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Half-Century Air Temperature Trends in Iran

Keivan Khalili[1], Samad Esfandiary[2], Neda Khanmohammadi[3], Mohammad Nazeri Tahrudi[4]

1. Assistant Professor, Department of Water Engineering, Urmia University, Iran, Email: khalili2006@gmail.com
2. Researcher of Soil and Water Research Institute, Jiroft, Iran, Email: esfandiary_samad@yahoo.com
3. Ph.D Student of Water Resource Management, Urmia University, Iran, Email: n.khanmohammadi@yahoo.com
4. Msc Student of Water Resource Management, Urmia University, Iran, Email: m_nazeri2007@yahoo.com

Abstract—Global warming and climate change will have a significant impact on the sustainability of water supplies in the coming decades. Impacts of these changes can be observed in hydrologic time series. In this study annual mean air temperature of 30 synoptic stations of Iran in the period of 1961 to 2010 used to investigate possible trends. Spearman and Mann-Kendall non-parametric trend tests which are known as appropriate tools in detecting linear trends of a hydrological time series are adapted in this study. Results showed that there was no significant difference between Mann-Kendall and Spearman tests and Spearman test employed to trend analysis of all synoptic stations. This analysis indicated that 46.7 and 10 percents of stations detected significantly positive trend at 1 and 5% levels respectively. Almost 6.7% of stations exhibited downward trend at 1% significant level and 36.6% of stations remained without any significant trend. It is concluded that increasing air temperature in most stations of Iran could be as the effect of global warming and climate changes in most parts of Iran.

Keywords—Annual mean air temperature, global warming, Synoptic stations, Trend Analysis

I. INTRODUCTION

Most recent studies indicated global warming, climate change and increasing world's air temperature (Anonymous 2007). Climate change is seen as one of the most important and defining issues of the twenty-first century. The effects of climate change - rising temperatures and sea-levels, shrinking glaciers, changes in range and distribution of plants and animals, changing precipitation patterns, and more intense heat waves are likely to worsen if countries do not reduce their greenhouse gases (Vinnikov et al. 2006). Making the best decisions with regard to global change will depend on a well-grounded understanding of the Earth system and the changes taking place within it. Many climate models and studies have been showed increasing air temperature of the earth. (Yildirim et al, 2004). Therefore, changes in trends of hydrologic time series are of great importance in the world (Zhang et al, 2001; Burn, and Elnur, 2002; Khalili et al, 2013). Trend analysis can be done by two parametric and non-parametric methods. Non-parametric methods such as Spearman and Mann-Kendall are more powerful than parametric methods because in non-parametric methods there are no normality, stationarity or independence assumptions that are not acceptable for most hydrological time series (Zhang et al. 2001). Turkes et al. (1995; 1996) used various non-parametric tests for investigating trend of mean air temperature of Turkey with 63 years data. They demonstrated that mean air temperature of Turkey detected upward trend. Maugeri and Nanni (1998) Showed seasonal and annual mean air temperature of Italy had increased in the last 20 years. Upward trends of minimum and maximum daily air temperature of Italy have reported by Brunetti et al (2000). Yue and Hashino (2003) studied the long term trend in annual, seasonal and monthly temperature in Japan and stated that the air temperature of country has increased from 1900 to 1996. Stafford et al. (2000) investigated air temperature of Alaska duration 50 years and showed that most increasing air temperature occurred in the middle part of country. Ghahraman (2006) investigated trend of mean air temperature of Iran that recorded at 34 synoptic stations and showed that 34% of stations detected positive trend while 15% had negative trend and 41% were without any significant trend. Tabari and Hosseinzadeh-Talaee (2011a) found increasing trends for maximum temperature in the western half of Iran. Tabari and Hosseinzadeh-Talaee (2011b) analyzed trend of yearly, seasonal and monthly minimum and maximum air temperature of arid and semi-arid of Iran in the period of 30 years that recorded at 19 synoptic stations using Mann-Kendall test. The results of this study showed that the annual maximum and minimum temperatures have increased 0.09 and 0.444 (c°) respectively per each decade. Rio et al. (2011) investigated trend of air temperature of Spain using 437 weather stations in the annual, seasonal and

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Issue 8(4), May 2014, pp. 208-213

monthly time scales. Results showed that more than 60% of Spain had increasing air temperature in spring and summer and in all stations air temperature increased about 0.1 to 0.2 (c°).

There are scientific evidences that global warming is due to the human activities in the last 50 years (Xu et al. 2003). Therefore the aim of this study was to investigate the trend of annual mean air temperature of Iran in the last 50 years.

II. MATERIALS and METHODS

The study area

The study area encompasses the entire region of Iran's geographical area of about 1650,000 km^2. Iran is located in Asia, approximately between 25°00′N and 38°39′N latitudes and between 44°00′E and 63°25′E longitudes (Fig. 1). The mean annual precipitation of Iran is about 224 mm. The data were compiled from the Iran Meteorological Organization, and 30 synoptic stations with sufficient length of records during the period of 1961–2010 were selected for the present analysis. Amount of annual average air temperature of selected stations presented in Table 1.

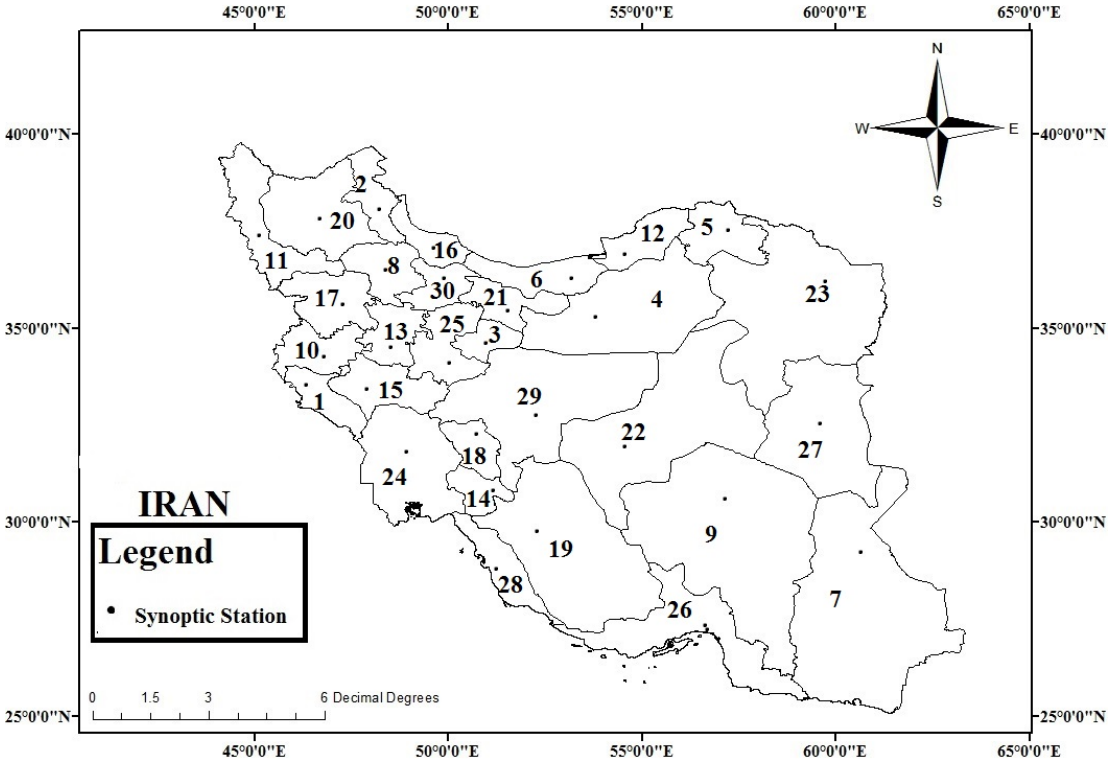

Figure 1: Location of the synoptic stations in the provinces of Iran

Table 1: Annual mean air temperature of 30 synoptic stations in Iran

Station	(c°)	No	Station	(c°)	No	Station	(c°)	No	Station	(c°)	
Ilam	16.873	1	Zahedan	18.518	7	Khoramabad	17.087	15	Mashhad	14.436	23
Ardabil	9.263	2	Zanjan	11.027	8	Rasht	16.067	16	Ahvaz	25.456	24
Qom	18.184	3	Kerman	15.744	9	Sanandaj	13.561	17	Arak	13.899	25
Semnan	18.132	4	Kermanshah	14.522	10	Shahrekord	11.743	18	Bandarabbas	26.940	26
Bojnord	13.362	5	Urmia	11.329	11	Shiraz	17.872	19	Birjand	16.478	27
Ramsar	16.987	6	Gorgan	17.781	12	Tabriz	12.695	20	Bushehr	24.713	28
			Hamadan	10.906	13	Tehran	17.604	21	Esfahan	16.393	29
			Yasoj	15.207	14	Yazd	19.318	22	Qazvin	14.082	30

Mann-Kendall test (MK)

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 208-213

Mann-Kendall is a non-parametric test that has been used to trend analysis of most hydrologic and climatologic time series (Lettenmaier et al, 1994; Ohmura and Wild, 2002). Kendall (1938) proposed a measure "tau" to seek a monotonic relationship between x and y series. Mann (1945) suggested using the test significance of Kendall's tau, where one of the variables is observations of a certain variable, which other is time as a test for trend. The test is known as Mann-Kendall's test (referred to as MK test hereafter), which is powerful on uncovering deterministic trend (Wang et al. 2005). Under the null hypothesis H_0, that a series $\{x_1, x_2, ...x_N\}$ come from a population where the random variables are independent and identically distributed, the MK test statistic is:

$$S = \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \text{sgn}(x_j - x_i) \quad (1)$$

Where, $\text{sgn}(x_i - x_j) = \begin{cases} +1, x_i - x_j > 0 \\ 0, x_i - x_j = 0 \\ -1, x_i - x_j < 0 \end{cases}$

And N is the number of observations. The statistic "tau" is estimated as:

$$\tau = \frac{2S}{N(N-1)} \quad (2)$$

Kendall (1975) showed that the square root of S, for the situations may be tie (i.e., equal values) in the x values, is given by:

$$\sigma_S = \sqrt{\frac{1}{18}[N(N-1)(2N+5) - \sum_{i=1}^{m} t_i(t_i-1)(2t_i+5)]} \quad (3)$$

Where, m is the number of values and ti is the number of some values in the ith tied group.

Under the null hypothesis, the statistic Z defined in the following equation is approximately standard normally distributed for the sample size N>=10 (Douglas et al., 2000).

$$Z = \begin{cases} (S-1)/\sigma_S, S > 0 \\ 0, \quad S = 0 \\ (S+1)/\sigma_S, S < 0 \end{cases} \quad (4)$$

If $Z \leq Z_{\alpha/2}$ then the null hypothesis H_0, there is no trend in time series will be accepted. Otherwise, the H_0 rejected and alternative hypothesis H1 will be accepted at α significance level. It has been found that positive serial correlation inflates the variance of the MK statistic S and hence increases the possibility of rejecting the null hypothesis of no trend (Hirsch, et al, 1982 and Hirsch and Slack, 1984).

Spearman Test

Spearman test was developed by Charles Spearman (1900) and like Mann-Kendall test is a non-parametric. The null hypothesis of test is uniform distribution and independency of time series. The statistic of test with the degree of freedom n-2 is compared with the critical values obtained from the table at 5% significant level.

$$p = 1 - \frac{1 - 6\sum (tu_i - u_i)^2}{(nu^3 - nu)} \quad (5)$$

Where, p is Spearman correlation coefficient, tu_i is defined as i-th rank of observation u_i, nu is number of training data, and $\sum (tu_i - u_i)^2$ is sum of squared differences between ranks. P is normally distributed normally distributed with mean zero and variance equal to $V(p) = \frac{1}{(nu-1)}$.

Spearman statistic is calculated as follows:

$$Z_s = \frac{p}{\sqrt{V(p)}} \quad (6)$$

Z_s is normally distributed and if Z_s|>1.96 the null hypothesis is rejected and time series detect significant trend at 95% level (Yu et al, 2002).

In order to investigate significant difference between Mann-Kendall and Spearman methods, t test method has been applied. Result of this test would show if both trend analysis needed or one method could be enough to test trends of air temperature. For each station statistic of t can be calculated as follow:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{S^2(\frac{1}{n_1} + \frac{1}{n_2})}} \quad (7)$$

In this equation $\bar{X}_1$ and $\bar{X}_2$ are average of statistic value of Mann-Kendall and Spearman tests respectively. n_1, n_2 are

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Issue 8(4), May 2014, pp. 208-213

number of Mann-Kendall and Spearman tests. Also variance of test is:

$$S^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2} \qquad (8)$$

Where, S_1^2 and S_2^2 are variance of statistic value of Mann-Kendall and Spearman tests respectively.

Result and Discussion

Mann-Kendall and Spearman tests compared using annual mean air temperature data recorded in the selected stations. Results of t-test showed that t statistic value is equal to 0.25 and there is no significant difference between Mann-Kendall and Spearman tests. Table 2 represent results of analyzing trend by Mann-Kendall and Spearman methods. Therefore Spearman test employed to trend analysis of all synoptic stations.

Table 2: Statistic of Mann-Kendall and Spearman tests for selected synoptic stations of Iran

station	Spearman	Mann-Kendall
Ahvaz	5.577	6.006
Esfahan	3.410	3.513
Tehran	5.404	5.889
Kerman	4.821	4.919
Urmia	0.929	1.322
Gorgan	0.994	1.188
Tabas	5.557	5.856

As presented in table 3, results of trend analysis showed that three stations (Bushehr, Esfahan and Hamadan Nozhe) detected positive trends at 5% significant level and 14 stations (Mashhad, Ahvaz, Rasht, Sanandaj, Shiraz, Tabriz, Tehran ,Yazd, Zahedan, Kerman, Kermanshah, Ghom, Semnan and Ramsar) detected positive trends at 1% significant level in the duration of 1961-2010. Only two stations (Shahrekord and Khoramabad) exhibited significant negative trend at 5% level. At remained stations there was no significant trend although statistic of 10 stations showed positive trend. Warming trend in air temperature showed global warming effect in Iran during the last 50 years. Similar studies such as Heino et al. (1999) Yue et al. (2002) and Yue and Hashino (2003) showed effect of global warming in different areas of the world. In Iran most studies confirmed increasing air temperature and global warming effect too. Ghahraman (2006) at a similar study in the different time duration and fewer stations showed that 44% of stations of Iran had upward trend which is in accordance with this study. This warming trend detected in Turkey too as a neighbor country with Iran that is concluded by Turkes et al. (1995; 1996). Tabari and Hosseinzadeh-Talaee (2011a; 2011b) showed increasing maximum and minimum monthly air temperature in the western half of Iran and arid and semi-arid regions of Iran using Mann-Kendall test. Using Spearman and Mann-Kendall tests showed similar results in this study that is in accordance with Yue et al. (2002).

