Study of genetic variability in *Helianthus annuus* for seedling traits: An Overview

Zain Naseem[1], Syed Ahtisham Masood[1], Qurban Ali[2], Arfan Ali[2] and Naila Kanwal[1]

[1.] Department of Plant Breeding and Genetics, University of Agriculture Faisalabad, Pakistan
[2.] Centre of Excellence in Molecular Biology, University of the Punjab Lahore Pakistan
Corresponding author: qurban.ali@cemb.edu.pk

Abstract: Sunflower (*Helianthus annuus* L.) is an important oilseed crop that contributes a major share in edible oil production globally because it is short duration crop, tolerant to drought and high in oil contents and yield potential. Present review described the importance of studying genetic variability and heritability of various traits among sunflower accessions in to improve its agronomic performance. Moreover, the objective of this review was to define relationship among various traits and direct and indirect effects of these traits on achene yield. That could help us in formulation of principles for the assortment of high yielding sunflower genotypes in forthcoming breeding program.
[Naseem Z, Masood SA, Ali Q, Ali A and Kanwal N. **Study of genetic variability in *Helianthus annuus* for seedling traits: An Overview.** *Life Sci J* 2015;12(3s):109-114]. (ISSN:1097-8135). http://www.lifesciencesite.com. 17

Keywords: *Helianthus annuus*,

Introduction

Helianthus annuus L. (Sunflower) belongs to the family *Asteraceae*. It contains 65 species in it 14 of which are annual plants. Eastern North America is reported as its origin. Apparently, it was domesticated around 3000 B.C. by Native Americans. The sunflower was introduced to Russian Federation in late 1800s where it became a food crop and significant improvement was brought in the way of its cultivation by Russian farmers. Since 3000 B.C. throughout the world it is used as ornamental plant, alimentary, feedstock, medicinal, decorations, dyes, fodder and body painting. Edible oil is one of the basic food requirements and important component of diet for the human beings. Pakistan is world's fourth largest consumer of the vegetable oil. The acute shortage of edible oil in the country is increasing every year with increasing population growth. Pakistan faces severe shortage of edible oil, and spends a big amount of foreign exchange on its import annually to meet the local demand. Total demand of edible oil during 2012-13 was 3.069 million tones; whereas local production of edible oil in the country was 0.567 million tons and 2.502 million tons edible oil was imported spending 241.936 billion rupees (Pakistan economic survey, 2013-14). This data indicates a big gap in production and consumption that may be bridged by increasing the area under oilseed crops and improving genetic potential of traditional and non-traditional oilseed crops. Sunflower is grown mostly as a source of vegetable oil and proteins in many countries including Pakistan (Hu *et al*., 2010). Genetic variability provides the plant breeders an opportunity for selecting higher yielding crop genotypes (Ali *et al*., 2013; Ali *et al*., 2012; Ali *et al*., 2014; Azam *et al*., 2014; Jahangir *et al*., 2014; Anwar *et al*., 2013; Muhammad *et al*., 2013; Zameer *et al*., 2015) and considered as 2nd important edible oilseed crop following soybean globally (Paniego *et al*., 2002). In Pakistan 0.7 million hectares area is under sunflower cultivation and contributes to 144 thousand tons of edible oil, 22% of the local oil production (Pakistan economic survey, 2013-14).

Genetic variability and combining ability

Hussain *et al.* (2000) determined the significant variation in CMS lines, restorer lines and test crosses for oil content. Minimum level of variation was observed in restorer lines and maximum variation in test crosses for oil content. The better parent heterotic effects were shown in maximum number of test crosses for seed yield and SCA effects contributed a major role in the performance of better quality test crosses. It was also determined that early flowering, small headed, shorter and rapid growing crosses had heavy seeds. Nehru *et al*. (2000) evaluated three restorer lines (HA 234B, No. 61 and KBSH-1) and forty-eight inbred sunflower lines and their 144 F1 hybrids. 81 hybrids showed positive heterosis over better parent for seed yield and 42 hybrids showed positive heterosis for oil content. The hybrid BLC-5R-2-7-3 × HA 234B had maximum oil yield. The line HA 234B has good potential for seed yield and oil content so it should be used for future breeding program. Petch, (2000) conducted an experiment in which different sunflower hybrids were evaluated against water stress in growth chamber. It was found that decrease in photosynthesis rate, root length and area, chlorophyll content, stomatal conductance, leaf area, transpiration rate, and dry matter accumulation exhibited dynamic metabolism disturbances of sunflower hybrids grown under severe water stress, but no significant difference was observed between the two hybrids under study.

