IMPACT OF MESQUITE (*PROSOPIS JULIFLORA*) ON GERMINATION AND EARLY GROWTH OF TWO *VACHELLIA* SPECIES

ALMOSHADAK, A. S.[1] – SULIMAN, E. A. H.[2*] – ALJEDDANI, G. S.[3] – KUTBY, A. M.[3]

[1]*Department of Biological Sciences, Faculty of Sciences King Abdulaziz University, Jeddah 21589, Kingdom of Saudi Arabia*

[2]*Faculty of Agriculture, University of Khartoum, Khartoum, Sudan*

[3]*Department of Biology, College of Science, University of Jeddah, Jeddah, Kingdom of Saudi Arabia*

**Corresponding author*
e-mail: eltayeb71_sha@yahoo.com

(Received 8th Jan 2024; accepted 26th Mar 2024)

Abstract. The experiments were carried out to evaluate the Allelopathic effect of extracts of leaves and pods of mesquite (*P. juliflora*) on germination and early growth of *Vachellia nilotica* and *Vachellia seyal*. Seeds of both *Vachellia* species were soaked in the extracts of leaves or pods of mesquite at four weights 3, 6, 9, and 12 grams. Leaf or pod extracts at the weight of 9 and 12 grams showed a significant reduction in germinated seeds of *V. seyal* and emerged seedlings of the two *Vachellia* species compared to the control. The radical length of the two species was significantly affected with leaf extracts of all weights and with pod extracts of weights of 9 and 12 g. The lowest plumule length of *V. seyal* and *V. nilotica* were achieved with leaf extracts of weights of 6, 9, and 12 g and pod extracts of weights of 9 and 12 g compared to the control. Pod extracts of all weights significantly decreased the shoot height of both *Vachellia* species and root length of *V. nilotica*, and water contents of the shoot and root of *V. seyal* and *V. nilotica* compared to the control. Significant reduction in root length of *V. nilotica* and shoot and root water content of *V. seyal* and *V. nilotica* associated with leaf extracts of all weights. The study concluded that; mesquite's leaf and pod extracts harm the germination and early growth of *V. nilotica* and *V. seyal*.
Keywords: *allelopathic, phytotoxic, extraction, seedlings, nilotica, seyal*

Introduction

Phytotoxic plants release toxic chemicals or secondary plant metabolites, which affect seed germination, cell division, cell elongation, membrane permeability, and ion uptake of the nearby plants (Dongre et al., 2007). Allelopathy is chemicals released by one plant species that affect the growth and reproduction of another plant (Argal et al., 2018). 3-oxo-juliprosopine, 3-oxo-juliprosine, and secojliprosopinal were isolated from mesquite (Nakano et al., 2004). Furthermore, L-tryptophan was released from mesquite leaves to the environment in sufficient quantities to elicit an Allelopathic effect (Nakano et al., 2001). Syringing and lariciresinol, isolated from mesquite leaves reported to leach and accumulate in soils under mesquite (Nakano et al., 2002). Leaves of *P. juliflora* contain water-soluble allelochemicals, which reach the ground with rainwater (Abbasi and Abbasi, 2011). The dry leaves are very rich in flavonoids, containing as much as 3.6% (Ibrahim et al., 2013). In addition, the leaves carry high concentrations of alkaloids (2.2%) (Damasceno et al., 2017).

Vachellia species are economically important trees in the Sub-Sahara as a source of forage and wood and gum Arabic production, used in food, and medicine, and used to increase soil fertility (Dossa et al., 2010). The objectives of this work; were to study the

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_31553162

Allelopathic effect of *P. juliflora* (mesquite) on germination and early growth of *V. nilotica* and *V. seyal* seedlings.

Materials and methods

Experimental site and collection of mesquite (P. juliflora) leaves, pods, and preparation extracts

The experiments were carried out from October 2022 to January 2023 in Najran, Kingdom of Saudi Arabia. Fresh leaves and ripened pods of *P. juliflora* were collected manually from different branches of naturally grown trees at a height of 2 to 3 m. The samples were collected from two locations (Wade Algwella and AL Malik Abdulaziz Street). Firstly, leaves were washed and exposed to sunlight for 12 h to remove excess moisture and extracted seeds from mesquite pods. Green leaves and no-seeds pods were ground mechanically using a grinder for no-seeds pods and hand mortar for green leaves.

