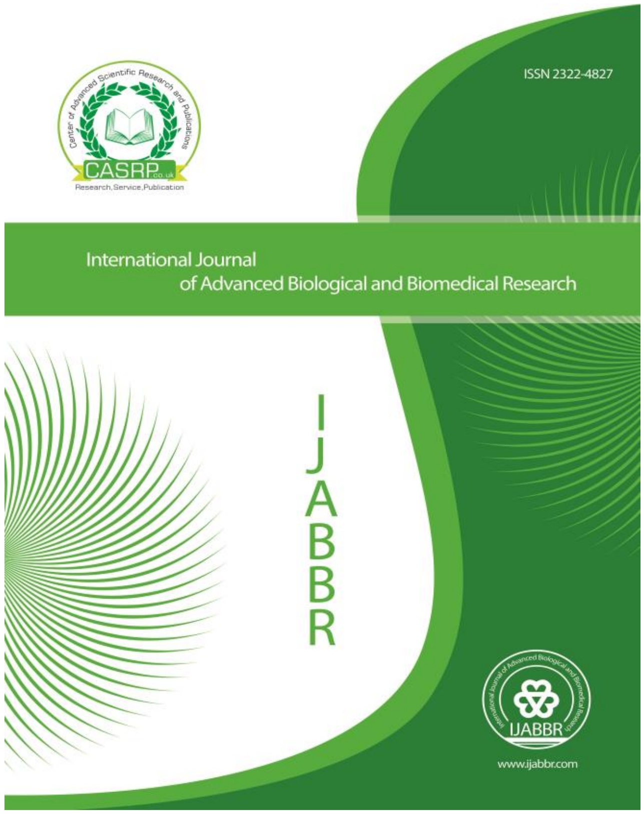
ISSN 2322-4827
CASRP
Research.Service.Publication
International Journal
of Advanced Biological and Biomedical Research
IJABBR
IJABBR
www.ijabbr.com

Available online at www.casrp.co.uk/journals

CASRP PUBLISHER

International journal of Advanced Biological and Biomedical Research 4(2) (2016) 202–210

Original Article **Open Access**

Nitrogen, phosphor and potassium changes in soil and wheat under foliar application of Leonardite, N and K

Elnaz Azizzadeh[1,*], Seyed Ali Reza Movahedi Naeini[2], Ebrahim Zeinali[3], Ghorban Ali Roshani[4]

[1]M.Sc. Student in chemistry and soil fertility, department of soil Sciences, Gorgan University of agriculture sciences and Natural resources Gorgan, Iran.

[2]Associate professor of department of soil Sciences, Gorgan University of agriculture sciences and Natural resources Gorgan, Iran.

[3]Associate professor of department of agronomy, Gorgan University of agriculture sciences and Natural resources Gorgan, Iran.

[4]Assistant professor of Gorgan institute for cotton research, Gorgan, Iran.

Abstract

This study was carried out in order to evaluate the changes of Nitrogen, phosphor and potassium uptake by wheat and remaining of them in soil under foliar application of Leonardite and foliar application of N and K. The experiment was conducted in Gorgan University of Agricultural Sciences and Natural Resources during 2013- 2014. The experiment was laid out a using split-plot arrangement based on complete block design with four replications. Treatments were nitrogen and nitrogen+potassium fertilizers in main plots and foliar application of nitrogen, potassium, humic power and mega humat with control in subplots. The results showed that, the effect of chemical fertilizers was significant on soil K content in harvesting stage, plant P and K content at heading beginning stage and grain N, P and K content at maturity. The effect of foliar application of Leonardite, Urea and potassium was significant on P and K content at heading beginning and harvesting stages, plant N, P and K content at heading beginning stage and grain N, P and K content at maturity. Interaction effect of chemical fertilizers and foliar application of Leonardite, Urea and potassium was significant on plant K content. Mean comparison results showed that, foliar application of Urea increased soil, plant and grain nitrogen content rather than other treatments. However, application of humic power and megahumat increased P uptake by wheat and accumulate in

* **Corresponding author:** M.Sc. Student in chemistry and soil fertility, department of soil Sciences, Gorgan University of agriculture sciences and Natural resources Gorgan, Iran.