Table 3: Results of the Spearman test of annual mean air temperature in Iran

station	statistic	station	statistic	station	statistic	station	statistic
Ilam	0.286	Zahedan	4.388**	Khoramabad	-2.855**	Mashhad	5.286**
Ardabil	1.137	Zanjan	0.757	Rasht	3.275**	Ahvaz	5.577**
Ghom	3.508**	Kerman	4.821**	Sanandaj	3.378**	Arak	0.316
Semnan	3.430**	Kermanshah	5.051**	Shahrekord	-3.075**	Bandarabbas	0.095
Bojnord	1.568	Urmia	0.929	Shiraz	5.548**	Birjand	-0.378
Ramsar	3.338**	Gorgan	0.994	Tabriz	4.174**	Bushehr	4.873*
		Hamadan	2.086*	Tehran	5.404**	Esfahan	3.410*
		Yasoj	0.788	Yazd	5.151**	Ghazvin	0.386

*: 5% significant level

**: 1% significant level

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 208-213

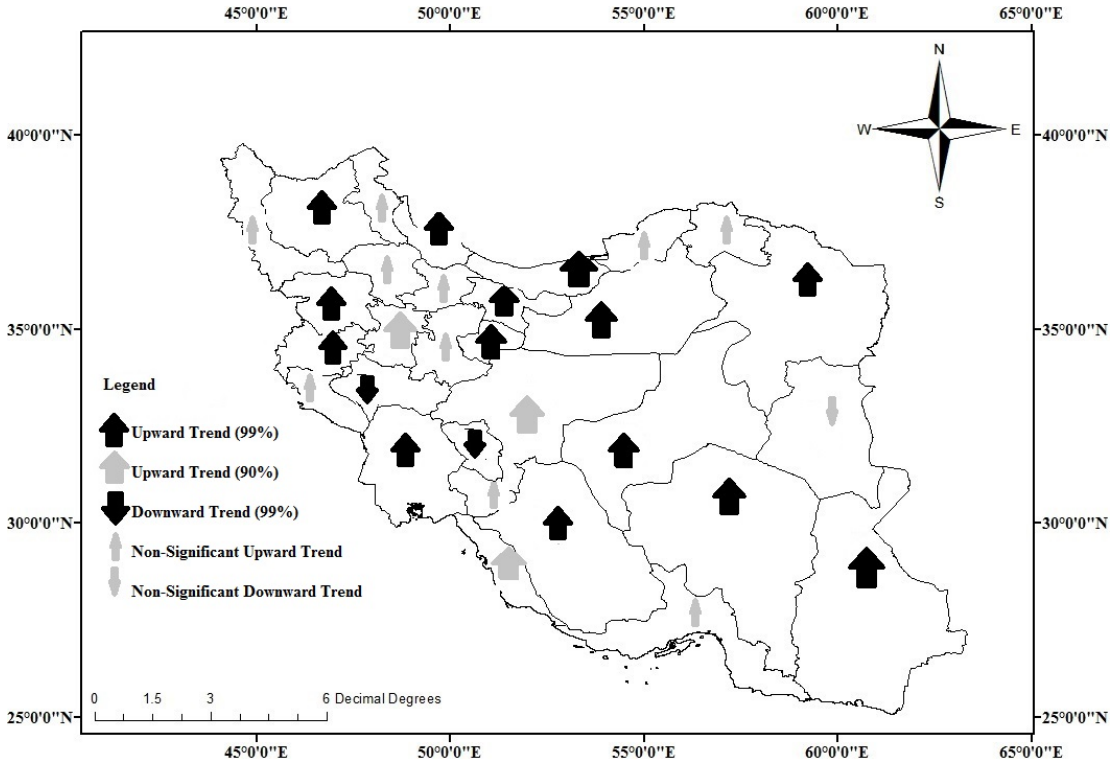

Figure 2 - Results of trend analysis of annual men air temperature of Iran in the last 50 years

CONCLUSION

Many researches about climate change showed that temperature changes cause changes in the occurrence of extreme events such as droughts, heavy rainfall and storms (Balling and Idso 1990). Trend studies of climatic parameters can be applied for optimal management of water resources, including irrigation management in agriculture (Wang et al, 2000). Also trend analysis of surface air temperature as one of the most important climatic parameters can be useful for investigation global warming and effect of climate changes on the studied areas. In this study annual mean air temperature of 30 synoptic stations used to investigate trends in the last 50 years. Mann-Kendall and Spearman methods applied to analysis air temperature trend and as results showed there was no significant difference between Mann-Kendall and Spearman tests which was in accordance with Yue et al. (2002). Almost 46.7 and 10 percents of stations detected significantly positive trend at 1 and 5% levels respectively. 6.7% of stations exhibited downward trend at 1% significant level and 36.6% of stations remained without any significant trend. From the results it can be demonstrated that in the last 50 years global warming occurred in Iran obviously and increasing air temperature in most stations of Iran could be as the effect of global warming and climate changes in most parts of Iran.

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A Comparative study to evaluate the effect of iron and silver nanoparticles against *Yersinia ruckeri* isolated from rainbow trout (*Oncorhynchus mykiss*)

A. zahedi tabarestani**,**M. yousefian,R. pourgholam,R.safari

***Abstract*—** In this study, the effect of iron and silver nanoparticles against *Yersinia ruckeri* was examined in vitro. Some of the common bacteria pathogens in the aquaculture due to produce a range of enzymes have resistance to various antimicrobial agents, for this reason alternative materials should be used to reduce this group of bacteria. In the present study, the possible application of these technology have been evaluate to control one of the most common bacteria in aquaculture and it seem the use of metallic nanoparticles is effective in reducing microbial outbreaks. Doses used in this study was (%0.1 , %0.2 and %0.3) of nonoparticles (with three replicates of bacteria concentrations) and was done in 3 times; 1 h, 6 h and 24 h after inoculation of nanoparticles. In this study it can be concluded that the doses of the %0.3was the best dose and there were significantly different with the other doses of nanoparticles, also bacteria concentrations were significantly different at different doses. Silver nanoparticles had the good antibacterial effects against this bacterium while iron nanoparticles had been weaker effect than silver nanoparticles and this bacterium are less sensitive to it. Results of this study showed, following the use of iron nanoparticles by increasing of concentrations to %0.3 the antimicrobial effect against *Y. ruckeri* was increasing and the number of bacteria in prolong incubation significantly reduced**.**

***Keywords*—** Iron nanoparticles , silver nanoparticles, *Yersinia ruckeri*

INTRODUCTION

With the increasing expansion of aquaculture industry particularly in intensive systems, the possibility of creating stress and decreasing of immunity system and also the environmental pollution cousing by waste from other farms, the possibility of serious and fatal infectious diseases in aquaculture industry has been increased. Using of antibiotics or vaccines in addition to the heavy costs, caused resistance against this pathogen[12]. For this reasons, today the science of nanotechnology in different part of agriculture science (in order to increase shelf life and pathogen detection), in environmental issues (for monitoring of environmental pollution and reduce the different kinds of environmental pollution, in aquaculture (in order to improved the growth and immunity system and also decresing of infection and non-infections diseases was used [3]. Some of the common bacteria pathogens in the aquculture due to produce a range of enzymes have resistance to various antimicrobial agents, for this reaseon alternative materials should be used to reduce this group of bacteria. Its seems that the use of metallic nanoparticle is effective tools to reducing microbial infection outbreaks[8].

In the present study, the possible application of this technology to control of common bacteria pathogens in aquaculture are studied. *Yersinia ruckeri* was isolated from kidney of infected and healthy rainbow trout using conventional and biochmical diagnostic tests [2]. Numerous studies have been done about the possibility reactions between nanoparticles with macromolecules of living organism. The negatively and positively charged differences between particles and miro-organisms act as electromagnetic absorbing and leading bind of nano particles to the cell surface and then, leads to cell death. Finally, a great number of these binding lead to oxidation of surface molecules and causes them to die quickly [6].

Soltani *et a*l, in 2009 examined the effect of silver nanoparticles on bacterial fish pathogens including *Aeromonas hydrophla*, *Yersinia ruckeri*, *Lactococcus gravieae* and *Streptococcus iniae*. Results of this study showed, the number of bacteria 90 min post-inoculation significantly was decreased, while no remarkable change was found in the bacterial count for the control samples (without silver nanoparticles). Alishahi et al., in 2009 were examined the antibacterial effects of silver nanoparticles on three major of fish pathogenic including *A. hydrophila*, *Y. ruckeri and S. iniae*. Maximum sensitivity was observed to silver nanoparticles against *Y. ruckeri*, while *S. iniae* was the most resistance isolated.

Gong *et a*l. (2007) studies the antibacterial activity of silver and iron complexes. Results showed the complex of silver and iron compare to single of each nanoparticle had the a stronger antibacterial effects. Because iron oxide as a super strong magnets, induces bacterial aggregation and increase the surface area of nano-silver with bacteria. Study of Stoimenov *et al* (2002) showed that iron oxide nanoparticle had the inhibitory effects against the growth of most gram-positive and gram-negative bacteria and prevents the

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Issue 8(4), May 2014, pp. 214-217

growth of it. Results of this study showed depending on resistant of these bacteria, the concentration inhibiting the growth of bacteria were different.

The main objective of this study was to evaluate the inhibitory effect of iron and silver nanoparticles against *Yersinia ruckeri* and compare the efficacy of two these inhibitors to each other.

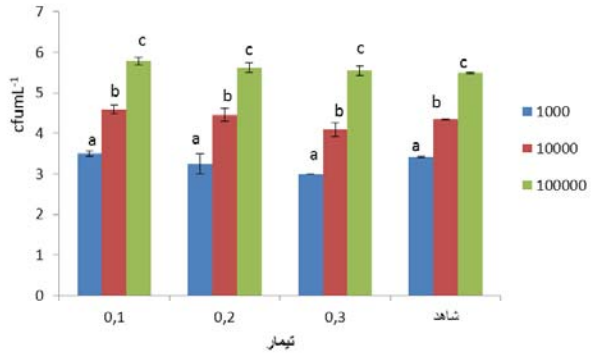
MATERIALS AND METHODS

To evaluate the inhibitory effect of metallic nanoparticles, at three doses (%0.1, %0.2 and %0.3) of iron and silver nanoparticles against *Y. ruckri*. The method that used to evaluated the efficacy of nanoparticles is serial dilution method. In this study, to evaluate the changing in the bacterial count, turbidity assy using spectrophotometer was used (540 nm). The first, 10^6 cfu/ml of *Y. ruckri* was added to Tryptos Soy broth (Merck, Darmstadt, Germany) medium, and then selected doses of nanoparticles separately (with 3 repeats) added to the medium. Samples were inoculated at 30 °C and at different times with intervals times including 1 h , 6 h and 24 h after inoculation of nanoparticles have been studied. From the Tryptos Soy agar medium for inoculation and colony count of bacteria were used. This study was done based on randomic complet blok design (RCBD). The obtained data were subjected to one-way analysis of variance using SPSS statistical software, release 18.0. Duncan's new multiple range test was used to determine the significant differences of the means at the %0.5 probability level.

RESULTS AND DISCUSSION

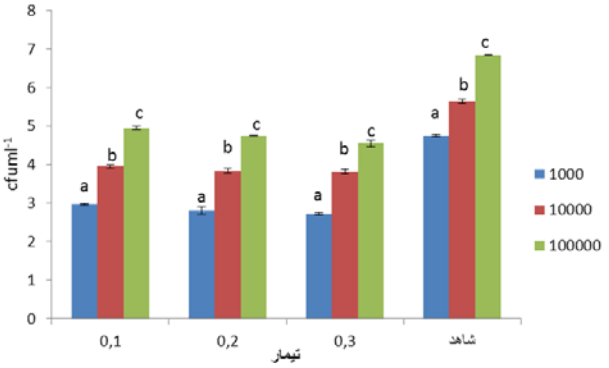
In the present study, a good antibacterial effect of silver nanoparticles against *Y. ruckri* was observed. The effects of iron nanoparticles against *Y. ruckri* were weaker in compare to silver nanoparticles and the bacteria are less sensitive to of this study showed following the use of Iron nanoparticles with increasing incubation times and concentrations of iron nanoparticles to %0.3antimicrobial effectits s ofagainst *Y. ruckri* was increased and the number of bacteria during incubation significantly decreased. Results of the mean log of *Y. ruckri* 1 h after inoculation of silver nanoparticles (Table I) showed that bacteria has not reaction with silver nanoparticles and no significantly was observed in log of bacteria in 3 doses with him and with the control.

Table I: the mean log of *Y. ruckri* 1 h after inoculation of silver nanoparticles



The mean log of *Y. ruckri* 6 h after inoculation of silver nanoparticles (Table II) showed that log of bacteria was changed and decresed (especially in .3% dose), also significantly differences was observed in different concentration of bacteria in each doses.

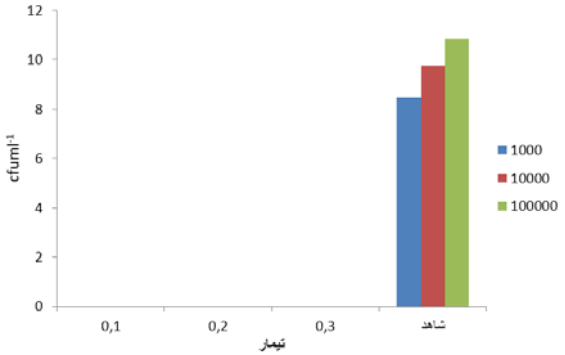
Table II: the mean log of *Y. ruckri* 6 h after inoculation of silver nanoparticles



The mean log *Y. ruckri* 24 h after inoculation of silver nanoparticles reached to zero, and no bacteria was found in any concentration except control group (Table III).

