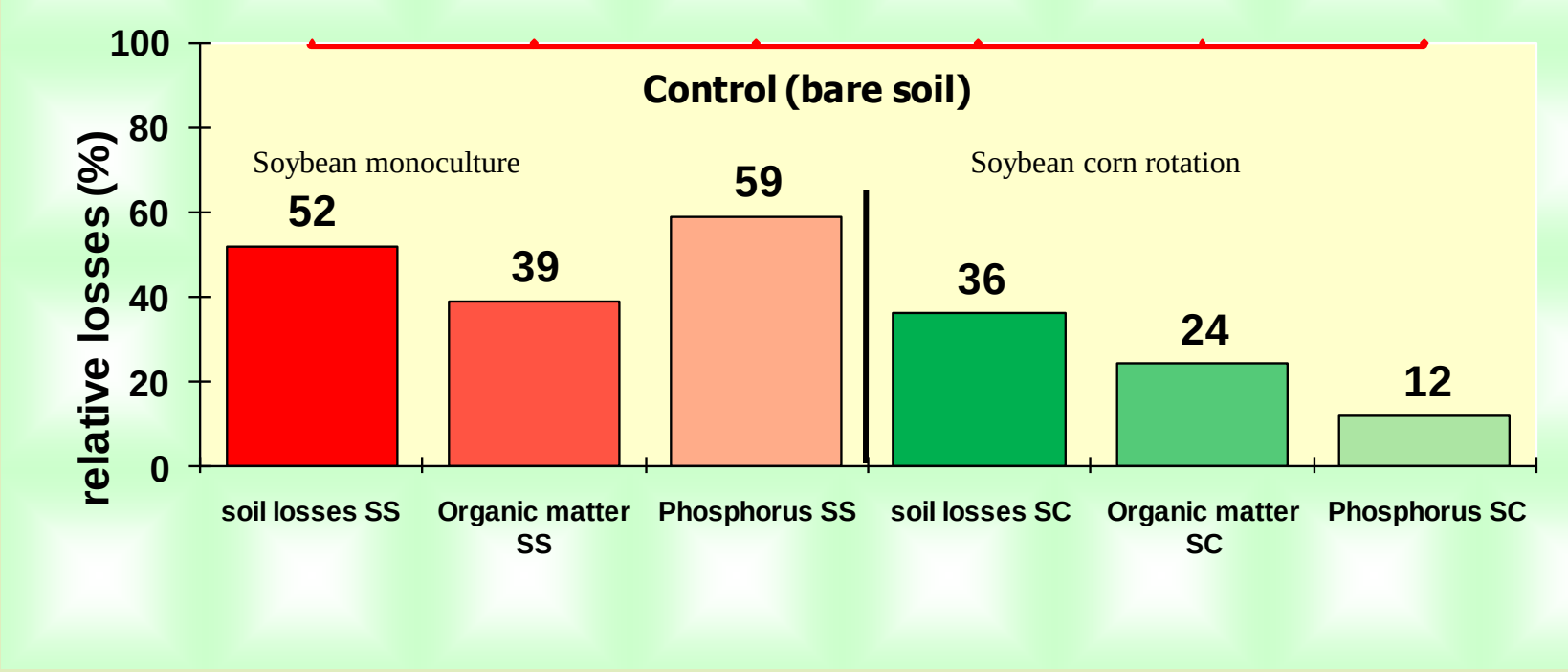
Soil surface after simulated rainfall

Bare soil (1.2 mm)

Soybean monoculture (0.5 mm)

Soybean corn rotation

Soil, organic matter and phosphorus losses under simulated rainfall condition



Organic Matter

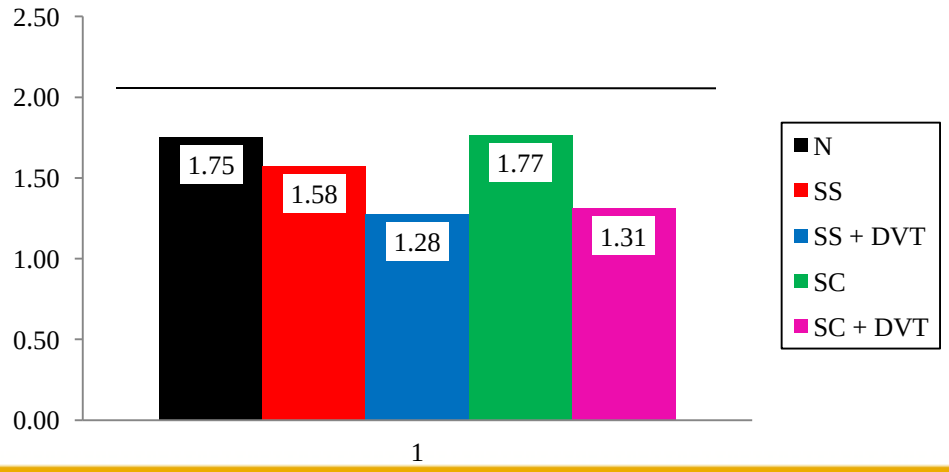
Benjamín Aráoz					
Deep (cm)	N	SS	SS + DVT	SC	SC + DVT
2.5	2.74 a	1.81 b	1.62 b	2.03 ab	1.89 ab
7.5	2.12 a	1.73 a	2.04 a	1.6 a	1.71 a
15	1.94 a	1.56 ab	1.72 ab	0.82 b	1.91 a
25	1.50 a	1.14 ab	1.37 a	0.74 b	1.52 a