Four weights (3, 6, 9, and 12 g) of each were soaked individually in 250 ml of distilled water (D.W.) for 24 h at room temperature. The solutions were filtered through a sieve (2 mm) and through Whatman No. 1 filter paper to remove undissolved large particles.

Prepared V. nilotica and V. seyal seeds

Fruits of *V. nilotica* were purchased from the local market, and seeds were been removed, while *V. seyal* seeds collected from different trees in the experiment region. Seeds of *V. nilotica* and *V. seyal* poured into the water for 30 min to examine the free insect's injury seeds, the floating seeds are unlikely to germinate. Dormancy of *V. nilotica* and *V. seyal* seeds broken by scarification of the seeds by diluting sulfuric acid (60%) for minutes, respectively and thoroughly washing with tap water. Sulfuric acid-treated seeds were soaked in the extract of different weights (3, 6, 9, and 12 g) of *P. juliflora* leaves or pods individually for 24 h (one hundred seeds of *V. nilotica* or *V. seyal* in each concentration) to use for both germination and emergence experiments. In addition, one hundred seeds of two species were soaked in distilled water and used as a control.

Germination experiments

The seeds soaked in the extract of leaf or pod were tested to germinate, and fifteen seeds of *V. nilotica* or *V. seyal* from any extracts were placed in Petri-dishes (9-cm id) lined with two Whatman No. 1 filter papers moistened with 2.5 ml of distilled water. Petri- dishes wrapped in black polyethylene and subsequently examined for germination when the radical protruded through the seed coat. The germination percent was calculated after one week, by counting the number of germinated seeds and the germination percentage was calculated using the following equation: germination percentage = germinated seeds / total seeds × 100.

Also measured the length of the radical length and plumule height of each seedling (all germinated seedlings) (*Fig. 1*) and the means for any treatments were calculated.

Emergence experiments

The seeds soaked in the extract of leaf or pod were tested for emergence, and fifteen seeds of *V. nilotica* or *V. seyal* from any extracts were planted in plastic pots (20 cm. in diameter), each filled with 3 Kg. of soil mixed (1:1 v/v) of sand and potting soil with

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_31553162

drainage holes in the bottom. The plastic pots were kept under natural conditions and irrigated every two days (500 ml). Seedling's emergence percent watched over 15 days by counting the number of emergent seedlings and the emergence percentage was calculated using the following equation: emergence percentage = emerged seeds / total seeds × 100.

