Effects of sowing date and skipping of irrigation on growth, yield, and yield components of winter grown sunflower (*Helianthus annuus* L.)

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ABSTRACT

The response of two winter grown sunflower cultivars (Damazin and Hysun 33) to three sowing dates (Oct 20th, Nov 20th and Dec 20th) and three skippings of irrigation (frequent irrigation, skipping at bud or at flowering stage) was investigated. Early sowing (Oct 20th) gave significantly taller plants, larger LAI, higher dry matter, greater seed yield and yield components than the second (Nov 20th) or third sowing date (Dec 20 th). Oct 20th sowing outyielded Nov 20th and Dec 20th sowings by about 10% and 18.2%, respectively. Plants that received skipped irrigation at bud or at flowering stages were significantly shorter, with smaller LAI and less dry matter than those of the frequent irrigation during both seasons. Also, they had significantly less seed yield by about 27.4 to 32.1% in the first season and 39.3% to 42.0 % in the second one compared with plants that received regular irrigation. The decrease in seed yield was attributed to a decrease in number of seeds/m^2 and 1000 - seed weight. The hybrid Hysun 33 outyielded Damazin in all parameters. The seed yield produced by hybrid was 2241 and 2042 in both seasons respectively and were 2171 and 2002 for Damazin. It is recommended that the hybrid be sown as early as October 20 with 8 irrigations for good growth and higher seed yield.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is currently the world's fourth largest oil seed crop (De Rodriguez *et al*., 2002). Sunflower is produced at approximately 23 million hectares in 40 countries of the world (Seiler *et al*., 2008). Two of the most important practices for sunflower production, particularly the winter grown sunflower, are sowing date and irrigation. These two factors are not fully investigated in the Sudan. Ali (1990) reported that mid - October to mid - November sowings gave the highest seed yield, number of seeds/head, and 1000 - seed weight compared to earlier (30^{th} of September) or later (30^{th} of November and 15^{th} of December) sowings. Moreover, seed and oil yields increased in proportion to the increase in the amount of irrigation given to the crop (Ghazy and abu Ghazala, 1999). Sunflower is greatly influenced by irrigation and vigorous growth and high seed yield can be achieved by application of optimum irrigation (Ramamoorthy *et al*., 2009). Currently, in Sudan, water is a primary limiting factor to agriculture and it is important to focus on how to increase crop production while reducing water consumption.. The objective of this study was, hence, to investigate the effects of sowing date and skipping of irrigation on growth, seed yield and yield components of winter grown sunflower**.**

MATERIALS AND METHODS

Field trials were carried out for two seasons (2005/06 -2006/07) to investigate the effects of sowing date and skipping of irrigation on growth, seed yield and yield components of two sunflower cultivars. The trials comprised 18 treatments which were: three sowing dates, namely Oct 20 th, Nov 20th and Dec 20th, designated as SD1, SD2 and SD3 and three skipping of irrigation periods: No skipping, skipping at bud stage or skipping at flowering, designated as W1, W2 and W3 and two cultivars, namely, Damazin (open pollinated) and Hysun 33 (Hybrid) designated as V1, and V2. The treatments were arranged in a strip – split –plot design with four replicates with the irrigation treatments as main plots, sowing dates as subplots and cultivars as sub – sub plots. The trials were conducted at two locations, at the experimental farm of the Faculty of Agriculture and Natural Resources, Abu Haraz and the experimental farm of the Faculty of Agricultural Sciences, Wad Medani, Sudan (latitude 14º 06´ N and longitude 33º 38´ E and 400 masl). The soil of the two locations (Wad Medani), was a heavy cracking clay vertisols, it is low in organic matter (0.5%), nitrogen about 0.03 % to 0.04 % and available phosphorus is about 6 mg/ kg of soil.