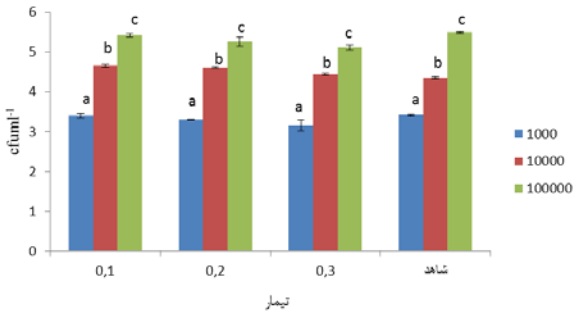
ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 214-217

Table III: the mean log of *Y. ruckri* 24 h after inoculation of silver nanoparticles



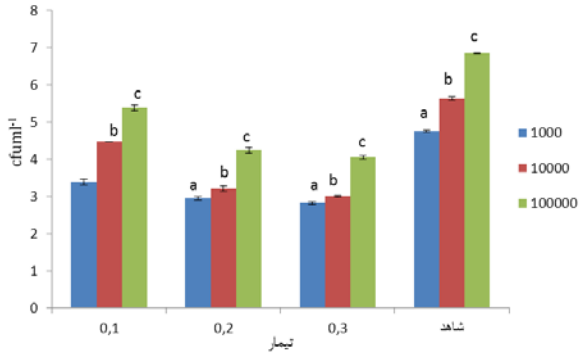
The mean log of *Y. ruckri* 1 h after inoculation of iron nanoparticles showed that the reaction of bacteria with iron nanoparticles were weaker than the silver nanoparticles and logs of bacteria in different doses was similar, this issue showed the disability of iron nanoparticles to reaction to bacteria (Table IV).

Table IV: the mean log of *Y. ruckri* 1 h after inoculation of iron nanoparticles



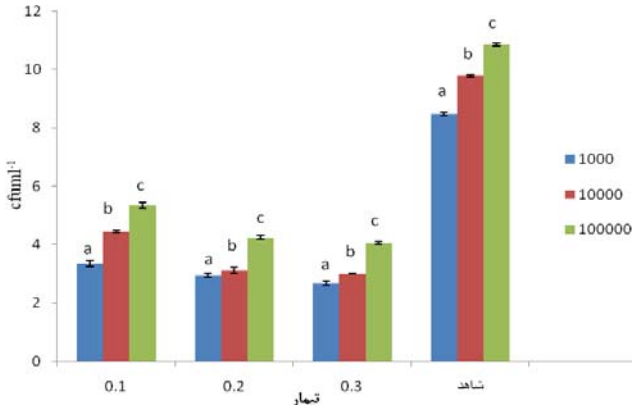
The mean log of *Y. ruckri* 6 h after inoculation of iron nanoparticles (Table V) showed that log of bacteria was decresed in different doses (.1%, .2% and especially in .3%), also significantly differences in different concentration of bacteria in each doses was observed.

Table V: the mean log of *Y. ruckri* 6 h after inoculation of iron nanoparticles



Average log of *Y. ruckri* 24 h after inoculation of iron nanoparticles(Table VI) showed a severe reduction in the dose of .3%, also in the dose of .1% and .2% of iron nanoparticles the log of bacteria has decreased dramatically and significant difference between the two doses in different concentration of bacteria

Table VI: the mean log of *Y. ruckri* 24 h after inoculation of iron nanoparticles



Soltani *et al*, in 2009 examined the effect of silver nanoparticles on bacterial fish pathogens including *A. hydrophla*, *Y. ruckeri*, *L. gravieae* and *S. iniae*. In this study, the number of bacteria 90 min post-inoculation significantly was decreased, while no remarkable change was found in the bacterial count for the control samples (without silver nanoparticles). Alishahi *et al.*, in 2009 were examined the antibacterial effects of silver nanoparticles on the three major fish pathogenic including *A. hydrophila*, *Y. ruckeri and S. iniae*. Maximum sensitivity to silver nanoparticles was observed against *Y. ruckeri*, while *S. iniae* was the most resistance isolated Gong *et a*l. (2007) studies the antibacterial activity of silver and iron complexes. Results showed the complex of silver and iron compare to single of each nanoparticle had the a stronger antibacterial effects. Because Iron oxide as a super strong magnets, induces bacterial aggregation and increase the surface area of nano-silver with

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Issue 8(4), May 2014, pp. 214-217

bacteria. Study of Stoimenov *et a*l (2002) showed that iron oxide nanoparticle had the inhibitory effects against the growth of most gram-positive and gram-negative bacteria and prevents the growth of its. Results of this study showed depending on resistant of these bacteria the concentration inhibiting the growth of bacteria were different.

CONCLUSION

The use of silver and iron nanoparticles is the unprecedented growth in aquculture industry and nowaday also for water treatment was used. In the present study, a comparison was done between iron and silver nanoparticles against *Y. ruckeri* . Because this bacteria are classified as gram-negative bacteria, the effect of nanoparticles agains gram-bacteria was higher. This issue related to the faty layers in cell wall of gram-negative bacteria, permeability rates of nanoparticles having regard to the nano-sized and high activity that leads to combination to bacteria and finally death it. In gram-positive bacteria because of the presence of lipids and glaycons in cell wall (that is hard and impenetrable) was impenetrablr and this issue is one of the reasons why gram-positive bacteria more resistand than gram–negative bacteria (Feng *et a*l., 2007). Compare to reduce the number of bacteria colonies in these two nanoparticles shows firstly silver nanoparticles are more effective than iron nanoparticles and then in the less time was effective against on, while in the iron nanoparticles with the increasing of time and in the dose of %0.3loge of bacteria reaches a minimum value. Since the iron nanoparticles had less the antimicrobial effect compare with silver nanoparticles so, it is suggested that the complex of iron and silver nanoparticles was used for increased the antimicrobial efficacy against *Y. ruckeri*.

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She received her M.Sc of Islamic Azad Ghaemshahr University in 2013. She iscurrently with Caspian Sea Ecology Research Center, Iran and her main research area is Fish Disease and Health Department,

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Composition and abundance of phytoplankton community structure in warm and cold seasons in the waters around Hormuz Island (Eastern part of the Persian Gulf)

H. Khandan Barani., S.J. Seyfabadi, and A.Mahvary

***Abstract*—** Changes in the phytoplankton community in the waters around Hormuz Island in the Persian Gulf were studied in both warm and cold periods from November 2009 to July 2010. Water samples were collected at depths of 0.5 m using Ruttner bottle and the composition and abundance of the phytoplankton genera was determined. Temperature, salinity, pH and nitrates+ nitrites levels were measured. Totally 43 genera belonging to three groups of diatoms (Bacillariophyceae, 27 genera), dinoflagellates (Dinophyceae, 15 genera) and cyanobacteria (Cyanophyceae, 1 genus) were detected; maximum and minimum number of phytoplanktonic genera were recorded in spring (35 G) and winter seasons (22 G), respectively. Diatoms contributed maximum percentage (83%) followed by dinoflagellates (9%) and cyanobacteria (8%). All three groups showed significant changes during the transition from cold to warm periods. The highest abundance were observed in the warm period and the highest correlations were observed for temperature.

***Keywords*—**phytoplankton; phytoplankton community structure; environmental parameters; Persian Gulf

INTRODUCTION

PHYTOPLANKTON are agents for primary production in the marine environment and play an important role in the cycle of nutrients, organic matter concentration, pH and dissolved oxygen in the environment. These roles of the phytoplankton community are related to ecological and biogeochemical cycles [11]. The higher nutrient level structures and genera of a particular marine ecosystem are tied to phytoplankton community composition; for example, fishery production depends on the diatom community [6&11]. In addition to the importance of phytoplankton as a primary food producer and for maintaining the ecological balance, phytoplankton species act as suitable indicators of water quality and environmental conditions [4]. Knowing the structure of a phytoplankton community is a major contribution to realizing the future of a marine ecosystem and biogeochemical processes. Environmental parameters such as light, temperature, salinity, pH, nutrients, and water turbulence influence phytoplankton community structure [9&14].

The importance of phytoplankton in aquatic ecosystems has led many algae biologists and ecologists to examine the biological aspects of these organisms [8,13,21&22]. Numerous studies have investigated phytoplankton community structure in different parts of the Persian Gulf; the results show that diatoms are the dominant society followed by dinoflagellates [2, 3, 15, 29 & 30]. It is important to understanding phytoplankton community structure and changes into be able to anticipate change and maintain the health of the ecosystem.

MATERIAL AND METHODS

The present study collected information about changes in the phytoplankton community structure during the warm and cold periods in the waters of the Straits of Hormuz.The Strait is located on the eastern part of Persian Gulf, which connected the Gulf with western Gulf of Oman and the Arabian Sea. Although it is an important pathway for the flow of oil tanker. Sampling stations (Fig. 1) were located in north and south of Strait

H. Khandan Barani. M.Sc, Department of Fisheries Hamoun International Wetland Research Institute University of Zabol. (e-mail: www.hashem.barani @uoz.ac.ir)
S.J. Seyfabadi. Ph.D, Dept. of Marine Biology, Faculty of Marine Science, Tarbiat Modares University. (e-mail: www. jseyfabadi @gmail.com)
A.Mahvary. Msc, Dept. of Marine Environment Research of Hormuz, Hormozgan Environment Organization. (e-mail: www.mahvary @gmail.com)

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Issue 8(4), May 2014, pp. 218-222

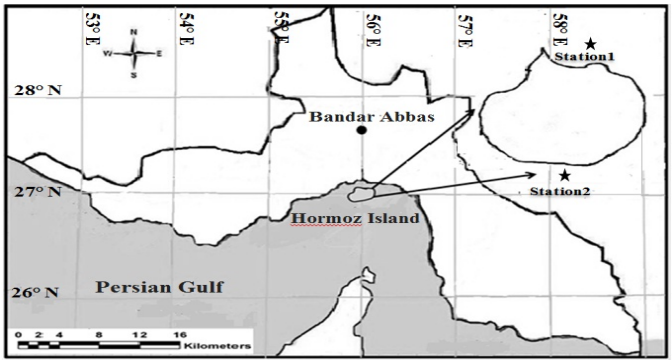

Fig 1: Location of the sampling stations

The climatic conditions prevailing in the Persian Gulf region form two main warm and cold seasons; thus, the changes in the phytoplankton community structure were investigated by collecting samples during the warm season in May and July 2010 and during the cold season in November 2009 and January 2010 to at two stations. The samples were collected in Ruttner bottle from the subsurface water layer (approximately 0/5 m in depth). One liter water samples were collected for phytoplankton analysis from each station (three replicates). The solution was stored in a dark container and transferred to the research laboratory of the marine environmental research station in Hormuz.

Water samples for quantitative phytoplankton were fixed in Lugol's iodine (1% final concentration) and examined by Sedgewick–Rafter cell under inverted microscope (Trinocular type TS100-F).Genera identification according to morphological characteristics of key books [10 & 12] was perform. Samples were collected from each station to determine nitrates + nitrites values and were stored in dark glass bottles and were immediately transported to the laboratory. In the laboratory, nutrient agents were measured using a photometer (palintest 7000).Water temperature, salinity and pH were measured in situ with a HORIBA-U-10.

The data was saved as a database using Excel. One-way ANOVA was used to evaluate the presence or absence of significant differences between stations for warm and cold seasons. Pearson's correlation test was used to determine the phytoplankton community structure in relation to other environmental parameters.

RESULTS

Table 1 shows the means for environmental parameters at the two stations during the warm and cold seasons. There were no significant differences between stations for any environmental parameter during the study period, but all parameters showed significant differences between the warm and cold seasons.

Table 1: Mean (± SD) of the different environmental parameters in two stations during November 2009 and January, April & July 2010.

	Cold period		**Warm period**	
parameters	November	January	April	July
Temperature (° C)*	24 ±0.1	21±0.1	30.6±0.1	32.2±0.1
Salinity (ppt)*	36±0.2	35.5±0.5	35±0.1	37±0.5
pH*	8.5±0.02	8.6±0.01	8.7±0.03	8.9±0.02
$NO_3 + NO_2$ (mol/Lμ)*	3±0.1	17±0.2	25±0.2	21±0.1

*Significant differences between warm and cold periods ($p < 0/01$)

The minimum and maximum temperatures during the study were 21 to 32.2 °C and the salinity was 35 to 37ppt. The PH ranged from 8.5 to 8.9 and the nitrates + nitrites from 3 to 25 mol/Lμ. The maximum values for temperature, pH and salinity were collected in July and the maximum nitrates + nitrites value was recorded in May. The minimum temperature was recorded in January and salinity was recorded in May. The minimum pH and nitrates + nitrites values were recorded in November.

Phytoplankton Community Composition

A total of 43 genera belonging to three important groups of phytoplankton (diatoms, dinoflagellates, cyanobacteria) were identified. Diatoms were the most common group of phytoplankton (83% of total abundance) and were more frequent during warm periods. Of the diatoms, *Chaetocerus* and *Pseudonitzschia* were the dominant genera observed in most samples. Dinoflagellates were observed in most months of the year, with lower abundances and diversity than diatoms. The diversity and frequency of this group was more evident in the warm period of the year. Of the identified genera, the flagellates *Gymnodinium* and *Peridinium* were dominant. A Green-blue alga was also more frequent in the warm season and the genera *Trichodesmium* was most frequently observed in warm seasons.

Temporal changes in the number of diatom and dinoflagellate genera are shown in Figure 2. The maximum number of diatom genera was recorded in May and the minimum was recorded in January. The maximum number of dinoflagellates was recorded in July and the minimum was recorded in January. An evaluation of the composition and abundance of the dominant genera in the four sampling times show that the maximum abundances for July, May and January were for to *Pseudonitzscha* and *Nitzschia*; *Chaetocerus* and *Gymnodinium* genera demonstrated the highest abundances in November.

