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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON THE YIELD, YIELD ATTRIBUTES AND PROTEIN CONTENT OF LENTIL

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Abstract

A field experiment was conducted at the Pulse Research Sub-station of Bangladesh Agricultural Research Institute (BARI), Gazipur during *rabi* season of 2015-16 and 2016-17 to evaluate the effectiveness of organic and inorganic sources of nutrients in terms of growth and yield maximization of lentil. The experiment was laid out in a randomized complete block design (RCBD) having six treatments with three replications. The treatments were T_1= Recommended dose ($N_{20}P_{15}K_{30}S_{10}Zn_3B_{1.5}$ kg ha^{-1}), T_2= IPNS (Inorganic) +2.5 t ha^{-1} cowdung, T_3= IPNS (Inorganic) +5 t ha^{-1} cowdung, T_4= IPNS (Inorganic) +1.5 t ha^{-1} poultry manure, T_5= IPNS (Inorganic)+3 t ha^{-1} poultry manure and T_6= Control. The results reveal that the integrated nutrient management had significant effects on the plant height, number of branches per plant, number of pods per plant, number of seeds per pod, 1000-seed weight, and seed yield of lentil. The maximum seed yield (1216 kg ha^{-1}) as well as protein content (26.1%) were recorded with T_4 treatment. The results advocate that satisfying the recommended dose through application of poultry manure @ 1.5 t ha^{-1} with IPNS inorganic fertlizer could be suggested for achieving yield miximization of lentil in chhiata soil series of Gazipur.

Keywords**:** Integrated nutrient management, yield attribute, quality, lentil yield

Introduction

Lentil (*Lens culinaris* Medik) is an important food legume with various uses as food because of its protein-rich grains. Lentil is the second most important pulse crop of Bangladesh in terms of area (2.704 lakh hectares) and production (3.555 lakh metric ton) (BBS, 2016) and it ranks the highest in terms of consumer preference as total pulse consumption (Krishi Diary, 2018). Lentil is also important in crop diversification in the cropping systems of Bangladesh. Lentil productivity is below potential due to low input usage and limited usage of modern agronomic practices. Declining soil fertility is major constraints to crop production. Organic manures facilitate improve most of the physical, biological and chemical characteristics of soil, thus improving soil fertility (Vishnoi *et al.*,

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2013; Zeidan, 2007). Nutrients play an important role for increasing the yield of lentil through their effect on the plant itself and on the nitrogen fixing by symbiotic process (Sahu *et al*., 2017). However, balanced fertilization including manures can increase the yield of lentil. Conjunctive use of manure along with chemical fertilizers reduces organic carbon depletions and the gap between potential yield and actual yield is bridged to a large extent (Tolanur and Badanur, 2003). Cowdung and poultry manure are the two common sources of organic manure. Between them, poultry manure is a rich source of nutrients as it contains 3.03 percent of nitrogen, 2.63 percent of phosphorus and 1.4 percent potassium (Vishnoi *et al*., 2013). Hence, attention is needed to increase organic matter content in soil through balanced fertilization accompanied with organic manure. Therefore, the experiment was undertaken to evaluate the proper organic source and to determine the optimum dose of organic and inorganic sources of nutrients for achieving higher yield of lentil.

Materials and Methods

The field experiment was conducted at research field of Pulse Research sub-station, Bangladesh Agricultural Research Institute (BARI), Gazipur during *rabi* seasons of 2015-16 (1st year) and 2016-17 (2nd year). The land of Gazipur is medium high with fine-textured (clay loam) grey terrace soils. It belongs to Chhiata soil series under the agroecological zone - Madhupur Tract (AEZ-28). The experimental area received rainfall from 1.40 to 118 mm during October to March. The mean minimum and maximum air temperatures during October to March of the experiment were 21.4 & 28.6°C in the 1st year and 20.3 & 29.0°C, respectively in the 2nd year. The average minimum and maximum humidity (%) were 51 and 88 during October to March. The initial soil (0-15 cm) sample and all manure samples were analyzed as outlined by Page *et al*. (1982). Cowdung and poultry manure that used in the experiment were analysed by the standard methods. The results of chemical analysis are shown in Tables 1 and 2.

