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Comparison of Different Direct Seeding Furrow Openers under Different Soil Conditions

Direct seeding and minimum tillage practices have been accepted worldwide as efficient tillage methods for soil and water conservation and environmental protection. To further optimize direct seeding, two major no-till opener styles (single disc and hoe type openers) were compared. Recommendations to simplify choosing suitable openers for direct seeding, based on the respective field conditions, have been worked out. The decision for a specific direct seeder is influenced by the agronomical conditions desired, as well as the theoretical field capacity of the direct seeder, whereby the collected results can be the basis for decision making.

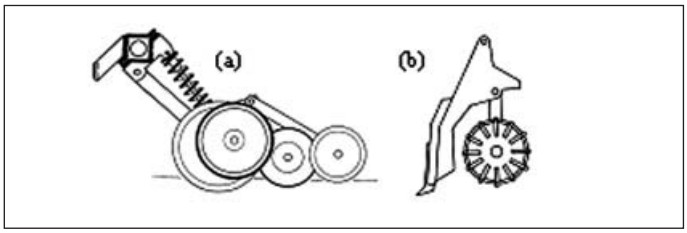

Fig. 1: Disk opener (a) and hoe opener (b)

The key consideration in increasing crop production as well as enhancing the processes of soil and water conservation is the better understanding of how to manage soil tillage practices in combination with soil types and climatic conditions. The detrimental effects of excessive tillage in accelerating soil erosion and land degradation have been worldwide recognized. Conservation tillage practices, which are any tillage systems that retain at least 30% of crop residues from the previous season on the soil surface after planting in order to minimize soil and water losses, compared to conventional tillage systems adopted in the same area, have been considered as the most important link between agriculture and sustainability. The objective of this study was to evaluate and compare the performance of the two major no-till opener styles, thesingle disc and hoe type openers, with regard to to the seed zone soil loosening and the seed row incorporated crop residue under different soil conditions.

Methods

In this study the performance of different furrow openers was evaluated under different soil and crop residue conditions with regard to the seed zone soil loosening and the seed row incorporated crop residue. Both are considered as one of the major parameters for designing and selecting a direct seeding furrow opener. For these experiments, a single disc opener of John Deere Model 750-A and a hoe opener of Amazone Model Airstar Primera were selected to represent the wide range of single disc and hoe type no-till drills respectively (*Fig. 1*).

These experiments were conducted under two soil moisture conditions. At each soil moisture condition, the soil was adjusted to represent three levels of soil strength (*Table 1*).

The two openers were adjusted to operate at a 50 mm soil depth and at a forward speed of 8 km/h. The following parameters were investigated:

- Soil loosening
- Amount of the incorporated crop residue

The determination of these parameters is achieved by using different methods:

- To measure the amount of soil loosening induced by the two furrow openers, special

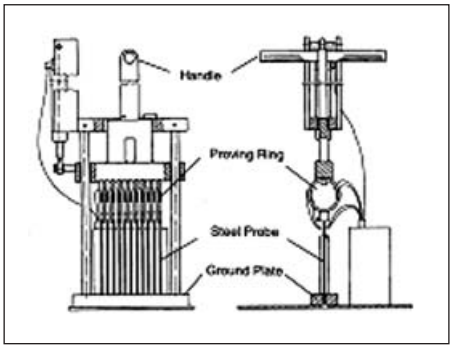

Fig. 2: Multiple cone penetrometer

Table 1: Soil properties

Soil-characteristics	Water-content	Penetration resistance (MPa)		
	(%)	low	medium	high
1	7.5	0.54 – 0.64	0.78 – 0.86	0.88 – 1.05
2	9.8	0.56 - 0.62	0.74 - 0.75	0.95 – 1.08

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Keywords
Soil tillage, direct seeding, furrow opener types

