**Scholars Journal of Agriculture and Veterinary Sciences** **e-ISSN 2348–1854**
Sch J Agric Vet Sci 2016; 3(3):207-211 **p-ISSN 2348–8883**

(An International Publisher for Academic and Scientific Resources) DOI: 10.36347/sjavs.2016.v03i03.009

# The Influences of Different Processing Methods after Wheat Harvest on Soil Moisture

**Zhang Xiao-Hong[1], Liu Fei[2], Zhou Zheng-Xiao[3], Ding Heng[3], Zhao Yuan-Feng[2]**
[1]College of Geographical Science, Shanxi Normal University, Linfen, China- 041004
[2]Department of Geography in Shanxi Normal University of Modern Arts and Sciences, Linfen, China- 041004
[3]Linfen Weather Bureau, Linfen, China -041000

***Corresponding Authors**
**Name:** Zhang Xiao-Hong
**Email:** jiaoxuekeyan@163.com

**Abstract:** Handlings of stubble in different patterns from the field after wheat harvest have different influences on soil moisture and soil fertility. This paper uses comparison method to study the three modes of high stubble returning by rotary tillage in autumn(MODE1), high stubble crushed straw mulching (MODE2) and high stubble crushed straw and sowing summer maize (MODE3) with their influences on soil moisture content for autumn sowing wheat. According to the results of the soil moisture data obtained through the drying method, in a depth of 100 cm soil body size sorting is MODE1 > MODE2 > MODE3, which means that the fallowed MODE1 was much better than MODE2 for field water retention, but both made the root layer soil reservoir experienced varying degrees of loss caused by a lack of rainfall, and the growth of summer maize exacerbated the consumption of soil water.
**Keywords**: wheat stubble, soil moisture, wheat harvest

## INTRODUCTION

Shanxi plateau is in the semi-arid climate zone, with a less precipitation and its seasonal variability, therefore has frequent drought, and the drought become one of the biggest limiting factors affecting its agricultural development [1]. To explore the specific management ways to achieve scientific and reasonable use of soil water resources is particularly important in this area. Yao-Du district lying in Linfen basin, which is one of the five big basins of Shanxi plateau system, is a region of yielding two crops a year. The fashion of agricultural production is mainly the two ways of winter wheat - summer maize and winter wheat -fallow, namely early in the first period of June after the winter wheat harvest, either followed by sowing summer maize, or implementing land fallowing, to the end of September-early October when the next winter wheat is sowed. Different ways of farming system and field management have different impacts and request on farmland soil moisture [2, 3]. From the point of the precipitation of Linfen city in recent decade, the rainfall concentrated in the period of the 4 months after the winter wheat field harvest to sowing, which accounts for more than 70% of annual precipitation (figure 1). It is a key period of soil moisture accumulation and the accumulation conditions plays an important role for the seeding, emergence and growth of the next crop of wheat. In recent years, conservation tillage characterized by no tillage planting combined with straw returning are widely implemented in wheat field in north China. Linfen Regional Agricultural Machinery Bureau also introduced 4 kinds of processing for wheat high stubble treatment after test-and-summary [4]. The purpose of this paper is to investigate the influences of the regional current wheat harvest post-processing ways on soil moisture, which is supposed to provide scientific reference basis for its wheat production and soil water use management.

## MATERIALS AND METHODS

### Experimental area

The investigated area is in Dongdu village, Yao-Dou district of Linfen, located in the south of Shanxi Province (lat.35 ° 55 ', long.111 ° 34 ', 484 m above sea level), with a frost-free period of 203 days, an average annual rainfall of 550 mm, and an average annual temperature of 9～13 ℃. The soil was cinnamonic soil and features of agricultural production in terms of profound soil layers, appropriate texture and moderate acidity and alkalinity.

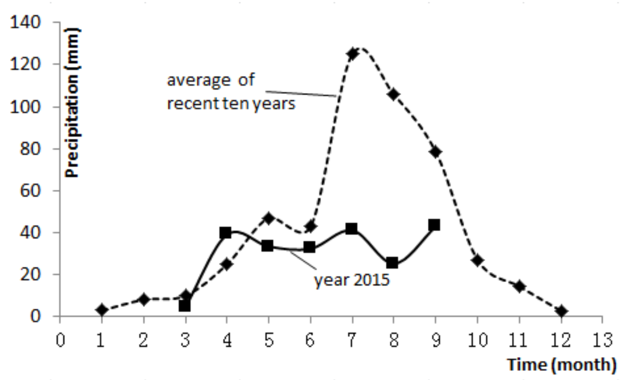


**Fig-1: Precipitation situation of Linfen city**

Note: Data was from Linfen Weather Bureau

**Experimental methods**

This research was carried out on three pieces of samples connected and adjacent to each other in Dongdu village, with no obvious difference in area and soil texture, only farmers handling of stubble in different ways.