Received 19 March 2016	Accepted 18 April 2016	Available online 25 April 2016
iThenticate screening 22 March 2016	English editing 15 April 2016	Quality control 21 April 2016

plant and grain tissues. Also results showed that integrated application of nitrogen+potassium and foliar application of potassium increased wheat K content. In final these results suggested that application of chemical fertilizers and foliar application of Leonardite, Urea and potassium had more effective on NPK supplying for wheat and uptake of these nutrients by wheat. Also improvement in soil properties and fertility status was recorded when chemical fertilizers were integrated with Leonardite, Urea and potassium as foliar application.

Keywords: Leonardite, Nutrient uptake, Organic acids, Wheat.

1. Introduction

In the world imbalanced use of chemical fertilizers by farmers has deteriorated soil health. Nitrogen, Phosphor and potassium play a key role in plant nutrition. These are the mineral elements required in the greatest quantity by cereal crop plants and these are the nutrients most often deficient. As a result of its critical role and low supply the management of NPK resources is an extremely important aspect of crop production (Novoa and Loomis, 1981).

Leonardite as resource of two humic acid source (megahumat and humic power), that humic acid is a naturally occurring polymeric organic compound, is a potential natural resource that can be utilized to increase growth, nutrient availability and yield (Sharif et al., 2002). Humic acid is a commercial product which is produced by decaying organic compounds. It contains elements that improve soil fertility, reduces soil nutrient deficiency and increases water and nutrient availability by forming chelates of various nutrients (Sanchez-Sanchez et al., 2002). environment-friendly re-vegetation of degraded soils. Humic substances constitute 65- 70% of organic matter in soils and are the subject of study in various fields of agriculture because of the multiple roles played by these materials, that can greatly benefit plant growth (Pin et al., 2011). Application of humic acid improves soil aggregation, structure, fertility, and moisture holding capacity, and increases microbial activity (Sharif et al., 2002). The foliar application of macro and micro-nutrients have very important role in improving of plant growth and development. Previous various experiments have been conducted on foliar spray of micro and micro nutrient in different crops and shown significant response to improve yield and quality their quality (Kumar et al., 2004). Humic acid application was also beneficial for nutrient uptake, particularly uptake of N, P, K, Mg, Ca, Zn, Fe, and Cu by plants (Nikbakht et al., 2008). Wojciechowska et al. (2005) report that foliar feeding significantly decreased nitrate contents in broccoli heads, as compared to non-feeding plants. The using of humic acid in soil increased absorption of nutrients from soil and plant nutrient efficiency (Adani et al, 1998). Humic acid-treated wheat plants showed somewhat positive growth responses on this relatively poor soil, while humic acid may have limited growth-promoting effects on plants adequately supplied with nutrients (Cooper et al., 1998). Sabzevari et al. (2009) reported that humic acid increased root content and caused the root system effectiveness and increased NPK uptake from soils. Some researchers reviled that humic acid increases the absorption of nitrogen, potassium, calcium, magnesium and phosphorus by plants (Adani et al., 1998; Ferrara and Brunetti, 2010).

Ayas and Gulser (2005) told that humic acid Application at medium levels increased yield and nutrient content of spinach. They concluded that humic acid application caused increased nitrogen uptake which was the main reason of enhanced vegetation growth of spinach. Application of humic acid increased head weight of lettuce due to increasing the availability of phosphorus and nitrogen uptake (Cimrin and Yilmaz, 2005). Therefore, the main aim of the present study is evaluation the effects of soil application of chemical fertilizers and foliar application of Leonardite, Urea and potassium on N, P and K uptake by wheat and remaining of them in soil.

2. Materials and methods

This field experiment was laid out to study on evaluation the effects of chemical application of nitrogen and potassium fertilizers and Leonardite on N, P and K uptake by wheat and remaining of them in the soils. This experiment was conducted in Gorgan University of Agricultural Sciences and Natural Resources during 2013- 2014. The Gorgan with 607 mm of rainfall had temperature averages 13C. According to Coupon climatic division Gorgan is Mediterranean warm and semi-humid climates with 54° East longitude, 37° N latitude and 13 m height from sea surface (Safahani et al., 2008) (table1).

