

PAPER • OPEN ACCESS

Effects of Different Mechanized Organic Fertilization Methods on the Soil Physicochemical Properties of Corn Field

To cite this article: Di Wu *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **233** 042009

View the [article online](#) for updates and enhancements.



IOP | ebooks™

Bringing you innovative digital publishing with leading voices to create your essential collection of books in STEM research.

Start exploring the [collection](#) - download the first chapter of every title for free.

Effects of Different Mechanized Organic Fertilization Methods on the Soil Physicochemical Properties of Corn Field

Di Wu^{1, a}, Qiping Dong^{1, a}, Xin Cheng^{1, a}, Siwei Zhang^{1, a}, Chunming Bai^{2, a}, Zhiyu Sun^{1, a}, Xinyue Liu^{1, a}, Qiaobo Song¹, Qingwen Shi¹, Yifei Liu^{1, *} and Xiaori Han^{1, *}

¹Shenyang Agricultural University, Shenyang, China

²Liaoning Academy of Agricultural Sciences, Shenyang, China

^aJoint first authors

*Co-corresponding author e-mail: liuyifeiscience@163.com

Abstract. In this study, corn continuous cropping soil was sampled and five mechanical tillage and fertilization methods were compared, so as to explore the influences of different organic fertilization methods on soil physicochemical properties, and to provide reference for finding the best continuous soil fertilization methods and solving soil fertility decline in the future. The soil and corn samples were collected and measured to analyze soil physical and chemical properties and corn yield. The results showed that the mechanical spreading of decayed cow dung improved soil structure enhanced soil water retention and increased soil organic matter content. Straw mulching and breaking surface application can increase effective soil porosity, improve soil surface characteristics, improve soil ventilation and water permeability, which is expected to play an important role in improving soil surface compaction. The deep application of straw into the field can improve the soil viscosity and high fertility, and can be used in good sandy soil. Particle organic fertilization can effectively improve soil water permeability without causing loose soil texture, improve soil water permeability and water retention, and increase pH value of acidic soil.

1. Introduction

Currently, only 3% of the non-frozen land area in the world can be utilized efficiently, 6% is moderate utilization rate, 13% is of low utilization value, and the rest can only be cultivated after some regulation are improved [1]. Frequent tillage and excessive use of fertilizers and pesticides not only aggravate the soil but also increase the cost of agriculture. Long-term heavy application of one fertilizer can lead to the loss of some other soil nutrients [2-3]. Many studies have proved that, with the increase of continuous years, soil bulk density increased, non-capillary pore surface increased, and the three comparisons were incongruous [4]. Others also concluded that with the increase of soil organic matter in successive years, the content of humic acid and the pH of soybean rhizosphere soil decreased significantly and eventually led to soybean stunting [5]. Maintaining good soil physical and chemical properties is of great significance for maintaining soil fertility, improving crop yield and quality and realizing the sustainable use of soil resources. Organic fertilizers are richer and more balanced than chemical fertilizers and can provide nutrients to crops and improve the soil. The results showed that the non-capillary pore gap of organic fertilizer application machine increased by 50% [6] and the number of soil micro-aggregates increased than that of no fertilizer application [7]. The effect of bio-organic fertilizer on improving pH value of acid soil was remarkable [8]. In addition, the



efficiency of mechanized fertilization was nine times that of conventional fertilization, and the greenhouse gas emissions were almost the same [8]. Mechanized fertilization means variable rate fertilization, more reasonable and accurate, can achieve the purpose of saving fertilizer and improving fertilizer use efficiency [9], which should be extended to agricultural production.

2. Material and method

2.1. Experimental material

2.1.1. Corn cultivar of the experiment: Shenghe 18

2.1.2. *Experimental setting*: Northern temperate continental monsoon climate in Lujiafangshen Village (N42 °16'CU E 123 °23'), Dagujiazi Town, Faku County, Shenyang City, Liaoning Province, with a relatively large annual temperature difference.