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 218-222

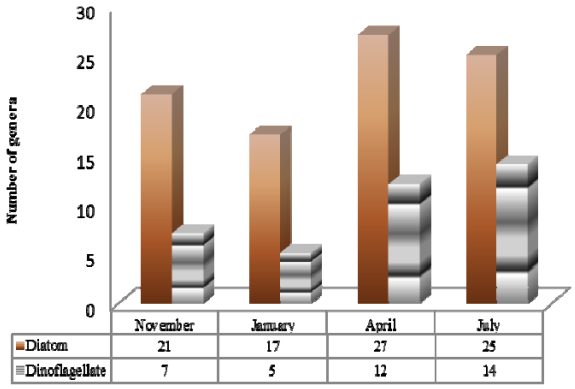

Fig 2: Temporal chenges in diatom and dinoflagellate number genera during November 2009 and January, April & July 2010.

Table 2 shows temporal changes in the abundance of phytoplankton groups during the study period. On average, the frequency rate for diatoms, dinoflagellates and cyanobacteria were 3, 0.34 and 0.3, respectively. The maximum and the minimum abundances for the three groups were observed in January and July, respectively.

Table 2: Temporal changes in phytoplankton abundance (cells per liter × 10^5) in the present study.

phytoplankton	November (2009)	January (2010)	July (2010)	April (2010)
Dinoflagellate	0.2	0.03	0.3	0.5
Diatom	1.1	0.45	5.1	6.2
Cyanobacteria	0.1	0.01	0.2	0.4
Total abundance	1.4	0.48	5.6	7.1

Abundance correlation results for the three phytoplankton groups with environmental parameters are listed in Table 3. There was a significant positive correlation at the 1% level between the frequencies of the three groups and temperature. Diatoms and cyan bacteria showed a significant negative correlation with salinity at the 5% level, but there was no such correlation for flagellates. All three phytoplankton groups showed a significant positive correlation with pH. Phytoplankton groups showed the lowest correlation with nitrates + nitrites; the only significant correlation was between diatoms and nitrates + nitrites.

Tabel 3: Bravais Pearson's correlation coefficients between phytoplankton abundance and environmental parameters measured

Phytoplankton	Temperature	Salinity	pH	$NO_3 + NO_2$
Dinoflagellate	0/954**	-0/527**	0/647**	0/619**
Diatom	0/788**	0/668ns	0/661**	-/350ns
Cyanobacteria	0/933**	-0/590*	0/610*	0/352ns

**, * & ns are the significance level of 1%, 5% and no significant respectively.

DISCUSSION

In the Hormuz waters, 43 phytoplankton genera were identified in the bacillariophyceae, dinophyceae and cyanophyceae groups. Phytoplankton analysis in this region indicated that phytoplankton diatoms were dominant for number and abundance; this is consistent with the results of Saraji (2001). In the present study, population fluctuations for diatoms were marked in the warm period by maximum abundance and diversity of species. Saadi and Hadi (1987) also reported a maximum frequency of diatoms in the Persian Gulf during the summer.

The variability of phytoplankton populations showed an increase in population during warm seasons and a decrease during cold seasons; however, the results of some studies in the area indicated an increase in the density of diatoms in the cold months of the year [29 & 30] , which is not consistent with the results of this study. Many studies show that diatoms respond to changes in environmental conditions, such as water temperature, salinity, pH, nutrients, and water depth [20, 31, 32, & 34]. It has been shown that phytoplankton cell abundance decreases in winter because of the decrease in light intensity and lower water temperatures, but the increase in light and temperature when the winter is over is a factor contributing to the increase in algae frequency. Studies have shown the importance of nutrients and turbulence in the development of the phytoplankton community [27 & 35]. Increased light intensity, higher water temperatures, stronger seasonal winds, more turbulence, and high nutrient levels in the study area during the warm period contributed to the flourishing of phytoplankton in the warm period.

Another phytoplankton structure characteristic observed in this study was the higher density of cyanobacteria and dinoflagellates in the warm period. Most studies conducted in the area found flagellates and cyanobacteria to be the dominant phytoplankton groups in the area after diatoms [29 & 30]. The maximum population density of these two phytoplankton groups occurred in the warm season, which is consistent with the results of this study in the Straits of Hormuz. One difference was that, for Cyanophyceae, only the genus Trichodesmium, which is a genera specific to tropical and subtropical regions, was observed in this study [34]. The maximum abundance of the genera was recorded in July. Studies have shown that high temperature and high light intensity are favorable conditions for cyanobacteria and dinoflagellates [18 & 19]. It is likely that desirable temperatures and light levels were the causes of their higher frequency during warm periods.

In the current study, environmental parameters and phytoplankton community structure showed significant seasonal variation. Studies in other parts of the world have also shown changes in biological communities during the transition from cold to warm conditions [8, 23 & 28].

Temperature is probably the most important factor in shaping the phytoplankton community in this area. The maximum significant positive correlation of all groups of

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 218-222

phytoplankton with temperature support this. Goldman and Carpenter (1974) found an increase in phytoplankton frequency caused by an increase in temperature, which is consistent with the results of this study. Alam *et al* (2001) studied the effect of environmental factors on the population dynamics of phytoplankton and found temperature to be the most important factor influencing the size and growth of phytoplankton.

Salinity appeared to play a limited role in the present study. A negative significant correlation between diatoms and cyanobacteria with salinity indicates this. Fewer varieties of diatoms were found in July compared to May, which is probably related the increase in salinity of the water caused by evaporation. The results of previous studies on diatoms and salinity support this finding [5 & 24]. Salinity influences the absorption or excretion of ions and, consequently, destroys the intracellular ion balance ratio and exerts osmotic stress on the phytoplankton cells. Common diatoms in this study were *Nitzschia* and *Pseudnitzschia* genera which showed fewer fluctuations in temperature and salinity. This might be a result of their ability to tolerate a wider range of temperature and salinity in these genera [25].

The narrow range for pH in this study reflects the stability of many phytoplankton genera, which have adapted to nearly neutral pH and are not able to endure extreme changes. Peterson *et al* (1984) showed the importance of pH as a factor affecting phytoplankton from its effects on nutrient absorption and nutrient balance. In the present study, the lowest correlation coefficient was found for the nitrates +nitrites phytoplankton group, which may be caused by sufficient levels of the nutrients in the environment or by the effect of high salinity in the region.

CONCLUSION

In this study, 43 genera belonging to three groups of phytoplankton (diatoms, flagellates, and cyanobacteria) were identified. Diatoms showed the highest number of genera and frequency in all samples. All three groups showed the highest correlation with temperature and the highest frequency was observed in the warm period of the year.

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Issue 8(4), May 2014, pp. 224-231

Selecting the Best Normalization Function for Annual Precipitation in Iran

Keivan Khalili[1], Sina Besharat[2], Mohammad Nazeri Tahrudi[3], Neda Khanmohammadi[4]

1. Assistant Professor, Department of Water Engineering, Urmia University, Iran, Email: khalili2006@gmail.com
2. Assistant Professor, Department of Water Engineering, Urmia University, Iran, Email: sina323@yahoo.com
3. Msc Student of Water Resource Management, Urmia University, Iran, Email: m_nazeri2007@yahoo.com
4. Ph.D Student of Water Resource Management, Urmia University, Iran, Email: N.Khanmohammadi@yahoo.com

Abstract—For hydrologic time series analysis, it is assumed that time series are normally distributed. Since most hydrological time series do not follow normal distribution and need to transform through normalization functions. In this study six common transition functions have been used to transform annual precipitation of 140 synoptic stations in Iran. Then according to the skewness coefficients, the best transformation functions to normal selected. Results indicated that logarithmic, Gamma and Power functions have been selected as the best normalization functions for the number of 75, 22 and 17 synoptic stations respectively. The logarithmic function for almost all stations accepted via skewness test and can be suggested for normalization annual precipitation of synoptic stations in Iran.

Keywords: Logarithmic function, Normality test, Skewness coefficient, Time series

I. INTRODUCTION

One of the most important classes of continuous distributions is the normal distribution. Since its discovery more than 350 years ago, it has developed into an indispensable tool for every branch of science, industry, and commerce. The normal distribution is called Gaussian distribution. This distribution has been presented first by Gauss (1801) and applied in the theory of error measurement. Given enough observations within a sample size, it is reasonable to make the assumption that returns follow a normally distributed pattern, but this assumption can be disproved. Many methods of time series analysis depend on the basic assumption that data were sampled from a normal distribution (Madansky, 1988; USEPA, 1996; Thode, 2002). Thus it is necessary to normalize hydrological data before any analysis and modeling. Adab et al. (2008) used Box-Cox function for normalizing annual rainfall data in Khorasan-Razavi province. Hamidi and Emamgholi (2009) among logarithmic, square root and other functions selected logarithmic function for converting annual river discharge series of Maroon River in Iran to normal. Saghafiyan et al. (2011) for normalizing annual rainfall data in Fars province of Iran used Box-Cox method. Shafie et al. (2011) in a random simulation of drought intensity by Palmer drought severity index used Box – Cox function with the $\lambda = 0.5$ for normalizing applied data. Nikmanesh and Taleb-Bidokhti (2012) compared two wavelet time-series models in modeling monthly rainfall of Arsanjan station located in the Fars province of Iran. In this study Box - Cox transformation has been used for normalization of rainfall time series. Ahmadi et al. (2012) used different functions such as logarithmic, square root, exponential and Box-Cox functions for normalizing monthly and daily river flow series of Baranduzchai River in the north west of Iran. According to the skewness coefficient, logarithmic function has been chosen for normalize data. Nazeri-Thrudi et al. (2012) by comparing common normalization methods according to skewness coefficients, applied power function as a transformation function to normal distribution in modeling PARMA time series of air temperature. Khalili et al. (2013) used monthly rainfall data of eight synoptic stations of Iran in the period of 2005-1955 and showed that for warm and dry regions in Iran square root function, was the best transition function and for the other regions such as warm and wet climates, Johnson function and moderate climates, inverse function can be used. Nazeri-Thrudi et al. (2013) used power and logarithmic functions, respectively for normalizing monthly air temperature and rainfall of Sanandaj station located in Koredstan province of Iran. Nazeri Thrudi et al. (2013) also in other study used ARIMA and PARMA models for modeling and forecasting wind speed of Bandarabbas station in the south of Iran. In this study gamma and logarithmic transformation functions for different months have been used. The main purpose of this study is to find the best normalization function for the annual precipitation of Iran in order to prepare time series before analyzing and modeling.

II. MATERIALS and METHODS

Study area

The study area encompasses the entire region of Iran's geographical area of about 1650,000 km^2. Iran is located in

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Issue 8(4), May 2014, pp. 224-231

Asia, approximately between 25°00′N and 38°39′N latitudes and between 44°00′E and 63°25′E longitudes (Fig. 1). The mean annual precipitation of Iran is about 224 mm. In this study, annual precipitation data from 140 weather synoptic stations of Iran were used. The details of these stations were given in Table 1.

