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Growth and Yield Performance Sunflower under NP Fertilizer Levels

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Abstract

The present study was carried out to assess the growth and yield performance of sunflower under NP fertilizer levels at oil seed section, agriculture research institute, Tandojam during the year 2012-2013. The experimental laid out in RCBD (factorial) with net plot size (3 × 4) m (12 m^2), the sunflower variety HO^{-1} was used and checked under various NP treatments i. e. F1 0-0 control, F2=80-40, F3 100-50, F4 150-50, F5 120-50 and 120-75 NP kg ha^{-1}. The results revealed that all the parameters of sunflower were significantly affected (P<0.05) by different NP levels. The results further revealed that maximum values for sunflowers traits under study i-e days to 75% maturity (91. 17), days to 90% maturity (16.1), plant height (184.25 cm), stem girth (6.65 cm), seeds $head^{-1}$ (116.91), seed index (90.33 g), yield kg ha^{-1} (2172), were recorded under treatment F4 i-e (150-50-0), Whereas; minimum values for various sunflower traits i.e. plant height (123.17 cm), stem girth (4.37 cm), head diameter (6.66 cm), seeds $head^{-1}$ (850.30) seed index 100 seeds weight and seed yield (1512.70 kg ha^{-1}) in control treatments where no fertilizer was applied. It was concluded that growth and seed yield also increased at 150-50 NP kg ha^{-1} and thus recommended for better performance and yield of sunflower crop.

Keywords: Growth; Yield; Performance; Optimization; Fertilizer; Levels

Introduction

Pakistan has chronic deficiency in edible oilseed production and is the third largest importer of edible oil in the world involving huge foreign exchange. Presently indigenous oil seed production is estimated 0.78 million tons which meets only 27% of domestic requirement, while the remaining 73% is met through imports [1]. For the year 2008-2009 (July-March), Pakistan imported 1.29 million tons edible oil and spent nearly Rs. 84.6 billion to meet its edible oil requirements and thus become the third largest importer of edible oil in the world. Nevertheless, the demand for the edible oil is increasing steadily over the time while production is stagnant. Thus, Pakistan is facing still facing an acute shortage of edible oil [2]. All this necessitates more concerted efforts to increase domestic oilseed production. Sunflower is one of the major oilseed crops of Pakistan grown over an area 1.12 million acres. Sunflower seed contains 25%-48% oil and 21%-27% protein [3]. Its oil contains high percentage of poly-unsaturated fatty acids (60%), accepted largely in diet to reduce cholesterol in blood and prevents heart diseases. Sunflower oil is quite palatable and contains soluble vitamins A, D, E and K. it is used in manufacturing of margarine [4]. Sunflower cake is used as cattle feed. The average yield of sunflower is low than the potential of the hybrids. Among the various factors appropriate fertilizer application plays crucial role to consumer optimum sunflower yield oil content [5].

The fertilizer requirement of sunflower varies depending on the rainfall received during crop season (sowing to harvest), runoff and soil moisture stress parameters [6]. An optimal dose based on a suitable soil water balance model would be more efficient compared with a general fertilizer dose [7]. It is therefore required to derive crop season moisture stress index based on daily rainfall and runoff and calibrate optimal fertilizer requirement of sunflower [8]. Multiple regression models of seed yield through rainfall, runoff and soil moisture stress index together with fertilizer variables could be calibrated for both prediction of seed yield and optimization of fertilizer at varying moisture stress levels [9,10]. Fertilizer treatment of 100-75 NP kg ha^{-1} proves to be the most favorable in improving the oil content of sunflower. Potassium had no effect on plant height but affected seed and oil yields reported that deficiency of N, P and K decreased seed yield of hybrid sunflower by 19.4, 15.3 and 22%, 7% respectively [11]. Also stated that sunflower hybrids respond well to application of fertilizers and they recorded significant increase in its seed yield by applying N, P, K in combination [12]. N play an imperative role in maximization of crop yields and improves the yield as well as quality of all crops. Additionally, higher rates of N increase photosynthetic processes, leaf area production, leaf area duration as well as net assimilation rate. The development of individual leaf area and total leaf area of crop plant and ultimately contributing towards higher grain yield [13,14]. Many researchers concluded that N increases grain yield by affecting the growth and development of sunflower. Phosphorus (P) is a major requirement for the growth of sunflower, its deficiency results in stunted growth, purplish discoloration of leaves [15]. It also affects flowering, fruit formation and seed production. Flower size is reduced to half its normal size and fruit head is decreased to one- third [16,17]. Uptake of major nutrients elements by sunflower has also been reported to be facilitated when P was applied at the rate of 40 kg ha^{-1}-60 kg ha^{-1} in the forest zone and the objectives of the experiment were to evaluate the effect of NP

fertilizer combinations on growth and yield of Sunflower and to find out the most suitable NP dose for obtaining higher yield soil conducted [18].

