EFFECT OF VARYING PLANTING PATTERN ON GROWTH, ACHENE YIELD AND OIL CONTENTS OF SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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A field experiment was conducted to evaluate the effect of varying planting pattern on growth, seed yield and oil contents of sunflower (*Helianthus annuus* L.) at the Agronomic Research Area, University of Agriculture, Faisalabad during spring 2003. The planting patterns were 45 x 10 cm, 45 x 20 cm, 45 x 30 cm, 60 x 10 cm, 60 x 20 cm, 60 x 30 cm, 75 x 10 cm, 75 x 10 cm and 75 x 10 cm. The yield attributes, achene yield and oil contents were maximum with 60 x 20 cm. The minimum achene yield and oil contents were recorded with planting pattern of 45 x 10cm.
Key Word: Sunflower, planting pattern, Achene yield

INTRODUCTION

Pakistan is chronically deficient in the production of edible oil and the situation is getting worse day by day with alarmingly increasing rate of population. About 1.44 m tons (69.6% of the country's requirements) of edible oil was imported, costing huge amount of foreign exchange in 2004-05 (Anonymous 2005a).
It is needed to improve the domestic oil production either by making substantial changes in the traditional methods of cultivation or by introducing new oilseed crops either conventional or non-conventional, which have higher yield potential and good adaptability to our growing environments. Among oilseed crops sunflower appears to be the most promising oilseed crop that not only fits in our present cropping system but also yields oil of premium quality. Sunflower (*Helianthus annuus* L.) ranks second to soybean in worldwide vegetable oil production which can be grown easily twice a year in spring and autumn both under irrigated as well as rainfed conditions. Its oil is quite palatable and contains vitamins A, D, E and K. Its seed contains 40-50 percent oil that is free from toxic elements. Its oil contains 4-9% palmitic acid, 1-7% stearic acid, 14-40% oleic acid and 48-74% linoleic acid (Anonymous, 2005b). In Pakistan it is grown on an area of 371 thousand hectares with an annual seed production of 260 thousand tons, giving an average seed yield of 700 kg ha^{-1}. Annual production of oil in the country is 99 thousand tons thus giving 266.84 kg oil per hectare (Anonymous, 2003).
Among the various factors responsible for lower yield of sunflower in our country non-uniform plant distribution exhibits a remarkable effect on the productivity of the crop. Uniform adjustment of the crop spacing in the field is one of the most important factors determining yield and quality of sunflower (Barros *et al*. 2004). Legha and Giri (1999) revealed that crop sown in the wider spacing (75 x 30 cm) produced better yield attributes. However, higher seed and oil yields were recorded at 50 x 30 cm crop geometry. However Nel *et al* (2000) reported a decrease in seed weight and seed yield with increase in plant densities. An increase in yield with reduced row spacing has also been reported by Zarea *et al*. (2005). While Pal *et al*. (1997) reported that maximum yield was obtained with intra-plant spacing of 20 cm and yield decreased significantly with in crease or decrease in intra-plant spacing.
Keeping in view the importance of plant distribution the present study was conducted with the object to investigate the effect of plant spacing on seed yield and oil contents of sunflower, under the agro-ecological conditions of Faisalabad.

MATERIALS AND METHODS

A field experiment to evaluate the effect of varying plant pattern on growth, seed yield and oil contents of sunflower (*Helianthus annuus* L.) was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad during spring 2003. The experiment was laid out in Randomized Complete Block Design with three replications. Treatments and net plot size for the relevant treatments were as under:

Planting pattern	Net Plot Size
45 x 10 cm	2.7 x 7.0 m (6 Rows)
45 x 20 cm	2.7 x 7.0 m (6 Rows)
45 x 30 cm	2.7 x 7.0 m (6 Rows)
60 x 10 cm	3.6 x 7.0 m (6 Rows)
60 x 20 cm	3.6 x 7.0 m (6 Rows)
60 x 30 cm	3.6 x 7.0 m (6 Rows)
75 x 10 cm	4.5 x 7.0 m (6 Rows)
75 x 20 cm	4.5 x 7.0 m (6 Rows)
75 x 30 cm	4.5 x 7.0 m (6 Rows)

