Sunflower (Helianthus annuus L.) hybrids performance at different plant spacing under agro-ecological conditions of Sargodha, Pakistan.

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Abstract. To study the performance of two sunflower hybrids at different planting densities, a field experiment was carried out at research area of University College of Agriculture, Sargodha during the year, 2010. The treatments comprised of sunflower hybrids (Hysun-38 and FH-331) and four plant spacing (17.5, 20, 22.5 and 25cm) between hills. Plant spacing significantly affected all estimated character, except number of leaves per plant. Plant spacing of 22.5cm was observed as a suitable planting density for obtaining the maximum achene's yield (1920 kg ha-1), where as lower plant spacing (17.5cm and 20cm) resulted less yield. Statistical analysis of data showed significant differences in plant height, number of leaves per plant, head diameter, number of achene's per head, 1000- achene's weight and achene's yield per hectare except plant population per unit area. Considering the superiority of 22.5cm plant spacing for the hybrid Hysun-38 showed the high productivity. Hybrid FH-331 is a poor hybrid as compared to hysun-38.

Keywords: growth, hybrids, plant spacing, Sunflower, yield.

1. Introduction

Sunflower (*Helianthus annuus* L.) probably originated in the southwestern United States, or some-where in Mexico. In world trade with an annual production around 9 millions tones, sunflower oil is the fourth important vegetable oil. Russian Federation, Ukraine, India and Argentina contribute more than 50% with respect to world acreage of sunflower crop. Volkmann and Rajcan,[1]. In Pakistan, sunflower was first introduced as an oil seed crop in 1960's. During the year, 2009-10, the production at country level is estimated at 0.680 million tons while 1.246 million tons of edible oil was imported by spending 77.78 billion rupees. The area under sunflower crop in 2009-10 was 872 thousand acres with seed and oil production of 554 and 211 thousand tons, respectively GoP [2]. For minimizing this existing gap between production and import of edible oil, we should grow sunflower crop preferably (Khan et al) [3]. The production of Sunflower is greatly influenced by proper selection of hybrid. When choosing a hybrid, we should focus on yield potentials and other parameters contributing to achieve higher production such as stalk strength, disease resistance, oil content, and maturity. With the increase of plant population per unit area of sunflower crop, decreased head diameter, number and weight achene's per head and a higher plant density above a certain limit had a negative effect on achene's yield (Majiri and Arzani) [4].Plant density is invariably linked with yield, more the plant stands; there is up to certain limit the higher the expected production (Bertoria *et al.,*) [5].Increasing sunflower population, generally, increases the achene's yield to certain level. Optimum population depends on cultural, environmental and field management factors (Robinson *et al.,* [6]; Weiss, [7].

The objectives of this study therefore, were, to determine the effect of varying plant population per unit area on growth and yield components of two sunflower hybrids under agro-ecological conditions of Sargodha.

2. MATERIALS AND METHODS

The experiment was conducted at the research farm of University College of Agriculture, Sargodha, during spring season 2010. Randomized complete block design with three replication having net plot size of 2.80 x 6m was used for this trial. The two hybrids were allotted to main plots and four different plant populations were allotted to sub plots. In each subplot, there were four rows with ridge to ridge distance of 70cm Different plant populations were maintained by varying plan to plant distance in each sub plot. All cultural practices like irrigations, weeds, insects control and other operations except under study were kept normal and uniform for all the treatments.

The following treatments were studied:

A. Sunflower Hybrids (Main Plots)

H_1 = Hysun – 38

H_2 = FH - 331

B. Plant spacing (Sub plots)

S_1 = 17.5 cm

S_2 = 20 cm

S_3 = 22.5 cm

S_4 = 25 cm

Before sowing of the crop the field was well prepared by ploughing twice with tractor followed by planking to make a fine seed bed and then ridges were made at 70cm apart. Basal dose of NPK was applied at the rate of 140-70-35 kg ha^{-1} respectively. Full dose of P, K and half dose of nitrogen was applied at the time of seed bed preparation while the reaming half of nitrogen was applied at head formation stage. Thinning was done after two weeks of crop emergence to maintain required plant population.

The observations recorded were;

1- Number of plants(m^{-2})

2- Plant height at maturity (cm)

3- Number of leaves plant^{-1}

4- Head diameter (cm)

5- Number of achene's per head

6- 1000 – achene's weight (g)

7- achene's yield (kg ha^{-1})

The above maintained parameters were recorded in the following way:

In each sub plot, the number of plants was determined and converted into plants per hectare. Ten plants were randomly selected from two rows in each treatment and their height was measured from ground level to the top edge of the collar disc and then their average was wok out. Number of leaves per plant was recorded from ten plants taken randomly selected from two rows in each sub plot and then their average was calculated. Head diameter from one edge of the head to the other was measured and their average worked out. Five representative discs were chosen in each sub plot and then total grains per disc were counted. Thousand achene's weight from each sub plot was counted and their weight was recorded. From each treatment two rows were harvested, heads were separated from stalk, threshed manually and weighted to record Achene's yield per plot and then converted into kg per hectare. The analysis of data collected was done statistically by the analysis of variance technique and using LSD test at 5 % level of probability treatment means were compared (Steel *et al.*, [8].