Materials and Methods

The present study was conducted at oil seed section, agriculture research institute, Tandojam to assess the growth and yield performance sunflower under NP fertilizer levels. The experimental description is as under: In this experiment the experimental design was Randomized Complete Block Design (RCBD) with three replications on variety HO $^{-1}$ in the plot size of (3 × 4) m=12 m^2 and 6 treatments were applied (Figure 1) [19].

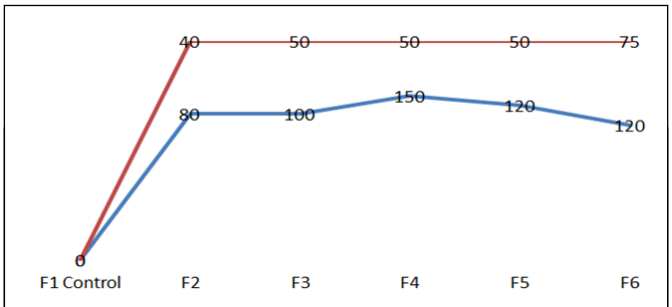

Figure 1: Seeds of sunflower variety HO-1 were drilled at a seed rate of 5 kg ha^{-1}. **Note:** -N -P

All the necessary cultural operations were adopted throughout the griming period according to the crop requirements uniformly in all the plots till the crop matured. The land was prepared by two cross wise dry plantings each followed by clod crushing and leveling to eradicated the weeds and equal distribution of irrigation water [20]. The seeds of sunflower variety HO^{-1} were drilled at a seed rate of 5 kg ha^{-1} by single culture hand drill at row spacing of 75 cm. The plant to plant distance of 45 cm was maintained in the experimental area. Earthening was performed after first irrigation. All the cultural practices for crop maintenance were adopted to maintain the experiment area [21].

Observations recorded

Days to 75% maturity: When 75% maturity was done the number of days was counted from date of sowing till to 75% maturity [22].

Days to 90% maturity: At the time of harvesting, total days from date of sowing to 90% maturity were counted.

Plant height (cm): Plant height was measured in centimeters from the base to tip of each selected plant with measuring tape.

Stem girth (cm): The stem girth was measured by means of Vernier Caliper at maturity of the crop in labeled plants in each treatment and mean was worked out.

Head diameter (cm): For recording head diameter, measuring tape was used in all replications of each treatment and averages were worked out [23].

Seeds head: Mature heads were harvested and the total number of seeds was counted as seeds $head^{-1}$.

Seed index (g): Seed index (100 seeds) from selected plants at maturity was obtained randomly and weighted in grams.

Seed yield (kg ha^{-1}): The harvested and cleaned seeds from each selected plant and each plot was weighed (g) to obtain yield kg ha^{-1} was obtained [24].

Statistical analysis

The data was collected and subjected to statistical analysis to analyze the variance in treatment means. LSD (Least Significant Difference) test was applied to observe the statistical differences within treatments following the method developed [24,25].

Results

The experiment was conducted at Oil Seed Section, Agriculture Research Institute, Tandojam to assess the growth and yield performance sunflower under NP fertilizer levels [26].

Days to 75% maturity

The results regarding days to 75% maturity of sunflower are presented and its Analysis of variance as Appendix-I. The results indicated that treatments had highly significant effect on days to 75% maturity [27]. It was further found that application of 150 kg NP ha^{-1}-50 kg NP ha^{-1} recorded maximum days to 75% maturity (91.17), followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (90.72) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (89.38) respectively. While the lowest (87.88) 75% days to maturity was observed in control plot where no fertilizer was applied (Figure 2) [28].