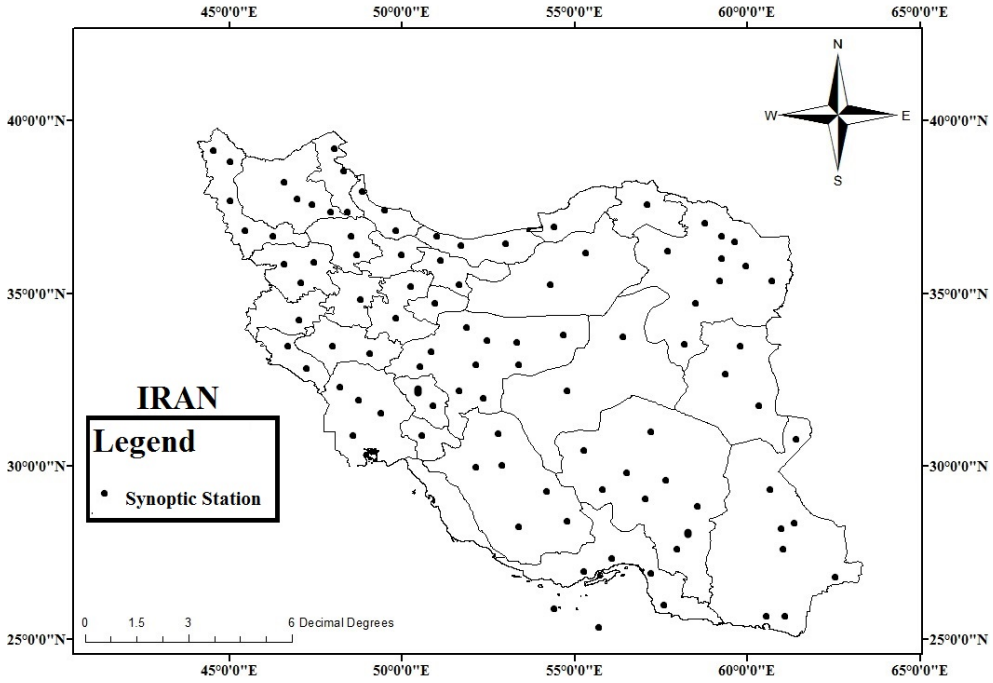

Figure 1 - Location of the studied synoptic stations in Iran

Table 1 – Statistical period of 140 synoptic stations in Iran

Station	Statistical period	Station	Statistical period	Station	Statistical period	Station	Statistical period	Station	Statistical period
Khoramdareh	1986-2010	Garmsar	1986-2010	Ghchan	1984-2010	Tabas	1961-2010	Mashad	1961-2010
Kohrang	1987-2010	Ardestan	1992-2010	Abomosa	1984-2010	Qom	1961-2010	Abadan	1961-2010
Lar	1990-2010	Bandare dair	1993-2020	Aghajari	1984-2010	Kermanshah	1961-2010	Ahvaz	1961-2010
Malayer	1990-2010	Bandare Mahshar	1987-2010	Qaemshahr	1984-2010	Orumiyeh	1961-2010	Arak	1961-2010
Manjil	1993-2010	Behbahan	1994-2010	Konarak	1984-2010	Dezfol	1961-2010	Babolsar	1961-2010
Marivan	1992-2010	Bijar	1987-2010	Karaj	1985-2010	Gorgan	1961-2010	Bandarabbas	1961-2010
Miyaneh	1987-2010	Berojen	1988-2010	Serakhs	1984-2010	Hamedan	1961-2010	Birjand	1961-2010
Maraveh	1993-2010	Bashroeyeh	1988-2010	Parsabad	1984-2010	Shahrud	1961-2010	Boshehr	1961-2010
Naeen	1992-2010	Bostan	1986-2010	Ferdous	1985-2010			Isfahan	1961-2010
Natanz	1992-2010	Borojerd	1989-2010	Sirjan	1985-2010	Zabol	1963-2010	Gazvin	1961-2010
Neyshabur	1991-2010	Daran	1989-2010	Dogonbadan	1985-2010	Chabahar	1963-2010	Khoramabad	1961-2010
Piranshahr	1986-2010	Dehloran	1990-2010	Jolfa	1985-2010	Iranshahr	1964-2010	Khoy	1961-2010
Ramhormoz	1987-2010	Islamabad	1987-2010	Mako	1985-2010	Semnan	1965-2010	Ramsar	1961-2010
Ravansar	1988-2010	Qorveh	1989-2010	Masjed Soleyman	1985-2010	Bandare Lengeh	1966-2010	Rasht	1961-2010
Robat-Poshtbadam	1992-2010	Golmakan	1987-2010	Minab	1985-2010	Kashan	1966-2010	Sabzevar	1961-2010
Dorodzan-Dam	1998-2010	Golpayegan	1992-2010	Nehbandan	1986-2010	Fasa	1966-2010	Saqes	1961-2010
Sarab	1986-2010	Gonabad	1987-2010	Dezfol	1986-2010	Jask	1968-2010	Sanandaj	1961-2010
Saravan	1986-2010	Ilam	1986-2010	Qaeen	1992-2010	Doshan-Tapeh	1972-2010	Shahrekord	1961-2010
Sardasht	1986-2010	Izeh	1993-2010	Baft	1989-2010	Ardabil	1976-2010	Shiraz	1961-2010
Sarepol-Zahab	1986-2010	Kabutarabad	1992-2010	Kahnoj	1989-2010	Eest Isfahan	1976-2010	Tabriz	1961-2010
Saveh	1993-2010	Gangam-Jam	1989-2010	Jiroft	1989-2010	Hamedan Airport	1976-2010	Tehran	1961-2010
Shahreza	1993-2010	Kangavar	1987-2010	Rafsanjan	1992-2010	Abadeh	1977-2010	Torbat-Heydariyeh	1961-2010
Tekab	1986-2010	Kashmar	1987-2010	Shahrbabk	1987-2010	Bojnord	1977-2010	Yazd	1961-2010
Torbat-Jam	1993-2010	Khalkhal	1987-2010	Anar	1986-2010	Noshahr	1977-2010	Zahedan	1961-2010

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 224-231

Yasoj	1987-2010	Khash	1986-2010	Ahar	1986-2010	Kish	1982-2010	Zanjan	1961-2010
Zahak	1993-2010	Khodabandeh	1994-2010	Aligodarz	1986-2010	Omideyh Paygahi	1983-2010	Bam	1961-2010
Zarqan	1989-2010	Khor-Biyabanak	1986-2010	Astara	1986-2010	Siri	1983-2010	Kerman	1961-2010
Zarineh	1989-2010	Khor-Birjand	1990-2010	Boshehr	1986-2010	Meragheh	1983-2010	Bandare Anzaly	1961-2010

Normal distribution is one the most important continuous probability distributions in the probability theory. As many statistical parameters are approximately normally distributed, the normal distribution is often used for statistical inferences. Main reason for this phenomenon is the role of normal distribution in the central limit theorem. In the other word, the central limit theorem can be shown that under certain circumstances, the sum of the values of different variables, with finite mean and deviation, increasing the number of variables, the distribution will be very close to a normal distribution. This rule is true under natural conditions and causes that a large number of unknown variables, follow normal distribution. This distribution sometimes called as Gaussian distribution because of using this function by Karl Friedrich Gauss. Normal distribution function is shown in figure 1.

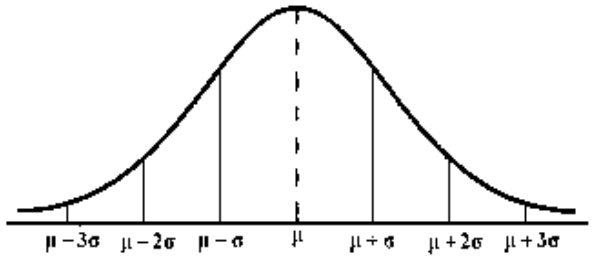

Figure 2 - Normal distribution function

The probability distribution function has two parameters: one determines the location (μ) and the other determines the scale of distribution (σ). Also mean distribution is equal to the location parameter and scale parameter is equal to its deviation. The probability distribution curve is symmetrical around the mean. In particular, if the mean is zero and standard deviation 1, the distribution is called the standard normal. This statistic is distributed as follows.

$$F\left(x\right)=\frac{1}{\sigma\sqrt{2\pi}}\exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right] \qquad \textbf{(1)}$$

In this study six common normal transformation functions in hydrology were used. The statistics of these tests are as follows:

1 - The logarithmic transformation

If the time series follow log-normal distribution, transforming by this function can be help to convert time series to normal distribution.

$$y_t=\log\left(X_t+a\right)^b \qquad t=1,2,3,\text{¼},N \qquad (2)$$

2 - Square root transformation

If the time series follow gamma distribution, square root function can be used to normalize series.

$$y_t=\sqrt{X_t} \qquad t=1,2,3,\text{¼},N \qquad (3)$$

3 - The exponential transformation

Non-normal distributed data (X_t) can be normalized using exponential function, by subtracting c parameter from series as below.

$$y_t=a(X_t-c)^b \qquad (4)$$

Where, a and b are exponential function parameters. Values of a, b and c are obtained iteration methods and amount of b is mostly equivalent to 0.5, 0.33 or 0.25.

4 - Inverse transformation

Non-normal time series X_t can be transformed to normal distribution with the inverse function as below:

$$y_t=\frac{1}{X_t} \qquad (5)$$

5 - Power transformation

$$y_t=X_t^a \qquad (6)$$

That in each scale, transfer and power functions, value a, is obtained by trial and error method.

6 - Box – Cox transformation

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Issue 8(4), May 2014, pp. 224-231

Box-Cox transformation for a time series is defined as follows:

$$y_t = \begin{cases} \dfrac{\left(X_t^{\lambda} - 1\right)}{\lambda} & \lambda \neq 0 \\ \log X_t & \lambda = 0 \end{cases} \qquad t = 1, 2, 3, \ldots, N \quad (7)$$

Where λ is between -2 and 2, and its value is estimated by trial and error method. So that the best amount of λ, closes the distribution of Y_t to the normal distribution. This function is applied particularly when the time series change increasing or decreasing. If the original time series X_t has a negative value, then Box – Cox transformation is defined as follows:

$$y_t = \begin{cases} \dfrac{\left(x_T + \lambda_2\right)^{\lambda_1} - 1}{\lambda_1} & \lambda_1 \neq 0 \\ Log\left(x_T + \lambda_2\right) & \lambda_1 = 0 \end{cases} \qquad (8)$$

Where the parameter λ is chosen so that: $X_t + \lambda_1 > 0$.

Another form of this transformation is applying geometric mean of the time series as follows:

$$y_t = \begin{cases} \dfrac{\left(X_t^{\lambda} - 1\right)}{\lambda} \cdot \dfrac{1}{g^{\lambda - 1}} & \lambda \neq 0 \\ \log(X_t) & \lambda = 0 \end{cases} \qquad (9)$$

Where, g is the geometric mean of the original time series.

Skewness test

In this test, skewness coefficient of time series X_t for t=1,2,…, N is calculated according to the following equation. If the value of this coefficient is equal to zero, then the distribution will be normal. Skewness is a criteria for symmetry or asymmetry of the distribution function. For a perfectly symmetric distribution, skewness coefficient is zero and for an asymmetric distribution towards higher values, skewness will be positive and towards smaller values, skewness tends to negative numbers. Kurtosis index indicates height of a distribution. In other words, kurtosis is a criterion of the curve height at the peak point and for a normal distribution is equal to 3. Positive kurtosis means that the peak of distribution is higher than normal distribution and negative kurtosis means that the peak of the distribution is lower than normal distribution. In general, if skewness and kurtosis amounts are not in the range of (-2, 2) used data do not follow normal distribution.

$$\gamma = \frac{\frac{1}{N}\sum_{t=1}^{N}\left(Xt - \bar{X}t\right)^3}{\left[\frac{1}{N}\sum_{t=1}^{N}\left(Xt - \bar{X}\right)^2\right]^{3/2}} \qquad (10)$$

In this equation, $\bar{X}$ is the mean value of time series. If the time series are normally distributed, then γ has a normal distribution with mean zero and standard deviation of the $\frac{6}{N}$. Therefore, by selecting the level of error (α), confidence level $(1-\alpha)$ is defined as the coefficient of skewness.

$$-U_{\left(1-\frac{\alpha}{2}\right)}\sqrt{\frac{6}{N}} \quad And \quad +U_{\left(1-\frac{\alpha}{2}\right)}\sqrt{\frac{6}{N}} \qquad (11)$$

Where $U_{(1-\frac{\alpha}{2})}$ is standard normal probability distribution for the $(1-\alpha)$ amount. If the γ is within the above range, the normality assumption is correct, otherwise it is invalid. This test is recommended for samples with more than 150 data and for the smaller number of samples, coefficient of skewness must be compared with the values presented in Table2 that are based on the α value. If $|\gamma| < \gamma n(N)$, then the assumption of normality is accepted.

Table 2 - Amount of $\boldsymbol{\gamma\alpha(N)}$ for different values of N and $\boldsymbol{\alpha}$ in order to test normality of time series

N	25	30	35	40	45	50	60
α=0.02	1.061	0.987	0.923	0.870	0.825	0.787	0.723
α=0.01	0.711	0.662	0.621	0.587	0.558	0.534	0.492
N	70	80	90	100	125	150	175

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 224-231

α=0.02	0.673	0.631	0.596	0.567	0.508	0.464	0.430
α=0.01	0.459	0.432	0.409	0.389	0.350	0.321	0.289

III. RESULTS and DISCUSSION

Different transformation functions have been used for normalizing annual precipitation data in Iran. But before normalizing data skewness coefficients calculated. Results of skewness coefficients have been summarized in Table 3.

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 224-231

Table 3 - Skewness coefficients of annual rainfall recorded at synoptic stations in Iran

IRAN									
Station	Skewness	Station	Skewness	Station	Skewness	Station	Skewness	Station	Skewness
Khoramdareh	0.812	Garmsar	-0.418	Ghchan	-0.542	Tabas	1.011	Mashad	0.387
Kohrang	-0.338	Ardestan	0.313	Abomosa	1.009	Qom	0.039	Abadan	0.534
Lar	0.846	Bandare dair	0.572	Aghajari	0.126	Kermanshah	0.319	Ahvaz	0.457
Malayer	0.073	Bandare Mahshar	0.423	Qaemshahr	-0.406	Orumiyeh	0.754	Arak	0.200
Manjil	0.137	Behbahan	-0.682	Konarak	1.362	Dezfol	0.235	Babolsar	0.291
Marivan	0.083	Bijar	0.364	Karaj	0.288	Gorgan	0.092	Bandarabbas	1.075
Miyaneh	0.472	Berojen	1.160	Serakhs	-0.283	Hamedan	-0.193	Birjand	0.177
Maraveh	-0.600	Bashroeyeh	1.161	Parsabad	0.179	Shahrud	0.747	Boshehr	1.160
Naeen	0.766	Bostan	0.688	Ferdous	0.241			Isfahan	0.349
Natanz	0.224	Borojerd	-0.023	Sirjan	0.212	Zabol	2.307	Gazvin	0.305
Neyshabur	0.323	Daran	0.534	Dogonbadan	-0.465	Chabahar	2.394	Khoramabad	0.042
Piranshahr	0.548	Dehloran	1.342	Jolfa	0.363	Iranshahr	0.462	Khoy	0.408
Ramhormoz	0.065	Islamabad	0.478	Mako	0.498	Semnan	0.456	Ramsar	0.420
Ravansar	0.063	Qorveh	1.497	Masjed Soleyman	0.347	Bandare Lengeh	0.930	Rasht	0.583
Robat-Poshtbadam	-0.160	Golmakan	0.246	Minab	0.073	Kashan	0.362	Sabzevar	0.139
Dorodzan-Dam	0.037	Golpayegan	0.458	Nehbandan	0.028	Fasa	0.183	Saqes	0.548
Sarab	-0.247	Gonabad	0.218	Dezfol	0.288	Jask	1.606	Sanandaj	0.367
Saravan	0.846	Ilam	0.468	Qaeen	0.326	Doshan-Tapeh	-0.091	Shahrekord	0.152
Sardasht	-0.094	Izeh	0.393	Baft	0.002	Ardabil	1.258	Shiraz	0.161
Sarepol-Zahab	0.082	Kabutarabad	0.498	Kahnoj	0.709	Eest Isfahan	0.218	Tabriz	1.020
Saveh	-0.630	Gangam-Jam	0.061	Jiroft	3.080	Hamedan Airport	-0.254	Tehran	0.058
Shahreza	0.300	Kangavar	0.637	Rafsanjan	0.297	Abadeh	0.894	Torbat-Heydariyeh	0.042
Tekab	0.912	Kashmar	-0.041	Shahrbabk	0.419	Bojnord	-0.381	Yazd	0.416
Torbat-Jam	-0.648	Khalkhal	1.280	Anar	0.786	Noshahr	-0.373	Zahedan	0.687
Yasoj	-0.510	Khash	0.505	Ahar	-0.173	Kish	0.955	Zanjan	0.010
Zahak	0.661	Khodabandeh	-0.469	Aligodarz	-0.173	Omideyh Paygahi	0.529	Bam	0.769
Zarqan	0.405	Khor-Biyabanak	0.103	Astara	0.981	Siri	1.610	Kerman	0.446
Zarineh	-0.314	Khor-Birjand	1.243	Boshehr	1.243	Meragheh	0.135	Bandare Anzaly	0.738

Results showed that 17% of the stations are close to the normal distribution and the other stations needed to be normalize. Then annual rainfall of all synoptic stations normalized using six common transformation functions included logarithmic, square root, exponential, inverse, power and Box – Cox transformations. The best function selected according to the skewness coefficients of transformed data by each method as presented in table 4.