Table 1
Minimum and maximum temperature mean, mean temperature and rainfall mean of Gorgan region.

Meteorological components	May6-Jun5	Jun6-Jul6	Jul7-Aug6	Aug7-Sep6	Sep7-Oct7	Oct8-Nov6
Minimum temperature mean (.C)	16.7	21.5	24.1	22.4	20.9	12.2
Maximum temperature mean (.C)	31.2	32.7	32.6	33.3	31.3	23.2
Mean temperature (.C) rainfall	2.8	27.1	28.3	27.9	26.1	16.7
Mean (mm)	28	2.5	11.3	17.9	66.8	24.6

The experiment was laid out a using split-plot arrangement based on complete block design with four replications. Treatments were nitrogen and nitrogen+potassium fertilizers in main plots and foliar application of nitrogen, potassium, humic power and mega humat with control in subplots. Main plots were consist of nitrogen fertilizer and potassium+ nitrogen fertilizers (nitrogen fertilizer was 200 kg/ha Urea and potassium was 200 kg/ha K_2SO_4 as chemical fertilizers). Sub plots were consist of control, foliar application of 400 l/ha Urea with 1.5% concentration (in two stages of before stem elongation and before heading), foliar application of 400 l/ha potassium with 1.5% concentration (in two stages of before stem elongation and before heading), foliar application of 10 l/ha humic power (in three stages of tillering beginning, before stem elongation and heading beginning) and application of 10 l/ha Megahumat (in three stages of tillering beginning, before stem elongation and heading beginning). Wheat c.v Zagros was cultivated in the present study. Sampling was performed using four topper leaves of 40 plants per plot. Leaves drying done in 70C for 72h then grinding and used for element determination in wheat tissues.

Phosphor determination in the soil was performed by Olsen method (Olsen, 1982). Also, soil nitrogen determination was performed by Kjeldal method using H_2SO_4 for sample digestion (Bermner and Mulvaney, 1982). Soil potassium determined flam photo metrically by using of Biotech Engineering Management Co. Ltd (AFP-100 model) (Cox et al., 1996). Plant phosphor determined spectrophotometricaly after digestion and plant potassium determined flam photo metrically by using of Biotech Engineering Management Co. Ltd (AFP-100 model) (Ehyaee, 1997). Also, plant nitrogen determination was performed by Kjeldal method using H2SO4 for sample digestion (Ehyaee, 1997) then founded by follow formula That Kjeldal result is X: $N= X\times 0.1\times 1.4/0.3$

The statistical analyses to determine the individual and interactive effects of treatments on soil and wheat traits were conducted using JMP 5.0.1.2 (18). Statistical significance was declared at $P\leq 0.05$ and $P\leq 0.01$. Treatment effects from the two runs of experiments followed a similar trend, and thus the data from the two independent runs were combined in the analysis.

3. Results and discussion

The results of analysis of variance showed that, the effect of chemical fertilizers on soil potassium content at harvesting stage was significant only. However, the effect of chemical fertilizers and foliar application of Leonardite, Urea and potassium was significant on P and K content at heading beginning and harvesting stages. Interaction effect of chemical fertilizers and foliar application of Leonardite, Urea and potassium was not significant on any parameters (table 1).

Mean comparison results showed that maximum soil P content was recorded in control and foliar application of Urea treatments at two heading beginning and harvesting stages and their differences were not significant. However, minimum soil P content was recorded in application of humac power and megahumat as Leoardite resources at two heading beginning and harvesting stages. Maximum soil K content as founded at application of nitrogen +potassium fertilizer at two heading beginning and harvesting stages as 326 and 297 mg/kg respectively. Between foliar application treatments, maximm soil K content was recorded in control treatment at two heading beginning (333 mg/kg) and harvesting (304 mg/kg) stages and minimum of that was recorded in foliar application of megahumat for at two heading beginning (306 mg/kg) and harvesting (277 mg/kg) stages (table 2).