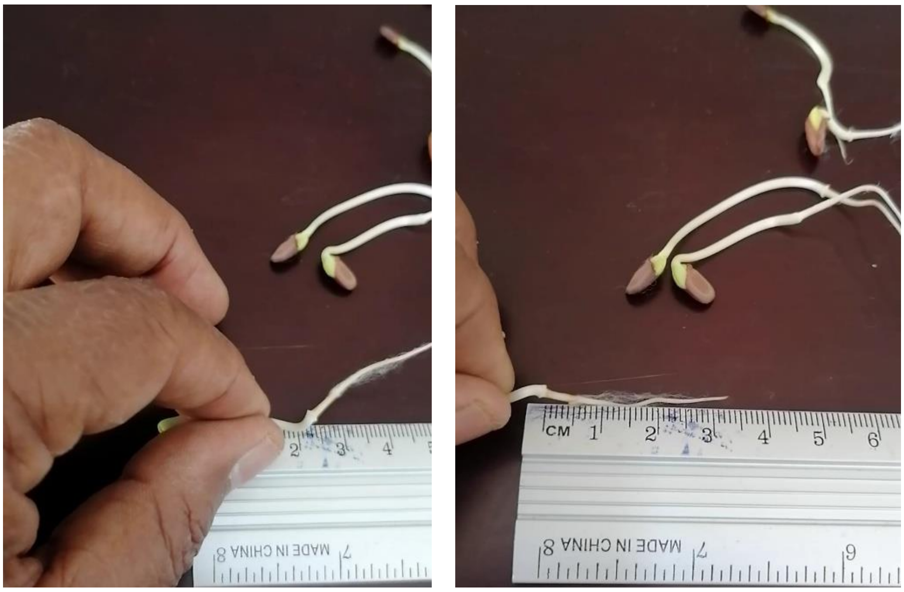

***Figure 1.** Measured the length of radical length (right) and plumule height (left)*

One-month-old seedlings the shoot height, and root length were measured (*Fig. 2*) and the means for any treatments were calculated. Shoot and root water content were determined, by the ratio between wet and dry weight using the following equation. The means for any treatments were calculated: water content = fresh weight – dry weight / fresh weigh × 100.

***Figure 2.** Measured the shoot height (right), and root length (left)*

APPLIED ECOLOGY AND ENVIRONMENTAL RESEARCH 22(4):3155-3162.
http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_31553162

Statistical analysis

Data on germination percent, radical length, and plumule height were recorded from three replicates (Petri- dishes) in a Completely Randomized Design (CRD). In emergence experiments, the data of emergence percent shoot height, root length, and shoot and root water content were recorded from three replicates (plastic pots) in Randomized Complete Block Design (RCBD). Data in all experiments were subject to analysis using Statistix 10 computer software. ANOVA tables were computed and means were separated by the least significant differences (LSD) for comparisons at a 0.05 level of significance.

Results

Effect of leaves and pods extracts of P. juliflora on germination percent, radical, and plumule lengths

The results indicated that there were significant differences among treatments. Leaf extracts of weights 6, 9, and 12 g significantly decreased the germination percentage of *V. seyal*. They achieved a similar germination percentage (60%), while pod extracts of the weights of 9 and 12 g, significantly decreased the germination percent of *V. seyal*, and gave a similar germination percent (46.67%) compared to the control, which gave germination percent in the range of 73.33% - 76.67%. The germination percentage of *V. nilotica* decreased as extracts of all weights of leaf and pod, but there were non-significant differences compared to the control, which gave a high germination percent in the range of 80.0% - 83.33% (*Table 1*).

Table 1. *Effect of pods and leaves extracts of P. juliflora on germination percentage*

Treatments	Germination percentage			
	Leaves extract		Pod extract	
	V. seyal	***V. nilotica***	***V. seyal***	***V. nilotica***
Control	76.67a	80.00 a	73.33ab	83.33a
3	66.67ab	80.00a	66.67abc	76.67ab
6	60.00b	66.67ab	56.67bc	76.67ab
9	60.00b	66.67ab	46.67c	66.67abc
12	60.00b	66.67ab	46.67c	63.33abc
SE ±	8.58		10.07	
CV	15.37		18.79	

Figures in a column followed by the same letter (s) are not significantly different according to the least significant differences (LSD)

The results show that the analysis of variance indicated that, there were significant differences among treatments, radical and plumule lengths of *V. nilotica* significantly decreased with pod extracts of the weights of 9 and 12 g compared to the control, while pod extracts of all weights showed significant reduce on the radical and plumule lengths of *V. seyal*. Leaf extracts of all weights had a significant reduction in radical length, they produced a lower radical length of *V. seyal* and *V. nilotica*, while the plumule length of both species was significantly affected with leaf extracts of the weights of 9, and 12 g compared to their respective controls (*Table 2*).

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_31553162

***Table 2.** Effect of pods and leaves extracts of P. juliflora on radical and plumule lengths (cm)*

Treatment	Leaves extract				Pod extract			
	Radical length		Plumule length		Radical length		Plumule length	
	V. seyal	*V. nilotica*	*V. seyal*	*V. nilotica*	*V. seyal*	*V. nilotica*	*V. seyal*	*V. nilotica*
Control	3.26a	3.34a	0.66a	0.62ab	2.7ab	2.97a	0.67a	0.67a
3	2.55bc	2.61bc	0.66ab	0.51abc	2.34bc	2.54ab	0.51bc	0.62a
6	2.36bc	2.58bc	0.48bcd	0.45bcd	2.4b	2.68ab	0.47bc	0.62a
9	2.03c	2.78b	0.37cd	0.36cd	1.84cd	1.76d	0.37d	0.48 bc
12	2.00c	2.41bc	0.33d	0.32d	1.55d	1.54d	0.29d	0.38cd
SE ±	0.29		0.08		0.27		0.05	
CV	13.77		20.85		14.57		11.35	