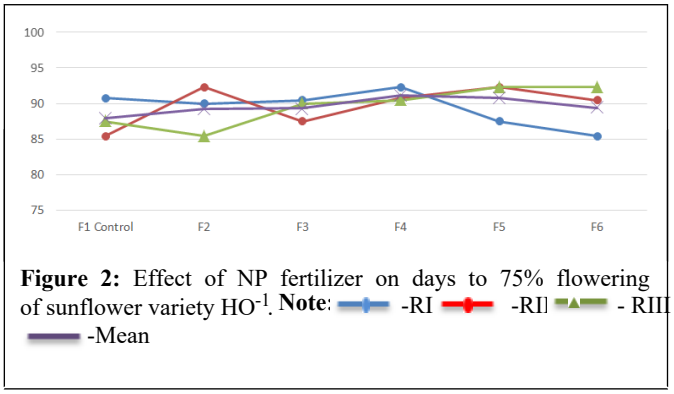

Figure 2: Effect of NP fertilizer on days to 75% flowering of sunflower variety HO^{-1}. **Note:** -RI -RII - RIII -Mean

Days to 90% maturity

The results regarding days to 90% maturity of sunflower and its analysis of variance as Appendix-II. The results indicated that treatments had highly significant effect on 90% maturity. The results indicated that application of 150 kg NP ha^{-1}-50 kg NP ha^{-1} recorded maximum days to 90% maturity (16.01), followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (15.36) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (15.32) respectively. While the lowest (14.16) days to 90% maturity was observed in control plot where no fertilizer was applied (Figure 3) [29].

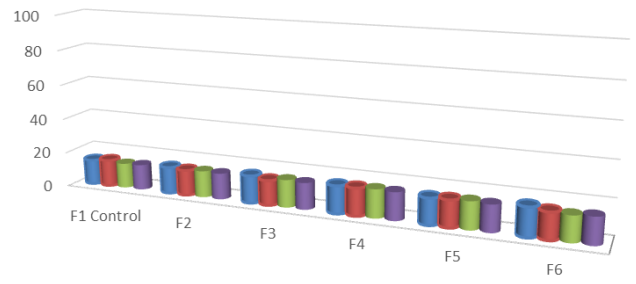

Figure 3: Effect of NP fertilizer on days to 90% maturity of sunflower variety HO-1. **Note:** -RI -RII -RIII -Mean

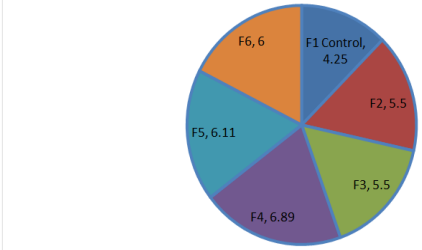

Figure 5: Effect of NP fertilizer on stem girth (cm) of sunflower variety HO-1.

Plant height

The results regarding plant height (cm) of sunflower are presented and its Analysis of variance as Appendix-III. The results indicated that treatments had highly significant effect on plant height (cm). It was further found that application of 150 kg NP ha^{-1}-50 kg NP ha^{-1} recorded maximum plant height (184.25 cm), followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (184.75 cm) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (154.92 cm) respectively. The lowest plant height (123.17 cm) was observed under control plot where no fertilizer was applied (Figure 4) [30].

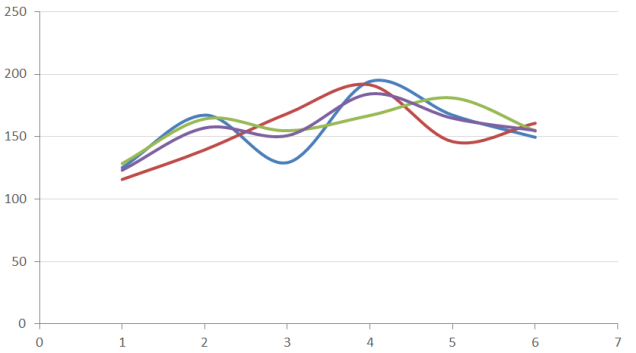

Figure 4: Effect of NP fertilizer on plant height (cm) of sunflower variety HO-1. **Note:** -RI -RII -RIII -Mean

Head diameter

The results on head diameter of sunflower are presented and their analysis of variance as Appendix-V. The results revealed that NP levels had significant effect on head diameter at 1 percent level of probability. It was further found that sunflower crop fertilized with 150 kg NP ha^{-1}-50 kg NP ha^{-1} produced wider head size (28.19 cm), followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (25.95 cm) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (25.70 cm) respectively. However the lesser (16.66) diameter of head was recorded under control treatment, where no application of fertilizers was used (Figure 6).

