J. Glob. Innov. Agric. Soc. Sci., 2017, 5(3): 105-110
ISSN (Online): 2311-3839; ISSN (Print): 2312-5225
http://www.jgiass.com

ALLELOPATHIC POTENTIAL OF *Moninga oleifera* LEAF EXTRACT TO EHANCED THE GROWTH OF SUNFLOWER (*Helianthus annuus* L.)

Junaid Hassan[1,*], Qaisar Maqsood[1], Sher Afzal[1], Rana Dildar Khan[1] and Muhammad Jamshaid[2]

[1]Department of Agronomy, University of Agriculture Faisalabad, Pakistan; [2]Department of Plant Breeding and Genetics, University of Agriculture Faisalabad, Pakistan
[*]Corresponding author's e-mail: junaidrana2287@hotmail.com

A Lab and a field experiment was conducted to investigate the growth and yield response of sunflower to the foliar application of *Moringa oleifera* leaf extract at the Agronomy Research Area, Department of Agronomy, University of Agriculture, Faisalabad during 2012. Field experiment was laid out according to randomized complete block design (RCBD) with factorial arrangement. Different concentrations of MLE (1, 2, 3 and 4%) were sprayed at 30, 45 and 60 DAS. For comparison there was control treatment with distilled water application. All other agronomic practices were kept normal and uniform throughout the crop growth period. Difference among treatments' means was compared by using least significant difference (LSD) test at 5% probability level. Maximum value for germination percentage (100%) and mean germinatin time (3.75) was observed in case of control and 4% *M. oleifera* leaf extract application, respectively. Highest value of 1000-achene weight (56.48g) was observed when 3% MLE was applied at 45 DAS. Interaction effects of other parameters were non-significant. As considering effect of concentrations, Maximum value of plant height (175.02cm) and achene yield (2.84 t ha^{-1}) was recorded when 3% MLE was applied. Highest values for Head diameter (22.12cm) and number of achene per head (1147.8) was recorded when 4% MLE was applied which were statistically at par with values obtained in case of 3% MLE application. And among different time of application, 45 DAS gave maximum values of all parameters.
Keywords: Allelopathy, *moringa oleifera,* sunflower, growth

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important oilseed crop in our country. It has shown its potential to contribute its share in domestic edible oil requirements. It has lion's share (34.1 g) in per capita vegetable oil consumption of daily oil intake (83 g) in our country (Anonymous, 2009). Sunflower cooking oil is extensively used by heart patients because of very low cholesterol and high fatty acid concentration (Ahmad and Hassan, 2000; Chaudhary and Mushtaq, 1999). Pakistan is bestowed with various ecologies, where sunflower can be cultivated because of its wide range of adaptability. Here sunflower can be grown twice in a year during spring and winter. Sunflower grown in spring is usually slower in growth than that sown in autumn (Kaleem *et al*., 2009).

Agronomic and yield traits such as plant height (Ahmad and Hassan, 2003), number of achenes head-1 (Kaleem *et al*., 2009), 1000-achene weight (Hassan *et al*., 2005) in sunflower are significantly influenced by the temperature, growth durations which are particular characteristics of seasonal changes (Killi *et al*., 2005; Qadir *et al*., 2007). Longer reproductive phase and warmer temperature at the time of seed development (spring sown) of sunflower is favorable for bumper achene yield and its contributing parameters (Kaleem *et al*., 2009) as well as biomass (Ahmad, 1993) than that of autumn season with high temperature and low relative humidity at the time of pollination which affects pollen vigor, causing poor pollination produces less weight and infertile achenes ultimately leading to head infertility and low achene yield (Miralles *et al*., 1997; Weiss, 2000).

