PHENOLOGY AND YIELD OF SUNFLOWER (*HELIANTHUS ANNUUS* L) HYBRIDS AS AFFECTED BY VARYING PLANT SPACING AND NITROGEN LEVELS UNDER SEMI ARID CONDITIONS OF SARGODHA, PUNJAB.

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ABSTRACT: The field experiment was conducted to study the effect of different plant spacing and nitrogen rates on phenology, and yield of sunflower hybrids at research area of University College of Agriculture, Sargodha, during spring season, 2010.The treatments include two hybrids (Hysun-33 and S-278) at three plant spacing (20, 25and 30 cm) with three levels of nitrogen (100, 125 and 150 kg N ha^{-1}). The trial was conducted in split split plot design and the data collected were statistically analyzed by employing the Fisher's analysis of variance technique and treatments means were compared using least significant difference (LSD) test at 0.05 level of probability. The obtained results revealed that there was a significant difference for days taken to flowering (DF), achene's formation (DAF) & physiological maturity (DPM) and yield in both of the hybrids except, number of days to germination (DG.). 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 decreased the days taken to flowering (DF), achene's formation (DAF) and physiological maturity (DPM) while increases the achene, s yield (AY) in sunflower. By contrast, with increasing nitrogen application phonological duration and achene's yield was increased. There was an interaction between hybrids and planting densities (HxD), hybrids and nitrogen (HxN) for days taken to flowering, achene's formation, physiological maturity, achene's yield ha^{-1} while no interaction for number of days to germination. The highest achene's yield (3.75 t ha^{-}) was produced by sunflower hybrid S-278 sown with 20 cm plant spacing (H_2D_1). Similarly Hybrid S-278 gave highest achene yield (3.57 t ha^{-1}) with the application of 125 kg N ha^{-1} (H_2N_2). In the interaction of density and nitrogen, highest achene's yield (3.72 t ha^{-}) was in D_1N_3 treatment which was statistically similar with D_1N_2 treatment and was followed by D_2N_2 and D_2N_3 treatment.

Key words: nitrogen, phenology, physiological maturity, plant spacing, yield.

INTRODUCTION

During 2009-10, the area under sunflower crop in Pakistan was 872 thousand acres with seed and oil production of 554 and 211 thousand tons, respectively (GOP, 2010). Sunflower yield is largely affected by selection of cultivar. Awasthi *et al.,* (1991) demonstrated that all varieties or hybrids have their own distinctive characteristics and yield potential. Pardisi (1992) worked on several sunflower cultivars and concluded that different hybrids are suitable for particular regions depending upon climatic conditions and soil type. Thus optimum plant population in the field may help in harnessing all the renewable resources in a proper amount and more efficiently for more crop yields. Kazemeini *et al.,* (2009) carried out a trial on sunflower by sowing at two spacing of 50 &75 cm and recorded the highest achene's yield at 75 cm row spacing.Fertilizers application having primary major nutrient elements can increase sunflower growth and yield substantially (Kho, 2000, Prasad *et al.,* 2002, Sadras, 2006). Nitrogen is an essential mineral nutrient for plant growth and development. High doses of nitrogen application overall crop assimilation, thus contributing to increase in seed yield (Asghar *et al.,* 2010, Nasim *et al.,* 2011). Malik *et al.,* (2004), concluded that different combinations of NPK had had highly significantly affected achene's yield and oil contents. The objectives of this study therefore, were, to determine the effect of planting densities and different levels of nitrogen on growth and developmental stages of sunflower hybrids for obtaining higher yield.