The land was prepared by a tractor operated chisel plough and then rotavator was used for breaking the clod and finaly the land was leveled by the leveler. The experiment was planned with six treatments such as T_1= Recommended dose ($N_{20}P_{15}K_{30}S_{10}Zn_3B_{1.5}$ kg ha^{-1}) as per FRG, (2012), T_2= IPNS (Inorganic) +2.5 t ha^{-1} cowdung, T_3= IPNS (Inorganic) +5 t ha^{-1} cowdung, T_4= IPNS (Inorganic) +1.5 t ha^{-1} poultry manure, T_5= IPNS (Inorganic) +3 t ha^{-1} poultry manure and T_6= Control (no addition of fertilizer or manure). The treatments of the experiment were laid out in randomized complete block design (RCBD) with three replications. The unit plot size was 12 m^2 (4 m × 3 m). Nutrients N, P, K, S, Zn and B were applied as urea, TSP, MoP, gypsum, zinc sulphate (heptahydrate) and boric acid; respectively during final land preparation.The test crop variety was BARI Masur-7. Seeds were sown in the 3rd week of November in both years at a rate of 35 kg ha^{-1}, sowing was done continuously in rows at a depth of 2-3 cm maintaining row to row spacing of 30 cm. The seeds were treated using the fungicide Provex 200 (at

Table 1. Fertility status of initial soil sample of the experimental field at Gazipur

	pH	OM (%)	Total N (%)	Ca	K	P	S	Zn	B
				meq. 100 g^{-1}		mg kg^{-1}			
	6.1	1.35	0.066	6.2	0.12	17	20	0.80	0.14
Critical level	-	-	0.12	2.0	0.12	7	10	0.60	0.20
Interpretation*	acidic	low	very low	high	low	optimum	medium	low	low

*FRG, (2012)

Table 2. Nutrient status of cowdung and poultry manure of the experiment

Type of manure	Moisture (%)	pH	OM (%)	Total N (%)	K meq. 100 g^{-1}	P	S	Zn	B
						%			
Cowdung	12.54	6.9	20.1	1.09	0.58	0.62	0.36	0.012	0.12
Poultry manure	12.36	8.1	21.9	1.42	0.84	0.85	0.49	0.015	0.16

2.5 g kg^{-1} seeds) before sowing for controlling of root rot disease. Hand weeding as well as thining of seedlings was done at 25 days after sowing (DAS). Again, hand weeding was done at around 50 DAS.Two sprays were done with fungicide of Rovral starting from 55 DAS to control *Stemphylium* blight disease and two times insecticide (Karate @ 2 ml L^{-1} of water) was sprayed at 10 days interval starting from 60 DAS to overcome insect infestation. The crop was harvested at maturity.

Data on the seed yield (kg ha^{-1}) at around 10% moisture basis were recorded from the whole plot technique. For straw yield (kg ha^{-1}), mature plants were collected from two $1m^2$ quadrates in each plot at harvest time. Harvest index (%) was determined as a ratio of economic yield to biological yield (Zerihun *et al*., 2013). The data of yield attributes included plant height, number of branches $plant^{-1}$ and number of pods $plant^{-1}$ were recorded from ten plants selected randomly from each unit plot. Ten pods were detached randomly from ten plants and the number of seeds per pod was counted and averaged. Thousand seed weight (g) was determined by counting of 500 seeds randomly from each plot and weighing through electronic balance and converting it into 1000-seed weight. Five plants from each plot were chosen randomly at seedling, vegetative, flowering and pod formation stages for recording nodulation per plant. Plants were smoothly uprooted and the soil from roots was removed carefully using tap water. Nodules were separated and counted from each plant and averaged. Separated nodules were sliced into two pieces to observe the inside color for determining of nodule activity. The light-pink or red coloured nodules were considered as active.

Seed samples were digested with di-acid mixture (HNO_3-$HClO_4$) (5: 1) as described by Piper (1966) for determination of N concentration (Micro-Kjeldahl method). Protein contein in lentil seed was calculated by multiplying %N by a factor 5.30 (FAO, 2018).

All the data of growth, yield attributing characters, number of nodules per plant and yield of lentil were statistically analysed by ANOVA procedure. Then, multiple comparisons were done by LSD at 5% level (Statistix 10., 1985).

