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Effect of Row Directions on Yield and Yield Components of Sunflower (*Helianthus annuus* L.)

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Abstract: Four row directions i.e., north-south (NS), east-west (EW), north east-south west (NESW) and north west-south east (NWSE) had very little effect on seed yield and other agronomic characters of sunflower. The differences in mean plant height, head diameter, seed yield, 100-achene weight and fatty acid profile were statistically non-significant. Similar trend was observed during both the single years. As an average of two years, although statistically non-significant, the highest seed yield of 3065 kg ha^{-1} from north east-south west (NESW) and the lowest yield of 2624 kg/ha were obtained from east-west (EW) row directions. The most pronounced effect of row directions was noted on the seed moisture content. As an average of two years, the maximum seed moisture content (21.4%) at harvest was obtained from east-west (EW) and the minimum (14.6%) from north-south (NS) row directions. NESW row direction also gave significantly lower moisture content (15.1%) than EW (21.4%) and NWSE (18.1%) row directions. Therefore, using north-south and NESW row directions would help to dry standing crop more quickly before harvest and reduce post harvest costs and losses. Seed production fields that require examination of sunflower heads to detect pollen production should be planted in NS rows for efficient rouging to keep genetic purity. For research plots, EW rows with plot labels on the east end often are preferred, because it is easier to evaluate most plots when all heads face the viewer.

Key words: *Helianthus annuus,* sunflower, row directions, agronomic characters, moisture content, Pakistan

Introduction

Sunflower *(Helianthus annuus* L.) is a phototropic crop from emergence to flowering and the head and leaves face east in the morning and west in the evening. About one day before the ray flowers open, phototropic movement ceases and the heads face east (Robinson *et al*., 1976). Calculations from a statistical model of light interception has shown that grain sorghum in north-south (NS) rows would intercept 44 and east-west (EW) 37 percent of direct sunlight during August in Colorado, USA (Allen, 1974). Robinson (1975) reported that sunflower grown in EW and NS rows did not differ in yield, oil percentage and seed size. NS row had the potential for yield advantage and may be slightly preferable over EW (Dhillon *et al*., 1982). When sunflower is to be harvested by hand, some growers of tall cultivars preferred rows directed north-south (NS), because heads overhanging the east side of the row could be gathered more easily (Moursi *et al*., 1980). Row direction experiments on other crops such as wheat, indicated that the direction of sowing had no effect on yield (Nordestgaard, 1984). In an other study on sorghum it was noted that fresh and dry weight of forage, total protein content and solar energy conversion efficiency were increased by sowing in NS row direction (Moursi *et al*., 1980). However, the effect was not important in commercial cultivation of sunflower (Slosser *et al*., 1986). Seed production fields that require examination of sunflower heads to detect pollen production should be planted in NS rows for efficient rouging to keep genetic purity. For research plots, EW rows with plot labels on the east end often are preferred, because it is easier to evaluate most plots when all heads face the viewer (Robinson *et al*., 1976). Little scientific work has so far done to determine the effect of row directions on agronomic and quality characteristics in sunflower. The present study was conducted to see the effect of row directions on sunflower yield, yield components, oil quantity and quality.