MATERIALS AND METHODS

The Experiment was conducted at the Research Area of University College of Agriculture, Sargodha during the spring seasons of 2010. The experiments was laid out in split split plot design and replicated three times, keeping net plot size 3.6 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) H_1= Hysun – 33 and H_2 = S-278, Plant spacing (sub plots), D_1= 20 cm, D_2= 25 cm and D_3= 30 cm and nitrogen levels (sub sub plot), N_1= 100 (kg ha^{-1}), N_2= 125 (kg ha^{-1}) and N_3 = 150 (kg ha^{-1}).Crop was sown on 13th March, 2010, with the help of a dibbler 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. Nitrogen, phosphorus and potassium were given in the form of Urea, DAP and SOP (K_2SO_4). 1/3rd dose of nitrogen and all of P and K fertilizer was applied at the time of sowing and remaining 2/3 rd of N was applied 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 taken to germination, flowering, achene's formation, physiological maturity and achene's yield (t ha^{-1}). Data recorded on the number of days to germination from the date of sowing to more than 75% of seeds emerged in each treatment and days to flowering and achene's formation were counted from the date of sowing to 75 % of the flowering, and when in 75 % of head, achene's formation was done in each sub sub plot. Days to physiological maturity were recorded when back side of 75 % of head turned yellow and outer bracket turned brownish. All plants was threshed for the estimation of plot yield and converted into t ha^{-1}. 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*., 1997).

RESULTS AND DISCUSSION

Days taken to germination (DG). Both the hybrids have shown taken non significant difference for germination time. Similarly plant spacing and nitrogen application has no effect on DG. Interaction between sunflower hybrids and plant spacing, hybrids and nitrogen, and plant spacing and nitrogen was also found to be non significant. This might be due to factors like soil moisture, environment required for seed germination were similar through out the experimental area. These results are in contrary to present findings of Bakhat *et al.,* (2006) who reported significant differences among sunflower hybrids for days taken to germination.

Days taken to flowering(DF). The data regarding the DF as affected by different levels of nitrogen and planting densities are given in table-1which showed that DF (61.94) and 62.05 were statistically similar at nitrogen levels of 125 and 150 kg ha^{-1}, respectively but significantly more than 100 kg N ha^{-1}. Similarly sunflower hybrids and plant spacing had significant effect on DF. The sunflower hybrid Hysun-33 took maximum DF (63.74) as compared to Hybrid S-278(59.77 days). As regard plant spacing, significantly maximum DF (62.33) was observed in case of 30cm plant spacing which was statistically at par by 25 cm plant spacing (61.66 days) while minimum (61.27 days) was recorded from 20cm spaced planting.

Interactive effects of factors for days to flowering. Data regarding the interactive effects for DF are shown in table 2. In the interaction effect of hybrids and planting densities, Hysun-33 hybrid took maximum days (64.44)

and (63.77 days) for flowering at 30 cm and 20 cm plant spacing, respectively which are statistically at par with each other. Whereas, hybrid S-278 showed significant difference for days to flowering (60.22) and (59.22) when sown at plant spacing of 30 and 20 cm, respectively. In the interaction effect of hybrids and nitrogen, Hysun-33 showed non significant difference at different nitrogen rates, while S-278 hybrid flowered earlier at low nitrogen levels. Increase in number of DF could be due to increased vegetative growth. Similar approaches were reported by kho (2000), Prasad *et al*., (2002), De Varennes *et al.,* (2002), Mojiri and Arzani (2003), and Sadras, (2006), that cultivars differed significantly in phenology and this difference might be due to varietal behavior of sunflower.

Days to achene's formation (DAF). Data in table-1 showed that nitrogen have significant effect on DAF, the maximum days (72.66) was recorded in case of those plots which were fertilized at the rate of 150 kg ha^{-1}, which was followed by plots fertilized at the rate of 125 kg ha^{-1}, while the minimum days (71.16) was recorded in case of plots which were fertilized with lowest rates of nitrogen (100 kg ha^{-1}). Sunflower hybrids showed significant difference among period of achene's formation. The sunflower hybrid Hysun-33 took more days (73.77) for achene formation as compared to S-278 (70.14). Effect of plant spacing was significant and 30cm plant spacing resulted in significantly maximum days (73.27) followed by 25 cm plant spacing (71.94 days), while 20 cm plant spacing resulted in significantly less days to achene's formation (70.66). There was a linear increase in duration to achene's formation with increase in plant spacing.