The yield of sunflower is controlled by different factors; however, the most important is availability of different nutrients (Habib *et al.,* 2006). Modern agriculture has great scope for plant growth regulators. They can affect plant activity and their physiological processes at low concentration (Frankenberg and Arshad, 1995). Plant extracts of a number of trees and crop residues have been reported to influence crop growth and yield (Guenzi *et al*., 1967; Chung and Miller, 1995; Atta and Bashir, 1999; Ahmed and Nimer, 2002; Farooq *et al*., 2008). Moringa leaves are rich in vitamins (A, B, C), essential minerals (K, Ca, Fe), antioxidants (Ascorbate, Phenolics), proteins and zeatin. Moringa leaf water extract enhanced the growth of young plants, strengthens plants, improves resistance against pathogens, increases lifetime, prolongs number of roots, stems and leaves, produces more fruits and generally enhances yield by around 20-35% (Fuglie, 2001; Foidle *et al*., 2001), high lighting its opportunity of use as a foliar application to enhance growth of plants. Moringa leaf extract contain Zeatin: a plant growth hormone from the Cytokinins group improves crop growth and yield of plants (Price, 1985).

MLE proved an ideal plant growth enhancer in many experiments (Makkar and Becker, 1996; Nouman *et al*., 2012). Plant height, leaf area, chlorophyll a and b contents

subjected to severe drought stress were increased significantly due to moringa leaf extracts (Ali *et al*., 2011). *Moringa oleifera* leaves in late sown wheat increased biological yield 6.00, 1000 grain weight 10.73, grain yield 10.70 and harvest index 4.00% when applied at tillering, jointing, booting and heading stages (Yasmeen *et al.*, 2011). Basra *et al.* (2011) reported that seed priming with freshly harvested moringa leaf extract (30 times diluted with distilled water) was the most effective concentration and extracted method for enhancing the growth of maize. The objective of this study was to evaluate the potential of *Moringa oleifera* leaf extract on growth and yield of sunflower.

MATERIALS AND METHODS

The experiment was carried out during spring 2012 at the Agronomic Research Farm, University of Agriculture, Faisalabad, Pakistan. The climate of the region is subtropical to semi-arid. The experimental area is located at 73.09^0 East longitudes, 31.25^0 North latitude and at an altitude of 183 m above sea level. The experiment was laid out in randomized complete block design (Factorial) with three replications. Net plot size was 7 m × 4.5 m. The seedbed was prepared by cultivating the field for 2-3 times with tractor-mounted cultivator each followed by planking. Sunflower hybrid, Hyson-33, was sown on 10th of February and crop was harvested on 1st of June. Sowing was done with the help of single row hand drill keeping R × R distances of 75 cm. Urea and DAP was used as a source of nitrogen and phosphorus. All the recommended phosphorus (100 kg ha^{-1}) and 1/3rd of the nitrogen were applied at sowing, 1/3 rd of nitrogen with 1st irrigation and the remaining 1/3rd of nitrogen at early flowering. In NPK form it was 150-100-63 kg ha^{-1}. All other agronomic practices were kept normal and uniform for all the treatments. Plant protection measures were adopted to keep crop free of weeds, insect pests and diseases. Thinning was done at 4-5 leaf stage to maintain an intra row plant to plant distance of 22.5 cm. Plant population was constant in all treatments. Seed yield was recorded at 15 % moisture content. Plant height was measured (in centimeters) at the completion of flowering. Ten plants were selected at random from each sub plot and their heights were measured from the soil surface up to top of flower. Ten heads were taken from randomly selected plants before harvesting from each sub plot. Diameter of each head was measured with the help of a measuring tape. Five sunflower heads from each sub plot/treatment were selected at random and threshed separately. Their number of achene per head was recorded separately and then averaged. Two samples of 1000-achenes were taken at random from each sub-plot and weighed on automatic electric balance. Seed yield was recorded on sub plot basis and then converted in to t ha-1. For stalk yield, weight of air dried stalks (along with leaves) per sub plot was recorded after threshing the seed and then converted into t ha-1. Harvest index was calculated by using the following formula as described by Hunt (1978).

Harvest Index= Achene yield x 100/biological yield.

Data was analyzed by Fisher's analysis of variance techniques using least significant difference test at 5% level of probability to compare the differences among treatment means (Steel *et al*., 1997).