2.1.3. *Soil type*: It is brown soil. The basic characteristics are shown in the table below.

Table 1. Soil basic properties of experiment

Soil texture	pH	Bulk density (g/cm ³)	Organic matter (g/kg)	Total N (g/kg)	Total P (g/kg)	Total K (g/kg)	Available N (mg/kg)	Available P (mg/kg)	Available K (mg/kg)
brown soil	5.06	1.39	11.89	2.3	0.12	15.92	100.8	19.28	141.44

2.1.4. *Experimental fertilizers*: (1) Organic fertilizers: cattle manure (nutrient content: organic carbon 33.81%, total nitrogen 2.41%, total phosphorus 1.017%, total potassium 0.867%, water 58.29%) was produced in the local cattle farm.

(2) Corn stalk: the corn stalk (nutrient content: 43.54% of organic carbon, 0.863% of total nitrogen, 0.260% of total phosphorus, 0.834% of total potassium, 9.07% of moisture) was selected according to the situation.

(3) Granule organic fertilizer: biochar base fertilizer (nutrient content of organic matter is equal to 45%, nitrogen, phosphorus and potassium is equal to 5%, medium and trace elements are equal to 2% and 25% of water).

(4) Conventional fertilizer: deep application of sustained-release base fertilizer (27-11-13) with 50 kg per mu, combined fertilizer application (15-15-15).

2.1.5. *Machinery for test*: Single disk broadcasting machine for organic fertilizer; mechanical chopping of straw (5-10cm); particle fertilizer sowing machine: the sowing machine is completed in one time when sowing with the fertilizer machine (local machinery); traditional field equipment spraying equipment such as fungus and pesticide.

2.2. Methods

2.2.1. *Experimental process*: The pH value was measured using an acidity meter (the soil water ratio was 1:2.5). The determination of the organic matter, total nitrogen using Elemental analyzer (Elemental Vario EL III, Germany). The measurement of soil bulk density (0-20cm) was carried out by the ring cutting method. The determination of soil moisture (water content) quality drying method is adopted to determine (105 °C, 12 h); harvest yield is normally weighed directly after full drying.

Experiment is divided into five areas, I : rotten cow dung to use mechanical broadcasting, broadcast 500 kilograms per mu air drying, water content of 20%, ridge on the rotary tillage 20 cm, sowing the recommended dosage 20% less than conventional fertilization treatment V area; II : straw returned broken, ridge on the rotary tillage 20 cm, 400 kg per mu, can cooperate with straw rotten agent and chemical nitrogen fertilizer, according to single factor spraying at the same time, the

recommended dosage with conventional fertilization treatment V when sowing; III: straw counters-field break the commune 30cm, 400kg per mu, can cooperate with straw rotten agent and chemical nitrogen fertilizer, according to single factor spraying at the same time, the recommended dosage with conventional fertilization treatment V when sowing; IV (CK) : granular fertilizer mechanical broadcasting, kinds of fertilizers than conventional fertilization treatment when V is reduced by 20%; V: conventional farming fertilizer management, 18kg nitrogen per acre, 5kg phosphorus pentoxide, 6kg potassium hydroxide, namely the basal 20kg urea +10kg potassium chloride, seed manure diammonium phosphate 10 kg, 15kg/mu fertilizer urea huge bellbottom period. Also can choose corn special fertilizer, because have straw to return field, potash fertilizer dosage can reduce appropriately.

3. Results and analysis

3.1. Effects of mechanized organic fertilizer on soil physical properties.

Compared with treatment V, the treatment I had the most significant increase in soil surface water content, followed by treatment IV. The results indicated that organic fertilizer could effectively improve soil water retention, but the effect of the deep application of straw into the field on the surface water content of the soil was little different from that of a single application of fertilizer.