Table 1
Analysis of variance (mean squares) for effect of chemical fertilizers and application of Leonardite, Urea and potassium on soil NPK content in two stages.

Soil		At heading beginning stage		At harvesting stage	
S.O.V	**df**	**Phosphor**	**Potassium**	**Phosphor**	**Potassium**
R	3	1.61	7.12	1.79	6.29
Chemical fertilizer (A)	1	0.42	1193.99	0.6	1145.75**
Errora	3	0.26	0.49	0.79	0.99
Foliar application (B)	4	44.4**	1117.65**	43.4**	1128.1**
A*B	4	0.44	0.49	0.68	0.74
Errorb	32	0.61	1.11	0.53	1.16
CV(%)		5.8	0.32	5.5	0.36

* and **: Significant at 5 and 1% probability levels, respectively.

Table 2
Mean comparisons for effect of chemical fertilizers and application of Leonardite, Urea and potassium on soil NPK content in two stages.

Soil	At heading beginning stage		At harvesting stage	
Treatments	**Phosphor(mg/kg)**	**Potassium(mg/kg)**	**Phosphor(mg/kg)**	**Potassium(mg/kg)**
Chemical fertilizer				
Nitrogen	13.6a	315b	13.2a	286b
Nitrogen+Potassim	13.3a	326a	13.03a	297a
Foliar application				
Control	15.8a	333a	15/1a	304a
Urea	15.8a	329b	15.7a	300b
Ptassium	13.4b	325c	13.2b	295c
Humic power	11.1c	309d	10.7c	280d
Megahumat	11.1c	306e	10.9c	277e

Means by the uncommon letter in each column are significantly different ($p<0.05$).

The results showed that, effect of chemical fertilizer was significant on plant P and K content at heading beginning stage. Also, the effect of foliar application of Leonardite, Urea and potassium was significant on plant N, P and K content. Interaction effect of chemical fertilizers and foliar application of Leonardite, Urea and potassium was significant on plant K content only (table3).

Table 3
Analysis of variance for effect of chemical fertilizers and application of Leonardite, Urea and potassium on plant NPK content at heading beginning stage.

Plant		At heading beginning stage		
S.O.V	**df**	**Nitrogen**	**Phosphor**	**Potassium**
R	3	0.0026	0.00085	0.006
Chemical fertilizer (A)	1	0.0002	0.0023**	0.66**
Errora	3	0.00001	0.000008	0.000002
Foliar application (B)	4	1.63**	0.167**	3.34**
A*B	4	0.00001	0.00007	0.54**
Errorb	32	0.0011	0.00034	0.0001
CV(%)		1.8	3.9	0.56

* and **: Significant at 5 and 1% probability levels, respectively.

The mean comparison results showed that, maximum plant P (0.47%) and K (1.7%) were recorded in application of nitrogen+potassium fertilizers. Maximum plant N content was recorded in foliar application of Urea

(2.61%) and minimum plant N content was founded in control treatment (1.51%) and their difference was significant. However, highest and lowest plant P content was founded in Leonardite resources (0.51%) and control (0.4%) treatments respectively (table 4).

Table 4
Mean comparisons for effect of chemical fertilizers and application of Leonardite, Urea and potassium on plant NPK content at heading beginning stage.

Plant	At heading beginning stage		
Treatments	**Nitrogen (%)**	**Phosphor (%)**	**Potassium(%)**
Chemical fertilizer			
Nitrogen	1.82a	0.45b	1.4b
Nitrogen+Potassim	1.82a	0.47a	1.7a
Foliar application			
Control	1.51c	0.4d	1.3d
Urea	2.61a	0.44c	1.32c
Ptassium	1.52c	0.46b	1.9a
Humic power	1.73b	0.51a	1.64b
Megahumat	1.75b	0.51a	1.65b

Means by the uncommon letter in each column are significantly different ($p<0.05$).

With regard to significant effect of effect of chemical fertilizers and foliar application of Leonardite, Urea and potassium interaction, results showed that highest plant K content was recorded in application of nitrogen+potassium fertilizer with foliar application of potassium (2%) treatment. Lower plant K content was founded in application of nitrogen fertilizer with control (2%) foliar application treatments (table 5).