RESULTS AND DISCUSSION

***Germination (%)*:** The results for germination percentage are given in the Fig.1. The results showed that the effect of different concentration levels of *M. oleifera* leaf extracts on germinations was significant. In control treatment where no extract is applied (100.00%) germination was observed that was the significantly maximum value for germination percentage followed by 85.71% in case of 2% *M. oleifera* leaf extract application. The lowest value of germination (66.667%) was recorded in treatment where 4% *M. oleifera* leaf extract was applied. It shows that *Moringa oleifera* leaf extract has negative effect on germination of sunflower seeds by increasing germination percentage. Khan *et al*. (2005) reported that the germination percentage was significantly reduced by the application of various tree extracts. Phiri and Mbewe (2010) reported decrease in germination percentage of groundnut seeds treated with *M. oleifera* leaf extracts. Phiri (2010) also reported reduction in germination percentage of rice by application of *M. oleifera* leaf extracts.

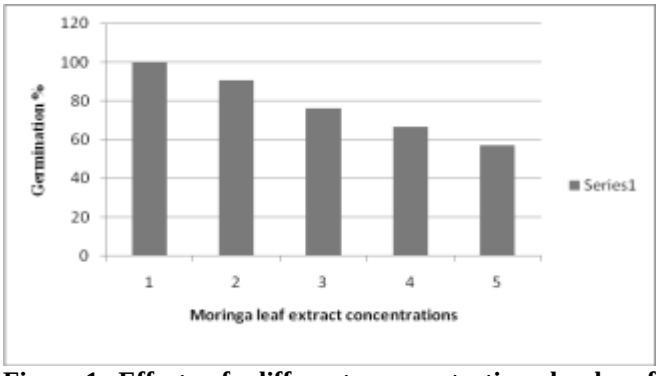

Figure 1: Effect of different concentration levels of *Moringa oleifera* leaf extract on Germination of sunflower.

***Mean germination time*:** The results for mean germination time are given in the Fig.2. The results showed that the effect of different concentration levels of *M. oleifera* leaf extracts for mean germination time was significant. The maximum value of mean germination time (3.75) was observed in case of 4% *M. oleifera* leaf extract application followed by 3.355 and 3.103 in case of 3% *M. oleifera* leaf extract and 2% *M. oleifera* leaf extract applcayion respectively. The lowest value of mean germination time (2.57) was recorded in control

where distilled water was applied. Kadioglu and Yusuf (2004) have also reported that sesame water extracts increased the mean germination time and hence events of germination of *Lolium perenne* L., *Amaranthus retroflexus* L., *Avena sterilis* L. and *Rumex cripus* L. These findings are supported by findings of Basra *et al*. (2011) reported decrease in mean germination time of maize crop due to increase in moringa leaf extract concentrations.

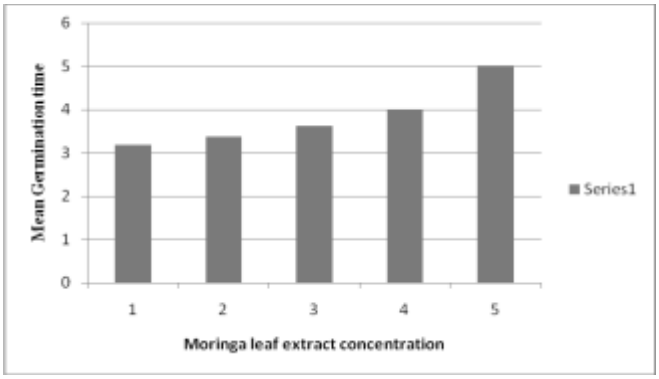

Figure 2: Effect of different concentration levels of *Moringa oleifera* leaf extract on mean germination time.

***Crop growth rate (g m^{-2} d^{-1})*:** The results regarding crop growth rate are given in the fig. 3. The results showed that the effect of both the time of application and concentration levels of *Moringa oleifera* leaf extracts on crop growth rate was significant. As considering the interactive effect of time of application and concentration levels, the results also showed the significant effect. The maximum value of crop growth rate (27.50 g m^{-2} d^{-1}) was observed when 3% *Moringa oleifera* leaf extract was applied at 45 DAS followed by 27.40 g m^{-2} d^{-1} and 26.68 g m^{-2} d^{-1} in case of 4% *Moringa oleifera* leaf extract when applied at 45 DAS and 3% *Moringa oleifera* leaf extract when applied at 60 DAS, respectively. The lowest value of crop growth rate (20.54 g m^{-2} d^{-1}) was recorded in control. Comparable results were reported by Yasmeen *et al*. (2011), who reported increase in crop growth rate of wheat by application of moringa leaf extracts. These results exposed that there was an increase in crop growth rate with application of moringa water extracts and supported by the finding of Foidle *et al*. (2001), who reported that foliar spray of moringa leaves extracts enhanced growth due to the presence of cytokinins, phenols, acrobats, potassium and calcium. Calcium and potassium present in moringa leaves have been reported to play vital role in the growth and development of crops through photosynthesis, and several other physiological processes (Hasegawa *et al*., 2000; Epstein and Bloom, 2005).

