Plant Population and Nitrogen Effects on Achene Yield and Quality of Sunflower (Helianthus Annuus L.) Hybrids

Amjed Ali, Ashfaq Ahmad, Tasneem Khaliq, Muhammad Afzal, Zafar Iqbal, and Rafi Qamar

***Abstract*—**The experiment was conducted to study the effect of varying plant population and nitrogen rates on growth, development, yield and quality of sunflower hybrids at research area of University College of Agriculture, Sargodha, during spring season, 2011.The treatments include two hybrids (Hysun-33 and S-278) and three planting densities (8.33, 6.66 and 5.55 plants m^{-2}) with three rates of nitrogen (100, 125 and 150 kg ha^{-1}). The obtained results revealed that there was a significant difference for days taken to anthesis (R 5.8 stage) and physiological maturity (R 9 stage), and achene yield (AY) as well as achene oil contents (AOC) in both of the hybrids except Leaf area index (LAI) and total dry matter (TDM). The hybrid S-278 started reproductive stages and matured earlier and gave higher achene's yield (3.34 t ha^{-1}) than hybrid Hysun-33 (2.73 t ha^{-1}). Increasing plant density increased the days taken to anthesis (DA) and physiological maturity (DPM), LAI, TDM, AY, AOC in sunflower. Similarly, with increasing nitrogen application phonological duration, LAI, TDM and AY was increased but AOC were reduced. The interaction between hybrids and planting densities (HxD), hybrids and nitrogen (HxN), Planting density and nitrogen (DxN) were non- significant for all the parameters.

***Keywords*—**Achene, plant population, phenology, quality, yield.

I. Introduction

SUNFLOWER (Helianthus annus L.), occupies an important position in the world among the new oil seed crops because of its quantity and quality.

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Amjed Ali is with the University College of Agriculture, University of Sargodha (corresponding author's phone: ++923336800878; e-mail: amjedalich@gmail.com

Ashfaq Ahmad is with the University of Agriculture, Faisalabad (e-mail: Aachatha1@yahoo.com)

Tasneem Khaliq is with the University of Agriculture, Faisalabad (e-mail: tasneemkhaliq1056@gmail.com

Muhammad Afzal is with the University College of Agriculture, University of Sargodha (e-mail: mafzal@uos.edu.pk

Zafar Iqbal is with the University College of Agriculture, University of Sargodha (e-mail: zafarrohils@yahoo.com

Rafi Qamar is with the University College of Agriculture, University of Sargodha (e-mail:rafi1573@gmail.com).

The yield of sunflower is controlled by several factors, including selection of suitable hybrids, proper production technology and management practices especially optimum plant population in the field and judiciously use of fertilizer, particularly nitrogen (Ishfaq et al., [1]. Sunflower yield is largely affected by selection of cultivar. Safavi [2] described that sunflower genotypes were significantly differed for genotypic and phenotypic traits and the range of variability was quite appreciable for almost all the characters studied among different genotypes.

Sunflower hybrids exhibited differential genotypic response to different nitrogen levels by increasing seed yields combined with achene oil yields (Ali and Samiullah,[3]. Maintaining an optimum plant population is a key factor for increasing yield (Ali et al., [4], Nasim et al. [5]. observed that with increasing nitrogen rates, there was addition in the biomass, yield and yield components, despite the fact that the oil contents were depressingly affected. Tafteh and Sepaskhah [6] reported that nitrogen is one of the main plant nutrients affecting plant growth and yield. The objectives of this study therefore, were, to determine the effect of plant population and different nitrogen rates on growth and developmental stages of sunflower hybrids for obtaining higher achene yield and oil contents.

II. Materials And Methods

The Trial was carried out at the Research Area of University College of Agriculture, Sargodha during the spring seasons of 2011. The experiments was laid out in split split plot design and replicated thrice, keeping net plot size 3.6 m x 6 m. Sunflower hybrids was randomized in main plots, planting densities in sub plots and nitrogen levels in sub sub plots. The treatments were, Hybrids (in main plots) H1= Hysun – 33 and H2 = S-278, Plant population (sub plots), PP1= 8.33 plants, PP2= 6.66 plants and PP3= 5.55 plants m-2 and nitrogen levels (sub sub plot), N1= 100 (kg ha^{-1}), N2= 125 (kg ha^{-1}) and N3 = 150 (kg ha^{-1}). Crop was sown on ridges of 60 cm spaced apart keeping plant to plant distance of 20, 25 and 30 cm. Phosphorus and potassium was applied at the rate of 60-30 kg ha^{-1}, respectively. N, P and K were given in the form of Urea, DAP and SOP (K_2SO_4). All of P and K fertilizer and 1/3rd dose of nitrogen was applied at the time of sowing and remaining 2/3 rd of N was given in two

splits, at first irrigation and flowering stage. All other cultural practices such as hoeing, irrigation and plant protection measures were kept normal for the crop. The observations recorded were; number of days to anthesis, and physiological maturity, LAI, TDM, AY and AOC. The data collected on various growth stages and yield were statistically analyzed by employing the Fisher's analysis of variance technique and treatments means were compared least significant difference (LSD) test at 0.05 level of probability (Steel et al., [7].