Interactive effects of factors for days to achene's formation. Data regarding the interactive effects for DAF are shown in table 2. In the interaction effect of hybrids and plant spacing, Hysun – 33 took maxim DAF (75.11) at 30 cm plant spacing, while minimum DAF was noticed in Hybrid S-278 at 20 cm plant spacing. In the interactive effect of hybrids and nitrogen, Hysun-33 took maximum days (75.11) to achene's formation where nitrogen was given at the rate of 150 kg ha^{-1} and minimum DF was observed in S-278 in plots where nitrogen was applied at the rate of 100 kg ha^{-1}, while the interaction between planting density and nitrogen for DAF was found non to be significant. These results are supported with the findings of Mujiri and Arzani (2003), and Sadras, (2006).

Days to physiological maturity (DPM). Statistical analysis of data on number of DPM is represented in table-1.Nitrogen application had significant effect on DPM. Highest number of DPM (95.05) was recorded from plot which was fertilized with nitrogen rates of 150 kg ha^{-1}, which was statistically similar (94.77) from plot in which nitrogen level was 125 kg ha^{-1}, while the minimum DPM (94.16) was noted from plot treated with 100 N kg ha^{-1}. Sunflower hybrids had significantly influenced DPM. Sunflower hybrid Hysun-33 matured in more number of days (97.48) than S-278 (91.85). Sunflower took maximum days to physiological maturity (95.83) at Plant spacing of 30 cm. while plant spacing of 25cm and 20 cm were not significant for DPM.

Interactive effects of factors for days to physiological maturity. Data regarding the interactive effects for DPM are shown in table 2. In the interaction effect of hybrids and plant spacing, Hysun-33 matured in more time (99.11 days) at plant spacing of 30 cm which was significant from all the other treatments. In the interactive effect of hybrids and nitrogen, Hysun-33 took maximum DPM (97.88) nitrogen at the rate of 150 kg ha^{-1} was statistically similar to same hybrid at nitrogen rate of 125 kg ha^{-1}. In the interaction effect of planting density and nitrogen in treatment D_3N_3 (plant spacing 30cm and N at the rate150 kg ha^{-1}) of crop matured in more time (96.50 days). These results agreed with those reported by Bakhat (2006), who found that DPM were different in various hybrids. The difference in sunflower ripening of different cultivars was reported by Goyne and Schneiter (1988) and Font *et al.,* (2008).

Achene's yield (t ha^{-1}). It is clear from the data given in table -1 that achene's yield kg ha^{-1} was affected significantly by all of the factors under study. Nitrogen levels of 125 kg ha^{-1} produced significantly higher achene's yield (3.27t ha^{-1}) which was statistically similar with those plots receiving 150 kg N ha^{-1} having 3.27t ha^{-1} while Lowest achene's yield (2.61 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 Abu-Ghazala *et al.,*(2001), Thavaprakash *et al.,* (2003), Abdel-Motagally and Osman (2006) and Al- Thabet (2006).It is clear from the table that the effect of sunflower hybrids on achene's yield was found significantly. The maximum grain yield of (3.34 t ha^{-1}) was recorded from hybrid S-278 as compared to hybrid Hysun-33 which produced (2.73 t ha^{-1}) achene's yield. The effect of plant spacing on achene's yield was also found to be significant. The highest seed yield was produced (3.42 t ha^{-1}) when sunflower plants were planted at 20 cm followed by 25cm plant spacing (3.05 t ha^{-1}). Significantly less yield of 2.63t ha^{-1} was obtained at plant spacing of 30 cm. The positive effect of closer plant spacing as obtained in the present study agreed well to the findings of Islam *et al*., (2000), and Jahangir *et al*., (2006).

Table-1. Days taken to germination, flowering, achene's formation & physiological maturity and Achene, s yield as affected by sunflower hybrids, planting densities and nitrogen rates.

Treatments	Day to germination	Days to flowering	Days to achene's formation	Days to physiological maturity	Achene's yield (t ha^{-1})
A= Hybrids					
Hysun-32	9.51 a	63.74 a	73.77 a	97.48 a	2.73 b
S-278	9.40 a	59.77 b	70.14 b	91.85 b	3.34 a
LSD value	0.276	0.159	2.347	1.795	0.23
S. Error	0.064	0.037	0.545	0.417	0.053
B=Plant spacing					
D_1(20cm)	9.66 a	61.27 b	70.66 c	94.11 b	3.42 a
D_2(25cm)	9.44 a	61.66 b	71.94 b	94.05 b	3.05b
D_3(30cm)	9.27 a	62.33 a	73.27 a	95.83 a	2.63 c
LSD value	0.411	0.964	0.817	0.853	0.184
S. Error	0.178	0.418	0.354	0.369	0.079
C= Nitrogen					
N_1 (100kg ha^{-1})	9.55 a	61.27 b	71.16 c	94.16 b	2.61 b
N_2 (125kg ha^{-1})	9.50 a	61.94 a	72.05 b	94.77 a	3.27 a
N_3 (150kg ha^{-1})	9.33 a	62.05 a	72.66 a	95.05 a	3.23 a
LSD value	0.31	0.49	0.28	0.317	0.089
S. Error	0.15	0.237	0.136	0.153	0.043