Shekar *et al.* (2000) studied combining ability of important yield components in sunflower parents and hybrids for days to 50% flowering, plant height, days to maturity, seed yield per plant, head size, 100 seed weight and oil content and reported additive gene action governing there traits. The best general combining ability for seed yield per plant, head diameter, 100 seed weight, oil content was shown by testers RHA-83R6 and RHA-345. The best hybrid combinations were CMS-338 × RHA-297, CMS-338 × RHA-274, CMS-234 × RHA-83R6 and CMS-851×RR-1 for days to 50% flowering, days to maturity, oil content and seed yield per plant respectively. Skoric *et al.* (2000) found that the significant heterotic effects were observed of various intensity levels. Regarding to the general combining ability (GCA) significant differences were observed among A-tester lines and Rf-lines. Some lines showed positive and negative highly significant general combining ability. For the inheritance of parameters both additive and non-additive genes were responsible. The maximum contribution to the expression of the parameters was due to A-testers. Tahir and Mehdi (2001) concluded that head diameter, 100-achene weight and seed yield per plant were reduced under water stress. Moreover, Significant but negative correlations of head diameter with fresh root and shoot weight were observed under water stress. Positive and significant correlation was perceived between dry shoot weight and seed yield per plant under water stress conditions.

Dasgustu (2002) showed that seed yield per plant was significantly and positively correlated with plant height and 1000 seed weight. Path coefficient analysis indicated that number of seeds per head, followed by 1000 seed weight were the most important traits for seed yield per plant. Khan *et al.* (2002) conducted an experiment to evaluate the morphological response of different wheat genotypes under water deficit condition. They found that most of the seedling traits were positively correlated to each other. However, root/shoot ratio and dry root/shoot weight was negatively correlated. Furthermore, no significant relation was found between emergence rate index and root/shoot ratio. Matsui and Singh (2002) conducted and experiment in which two cowpea genotypes T96D-604 (drought tolerant) and TVu7778 (drought susceptible) were evaluated under water stress condition. It was found that the root dry matter per leaf area, which indicated the capacity to absorb water, of IT96D-604 was significantly higher than that of TVu7778. However, the centers of root length density and root dry matter of both varieties moved downwards significantly under water-stress conditions compared with those of the well-watered condition.

Tahir *et al.* (2002) observed highest correlation of seed yield with number of filled seeds per plant, followed by seed filling percentage and head diameter in different sunflower accessions. They conclude that head diameter, 1000-seed weight and number of filled seeds per plant were important characters to improve seed yield. De-Figueiredo *et al.* (2003) conducted an experiment to evaluate the response of environmental stress on emergence of sunflower, maize and soybean seeds. Water stress was applied at levels of -1.1; -1.2; and 0.6 MPa. The result showed that high temperature was one of the most critical factors to which seed was exposed and seedling emergence depended upon the environmental stress. Rauf *et al.* (2008) studied combining ability effects of sunflower under moisture stress at seedling stage. They reported that large germplasm may be screened using seedling traits as the rapid and reliable method. Combining ability of seedling traits such as root length, shoot length root weight and shoot weight was reported. Genetic variation decreased among breeding lines and indicated their differences in moisture sensitivity and variability was low over environments, but high within environment. Additive genetic variability was noted under moisture stress.