The land was disc ploughed, harrowed, leveled and ridged into 60 cm ridges. Seeds of sunflower were sown by hand in holes kept at equal distances by means of a marker to insure a population of 83335 plants / ha. The holes were 20X60 cm apart and three seeds per hole were placed. The plants were thinned to one plant/hole two weeks later. Plot size was 4.2 X 5 m^2. A fertilizer dose of 86 kg/ha was applied as urea in a split dose at 12 and 30 days after sowing. A single herbicide spray with "Stomp" at the a rate of 1.0 l/ha was applied pre emergence to control weeds. Irrigation was applied adequately at 12 days interval in both seasons. However, the skipping of irrigation was carried out as planned, i.e at the bud and flowering stages. Water application into individual plots was measured by parshall flume H_{26-2} (50 mm throat). The total amount of water applied during the first season was 18645 m^3 , 18192 m^3 and 18091m^3 for SD1, SD2 and SD3, respectively and was 18157 m^3, 18033 m^3 and 18010 m^3 for the same irrigation periods in the second season, respectively.

For growth analysis determinations, five plants were sampled, at random one month after sowing and then every 15 days using the second inner rows. The following parameters were determined: Plant height (cm), leaf area Index (LAI) and the weight of all the plant parts. The following seed yield components were determined: seed yield (kg/ha), head diameter (cm), 1000 seed weight (g), number of seeds / head and percentage of empty seeds (%).

The data were subjected to the analysis of variance procedure and the treatment means were separated using Duncan's Multiple Range Test .

RESULTS AND DISCUSSION

a- Growth and development

1- Sowing date

The effects of the three factors, on plant height, LAI were similar in both seasons and hence the data of the first season only was presented. The plants reached their maximum heights during (75 to 90 days after sowing (DAS). Sowing date had significant effects on plant height at almost all sampling dates (Table1). The first sowing date produced significantly (P=0.05) taller plants than the second and third ones. Also, it had marked effects on LAI at all sampling dates during the two seasons and SD1 produced significantly (P=0.05) higher LAI than the second and third sowing date. Significant differences were observed between LAI of the second and third sowing at almost all sampling dates (Fig 1a and 1b).

These results agree with those of Hosseini and Hashemi (2004), who showed that different cultivars had different leaf areas at different sowings (27 May or 9 June) . Singh and Gupta (2003), reported that 20th of February sowing produced significantly higher leaf area index of 1.3 than that of 5th February or 7 March sowing date at 90 days.

Table1. Effects of sowing date (SD) and skipping of irrigation (W) on plant height (cm) of the two sunflower cultivars (V1 and V2) during season 2005/06.

Treatment	Days after sowing				
	30	45	60	75	90
SD1	28.7	67.9	132.5	162.9	164.5
SD2	32.7	76.5	125.0	140.8	151.7
SD3	32.2	79.9	125.3	139.9	142.4
SE±	0.3	3.3	3.2	1.4	1.1
W1	29.2	72.8	128.5	152.8	155.6
W2	32.1	76.1	123.1	144.9	149.4
W3	32.5	75.3	131.2	146.0	153.7
SE±	1.5	2.3	1.3	1.7	1.4
V1	32.8	80.1	133.7	152.1	157.5
V2	29.7	69.4	121.6	142.8	148.3
SE±	0.5	1.2	1.2	1.2	1.1
Mean	31.3	74.8	127.6	147.9	152.9
C.V%	9.1	9.3	5.8	4.8	4.1