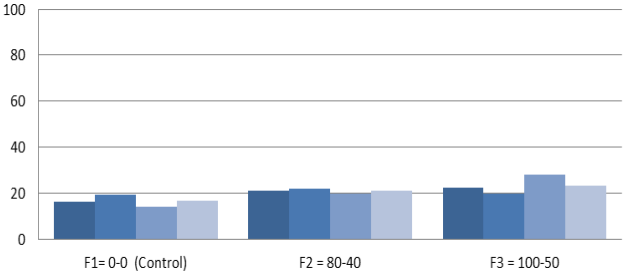

Figure 6: Effect of NP fertilizer on head diameter (cm) of sunflower variety HO-1. **Note:** -RI -RII -RIII -Mean

Stem girth

The results regarding stem girth of sunflower and their analysis of variance as Appendix-IV. It may be seen from the results that stem girth differed significantly at 5% probability level [31]. It was observed that NP applied at 150-50 kg ha^{-1} recorded maximum stem girth (6.65 cm), followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (6.58 cm) and 120 kg NP ha^{-1}-75 kg NP ha^{-1}) (6.37 cm) respectively. However lower (4.37 cm) stem girth was observed under control treatment where no fertilizer was applied (Figure 5).

Seeds head^{-1}

The results regarding number of seeds head^{-1} and their analysis of variance as Appendix-VI. The results revealed that NP levels had significant effect on number of seeds head^{-1}. It was further found that application of 150 kg NP ha^{-1}-20 kg NP ha^{-1} resulted in maximum number of seeds (1161.90 head^{-1}) which was followed by 120-50 kg NP ha^{-1} (1059 head^{-1}) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (1050 head^{-1}). However the minimum (850.30) number of seeds was observed under control treatment (Figure 7).

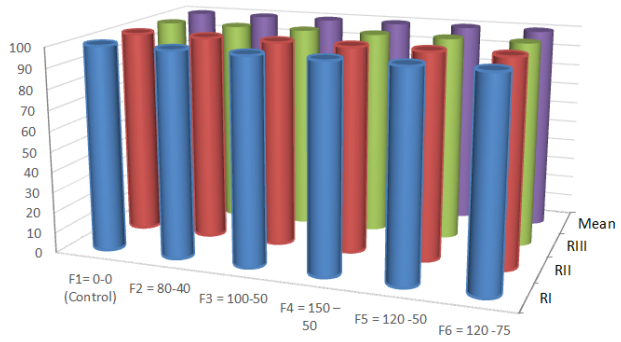

Figure 7: Effect of NP fertilizer on number of seeds head^{-1} of sunflower variety HO^{-1}. **Note:** -RI -RII -RIII -Mean

Seed index

The results on mean seed index value of sunflower are shown and their analysis of variance as Appendix-XII revealed that the differences in seed index value due to different NP levels were highly significant statistically.

The results further revealed that plots treated with 150-50 kg NP ha^{-1} gave higher seed index value (90.33 g), followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (76.00 g) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (75.33 g) respectively. Whereas, the lowest (47.66) seed index was observed under control treatment where no application of NP were applied (Figure 8).

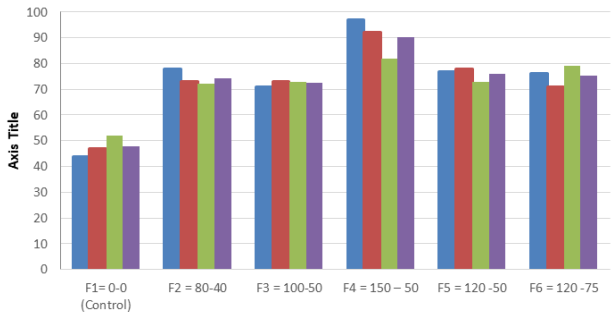

Figure 8: Effect of NP fertilizer on seed index (g) of sunflower variety HO^{-1}. **Note:** -RI -RII -RIII -Mean

Seed yield (kg ha^{-1})

The results on average seed yield ha^{-1} of sunflower recorded are presented and their analysis of variance as Appendix-VIII revealed that seed yield differed significantly (P<0.01) NP levels.

