The effect of rice (*Oryza sativa L.*) cultivation on the soil physical properties

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Abstract- **Rice (*Oryza sativa L.*) cultivation is due to special conditions of land preparation affect on physical characteristics such as soil bulk density, surface aggregates dispersion, infiltration rate and compaction. The study area is located at Lenjan, in Isfahan province, in the center of Iran, soil physical properties of rice cultivation, wheat cultivation (*Triticum aestivum L.*) and rice–wheat rotation with more than 50 years old were examined and compared. In the upper horizons for paddy soils, wheat – rice and wheat fields the average of soil bulk density (BD) were 1.9, 1.7, 1.5 g/cm^3 respectively, and magnitudes of mean weight diameter (MWD) were 0.87, 1.15 and 1.6 and infiltration rate (IR) showed the minimum value in rice fields and the maximum value in wheat fields, 0.48, 0.7 cm/hr respectively. Particle size distribution (PSD) revealed no differences in any fields. This study confirmed that wet tillage for rice creates a poor physical condition in the soil.**

Key words: Paddy soil, Puddling, soil Bulk density, Soil Compaction.

I. INTRODUCTION:

Globally, the harvested area of rice can be ranked second after wheat, but rice provides more calories per hectare than any other cereal crop [11] and rice is the most important staple food in Asian countries, including Iran. In the Lenjan region rice cultivation is devoted more than 5500 hectares [10].

Land preparation for rice cultivation starts with flooding of fields for at least two days. Afterwards, the soil is puddled at water content between field capacity and saturation, comprising repeated ploughing, harrowing and finally leveling [12, 13].

Studies have shown that wet tillage for rice can destroy soil structure [8], cause soil compaction and is a concern in crop production and environmental management [1, 17, 6].

Rice cultivation involves ploughing the soil when wet, puddling it and keeping the area flooded for the duration of rice growth. Puddling breaks down and disperses soil aggregates into micro-aggregates and individual particles in humidity close to saturation [4, 5].

The highest bulk density with highest puddling index and lowest percolation rate was observed when puddling operation was performed by the tractor [4].

Puddling assists weed control and homogenization of the soil by destroying aggregates and macrospores. The low mechanical strength of the puddled layer allows easy transplanting [14].

In a sandy loam soil percolation rate of water into the soil decreased from 30.1mm/day in unpuddled soil to 13.2 mm/day with medium puddling and 11.9 mm/day with high puddling [12].

Degradation of the regional soils in Brazil is mainly related to high soil density, low porosity, and low water infiltration rate and it is progressively worsening because of the intensity of tillage applied in rice production [9].

In this research the effects of rice cultivation on soil physical properties in comparison with wheat cultivation and wheat-rice rotation are analyzed.

II. MATERIAL AND METHOD:

A. *Study area:*

The study area is located at 32° 21′ N latitude and 51° 24′ E longitude and 1701 m above mean sea level and the average of rain fall is 125 mm annually. The soils have a similar series of soil in the region and are classified as Typic Haplocalcids and Typic Endoequepts and they are located on the river terraces of Zayandehrood.

B. *Laboratory studies:*

Bulk density was measured by clod method[19], MWD analyzed by wet sieve method[18], particle size distribution were measured by pipette method and infiltration rates was determined using double -ring method[19]. Table 1 shows properties of soils.

III. RESULTS AND DISCUSSION:

Comparison of BD between three cultivations showed that the mean of BD of the surface horizon in rice cultivation was 1.91 g/cm^3, in wheat cultivation was 1.5 g/cm^3 and in wheat-rice rotation was 1.7 g/m^3. The magnitude of BD was increased with increasing depth in two profiles. In wheat cultivation it was 1.5 g/cm^3 at the surface and 2.06 g/cm^3 at 140 cm, and in wheat-rice alternation it was 1.7 g/cm^3 at the surface and 2.2 g/cm^3 at 83 cm, but in rice cultivation the magnitude of BD was decreased from surface to depth because of gravel at the depth. Fig. 1. Shows BD of different profiles. Aggregates can be destroyed and disruptive because

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of tillage operations and repeated puddling leads to the formation of a subsurface plough pan. The BD of this compacted layer has been found to increase with increase in puddling and disturbed aggregates [16, 12].

The results show that the highest MWD in the surface layers is related to wheat cultivation and the lowest MWD is related to rice cultivation. The magnitude of MWD is 1.6 in wheat cultivation and 0.87 in rice cultivation. That is, about 50 percent decreasing was shown in aggregate stability of rice in comparison with wheat. Puddling is the reason of dispersion of soil surface aggregates [14, 3]. Some factors such as soil texture, type of clay minerals, CEC value, the amount of organic matter, extractable iron affect the aggregate stability [15].

Fig. 2. shows that the highest (MWD) was recorded in the lowest clay content, this effect cannot clearly be attributed to different levels of clay content in the soils[2,5].