Table 5
Mean comparisons for interaction effect of chemical fertilizers*application of Leonardite, Urea and potassium on plant NPK content at heading beginning stage.

Chemical fertilizer	Foliar application	Plant potassium at heading beginning stage (%)
Nitrogen	control	1.18e
Nitrogen	Urea	1.2e
Nitrogen	ptassium	1.8b
Nitrogen	humic power	1.51c
Nitrogen	Megahumat	1.52c
Nitrogen+Potassium	control	1.43d
Nitrogen+Potassium	Urea	1.45d
Nitrogen+Potassium	ptassium	2a
Nitrogen+Potassium	humic power	1.77b
Nitrogen+Potassium	Megahumat	1.78b

Means by the uncommon letter in each column are significantly different ($p<0.05$).

The effect of chemical fertilizer and foliar application of Leonardite, Urea and potassium were significant on grain N, P and K content at maturity. Interaction effect of chemical fertilizers and foliar application of Leonardite, Urea and potassium was not significant on any parameters (table 6).

The mean comparison results showed that maximum grain N (58.2 kg/ha), P (13.5 kg/ha) and K (24.33 kg/ha) were recorded in application of nitrogen+potassium chemical fertilizers. Moreover, highest grain nitrogen content (89.8 kg/ha) was founded in foliar application of Urea and lowest grain N content (44.2 kg/ha) was recorded in foliar application of potassium treatment. Maximum grain P fertilizer was recorded in foliar application of humic power (17.5 kg/ha) and megahumat (18.9 kg/ha) and differences between them was not significant. Highest grain

K content (29.1 kg/ha) was recorded in foliar application of potassium treatment and lowest was recorded at control (9.71 kg/ha) treatment (table 7).

Table 6
Analysis of variance (mean squares) for effect of chemical fertilizers and application of Leonardite, Urea and potassium on grain NPK content at maturity.

Grain		Absorption in grain		
S.O.V	**df**	**Nitrogen**	**Phosphor**	**Potassium**
R	3	15.4	0.05	1.5
Chemical fertilizer (A)	1	207**	23*	1009**
Errora	3	11.5	0.7	1.9
Foliar application (B)	4	3867**	220**	537**
A*B	4	8.1	0.4	5.1
Errorb	32	13.4	1.4	1.3
CV(%)		6.4	9.3	6

* and **: Significant at 5 and 1% probability levels, respectively.

Table7
Mean comparisons for effect of chemical fertilizers and application of Leonardite, Urea and potassium on grain NPK content at maturity.

	Absorption in grain		
Treatments	**Nitrogen (Kg/ha)**	**Phosphor (Kg/ha)**	**Potassium (Kg/ha)**
Chemical fertilizer			
Nitrogen	54.3b	12.1b	14.12b
Nitrogen+Potassim	58.2a	13.5a	24.33a
Foliar application			
Control	30.3d	6.02c	9.71e
Urea	89.8a	10.7b	13d
Ptassium	44.2c	11.4b	29.1a
Humic power	56.9b	17.5a	22.5c
Megahumat	60.7b	18.9a	23.06b

Means by the uncommon letter in each column are significantly different ($p<0.05$).

Based on the results soil application of nitrogen+potassium chemical fertilizer had the positive effect on soil, plant and grain mineral content. Moreover, the foliar application of Urea increased soil, plant and grain nitrogen content rather than other treatments. Urea fertilizer contains 46% pure nitrogen that foliar application of them increase leaf absorption of nitrogen and accumulate it in plant and grain tissues. Moreover, dropping of foliar application of Urea fertilizer on soil surface increased soil nitrogen content. However, adequate nitrogen supplying by foliar using of it decreased nitrogen uptake from soil and increased it in soil samples. This increase may be attributed to higher microbial activity in these treatments which favoured the conversion of the organically bound nitrogen to inorganic form (Panwar, 2008). Similar increase in available N in soil due to addition of organics was observed in wheat (Singh et al., 2006).