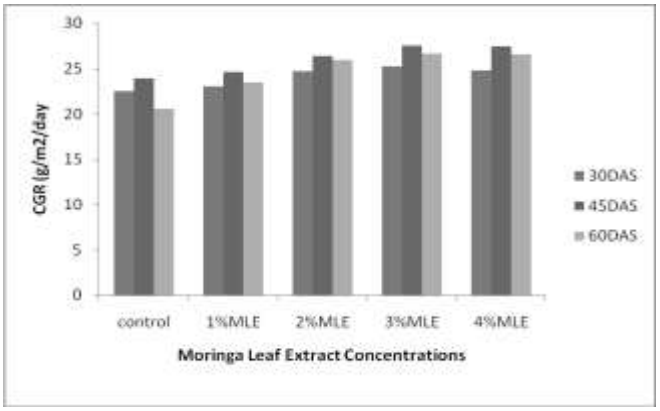

Figure 3: Effect of different time of application and concentration levels of *Moringa oleifera* leaf extract on crop growth rate.

***Leaf area index*:** The results for leaf area index are given in the fig. 4. The results showed that the effect of both the time of application and concentrations levels of *Moringa oleifera* leaf extracts on leaf area index was significant. As considering the interactive effect of time of application and concentration levels, the results showed non-significant effect. As regards effect of time of application, the maximum value of crop growth rate (3.67) was observed when *M. oleifera* leaf extract was applied at 45 DAS. The lowest value of leaf area index (3.28) was recorded at 60 DAS. As regards effect of concentration, the maximum value of crop growth rate (3.94) was observed when 3% *M. oleifera* leaf extract was applied.

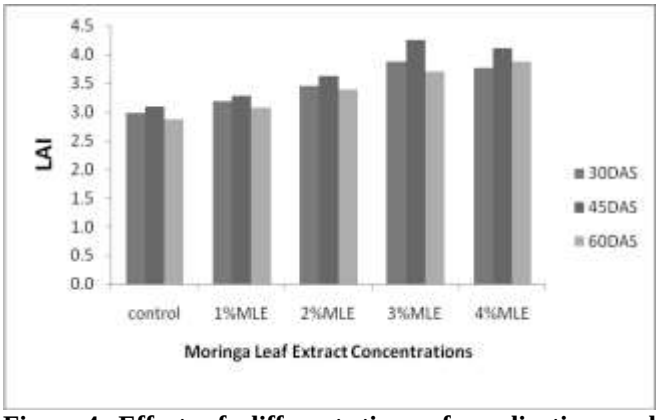

Figure 4: Effect of different time of application and concentration levels of *Moringa oleifera* leaf extract on Leaf area index.

The lowest value of leaf area index (2.98) was recorded in control. These findings are supported by the findings of Ali *et al*. (2011), who reported the increase in leaf area due to moringa leaf extract foliar application. These results showed that the leaf area index was significantly affected due to the foliar spray of moringa leaf extract and this increase in the

leaf area index may be due to the growth promoting effect of various growth enhancers which are present in moringa leaf extract claimed by Foidle *et al.* (2001) that the foliar application of moringa leaf extract can be used as natural growth enhancer in different crops.