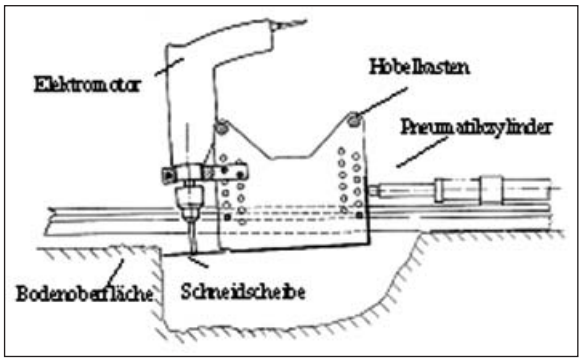

Fig. 3: Soil plane

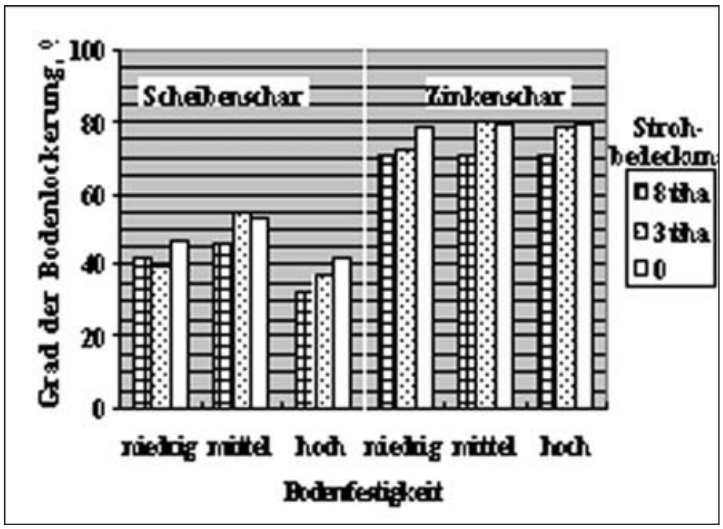

Fig. 5: Degree of soil loosening in the top 0 to 140 mm depth of the seed furrow (soil condition 1)

multi-probe seed row penetrometer according to [3, 2] was used (*Fig. 2*).

- To quantify the amount of the seed row incorporated crop residue, a soil plane according to [1, 2] was used (*Fig. 3*).
- For better interpretation of the results, the amount of the incorporated crop residue is determined according to the following equation:

$$\Phi = (m_r / m_s) \cdot 100$$

Where:

Φ = percentage of incorporated crop residue in the seed row, %

m_r = dry mass of the incorporated crop residue in g

m_s = dry mass of soil, g

Results

One of the most important findings of this study is that the increase in the amount of crop residue cover density was associated with an increase in the amount of seed row incorporated crop residue produced by both openers. Similarly, the increase in the amount of crop residue cover was observed to result in decreasing the true seeding depth, the speed of seedlings emergence and the final plant population for the no-till single disc opener.

The initial soil strength, which is relatively high under no-till conditions, was found to have significant effects on the performance of no-till opener. The results indicated that the increase in the initial soil strength was associated with a reduction in the amount of seed row incorporated crop residue as a result of improving the cutting ability of the opener (specially for the disc opener). Similarly the initial soil strength was found to influence the degree of seed zone soil loosening and hence the seed furrow geometrical characteristics (*Fig. 4, 5*).

Conclusions

Based on the results of this study, the no-till hoe type opener appears to handle the high amount of crop residue cover and the high levels of soil strength more better, compared to the single disc opener. Nevertheless the use of the hoe type openers on fields, which are highly susceptible to soil erosion, is not recommended. Similarly, when using disc openers on fields of tough residue conditions, partial removal of crop residue in front of the opener is necessary to improve the efficiency of the disc opener. Hence with various disc coulters or residue removers in front of the disc openers could attain that.

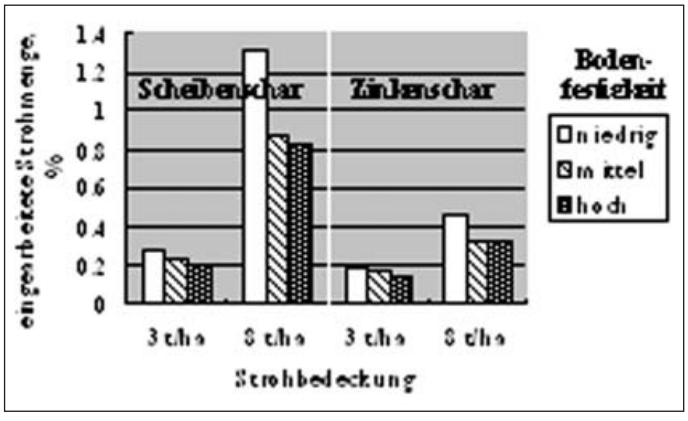

Fig. 4: Incorporated crop residue (Φ) in the top 0 to 50 mm depth of the seed furrow (soil condition 1)

Literature

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