The results further showed that sunflower fertilized with 150 kg NP ha^{-1}-50 kg NP ha^{-1} gave maximum seed yield (2172.00 kg ha^{-1}), followed by 120-50 kg NP ha^{-1} (1934.70 kg ha^{-1}) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (1916.30 kg ha^{-1}) respectively. While control treatment produced lowest seed yield (1512.70 kg ha^{-1}) (Figure 9).

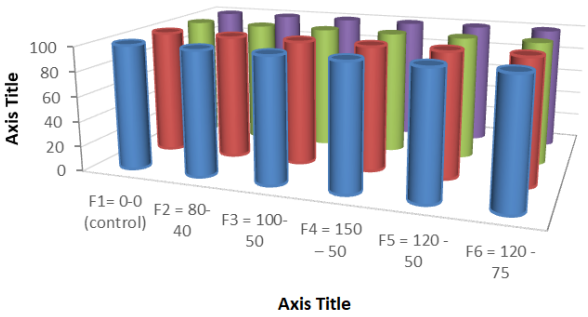

Figure 9: Effect of NP fertilizer on seed yield (kg ha^{-1}) of sunflower variety HO^{-1}. **Note:** -RI -RII -RIII -Mean

Discussion

No doubt, the application of nutrients, particularly Nitrogen (N) and Phosphorus (P), either in the form of bio-fertilizer or artificial fertilizers, play a vital role in boosting up production in sunflower. Obtained high seed yield (4.3 t ha^{-1}) and oil yield (1.7 t ha^{-1}) by different levels of Nitrogen application. But maximum inherent potential of a variety can only be achieved when nutrients are applied in balanced form with Recommended Dose of Fertilizers (RDF). However, the effect of N application on the oil content of sunflower seed is somewhat controversial. Nitrogen application did not affect the oil content of sunflower seed either way. On the other hand, observed that increased doses of N application decreased the oil content of sunflower seed. Maximum plant height (87.54 cm), seed yield ha^{-1} (1302.75 kg) and leaf area plant^{-1} (9909.5 cm^2) was achieved in plots with highest dose of Nitrogen (225 kg ha^{-1}) Phosphate compounds act as energy currency within the plant. Plants suffering from P deficiency are retorted in growth and the shoot root dry matter ratio is usually low. Thus not only low yield but also poor quality fruit and seed are obtained from P deficiency in crops. Quantifying the optimum fertilizer rate accurately is essential to maximize the profitability and minimize the potential negative environmental impact. As stated in some previous studies, the Economic Optimum Nitrogen Rate (EONR) was closely related to the fertilizer N price/crop value ratio, and the EONR was reported to be 100-110 kg ha^{-1} N to achieve good sunflower production.

The results revealed that the application of 150 kg NP ha^{-1}-50 kg NP ha^{-1} recorded maximum days to 75% maturity (91.17), followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (90.72) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (89.38) respectively. While the lowest (87.88) days to 75% maturity was observed in control plot where no fertilizer was applied. The results indicated that application of 150 kg NP ha^{-1}-50 kg NP ha^{-1} recorded maximum days to 90% maturity (16.01), followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (15.36) and 120-75 kg NP ha^{-1} (15.32) respectively. While the lowest (14.16) 90% maturity was observed in control plot where no fertilizer was applied. It was further found that application of 150 kg NP ha^{-1}-50 kg NP ha^{-1} recorded maximum plant height (184.25 cm), followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (184.75 cm) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (154.92 cm) respectively. The lowest plant height (123.17 cm) was observed under control plot where no fertilizer was applied. The results illustrated that NP applied at 150 kg ha^{-1}-50 kg ha^{-1} recorded maximum stem girth (6.65 cm), followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (6.58 cm) and

120 kg NP ha^{-1}-75 kg NP ha^{-1}) (6.37 cm) respectively. However lower (4.37 cm) stem girth was observed under control treatment where no fertilizer was applied. Reported that Nitrogen levels of 135 and 185 kg ha^{-1} produced statistically similar plant height, but significantly higher than 85 kg N ha^{-1}. This increase in plant height might be due to the positive effect of Nitrogen element on plant growth. Increase in plant height with Nitrogen application. These results are partially in line with those, who stated that Nitrogen alone or in combination with Phosphorus increased plant height.