***Plant height (cm)*:** The results regarding plant height are given in the Fig.5. Plant height of sunflower was significantly increased by foliar application of moringa oleifera leaf extract. As considering the interactive effect of time of application and concentration levels, the results showed non-significant effect. As regards effect of time of application, the maximum value of plant height (170.61cm) was observed when *M. oleifera* leaf extract was applied at 45 DAS. As regards effect of concentration, the maximum value of plant height (175.02cm) was observed when 3% *M. oleifera* leaf extract was applied. The lowest value of plant height (153.07cm) was recorded in control. These findings are supported by Culver *et al.* (2012), who reported the increase in plant height due to the foliar application of *Moringa oleifera* leaf extract. Moreover, Zeatin present in moringa leaves plays an integral part in plant cell division and elongation (Taiz and Zeiger, 2006). Thus, due to increased plant cell division, plant length of sunflower was significantly increased.

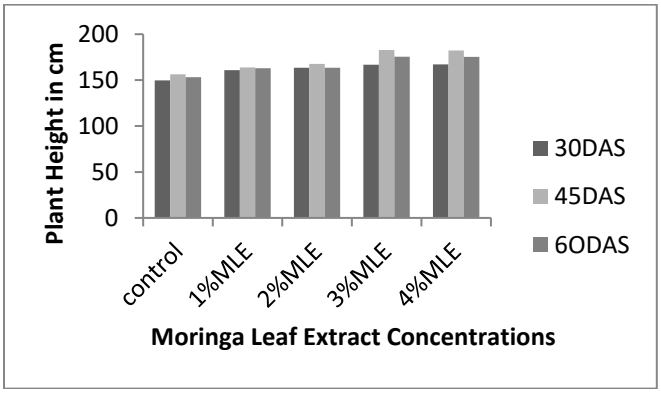

Figure 5: Effect of different time of application and concentration levels of *Moringa oleifera* leaf extract on Plant height.

***Head diameter (cm)*:** The results regarding plant height are given in the Fig. 6. The results showed that the effect of both the time of application and concentrations levels of *Moringa oleifera* leaf extracts on head diameter was significant. As considering the interactive effect of time of application and concentration levels, the results showed non-significant effect. As regards effect of time of application, the maximum value of head diameter (21.03cm) was observed when *M. oleifera* leaf extract was applied at 45 DAS. As regards effect of concentration, the maximum value of head diameter (22.12cm) was observed when 4% *M. oleifera* leaf extract was applied, which was statistically at par with 22.09cm in case of 3% MLE. The lowest value of head diameter (18.08cm) was recorded in control. These findings are also supported by the findings of Makkar and Becker (1996), who reported that plants treated with the foliar spray of growth hormone, will not only produce more number of fruits but also produce larger fruits and therefore give a 20-35% higher yield at harvest. Similarly, foliar spray of plant growth hormones increase the seed length, number of fruits per plant, weight of fruits per plant and total yield of fruits (Ali *et al.*, 2010).

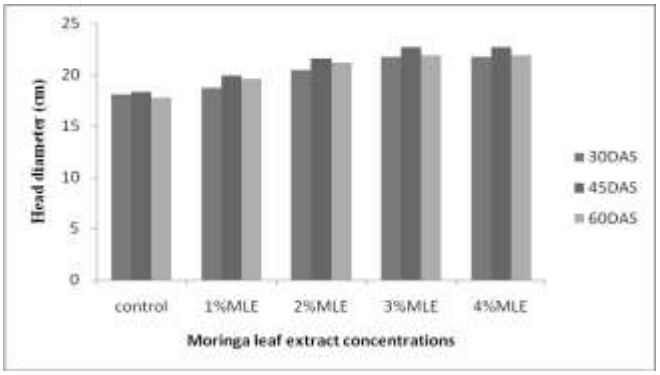

Figure 6: Effect of different time of application and concentration levels of *Moringa oleifera* leaf extract on Head diameter.

***Number of achene per head*:** The results regarding plant height are given in the Fig.7. The results showed that the effect of both the time of application and concentrations levels of *Moringa oleifera* leaf extracts on number of achene per head was significant. As considering the interactive effect of time of application and concentration levels, the results showed non-significant effect. As regards effect of time of application, the maximum value of number of achene per head (1050.7) was observed when *M. oleifera* leaf extract was applied at 45 DAS. As regards effect of concentration, the maximum value of number of achene per head (1147.8) was observed when 4% *M. oleifera* leaf extract was applied which was statistically at par with 1138.0 in case of 3% *Moringa oleifera* leaf extract. The lowest value of number of achene per head (855.1) was recorded in control These finding are supported by the work of Makkar and Becker (1996), who reported that leaf extracts of *Moringa oleifera* are rich in amino acids, calcium, potassium, iron and zeatin, which are vital plant growth promoter and enhancer. It produces more fruits and increases the yield of plants. Fuglie (2000) reported that *Moringa oleifera* leaf extracts speed up the growth of young plants, strengthens them, increase number of roots, generates larger fruits and generally yield increases from 20 to 35% Similarly, Ali *et al.* (2010) reported that foliar application of plant growth hormones enhances the number of seeds per fruit, seed length and number of fruits per plant, hence total yield.