Path coefficient and correlation

Gill *et al.* (2003) derived information on correlations among various traits of 45 sunflower genotypes grown over four environments. Oil yield per plant had the highest correlations with seed yield per plant followed 100-seed weight plant height and percent oil contents. Path coefficient analysis revealed that selection for any trait would influence oil yield plant through seed yield per plant. Khan *et al.* 2003; Abbas *et al*., 2014; Ali *et al*., 2014abc and Tariq *et al*., 2014 reported the variability and correlations of grain yield with different traits like plant height, head diameter, 100-grain weight and oil contents in sunflower hybrids developed at NARC, Islamabad, Pakistan. Highly significant differences were observed among the hybrid for all traits studied except oil contents. Grain yield was non-significantly correlated with plant height and oil contents. Bosnjak (2004) analyzed water availability over a period of 39 years and found drought to be a predominant feature in summer, the results of which up to 50% yield losses in sunflower that could have been obtained in irrigated conditions. He also predicted that severe droughts may be expected in the future with global climatic changes. Dusanic *et al.* (2004) observed that positive correlations existed between 1000-seed mass and seed yield. While direct effects of the other traits were low and their high total effects were masked by the indirect effects of the 1000-seed mass and number of filled seeds. Seed yield is a complex trait which is influenced by a large number of factors which act individually or jointly. It is therefore important to study relationships between the various traits and seed yield.

Goksoy *et al.* (2004) studied the relation between yield and irrigation water applied at different growth periods to understand and govern the most perilous periods for sunflower. Therefore, it was observed that HFM (heading, flowering and milking) irrigation was the best choice for maximum yield under the local conditions, but these irrigation patterns must be re-considered in regions where water resources were more inadequate. It was suggested that in case of more limited irrigation, the limitation of irrigation water at the flowering stage should be avoided Habib (2004) evaluated forty S1 families obtained from a random mating population of sunflower of different seedling traits. Phenotypic and genotypic coefficients of variation were high for root/shoot ratio, dry root weight, fresh root weight and fresh shoot weight. The seedlings which took more time to emerge were vigorous for most of traits except fresh shoot length. Root traits exhibit strong and positive genotypic and phenotypic correlation with other traits. Turhan and Ayaz (2004) evaluated eighteen early maturing hybrids of sunflower (*Helianthus annuus* L.) in a field experiment to judge the degree of variation in different quantitative characters. For all the 9 traits examined hybrids show significant differences. Physiological characters showed very low quantity of genetic advance but heritability and genetics progress were superior for all character.

Kaya *et al.* (2005) evaluated treated seeds (control, KNO3 and hydropriming) of sunflower cultivar at germination and seedling growth for tolerance to salt (NaCl) and drought conditions. Results revealed germination delay in both solutions. Germination, root and shoot length were higher but mean germination time and abnormal germination percentage were lower in NaCl. Inhibition of germination at same water potential of NaCl resulted from osmotic effects rather than salt toxicity. Hydropriming increased germination and seedling growth under salt and drought stress. Farratullah *et al.* (2006) concluded that seed yield was a quantitative character and dependent on its own component characters in sunflower. Such interdependence of contributing characters, as well as the characters of economic significance often deludes and thus makes correlation coefficient by and large variable during selection particularly in sunflower.

Habib *et al.* (2006) conducted an experiment comprising of 104 sunflower genotypes to study genetic correlation coefficients, direct and indirect effects of different plant traits on seed yield. The genetic correlation of 100-achene weight was positive and significant with seed yield of sunflower. Path analysis indicated that seed yield can be improved by increasing the 100-achene weight. Arshad *et al.* (2007) evaluated 20 sunflower hybrids for various parameters under field conditions to estimate genetic parameters, path analysis, correlation coefficient, and linkage distance. They observed that days to maturity had positive correlation with head diameter but negative association with seed yield. However, seed yield had highly positive genotypic correlation with oil contents but non-significant relation with 100 seed weight. Moreover, oil contents had negative association with days to flower initiation, completion and plant height but positive correlation with seed yield. Kaya *et al.* (2008) investigated relationship between seed yield and agronomic characters in sunflower without considering genetic effects. Oil content, plant height and 1000-seed weight had positive correlations with seed yield. A diverse relationship was determined between the seed yield of hybrid and oil contents. Results of the regression analysis indicated that there was a negative correlation between yield and oil contents and both levels of 40-50% oil contents increased equivalently after this point. Up to 70g 1000-seed weight sunflower seed yield increased, but hybrids sacrificed yield performance to get larger size seeds after this point. Seed yield gradually increased with increasing plant height demonstrated higher yield performance in this research. Rauf and Sadaqat (2007) reported that productivity of sunflower was strongly regulated by the availability of water and greatest yield losses occurred due to water shortage at flowering. Therefore, it is critical to manage the deleterious effect of drought stress at this stage. Evolving crop genotypes which have enhanced drought tolerance are the most successful and cheapest strategy to cope with drought. Ahmad *et al.* (2009) evaluated six hybrids under five drought stress levels produced by using PEG-6000. Germination percentage, plant height stress index, root length stress index and dry matter stress index were used to evaluate the genotypic response to PEG induced water stress. G-101 and 64-A-93 were drought tolerant. Dry matter stress index was good indicator of drought tolerance in sunflower.