Results and Discussion

Growth attributes of lentil

Growth attributes like plant height and number branches per plant were influenced significantly due to imposing different integrated nutrient treatments (Table 3). In the experiment, the tallest plant (31.2 cm) was found in T_4 treatment which was statistically similar with T_1, T_2 and T_3 treatments. The most dwarf plant (27.5 cm) was observed in T_6 treatment (control).The plant height increased progressively due to application of cowdung and poultry manure with inorganic fertilizers. Similar observation was noted by Singh *et al*. (2011).

Table 3. Effects of integrated nutrient management on the growth and yield attributes of lentil

Treatment	Plant height (cm)	No. of branches plant^{-1}	No. of pods plant^{-1}	No. of seeds pod^{-1}	1000-seed weight(g)
T_1	30.7	2.82	52.8	1.90	20.3
T_2	29.6	2.84	55.4	1.93	21.0
T_3	28.7	2.80	51.8	1.83	20.6
T_4	31.2	2.86	55.9	1.93	22.0
T_5	28.0	2.73	53.6	1.80	20.5
T_6	27.5	2.46	50.8	1.73	19.6
$LSD_{0.05}$	2.7	0.2	3.9	0.05	0.9
CV (%)	5.01	3.29	4.03	1.51	2.28

Note: T_1= Recommended dose (FRG, 2012), T_2= IPNS (Inorganic) +2.5 t ha^{-1} cowdung, T_3= IPNS (Inorganic) +5 t ha^{-1} cowdung, T_4= IPNS (Inorganic) +1.5 t ha^{-1} poultry manure, T_5= IPNS (Inorganic) +3 t ha^{-1} poultry manure and T_6= Control.

Table 4. Effect of integrated nutrient management on the yields and harvest index of lentil

Treatment	Seed yield (kg ha^{-1})			Straw yield (kg ha^{-1})			HI (%)		
	1st yr.	2nd yr.	Mean	1st yr.	2nd yr.	Mean	1st yr.	2nd yr.	Mean
T_1	1105	949	1027	1700	1584	1642	39.4	37.3	38.4
T_2	1274	1095	1185	1886	1788	1837	40.3	37.8	39.1
T_3	1078	973	1026	1657	1600	1629	39.4	37.8	38.6
T_4	1312	1120	1216	1956	1817	1887	40.3	38.1	39.2
T_5	1065	967	1016	1703	1594	1649	38.5	37.8	38.2
T_6	820	735	778	1497	1302	1400	35.3	36.2	35.7
$LSD_{0.05}$	182	228	-	345	298	-	1.21	ns	-
CV (%)	9.06	12.9	-	10.9	10.1	-	1.71	3.63	-

Note: T_1= Recommended dose (FRG, 2012), T_2= IPNS (Inorganic) +2.5 t ha^{-1} cowdung, T_3= IPNS (Inorganic) +5 t ha^{-1} cowdung, T_4= IPNS (Inorganic) +1.5 t ha^{-1} poultry manure, T_5= IPNS (Inorganic) +3 t ha^{-1} poultry manure and T_6= Control.

The maximum number of branches per plant (2.86) was recorded from T_4 treatment which was statistically similar to T_1, T_2, T_3 and T_5 treatments and the minimum number (2.46) being noted in T_6 treatment was significantly inferior to others treatments (Table 3). Application of cowdung or poultry manure along with chemical fertilizers enhanced the branches per plant of lentil. Krishnan (2016) reported the maximum numbers of branches per plant in green gram (11.6 and 12.9) due to application of NPK fertilizers (20:40:20 kg ha^{-1}) with vermicompost and farmyard manure. However, integrated nutrient management is one of the important issues for sustainable crop production.

Yield attributes of lentil

Significant variation in the number of pods per plant of lentil was observed between the treatments (Table 3). The highest number of pod per plant (55.9) produced in treatment T_4 was statistically identical to T_2 (55.4), T_5 (53.6) and T_1 (52.8). The lowest number of pod per plant was recorded in T_6 (50.8). Mohammed *et al.* (2016) observed the possitive effect of poultry litter on the number of pods per plant. This particular parameter is a significant component that directly imparts the effects on potential yield.