III. Results And Discussion

A. Days to anthesis (R 5.8 stage)

The data given in Table showed that sunflower hybrids and planting densities had significant effect on DA. The Hysun-33 took maximum DA (65.48) as compared to Hybrid S-278 (60.18 days). Regarding plant population, significantly maximum DA (63.88) was observed in case of 8.33 plants m^{-2} which was followed by 6.66 plants m^{-2} (63.16 days) while minimum (61.44 days) was recorded from 5.55 plants m^{-2}. Similarly, DA was significantly increased with increasing levels of nitrogen, and highest DA (63.77) was noted when nitrogen was applied at the rate of 150 kg ha^{-1}. Increase in number of DA could be due to increased vegetative growth. Similar approaches were reported by De Varennes et al., [8] and Sadras [9], that cultivars differed significantly in phenology and this difference might be due to varietal behavior of sunflower. The interactive effects were non-significant among all the treatment.

B. Days to physiological maturity (R 9 stage)

Statistical analysis of data on DPM is represented in Table. Hybrid Hysun-33 matured in more days (107.22) than S-278 (97.56). Sunflower took maximum days to physiological maturity (103.44) at Plant population of 8.33 plants m^{-2}, which were statistically at par with the DPM (103.22) at plant population of 6.66 plants m^{-2}, while minimum DPM (100.50) were noted in case lowest plant population (5.55 plants m^{-2}). Nitrogen application had significant effect on DPM. Highest DPM (103.67) was recorded from plot which was fertilized with nitrogen rates of 150 kg ha^{-1}, which was followed (102.50 days) by the plot in which nitrogen level was 125 kg ha^{-1}, while the minimum DPM (101.00) was noted from plot treated with 100 N kg ha^{-1}. These results agreed with those reported by Bakhat [10] who found that DPM were different in various hybrids. The difference in sunflower ripening of different cultivars was reported by Font et al., [11]. The interactive effects for DPM were non- significant among all the treatment.

C. Leaf area index

Data in the Table showed that the hybrid differences in maximum LAI were non-significant, averaged, maximum LAI value was 4.08 for Hysun-33 and 4.03 for Hybrid S-278. Ishfaq et al. [1] reported non-significant differences for LAI among sunflower hybrids. Averaged over all, the highest LAI (4.35) was recorded for the crop sown at plant density of 8.33 plants m^{-2}) that declined to 4.17 and 3.66 for 6.66 plants m^{-2} and (5.55 plants m^{-2}), respectively. Time of achieving maximum leaf area indices correspond to their anthesis in respective to planting densities. Nitrogen application influenced leaf area indices significantly ($P \leq 0.05$) throughout crop growth period. Averaged over all, the maximum LAI (4.48) was observed by N3 treatment (150 kg N ha^{-1}) that was followed with treatment N2 (125 kg N ha^{-1}) that showed 3.96, and LAI (3.45) was recorded in plots that were fertilized with 100 kg N ha^{-1} (N1). So, higher LAI could be credited to significant developments in leaf expansion which is dependent on high nitrogen rates. The greater leaf spreading out in sunflower was endorsed due to higher rate of cell division as described by Andrade, [12] and Ishfaq et al. [1].

D. Total dry matter (t ha^{-1})

Data in Table revealed that averaged over all, higher TDM (9.09 t ha^{-1}) was accumulated by Hysun-33 as compared to (8.54 t ha^{-1}) that was achieved by S-278 at final harvest of sunflower hybrids. Plant density significantly influenced TDM of sunflower hybrids, averaged over all, the maximum TDM (9.55 t ha^{-1}) were produced when crop was sown at planting density of (8.33 plants m^{-2}) that was followed with treatment PP2 (6.66 plants m^{-2}) obtaining TDM of (8.74 t ha-1), whereas, minimum (8.24 t ha-1) were recorded in PP3 treatment (5.55 plants m^{-2}). Sedghi et al. [13] also observed increase in TDM with higher planting densities. The effect of nitrogen was pro-motive and significant in production of final TDM. Averaged over all, the maximum TDM (9.94 t ha^{-1}) was produced by N3 treatment (150 kg N ha^{-1}) that was followed with treatment N2 (125 kg N ha^{-1}) that produced 8.95 t ha-1 and minimum TDM (7.63 t ha^{-1}) was observed in plots that were fertilized with 100 kg N ha^{-1} (N1). The enhancement of TDM with increasing levels of nitrogen was due to better crop growth rate, which produced maximum photosynthates. Interactive effects of planting densities with sunflower hybrids, and nitrogen were found to be statistically non-significant.