The results showed that the sunflower crop fertilized with 150 kg NP ha^{-1}-50 kg NP ha^{-1} produced wider head size (28.19 cm), followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (25.95 cm) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (25.70 cm) respectively. However the lesser (16.66) diameter of head was recorded under control treatment, where no application of fertilizers was used. It was further found that application of 150-20 kg NP ha^{-1} resulted in maximum number of seeds (1161.90 $head^{-1}$) which was followed by 120 kg NP ha^{-1}-50 kg NP ha^{-1} (1059 $head^{-1}$) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (1050 $head^{-1}$). However the minimum (850.30) number of seeds was observed under control treatment. The results further revealed that plots treated with 150 kg NP ha^{-1}-50 kg NP ha^{-1} gave higher seed index value (90.33 g), followed by 120-50 kg NP ha^{-1} (76.00 g) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (75.33 g) respectively. Whereas, the lowest (47.66) seed index was observed under control treatment where no application of NP were applied. The results further showed that sunflower fertilized with 150 kg NP ha^{-1}-50 kg NP ha^{-1} gave maximum seed yield (2172.00 kg ha^{-1}), followed by 120-50 kg NP ha^{-1} (1934.70 kg ha^{-1}) and 120 kg NP ha^{-1}-75 kg NP ha^{-1} (1916.30 kg ha^{-1}) respectively. While control treatment produced lowest seed yield (1512.70 kg ha^{-1}). The minimum head diameter (13.28 cm) was recorded in case of plots which were fertilized with lowest rates of NP (85 kg ha^{-1}-50 kg ha^{-1}), while the rest of NP combinations were intermediated. The significant effect of Nitrogen and Phosphorus application on head diameter has also been reported by various researchers.

Conclusion

It is concluded that Nitrogen and Phosphorus are important nutrients for the growth, development and seed yield of sunflower. It was observed that as the Nitrogen and Phosphorus levels increased that growth and seed yield also increased and better performance of sunflower crop was exhibited on 150 kg NP ha^{-1}-50 kg NP ha^{-1}.