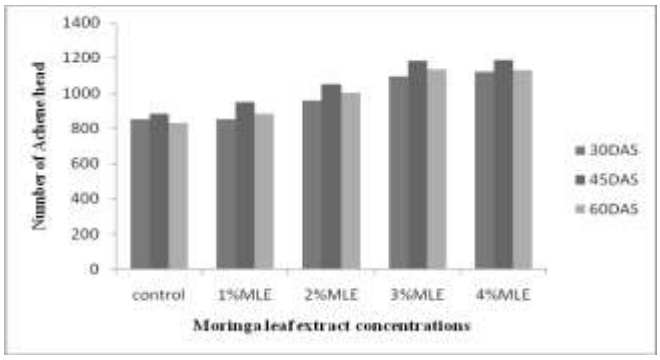

Figure 7: Effect of different time of application and concentration levels of *Moringa oleifera* leaf extract on number of achene per head.

***1000 Achene Weight (g)*:** The results regarding plant height are given in the Fig. 8. The results showed that the effect of both the time of application and concentrations levels of *Moringa oleifera* leaf extracts on 1000-achene weight was significant. As considering the interactive effect of time of application and concentration levels, the results also revealed the significant effect. As regards interactive effect time of application and concentration, the maximum value of 1000-achene weight (56.48g) was observed when 3% *Moringa oleifera* leaf extract was applied at 45 days after sowing. The lowest value of 1000-achene weight (50.17g) was recorded in control. These findings are supported by the work of Yasmeen *et al*. (2012), who reported the increase in 1000 grain weight is achieved when *Moringa oleifera* leaf extract is applied at different growth stages. This is due to delay in leaf senescence that may provide more photo assimilates to the grain. 1000-achene weight is an important yield contributing factor as Foidle *et al*. (2001) reported that plants sprayed with growth hormone would also have more and heavier fruit and therefore a higher yield at harvest.

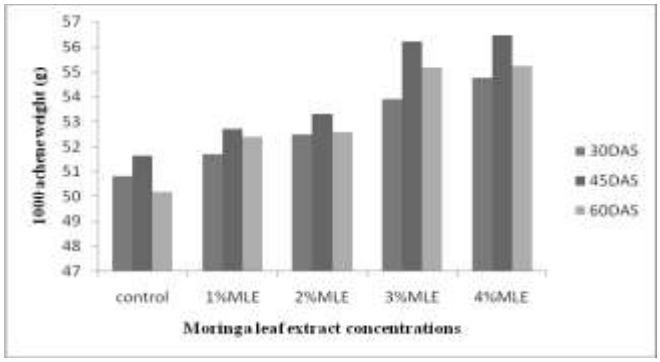

Figure 8: Effect of different time of application and concentration levels of *Moringa oleifera* leaf extract on 1000 achene weight.

***Achene yield (t ha^{-1})*:** The results regarding plant height are given in the Fig. 9. The data showed that the effect of both the time of application and concentrations levels of *Moringa oleifera* leaf extracts on achene yield was significant. As considering the interactive effect of time of application and concentration levels, the results showed non-significant effect. As regards effect of time of application, the maximum value of achene yield (2.69 t ha^{-1}) was observed when *M. oleifera* leaf extract was applied at 45 DAS. As regards effect of concentration, the maximum value of achene yield (2.84 t ha^{-1}) was observed when 3% *M. oleifera* leaf extract was applied. The lowest value of achene yield (2.29 t ha^{-1}) was recorded in control. These findings are supported by the work of culver *et al*. (2012), who reported that *Moringa oleifera* leaf extract increases plant height and final yield in field condition. More achene yield is due to the higher number of achene per head and 1000-achene weight caused by the moringa foliar application. Enhanced yield is due to the zeatin presence in *Moringa oleifera* leaf extract. El-Awady (2003) reported that *M. oleifera* contain high concentration of zeatin.