Table 4 – Best-fit function for transform annual rainfall to normal distribution in synoptic stations of Iran

Station	function	Station	function	Station	function	Station	function	Station	function
Khoramdareh	Log	Garmsar	Power	Ghchan	Power	Tabas	Log	Mashad	Log
Kohrang	Gamma	Ardestan	Log	Abomosa	Log	Qom	None	Abadan	Log
Lar	Log	Bandare dair	Log	Aghajari	Gamma	Kermanshah	Log	Ahvaz	Gamma
Malayer	None	Bandare Mahshar	Log	Qaemshahr	Power	Orumiyeh	Log	Arak	Log
Manjil	Gamma	Behbahan	Power	Konarak	Log	Dezfol	Log	Babolsar	Log
Marivan	Log	Bijar	Log	Karaj	Log	Gorgan	None	Bandarabbas	Log
Miyaneh	Gamma	Berojen	Log	Serakhs	Gamma	Hamedan	Power	Birjand	Gamma
Maraveh	Box Cox	Bashroeyeh	Log	Parsabad	Gamma	Shahrud	Log	Boshehr	Log
Naeen	Log	Bostan	Log	Ferdous	Gamma			Isfahan	Log
Natanz	Log	Borojerd	None	Sirjan	Log	Zabol	Log	Gazvin	Log
Neyshabur	Log	Daran	Log	Dogonbadan	Power	Chabahar	Log	Khoramabad	None
Piranshahr	Log	Dehloran	Log	Jolfa	Gamma	Iranshahr	Gamma	Khoy	Gamma
Ramhormoz	None	Islamabad	Log	Mako	Log	Semnan	Gamma	Ramsar	log
Ravansar	None	Qorveh	Log	Masjed Soleyman	Log	Bandare Lengeh	Log	Rasht	Log
Robat-Poshtbadam	None	Golmakan	Log	Minab	None	Kashan	Gamma	Sabzevar	Gamma
Dorodzan-Dam	None	Golpayegan	Gamma	Nehbandan	None	Fasa	Gamma	Saqes	log
Sarab	None	Gonabad	Log	Dezfol	none	Jask	Log	Sanandaj	Log
Saravan	Log	Ilam	Log	Qaeen	Log	Doshan-Tapeh	None	Shahrekord	Power
Sardasht	None	Izeh	Gamma	Baft	None	Ardabil	Log	Shiraz	Gamma
Sarepol-Zahab	None	Kabutarabad	Gamma	Kahnoj	Log	Eest Isfahan	Gamma	Tabriz	Log
Saveh	Power	Gangam-Jam	None	Jiroft	Log	Hamedan Airport	Power	Tehran	None
Shahreza	Log	Kangavar	Log	Rafsanjan	None	Abadeh	Log	Torbat-Heydariyeh	None

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 224-231

Tekab	Log	Kashmar	None	Shahrbabk	Log	Bojnord	Power	Yazd	Log
Torbat-Jam	Power	Khalkhal	Log	Anar	Log	Noshahr	Power	Zahedan	Log
Yasoj	Power	Khash	Log	Ahar	Power	Kish	log	Zanjan	None
Zahak	Log	Khodabandeh	Power	Aligodarz	None	Omideyh Paygahi	Log	Bam	Log
Zarqan	None	Khor-Biyabanak	Power	Astara	Log	Siri	Log	Kerman	Gamma
Zarineh	Power	Khor-Birjand	Log	Boshehr	Log	Meragheh	Log	Bandare Anzaly	Log

After selecting the best transformation function for annual precipitation of studied stations, skewness coefficients of normalized series have been calculated. The values of skewness coefficients calculated before transformation could be compare with the values of skewness after using normalization functions. This comparing will be indicate effect of selected normalization function on the normalizing rainfall data. Results of calculated skewness coefficients after normalizing have been presented in Table 5.

Table 5 – Skewness coefficients of normalized annual rainfall data in Iran

Station	**Skewness**	**Station**	**Skewness**	**Station**	**Skewness**	**Station**	**Skewness**	**Station**	Skewness
Khoramdareh	0.064	Garmsar	0.019	Ghchan	0.011	Tabas	-0.185	Mashad	-0.069
Kohrang	-0.110	Ardestan	-0.011	Abomosa	-0.021	Qom	0.039	Abadan	0.065
Lar	0.028	Bandare dair	0.060	Aghajari	-0.100	Kermanshah	0.093	Ahvaz	0.002
Malayer	0.073	Bandare Mahshar	0.003	Qaemshahr	0.078	Orumiyeh	-0.182	Arak	-0.042
Manjil	0.044	Behbahan	0.189	Konarak	0.048	Dezfol	-0.099	Babolsar	0.143
Marivan	-0.149	Bijar	0.087	Karaj	-0.011	Gorgan	0.092	Bandarabbas	0.143
Miyaneh	0.007	Berojen	-0.120	Serakhs	0.097	Hamedan	0.022	Birjand	0.017
Maraveh	-0.039	Bashroeyeh	0.025	Parsabad	0.056	Shahrud	-0.099	Boshehr	0.059
Naeen	-0.020	Bostan	0.096	Ferdous	0.094			Isfahan	-0.071
Natanz	-0.078	Borojerd	-0.263	Sirjan	-0.023	Zabol	-0.312	Gazvin	0.062
Neyshabur	-0.078	Daran	-0.004	Dogonbadan	0.060	Chabahar	0.087	Khoramabad	0.041
Piranshahr	0.124	Dehloran	0.085	Jolfa	0.048	Iranshahr	0.032	Khoy	0.085
Ramhormoz	0.065	Islamabad	-0.047	Mako	0.021	Semnan	0.158	Ramsar	0.018
Ravansar	0.063	Qorveh	-0.072	Masjed Soleyman	-0.019	Bandare Lengeh	0.019	Rasht	0.046
Robat-Poshtbadam	-0.160	Golmakan	0.073	Minab	0.129	Kashan	0.066	Sabzevar	0.047
Dorodzan-Dam	0.037	Golpayegan	0.028	Nehbandan	0.063	Fasa	0.028	Saqes	-0.101
Sarab	-0.247	Gonabad	0.099	Dezfol	0.122	Jask	-0.001	Sanandaj	-0.110
Saravan	-0.154	Ilam	0.106	Qaeen	-0.119	Doshan-Tapeh	-0.091	Shahrekord	-0.076
Sardasht	-0.094	Izeh	0.002	Baft	0.065	Ardabil	0.062	Shiraz	0.010
Sarepol-Zahab	0.082	Kabutarabad	0.126	Kahnoj	0.014	Eest Isfahan	-0.008	Tabriz	0.073
Saveh	0.018	Gangam-Jam	-0.177	Jiroft	0.061	Hamedan Airport	0.155	Tehran	0.058
Shahreza	0.076	Kangavar	0.297	Rafsanjan	0.094	Abadeh	-0.067	Torbat-Heydariyeh	0.042
Tekab	0.023	Kashmar	0.080	Shahrbabk	-0.041	Bojnord	0.017	Yazd	0.034
Torbat-Jam	0.056	Khalkhal	0.016	Anar	0.198	Noshahr	0.002	Zahedan	-0.107
Yasoj	0.072	Khash	0.014	Ahar	-0.021	Kish	-0.059	Zanjan	0.010
Zahak	-0.010	Khodabandeh	0.661	Aligodarz	0.102	Omideyh Paygahi	-0.064	Bam	-0.018
Zarqan	0.405	Khor-Biyabanak	0.039	Astara	-0.047	Siri	0.170	Kerman	-0.076
Zarineh	0.033	Khor-Birjand	-0.021	Boshehr	-0.018	Meragheh	-0.016	Bandare Anzaly	0.135

IV. CONCLUSIONS

Many methods of time series analysis depend on the basic assumption that data were sampled from a normal distribution. In this study annual precipitation of 140 synoptic stations in Iran has been employed to select the best normalization function. Skewness test of original data showed that rainfall of 25 synoptic stations are close to zero and could be assume normal. Other stations follow distribution functions such as Wakeby and GEV distributions. After that according to the skewness coefficients, the best transformation functions to normal distribution selected. Results showed that logarithmic transformation with 75 stations selected as the best function. Gamma function was the best transformation function for the number of 22 stations and power transformation fitted the best function for 17 stations. While logarithmic function was accepted for almost all stations according to the skewness test and suggested as the best normalization function for annual precipitation of synoptic stations in Iran. Comparing results with Khalili et al. (2014) showed that the best normalization function of annual precipitation data was logarithmic function while for monthly precipitation data square root, inverse and other functions selected for different climates of Iran.

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 224-231

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Issue 8(4), May 2014, pp. 231-234

The role of biological control in sustainable agriculture

Abdolreza BorjiAbad[1], MeysamMadadi Zadeh[1], AbdolahEslami[1], Ayub amiri[2]

abdolrezaborji@gmail.com

Abstract:
Nowadays, in order to supply the food needs a growing population, increasing the performance of crops per unit area has been an impressive increase in performance to look for excessive use of chemical fertilizers and pesticides can be fitted, unaware of the possible consequences of the large intake of these chemicals to the environment and human looking, based on this in this article were it to try one of the methods of biological pest control, namely compilation control (bio-containment) evaluates. Biological control method with useful live agents against decisions harmful organism (pest) can be fitted in. By applying this method to control harmful organism, topically, or because it populations will be removed to a size-reduced its economic damage was not the nutritional and other pest is not considered.
The use of natural enemies of pests can be effective step in reducing environmental pollution, but it should be noted that this type of control will not be alone in destroy all pests. To get more effective results consolidated control that it is better to apply several methods used to control rather than a method.

Keywords:environment, natural enemies, consolidated control, population, pests

Introduction:
With the increasing population of the Earth and the demand for food two ways to meet these needs on the track was the first agricultural researchers have increased land cultivation way of arable land because of a lack of fertile arable this fails. The second way to increase production per unit area of human access to the production of chemical fertilizers and pesticides was achieved to a certain extent but this increased production was not problem-free. With the use of chemical pesticides and fertilizers from indiscriminate human health and environmental risk also fell heavily from the prevalence of chronic cancers in humans caused by the use of nitrogen fertilizers and pesticides over the limit to the destruction of nature and the loss of useful organisms hence agricultural scientists to try to change the policy of intensive agriculture and organic and sustainable agriculture to the unstable side of the mbahsi agricultural science was raised in sustainable agriculture.

Sustainable agriculture:Sustainable agriculture, the development of operational policies and has the ability to produce food and clothing for the people ensures that natural resources are destroyed and no at the same time, agricultural trade and economic status and social values. One of the following strategies for sustainable agriculture in the fight against pests and weed control blend (IPM[1]).

Consolidated controls (IPM):

This way, the system for regulating pest populations in which the aspects related to the environment and the species population dinamism, observe and different techniques can be used to control pest population density refers to the economic losses under a threshold. In this way the different methods to control a pest can be used to reduce its population. In this way, to control a pest control methods such as multiple chemical control or any other method, such as biological and agronomic toam, or used to emphasize is that it is possible to work with all the procedures can be populated (compatibility with each other) pest control unit and a program of economic losses to prevent complications from the operation to at least. One of the subsets of consolidated control biologic control.

Biological control or inhibit the biological:

Useful live agents against harmful organism (pest). By applying this method to control harmful organism, topically, or because it populations will be removed to a size-reduced its economic damage was not the nutritional and other pest is not considered. Insectivorous organisms, parazitoid, and decreased the number of pathogens are the most important factor controlling pests. Agricultural pests in all different ecosystems include woodsy pasture, horticultural crops, natural enemies, and many have. They are fed with vegetarian species of pest populations are reduced and the natural balance in normal units (ICUs) are different dracusistm. these factors include pathogenic microorganisms (viruses, bacteria and fungi), different groups of birds, nematode, bend the end are insectivorous. If these factors in nature there's no insect populations are the unexpected increase technology. In fact the activity causing the damage species outbursts prevented them. Of course, nowadays some dedicated vegetarian species of weeds for weed control that is used to control the weed, biological methods.

Tips on choosing a biologic factor which needs to be addressed:

[1]- Integrated pest managment

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 231-234

A .High Power Search Casting: The power of search of a biological agent is high time it comes down to access
B .Expertise and dependence on pesticides: Here are the biological factors, the biology of its host and is forced to fed it.
C. Have coordination between the life cycles of pests and natural enemies of insects and mites: should be between pest and natural enemy of the Coordination life to exist. Otherwise, the influence of biological factors on populations would be.

D.Have a high proliferation of biological factor:If the be high proliferation of biological factor comfortably create significant population increase will prevent the pest population.
F. Having the ability to adapt new zone climate: The climate zone is consistent
G. Have behavior cumulative: the biological factor where Have tended to be higher pest densities, because the pest density is not uniform over the entire field.

Factors that lead to failure of the biological control:
A. Weather conditions: hot summer weather and cold winter weather also causes wasted biological agent.
B.The lack of coordination with the pest biological race race: pest and natural enemy of life not fit cause operating failures, because the egg eater and ramal biological activities of plant with it investment is egg time to coordinate it cleans go biological agent.
C. Lack of acceptance plant race: race may not be coordinating pest and natural enemy not actually accepted.
D. Appropriate Habitat is different from natural pest enemy: RAS reference location may vary with the natural enemy.
E. lack of access to a host of natural enemies: a host of natural enemies out of reach.
F. Competition: natural enemies may be imported, enter the competition with native natural enemies, causing failure of biological control in that case.