Means followed by similar letters in each column are not significantly differ at the 5 % level of probability.

Table-2. Interactive effects of hybrids, nitrogen and plant spacing on phenology and yield of sunflower.

Treatments	Day to germination	Days to flowering	Days to achene's formation	Days to physiological maturity	Achene's yield (t ha^{-1})
Interaction (H x D)					
H_1D_1	NS	63.00 b	72.67 bc	96.67 b	3.10 c
H_1D_2	NS	63.77 ab	73.56 b	96.67 b	2.65 de
H_1D_3	NS	64.44 a	75.11 a	99.11 a	2.46 e
H_2D_1	NS	59.56 c	68.67 d	91.56 c	3.75 a
H_2D_2	NS	59.56 c	70.33 c	91.44 c	3.46 b
H_2D_3	NS	60.22 c	71.44 bc	92.56 c	2.82 cd
S. Error	0.216	0.484	0.681	0.597	0.106
Interaction (H x N)					
H_1N_1	NS	63.33 a	73.00 c	96.89 b	2.31 c
H_1N_2	NS	64.00 a	73.78 b	97.67 a	2.97 b
H_1N_3	NS	63.89 a	74.56 a	97.89 a	2.92 b
H_2N_1	NS	59.22 c	69.33 e	91.44 d	2.91 b
H_2N_2	NS	59.89 bc	70.33 d	91.89 cd	3.57 a
H_2N_3	NS	60.22 b	70.78 c	92.22 c	3.54 a
S. Error	0.185	0.277	0.567	0.453	0.073
Interaction (D x N)					
D_1N_1	NS	NS	NS	93.83 c	2.86 c
D_1N_2	NS	NS	NS	94.17 bc	3.68 a
D_1N_3	NS	NS	NS	94.33 bc	3.72 a

D_2N_1	NS	NS	NS	93.83 c	2.59 de
D_2N_2	NS	NS	NS	94.00 bc	3.28 b
D_2N_3	NS	NS	NS	94.33 bc	3.29 b
D_3N_1	NS	NS	NS	94.83 b	2.38 e
D_3N_2	NS	NS	NS	96.17 a	2.86 c
D_3N_3	NS	NS	NS	96.50 a	2.68 cd
S. Error	0.277	0.536	0.403	0.429	0.1

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

Interactive effects of factors for achene's yield. Data regarding the interactive effects for AY is shown in table 2.The highest AY (3.75 t ha^{-}) was produced with sowing sunflower hybrid S-278 on 20 cm plant spacing (H_2D_1), which was followed by the same hybrid sowing on 25 cm plant spacing (H_1D_1), while the lowest AY (2.46 t ha^{-1}) was obtained for H_1D_3. However, interactive effect of hybrid and nitrogen gave highest yield (3.59 t ha^{-}) in H_2N_2 which was statistically similar with H_2N_2 treatment. While highest AY (3.72 t ha^{-}) was in D_1N_3 treatment which was statistically similar with D_1N_2 treatment and was followed by D_2N_2 and D_2N_3 treatments. Similar results were also reported by Hedge and Havanagi (1987) and Sharma *et al.,* (1992) who obtained higher seed yield with closer plant spacing with increasing rate of nitrogen-phosphorus application in sunflower crop.

Conclusion: Hybrid, S-278 of sunflower, sowing on plant spacing of 20 cm and nitrogen application at the rate of 125 kg ha^{-1} is the best treatment for obtaining maximum return under the agro-ecological conditions of Sargodha.

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