3. RESULTS AND DISCUSSION

3.1. Plant population (m^{-2})

It is evident from table (1) that sunflower hybrids have not significant effect on plant population per hectare. It means that both the hybrids have same germination percentage and showed similar seedlings per unit area. By contract plant spacing has significant effect on plant population per hectare. The maximum plant population of 80235 plants per hectare recorded from the plant spacing of 17.5cm followed by 20cm plant spacing (70,100) while significantly minimum population of 55230 plants per hectare were recorded when sunflower was planted at spacing of 25cm. It means plant population increased with decreased plant spacing (Azam *et al.,* [9]. However interaction between sunflower hybrids and plant spacing affecting plant population was found to be non significant. These results are in contrary to those reported by Bakht *et al,* [10], working on performance of various sunflower hybrids concluded that number of plants per hectare were significantly affected by sunflower hybrids.

3.2. Plant height at maturity (cm)

The growth behavior of a crop plant is measured in term of plant height the related to plant height (table1) shows that both sunflower hybrids and plant spacing had significant effect on plant height. The sunflower hybrid Hysun-38 obtained maximum plant height (212.62cm) as compared to Hybrid 331(177.18cm).As regard plant spacing, significantly maximum plant height (202.87cm) was observed in case of 25cm space planting as compared to minimum (186.50cm) plant height recorded from 17.5cm spaced planting. It is clear from the table number 1 that there is progressive increase in plant height with the increase of plant spacing form 17.50 to 25cm.The increase in plant height in case of 25cm spaced planting mainly due to more supply of nutrient, light, moisture and air as compared to narrow spacing. Similarly the interactive effect of sunflower hybrids and plant spacing was also significant. Sunflower hybrid, Hysun-38 produced maximum plant height (220.25cm). when shown 25cm spaced planting followed by sunflower hybrid Hysun-38sown in 22.5 cm spaced planting but the difference between them was found to be non- significant while sunflower hybrid 331 sown at 17.5 cm spaced planting produced significantly minimum (170.50cm) plant height which is statistically at par with hybrid FH-331 sown in 20 cm spaced planting. These results are in line with xiao *et al.,* [11] who reported that plant height decreased with increasing plant population in the field. These results are also in accordance with Abdel- motagally and osman [12], they reported that sunflower cultivars significantly differed in plant height and these differences may be due to varietal behavior.

3.3. Number of leaves plant^{-1}

It is evident from the date (table 1) that sunflower hybrid have significant effect on number of leaves of per plant. The sunflower hybrid hysun-38 produced significantly more number of leaves (20.03) per plant as compared to hybrid FH-331 (18.07). The effect of plant spacing on the number of leaves per plant was non significant although 22.50 spacing of plants produced apparently more number of leaves per plant (19.47) than other treatments. The interaction between sunflower hybrids and plant spacing was statistically analyzed and was also found to be non significant, on an average number of leaves per plant ranged between 17.75 to 20.60. Abdel *et al.,* [12] concluded that number of leaves per plant showed significant difference among the hybrids. These results are also supported by bakht *et al.,* [10], who observed significant differences for number of leaves among different hybrids.

3.4. Head diameter (cm)

Table-2 presented the sunflower hybrids have significant effect on head diameter. The sunflower hybrid Hysun 38 produced significantly higher head diameter (21.05cm) as compared to FH-331 (15.65cm). Effect of plant spacing was highly significant and 30cm plant spacing resulted in significantly larger head diameter (19.87cm) followed by 22.5 cm plant spacing (19.55cm) but the difference between them was statistically at par while 17.25cm resulted in significantly smaller head diameter (16.12cm). There was a linear increase in head diameter with increase in plant spacing. These results are supported with the findings of Al-Thabet [13] who concluded that head diameter was significantly increased as the space between plants increased, similar results were also reported by Allam, and Galal, [14] and Salehi and Bahrani [15].

