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Assessment the Effect of Different Planting Pattern (Rice-Wheat, Corn-Wheat) and Growth Stage on Soil Chemical Properties

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ABSTRACT

Conducting research on monitoring contaminated fields by heavy metals is necessary in order to achieve sustainable agriculture, increase product quality and keep public health. This study was carried out using split plot experiment based on randomized complete blocks design with three replications during 2014-2015 in Khuzestan agricultural research center in order to evaluate the effect of cropping systems and different growth stages on arsenic content and other chemical properties of conventional cultivation. The main factor consisted of planting pattern at two levels (rice-wheat and corn-wheat), and the sub-factor included different growth stages in three levels (Tillering, flowering, and maturity). The results of the analysis of variance showed that the effect of cultivation system on concentration of arsenic, cationic exchange capacity, electrical conductivity, soil organic matter, phosphorus concentrations, pH, and concentration of soil lime was significant at 1% probability level. The effect of different growth stages on all traits except of electrical conductivity (at 5% probability level) was non-significant. The interaction effects of the treatment on all traits were non significant. According mean comparison rice-wheat cropping system had more arsenic concentration (8.68 mg.kg^{-1}) than corn-wheat cropping system (6.73 mg.kg^{-1}). Comparison of different growth stages showed that soil electrical conductivity decreased over time; therefore, the lowest concentration was found in maturity stage (2.62 ds.m^{-1}) that was affected by continuous irrigation. Arsenic and phosphorus are absorbed via similar system by plants because of they are analog; so low concentration of phosphorus and high concentration of arsenic lead to the activation of the absorption system which results in increased absorption of arsenic compared to phosphorus. Finally use of phosphorus fertilizers based soil test is recommended according standard of soil and water institute.

Keywords*:* *Arsenic, Phosphate Fertilizer, Ripening, Rotation.*

INTRODUCTION

Agricultural soils in many parts of the world are slightly or moderately contaminated by heavy toxic metal such as cadmium, copper, zinc, nickel, cobalt, chrome, lead, and arsenic (Yadav, 2009). Arsenic is a natural component of the earth's crust. It can be found in soil and water that have interacted with arsenic rich rocks. (Hezbullah *et al*., 2016).

