Pak. J. Agri. Sci. Vol. 34 (1-4), 1997

EFFECT OF SPATIAL ARRANGEMENT ON AGRONOMIC TRAITS OF TWO AUTUMN-PLANTED SUNFLOWER HYBRIDS

Riaz Ahmad, M. Shafi Nazir, M. Saeed, Tariq Mahmood & A. Jabbar
Department of Agronomy, University of AgricUlture, Faisalabad

Effect of spatial a"angement on yield and yield components of two autumn-sown sunflowe, hvbnds viz. 5F-100 and C-206 was determined for two consecutive years. The spatial arrangements comprised *60x20,* 60x30, 60x40, 60x50, 60x60 and 60x60 cm (the latter with two plants hill'). The maximum plant density of 7.75 m was recorded for 60 x 20 cm against the minimum of 2.69 for 60 x 60 cm with one plant hill'. By contrast, the crop planted at 60 x 60 cm with one plant hiil' produced the highest leaf area plant', number of achenes head' and 1000-achene weight as against the lowest at 60 x 20 cm. However, sunflower hybrid C-206 grown in the pattern of 60 x 20 cm gave the maximum seed yield of 3.53 t na', while sunflower hybrid SF-100 planted at 60 x 60 cm with one plant hiU-' produced the minimum seed yield of 2.38 t ha'

Key words: agronomic traits, autumn-planted sunflower, spatial arrangement

INTRODUCTION

Among the non-conventional oilseed crops, sunflower has shown great promise to improve the domestic production of edible oil because of its high oil content and wide adaptability to our soils and climatic 'conditions. Semi-dwarf types of sunflower have been reported to be Superior to standard height cultivars in yielding ability due to increased productive development (Goldworthy, 1970). However, semi-dwarf cultivars require different agro-management practices for their Successful production.

Plant population is one of the important components of the sunflower production technology which often varies with the growth habitat of the cultivars. According to RObinson (1976), sunflower yield is the outcome of the interaction of three components viz. number of head ha', number of seeds heao' and average weight per seed. Number of head ha' is a function of plant population while number of seeds head' and seed weight depend on number of head ha', climate, type and fertility of soil and type of hybridl cultivar. Arguments regarding the optimum plant population and seeding rate are common but high population is generally needed for high yield (Zubriski and Zimmerman, 1974).

Plant population depends on spatial arrangement of plants within a unit area which may vary according to the growth pattern of cUltivars/hybrids. The main objective of maintaining appropriate plant population per unit area in a particular pattern is to ensure maximum interception of sunlight by the crop for optimizing rate of photosynthesis. The present study was therefore, designed to determine the response of semi~dwarf and standard height sunflower hybrids to different spatial arrangements in irrigated environment under the agro-ecological conditions of Faisalabad.

MATERIALS AND METHODS

This study was conducted at the research area of the Agronomy Department, University of Agriculture, Faisalabad, during the autumns of two consecutive years. The experiment comprised two sunflower hybrids SF-100 (semi-dwarf) and C-206 (standard height), while the spatial arrangements were 60 x 20, 60x30, 60x40, 60x50, 60 x 60 cm with one plant hiil' and 60 x 60 cm with two plants hill'. The experiment was quadruplicated in a randomized complete block design with split plot arrangement. The spatial arrangements were randomized in the main plots and sunflower hybrids in subplots. The net plot size was 3.60 x 7.20 m. The crop was SOwn manually with the help of a dibble as per treatments on a well prepared seedbed. A basal dose of fertilizer @ 100 kg N + 100 kg PzOsha' in the form of OAP and urea was applied. All the P and half of N were added at sowing, while remaining N was applied with first irrigation. Thinning was done at 4 to 5 leaf stage to maintain the desired plant population in all treatments. In addition to "Rouni" (soaking irrigation for seedbed preparation), four irrigations each of 7.5 cm were given to mature the crop. Weeds were kept under control by interculture and hand weeding. The crop was harvested manually in first week of December during both years. Harvested crops were

sundried and threshed manually. Seed yi.eld was recorded at 15% seed moisture content. Standard procedures were followed for recording the data on desired growth and yield parameters. The data obtained were analysed by Fisher's analysis of variance technique and LSD test at 0;05 P was used to compare the differences among treatment means (Steel and Torrie, 1980).

RESUI TS AND DISCUSSION

Plant Density m^{-2}: Spatial arrangements had a significant effect on plant density per unit area in both the years (Table 1). In both the years the maximum number of plants m^2 was recorded at a spatial arrangement of 60 x 20 cm followed by a gradual decrease in rest of the treatments with the exception of 60 x 60 cm (two plants hilr') which was at par with 60 x 30 cm. Averaged over two years, the maximum number of plants m^{-2} (7.75) was recorded for 60x20 cm spatial arrangement as against the minimum of 2.69 m^2 for 60 x 60 cm with one plant hill'. Differences in plant density per unit area among various spatial treatments were attributed to their variable spatial arrangements. Almost the same plant density m^2 in both years was recorded in both the hybrids which ranged between 4.65 and 4.75 plants m^2.