Sunflower hybrid (Hysun-33) was sown on 10.02.2003 on a well prepared seed bed with single row hand drill using seed rate of 8 kg ha^{-1}. The fertilizers were applied at the rate of 100 and 75 kg N P ha^{-1}as urea and triple super phosphate, respectively. Half of the nitrogen and full phosphorus was applied at sowing while remaining half nitrogen was applied with first irrigation. Plant to plant distance was maintained by thinning at 2-4 leaf stage. All other agronomic practices were kept normal and uniform for all the treatments. The crop was harvested manually on 27.05.2003. Ten plants were selected at random for recording plant height, head diameter and number of achenes per head. Biological and achene yield was recorded on per plot basis and was converted to per hectare. The oil contents were determined by following the procedure recommended by AOAC (1984). The data collected were tabulated and analyzed statistically using Fisher's analysis of variance technique and Least Significance Difference (LSD) Test at 5 percent probability level was used to compare the treatments' means (Steel *et al*. 1997).

RESULTS AND DISCUSSION

An attempt was made to determine the effect of varying planting pattern on the growth, achene yield and oil contents of sunflower. The results obtained are presented and discussed as under

The data regarding number of plants per plot presented in Table 1 show that planting pattern had significant effect on plant population per plot. Maximum number of plants per plot was obtained in treatment where plants were arranged in 45 x 10 cm spacing. It was also statistically at par with that of

Table 1. Effect of different plating patterns on the growth, yield and oil contents of sunflower

Treatments	Number of Plant per plot	Plant height (cm)	Head diameter (cm)	No. of achenes per head	1000-achene weight (g)	Achene yield (t ha^{-1})	Oil Content (%)
45 x10 cm	409.67 a	190.33 a	13.09 g	1191.33 e	41.02c	2.46 i	37.39 h
45 x 20 cm	202.33 b	182.53 b	15.20 d	1246.66 b	47.32 b	3.67 b	41.65 b
45 x 30 cm	136.00 c	174.00 c	18.34 a	1213.00 cd	45.12 c	3.37 c	41.15 c
60 x10 cm	407.33a	186.46 ab	14.34 e	1196.66 e	42.00 g	2.72 h	38.12 g
60 x 20 cm	203.67 b	181.43 b	16.46 c	1298.00 a	51.52 a	3.76 a	42.25 a
60 x 30 cm	134.00 c	167.76 d	18.48 a	1209.33d	43.66 f	3.24 d	40.39 d
75 x10 cm	409.00a	186.03 ab	15.18 d	1208.00 d	41.32 h	3.15 e	38.72f
75 x 20 cm	203.33 b	188.66 a	17.25 b	1217.66 c	44.00 e	3.08 f	39.69 e
75 x 30 cm	132.00 c	167.80 d	18.22 a	1212.33 cd	44.25 d	2.97 g	38.37 g
LSD at 5%	10.55	5.31	0.78	8.06	0.18	0.08	0.44

planting pattern of 60 x 10 cm and 75 x 10 cm. Minimum plant population per plot was obtained in planting pattern where plants were arranged with 75 x 30 cm plant spacing which was statistically at par

with plant spacing of 60 x 30 cm and 45 x 30 cm. This variation in plant population was due to different planting patterns.

Plant height increased significantly due to planting pattern. Maximum plant height (190.33 cm) was obtained with planting pattern of 45 x 10 cm which was statistically at par with 75 x 20 cm, 60 x10 cm and 75 x10 cm. Significantly minimum plant height (167.80 cm) was obtained in case of planting pattern of 60 x 30 cm. Greater plants height in narrow spaced plots might be due to increased competition among the crop plants for light. These results confirm the findings of Esechie *et al*. (1996) who also reported that plant height increases with increase in plant population.