The number of seeds per pod also differed significantly among the treatments and the highest was in T_4 (1.93) followed by T_2 and T_1 while the lowest in T_6 (1.73). Vishnoi *et al.* (2013) found that the number of seed per pod was significantly influenced by organic and inorganic sources of phosphorus in lentil. The 1000-seed weight ranged from 19.6 to 22 g and differed significantly among the treatments, the highest weight (22.0 g) was recorded in T_4 and the lowest value (19.6 g) being noted in T_6 treatment (Table 3). Nandini Devi *et al*. (2013) noted that seed index of soybean was maximum (12.86 g) with the integrated application of 75% RDF coupled with vermicompost at a rate of 1 t ha^{-1}. The above yield attributes was improved due to an adequate supply of nitrogen, phosphorus, potassium and sulphur to the crop at the early stages as well as steady supply of nutrient at later stages for application of manure.

Yield of lentil

Seed and straw yields were increased due to application of cowdung or poultry manure along with inorganic fertilizers over the control treatment (Table 4). The highest seed yield of lentil was recorded in T_4 (1312 kg ha^{-1} in the 1^{st} year and 1120 kg ha^{-1} in the 2^{nd} year) which was statistically similar to T_2 in the 1^{st} year and similar to T_2, T_3, T_5 and T_1 in the 2^{nd} year. The lowest seed yield of lentil (820 kg ha^{-1} in the 1^{st} year and 735 kg ha^{-1} in the 2^{nd} year) were noted in T_6 treatment. The mean seed yield ranged from 778 to 1216 kg ha^{-1} across the treatments (Table 4). Singh *et al.* (2018) reported that grain and straw yield were significantly ($P < 0.05$) enhanced in balanced (with

FYM) fertilization treatments compared with the unfertilized control. Organic manure (poultry manure) with mineral fertilizer might had long residual effect which enhances the growth and yield of the crop. However, it is reported in this study that poultry manure contained high percentage of nitrogen, phosphorus, potassium and other nutrients which ultimately improved the crop productivity. Ewulo (2005) corroborated the similar result that poultry manure contained higher amount of nitrogen and phosphorus for the healthy growth of plants. Significantly the highest straw yield was produced in T_4 (1956 kg ha^{-1} in the 1st year and 1817 kg ha^{-1} in the 2nd year) which was statistically alike with T_5, T_3, T_2 and T_1 treatments and the lowest in T_6 (1497 kg ha^{-1} in the 1st year and 1302 kg ha^{-1} in the 2nd year). The mean straw yield of lentil (average of two years) varied from 1400 to 1887 kg ha^{-1} across the treatments (Table 4). The harvest index (HI) varied between 35.3-40.3% in the 1st year and 36.2-38.1% in the 2nd year across the the treatments. However, the highest harvest index (40.3% in the 1st year and 38.1% in the 2nd year) was recorded in T_4 treatment and the lowest in T_6 treatment in both years. Krishnan (2016) noted that maximum harvest index of green gram (29.5%) was recorded under NPK (20:40:20 kg per hectare) with farmyard manure.

Table 5. Effect of integrated nutrient management on the number of nodules per plant in different dates (pooled data of 2- years)

Treatment	No. of nodules $plant^{-1}$ after 30 DAS	No. of nodules $plant^{-1}$ after 45 DAS	No. of nodules $plant^{-1}$ after 60 DAS	No. of nodules $plant^{-1}$ after 75 DAS
T_1	8.2	18.4	24.5	21.1
T_2	10.5	21.3	30.8	23.5
T_3	9.0	22.0	32.0	28.9
T_4	12.7	26.6	35.1	30.0
T_5	10.0	23.2	32.6	28.7
T_6	8.0	16.9	23.8	22.8
LSD (0.05)	2.7	3.5	2.7	3.5
CV (%)	15.0	8.93	4.97	7.48

Note: T_1= Recommended dose (FRG, 2012), T_2= IPNS (Inorganic) +2.5 t ha^{-1} cowdung, T_3= IPNS (Inorganic) +5 t ha^{-1} cowdung, T_4= IPNS (Inorganic) +1.5 t ha^{-1} poultry manure, T_5= IPNS (Inorganic) +3 t ha^{-1} poultry manure and T_6= Control.