The three treatments of farmland were handled from the field as follow:

High stubble returning by rotary tillage（MODE1）: Temporarily not to do anything with the high wheat stubble after wheat harvest smashed and returned it by rotary cultivator with fertilization and seeding directly in autumn.

High stubble crushed and straw mulching（MODE2）: After wheat harvest used straw return machine first to crush the high wheat stubble and covered over the field directly, and then carry on the deep loosening with a deep scarifier, fallowed till the next winter wheat seeding time when hard stubble machine direct sowing was applied.

High stubble crushed mulching and sowing summer maize（MODE3）: Immediately seeded summer corn on the high stubble crushed straw mulching base, adopted mechanical harvest at the end of September, and then applied returning straw crushing.

Traditional way of soil auger was used to take soil samples. It was done from the field in early June (as CK) and in early October respectively. For each point soil sample depth was 100 cm, with 10 cm for a hierarchical collection into aluminum box, brought back to the lab to measure soil moisture by drying method.

Balanced the weight of the collected soil samples with accuracy of 0.0001, then dried them in 105 ℃ oven for 24 hours to constant weight, afterwards weighed the dry soil sample and empty aluminum box. According to the measurement data calculated the following indexes [5]:

**∗ Soil water mass content($\theta m$): $\theta m=(W1-W2)/(W2-W0)*100\%$**

*W1* is the weight of aluminum box and soil sample before drying, *W2* is that of aluminum box and soil sample after drying, and *W0* is that of aluminum box.

**∗ Soil water storage (Water depth, *Dw*, mm): $Dw=\sum\theta v\cdot h$, $\theta v=\theta m\cdot\rho$,**

Where $\theta v$ is the Volumetric water content(%), $h$ is the depth of soil layer calculated (cm)， $\theta m$ is the soil water mass content as above,$\rho$is the soil bulk weight.

**Method of analyzing**

All data obtained was processing on Microsoft Excel (2010).

**RESULTS**

**Profile distribution characters of soil moisture**

Soil moisture content of the three modes all showed a trend of falling with depth deepening, contrasted with that of CK, which presented the opposite trend below 30 cm and was much greater (figure 2). This indicated that deep soil water content from the field in June were still relatively abundant, but after a summer maize growth season, before the crop of winter wheat planting in early October, three kinds of processing modes all had varying degrees of soil water loss mainly because of rainfall lack during the experiment, which was only 40% of the average amount of recent 10 years. The soil water content of MODE1 is higher than MODE2 or MODE3 in overall profile, and that of MODE2 higher than MODE3. This means the high crop stubble covering in the whole period reduces the soil evaporation greatly in MODE1, which is the obvious advantage in the aspect of maintaining soil moisture storage; while in MODE2 wheat stubble crushed and covering directly on the field with deep loosening may have decreased soil compactness thereby aggravated soil moisture evaporation loss. The low soil water content of MODE3 was mainly due to the growth of summer maize consumption of soil water.