Humic acid resources (megahumat and humic power) are potential compounds that can be used for increasing nutrient availability and crop production in sustainable agriculture system. They play a main role in micronutrients transport and availability, which higher pH fixed them in soils. Foliar application of humic power and megahumat increased P content in plant and grain but decreased P content in the soil. The increase in available P is due to the addition of P through foliar application of Leonardite in excess of removal by the crop. Similar findings were also reported by (Bahadur et al., 2012). These results showed that application of Leonardite resources as humic power and megahumat increased P uptake by wheat and accumulate in plant tissues and grains. Humic acid has been found to alter micronutrient uptake in wheat plants, being effective at ameliorating leaf interveinal chlorosis (Mackowiak et al., 2001). Mokhtari et al. (2008) founded that the application of humic acid can increases the absorption of some nutrients such as nitrogen, potassium, calcium, magnesium and phosphorus by plants and increased their accumulation in different tissues. Ghosh et al. (1981) proposed that humic acid increased root content and caused the root system effectiveness that lead to increasing of plant material uptake and in final increasing of plant growth. Halime et al. (2011) told that humic substances are generated through organic matter decomposition and employed as soil fertilizers in order to improve soil structure and soil microorganisms. The N, P and K are treated as the limiting elements for good growth in plants (Halder et al., 2007). With regards to this which humic acid application was also beneficial for nutrient uptake, particularly uptake of N, P, K, Mg, Ca, Zn, Fe, and Cu by plants (Nikbakht et al., 2008) in this study showed that application of humic power and magahumat increased P uptake by wheat and accumulate it in plant and grain and decreased amount of P content in soil. These results are in accordance with the findings of Baldotto and Baldotto (2013), who reported greater number of leaves which might be due to improvement of micro and macro nutrient uptake and reduction in water evaporation from soils. Dell'Agnola and Nardi, (1987) told that to elucidate the effects of humic substances and bio-stimulators, several hypotheses suggesting the formation of a complex between these substances and mineral ions, their involvement in the enhancement of enzyme catalysis, their influence of stimulating respiration, photosynthesis and nucleic acid metabolism, and their hormonal activity have been reported. Humic acid effectively improves soil fertility and crop production especially in poor soils and alkaline-calcareous soils (Rajaei, 2010). Our results is supported by the finding of Russo and Berlyn (1992) and Hao and Papadopoulos (2003) who reported that HA sprays increased fruit yield and reproductive growth of tomato and increasing of some elements in plant tissues. Foliar application of HA promoted growth and increased yield by 10.5% in processing tomatoes over untreated controls (Brownell et al., 1987). They have also reported that leonardite extracts containing higher concentration of humic acid should be applied as soil application, while those with lower HA concentration should be used as post emergence foliar spray.

The present study showed that, the combined soil application of nitrogen+potassium and foliar application of potassium increased wheat K content. However, the potassium uptake by wheat increased with the increasing levels of fertilizers and integration with Leonardite and foliar application of potassium. Integrated plant nutrient system has assumed a great importance and has vital significance for the maintenance of soil productivity. Foliar application of potassium supplies adequate K for leaves consuming, then accumulate this element in plant tissues such as leaves and grains. Foliar sprays of these substances also promote growth, and increases yield and quality in a number of plant species at least partially through increasing nutrient uptake, serving as a source of mineral plant nutrients and regulator of their release (Atiyeh et al., 2002). In this study, the increased increase of potassium in plant tissues and grain of wheat be due to the greater effect of foliar application for uptake of mineral nutrients rather than soil application of chemical potassium and nitrogen fertilizer. The increased uptake of K by wheat may be ascribed to the release of K from the Kbearing minerals by complexing agents and organic acids produced during decomposition of organic resources. Similar results were also observed by (Mohapatra et al., 2008) in rice–potato (*Solanum tuberosum* L.) cropping system and (Sawarkar et al., 2013) under soybean-wheat cropping sequence in a Vertisol.