Vashisth and shantha (2009) proposed that if the seeds of flower (*Helianthus annuus* L.) exposed in batches of magnetic fields of strength and treatment of seed in this field increase the germination speed, seedling length and seedling dry weight. Exposure of seeds to magnetic field coat membrane integrity and reduced the cellular leakage and electrical conductivity. Treated seeds planted in soil resulted higher seedling dry weight, root length, root surface area and root volum in 1-month-old seedling. The higher enzyme activity in magnetic field treated sunflower seeds triggering the fast germination and early vigour of seedling. Akram *et al.* (2010) observed considerable variations in the root, shoot length and biomass of different hybrids of maize at different salinity levels at seedling stage. The leaf sample was analyzed for inorganic osmolytes (sodium, potassium and calcium) and it was found that hybrid Pioneer32B33 and Pioneer30Y87 had high root shoot fresh weight, biomass, and high K+/Na+ ratio and showed best salt tolerance performance at all salinity levels on overall basis. Farhani *et al.* (2011) studied the effect of seed size on seedling vigour in sunflower. Effect of seed size was significant on germination whereas, non-significant on seedling dry weight, seedling vigour and length. The maximum germination percentage, seedling dry weight and seedling vigour were observed in types with small seeds but the highest seedling length was observed in types with large seeds. Geetha *et al.* (2012) performed an experiment using fifty genotype of sunflower for screening seedling traits. Two levels of osmotic stress were created and compared with control using PEG-6000. The result showed decrease in root length, shoots length, root/shoot ratio, germination percentage and seedling dry weight with increasing water stress.

Hadi *et al.* (2012) studied the association between seed size and seedling growth under water deficit conditions. Irrigation treatments of 60, 120 and 180 mm were applied and seed length and width, seed weight, kernel weight, shell weight, dry weight of hypocotyls and cotyledon leave were all affected by water deficit. Saensee *et al.* (2012) performed an experiment to evaluate the response of different sunflower genotypes at seedling stage. They recorded the data for plant height, root length, dry matter contents, germination percentage and relative water content. They concluded that all these traits decreased with increase in water stress in all sunflower genotype. Fatemi (2014) reported that the successful establishment of plants largely depends on successful germination and also investigate the effects of ascorbic acid on rate, stamina index, hypocotyls and redical length, seedling fresh and dry weight of sunflower under various water potential induced by PEG6000. Parameter give negative responded with water stress. Seed priming was considered an appropriate tool for improving germination characteristics of sunflower under water stress.