Cañete					
Deep (cm)	N	SS	SS + DVT	SC	SC + DVT
2.5	2.16 a	1.55 b	1.43 b	1,70 ab	1.74 ab
7.5	1.61 a	1.27 a	1.47 a	1,35 a	1.75 a
15	1.30 a	1.15 a	1.12 a	1,32 a	1.35 a
25	1.28 a	0.94 a	1.04 a	1,20 a	1.13 a

Virginia					
Deep (cm)	N	SS	SS + DVT	SC	SC + DVT
2.5	2.06 a	1.44 b	1.16 b	1.68 ab	1.74 ab
7.5	1.76 a	1.21 b	1.24 b	1.43 ab	1.82 a
15	1.45 a	1.28 a	1.18 a	1.36 a	1.50 a
25	1.14 ab	0.98 b	0.96 b	1.13 ab	1.42 a

Las Cejas					
Deep (cm)	N	SS	SS + DVT	SC	SC + DVT
2.5	1.86 a	1.31 b	1.22 b	1.45 ab	1.39 ab
7.5	1.53 a	1.24 a	1.27 a	1.36 a	1.32 a
15	1.24 a	0.95 a	1.09 a	1.17 a	1.15 a
25	1.11 a	0.83 a	0.91 a	1.03 a	1.12 a

Stratification rate (2.5/25 cm)



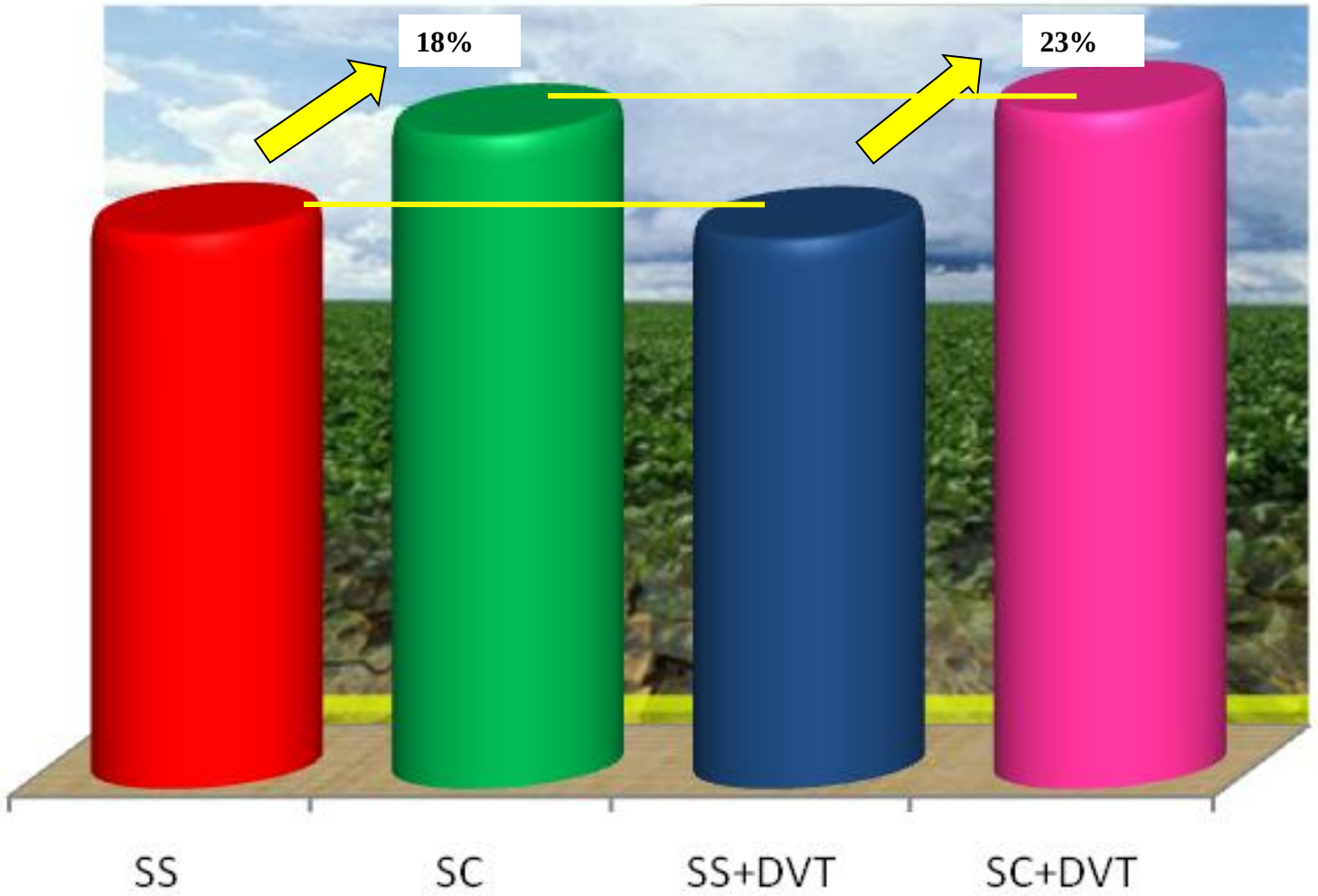
Infiltration Rate (cm h^{-1})

