INTRODUCTION

The relations between soil and water are complex. Being informed of these relations is of great importance in various issues of irrigation and drainage [1]. For example, soil moisture characteristic curve is the most important physical characteristics of soil. It shows the relationship between suction (matric potential) and soil moisture. Some of the effective factors on soil moisture characteristic curve are hysteresis, soil structure, porosity, form of soil pores, soil compaction, temperature and the soil mineral materials [1]. The slope of soil moisture characteristic curve is mild because in heavy soils, the distribution of soil pores is more uniform and most of the moisture is absorbed by soil particles surface but in coarse soils due to coarse pores, great part of moisture is emptied in a specific suction suddenly and the characteristic slope is getting steeper [1, 8, 14]. Moisture characteristic curve in low suction is greatly dependent upon soil structure but in strong suction due to the increase of adsorption is mostly affected by soil texture [1, 8, 14]. Hysteresis defines that soil behavior is not equal during the advance of a process with its behavior during the return of the same process (Alizadeh, 2011). In equilibrium state in definite suction, soil moisture during the dryness is more than the wetting phase and then, soil characteristic curve in dryness is above the related curve in wetting phase. This means that during drainage, water is kept in soil with more force. Generally, hysteresis reasons are as follows [2, 6–8, 12, 14].

1—Heterogeneity of soil pores is called ink bottle. Matric potential (suction) of soil during dryness is compatible with the fine pores of soil and during wetting phase is compatible with the radius of coarse pores and as these two values are different, dewatering process is not compatible.

2—The influence of water contact angle with soil, in which contact angle during water adsorption is greater than contact angle during dryness.

3—Retained air reducing the soil water capacity.

4—Expansion and contraction of clay particles affecting the soil structure and the deformation of soil pores.

It can be said that among the above factors, the first factor has great importance in creating hysteresis [8]. Prunty and Bell (2007) showed that in low moisture that little change in the moisture leads into considerable change of soil matric potential, moisture hysteresis is of great importance and then, it should be con-
considered in soil physics issues. Ball and Robertson (1994) showed that moisture hysteresis is more observed in ploughed soils than natural soil. Baybordi (2005) believed that hysteresis is effective on the amount of moisture measured by gypsum block.

One of the effective factors on the content and soil moisture capacity is soil compaction being evaluated in agricultural land with bulk density index. Soil compaction can be effective on soil structure and soil matrix potential (for a specific moisture). In other words, soil compaction can affect intensity of hysteresis.

There are various methods and tools to measure the moisture and potential of soil matrix. One of the easiest methods is gypsum block [9]. Qanadzadeh et al. (2009) in a study evaluated five kinds of gypsum blocks. The blocks were different based on the type of gypsum and the composition of various values of gypsum and cement. The results showed that the blocks made of the composition of gypsum and cement had significant correlation with the moisture of soil.

Ghahreman et al. (2009) by calibration of gypsum block in three textures of soil (sandy loam, loam and clay loam) and in five levels of salinity of soil saturation extract (ignorable, 2, 6, 10, 18 dS/m) presented some equations to correct the read of gypsum block and removing the effect of salinity.

Malazian et al. (2011) evaluated the performance of the MPS–1 sensor by testing for a wide range of varying soil conditions, including temperature and hysteresis. The results showed that hysteresis had little influence on the performance of sensor in measuring the soil matrix potential.

Alizadeh et al. (2009) evaluated the effect of soil compaction and texture (sand, loam and clay) on the accuracy of Teta probe. The results showed the device in sand soil had the highest accuracy and by increasing the amount of clay, the accuracy of the device is reduced. The effect of soil compaction on the accuracy of the measurements in sand soil was ignorable and by heavy soil texture, the effect of soil compaction on the accuracy of device is increased.

Considering the effect of soil compaction on hysteresis and the effect of these on the amount of moisture of gypsum block, this study was done by the following aims:

1—The investigation of the effect of soil compaction on hysteresis
2—The investigation of the effect of hysteresis on the performance of gypsum blocks
3—The investigation of the effect of soil compaction on the performance of gypsum blocks

MATERIALS AND METHODS

In this study, the experiment was done in a heavy texture soil in three bulk density (natural in the farm and plus 10% and minus 10%) and for two phases of wetting and drying. To do this, bulk density of natural soil was measured in farm (sampling location) with the value 1.2 gr/cm³. Soil texture (Silty Clay) was determined by hydrometer method [4]. Based on the soil bulk density, the moisture of soil and vase volume, soil mass being poured in the vase was calculated. This soil mass was poured as 5 cm layers inside the vase such that specific bulk density was obtained. After putting the gypsum block in the vase, the measurement of soil moisture by weighting method and block reading was done consecutively. At first, the test was carried out during drying phase and then without taking the soil and block out of the vase, it was done wetting process. During drying process, in the interval of both consecutive readings, the vase was put for 24 to 48 hours exposed to in the open atmosphere (to reduce moisture) and by putting the plastic cover on soil surface, it was put in the shade (to make the moisture distribution in vase more uniform). Also, during wetting process, after adding water to vase, besides putting the plastic cover on soil surface, the vase was put for 24 hours in the shade. The experiment was carried out in three bulk density including natural bulk density in the soil and plus 10% and minus 10%. In this study, gypsum block model 5201F1L and reader model 5910F1 were applied. This reader showed the value of electric resistance of the block as zero to 100 indexes (zero for dry block with the maximum electric resistance and 100 for saturation block with the minimum electrical resistance).

RESULTS

Calibration curve of gypsum block is shown in two stages of drying and wetting in various compactions in Fig. 1. As is shown in this figure, hysteresis has considerable effect on calibration curve of gypsum block. Like the moisture characteristic curve, calibration curve of the block during drying is above the related curve in wetting phase and its reason is explained in the previous section. The effect of hysteresis on calibration curve of gypsum block is increased by decreasing soil compaction (the reduction of soil bulk density). This is due to the fact that by reducing soil compaction and because of soil heavy texture, the fine pores are reduced and in other words, soil pores distribution gets non-uniform. Thus, considering the effect of ink bottle, hysteresis is increased. Because of this, by increasing soil bulk density, due to the uniform distribution of the pores, calibration curve of gypsum curve in two phases of drying and wetting gets closer.

Calibration curve of gypsum block in various bulk densities during drying and wetting is shown in Fig. 2 and 3, respectively. The results show that the effect of soil compaction on calibration curve of gypsum block during drying inverse is in wetting stage and this is due to moisture hysteresis. As is shown in Fig. 2, during drying as a definite soil moisture by increasing soil bulk density (soil compaction), the electrical resis-