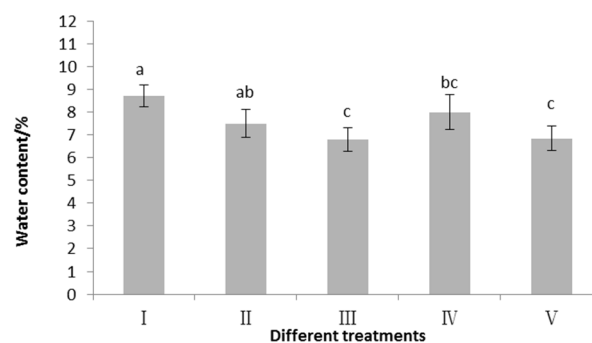


Figure 1. Effects of different treatments on soil water content

The soil bulk density treatment II < I < III < IV < V suggesting that organic fertilizer especially straw returned table can better improve soil aeration increase water supply, reduce the root stretching resistance.

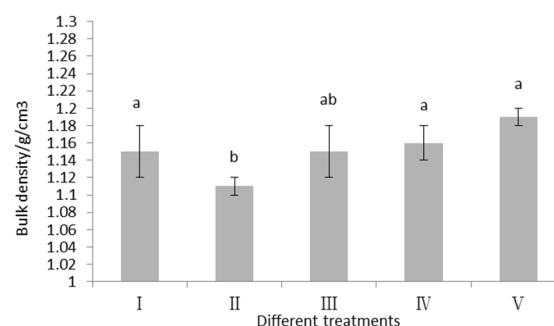


Figure 2. Effects of different treatments on soil bulk density

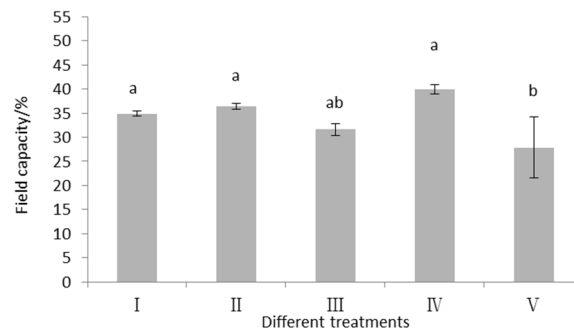


Figure 3. Effects of different treatments on field capacity

The I, II, IV improved the soil water retention capacity at the same time keep the soil moisture is absorbed by crops efficient utilization. The effect of mechanical sowing of particle organic fertilizer was the best. The effects of different treatments on soil total porosity were not obvious.