Figures in a column followed by the same letter (s) are not significantly different according to the least significant differences (LSD)

Effect of leaves and pods extracts of P. juliflora on emergence percentage, shoot height, and root length

The analysis of variance showed that there were significant differences among treatments, leaf and pod extracts of the weights of 9 and 12 g showed a significant decrease in the emergence percent of *V. seyal* and *V. nilotica* compared to their controls. (*Table 3*).

***Table 3.** Effect of pods and leaves extracts of P. juliflora on emergence percentage*

Treatments	Emergence percentage			
	Leaves extract		Pod extract	
	V. seyal	*V. nilotica*	*V. seyal*	*V. nilotica*
Control	68.89ab	75.56a	71.11abc	82.22a
3	64.45abc	75.56a	66.67abcd	75.56ab
6	55.55bc	66.67abc	53.33de	75.55ab
9	46.67c	55.55bc	40.00e	62.22bcd
12	46.11c	53.33bc	40.00e	57.78cd
SE ±	9.87		7.82	
CV	19.88		15.33	

Figures in a column followed by the same letter (s) are not significantly different according to the least significant differences (LSD)

The analysis of variance indicated that there were significant differences among treatments. Pod extracts of all weights, significantly decreased the shoot height of both species and the root length of *V. nilotica* compared to their controls, while pod extracts of the weights of 9 and 12 g showed a significant reduction of the root length of *V. seyal*. Leaf extracts of the weights of 9 and 12 g achieved a significant decrease in the shoot height of *V. seyal* and *V. nilotica,* they gave (7.20, 6.76) and (4.53, 4.31) compared to

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_31553162

their controls, which gave 8.58 and 5.91, respectively. Leaf extracts of all weights significantly reduced the root length of *V. nilotica* compared to the control which gave 26.81 cm, while the extract of the weights of 6, 9, and 12 g showed a significant reduction in the root of *V. seyal* compared to the control, which gave 24.47 cm (*Table 4*).

Table 4. *Effect of pods and leaves extract of P. juliflora on root length and shoot height (cm)*

Treatment	Leaves extract				Pod extract			
	Shoot height		Root length		Shoot height		Root length	
	V. seyal	*V. nilotica*	*V. seyal*	*V. nilotica*	*V. seyal*	*V. nilotica*	*V. seyal*	*V. nilotica*
Control	8.58a	5.91de	24.67ab	26.83a	9.11a	5.97c	22.22bcd	27.61a
3	8.36ab	5.82de	22.22bcd	23.67abc	7.69b	4.30d	21.55cd	24.11b
6	7.78abc	5.07ef	20.78cde	23.22bc	7.67b	4.47d	21.33cd	22.83bc
9	7.2bc	4.53f	18.05e	20.39cde	6.66bc	4.41d	18.66ef	20.67cde
12	6.76cd	4.31f	18.55e	19.67de	6.66bc	4.31d	18.28f	20.28def
SE ±	0.59		1.58		0.51		1.10	
CV	11.29		8.89		10.10		6.19	

Figures in a column followed by the same letter (s) are not significantly different according to the least significant differences (LSD)

Effect of leaves and pods extracts of P. juliflora on the shoot and root water content

Results of the analysis showed that there were significant differences among treatments, leaves, and pod extracts of all weights significantly decreased the shoot and root water content of *V. nilotica* and *V. seyal*. Significant. Pod extract of the weight of 12 g achieved a lower shoot water content of *V. nilotica* 9.7% compared to the *V. seyal*, which gave 10.40% (*Table 5*).