The steady-state infiltrability values are presented in fig. 3. The observed values differ between cultivations and reveal a strong dependence of the (IR) between paddy rice cultivation and wheat cultivation, which is due to an increasing in BD of plough pan(table1). Infiltration rate of the puddle horizon was found to be 0.48 cm/hr, but in wheat cultivation it was 0.7 cm/hr (table 2). Infiltration rate decreases further after 14 cycles of ploughing and compaction [7].

About 2-3 percent differences in (PSD) of three soils, that is the soils with similar characteristics were selected for the research.

Degradation of soils is done because of puddling by disperses surface aggregates, increasing bulk density and decreasing mean weight diameter and infiltration rate.

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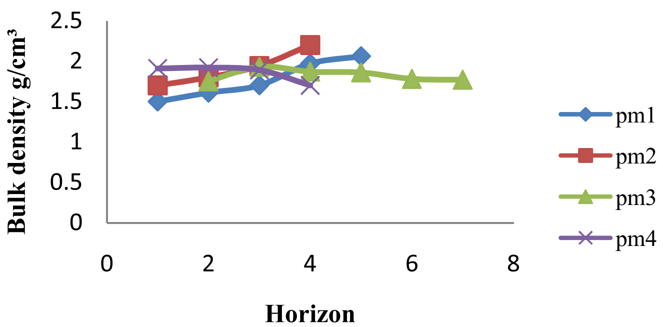

Figure 1. Bulk density of different profiles

(Pm1 shows wheat, pm2 and pm3 shows wheat-rice and pm4 shows rice cultivation).

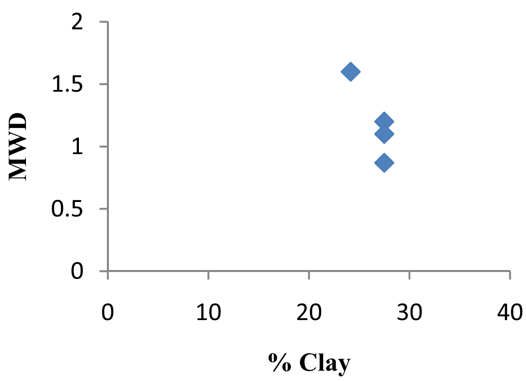

Figure 2. Relationship between clay content and MWD.

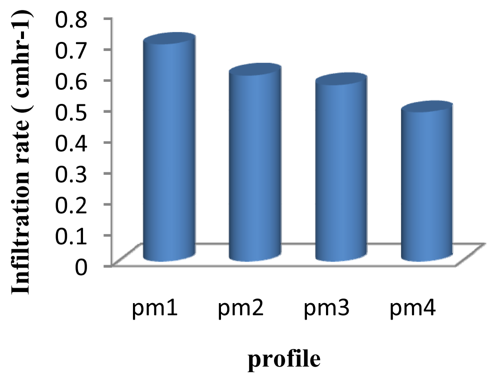

Figure 3. Compare infiltration rate in different fields.

TABLE I. SELECTED PROPERTIES OF THE SOILS

Profiles	Horizon	Depth (cm)	Texture	Sand (%)	Clay (%)	Silt (%)	Bulk density(g/cm³)
pm1	Ap	0-20	Sandy Clay Loam	55.83	24.16	20.01	1.5
(Wheat)	Bd	20-53	Sandy Clay Loam	59.16	24.16	16.68	1.61
	2Btky1	53-98	Sandy Clay Loam	52.5	20.83	26.67	1.7
	2Btky2	98-140	Sandy Clay Loam	65.83	20.83	13.34	1.97
	2Btky3	>140	Loam	45.83	20.83	33.34	2.06
pm2	Ap	0-34	Clay Loam	39.16	27.5	33.34	1.7
(Wheat- Rice)	Btk	34-50	Sandy Clay Loam	59.16	20.83	20.1	1.8
	Btky1	50-83	Sandy Clay Loam	52.5	20.83	26.67	1.94
	Btky2	83-121	Sandy Clay Loam	65.83	20.83	13.34	2.2
	C	>121	_	_	_	_	_
pm3 (Wheat- Rice)	Ap	0-35	Clay Loam	22.5	27.5	50	1.75
	Bd	35-62	Sandy Clay Loam	49.16	27.5	23.34	1.93
	2Btk1	62-101	Loam	29.16	24.16	46.68	1.87
	2Btk2	101-135	Loam	29.16	24.16	46.68	1.86
	2Btk3	135-164	Loam	35.83	24.16	40.01	1.9
	2Btk4	>164	Loam	35.83	24.16	40.01	2.1
pm4	Ap	0-20	Clay Loam	25.83	27.5	46.67	1.9

(Rice)	Bd	20-50	Clay Loam	35.83	30.83	33.34	1.92
	Btk	50-77	Clay Loam	29.16	30.83	40.01	1.89
	Bg	77-95	Loam	29.16	24.16	46.69	1.7
	C	>95	_	_	_	_	_

TABLE II. PHYSICAL SOIL PROPERTIES

Profile	MWD	Infiltration rate(cmhr-1)
pm1	1.6	0.7
pm2	1.2	0.6
pm3	1.1	0.57
pm4	0.87	0.48