These results suggested that application of chemical fertilizers and foliar application of Leonardite, Urea and potassium on the basis of soil test was although more effective in comparison to below the recommended chemical application of nitrogen and potassium fertilizers, but the integrated use of that was more effective in enhancing NPK uptake from soils and accumulation in plant tissues and grain of wheat. Improvement in soil properties and fertility status was recorded when chemical fertilizers were integrated with foliar application of Leonardite, Urea and potassium.

References

Adani, F., Genevini, P., Zaccheo, P., Zocchi, G., 1998. The effect of humic acid on tomato plant growth and mineral nutrition. J. Plant. Nutr., 21, 561–575.

Atiyeh, R.M., Edwards, C.A., Metzger, J.D., Lee, S., Arancon, N.Q., 2002. The influence of humic acids derived from earthworm-processed organic wastes on plant growth. Biores. Technol., 84, 7-14.

Ayas, H., Gulser, F., 2005. The effects of sulfur and humic acid on yield components and macronutrient contents of spinach. J. Biol. Sci., 5(6), 801-804.

Bahadur, Lal, Tiwari, D.D., Mishra, J., Gupta, B.R., 2012. Effect of integrated nutrient management on yield, microbial population and changes in soil properties under rice-wheat cropping system in sodic soil. J. India. Soci. Soil. Sci., 60(4), 326- 329.

Baldotto, M.A., Baldotto, L.E.B., 2013. Gladiolus development in response to bulb treatment with different concentrations of humic acids. Revista. Ceres., 60, 138-142.

Bermner, J.M., Mulvaney, C.S., 1982. Nitrogen-Total. P. 595-624. In: Page, A. L, et al (eds). Methods of soil analysis. Part 2. 2nd ed. Agron. Momger. 9.

Brownell, J.R., Nordstrom, G., Marihart, J., Jorgensen, G., 1987. Crop responses from two new leonardite extracts. Sci. Total. Environ., 62, 491-499.

Cimrin, K.M., Yilmaz, I., 2005. Humic acid applications to lettuce do not improve yield but do improve phosphorus availability. Acta. Agr. Scand. B-S P., 55, 58-63.

Cooper, R.J., Liu, C., Fisher, D.S., 1998. Influence of humic substances on rooting and nutrient content of creeping bentgrass. Crop. Sci., 38, 1639–1644.

Cox, A.E., Joern, B.C., Roth, C.B., 1996. Non-exchangeable ammonium and potassium determination in soils with modified sodium tetraphenylboron method. Soil. Sci. Soc. Am. J., 60, 114-120.

Dell'Agnola, G., Nardi, S., 1987. Hormone-like effect and enhanced nitrate uptake induced by depolycondensed humic fractions obtained from Allolobophora rosea and A. caliginosa faeces. Biol. Fertil. Soil., 4, 115-118.

Ferrara, G., Brunetti, G., 2010. Effects of the times of application of a soil humic acid on berry quality of table grape (Vitis vinifera L.) cv Italia. Spanish. J. Agr. Res., 8, 817-822.

Ghosh, D.K., Roy, Malic, S.C., 1981. Effect of fertilizers and spacing on yield and other characters of black cumin (Nigella sativa L.). India. Agr., 25, 191-197.

Halder, N.K., Ahmed, R., Sharifuzzaman, S.M., Bagam, K.A., Siddiky, M.A., 2007. Effect of boron and zinc fertilization on corm and cormel production of gladiolus in grey terrace soils of Bangladesh. Int. J. Sustain. Crop. Prod., 2, 85-89.

Halime, O.U., Husnu, U., Yasar, K., Huseyin, P., 2011. Changes in fruit yield and quality in response to foliar and soil humic acid application in cucumber. Sci. Res. Essay., 6(13), 2800-2803.

Hao, X., Papadopoulos, A.P., 2003. Effect of calcium and magnesium on growth, fruit yield and quality in a fall greenhouse tomato crop grown on rockwool. Can. J. Plant. Sci., 83, 903-912.

Kumar, S., Kumar, S., Verma, D.K., 2004. Effect of micro-nutrients and NAA on yield and quality of litchi cv.

Mackowiak, C.L., Grossl, P.R., Bugbee, B.G., 2001. Beneficial effects of humic acid on micronutrient availability to wheat. Soil. Sci. Soc. Am. J., 65, 1744–1750.