References

1. Ahmad, S., R. Ahmad,. M.Y. Ashraf, M. Ashraf and E.A. Waraich. 2009. Sunflower (*Helianthus annuus* L.) response to drought stress at germination and seedling growth stages. Pak. J. Bot. 41(2): 647-654.
2. Abbas, SQ, MUl Hassan, B Hussain, T Rasool and Q Ali. 2014. Optimization of zinc seed priming treatments for improving the germination and early seedling growth of *Oryza sativa*. Adv. life sci., 2(1) pp: 31-37.
3. Akram, M., M.Y. Ashraf, R. Ahmad, E.A. Waraich, J. Iqbal and M. Mohsan. 2010. Screening for salt to lerance in maize (*Zea mays* L.) hybrids at an early seedling stage. Pak. J. Bot. 42: 141-154.
4. Ali A, Muzaffar A, Awan MF, Ud Din S, Nasir IA. 2014. Genetically Modified Foods: Engineered tomato with extra advantages. Adv. Life Sci., 1 (3): 139-152.
5. Ali MA, Rehman I, Iqbal A, Din S, Rao AQ, Latif A, Samiullah TR, Azam S, Husnain T. (2014). Nanotechnology, a new frontier in Agriculture. Adv. life sci., 1(3): 129-138.
6. Ali Q, Ahsan M, Ali F, Aslam M, Khan NH, Munzoor M, Mustafa HSB, Muhammad S. 2013. Heritability, heterosis and heterobeltiosis studies for morphological traits of maize (Zea mays L.) seedlings. Adv. life sci., 1(1): 52-63.
7. Ali Q, Ali A, Ahsan M, Ali S, Khan NH, Muhammad S, Abbas HG, Nasir IA, Husnain T. 2014c. Line × Tester analysis for morpho-physiological traits of Zea mays L. seedlings. Adv. life sci., 1(4): 242-253.
8. Ali Q, Ali A, Awan MF, Tariq M, Ali S, Samiullah TR, Azam S, Din S, Ahmad M, Sharif NM, Muhammad S, Khan NH, Ahsan M, Nasir IA and Hussain T. 2014b. Combining ability analysis for various physiological, grain yield and quality traits of *Zea mays* L. *Life Sci J* 11(8s):540-551.
9. Ali, Q., A. Ali, M. Tariq, M.A. abbas, B. Sarwar, M. Ahmad, M.F. Awaan, S. Ahmad, Z.A. Nazar, F. Akram, A. Shahzad, T.R. Samiullah, I.A. Nasir, and T. Husnain 2014a. Gene Action for Various Grain and Fodder Quality Traits in *Zea Mays*.” *Journal of Food and Nutrition Research*, 2(10): 704-717.
10. Ali, Q., M. Ahsan, M.H.N. Tahir and S.M.A. Basra, 2012. Genetic evaluation of maize (*Zea mays* L.) accessions for growth related seedling traits. *IJAVMS,* 6: 164-172.
11. Anwar M, Hasan E, Bibi T, Mustafa HSB, Mahmood T, Ali M, 2013. TH-6: a high yielding cultivar of sesame released for general cultivation in Punjab Adv. life sci., 1(1): 44-57.