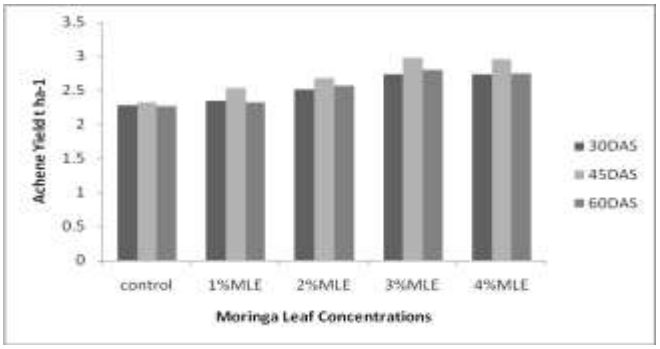

Figure 9: Effect of different time of application and concentration levels of *Moringa oleifera* leaf extract on Achene Yield.

REFERENCES

Ahmad, S. and F. U. Hassan. 2000. Oil and fatty acid composition of spring sunflower under rainfed conditions. Pak. J. Biol. Sci. 3:33-35.

Ahmad, R. 1993. Physio-Agronomic characteristics of semi dwarf and standard height sunflower hybrids as affected by nutritional area and potassium application. Ph.D. thesis, Department of Agronomy, Univ. Agri., Faisalabad.

Ahmad, R., M. Saeed, T. Mahmood and Ehsanullah. 2001. Yield potential and oil quality of two sunflower hybrids as affected by K application and growing seasons. Int. J. Agri. Biol. 3:51-53.

Ahmed, D. M. and A.M. Nimer. 2002. Effects of Acacia senegal (L., Wild) on sandy soils. A case study of El Damokya Forest, Northern Kordofan State. University of Khartoum. J. Agric Sci. 10:106–118.

Ali, M. M., M. Ashrafuzzaman, M. R. Ismail, S. M. Shahidullah and A. K. M. A. Prodhan. 2010. Influence of

foliar applied GABA on growth and yield contributing characters of white gourd (Benincasa hispida). Int. J. Agric. Biol. 12:373–376

Ali, Z., S.M.A. Basra, H. Munir, A. Mahmood and S. Yousaf. 2011. Mitigation of drought stress in maize by natural and synthetic growth promoters. J. Agri. Soc. Sci.7:56–62

Anonymous. 2009. Economic Survey, Govt. of Pakistan, Finance Division, Economic Advisor's Wing, Islamabad.

Atta, H.A. and I.A. Bashir. 1999. Adverse effects of Eucalyptus camaldulensis (Dehn) leaf extract on germination and seedling growth of wheat. University Khartoum J. Agric. Sci. 7:70-79.

Basra, S.M.A., M.N. Iftikhar and I. Afzal. 2011. Potential of moringa (*Moringa oleifera*) leaf extract as priming agent for hybrid maize seeds. Int. J. Agri. Biol.13:1006–1010

Chaudhary, A. U. and M. Mushtaq. 1999. Optimization of K in sunflower. Pakistan J. Biol. Sci. 2:887-888.

Chung, M. and D. A. Miller. 1995. Allelophathic influence of nine forage grasses on germination and seedling growth of alfalfa. J. Agron. 87:767-782

Culver, M., M. Tagwira, and Z. Albert. 2012. Effect of Moringa oleifera leaf aqueous extract on growth and yield of rape and cabbage. African J. Biotechnol.11:13796-13800

El Awady, A. 2003. Moringa Tree: Nature's Phamarcy. http: //www.islamonline.net/english/Science/2003/02article06.shtml(download 20/10/2007).

Farooq, M., S.M.A. Basra, H. Rehman, and B.A. Saleem. 2008. Seed priming enhancement the performance of late sown wheat by improving chilling tolerance. J. Agron Crop Sci. 194: 55-60.