Mohapatra, B.K., Maiti, S., Satapathy, M.R., 2008. Integrated nutrient management in potato (Solanum tuberosum) - jute (Corchorus olitorius) sequence. India. J. Agron., 53(3), 205-209.

Mokhtari, I., Abrishamchi, P., Ganjeali, A., 2008. The effects of calcium on amelioration of injuries salt stress on seed germination of tomato (Lycopersicon esculentom L.). Iran. J. Sci. Food. Technol., 22(1), 89-100.

Nikbakht, A., Kafi, M., Babalar, M., Xia, Y.P., Luo, A., Etemadi, N., 2008. Effect of humic acid on plant growth, nutrient uptake, and postharvest life of gerbera. J. Plant. Nutr., 31, 2155- 2167.

Novoa, R., Loomis, R.S., 1981. Nitrogen and plant production. Plant. Soil., 58, 177–204.

Olsen, S.R., Sommers, L.E., 1982. Phosphorus. In A.L. page, R.H., Miller, and D.R., Oya, K., 1972. Evalutoin of potassium availability of four Michigan soils. Department of Agricultue Chemistry. Coll. Agr. Univ. Ryukus., 19, 123-257.

Panwar, A.S., 2008. Effect of integrated nutrient management in maize (Zea mays) - mustard (Brassica campestris var. toria) cropping system in mid hills altitude. India. J. Agr. Sci., 78(1), 27-31.

Pin, L., Guang, S., Lin, Z., 2011. Effect of humic acid from straw on growth and pest resistance of Salvia splendens. en.cnki.com. cn. doi:cnki:sun:fzsa.0.2011-03-007.

Rajaei, M., 2010. Plant nutrition. Text booklet of Islamic Azad University of Jahrom, Khayam Press.

Russo, R.O., Berlyn, G.P., 1992. Vitamin humic algal root biostimulant increases yield of green bean. Hortic. Sci., 27(7), 847.

Safahani, A., Kamkar, B., Zand, E., Bagherani, N., Bagheri, M., 2008. Reaction of grain yield and its components of canola (Brassica napus L.) cultivars in competition with wild mustard (Sinapis arvensis L.) in Gorgan. Iran. J. Crop. Sci., 9, 356-370.

Sanchez-Sanchez, A., Sanchez-Andreu, J., Juarez, M., Jorda, J., Bermudez, D., 2002. Humic substances and amino acids improve effectiveness of chelate FeEDDHA in lemon trees. J. Plant. Nutr., 25, 2433-2442.

SAS Institute, 2002. JMP statistics and graphics guide. SAS Institute Inc., Cary, NC.

Sawarkar, S.D., Khamparia, N.K., Thakur, Risikesh, Dewda, M.S., Singh, Muneshwar, 2013. Effect of long-term application of inorganic fertilizers and organic manure on yield, potassium uptake and profile distribution of

potassium fractions in vertisol under soybean - wheat cropping system. J. India. Soc. Soil. Sci., 61(2), 94-98.
Sharif, M., Khattak, R.A., Sarir, M.S., 2002. Effect of different levels of lignitic coal derived humic acid on growth of maize plants. Comm. Soil. Sci.Plant. Anal., 33, 3567-3580.
Singh, Muneshwar, Singh, Mohan, Kumawat, B., 2008. Influence of nutrient supply system on productivity of soybean - wheat and soil fertility of vertisol of Madhya Pradesh. J. India. Soc. Soil. Sci., 56(4), 436-441.
Wojciechowska, R., Rożek, S., Rydz, A., 2005. Broccoli yield and its quality in spring growing cycle as dependent on nitrogen fertilization. Folia. Hort., 17/2, 141–152.

How to cite this article: Azizzadeh, E., Movahedi Naeini, S.A.R., Zeinali, E., Roshani, G.A., 2016. Nitrogen, phosphor and potassium changes in soil and wheat under foliar application of Leonardite, N and K. International journal of Advanced Biological and Biomedical Research, 4(2), 202-210.