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Arsenic contamination of soil can occur as a result of both natural sources and anthropic activities, including the use of arsenical pesticides and herbicides, atmospheric deposition, mining activity, waste disposal, and other sources (Mandal and Suzuky, 2002). There is increasing concern worldwide regarding the contamination of soil with arsenic and the potential risk to human and environmental health arising from mention contamination (Smith *et al*., 1998). Plants exposed to high arsenic concentrations show reduced germination, decreased chlorophyll content and photosynthesis rate, reduced height, tillering or ramification, decreased root and aerial biomass growth and yield (Talano *et al*., 2013). Arsenate is toxic to plants because it acts like phosphate and is transported through the plasmatic membrane by the phosphate carriers (Smith *et al*., 2010). Arsenic concentration level in plants followed that trend: roots > leaves > shoots > pods > grains (Lee and Yu, 2012). Food and Agriculture Organization (FAO) recommends the daily intake of 15 micrograms of inorganic arsenic per kilogram of body weight (The Joint FAO/World Health Organization, Expert Committee on Food Additives; JECFA, 2000). Bustingorri *et al.* (2014) found a negative correlation between soybean yields and soil arsenic concentration, in agreement with similar studies in rice, wheat, and barley crops. Azimzadeh and Khademi (2012) showed that arsenic concentration in rice fields between Amol and Babol has increased significantly due to continuous use of chemical fertilizers and pesticides. Liu *et al.* (2012) by studied the uptake of arsenic, phosphorus and the soil arsenic bioavailability at different growth stages of wheat and rapeseed concluded wheat yields were elevated at low rates of arsenic addition (<60 mg.kg^{-1}) but reduced at high rates of arsenic concentrations (80–100 mg.kg^{-1}); while the growth of rape had not showed significant responses to the arsenic addition. Karimi *et al.* (2015) showed that with increasing the arsenic concentration in irrigation water, arsenic levels of roots, shoots and seeds increased. Arsenic uptake rates decreased in the presence of phosphate. Also, at 125 and 625 mg.l^{-1} arsenic concentration levels, the measured arsenic concentrations of seed and shoot exceeded the tolerance limit, regardless of the phosphate presence. Among wheat varieties, Sardari had significantly less uptake of arsenic compared with two other varieties. Besides, phosphate concentrations in all wheat varieties followed the following order: seed > root > shoot. Reichmans (2007) investigated the effect of different concentrations of arsenic on the dry weight of the root, shoots, and height of beans. The results showed that the highest dry weight of shoot was observed in control treatment without arsenic; then as arsenic concentration increased up to 5 micro molar, the dry weight of shoot decreased. Although the dry weight changes of aerial organs in beans were not significantly different from each other at concentrations of 5, 7.5, and 10 μM arsenic, the dry weight of aerial organs in these treatments, in comparison with control treatment and 2 μM arsenic decreased significantly. Mc-Bride *et al.* (1997) studied an experiment on the columns of soil treated with sewage sludge where red clover was planted. They reported that the process of heavy metals absorption in the plant shoots followed the following pattern: Mn> Zn> Cu> Mo> Ni> Cd> Pb> As. Otones *et al.* (2011) studied soils and vegetation of floodplain of the Elbe River in Germany in terms of heavy metals pollution. The results showed bio-accessibility to elements such as mercury, nickel, and lead in the soils was high for cultivated crops and there was the risk of their entering into the human food chain. Transfer coefficient varies in different seasons and months of the year, depending on the river overflows and it has changed as follows in average: Ni> Zn> Cu> Cd> As> Hg> Pb. The World Health Organization has determined the allowed rate of arsenic in drinking water as 10 µ gr.l^{-1} (WHO, 2006). Wang and Zhou (2005) examined the react of legume and non-legume species to the uptake of heavy metals in contaminated soils in field and greenhouse research and stated that among the plant species, corn absorbed the maximum amount of manganese, arsenic and cadmium and wheat absorbed the highest rate of lead.

Kohian-Afzal (2004) reported in his study that the increase of arsenic concentration with the increase of arsenic-bearing treatments was significant both in shoots and root and stated that arsenic concentration in the root of the spinach, radish and lettuce was more than its concentration in aerial organs. Ladan (2010) reviewed the capability of refining the soils contaminated with arsenic via ornamental cabbage and scallion. The results showed that with regard to low absorption of arsenic by scallion, this plant is not a good option to clear pollution from arsenic-polluted soils. With increase of arsenic in soil, its absorption by ornamental cabbage increased and this trend continued up to a concentration of 200 mg.kg^{-1}; in a concentration of more than 200 mg.kg^{-1} due to the incidence of arsenic toxicity (even with apparent symptoms as necrosis) the absorption of this element decreased. Kardan (2011) examined the effect of organic fertilizers on increasing the uptake of arsenic by cress in soil contaminated with arsenic. The results showed that with increasing concentration of arsenic, the dry weigh of shoots decreased in plant. This trend shows a decrease in the efficiency of the plant at high concentrations of arsenic. Although organic matter by itself did not increase the ability of cress to absorb arsenic, the interaction, and the increase of organic matter increased uptake index as well as the transfer coefficient. Therefore, it can be said that organic matter increased arsenic absorption ability by cress. Monitoring arsenic element according several planting pattern and different growth stages to evaluate arsenic pollution trends in cultivated soils to keep healthy product is very important. Therefore, this research was carried out to examine the change of soil properties under influence of prevailing cultivation systems and different growth stages.