Types of biological control of pests:
A.Biological control) classic: to enter a biological agent and releasing it in a permanent ecosystem wastqrar. this procedure after economic and successful stqrarebsiar.
B. natural enemies) and releasing in a region: can be used with a biological agent in the course of emancipation is an ecosystem to tourtbiai or seasonal pest population in the high number of natural enemy to temporarily increase the pest population is desirable to reduce. Use this method to suppress the pest population peak. Often this method when the native or non-native pest and natural enemy in the region does not exist or is not entitled to much performance can be used to increase the efficiency of natural enemy populations also rise. This seasonal triggering method as well..
C. the natural enemies of the pests) support in one area: to be natural enemies will have maximum performance is required in addition to the methods of preservation and protection of native biological agents, in cases of non-native natural enemies imported Bayes.

The biological fight pests in greenhouses is a factor in healthy crop produce:
Also, nowadays, the increasing need to cultivate alternative herbal products lead tojamming and limited, such as greenhouses, for a vast and broad. Despite being a greenhouse space due to the factors being manageable conditions are suitable for the production of natural products as compared to the conditions. But the issue is not that it leads to production of greenhouse products of harm and damage caused by pests and plant diseases in greenhouse environmental conditions are safe, but for most diseases and diseases of the ideal plant and due to the limitation of space and fighting methods, in the event of damage-causing factors way to damage and reduce the intensity of greenhouse, greenhouse products performance is far heavier crops Non-greenhouse. So the need to combat and control the pests in greenhouses of botanical importance than farms. Fatal injuries and effects of chemical residues in plant products on human health are not worn on the person. In addition to this fundamental issue should be kept in mind that the use of chemical pesticides in agriculture in the long term lead to the emergence of resistance to pests and plant diseases, and manufacturers will be forced to use a higher amount of new chemical pesticides which are in addition to those that are not from the perspective of economic affordable leading to damage to the environment.So it is necessary to other pest control methods such as biological control in greenhouses is more felt. Biological control in fact live agents use approach (as an enemy) to control pest populations (both native and non-native). In addition, due to the limitation of greenhouse environment, the possibility of the success of this type of control will be higher.

The benefit of the use of biological agents
A.The lack of environmental pollution: no threat to wildlife, insects and other non-target soil organisms do not have the.
B. Optional: optional) and makes a natural balance in the ecosystem to not eating.
C. Sustainable pest control in akosism): in some cases the use of biological agents leads to biological control is a classic in the form of realization of this method, for several years or have years of the need to spend money.
D. The effect of water and material cycles) of cargo losses.

Disadvantages of biological control
A. To the ticks and insects) of all the vegetarian one affect ecosystems.
B. After identifying biological agents, the possibility of achieving their breeding technique is not easy.

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 231-234

(Clong-term maintenance is a problem)
D.Farmer and producer of biological control agent into the result didn't see speed and in terms of psychology, not satisfied consumer.

Results of measurements:
The use of natural enemies pat can step in reducing the environmental filth, but it should be noted that this type of control will not be alone, destroy all the pat to be effective. To get more effective results consolidated control that it is better to apply several methods used to control rather than a method.

Suggestions for further use of biological control in Iran:
A. Managers and planners: this is a great role in people can successfully conduct and role of biologic programs in sustainable agriculture. The task of the gozaran policy, planners and managers of the country which is to draw up and submit the appropriate application for sustainable development of agricultural production and raise the quality of products to enhance the health of the community and be diligent to supply the global market

B. Researchers: researchers in addition have to find proper solutions to problems that are applicable. Must be in to work and the implementation of the proposed solutions to the farmers and experts and even the most diligent administrators.
C. Farmers and greenhouse owners: in our country, such as many areas of the world have the ability, experience and greenhouse owners information far more than other farmers. Of course, should bear in mind that the relatively high cost of risk and changes in the greenhouses, the developments of this sector. But the necessity of taking advantage of the knowledge of the day to develop this part of the production, especially in the absence of not only health, but also produce more manufactured products is considered an essential and vital, is completely
D. Consumers: consumers should support the production of healthy products and for providing the consumer with the purchase of products and they are keen to their health but also in sustainability and environment share hazt

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ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 235-238

Studying the rol of Mycorrhizaas a biofertilizer in agricultural in agriculture

Bijani. Madine, Borjiabad. Abdolreza, Madadizade. Meysam and Soleymani.Saiede

Abstract:

Following the huge growth of world Population in recent years; The Production of agricultural crops in unavoidabl one of the strategies of high Production of agricultural crop is to increase the yield in area unit for mid-term or Long-term by using chemical and biological fertilizers. among the different fertilizers; The chemical fertilizers are more used because of Their suitable effectiveness and their more comfortable use, ignoring That their excess use leads to environmental Pollution and this problem is one of concerns of today huma To solve this problem; it seems necessary that suitable strategies are offerd to decrease the application of all kinds of chemical fertilizers; and consequently the envirnmental pollution the researchers believe thatby a good and correct management and by using bioligic fertilize and microorganism; we can Provide better nutritional conditions to Plants. Some of soil miccroorganisms are able to form a symbiotic relation to host through occupation of a part of plan's roots. Among these; the fungus symbiosism to plant is one of the most importas phenomena in natural and agricultural ecosystems. mycorrhizafungs is able to form a symbiosysm to the roots of terristrial Plants. Then both of the can benefit and help each others life. The most of identified plants on earth plant can form the symbiotic relation. But It is variable depending on the root of host plant and morphologic proparties of symbiont fungus. The most intersting propert of mycorrhiza fungus is to increase the growth of host plant; and this symbiosis causes the quick exchange of nutritional elements between host plant and fungus. Then biofertilizer ofmycorrhiza can help us reach Sustainable agicul.

Key words:Fertilizer; yield; nutritional elements; mycorrhiza.

Introduction:

Symbiosis between plant roots (marcosymbiont) and fungu (microsymbiont) was firstly discovered by a poland scientis komenskey; in 1881, and Than it was called mycorrhiza. Or root fungus. It has many kinds Am; ectomycorrhiza; ectendomycorrhiza, ericoid, arbotoid, monotropiod and orkidmycorrhiza. It's found that among 3611 species from263 families of teristerial plants, 80 % of species and 92% of families are mycorrhiza, That these values are different in briophits (wangan, 2005).

The importance of mycorhiza symbiosis:

One of the largest symbiosis identified among the plants and microorganism; is mycorrhizasymbiosis (Ardakam; et al., 2006). In these plants; the food absorption is higher because of a wide hypha network hypha is the relation between soil and root than as root branches absorbe food elements (Rilling et al; 2002).

The Symbiosis of mycorrhiza fungus increase the plant resistance a successful propagation due to absorption of food elements (Davies et al., 2005). Many researchers reported that symbiosis to mycorrhiza fungus increas tolerance against infestations and stresses such as salt and drought (Nemes and Vu, 1995). They believe That the telorance increase is because of in increase in absorption of N; P; trace elements and increasing water take up (Alizadeh, 2006). Also This fungus plays a significant role in maintanin the stability of soil structure and improving the aquatic relations and PH telorance (Bethlen falvay et al, 1986).

The application aspects of mycorrhizafungus in sustainal agricalture:

The sustainable agriculture is a system that increas the quality of environmental and storages of natural research in addition to correct management and using the resourcs to supply the food requirements of humans Also this sysem is economically dynamic and tries to maintain

The resources to future generations(Sedaghati, 2000). Today , it's very important to invent the modern methods to manage the exploitation of resources and reach sustainable agriculture. One of main aspects in sustainable agriculture is to use biofertilizers in farm ecosystems(Sharma, 2002). Since using fertilizer and poisons has been minimized in sustainable agriculture operations, it's considered as an important significance in balance of soil ecosistems(Majidian et al, 2002).

The effect mycorrhiza symbiosis with plant on sustainability of soil:

The root is an important source to absorption the soil's organic matter and also penetrat in to the soil and secrete some materials that change the physical, chemical and biologic properties of soil. The materials secreted from root is an important nutritional source of rhizospher microorganisms. The mycorrhiza causes The change in root secretion s of colonized plants. Mycorrhiza increases the rate of carbohydrate allocated to the root . Consequently, the root secretion increase and raising soil stability causes increase in population of microflora and microphone in soil.

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 235-238

Then the availability of plant to nutritional element increases(Varma and Hock, 1995). In root medium, the external myceliums of mycorhiza penetrate in soil up to few centimeters and by secreting organic and adhesive matters creates soil elements that are very important in soil stability(Thagarajan and Ahmad, 1994). This role is very important in sand and coastal lands(Muthukumar and Rajeshkannan, 2001). The effect of mycorrhiza symbiosis on improving water absorption from soil and telorance to drought:

Drought is the most common environmental stress and the most important factor limiting the successful production of farm crops in dry and semidry regions of world(Kramer and Boyer, 1995). The studies show that mycorrhiza fungus is sensitive to growth of plants under drought stress (Azcon A) and Ruiz-Lozano, 1996). Mycorrhiza fungus can penetrate into micro-pores causes increase in water take up (Tisdall, B) 1991). The plants that have mycorriza symbiosis absorbs water more quickly from soil and causes decrease in water potential of soil, because the aerial parts develop very much. C) Also their root grows very much these factors result in higher contact area of mycorhiza roots to soil and then absorb water very quick. The direct effect of Arbuscular based on water transmission through hyphae is reported in someinvestigation(Maggio, 2001). Then this fungus increases the tolerance to draught stress(Barea and azocon; Aguilar, 1983). The role of mycorrhiza in phosphure absorption:

Phosphor is one of important parts of enzyms, protein, ATP, RNA and DNA. ATP plays a role in reaction of energy exchange. RNA and DNA are the parts of genetic information(Peyvandi et al, 2009). Phosphor consists 0.5 to 1 percent of dry weight of plant and it's poisoning is more then 1 percent (TabaTabaei, 2009). In most of agricultural regulations, deficit of phosphor following nitrogen is the main factor in producing farm corps(Mosali et al, 2006). Felcher et al(2008) world regions experience phosphor deficit that causes culture limitation. In dry regions, because of high PH and calcium ion concentration, the phosphorelements aren't available to plant (Harmsen et al, 2001).

The efficiency of phosphate fertilizers in such regions is low and their absorbed value by plant in first year is only 5 to 20 percent(Malakuti,19960). So the plant often experience lack of these elementregarding this, using new technologies to biofertilizers is very important, siol application of phosphate can not satisfy the requirments of agriculture sectore and the new resources should be considered, that this method usually includes biologic, physical and chemical ones (Chabot et al, 1996).

In mast times, mycorrhiza plants cause better yield through higher absorption of phosphor The mechanisms such as increasing absorption, PH decrease in root area and high activity phosphatase inmyceliums of solving phosphate stones is as following (Kucey and Diab, 1984).

$$Ca3(Po4)3OH \rightarrow 5Ca^{2+} + 3Po_4^{3-} + OH$$

Many researches showed that plant infection improve the absorption of soil phosphate this is significant in the lands with low phosphor (shirani et al,2000) The highest efficiency of phosphor absorption in mycorhiza plants is possible when the soil productivity is low. Shirani rad et al(2000) found that VAM in low level of phosphor cause increase in phosphor absorption. But in low levels of productivity results in yield decrease.The mechanism to increase phosphor absorption by mycorrhiza plants.

Solubility of soil phosphor by releasing organic acids and phosphatase enzyms (Chen et al., 2001).
Increasing phosphor mobility by mycorrhizahypha and itis combination trend to phosphate ions (Mukerji and Chmola, 2003).
Excavation higher valum of soil (Feng et al., 2002).
The role of Mycorrhiza in nitrogen absorption;
Nitrogen is one of the macronutrients in plant growth. It is stability is very important in satisfying the nutritional requirements of plant and it,s replacement is economically and environmentally valuable in sustainable agriculture (Ohara et al., 2002).
Mycorrhiza plants contribute to absorption and stability of nitrogen . There are two significant theories about nitrogen absorption by mycorrhiza . In first theory, the mycorrhiza causes increase in nitrogen absorption by mycorrhiza
The second theory assumes that Mycorrhiza uptake of water and nutrients, the plant physiological conditions to provide optimum nitrogen fixation (Rilling et al., 2002).
Mycorrhiza plants prefer to absorb ammonium nitrogen because it has lower mobility in the soil. Mycorrhizasymbiosis in nitrogen fixing plants, allocate higher amounts of Photosynthesis fixed carbon too root that causes growth increase and the activity of nitrogen fixing bacteria also , mycorrhiza can compensate the increasing of carbon use (Vessey, 2003).
Mycorrhiza fungi, nitrogen-fixing symbiosis and cooperation method are affected.
In a greenhouse experiment, reduced the Mycorrhiza Soil disturbance reduces the accumulation of phosphorus, nitrogen and dry matter and dry matter in soybean nodules. In addition, the percentage of iron from plant nitrogen fixation was reduced from 32 to 12 percent (Olsen and Habt, 1995).
The role of mycorrhiza in decreasing the poisoning of heavy metals; mycorrhiza is effective in decreasing the poisoning of heavy elements. The researches of Joniz et al(1997). Showed that decreasing cadmium absorption in clover plant is because of symbiosis of mycorrhiza fungus. Also mycorrhiza decrease lead and cadmium transmission to plant's stem (Bradley et al., 1998).
In studying the effect of mycorrhiza fungus on Corn plant in soils infested by heavy elements showed that infestation of

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 235-238

mycorrhiza fungus isolated from soils polluted by this heavy element increase colonization percent.They also concludedthatmycorhiza fungus increase plant telorance to heavy elements (weissen,1995)byplanting
Shahdaneh in soils polluted by heavy metals,it's heavy element's in root,leaf and stem was higher than non-mycorhiza plants.(Norris et al,1992)

Conclusion:

Maintaining environment and keeping soil and water of this country and producing healthy agriculture are currently thy duties of engineers of agriculture .Thy biofertilizer is very important in improving physical and chemical properties and productivity of soil. Toreach sustainable agriculture we hope to be one of producer countries in future by using these biofertilizers.