Table 5. *Effect of pods and leaves extracts of P. juliflora on the root and shoot water content*

Treatment	Water content %							
	Laves extract				Pod extract			
	Shoot		Root		Shoot		Root	
	V. seyal	*V. nilotica*	*V. seyal*	*V. nilotica*	*V. seyal*	*V. nilotica*	*V. seyal*	*V. nilotica*
Control	14.53a	12.93b	13.81a	12.90ab	12.90a	12.59a	13.47a	12.53ab
3	11.23c	11.15c	11.30bc	10.45c	11.26b	10.91bc	11.69bc	10.96cd
6	11.41c	11.13c	11.31bc	10.60c	11.08b	10.28cd	11.54bcd	10.60d
9	10.75c	10.64c	10.93c	10.79c	10.74bc	10.27cd	11.13cd	10.60d
12	10.38c	10.46c	11.50bc	10.14c	10.40c	9.70d	11.50bcd	10.56d
SE ±	0.69		0.89		0.32		0.50	
CV	7.36		9.58		3.57		5.37	

Figures in a column followed by the same letter (s) are not significantly different according to the least significant differences (LSD)

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_31553162

Discussion

Vachellia species have a hard coat, which helps them to survive in hard conditions (Baskin and Baskin, 2005). There are many methods to improve the germination of dormant seeds of *Vachellia* species (Narbona et al., 2006). In the present, study the dormancy of *Vachellia* species seeds was broken by scarification by sulfuric acid. The germination percent of the control of the two species were (73.33% -76.67%) and (80% - 83.33%) for *V. seyal* and *V. nilotica* respectively. The low germination percentage of the control of the two species may be due to the different sizes of both *Vachellia* seeds. Steven et al. (2012) reported that only the largest seed size responded better to the H_2SO_4.

The finding of the present study indicated that the leaf and pod extracts at the weights of 9 and 12 g significantly reduced the germination percent of seeds of *V. seyal,* also there was a reduction in the germination percent of *V. nilotica,* but non-significant compared to the control. The lignified cells in the epidermis layer of *V. nilotica* 6-7 layers, while in *V. seyal* 3-4 layers (Mustafa et al., 2017). The percentage of imbibed seeds of *V. seyal* after 20 min of acid was 98%, while *V. nilotica* after 60 min the percentage of imbibed seeds was 44% (Yousif et al., 2019). This may be due to the increase in the imbibition of *V. seyal* by the extracts of leaf and pods, which contain soluble allelochemicals such as tannin, phytic acid, and phenol (Argal et al., 2018), these compounds are capable of inhibiting the seed's germination processes and discourage the growing of other plants near it (Muturi et al., 2017).

Emergence and seedling establishment constitute the most critical periods in the life cycle of plants. The leaf and pod extracts of the weight of 9 and 12 g, significantly decreased the emergence percent of the two *Vachellia* species. This may be due to an increase in the activity of phenols released from leaves and pods of *P. juliflora*. These compounds are toxic and cause disturbances by interfering with the enzymology of the target plants (Thoyabet et al., 2009).

Decreased in radical and root lengths and plumule and shoot heights achieved by leaf and pod extracts. These results could be again attributed to that, extracts of leaves and pods of *P. juliflora* contain soluble allelochemicals such as tannin, phytic acid, and phenol (Argal et al., 2018). The result of the present study showed a positive relation between shoot height, root length, and shoot and root water content, which explained the relationship between water content and plant biomass. In addition, the decrease in water content; may be due to oxidative stress, which affects root growth and water absorption (Soln et al., 2022).

Conclusion

The results of this study showed the Allelopathic effect of the extracts of pods and leaves of *P. juliflora,* which reduced the number of germinated seeds and inhibited radical and plumule lengths. In addition, it reduced the emergence percent, decreased root length, and shoot heights of seedlings, and subsequently decreased in water content of shoot and root of both species under test, which reflected in the weak establishment of *V. seyal* and *V. nilotica* in the area invaded by *P. juliflora*.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_31553162

REFERENCES

[1] Abbasi, T., Abbasi, S. A. (2011): Sources of pollution in rooftop rainwater harvesting systems and their control. – Critical Reviews in Environmental Science and Technology 41: 2097-2167.

[2] Argal, S., Mir, R. A., Singh, R. P., Agarwal, R M. (2018): Analysis of allelopathic and osmotic constituents of *Prosopis juliflora* (Sw.) DC. – International Journal of Scientific Research and Reviews7(1): 219-226.