MATERIALS AND METHODS

Field and treatment information

This research was conducted in shavoor research station to monitoring arsenic concentration in soil and plant in two main cropping systems in Khuzestan province (south west of Iran) via a split plot experiment based on randomized complete blocks design with three replications during 2014-2015. The main factor included two cropping systems (rice-wheat, corn-wheat) and sub factor included different growth stages (Tillering, flowering, and maturity). Place of research was located in 70 km North of Ahvaz at longitude 48 27′33″E and latitude 32"37' 0 N in Khuzestan (Southwest of Iran). The average annual rainfall, temperature, and evaporation in region is 240 mm, 22 C and 3000 mm, respectively.

Traits measure

Before planting compound samples of the soil were taken from a depth of 0-30 cm. The dried samples of soil were passed through 2 mm sieve and some of physical and chemical properties (soil texture, pH, salinity, organic matter, cation exchange capacity, percent of lime, phosphorus) were measured (Table 1). Then, at different growth stages concentration of arsenic in the soil was measured. In addition, some soil properties such as pH, salinity, organic matter, cation exchange capacity, lime and phosphorus were measured. The same steps and examining the concentrations of arsenic were done in the second cultivation system.

Table 1. Soil properties of experiment site (depth: 0-30cm)

EC ($ds.m^{-1}$)	pH	P_b ($g.cm^{-3}$)	OC (%)	P	K	Fe	Cu	Mn	Zn
				(ppm)					
2.8	7.8	1.35	0.7	10.9	239	9.6	1.3	8.5	0.6

Total arsenic concentration in soil

The soil samples were digested by the nitric acid and hydrochloric acid in Erlenmeyer flask using an electrical stove. One gram of soil sample with the accuracy of 0.1 milligram was measured and moved to the Erlenmeyer flask. One or two control samples were also prepared along with the sample according to the method. Then 10 milliliter of Aqua Regia was added to the sample drop by drop. Then, the sample was kept in the room temperature for one night and the next day 4 four glass pellets were added to it and the small funnel (or glass hour) was placed in the mouth of the flask and was heated for 2 hours at temperature of about 95 centigrade. Then, Erlenmeyer flask was removed from the stove and after getting cool, the funnel or glass hour was washed with nitric acid one percent, and the solution was transferred to the flask. Then the solution was filtered inside 50 milliliter Joje Balloon and through filter paper and was washed with a little nitric acid 1 percent in flask and reached the volume. Finally, arsenic concentration in prepared extract was read by graphite furnace device (Hudson *et al.*, 2004).

Soil Salinity

Soil salinity was measured in extracts prepared from soil samples by EC meter with glass electrode in a soil suspension with the volume ratio of 1 to 5 using potassium chloride solution of 0.01 molar. Reading was done by EC meter (Page *et al.*, 1982).

Soil Acidity

First saturated soil was prepared via p2sp standard method; pH meter was calibrated by buffer solutions with pH of 4, 7, and 9.18. The electrode was gently inserted in the saturated soil as far as the junction of KCl electrode was placed under the surface of saturated soil. After the pH meter was stable, the pH was recorded to 0.01 levels and rate of acidity was read (Page *et al.*, 1982).

Soil Organic Carbon

10 ml of normal potassium dichromate I as well as 10 ml of concentrated sulfuric acid were added to 1 gr of soil and were left for half an hour. Then 100 ml distilled water and 15 drops of phenanthroline reagent were added and titrated with ferrous ammonium sulfate (0.25 M) to achieve red color. Then sample was oxidized by potassium dichromate and sulfuric acid, and after 30 minutes reaction was stopped through diluting with water. Additional dichromate was titrated to ferrous sulfate, and finally organic carbon content was reported based on oven dry weight of soil (Walkely and Black, 1934).