Table 6. Effect of integrated nutrient management on protein content in seed of lentil (pooled data of 2-years)

Treatment	N content	Protein content	Protein yield
	(%)		$kg\ ha^{-1}$
T_1= Recommended dose (FRG, 2012)	4.56	24.2	249
T_2= IPNS (Inorganic)+2.5 t ha^{-1} cowdung	4.86	25.6	304
T_3= IPNS (Inorganic)+5 t ha^{-1} cowdung	4.78	25.3	260
T_4= IPNS (Inorganic)+1.5 t ha^{-1} poultry manure	4.92	26.1	317
T_5= IPNS (Inorganic)+ 3.0 t ha^{-1} poultry manure	4.77	25.3	257
T_6=Control	4.53	24.0	186
LSD (0.05)	0.24	1.31	40.3
CV (%)	2.79	2.87	8.45

Nodulation of Lentil

The number of nodules per plant was influenced significantly by the different treatments. Per plant nodules in each treatment progressively increased from 30 days after sowing (DAS) to 60 DAS, and then decreased in irrespective of treatments (Table 5). Per plant nodules ranged across the treatments from 4.0-12.7 at 30 DAS; 16.9-26.6 at 45 DAS; 23.8-35.1 at 60 DAS and 22.8-30.0 at 75 DAS. The highest number of nodules (12.7, 26.6, 35.1 and 30.0, respectively) was always recorded in T_4 treatment and the lowest number of nodules noted in T_6 (control) treatment (Table 5). Nandini Devi *et al.* (2013) reported that the maximum nodules per plant of soybean (43.00) were found in the integration of 75% RDF with organic vermicompost at a rate of 1 t ha^{-1}. It reveals that the minimum numbers of nodules per plant were formed at the earlier stage (30 DAS) of the crop which gradually increased with time and reached the maximum value at the mid-flowering stage (60 DAS) and then declined to the reduced number of nodules after completion of flowering of the crop. This finding was supported by Kevin Zaychuk (2006). Albiach *et al.* (2000) noted that organic fertilizers are not only the source of organic matter and nutrient, but also boost microbial population and improve physical, biological and chemical properties of the soil. Thus, with long-term retention of organic matter in agricultural systems, survival and growth condition of rhizobia may improve with time and allow nodulation without the addition of lime.

Protein content of lentil

The N content as well as protein content of lentil seed were significantly influenced by integrated nutrient management. In the experiment, the highest protein content (26.1%) was achieved in T_4 treatment that was statistically identical with T_2, T_3 and T_5 treatments and lowest protein content (24.0%) was recorded in control (T_6) treatment (Table 6). Among various treatments, the treatment T_4 {IPNS (Inorganic)+1.5 t ha^{-1} poultry manure} produced significantly higher protein yield (317 kg ha^{-1}) in lentil seed (Table 6). Nandini Devi *et al.* (2013) reported that integration of 75% RDF with vermicompost at the rate of 1.0 t ha^{-1} produced significantly higher protein content of soybean seed.

Conclusion

From the two years study, the lentil performed better in T_4 {IPNS (Inorganic) +1.5 t ha^{-1} poultry manure} treatment regarding to plant height, branches per plant, pod number, seed weight, nodule formation and protein yield. The highest seed yield was produced from the treatment of IPNS (Inorganic) + 1.5 t ha^{-1} poultry manure (T_4). The results suggest that satisfying the recommended fertilizer dose through application of poultry manure @ 1.5 t ha^{-1} with IPNS inorganic fertlizer could be suggested for achieving the maximum yield potential of lentil at chiata series soil of Gazipur.

References

Albiach, R., R. Canet, F. Pomares, and F. Ingelmo. 2000. Microbial biomass content and enzymatic activities after the application of organic amendments to a horticultural soil. *Biores. Technol*., **75:** 43-48.

BBS. 2016. Yearbook of Agricultural Statistics of Bangladesh-2015. Bangladesh Bureau of statistics. Statistics and informatics Division. Ministry of planning. Government of the people's republic of Bangladesh. Dhaka.p. 138.

Ewulo, B.S. 2005. Effect of poultry dung and cattle manure on chemical properties of clay and sandy clay loam soil. *J. Anim. Vet. Adv.*, **4** (10):839-841.