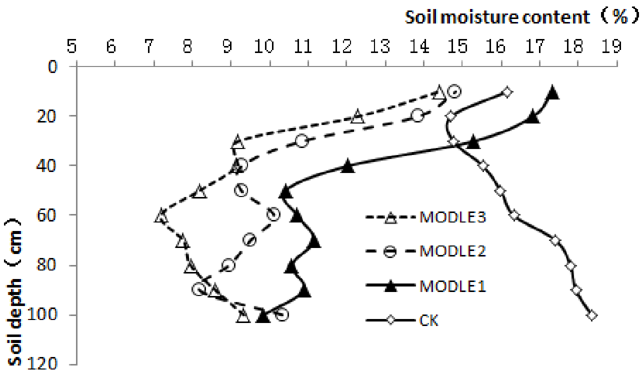


**Fig-2: Soil moisture content of different processing mode compared against the CK**

The three processing pattern's soil moisture content changing with the depth of soil layer were not the same performance. Although in the upper area all soil water content decreased with soil depth increasing, the depths of the decline were significantly different. MODE1 at 50 cm depth stop decline, with a decreasing amplitude of 40%, and the 0 ~ 20 cm drop was relatively small (2.9%); MODE2 water content decreased by the depth of 40 cm, fell 37%; MODE3 decreased by the depth of 60 cm, fell as much as 50%, but paused at 30 ~ 40 cm. The result suggested that no-till high stubble coverage and smashing before the next winter wheat seeding had bigger water loss depth and intensity in dry years. But because the rain storage capacity and the ability to prevent surface evaporation was also strong, its soil moisture content kept at a high level in the 1 m depth of profile, especially at the surface 0 ~ 30 cm that had a net increase compared with the early CK, which is very favorable to the autumn wheat sowing and emergence. While in the MODE3 although due to the vegetation cover effect reduced the strong evaporation depth, strong root absorbing of water consumption and transpiration, particular in the 40-80 cm root active layer, made the soil water content significantly lower than that of the two fallowing processing modes.

**Effects on soil water storage and consuming**

As shown in figure 3, the 1 m soil water storage of MODE1 was 186 mm, greater than that of MODE2 (157 mm) or MODE3 (140 mm), and that of all three processing patterns were significantly lowered since wheat harvesting in June from CK (246 mm). That is, after a harboring of little rain (142.2 mm) in the dry season, which was only 40% of the average precipitation in recent 10 years, the two fallowed processing's 1 m soil water storages were reduced by 24% and 36% respectively, compared with that in June, and that of the processing of summer corn was reduced by 43%. It indicates that the water retention capacity of fallowing MODE1 is much better than MODE2, but caused by a lack of rainfall and the transpiration, either soil reservoir experienced varying degrees of loss in the root layer, and the growth of summer maize exacerbated the losing by the consumption of soil moisture.

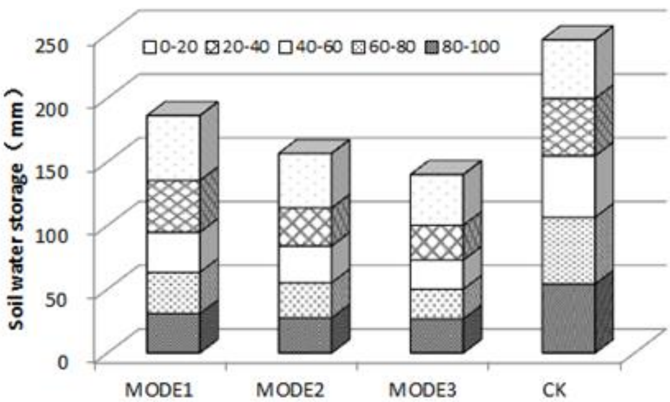


**Fig-3: The soil water storage of different processing compared with CK**

To quantitatively describe the soil water consumption and utilization of different processing modes, we calculated the stratified difference between corresponding water storage in October and that of the CK stored in June (the loss of water) and their corresponding percentage of CK reservoir, according to the above data (table 1).

**Table 1 The layered soil water consuming of different processing**

| Soil depth/ | 0-20 | | 20-40 | | 40-60 | | 60-80 | | 80-100 | | 0-100 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| treatment | (mm) | % | (mm) | % | (mm) | % | (mm) | % | (mm) | % | (mm) | % |
| MODE1 | -4.9 | -11 | 4.5 | 10 | 16.7 | 35 | 20.1 | 38 | 23.1 | 43 | 59.5 | 24 |
| MODE2 | 3.3 | 7 | 15.2 | 34 | 19.3 | 40 | 25.0 | 48 | 26.5 | 49 | 89.2 | 36 |
| MODE3 | 6.2 | 14 | 17.8 | 40 | 25.3 | 53 | 29.1 | 55 | 27.3 | 51 | 105.8 | 43 |

It can be seen from the calculated results that the stratified water consumption and the percentage of MODE1 and MODE2 were increasing with depth deepening, including MODE1 in surface layer 0-20 cm negative, which indicated that the accumulation of precipitation was greater than the loss of soil evaporation in this level. For both leisure processing without crop growth, the change of the 1 m deep soil reservoir mainly depended on precipitation revenue and expenditure of soil evaporation. With the increase of depth, precipitation infiltration compensation became less and less, leading to lower soil reservoir water loss percentage increase, to 80-100 cm the maximum loss nearly half percent. Comparatively speaking, in MODE2 water loss and the proportion were bigger than MODE1 at each level, especially at 20-40 cm, where the water loss rate was 3.4 times that of MODE1, and that of the whole 1 m depth was 50% more. It always again showed that immediately after the field round deep loosening is not conducive to maintain soil moisture, instead stubble no-till helps reduce the evaporation loss and accumulation of precipitation resources. Soil reservoir consumption in each layer of MODE3 were higher than that of MODE1 and MODE2, and the soil water loss rate were 1.0 ~ 1.9 times and 1.2 ~ 4.0 times of the later respectively, which is the result of maize growth consumption and using of soil moisture.