Materials and Methods

A field experiment was conducted using NK-265 sunflower hybrid in four row directions i.e., north-south (NS), east-west (EW), north east-south west (NESW) and north west-south east (NWSE) at National Agricultural Research Centre (NARC), Islamabad, Pakistan during spring 1991 and 1992. The experiment was laid down in randomized complete block design having four replications, with a plot size accommodating of 5 meter long 10 rows, spaced 75 cm apart having 25 cm distance between the plants. The trails were sown on 15 and 25 February during 1991 and 1992, respectively. Fertilizer dose of 60 N and 60 P_2O_5 (kg/ha) was applied in the form of urea and DAP at the time of sowing, while 60 N (kg/ha) was given at the time of first irrigation, when the plants attained 35-45 cm height. The crop was thinned to one plant per hill at 2-4 leaf stage. Two hoeings were done to eradicate the weeds. Earthing up was done manually after the second irrigation to prevent the crop from lodging. Days to flower initiation (DFI) was recorded when 5 percent of the total floral buds per plot opened their ray florets whereas, days to flower completion (DFC) when about 90-95 percent of the buds per plot opened to flower. Plant height (PH) was recorded on 10 randomly selected plants in each treatment from ground level to the receptacle of the head. Head diameter (HD) was also noted from the same randomly selected plants from one edge of the head to the other. Two central rows of 7.5 m length were manually harvested for recording the data on seed yield (kg/ha), oil content (OC), moisture content (MC), fatty acid profile (FAP) and 100-achene weight (100-AW). The data were analyzed using analysis of variance (Steel and Torrie, 1980) and Duncan's new multiple range test (Duncan, 1955) for separating different treatment means.

Results and Discussion

The four row directions tested had little effect on agronomic characters of sunflower during both the years (Table 1). The four treatment means for DFI, DFC, yield, 100-AW and FAP were not significantly different from each other. However, the PH means for 1991 and average of both the years, HD means for 1991, OC means for 1991 were significantly different. Moisture content was

Table 1: Effect of row directions on yield and yield components of sunflower at NARC, during, 1991-92

Directions	DFI (days)			DFC (days)			PH (cm)			HD (cm)			Yield (kg/ha)		
	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean
NS	61	87	74.0	68	92	80.0	145	164	154.5	14.9	16.8	15.9	2106	3264	2685.0
EW	61	86	73.5	67	92	79.5	148	165	156.5	15.1	17.5	16.3	2025	3223	2624.0
NESW	61	86	73.5	67	91	79.0	136	163	149.5	16.6	17.5	17.1	2463	3666	3064.5
NWSE	62	86	74.0	68	92	80.0	138	163	150.5	14.9	17.5	16.2	2418	3620	3019.0
Mean	61	86	--	67	91	--	141	163	--	15	17.3	--	2253	3443	--
CV (%)	1.7	1.3	--	1.3	0.9	--	3.3	3.0	--	6.9	7.5	--	13.1	14.8	--
LSD 1	NS	NS	NS	NS	NS	NS	7.4	NS		1.7	NS	NS	NS	NS	NS
LSD 2	NS			NS			NS			NS			NS		
LSD 3	3.1			4.2			15.0			NS			751		

Table 1: (Contd.)

Directions	100-AW (gm)			IC (%)			MC (%)			OA (%)			LA (%)		
	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean	1991	1992	Mean
NS	4.8	6.1	5.4	45.2	38.8	42.0	11.0	18.3	14.6	37.6	42.1	39.8	55.6	46.9	51.2
EW	5.4	6.0	5.7	46.5	39.1	42.8	18.8	24.0	21.4	36.3	40.5	38.4	56.7	47.8	52.3
NESW	5.5	5.9	5.7	43.7	39.6	41.6	11.0	19.3	15.1	37.0	43.3	40.1	55.5	42.0	48.7
NWSE	5.8	5.3	5.6	44.5	40.7	42.6	13.3	23.0	18.1	37.7	35.7	36.7	55.8	54.8	55.3
Mean	5.8	5.9	--	45.0	39.6	--	13.5	21.1	--	37.2	40.4	--	55.9	47.9	--
CV (%)	9.9	11.1	--	2.3	9.7	--	15.9	12.6	--	21.2	19.3	--	15.4	19.4	--
LSD 1	NS	NS	NS	1.7	NS	NS	3.4	4.2	2.5	NS	NS	NS	NS	NS	NS
LSD 2	NS			NS			3.6			NS			NS		
LSD 3	NS			3.7			3.1			NS			NS		