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ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 239-243

A 3D finite element study on effect of soil elastic modulus of different soil types in single pile and pile group behavior

MOHAMMAD FARID NIKSHOAR

M.Sc of Geotechnical Engineering

TEHRAN, IRAN

f_niknik@yahoo.com

Abstract: **Behavior of pile groups in different situations is one of main issues for geotechnical engineers. Effects of piles on each other in pile groups is very complicated and important and it becomes even more complicated when the effect of soil on pile's behavior interferes, so finding out the effects of soil properties on pile groups behavior before design is necessary. In this paper the effect of soil elastic modulus on load bearing capacity and group efficiency of pile groups is studied using finite element method on four different soil types. Pile groups with Linear and square shape arrangements and single piles are used and their load bearing capacity and group efficiencies are compared.**

Key-Words: Pile group, 3D Finite element, Soil Elastic modulus, Load Bearing capacity, Group Efficiency

1 Introduction

Soil plays a major role in behavior of structures made for transferring load to soil through them. Soil characteristics should be known well for designing or analyzing these structures as it is one side of the system instead of load transferring structure. So the behavior of single piles and pile groups should be studied simultaneously with soil properties. A determinant soil parameter especially in its settlement is soil elastic modulus.

A lot of researches have been made and different methods and approaches have been provided for analysis of piles. Finite element method (Sheng et al. [1]; Said et al. [2]; Comodromos and Bareka [3]; Comodromos et al. [4]) is one of most powerful approaches for analyzing geotechnical problems such as behavior of single piles and pile groups[5].

Nowadays finite element based programs are available for engineers. Two famous programs for this method are PLAXIS 2D and PLAXIS 3D programs. These programs have huge capabilities in modeling and provide appropriate results in analyzing geotechnical problems. The program used here for modeling single piles and pile groups is PLAXIS 3D program.

2.1Modeling

If the cap is placed on the ground, its load bearing disturbs the results so the cap is placed above the ground surface and the cap's thickness in all models is 50 centimeter just like the piles diameter. For modeling linear and square pile groups fixed head cap is used and same concrete material used for it as piles. For better comparison between different piles (single piles and pile groups) same 6000 KN load is used for each pile and considering the pile group cap size the amount of cap load is somehow each pile of the group bears same 6000 KN.

Pile group efficiency is derived from following equation:

$$\rho = \frac{P_{Group}}{n * P_{Single}}$$

Where:

ρ- Pile group efficiency

P_{Group}- Load bearing capacity of pile group

P_{Single}- Load bearing capacity of single pile

n- Number of piles in group

Four different soil types are used for modeling. The soil and the material used for cap and piles characteristics are illustrated in table1.

φ,γ and c parameters are taken from Bardet[6] and Alam Singh[7] books and the elastic modulus range are from bowels[8] book.

2.2 Effect of soil Elastic modulus on pile group behavior

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 239-243

One of the effective parameters on settlement behavior of the loaded soil is elastic modulus of the soil. Variation of this parameter is caused by different factors like the amount of soil compactness can effect settlement and load bearing capacity of pile groups. The range of elastic modulus for soils is extensive, for example this range changes from 25 to 250 mega Pascal in clayey sand so a general study is necessary.

The importance of this effect is using some soil improvement methods like dynamic compaction, the soil compactness increases which results higher soil elastic modulus. For example the range of elastic modulus for loose sand is between 10 to 25 mega Pascal when it ranges from 50-81 mega Pascal for compacted sand.

The object of this paper is the evaluation of soil elastic modulus influence on single and group of the piles.

When the other parameters of the soil like C, φ and γ are not changed, the elastic modulus of the soil (Es) is varied, which leads to change of two dependent parameters G and Eoed for finding out the effect of soil elastic modulus on load bearing capacity and efficiency of pile groups in four different types of soils.

Pile groups consist of 3 linear piles and 9 square piles arranged in 2, 4 and 6 pile diameter spacing used.

After modeling the piles it can be interpreted from figures that the load bearing capacities of single piles increases with incretion of elastic modulus in relatively linear manner and this happens for SP soil type with higher gradient.

2.3Pile groups in sandy soil

In linear and square pile groups of SP soil type the group efficiency increases slightly with incretion of soil elastic modulus when the piles are close in group. When the piles spacing gets more in square and linear groups they behave different, the increase of group efficiency because of incretion of soil elastic modulus in square pile groups is much more than pile groups with linear formations. The reason of this behavior can be the behavior of square pile group as a block where the linear group behaves more like separate piles. Anyway the group efficiency of linear pile groups is more than square pile groups and their efficiency is more steady and with lower variation.

In linear and square pile groups modeled in SM soil type the variations of pile group efficiencies is very light with incretion of soil elastic modulus and it has a relatively specific manner.

2.4 Pile groups in fine graded soils

Soil types used here are CH and MH which their characteristics specified before.

In these soil types pile group efficiency increases with rise of soil elastic modulus but the pace of this incretion is varies between different soil types and different pile group formations. Just like sandy soil types linear pile groups has higher group efficiency than 9 pile square piles. Some of these linear groups have group efficiency as high as twice of square pile groups with same spacing between piles.

In CH soil type the pace of group efficiency incretion is higher in low soil elastic modulus and when the soil elastic modulus increases the pace of group efficiency decrease but in silty type of soil this change is much lower and the increase of group efficiency with incretion of soil elastic modulus is relatively steady.

Pile group efficiencies are higher than one in some cases which is so important because it shows the perfect roll of group acting in these cases as well as in some cases the group efficiency is too low so good design considering soil type is an important issue.

An important fact is when piles spacing are too close the pile group efficiency decreases a lot, sometimes to half of wider formations, so it's very important to use the proper group formation.

3 Figures and Tables

Table1-modeled materials specifications

	γ (KN/m^3)	ψ(°)	C (KN/m^2)	ϕ(°)	E (KN/m^2)	G (KN/m^2)	E_{oed} (KN/m^2)	ν	Material model
SP	17	4	0.1	34	24700	9500	33250	0.3	Mohr-coulomb

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 239-243

SM	18.8	0	12	34	13000	5000	17500	0.3	Mohr-coulomb
CH	15.5	0	25	19	20250	7500	32500	0.35	Mohr-coulomb
MH	14	0	35	25	15600	6000	21000	0.3	Mohr-coulomb
Piles & Cap	24	---	---	---	$2.92*10^7$	1.123E7	3.931 E7	0.3	Linear elastic

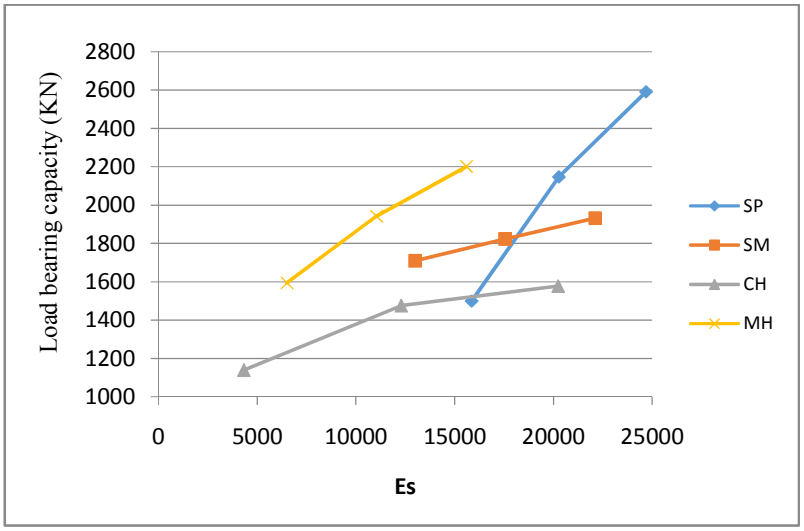
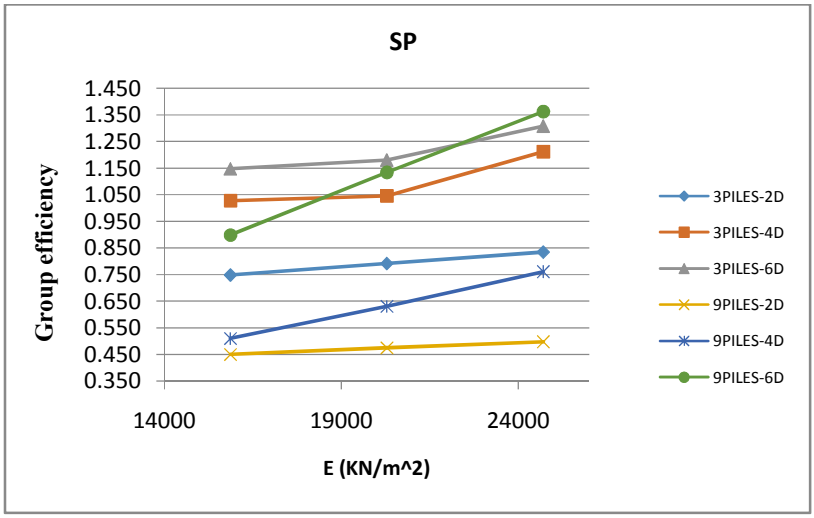


FIG 1 – Load bearing capacity of single piles



ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 239-243

FIG 2- Pile group efficiency of SP soil type

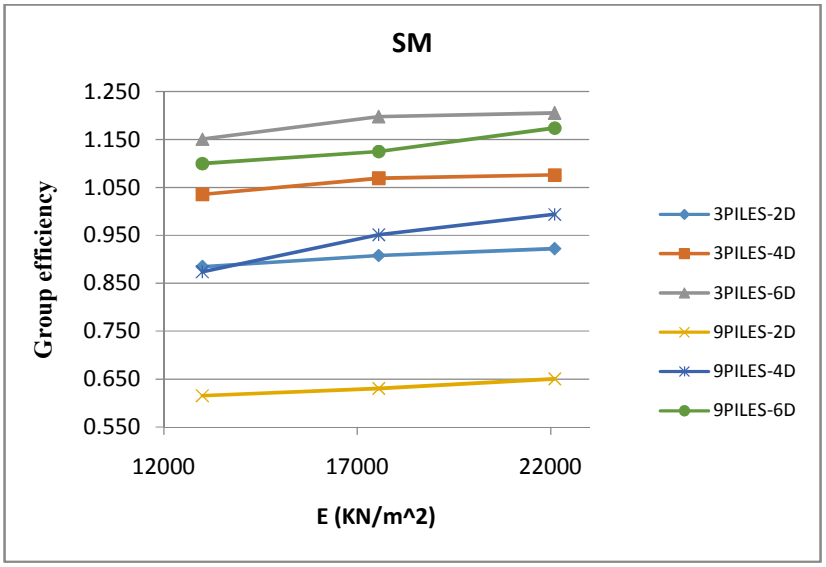


FIG 3- Pile group efficiency of SM soil type

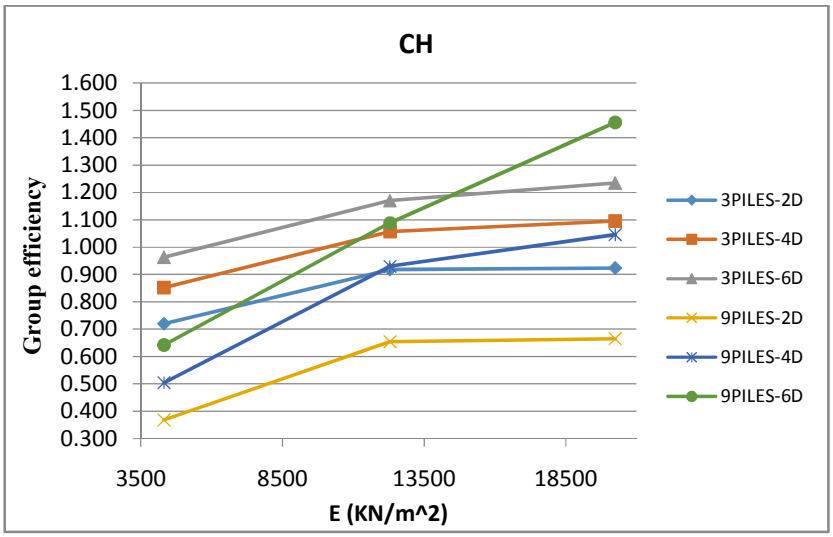


FIG 4- Pile group efficiency of CH soil type

ISSN (Online): 2305-0225
Issue 8(4), May 2014, pp. 239-243

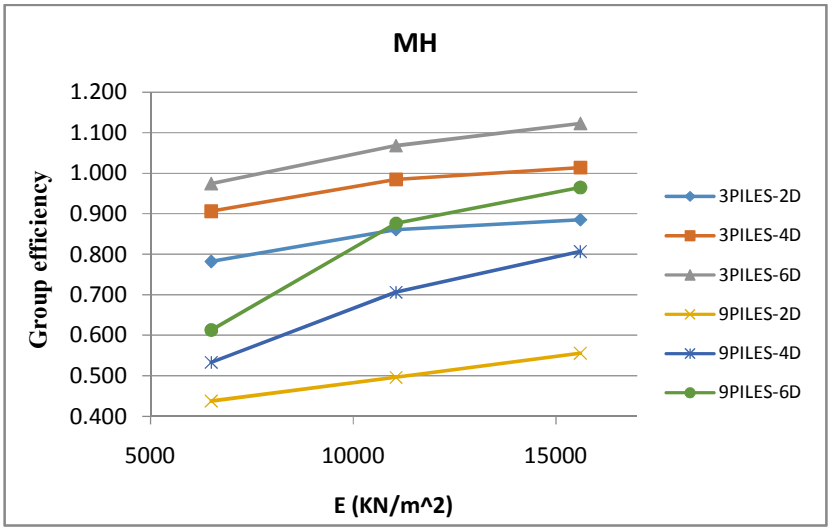


FIG 5- Pile group efficiency of MH soil type

Conclusion

Linear pile groups have more predictable behavior than square or other pile groups with surrounded piles because of complicated behavior of them like block acting manner.

Increase of soil elastic modulus when other parameters are unchanged has little effect on incretion of pile group efficiency but this effect is higher in CH and MHsoil types and pile group efficiency increases when soil elastic modulus gets higher.

Pile group efficiency increases with higher pace when soil elastic modulus gets higher in linear pile groups rather than square pile groups.

Pile spacing should be considered as an important factor in pile groups due to its important role in pile group efficiency.

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