FAO. 2018. Analysis of Protein. Food and agriculture Origination publication, FAO Food and Nutrition Paper 14/7, Centre for Food Safety, UN. http://www.cfs.gov.hk/english/programme/programme_nifl/files/Analysis_of_Protein.pdf (accessed on 08 January 2018)

FRG (Fertilizer Recommendation Guide). 2012. Fertilizer Recommendation Guide, Published by Bangladesh Agricultural Research Council, Dhaka, Bangladesh.

Kevin Zaychuk., 2006. Nodulation and Nitrogen Fixation Field Guide for the Assessment of Pulse Crops. Edited by Kevin Zaychuk, 20/20 Seed Labs Inc-December, 2006. http://www.agr.gov.sk.ca/docs/production/inoculationpulses.asp

Krishi dairy. 2018. Krishi Tatha Services, Department of Agriculture Extension (DAE), Khamarbari, Dhaka. Bangladesh. 15p.

Krishnan, T.K. 2016. Effect of inorganic and organic fertilizer on growth and yeild of green gram (*Vigna radiata* L. Wilezek) under guava based agri-horti system. MS Thesis, Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (up)-221005, India

Mohammed, H., M. Shamim, A. Sultan, M. Abuyusuf, and B. Purnendu. 2016. Effect of biochar, poultry litter, cowdung and vermicompost on the yield of lentil. Biodiversity management of organic farming enhances agricultural ssustainability. https://www.researchgate. Net/publication/ 275270245.

Nandini Devi K., T.B. Singh, H.S. Athokpam, N.B. Singh and D. Shamurailatpam. 2013. Influence of inorganic, biological and organic manures on nodulation and yield of soybean (*Glycine max* Merril L.) and soil properties. *Autralian Journal of Crop Science*, **7(9):**1407-1415.

Page, A.L., R.H. Miller, and D.R. Keeney (Eds.). 1982. Agronomy Series 9 ASA, SSSA. *Methods of Soil Analysis* (Part 2, 2nd ed., pp. 403-427). *Am. Soc. Agron.*, Madison, USA.

Piper, C.S. 1966. *Soil and Plant Analysis*. Adelaide University Press, Australia

Sahu, G., Chatterjee N. and Ghosh G. K. 2017. Integrated nutrient management in lentil (*Lens culinaris* Medikus) in red and lateritic soils of West Bengal. *Bull. Env. Pharmacol.life Sci.,* **6** (4): 55-62.

Singh, G. H., H.S. Ram, N. Sekhon, Aggarwal and V. Khanna. 2011. Effect of nutrient management on nodulation, growth and yields of Lenlil (*Lens culinaris* Medik.) genotypes. *American-European Journal of Agronomy*. **4(3):**46-49.

Singh, S.R., D.K. Kundu, P. Dey, P. Singh, B.S. Mahapatra. 2018. Effect of balanced fertilizers on soil quality and lentil yield in Gangetic alluvial soils of India. *The Journal of Agricultural Science*, 156, 225–240. https://doi.org/10.1017/S0021859618000254

Statistix 10. 1985. An Analytical Software, Po Box 12185, Tallahassee, FL 32317, Copy right © 1985-2013

Tolanur, S.T. and V.P. Badanur. 2003. Effect of integrated use of organic manure, green manure and fertilizer nitrogen on sustaining productivity of Rabi sorghum-chickpea system and fertility of a vertisol. *J. Indian Soc. Soil Sci*., 51:41-44.

Vishnoi, G., J.S. Kumar, J.S.A. and P.J. George. 2013. Effect of organic manure and phospjorus fertilizers on growth, yield and economics of lentil in sandy loam soil. *An Asian Journal of Soil Science*, 8(1): 76-79.

Zeidan, M.S. 2007. Effect of organic manure and phosphorus fertilizers on growth, yield and quality of lentil plants in sandy soil. *Res. J Agric. Biol. Sci.*, **3**(6):748-752.

Zerihun, A., J. J. Sharma, D. Nigussie and K. Fred. 2013. The effect of integrated organic and inorganic fertilizer rates on performances of soybean and maize component crops of a soybean/maize mixture at Bako, Western Ethiopia. *Afr. J. Agric. Res.*, **8(29)**, pp. 3921-3929, DOI: 10.5897/AJAR12.1044