LSD 1 = (0.05) for treatment means LSD 2 = (0.05) for interaction of treatment x year
LSD 3 = (0.05) for year means

the only character which was significantly affected by row directions during both the years. Robinson *et al*. (1982) have also found that sunflower grown at Minnesota in EW, NS and 16 other magnetic compass row directions did not differ in yield, oil percentage, seed size and 100-achene weight. The plant height in four row directions during 1991 was significantly different. The taller plants (148 cm) were found in EW row directions, followed by NS directions (145 cm) during 1991, but this difference is too small to use for any practical purpose. Row directions had little but significant affect on HD during 1991. The largest head size (16.6 cm) in 1991 were obtained from NESW direction, while other three directions had almost similar head sizes (14.9 to 15.1 cm), which were smaller than the heads obtained from NESW row direction. Similar results were obtained by Slosser *et al*. (1986) during a field experiment.

During both the years, yield was not significantly affected by the row directions as also reported by Robinson (1975).

However, comparatively higher yields were obtained from NESW and NWSE row directions. In 1991, 2106 and 2025 kg ha^{-1} were recorded for NS and EW directions, respectively. In 1992 comparatively higher yields of 3666 and 3620 kg ha^{-1} were obtained from SWNE and EW row directions as compared to 3264 and 3223 kg ha^{-1} for NS and NWSE directions, respectively. The reason for consistent higher yields from NESW (3065 kg ha^{-1}) and SWNE (3019 kg ha^{-1}) row directions during both years may be due to higher interception of sun light by upper leaves near the head, which play more affective role in photosynthesis during the reproductive phase of sunflower. Row direction had significant effect on oil content during 1991. The highest oil content (46.5 percent) was obtained from EW direction, followed by NS (45.2 percent), which were significantly higher than the OC obtained from ENSW (43.7%) direction.

During 1992, the row direction did not effect oil content significantly (Robinon *et al*., 1982). Oleic acid and LA were not affected significantly by the row directions. However, a conspicuous change was observed in OA and LA in 1992, where NWSE direction comparatively gave a lower percentage of OA (35.7) and higher percentage of LA (54.1). Moisture content of seed was effected most pronouncedly by the row directions during both the years. Lower moisture contents were obtained in NS and NESW directions, when crop was harvested after physiological maturity. In 1991, the moisture content of seed was 11 percent in NS and NESW row direction, compared to 18.8 percent in EW and 13.3 percent in NWSE directions. A similar trend was noted during 1992 and the seed moisture content of 18.3, 19.3, 24 and 23 percent were recorded in NS, NESW, EW and NWSE row directions, respectively. These results strongly indicated that interception of solar radiation was higher in NS and NESW direction (Moursi *et al*., 1980). This finding can be utilized for commercial cultivation of sunflower in NS and NESW row directions for early drying of the crop to reduce the period for which it occupies the field after physiological maturity. It also help to minimize the post harvest losses and additional cost for drying the produce.

Row directions i.e., NS, EW, NESW and NWSE had very little effect on seed yield and other agronomic characters of sunflower. As an average of two years, although statistically non-significant, the highest seed yield of 3065 kg ha^{-1} from north east-south west (NESW) and the lowest yield of 2624 kg ha^{-1} were obtained from east-west (EW) row directions. The most pronounced effect of row directions was noted on the seed moisture content (MC). As an average of two years, the maximum seed moisture content (21,4 percent) at harvest was obtained from east-west (EW) and the minimum (14.6 percent) from north-south (NS) row directions. NESW row direction also gave significantly lower moisture content (15.1 %) than EW (21.4 %) and NWSE (18.1%) row direction. These findings can be utilized for commercial cultivation of

sunflower in NS and NESW row directions for early drying of the crop to reduce the period for which it occupies the field after physiological maturity. It also help to minimize the, post harvest losses and additional cost for drying the produce: Seed production fields that require examination of sunflower heads to detect pollen production should be planted in NS rows for efficient rouging to keep genetic purity. For research plots, EW rows with plot labels on the east end often are preferred, because it is easier to evaluate most plots when all heads face the viewer.

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