treatments	Benjamín Aráoz	Virginia	Cañete	Las Cejas
N	5.3^{a}	3.2^{a}	3.5^{a}	4.2^{a}
SS	1.7^{c}	0.9^{c}	1.7^{b}	2.4^{b}
SS + DVT	2.9^{b}	3.4^{a}	3.1^{a}	3.5^{a}
SC	1.9^{c}	1.6^{b}	1.6^{b}	2.2^{b}
SC + DVT	3.1^{b}	3.6^{a}	3.3^{a}	3.9^{a}

Macroporosity (%)

treatments	Benjamín Aráoz	Virginia	Cañete	Las Cejas
N	8.2^{a}	6.5^{a}	7.5^{a}	7.2^{a}
SS	4.3^{b}	4.7^{b}	5.0^{b}	4.2^{b}
SS + DVT	5.2^{b}	4.6^{b}	4.7^{b}	4.5^{b}
SC	5.2^{b}	5.3^{b}	5.8^{b}	5.2^{b}
SC + DVT	5.7^{b}	5.3^{b}	5.9^{b}	5.4^{b}

Soybean yields (ton/ ha)



Conclusions

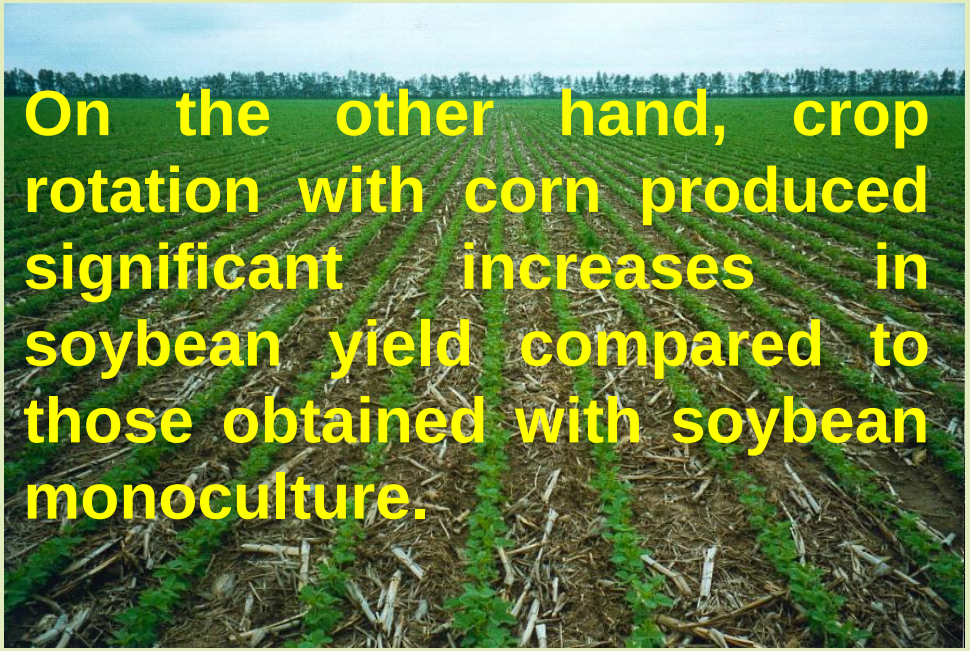
In deep vertical tillage treatments, both bulk density and penetration resistance were lower than in treatments without DVT.

However, only one of the four locations analyzed in this work showed values of both parameters being slightly higher than those considered critical for normal soybean root growth.

With deep vertical tillage, infiltration rates were significantly higher than without tillage. However, N had the highest rate, probably due to the conservation of soil porous system.

Organic matter content was significantly higher in soils with few years of agricultural use than in soybean monoculture treatments, while soybean/corn rotation showed intermediate values at all sites. Deep vertical tillage also caused a significant decrease in the amount of residue cover.

None of the sites tested showed soybean yield increases caused by deep vertical tillage. Therefore, this practice turned out to be ineffective and expensive.



There was also a greater amount of residue cover, which improved the sustainability of the farming system.

It is advisable to quantify the parameters mentioned in this study before deciding whether or not deep tillage equipments should be used.

On the basis of the results obtained in our region, we do not recommend interrupting direct seeding.

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I really thank you for your attention

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