Leaf Area (LA) Plant": The data on LA plant' recorded at flowering showed that there were significant differences among the various spatial treatments. In 1988, the maximum LA (7445 crrr') was recorded at a spatial arrangement of 60x60 cm with one plant hill' which was statistically at par with 60x50 cm (7055 ern" plant'). By contrast, the lowest LA plant' was found in 60x20 cm pattern (5090 crrr') which was in turn statistically equal to the pattern of 60x60 cm with two plants hill': Similarly, in 1989, the maximum LA plant' was noted in a spatial pattern of 60x60 cm with one plant hill' followed by 60x50 cm pattern. However, these two treatments differed significantly from each other. The lowest LA was recorded for 60x20 cm pattern and it was statistically at par with the pattern of 60x60 cm with two plants hill'. A similar trend was noticed for the two years average data. Lo~~A plant' in closer spacing might be attributed to severe competition among plants for various growth factors like water, nutrients, light; etc: Poor penetration of light into crop canopy might have caused senescence/abscission of lower older leaves. These results are supported by the findings of Srinivas and Patil (1977). As regards sunflower hybrids, C-206 produced significantly more LA ptant'. than SF-lOO in both years. Two years average data also showed the same trend. Hybrids C-206 and SF-lOO produced LA of 7472 and 5627 ern^2 $plant^{-1}$, respectively.

Number of Achenes Head": Spatial arrangement significantly affected number of achenes head" (Table 2). Spatial pattern of 60x60 cm (one plant hilr') produced the maximum number of achenes head" followed by 60x50 cm pattern in both the years. On the contrary, minimum number of achenes head' (927) was recorded in plants grown in the pattern of 60x20 cm. More number of achenes $head^{-1}$ at 60x60 cm pay~rn. (one plant hill'] was attributed to larger head diameter. These results also suggest that as the head size increases, number of achenes head' also increases. These findings are in line with those of Khalifa (1984) and Holt and Zentner (1984). The hybrids, SF-l Q()..aRdC-206 differed significantly from each other in 1988 but not in 1989 (Table 2). The hybrid C-206 produced significantly more number of achenes head' (1143) than SF-lOO in 1988. Similarly, on the basis of two years average, C-206 signi.ficantly outnumbered SF-lOO.

1000-Achene Weight: Weight of 1000 achenes expresses the magnitude of achene development which is an important determinant of seed yield and seed quality. Thousand achene weight was significantly affected by spatial arrangements during both 1988 and 1989 (Table 2). Average of two years data showed that crop planted at 60x60 cm with one plant hill' produced maximum 1000-achene weight but was statistically at par with all other treatments except 60x20 cm which gave the minimum 1000-achene weight. There was a progressive increase in 1OOO-acheneweight with each increase in the size of land area plant'. Higher achene weight at wider land area was also reported by EI-Sayed *et al.* (1984) and Gubbels and Dedio (1990). However, contradictory results. have been reported by Holt and Zentner (1984) who recorded higher achene weight at closer spacing. The hybrid C-206 produced significantly more 1OOO-acheneweight than SF-lOO in both years. Two years average also showed a similar trend.

Seed Yield: Seed yield is a function of interplay of various yield components. Spatial arranqement had a significant effect on seed yield ha' (Table 2). Crop grown at 60x20, 60x30, 60x40 and 60x60cm (two plants hiu-') had significantly higher seed yield than

Table 1. Growth parameters of two sunflower ~YQrigsas affected by different spatial arrangements

Treatment	Plant population (m^{-2})			Leaf area (cm^2)		
	1988	1989	Mean	1988	1989	Mean
A. Spatial arrangements						
60x20 cm	7.84 a	7.67a	7.75a	5090d	5247d	5169 d
60x30 cm	5.20 b	5.37b	5.28b	5819bc	6634c	6227 c
60x40 cm	4.02 c	4.04c	4.03c	6179b	7137c	66S8 c
60x50 cm	3.16 d	3.24 d	3.20 d	7055 a	7978 b	7517 b
60x60 cm	2.69 e	2.69 e	2:69 e	7145 a	9058 a	8252 a
60x60 cm (two plants hill')	5.34 b	5,46b	5,40 b	$383 cd	5571 cd	5476 d
B. Sunflower hybrids						
SF-lOO	4.65^{NS}	4.75^{NS}	4.70^{NS}	5071b	6184b	5627 b
C-206	4.76	4.73	4.75	7253a	7691a	7472 a

NS = Non-significant; means followed by different letters in a column are significantly different at 0.05 P.