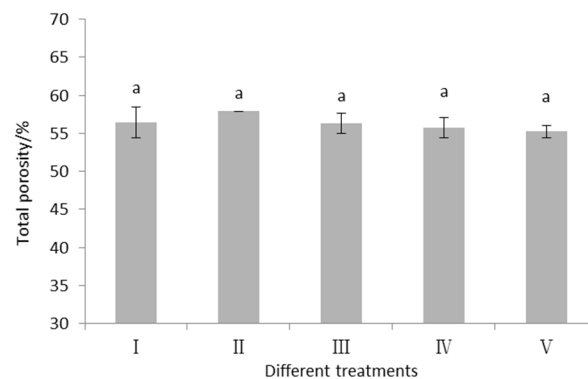


Figure 4. Effects of different treatments on total porosity

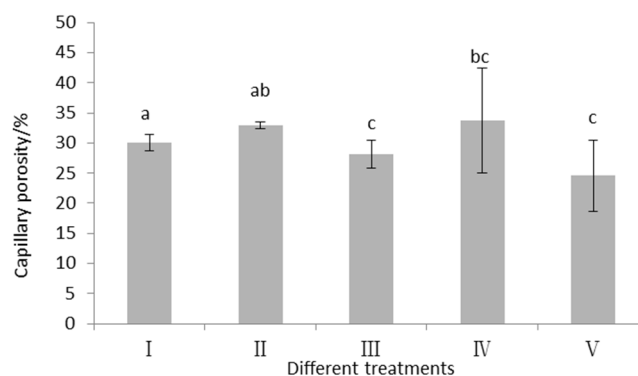


Figure 5. Effects of different treatments on Capillary porosity

The II and IV capillary porosity are higher than treatment V to 34.32% and 37.60% respectively. Combined with the above data analysis, the improvement of soil water content and water retention by the mechanical spreading of decayed cow dung was the most obvious. Straw mulching and breaking table application can effectively loose soil surface, improve soil ventilation and permeability and even play an important role in improving soil surface compaction. The deep application of crop straw into the field can improve the soil viscosity and toughness and improve the ability to maintain fertilizer. The mechanical application of particle organic fertilizer increased the proportion of effective interspace and field water holding without significantly changing soil bulk density and total porosity,

which indicated that particle organic fertilizer could effectively improve soil water permeability without causing loose soil texture and improving soil water permeability and water retention.

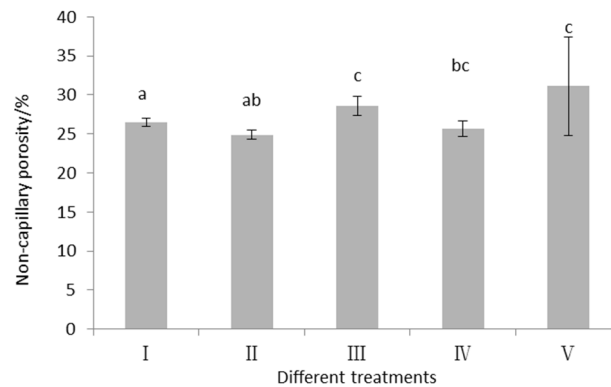


Figure 6. Effects of different treatments on non-capillary porosity

3.2 Effects of mechanized organic fertilizer on soil chemical properties.

In this experiment, the soil was acidic, and the pH of each organic fertilizer treatment decreased first and then rose. This is because the organic acids generated during the decomposition of organic fertilizers temporarily reduce the soil pH value. Under the continuous decomposition of organic materials, organic acids are constantly transformed and the soil pH value will rise. As you can see treatment IV pH picks up, the earliest II, III picks up more slowly. Comparison of soil pH, handling I, II, III, IV than handling V respectively 3.04%, 1.74%, 2.60%, 4.76%, 5% difference is significant. It shows that organic fertilizer can improve acid soil effectively, and the mechanical spreading effect of granular organic fertilizer (biochar base fertilizer) is the best (Fig.7).

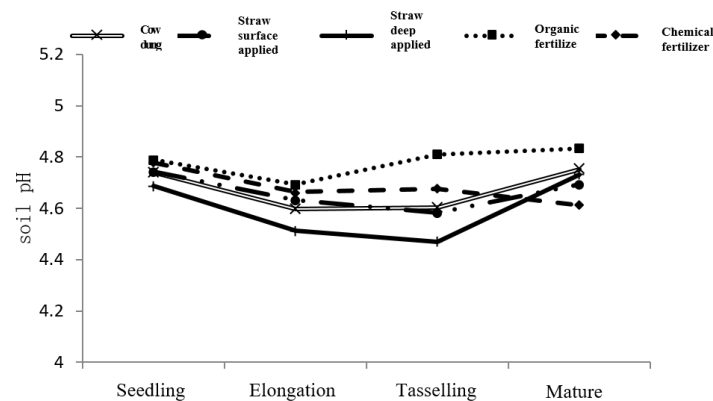


Figure 7. Effects of different treatments on topsoil pH in different corn growth stages

The average contents of soil organic matter were 1.424% and 1.744% respectively before and during harvest. Average organic content increased by 22.5% than before fertilization, harvest treatment I, II, III, and IV than V respectively increased by 16.38%, 10.76%, 6.49% and 12.33%, and I > IV > II > III > V, shows the organic manure treatment can obviously increase soil organic matter content. Among them, the rotten cow dung mechanical broadcasting work best.