Cation exchange capacity

In general, cation exchange capacity is a marker for the total amount of negative loads per mineral weight unit and is expressed by m Eq. per 100 gr. For this purpose and in order to measure CEC, 100 ml of sodium acetate was added to 5 g soil in three times, so that each time 33 ml of sodium acetate was added and the mix was shaken for 10 minutes. Then, the mi was centrifuged for 3 minutes and the upper extract was removed and in the next step the same action was done with alcohol and each time the upper extract was read with EC meter and when it was almost equal to Alcohol EC, washing was stopped. In the third step, 100 ml of the normal ammonium acetate I was added in three steps and after the operations mentioned at each step, the upper extract was removed and the rate of its sodium was measured with a flame photometer (Sumner and Miller, 1996).

Soil texture

Fifty grams of dry and sieved soil and was placed in a container and 50 ml of Calgon solution and 300 ml of distilled water were added to it and were mixed with electric mixer for 5 minutes. The resulting mixture was transferred to a one-liter graduated cylinder and was brought to the one liter of distilled water. Then it was mixed by manual mixer and after 40 seconds and in different times (5 hours) the particles were read by hydrometer. Then, by doing necessary corrections the percentage of sand, silt, and clay was calculated (Gee and Bauder, 1986).

Concentration of soil phosphorus

Soil extract was prepared with normal sodium bicarbonate 0.5. The phosphorus of this extract was measured through by Olen method and using ascorbic acid as the regenerative material and calorimeter at the wavelength of 880 Nm (Olsen and Sommers, 1982).

Lime soil

First, 5 g soil was weighed and 100 cm^3 of normal hydrochloric acid was added to it. Then, solution was filtered and 20 cm^3 of it was titrated by base and the amount of calcium equivalent to lime was measured (Ehyaee, 1993).

Statistical Analysis

Analysis of variance and mean comparisons were done via SAS software (Ver.8) and Duncan multiple range test at 5% probability level.

RESULTS AND DISCUSSION

Arsenic concentration in soil

The ANOVA results showed that the effect of cropping systems and different growth stages on arsenic concentration were significant and non-significant at 1% probability level, respectively (Table 2). According to the mean comparisons, the rice-wheat cropping system had higher amounts of the arsenic (8.86 $mg.kg^{-1}$) than the corn-wheat cropping system (6.73 $mg.kg^{-1}$) which is lower than the critical level (10 $mg.kg^{-1}$) (Table 3). It should be noted that soils with the total arsenic concentration more than critical level are considered as polluted (Adriano, 2001). Higher concentration of arsenic in rice-wheat lands in comparison to the lands with corn-wheat cropping systems is due to the use of more phosphate fertilizers in the corn-wheat cultivation; when phosphorus solubility increases arsenic toxicity decreases and much the use of phosphate fertilizers leads to the movement of arsenic from the root to crop (Woolson *et al.*, 1971). Arsenic and phosphorus compete with each other during absorption through the cell membrane through and usually arsenic uptake is inhibited with the increase of phosphorus (Chen *et al.*, 2006). Arsenic availability in soil depends on the pH (Chambers *et al.*, 1998). The arsenic toxicity increases in acidic soils particularly in pH less than 5 when the species that can be linked with arsenic such as oxygenated compounds of iron and aluminum are mainly found soluble, but arsenic absorption by the plant may increase in soils with high pH. The total arsenic concentrations in soil enhances in proportion with organic materials in the soil. Some soil factors, such as low pH, low concentrations of the soil phosphorus and abundance of organic ligands have been known as factors enhancing uptake of arsenic into the plant shoots (Chen *et al.*, 2003). Arsenic in heavy soils is more than light soils, and arsenic concentration in the clay soils is more than sandy soils (Mahimairaja *et al.*, 2005). The amount of heavy elements displaced in the soil environment is a function of the amount of clay, organic matter, and cationic exchange capacity. Interaction effect of treatments on measured trait was no significant (Table 2). The means comparison showed that there was no significant difference among different growth stages, but there was a decreasing trend in the total levels of arsenic from the tillering stage (7.84 $mg.kg^{-1}$) to maturity stage (7.54 $mg.kg^{-1}$) (Table 3). This result is similar to finding of some researchers (Ebrahimi *et al.*, 2013). The mean arsenic concentration in non-polluted soils ranges from 5 to 10 micrograms per gram. Maximum allowed concentration of the total arsenic in agricultural soils in Iran, UK, Germany, Poland, Canada and Australia is considered 10, 20, 40, 30, 25 and 50 $mg.kg^{-1}$, respectively (Ghaban, 2002).