Table 2. Yield and yield components of two sunflower hybrids as affected by d'ifferent spatial arrangements

Treatment	No. of achenes $head^{-1}$			1000-achene weight (g)			Seed yield (t ha^{-1})		
	1988	1989	Mean	1988	1989	Mean	1988	1989	Mean
A. Spatial .arrangements									
60x20 cm	800d	1050 e	926 e	43.76b	37.28b	40.52b	3.06 a	3.39 a	3.2.2a
60x30 cm	986c	1158 d	1073 d	46.96ab	38.87 ab	41.91 ab	2.98 a	3.25 ab	3.12a
60x40 cm	1092b	1259c	1175c	46.42 ab	38.92 ab	42.67 a	2.97 a	3.17 ab	3.07a
60x50 cm	1190ab	1359b	1274b	46.78 ab	39.18 a	42.98 a	2.69 bc	3.08 b	2.82b
60x60 cm	1267a	1437 a	1358 a	47.74 a	39.59 a	43.62 a	2.52 c	3.01 b	2.77b
60x60 cm (two plants hiW')	902 c	1131d	1016d	46.32 ab	38.98 a	42.52 a	2.84 ab	3.26 ab	3.05a
B. Sunflower hybrids									
SF-lOO	935b	1251 ^{NS}	1096b	42.93b	37.60b	42.26b	2.55b	2.80b	2.67b
C-206	1143a	1214	1179a	49.39a	40.33a	44.80a	3.13a	3.58a	3.31 a

NS = Non-significant; means followed by different letters in a column are significantly different at 0.05 P.

that of 60x50 and 60x60 cm (one plant $hill^{-1}$) in both the years. However, former treatments were statistically equal to one another. The lowest yield was recorded at 60x60 cm (one plant $hill^{-1}$). Average of two years data also exhibited the same trend. Differences in seed yield among the various spatial arrangements may be attributed to the variable plant density ha^{-1}. These results are in agreement with those reported by Sidhu and Bains (1980),, Ali *et al.* (1988),, Gubbels and Dedio (1990) and Zaffaroni and Schneiter (1991), while these are contradictory to those of Campiglia *et al.* (1989) who found non-significant difference in seed yield between cultivars or row spacings. The hybrid C-206 produced significantly higher seed yield than SF-lOO in both years. On the basis of two years average data, C-206 and SFcl00 had seed yields of 3.31 and 2.67 t ha', respectively, being significantly different from each other. On overall basis, sunflower hybrid C-206 grown in the pattern of 60x20cm produced maximum seed yield (3.53 t ha^{-1}),, while SF-lOO grown at 60x60cm (one plant $hill^{-1}$) gave the minimum seed yield (2.38 t ha^{-1}) in both the years.

REFERENCES

Ali, M., M. Aslam and S.A. Khan. 19$8. Plant spacing cum number of plants .pir hill in sunflower. Pak. J. Agri. Res.9(1)t~6-78.

Campiglia, E., R. Paolini and E. Bo..nari. 1989. The effect of plant density and row spacing on the behaviour of different mo~p;t'l()logical types of *He/ianthus annuus* L. Rivis!~i1i Agronomia, 23(3): 283-288 (Field Crop Ab~~: 43(6): 44'14, 1990).

EI-Sayed, M.M., L.K. Mllh~tnmed and M.M. Ebaid. 1984. Effect of .. plant spacing, nitrogen and phosphorus rates on yield, its components ,and oil of sunflower variety Giza 1 *(He/ianthus annuus* L.). Ann. Agri.. Sci. Moshtohor, 21 (1): 251-261.

Goldworthy, P.R. 1970. The growth and yield of tall and short sorghum in Nigeria. J. Agri. Sci. 75: 109-122.

Gubbels, G.H. and W. Dedio. 1990. Response of early-maturing sunflower hybrids to row Spacing and plant density. Canadian J. Plant Sci, 70(4): 1169-1171,

Holt, N.W, and R.P. Zentner. 1984. Effect of plant density and row spacing on agronomic performance and economic returns of non-oilseed sunflower in south eastern Saskatchewan. Canadian J. Plant Sci. 65(3): 501-509.

Khalifa, F.M. 1984. Effect of spacing on growth and yield of sunflower *(He/ianthus annuus* L.) under two systems of dry farming in Sudan. J. Agri. Sci. UK. 103(1): 213-222.

Robinson, R.G., D.L Rabas, L.J. Smith, 0.0. Warnes J.H.Ford and W.E. Lueschen. 1976. Sunflowe~ population, row width and row direction. Minnesota Agri. Exp.Stn. Mise. Rep. 141.

Sidhu, B.S. and D.S. Bains. 1980. Effect of planting technique on growth and seed yield of sunflower. J. Res. Punjab Agri.. Univ. 17(2); 148-151.

Srtnivas, K. and S.V. Patil, 1977. Effect of spacing and fertility levels on growth and yield of sunflower *(He/ianthus annuus* L.). Mysore J. Agri. Sci.11(1):41-45.

Steel, R.G.D. and J.H. Torrie. 1980. Principles and Procedures of Statistics. McGraw Hill Book Co. Inc., New York.

Zaffaroni, E. and A.A. Schneiter. 1991. Sunflower production as influenced by plant type, plant population and row arrangement. Agron. J. 83(1); 113-118.

Zubriski, J.C. and D.C. Zimmerman. 1974. Effects of nitrogen, phosphorus and plant density on sunflower. Agron. J. 66: 798-801.