## DISCUSSIONS

Studies have shown that the depth of the dramatic change of soil water layer (active layer) in wheat field is about 0-80 cm [6]. This layer is very susceptible to the influence of the atmospheric environment and the soil fluctuation of dry and wet is intense. In late spring or early summer season when precipitation is lack, soil moisture is easy to drop to the crop wilting content; while in rainy period, it can be reached to the maximum capacity humidity in a short period of time. The highest fluctuating range is from 6% to 22%, and close to the surface of top layer is often in the dry state.

Li Ling-ling has also concluded that different cultivation measures had a greater influence on the soil moisture content on the surface of 0~10 cm, and no-till straw mulching can significantly increase the soil moisture at seeding time. Usually 0-200 cm soil water storage annual change can be parted into three stages of spring and summer crops growing water-loss period (mid-May to the second July), summer-autumn the rainy season soil-water-increasing period (the middle July to mid-October) and winter-spring the one phase soil-water period (November to the early May of next year) [7].

In this study the dramatic decreasing soil water depths of the three processing were 0 ~ 50 cm, 0 ~ 40 cm and 0 ~ 60 cm respectively, variated in soil moisture between 7% ~ 18%; deep down to 1 m were the slowly changing layer of soil moisture, fluctuated between 7% and 12%. The soil moisture content sorting was MODE1 > MODE2 > MODE3, of which the surface layer (0~30 cm) in MODE1 was significantly higher than that of the other two processing mode, compared with the early CK a net increase in state. This suggests that high no-till stubble coverage and smashed till the next winter wheat seeding in dry years is more conducive to the accumulation and keep of soil moisture than directly smashing stubble combined with deep loosening immediately after wheat harvest, because it can reduce soil surface evaporation significantly. Although due to the vegetation cover effect reduces the strong evaporation depth in summer corn planting, but the root absorbing water consumption and transpiration is also strong, especially at 40-80 cm the root active layer. In normal year the period of July to September should be rainy and soil-water-increasing season, but the 1 m deep soil moisture of the three patterns in the experiment were significantly lower than that of CK in June, except the surface layer of MODE1. This is mainly due to 2015 was an unusual year of little rain, of which in the key water storage period it only accept less than half of the average precipitation of recent ten years from the field.


## ACKNOWLEDGEMENTS

This work was supported by the students' innovative entrepreneurial training program of Shanxi normal university of modern arts and sciences.


## REFERENCES


1. Wanzhong M, Jingbo Z; Meteorological Disasters and Climate Change of Shanxi in Recent Six Hundred Years. China Social Sciences Publishing House (in Chinese), 2014.
2. Junhong L, Junjie L; Study of Conservation Tillage on Winter Wheat Yield and Soil Moisture. Chinese Journal of Soil Science (in Chinese), 2014; 45(6):1343-1349.

3. Liu WG, Zhang JC, Cao WX; The dynamic variation of soil moisture on the dryland wheat under various culture models. Acta Agriculturae Boreali-Occidentalis Sinica, 2006; 15(4):112-6.
4. Yuejin C; Four Kinds of Processing of High Stubble for Wheat. Shanxi agricultural machinery (in Chinese), 1998; (05):11.
5. Changyong H; Pedology. China Agriculture Press (in Chinese), 2000.
6. Zhiqiang G; Research Progress of Soil Water Operation Rules and Moisture Storage Keeping Technology for Dryland Wheat. The 15th China's Wheat Cultivation Science Academic Symposium [C] (in Chinese), 2012; [A] (11):415-422.
7. Li LL, Huang GB, Zhang RZ, Jin XJ, Li GD, Chan KY; Effects of conservation tillage on soil water regimes in rainfed areas. Acta Ecologica Sinica, 2005; 25(9):2326-32.