3.5. Number of achene's head^{-1}

Statistical analysis of data showed that sunflower hybrids had significantly influenced number of achene's per head (table 2). Sunflower hybrid Hysun -38 produced significantly higher number of grains per head (1363.95) than FH-331 (1269.45), similarly effect of plant spacing on number of achene's per cob was also significant. Significantly there is progressive increase in number of grains per head with increase in plant spacing from 17.50 to 25cm. Plant spacing of 25cm produced significantly higher number 1430.52 as compared to minimum 1179.33 of achene's per head recorded from 17.25cm spaced planting. Interactive effects of sunflower hybrids and plant spacing was also found to be significant. The Hysun-38 hybrid sown at plant spacing 25cm produced maximum number of achene's per head (1509.75) while FH-331 hybrid at plant spacing of 17.50cm produced minimum number of achene's per head (1148.32). The decreased number of achene's per head with increasing plant population might be due to more competition among plants in case of nutrients light, moisture due to less pacing. These results are supported by Mojiri and Arzani [4] they concluded that number of achene's per head was increased with decreasing plant density.

3.6. 1000- achene's weight (gm)

Data reported in table-2 demonstrated the comparative effect sunflower hybrids and plant spacing on thousand achene's weight.1000-achene's weight of hybrid Hysun-38 (56.80g) produced significantly more than FH-331 (40.35g). Effect of plant spacing was highly significant and 25cm plant spacing resulted in significantly more 1000 achene's weight (51.12g) followed by 22.5cm plant spacing (50.29g) but the difference between them was statistically at par while 17.50cm plant spacing resulted in significantly less 1000- achene's weight. There was a linear increase in 1000 – achene's weight with increase in plant spacing. It was due to less plant population that produced significantly bold grains due to less competition and more availability of light, nutrients and feeding area per plant as compared to higher plant population. The findings are in conformity with the recommendation of Malik *et al*., [16] and Al- Thabet [13], they demonstrated that 1000 achene weight decreased with increasing plant density.

3.7. Achene's yield (kg ha^{-1})

The final grain yield is a function of combined effect of all the individual yield components. It is clear from the table (3) that the effect of sunflower hybrids on achene's yield was found significant. The maximum grain yield of 1955.00 kg ha^{-1} was recorded from hybrid Hysun -38 as compared to hybrid FH-331 which produced 1658.04 kg 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 (1920kg ha^{-1}) when sunflower plants were planted at 22.5 cm followed by 25cm plant spacing (1903.56 kg ha^{-1}) but the difference between them was statistically at par while 20cm plant spacing resulted in significantly less grain yield (1682.52 kg ha^{-1}).The interactive effect of sunflower hybrids and plant spacing were also significant. Significantly higher grain yield of 2110 and 2095 kg ha-1 was obtained from hybrid Hysun -38 at plant spacing of 22.5 cm and 25cm respectively. It was followed by 1850 kg ha-1 yield of same hybrid at plant spacing of 17.5cm. Significantly less yield of 1590 kg ha-1 was obtained from hybrid FH -331 at plant spacing of 17.5cm. The increase in achene's yield per plant with increasing plant spacing might attributed to increase in head diameter and 1000 achene's weight.These results are according to Majiri and Arzani [4], Al-Thabet [13] and Kazemeini *et al.,* [17].

4. CONCLUSION

Plant spacing of 22.5cm for the hybrid Hysun-38 showed the high productivity. Hybrid FH-331 is a poor hybrid as compared to Hysun-38.

Table 1. Plant population ha-1, Plant height (cm) and No. of leaves plant-1 of sunflower hybrids at different plant spacing.

Plant Spacing cm	Plant population ha^{-1} Hysun-38 FH-331 mean	Plant height cm Hysun-38 FH-331 mean	No of leaves plant^{-1} Hysun-38 FH-331 mean
S1 =17.5cm	80,235 79,125 79,680a	205.50cd 170.50e 186.50d	20.45 17.75 19.10

S2 =20 cm	70,100	68,600	69,300b	209.75b	172.25e	191.00c	19.25	17.95
							18.60	
S3 = 22.5cm	61,765	60,995	61,380c	218.00a	180.50c	199.25b	20.60	18.50
							19.47	
S4 =25cm	55,230	54,880	55055d	220.25a	185.50b	202.875a	19.85	18.10
							18.97	
Mean	66832	65875		212.62a	177.18b		20.03a	18.07b

Any two means not sharing a letter differ significant at 5% level of probability (LSD)

Table: 2. Head diameter, No. of achene's per head and 1000-achene, s weight as affected by sunflower hybrids and plant spacing.