References

1. Ali A, IR Noorka (2013) Nitrogen and Phosphorus management strategy for better growth and yield of sunflower (*Helianthus annuus* L.) hybrid. Soil Environ 32: 44-48.
2. Ali A, A Ahmad, T Khaliq, J Akhtar (2012) Planting density and Nitrogen rates optimization for growth and yield of sunflower (*Helianthus annuus* L.) hybrids. Plant Sci 22: 1070-1075.
3. Al Nawaz HA (1989) Influence of varying levels of Potassium fertilization on yield and yield components of sunflower (*Helianthus annuus* L). Mesopotamia J Agric 20: 4641-4642.
4. Andraski T W, L G Bundy (2005) Cover crop effects on corn yield response to Nitrogen on irrigated sandy soil. Agro J 97: 1239-1244.
5. Angelova M, I Christov (2003) Removal and consumption of N P_2O_5, K_2O from sunflower.38: 51-53.
6. Ashoub MA, IM A Aziz, MM Shahin, MN Gohar (2003) Impact of irrigation and Nitrogen fertilization on yield, yield components and chemical contents of sunflower. Arab Univ J of Agril Sci 11: 191-204.
7. Ayup M, A Tanveer, Z Iqbal, MS Sharar, M Azam, et al. (1998) Response of two sunflower (*Helianthus annuus L.)* cultivars to different levels of Nitrogen. Pak J Biol Sci 1: 348-350.
8. Bakht J, M Shafi, M Yousaf, HU Shah, (2010) Physiology, phenology and yield of sunflower (autumn) as affected by NPK fertilizer and hybrids. Pak J Bot 42: 1909-1922.
9. Bange MP, GL Hammer, SP Milroy, KG Rickert (2000) Improving estimates of individual leaf area of sunflower. Agron J 92: 761-765.
10. Basra SM A, MN Zia, T Mehmood, I Afzal, A Khaliq, et al. (2003) Comparision of different invigoration techniques in wheat Triticum aestivum L seeds. Pak J Arid Agr 5: 11-17.
11. Belanger G, JR Walsh, JE Richards, PH Milburn, N Ziadi, et al. (2000) Comparison of three statistical models describing potato yield response to Nitrogen fertilizer. Agr J 92: 902-908.
12. Blamey FPC, J Chapman (1981) Protein, oil and energy yields of sunflower as affected by N and P fertilization. Agron J 73: 583-587.
13. Chitale S, K Upadhyay, RK Gajpai, BS Joshi (2004) Effect of higher fertility levels combined with farmyard manure and row spacing on seed yield, oil yield and economics of sunflower (*Helianthus annus* L) J. Oilseeds Res 21: 189-191.
14. Deng LQ, ZP Liu AW, Cheng QR Shen, MD Chen (2002) Influence of N and P fertilizers on sunflower grown in littoral soils with different salinity. Chinese J Oil Crop Sci 24: 61-64.
15. Fagbayide JA, GO Adeoye (1999) Sunflower growth and mineral uptake as influenced by fertilizer Phosphorus. Trop oilseeds J 4:21-28.
16. Gu J H Gao (1998) A study of the field limiting soil nutrient factors for sunflower on loess plateau and the optimum fertilizer rates. Chinese J Oil Crop Sci 20: 84-87.
17. Hussain MK, E Rasul, SK Ali (2000) Growth analysis of sunflower under drought conditions. Int J Agri Biol 2: 136-140.
18. Iqbal M, M Ashraf (2005) Pre-sowing seed treatments cytokinens and its effect on growth photosynthetic rate, ionic levels and yield of two wheat cultivars differing in salt tolerance. J Integ Plant Biol 47: 1315-1325.
19. Jabran K, ZA Cheema, MFarooq, M Hussain (2010) Lower doses of pendimethalin mixed with allelopathic crop water extracts for weed management in canola (*Brassica napus* L). Int J Agric Biol 12: 335-340.
20. Kale KD, AS Patil, AL Pharande (2005) Response of sunflower to application of sources of N and P and their residual effect on maize for fodder in an alfisol. J Maharashtra Agric Univ 30: 220-222.
21. Kamel MS, R Shabana, AK Ahmed, SI Mohandes (1980) Response of an exotic hybrid and a local unflower cultivar to N application in Egypt. J Agron Crop Sci 149: 227-234.
22. Killi F (2004) Influence of different Nitrogen levels on productivity of oilseed and confection sunflowers (*Helianthus annuus* L.) under varying plant populations. Int J Agric Biol 6: 594-598.
23. Malik MA, MF Saleem, M Sana, A Rehman (2004) Suitable level of N, P and K for harvesting the maximum economic returns of sunflower (*Helianthus annuus L.)*. Int J Agri and Biol 6: 240-242.
24. Malik MA, MF Saleem, M Sana, A Rehman (2006) Suitable level of N, P and K for harvesting the maximum returns of sunflower. Int J Agri Biol 6: 240-242.
25. Massignam AM, SC Chapman, GL Hammer, S Fukai (2009) Physiological determinants of maize and sunflower achene yield as affected by Nitrogen supply. Field Crops Res 113: 256-26.
26. Murali AP, TN Balasubramanian, MM Amanullah (2009) Impact of climate and nutrient management on yield components and yield of sunflower. AmEurasian J Sustain Agric 3: 13-16.
27. Osman M, T Hussain MY, Khan A Khan (1980) Effect of various doses of NPK on the yield of sunflower CV. J Sci Tech 4: 22-24.
28. Peker K, H Ozer (2005) Determination of economically optimal rate of Nitrogen fertilizer for irrigated sunflower in Eastern Anatolia, Turkey. Bulgarian J Agri Sci 11: 323-330.
29. Perez R, ST Garcia, AM Trujillo ML, Darias DQ Venegas, SM Ibanez (2002) Concentration of N, P and K in plant organs of sunflower (*Helianthus annuus* L). Centro Agricola 29: 43-46.

30. Poonia KL (2000) Effect of planting geometery, Nitrogen and sulphur on growth and yield of sunflower (*Helianthus annuus* L). J Eco Physi 3: 57-71.

31. Qahar A, ZH Khan, S Anwar, H Badshah, H Ullah (2010) Nitrogen use efficiency, yield and other characteristics of sunflower (*Helianthus annuus* L.) hybrids as affected by different levels of Nitrogen. Biodivers Conserv 3: 121- 125.