12. Arshad, M., M.K. Ilyas and M.A. Khan. 2007. Genetic divergence and path coefficient analysis for seed yield traits in sunflower (*Helianthus annuus* L.) Hybrids. Pak. J. Bot. 39: 2009-2015.
13. Azam S, Samiullah TR, Yasmeen A, Din S, Iqbal A, Rao AQ, Nasir IA, Rashid B, Shahid AA, Ahmad M, Husnain T. 2013. Dissemination of Bt cotton in cotton growing belt of Pakistan. Adv. life sci., 1(1): 18-26.
14. Bosnjak, D. J. 2004. Drought and its relation to field crops production in Vojvodina Province (Serbia, Serbia & Montenegro). Agrn. J. 40: 45–55.
15. Butt SJ, Varis S, Nasir IA, Sheraz S, Shahid A, Ali Q. Micro Propagation in Advanced Vegetable Production: A Review. (2015). Adv. Life Sci. 2(2). pp: 48-57.
16. Dar AI, Saleem F, Ahmad M, Tariq M, Khan A, Ali A, Tabassum B, Ali Q, Khan GA, Rashid B, Nasir IA, Husnain T. Characterization and efficiency assessment of PGPR for enhancement of rice (*Oryza sativa* L.) yield. (2014). Adv. Life Sci. 2(1). pp: 38-45.
17. De-figueiredo, E., M.C. Albuquerque, N.M. Carvalho. 2003. Effect of the type of environment stress on the emergence of sunflower (*Helianthus annuus* L.), soybean (Glycine max L.) and maize (Zea mays L.) seeds with different levels of vigor. Seed Sci. Technol. 31: 465-467.
18. Dušanic, N.V. Miklic, J. Joksimovic and Atlagic. 2002. Path coefficient analysis of some yield components of sunflower. Breed and Genet. 1: 531-537.
19. Farahni, A.H., P. Moaveni and K. Maroufi. 2011. Effect of seed size on seedling vigour in sunflower (*Helianthus annuus* L.). Adv. Environ. Biol. 5(7): 1701-1705.
20. Farratullah, Farooq-e-Azam and I.H. Khalil. 2006. Path analysis of the coefficients of sunflower (*Helianthus annuus* L.) hybrids. Int. J. Agri. & Bio. 8: 621-625.
21. Fatemi, S.N., 2014. Germination and seedling growth in primed seeds of sunflower under water stress. Ann. Res. Rev. Biolo 4(23): 3459-3469.
22. Geetha, A., A. Sivasankar, L. Prayaga, j. Suresh and P. Saidaiah. 2012. Seedling of sunflower genotype for drought tolerance under laboratory conditiosns using PEG. Sabrao J. breed and genetic. 44(1): 28-41.
23. Gill, H., R.K. Sheoran, A. Shahid, and H. Ahmed. 2003. Correlation for oil yield in sunflower (*Helianthus annuus* L.). Nat. J. Plant Imp. 5(1): 43-46.
24. Goksoy, A.T., A.O. Demir, Z.M. Turan and N. Dagustu. 2004. Responses of sunflower (*Helianthus annuus* L.) to full and limited irrigation at different growth stages. Field Crops Res. 87: 167–178.
25. Habib, H., S.S. Mehdi and M.A. Anjum. 2006. Genetic association and path analysis for seed yield in sunflower (*Helianthus annuus* L.). Pak. J. Agri. Sci. 43(3-4): 136-139.
26. Habib, S. 2004. Genetic variation of seedling traits in a random mating population of sunflower. Pakistan J. Agric. Res. 18. (1): 61-65.
27. Hadi, H., F. Khazaei, N. Babaei, J. Daneshian and A. Hamidi. 2012. Evaluation of water deficit on seed size and seedling growth of sunflower cultivars. Int. J. Agri. Sci. 2(3): 280-290.
28. Hu, Y.M., W.C. Ye, Z.Q. Yin and S.X. Zhao. 2007. Acta Pharm. Sin. 42(3): 286-291.
29. Hussain, S.Z., R.J. Anandam and A.S. Rao. 2000. Effect of different fungicides and homeopathic drugs on seed borne fungi of sunflower (*Helianthus annuus* L.). Ind. J. Plant Prot. 28: 148- 151.
30. Jahangir GZ, Nasir IA, Iqbal M. Disease free and rapid mass production of sugarcane cultivars. (2014). Adv. life sci., 1(3): 171-180.
31. Kaya, Y., G. Evcl, S. Durak, V. Pekcan and T. Gucer. 2007. Determining the relationships between yield and yield attributes in sunflower. Turk. J. Agri. 31: 237-244.
32. Khan JA, Afroz S, Arshad HMI, Sarwar N, Anwar HS, Saleem K, Babar MM, Jamil FF (2014). Biochemical basis of resistance in rice against Bacterial leaf blight disease caused by Xanthomonas oryzae pv. oryzae. Adv. life sci., 1(3): 181-190.
33. Khan, A., I. Ullah, B. Murtaza and M. Yousaf. 2003. Variability and correlation studies in different newly developed sunflower hybrid. Asian J. Plant Sci. 2(12): 887-890.
34. Khan, M.Q., S. Anwar and M. I. Khan. 2002. Genetic variability for seedlings trait in wheat (*Triticum aestivum* L.) under moisture stress condition. Asian J. Plant Sci. 1: 588-590.
35. Matsui, T. and B. B. Singh. 2003. Root characteristics in cow pea related to drought tolerance at the seedling stage. Exp.Agric. 39: 29-38.
36. Muhammad S, Shahbaz M, Iqbal M, Wahla AS, Ali Q, Shahid MTS, Tariq MS. 2013. Prevalence of different foliar and tuber diseases on different varieties of potato. Adv. life sci., 1(1): 64-70.