Head diameter was affected significantly by different plant patterns. Maximum head diameter (18.48 cm) was obtained in case of 60 x 30 cm which was statistically at par with that of 45 x 30 cm (18.34 cm) and 75 x30 cm (18.22 cm). These were followed by a head diameter of 17.25 cm in case of planting density of 75 x 20 cm. The significantly minimum head diameter (13.09 cm) was obtained where plants were spaced at 45 x10 cm. Head diameter increased by increasing the plant to plant and row to row distance in sunflower. The reduced head size in case of closer plant spacing was probably due to more inter-plant competition for nutrients, moisture, light and air thus producing heads having smaller diameter. The results obtained confirm the findings of Legha and Giri (1999) and Esechie *et al*. (1996).

Planting patterns significantly affected the number of achenes per head and significantly maximum number of achene (1298.00) was obtained in case of 60 x 20 cm planting pattern. It was followed by 1246.66 achenes per head with planting pattern of 45 x 20 cm. Achenes per head in case of 75 x 20 cm (1217.66) were statistically lower than the above mentioned patterns but it was statistically at par with planting pattern of 45 x 30 cm (1213.00) and 75 x 30 cm (1212.33). Minimum number of achenes per head was observed in case of planting pattern of 45 x 10 cm where 1191.33 achenes were produced per head and these were statistically similar with that of 60 x 10 cm (1197.66). These differences in achene number can be attributed to the differences in head diameter. These results confirm the findings of Rajput *et al*. (1994) and Esechie *et al*. (1996).

1000-achene weight was affected significantly by different planting patterns and maximum 1000-achene weight (51.52 g) was obtained with planting pattern of 60 x 20 cm. It was followed by planting pattern of 45 x 20 cm, 45 x 30 cm, 75 x 30 cm, 75 x 20 cm, 60 x 30 cm, 60 x 10 cm and 75 x 10 cm which produced 47.32, 45.12, 44.25, 44.00, 43.66, 42.00 and 41.32 g seed weight, respectively. Minimum 1000-achene weight (41.02 g) was obtained in planting pattern of 45 x 10 cm. Lower achene weight with higher plant population might be due to increased competition among crop plants for available resources. These results are in line with those of Legha and Giri (1996), Esechie *et al*. (1996) and Barros *et al*. (2004) who reported that planting pattern had significant effect on 1000- achene weight.

The achene yield was affected significantly by different planting patterns. Maximum achene yield (3.76 t ha^{-1}) was obtained with 60 x 20 cm. The minimum achene yield was obtained when crop was sown with 60 x 20 cm spacing. The maximum achene yield with 60 x 20 cm can be attributed to greater head diameter, number of achenes per head and 1000-achene weight. These results are in line with those of Brass *et al.* (2004) and Zarea *et al*. (2005) who reported that achene yield of sunflower increased with increase in plant densities. The results are, however, contradictory to those of Nel *et al*. (2000) who reported higher achene yield at lower plant densities. This contradiction in results can be attributed to difference in genetic makeup, climatic conditions or fertility status of the soil.

Maximum achene oil contents (42.25%) were obtained for the planting pattern of 60 x20 cm which was statistically different and followed by the planting pattern of 45 x 20 cm which resulted in 41.65% achene oil contents. Minimum achene oil contents (37.39%) were observed in case of planting density of 45 x 10 cm. The results obtained during the study are well supported by the findings of Brass *et al.* (2004) and Zarea *et al*. (2005) who reported an increase in oil yield with increase in planting density. These results are in contradiction with those of Nel *et al*. (2000) who reported that oil contents were not affected significantly by planting density. These contradictory results might have been due to the difference in climatic conditions.

CONCLUSION

On the basis of present find it is concluded that for obtaining higher achene yield and oil contents sunflower should be sown in 60 cm apart rows keeping a plant to plant distance of 20 cm.

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