Foidle, N., H.P.S. Makkar and K. Becker. 2001. The potential of Moringa Oleifera for agricultural and industrial uses. In: Fuglie, L.J. (Ed.), The Miracle Tree: The Multiple Attribute of Moringa. pp: 45–76.

Frankenberger, W.T.Jr. and M. Arshad. 1995. Phytohormones in Soil: Microbial Production and Function. Marcel Dekker Inc. New York, USA. pp:503.

Fuglie, L. J. 2001. Natural nutrition for the tropics. In: Fubalie, L.J. (ed). The Miracle Tree: The Multiple Attributes of Moringa. CTA Publication,Wageningen, The Netherlands. pp:103- 115.

Fuglie, L.J. 2000. The Miracle tree: Moringa oleifera: Natural nutrition for the tropics. the miracle tree: The Multiple Attributes of Moringa. pp .72.

Guenzi, W. D., T. M. McCalla and F. A. Norstadt. 1967. Presence and persistence of phytotoxic substances in wheat, oat, corn and sorghum residues. J. Agron. 59:163–165

Habib, H., S. S. Mehdi, A, Rashid, M. A. Anjum. 2006. Genetic association and path analysis for seed yield in sunflower (Heliantus annuus L.). Pak. J. Agri. Sci. 43:131-135.

Hassan, F. U., R. A. Ahmad, G. Qadir. 2003. Oil and fatty composition of sunflower in response to seasonal variation. HELIA. 35:159-166.

Hunt, R. 1978. Plant growth analysis. The institute of biology studies in Biology. Edward Amald (Pub., Ltd.) 96: 8-38.

Kadioglu, I., Y. Yusuf. 2004. Allelopathic effect of plant extracts against seed germination of some weeds. Asian J. of Plant Sci. 3:472-475.

Kaleem, S., F. U. Hassan and A. Saleem. 2009. Influence of environmental variations on physiological attributes of sunflower. African J. Biotech. 8:3531-3539.

Khan, T.D., M.I. Chung, T D. Xuan and S. Tawata. 2005. The exploitation of crop allelopathy in sustainable agriculture production. J. Agron & Crop Sci. 191:172-184.

Makkar, H .P. S. and K. Becker. 1996. Nutritional value and anti-nutritional components of whole and ethanol extracted Moringa oleifera leaves. Animal Feed Science and Technology. 63:211-228.

Miralles, O. B., J. Valero and F. Olalla. 1997. Growth, development and yield of five sunflower hybrids. European J. Agron. 6:47-59.

Nouman, W., M. T. Siddiqui, S. M. A. Basra, I. Afzal and H. Rehman. 2012. Enhancement of emergence potential and stand establishment of Moringa oleifera Lam. by seed priming. Turkish Journal of Agriculture and Forestry. 36:227–235.

Phiri, C. 2010. Influence of *Moringa oleifera* leaf extracts on germination and early seedling development of major cereals. Agric. Biol. J. N. Am. 1:774-777.

Phiri, C. and D.N. Mbewe. 2010. Influence of *Moringa oleifera* leaf extracts on germination and seedling survival of three common legumes. Int. J. Agri. Biol. 12:315–317.

Price, M.L. 1985. The Moringa Tree. ECHO Technical Notes. Educational Concerns for Hunge Organization, N, ft. Meyers, FL.

Qadir, G., F. U. Hassan and M. A. Malik. 2007. Growing degree days and yield relationship in sunflower. Int. J. Agri. Biol. 9:564-568.

Taiz, L. and E. Zeiger. 2006. Plant physiology, 4 edition. Sinauer Associates Inc. Publishers, Massachusetts, USA.

Weiss, E. A. 2000. Oil seed Crops. Blackwell Sci., Ltd., Paris, Tokyo, Berlin, Victoria. pp.364.

Yasmeen, A., S. M. A. Basra, I. Afzal and M. Farooq. 2012. Effect of natural and synthetic growth enhancers on antioxidant status of wheat under saline conditions. Plant Growth Regul., Revision submitted

Yasmeen, A., S. M. A. Basra, R. Ahmad and A. Wahid. 2011. Performance of late sown wheat in response to foliar application of Moringa oleifera Lam. leaf extract. Chil. J. Agri. Res. 72:92-97