Table 2. ANOVA result of measured traits

S.O.V	df	As_{Soil}	CEC	EC	O.C	P	pH	TNV
Replication	2	0.0760^{*}	0.0830**	0.885*	0.9620^{**}	0.0623^{**}	0.660^{**}	0.0770^{**}
Cropping system	1	555.367^{**}	12.666**	232.881**	118.223^{**}	234.524^{**}	875.50^{**}	123.43^{**}
Error a	2	1189.18	987.456	856.695	1108.146	10876.09	672.72	555.434
Growth Stage	2	1013.066^{ns}	443.042^{ns}	219.488*	171.45^{ns}	152.145^{ns}	133.92^{ns}	654.008^{ns}
Cropping system* Growth stage	2	11.880^{ns}	93.251^{ns}	45.776^{ns}	89.453^{ns}	65.877^{ns}	41.912^{ns}	34.143^{ns}
Error b	4	11648	13107	3124	51.28	6084	2264	6414
CV (%)	-	14.27	7.33	17.84	9.36	8.572	6.37	1.98

^{ns}, * and **: no significant, Significant at 5% and 1% of Probability level, Respectively. **As_{Soil}:** Arsenic of soil, **CEC:** Cation exchange capacity, **EC:** Electrical conductivity, **O.C:** Organic carbon, **P:** Phosphorus, **TNV:** Total Neutralizing Value.

Table 3. Mean comparison of cropping system and growth stage on measured traits

Treatment	As_{Soil} ($mg.kg^{-1}$)	CEC (meq.100gr)	EC ($ds.m^{-1}$)	O.C (%)	P ($mg.kg^{-1}$)	pH	TNV (%)
Cropping system							
Rice-wheat	8.68^{a*}	16.11^{a}	3.76^{a}	0.89^{a}	7.33^{b}	7.01^{b}	39.56^{b}
Corn-wheat	6.73^{b}	14.83^{b}	2.50^{b}	0.67^{b}	10.83^{a}	7.86^{a}	41.21^{a}
Growth Stage							
Tillering	7.84^{a}	15.60^{a}	3.67^{a}	0.83^{a}	9.26^{a}	7.55^{a}	40.54^{a}
Flowering	7.73^{a}	15.45^{a}	3.12^{ab}	0.78^{a}	9.11^{a}	7.44^{a}	40.37^{a}
Ripening	7.54^{a}	15.36^{a}	2.62^{b}	0.73^{a}	8.89^{a}	7.32^{a}	40.24^{a}

*Similar letters in each column show non-significant difference at 5% level in Duncan's Multiple Rang Test.