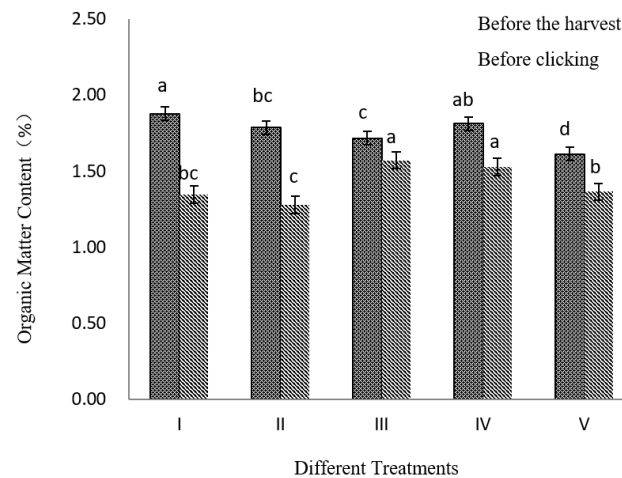


Figure 8. Effects of different treatments on topsoil organic matter content

4. Conclusion

The improvement of soil physical and chemical properties by organic fertilizer treatment was better than that by only chemical fertilizer treatment. Among them, the effect of mechanical spreading of decayed cow dung on soil water content and water retention was the most obvious, and the soil organic matter content was effectively increased. However, the regulation of soil gap is not as good as particle organic fertilizer and straw. Straw returning to the field and breaking the surface application can effectively adjust the effective soil gap, but the water conservation and fertilizer conservation are not as good as other organic fertilizer treatment. It can be used to improve soil surface hardening and other problems. The deep application of crop straw into the field can improve the soil viscosity and toughness and improve the ability to maintain fertilizer. The mechanical application of granule organic fertilizer can improve the water permeability and water retention of soil and the pH value of acidic soil.

Acknowledgments

This study was funded by Natural Science Foundation of China (31772391, 31301842), National Key Research and Development Plan (2018YFD0201206), the Xing Liao Talents Project and Sheng Jing Talents Project (RC170338), China Scholarship Council Project (CSC 201708210143) and National Peanut Research System (CARS-13- Nutrient Management).

References

- [1] Hou, X.S., (2011) Spatial and temporal distribution of physicochemical and biological characteristics of soil in different tillage methods [D]. Heilongjiang Bayi Agricultural University.
- [2] Wang, Y. Zhang, Y.P., (2001) Quantitative Effect of Soil Texture Composition on Retardation Factor of K⁺ Transport [J]. *Pedosphere*, 11(4):377-382.
- [3] Xia, L.Z. Yang, L.Z et al., Study on nutrient and salt status of artificial soil in subtropical cultivation in southern Jiangsu [J]., *Jiangsu agricultural science*, (6):43-46.
- [4] Yu, G.W et al., (1993) Study on the obstacle mechanism of soybean continuous cropping [J]., *Soybean science*, 12(3):237-243.
- [5] Zhou, Y.J et al., (1996) Effect of continuous cropping of soybean on soil humus composition. *Soybean science*, 15(3):235~ 242.
- [6] Wang, Y.H et al., (1994) Study on the comprehensive effect of straw returning to the field under long-term orientation [J]. *Chinese Journal of Soil Science*, 1994(S1):53-56.
- [7] Qu, G.W., (2004) Preliminary study on the effects of bioorganic fertilizers on soil physical properties and corn yield [J]., *Journal of Dandong textile college*.

- [8] Li, K et al., (2017) Research status and trend of Corn Fertilizer Technology and Fertilizer Machinery [J]., Study on Agricultural Mechanization.,(1):264-268.
- [9] Alfred, G.H., (2016)The sustainability of changes in agricultural technology: The carbon, economic and labour implications of mechanisation and synthetic fertiliser use[J]. Ambio, 45(8):885-894.