[3] Baskin, C. C., Baskin, J. M. (2005): Seed dormancy in trees of climax tropical vegetation types. – Tropical Ecology 46: 17-28.

[4] Damasceno, G. A. B., Ferrari, M., Giordani, R. B. (2017): *Prosopis juliflora* (SW) an invasive species at the Brazilian Caatinga: phytochemical, pharmacological, toxicological and technological overview. – Photochemistry Reviews (16): 309-331.

[5] Dongre, P. N., Singh, A. K. (2007): Inhibition effects of weeds on the growth of wheat seedlings. – Allelopathy J. 20(2): 387-394.

[6] Dossa, E. L., Diedhiou, S., Compton, J. E., Assigbetse, K. B., Dick, R. P. (2010): Spatial patterns of P fractions and chemical properties in soils of two native shrub communities in Senegal. – Plant and Soil 327: 185-198.

[7] Ibrahim, M. M., Nadir, A. M., Ali, A. T., Ahmad, V. U., Rasheed, E. R. (2013): Phytochemical analyses of Prosopis juliflora Swartz DC. – Pak. J. Bot. 45(6): 2101-2104.

[8] Mustafa, E. M., Alkamali, H. H., Eltahir, A. S. (2017): Comparative anatomical study of some acacia taxa seeds grown in Central Sudan. – European Journal of Advanced Research in Biological and Life Sciences 5(1).

[9] Muturi, G. M., Poorter, L., Bala, P., Mohren, G. M. (2017): Unleached Prosopis litter inhibits germination but leached stimulates seedling growth of dry woodland species. – Journal of Arid Environments 138: 44-50.

[10] Nakano, H., Fujii, Y., Yamada, K., Kosemura, S., Yamamura, S., Hasegawa, K., Suzuki, T. (2001): A growth-inhibitory substance exuded from freeze-dried mesquite (*Prosopis juliflora* Sw.) DC. leaves. – Plant Growth Regulation 33: 165-168.

[11] Nakano, H., Fujii, Y., Yamada, K., Kosemura, S., Yamamura, S., Hasegawa, K., Suzuki, T. (2002): Isolation and identification of plant growth inhibitors as candidates from Allelopathic substance(s), from aqueous leachate from mesquite (*Prosopis juliflora* Sw.) DC. leaves. – Plant Growth Regulation 37: 113-117.

[12] Nakano, H., Nakajima, E., Hiradat, S., Fujii, Y., Yamada, K., Shigemori, H., Hasegawa, K. (2004): Growth inhibitory alkaloids from mesquite (*Prosopis juliflora* Sw.) DC. – Leaves Phytochemistry 65: 587-591.

[13] Narbona, E., Ortiz, P. L., Arista, M. (2006): Germination variability and the effect of various pre-treatment on germination in the perennial spurge *Euthorbia nicaeensis* All. – Flora-Morphology, Distribution, Functional Ecology of Plants 201: 633-641.

[14] Soln, K., Klemencic, M., Koce, J. D. (2022): Plant cell responses to allelopathy: from oxidative stress to programmed cell death. – Spring Journal 259(5): 1111-1124.

[15] Steven, L. P., Mounir, L., and Abdoul, A. A. N. (2012): Germination dynamics of Acacia species under different seed treatments. – Range Mgmt and Agroforestry 33(1): 37-42.

[16] Thoyabet, S. A., Ray, R. H., Sven, V., George, S. E. (2009): Effects of leaf extract of *Zizyphus spinachristi* and *Prosopis juliflora* on each other’s seedlings roots. – Allelopathy Journal 23: 111-118.

[17] Yousif, M. A. I., Yan, R. W., Xiao, W. H. (2019): Seed dormancy and dormancy breaking of selected *Acacia* species from Sub-Saharan Africa. – Seed Science and Technology 47(2): 131-144.

http://www.aloki.hu ● ISSN 1589 1623 (Print) ● ISSN 1785 0037 (Online)
DOI: http://dx.doi.org/10.15666/aeer/2204_31553162