37. Nehru, S.D., A. Manjunath, and D. Basavarajaiah. 2000. Extent of heterosis for seed yield and oil content in sunflower. Karnataka J. Agric. Sci. 13: 718-720.
38. Pakistan economic survey. 2013-13. Ministry of Finance, Economic Advisor's Wing, Islamabad.
39. Peniego, N., M. Echaide, M. Munoz, L. Fernandez, S. Torales, P. Faccio, I. Fuxan, M. Carrera, R. Zandomeni, E.Y. Suarez, and H.E. Hopp. 2002. Microsatellite isolation and characterization in sunflower (*Helianthus annuus* L.). Genome 4: 34-43.
40. Petcu, E., A. Arsintescu and D. Stanciu. 2001. The effect of drought stress on fatty acid composition in some Romanian sunflower hybrids. Romanian Agric. Res. 15: 39–42.
41. Qamar Z, Nasir IA, Jahangir GZ, Husnain T. 2014a. In-vitro Production of Cabbage and Cauliflower. Adv. life sci., 1(2): 112-118.
42. Qamar, Z, Aaliya K, Nasir IA, Farooq AM, Tabassum B, Qurban A, Ali A, Awan MF, Tariq M and Husnain T. An overview of genetic transformation of glyphosate resistant gene in *Zea mays*. *Nat Sci*. 2015;13(3): 80-90.
43. Rauf, S. and H.A. Sadaqat. 2007. Sunflower (*Helinathus annuus* L.) germplasm evaluation for drought tolerance. Comm. Biom. Crop Sci. 2: 8–16.
44. Rauf, S., H.A. Sadaqat and I.A. Khan. 2008. Effect of moisture regimes on combining ability variations of seedling traits in sunflower (*Helianthus annuus* L.). Can. J. Plant Sci. 88: 323-329.
45. Sabbir MZ, Arshad M, Hussain B, Naveed I, Ali S, Abbasi A and Ali Q, (2014). Genotypic response of chickpea (*Cicer arietinum* L.) for resistance against gram pod borer (*Helicoverpa armigera* (Hubner)). Adv. life sci., 2(1): 23-30.
46. Saensee, K., T. Machikowa and N. Muangsan. 2012. Comparative performance of sunflower synthetic varieties under drought stress. Inter. J. of Agric. and Biol. 14(6): 929-934.
47. Shan MA, Tahira F, Shafique M, Hussnain M, Perveen R, *et al* (2015). Estimation of Different Biochemical Intensities in Drinking Water from Eastern Region of Lahore City. Adv. life sci., 2(3): 131-134.
48. Shekar, G.C., H. Jayaramegowda, S.D. Nehru, B.H. Halaswamy and S. Ashok. 2000. Combining ability of early maturing cms lines and restorers in sunflower. Mysore J. Agric. Sci. 34: 289-293.
49. Skoric, D., S. Jocic, and I. Molnar. 2000. General (GCA) and Specific (SCA) combining abilities in sunflower. In: Proc. of the 15th International Sunflower Conference. Toulouse, France June 12-15. E: 23-29.
50. Tahir, M.H.N. and S.S. Mehid. 2001. Evaluation of open pollinated sunflower (*Helianthus annuus* L.) populations under water stress and normal conditions. Int. J. Agric. Biol. 3: 236–238.
51. Tahir, M.H.N. and S.S. Mehid. 2001. Evaluation of open pollinated sunflower (*Helianthus annuus* L.) populations under water stress and normal conditions. Int. J. Agric. Biol. 3: 236–238.
52. Tahir, M.H.N., M. Imran and M.K. Hussain. 2002. Evaluation of sunflower (*Helianthus annuus* L.) inbred lines for drought tolerance. Int. J. Agric. Biol. 3: 398–400.
53. Tariq M, Ali Q, Khan A, Khan GA, Rashid B, Rahi MS, Ali, A, Nasir IA, Husnain T. (2014). Yield potential study of Capsicum annuum L. under the application of PGPR. Adv. life sci., 1(4): 202-207.
54. Turhan, H. and C. Ayaz. 2004. Effect of salinity on seedling emergence and growth of sunflower (*Helianthus annuus* L.) cultivars. Int. J. Agri. Biol. 6(1): 74-78.
55. Vashisth, A. and S. Shantha. 2009. Effect on germination and early growth characteristics in sunflower (*Helianthus annuus* L.) seeds exposed to static magnetic field. J. of plant physiol. 167: 149-156.
56. Zameer M, Mahmood S, Mushtaq Z, Tabasum B, Ali Q, et al. (2015). Detection of bacterial load in drinking water samples by 16s rRNA ribotyping and RAPD analysis. Adv. Life Sci. 2(3). pp: 135-141.

3/25/2015