Soil organic matter

The ANOVA results showed that the effect of cropping systems and different growth stages on soil organic matter were significant and non-significant at 1% level, respectively (Table 2). According to the mean comparisons, lands with rice-wheat cropping system had higher amounts of the soil organic matter (0.89%) than the corn-wheat cropping system (0.67%) (Table 3). Organic matter, due to the constructive influences on chemical properties of soil (keeping essential elements and increasing the ease of ability to absorb nutritious elements by plant) and impact on physical characteristics of the soil (increasing soil sustainability) requires proper management in the farms. Cultivation systems have a great effect on organic matter accumulation in soil; therefore, rice-wheat rotation due to more plant residues have more amounts of organic matter in the soil which influence the increased solubility of arsenic in these areas (Kirkhan, 2006; Fitez and Venzel, 2002). Researchers stated that the dominant concentration of heavy metals uptake depends on both the rate and the type of organic matter in soil. Therefore, decomposition of the organic species of heavy metals causes the release of these elements as bio-available form, which may be toxic for agricultural products (Nolan *et al*., 2005). Bahmanyar (2008) concluded in his studies that the amount of organic matter in the surface layer of the soil increased in lands under rice cultivation. The increase of organic matter in rice cultivation uses and rice rotation with other products is due to continuous cultivation of rice, creation of the anaerobic conditions, improper the conditioning of soil, and accumulation of plant tissues in the surface layer of the soil, especially crop rotation. Interaction effect of treatments on measured trait was no significant (Table 2). According to mean comparisons, there was no significant difference between different growth stages, but there was a decreasing trend in organic matter level from the initial steps of tillering stage (0.83%) to the maturity (0.73%) (Table 3). Although the difference is not significant, the decreasing trend is probably due to the consumption of soil organic matter during the growth and development trend.

Soil phosphorus

The ANOVA results showed that the effect of cropping systems and different growth stages on soil phosphorus were significant and non-significant at 1% level, respectively. According to the mean comparisons, corn and wheat cropping system had higher amounts of soil phosphorus (10.83 $mg.kg^{-1}$) than rice-wheat cropping system (7.33 $mg.kg^{-1}$) (Table 2). There is an inverse relationship between the rate of soil arsenic and the soil phosphorus (Tu and Ma, 2004). The declining effect of phosphate in rice-wheat rotation is probably due to the analogue state of arsenic and phosphorus together and since they are absorbed through a similar system they affect absorption of one another via the cell membrane. In similar concentrations of arsenic and phosphate, the efficacy of plants root to absorb phosphate is more than arsenic. Low concentration of phosphorus in the plants growth environment under the arsenic stress leads to the activation of this uptake system which results in the increase of arsenic absorption rather than phosphorus. Due to physical and chemical similarities between arsenic and phosphate, these two ions compete for being absorbed on the surface of colloids. Therefore, when phosphorus solubility enhances, arsenic toxicity reduces, and much use of phosphate fertilizers lead to the transfer of arsenic from the roots (Woolson *et al.*, 1971). Shalikar *et al.* (2009) concluded that the amount of phosphorus in rice-bean crop rotation increased in comparison to rice-fallow and rice-clover rotations and which is due to further increase of organic matter in this crop rotation or difference in the management because of heterogeneous use of the phosphorus fertilizers in this crop rotation. According the mean comparison there was no difference between different growth stages, but there was a decreasing trend from the tillering stage (9.26 mg.kg^{-1}) to maturity stage (8.89 mg.kg^{-1}) (Table 3). The ANOVA results showed that interaction effect of treatments on soil phosphorus trait was non significant (Table 2). It should be noted that phosphorus is an element with very low mobility and it will be available for the plant very slowly. Therefore it has a low range of changes during the cultivation until the harvest which is very limited and ignorable. Malakoti *et al.* (2005) stated that the average for critical limit of phosphorus was 10.5 mg.kg^{-1}.