Plant Spacing (cm)	Head diameter (cm) Hysun-38 FH-331 Mean	No. of achene's head Hysun-38 FH-331 Mean	1000-achene,s weight (g) Hysun-38 FH-331 Mean
S1 =17.5cm	18.00c 14.25f 16.12c	1210.34f 1148.32g 1179.33d	52.36 38.45 45.40c
S2 =20 cm	20.45b 15.27e 17.86b	1315.39d 1272.45e 1293.92c	55.79 39.24 47.51b
S3 = 22.5cm	22.75a 16.35d 19.55a	1420.32b 1305.75d 1363.03b	58.93 41.65 50.29a
S4 =25cm	23.00a 16.75d 19.87a	1509.75a 1351.30c 1430.52a	60.15 42.09 51.12a
Mean	21.05a 15.65b	1363.95a 1269.45b	56.80a 40.32b

Any two means not sharing a letter differ significant at 5% level of probability (LSD)

Table 3. Achene's yield (kg ha-1) as affected by sunflower hybrids and plant spacing.

Plant Spacing cm	Achene's yield kg ha^{-1} Hysun -38 FH-331 Mean
S1 = 17.5cm	1850b 1590d 1720.00 b
S2 = 20cm	1765ab 1600d 1682.52 b
S3 = 22.5 cm	2110a 1730c 1920.00a
S4 = 25cm	2095a 1712c 1903.56a
Mean	1955.00a 1658.04b

Any two means not sharing a letter differ significant at 5% level of probability (LSD)

5. Reference

[1] Vollmann, J and I Rajcan, 2009. Handbook of plant Breeding. Springer Dordrecht Heidelberg Condon new York.

[2] GoP.2010. Agricultural statistics of Pakistan 2009-10, Govt. of Pakistan, Ministry of food, Agriculture and livestock, economic wing. Islamabad, Pakistan.

[3] Khan, M. S., M.S.Swati, I.H. Khalil and A.iqbal 2003. Heterotic studies for various characters in sunflower. Asian J. plant Sci., 2: 10 10-1014.

[4] Mojiri, A and A. Arzani, A.. 2003 Effects of nitrogen rate and plant density on yield and yield components of sunflower J. Sci and technology of Agric. And natural resources, 7 no. 2, 115-125.Abdel, A.A, S.A Saleh, M.A Ashoub and M.M. El-Gazzer 1984. Correlation study between leaf surface, head characteristics and yield of certain sunflower cultivars in Egypt. Seed abstracts 1989 Ab.no 02370.

[5] Bertoria L, R. Burak and A. Nivio.1998. Effect of plant densities on yield and quality of for age maize. Maize growers co-operative news letter santa catarina, Brazil.

[6] Robinson, R.G.,J.H. Ford, W.E. Lues Chem D.L Rabas l.j. Smith, DD Warnes and j.V. Wier Sma . 1980 Response of sunflower to plant population. Agron. J.72.869-871

[7] Weiss, E.A 2000 oil seed crops Blackwell Sci Led. London. 364P.

[8] Steel, R.G.D., J.H. Torrie and D. A Deckey. 1997. Principles and procedures of statistics: A biometerical approach. 3rd ed. Megraw Hill book Co. Inc. New York: 400-428.

[9] Azam M.Ali, M. Amin, S. Bibi and M. Arif 2007. Effect of plant population on maize hybrids. Journal of Agricultural and Biological Sciences vol.2 No.1.

[10] Bakhat J., S. Ahmad, M. Tariq, H. Akbar and M. Shafi. 2006. Performance of various hybrids of sunflower in Peshawar valley. J.Agri.Sci., 3: 25-29.

[11] Xiao, S., S. Chen, L. Zhao and G.Wang. 2006. Density effects on plant height, growth and inequality in sunflower population. J.Integrative pl. boil., 48:513-519.

[12] Abdel-Motogally, F..M..F., and E.A Osman..2010. Effect of nitrogen and potassium fertilization combinations on productivity of two sunflower cultivars under east of Elewinate condition.American Eurasian J.Agrica and environmental. Sci, 8(4): 397-

[13] Al-Thabet, S.S.2006. Effect of plant spacing and nitrogen levels on growth and yield of sunflower *(Helianthus Annus* L.) J. Agric. Sci., 19: 1-11.

[14] Allam, A.Y and A.H Galal. 1996 Effect of nitrogen fertilization and plant density on yield and quality of sunflower Assiut J.Agric Sci, 27, no 2, 169 -177.

[15] Salehi, F and M.J Bahrani, 2000. Sunflowr summer planting yield as affected by plant population and nitrogen application rates. Iran Agric. Res., 19, no.1 63-72.

[16] Malik A.M, S..H. Shah, S.Mahmood and M.A Cheema 2001 Effect of various planting geometries on the growth, seed yield and oil contet of new sunflower hybrid (SF-187)Int. j of Agri and Bio 03-1,55-56.

[17] Kazemeini, A. S., M. Edalat and A. Shekoofa. 2009. Interaction effects of deficit irrigation and row spacing on sunflower growth, seed yield and oil yield. African Agri. Res., 4: 1165-1170.