E. Achene yield (t ha^{-1})

Table showed that AY was affected significantly by all of the factors under study. The maximum AY of (3.00 t ha-1) was recorded from hybrid S-278 as compared to hybrid Hysun-33 which produced (2.75 t ha^{-1}). The effect of plant population on AY was also found to be significant. The highest seed yield was produced (3.11 t ha^{-1}) when plant population was 8.33 m^{-2} followed by 6.66 plants m^{-2} (2.94 t ha^{-1}). Significantly less yield of 2.58t ha^{-1} was obtained at planting density of 5.55 plants m^{-2}. The positive effect of higher planting density per unit area as obtained in the present study agreed well to the findings of Islam et al., [14], and Jahangir et al., [15] Nitrogen levels of 150 kg ha-1 produced significantly higher AY (3.16t ha-1) which was followed with those plots receiving 125 kg N ha^{-1} having 2.95 t ha^{-1} while Lowest achene's yield (2.51 t ha^{-1}) was recorded in case of those plots which were fertilized at the rate of 100 kg ha^{-1}. These results are in confirmatory with those of Abdel-Motagally and Osman [16] and Al- Thabet [17]. The

interactive effects for achene yield were non- significant among all the treatment.

F. Achene oil content (%)

It is clear from the data given in table that AOC was affected significantly by all of the factors under study. The sunflower hybrids showed significant response for AOC. The maximum AOC of (41.47%) was recorded from hybrid S-278 as compared to hybrid Hysun-33 which produced (38.10%). It might be due to genetic prospective of sunflower hybrids as described by Zheljazkov et al. [18] and Nasim et al. [19]. The effect of plant population on AOC was also found to be significant. The highest AOC was produced (40.90%) when plant population was 8.33 m-2 which was statistically at par with 6.66 plants m^{-2} (40.25%). The increase in AOC at higher planting densities was also recorded by Ishfaq et al. [1] who described that achene oil yield per plant was reduced increasing planting densities, while the percentage of oil in seed was not exaggerated by higher plant population. With the increase of nitrogen levels, reduction in AOC was noted. Nitrogen levels of 150 kg ha^{-1} produced significantly lesser AOC (38.83%) while highest AOC (40.73%) was recorded in case of those plots which were fertilized at the rate of 100 kg ha^{-1}. This indicates that with increasing nitrogen rates, achene yield was increased but reduced oil contents. Ishfaq et al. [1] also recorded such findings in response to nitrogen. The interactive effects for AOC were non- significant among all the treatment.

IV. Conclusion

Hybrid, S-278 of sunflower, sowing under plant population of 8.33 plants m^{-2} and nitrogen application at the rate of 150 kg ha^{-1} is the best treatment for obtaining maximum return under the agro-ecological conditions of Sargodha.

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TABLE I
EFFECT OF NITROGEN FOR DAYS TO ANTHESIS, DAYS TO PHYSIOLOGICAL MATURITY, TOTAL DRY MATTER, LEAF AREA INDEX ACHENE YIELD AND OIL CONTENTS OF SUNFLOWER HYBRIDS UNDER VARYING PLANTING DENSITIES.

Treatments	**Days to R-5.9 stage**	**Days to R-9 stage**	**LAI**	**TDM ($t\ ha^{-1}$)**	**AY ($t\ ha^{-1}$)**	**AOC (%)**
Hybrids						
H_1(Hysun-33)	65.48 a	107.22 a	4.08	9.09a	2.75 b	38.10 b
H_2 (S-278)	60.18 b	97.56 b	4.03	8.54 b	3.00 a	41.47 a
LSD value	0.31	1.72	0.1	0.416	0.21	2.5
Plant population						
PP_1(8.33plants m^{-2})	63.88 a	103.44 a	4.35 a	9.55 a	3.11 a	40.90 a
PP_2(6.66 plants m^{-2})	63.16 b	103.22 a	4.17b	8.74 b	2.94 b	40.25 a
PP_3(5.55 plants m^{-2})	61.44 c	100.50 b	3.66 c	8.24 c	2.58 c	38.20 b
LSD value	0.69	0.99	0.14	0.493	0.065	0.862
Nitrogen rates						
N_1(100 kg ha^{-1})	61.88 c	101.00 c	3.54c	7.63 c	2.51 c	40.73 a
N_2(125 kg ha^{-1})	62.83 b	102.50 b	4.16b	8.95 b	2.95 b	39.79 b
N_3(150 kg ha^{-1})	63.77 a	103.67 a	4.48a	9.94 a	3.16 a	38.83 c
LSD value	0.59	0.57	0.12	0.242	0.108	0.49
Interactions						
HxD	NS	NS	NS	NS	NS	NS
HxN	NS	NS	NS	NS	NS	NS
DxN	NS	NS	NS	NS	NS	NS

followed by similar letters in each column are not significantly differ at the 5 % level of probability.
NS = non significant. * Significant