Soil Acidity

The ANOVA results showed that the effect of cropping systems and different growth stages on soil acidity were significant and non significant at 1% level, respectively (Table 2). According to the mean comparisons, corn-wheat cropping system had higher amounts of soil acidity (7.86) than rice-wheat cropping system (7.01) (Table 3). The reduction of pH could be due to the increase of organic matter. Rotation has a great effect on soil acidity. Soil acidity in farms with flooding conditions (like paddy soils) is almost neutral and their redox potential is about 200 mV (Maejima *et al.*, 2007). Marchner (2003) stated that in various studies there was an inverse relationship between the increase of rhizosphere pH and buffering power percentage of clay soil, and pH changes have been observed in sandy soils with low buffering power. High buffering power of soil and initial pH of soil have an effective role in the rhizosphere pH changes. Therefore, the increase of rhizosphere pH leads to the increase of negative surface load in soil minerals and decreases the absorption of arsenic anions and soluble arsenate increases in this state. Comparison of the means showed that there is no significant difference between different growth stages. After the initial stages of plant growth and development, a decreasing trend is observed in the rates of soil acidity. Soil acidity is 7.55 at tillering stage and 7.32 at maturity stage (Table 3), gradually a decreasing trend was observed in the rate of soil acidity as we approached to the ending stages of growth which could be related to frequent irrigation and rainfall during the cultivation season which reduces the soil acidity. Interaction effect of the treatments on measured trait was no significant (Table 2). Bahmanyar (2008) and Chen-Ming *et al.* (1994) stated that cultivation in the soils of paddy fields causes the change of pH towards neutral. The cultivation in the soils of paddy fields causes the change of pH towards neutral and the increase of organic matter.

Soil lime percentage

The ANOVA results showed that the effect of different cropping systems and various growth stages on lime soil were significant and non-significant at 1% level, respectively (Table 2). According to the mean comparisons, corn-wheat cropping system had higher amounts of soil lime (14.21%) than rice-wheat cropping system (39.56%) (Table 3). Blackmore *et al.* (1987) stated that since arsenic in calcareous soils is in nonabsorbable forms and even though the significant increase of arsenic in some soil treatments are even more than the normal level, this matter has not had a significant negative effect on the rotation. Moreover, this issue can be related to the physiology of plant itself. Therefore the kind of plant and soil conditions can have great effects on the rate of arsenic. Water logging in calcareous soils reduces pH and lowers redox potential which depends on the rate of soil organic matter and short period of waterlogging and low rate of organic matter cannot direct oxidation-reduction process to negative value (Khoshgoftarmanesh and Kalbasi, 2012). Soils with more than 5% lime are called calcareous soils. A wide area of Iran is covered by calcareous soils which can be due to nature of native material and low rainfall. Comparison of the means show that there is no significant difference between different growth stages in terms of soil lime percentage, although as the time passes from tillering stage (40.54%) to maturity stage (40.24%), a decreasing trend is observed in the rates of soil lime (Table 3). The ANOVA results indicated that the interactive effect of cropping systems and various growth stages on lime percentage was not significant (Table 2). Alloway (1990) stated that arsenic in limestone is 1 to 20 $mg.kg^{-1}$, and in phosphate stones it is less than 100 to $mg.kg^{-1}$. Mahimairaja *et al.* (2005) believed that lime is one of the factors influencing the absorption of soil arsenic and it reduces soil arsenic mobility.

Cation exchange capacity

The effects of different cropping systems and various growth stages on the cation exchange capacity were significant and non-significant at 1% level, respectively (Table 2). According to the mean comparisons, rice-wheat rotation had higher amounts of cation exchange capacity (16.11 mEq per 100 g soil) than corn-wheat rotation (14.83 mEq per 100 g soil) (Table 3). One of the reasons of the increase of cation exchange capacity in the use of rice-wheat rotation and other products rather than the use of corn-rice rotation is the increase of organic matter in the surface layer of soil. Moreover, the cause of its increase in the hard layer of plowing pan of rice cultivation is clays with many layer loads (Binggan and Linsheng, 2010). The increase of organic matter and sewage sludge leads to the increase of soil cationic exchange capacity. Organic matter colloids get negative charges due to the ionization of active agent groups such as carboxyl and hydroxyl and these charges increase the soil cationic exchange capacity several times. Therefore, high cationic exchange capacity of the studied soils indicates their high potential to hold elements in soil (Williams and Wollum, 1981). The permitted amount of heavy metal accumulation and entry depends on the soil CEC (cationic exchange capacity) and the amount of metals entry to the soil increases as the cation exchange capacity increases (Dolgen *et al.*, 2007). Cation exchange capacity in rice-bean and rice-fallow crop rotations has increased in comparison with rice-clover crop rotation which is due to more organic matter in rice-bean crop rotation and more amounts of clay in rice-fallow crop rotation (Shalikar *et al.*, 2009). Comparison of the means showed that there were no significant difference between different growth stages in terms of cation exchange capacity, but a decreasing trend can be observed in the level of cationic exchange capacity from tillering stage (15.60 mEq per 100 g soil) to maturity stage (15.36 mEq per 100 g soil) in the soil of agricultural lands (Table 3). The

ANOVA results indicated that the interaction effect of cropping systems and various growth stages on cation exchange capacity was not significant (Table 2). Khan-Mirzaei *et al.* (2012) measured the mean cationic exchange capacity of the soils as 14.88 in the range of 5.2 to 26.6 Cmol per kg.

Soil Salinity

The ANOVA results showed that the effects of different cropping systems and various growth stages on soil salinity were significant at 1% and 5% levels, respectively (Table 2). According to Table 3, rice-wheat cropping system had much higher rate of salinity (3.76 $ds.m^{-1}$) than corn-wheat cropping system lands (2.50 $ds.m^{-1}$) which could result from further times of irrigation in that irrigating system. Chlorine is an element with high concentration in saline soils. With increasing levels of salinity, the rate of acidity decreased and the amount of EC increased (Muhling and Lauchi, 2003). Dehghani *et al.* (2007) stated that the decrease of acidity could be due to the increase of ionic strength and the increase of hydrogen ion activity as a result of the decrease of activity coefficient of that ion, so that because of the increasing salinity of the soil, the cations available in the soil solution have increased sharply. Therefore, H^+ which is on the surface of colloid is replaced with cations and thus the soil solution acidity as well as the soil acidity will decrease. Samplings during different growth stages indicated a significant difference, so that at the initial stages of growth (tillering) the soil sanity rate was higher (3.67) and then by approaching to the ending stages of growth (maturity), the soli salinity level decreased (2.62) (Table 3). The interaction effect of various cropping systems and growth stages on soil sanity was not significant (Table 2).

CONCLUSION

Monitoring the quality of agricultural products provides a mean to ensure consumer protection on one hand, and can be reflected in the international trade (such as stopping imports or exports), on the other hand; therefore, the analysis of wheat elements is essential in terms of the concentration of heavy metals especially arsenic. Since arsenic and phosphorus are absorbed by plants similarly, the use of proper concentrations of phosphorus in the media contaminated with arsenic can be an important strategy to reduce arsenic accumulation in soil because in case of shortage of phosphorus and high concentration of arsenic the plant replaces phosphorus with arsenic. Therefore, the use of phosphate fertilizers is recommended according to the standards of Soil and Water Institute and in accordance with the soil test. All the studied soils had the mean arsenic concentration of 7.56 $mg.kg^{-1}$ which is less than the critical level (10 $mg.kg^{-1}$) in many countries. According to the results, the concentration of arsenic in rice-wheat rotation is more than corn-wheat rotation, which is due to the less use of phosphate fertilizers in the rice-wheat rotation. Arsenic absorption decreased from the beginning to the end of plant growth stages but it was not significant. There was not a significant difference between the qualitative traits of soil at all stages of plant growth. Only salinity was significantly different from tillering stage to maturity stage which could be due to more irrigation occasions. The mean arsenic element concentration in the studied soils was 7.56 mg/kg which is less than the critical level. Some properties of the soil such as low pH, low concentration of phosphorus, low percentage of lime, abundance of organic matter, high salinity and high capacity of cationic exchange increase the concentration of arsenic. The average cationic exchange in the soils was 15.61 m Eq. Moreover, the mean percentage of lime is about 40% which indicates high potential of soils to hold elements in them. Adding organic matter to calcareous soils leads to increase of arsenic absorption. The mean acidity in the soils was 7.47 which is one of the features of arid areas.

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