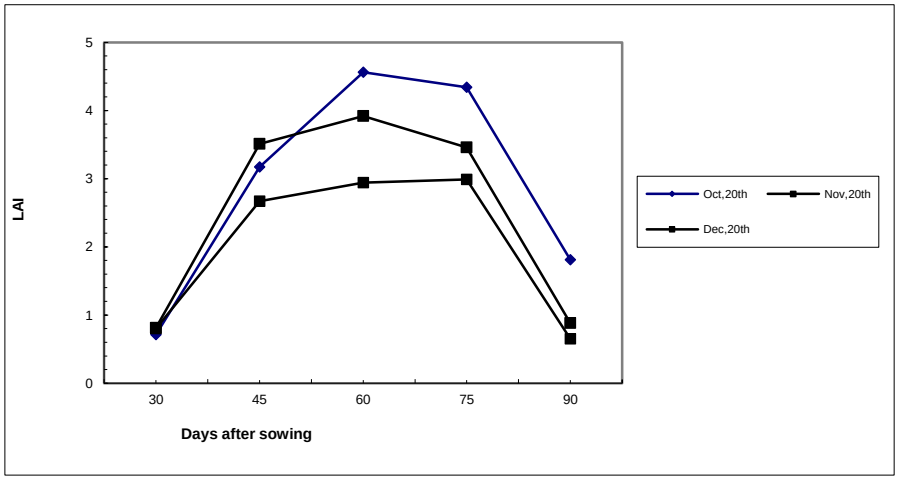
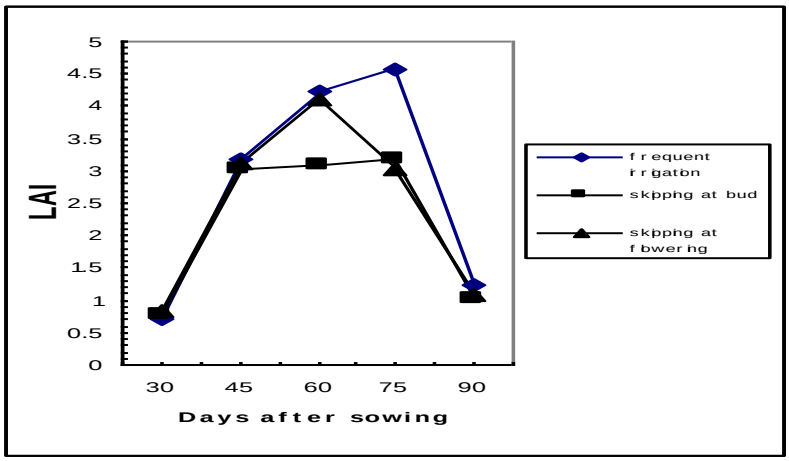


Fig. 1a. Effects of sowing date on LAI of sunflower grown during season 2005/06.



Effects of skipping of irrigation on LAI of sunflower grown during season2005/06 2005/06.

The Maximum dry weight of the different plant parts were attained at or shortly before 75 DAS during both seasons. However, the plants of SD1 attained their maximum dry at 90 DAS(Table 2a and 2 b).

Sowing date had significant (P=0.05) effects on the dry weights at almost all sampling dates in both seasons. The first sowing date produced significantly (P=0.05) heavier weights than those of the second and third sowing dates at 60 ,75 and 90 DAS in the first season and at all sampling dates during the second season. No significant differences between weights of the second and third sowings were observed at all sampling dates except at 75 and 90 DAS in the first season and 60 and 75 DAS in the second season. A progressive increase in the mentioned parameters was associated with earliness of planting. The first sowing date produced significantly (P=0.05) greater weights than the other sowings. Hence, the first sowing date produced significantly (P=0.05) taller plants, greater LAI and dry weight of leaves, stems, roots, and heads at least for one season. On other hand, delayed sowing was associated with a decrease in all vegetative characters for plants up to 45 days after sowing

Table 2a. Main effects of sowing date (SD) and skipping of irrigation (W) on dry weights (g) of leaves/plant, stems, roots heads and the plant of the two sunflower cultivars (V) when they attained their maximum values during 2005/06 season.

Treatment	Days after sowing				
	75 Leaves	75 Stems	75 Roots	90 Heads	90 Total dry wt
SD1	31.7	47.6	8.8	45.3	118.1
SD2	21.9	40.9	8.1	33.4	97.0
SD3	18.1	32.7	6.1	28.7	83.0
SE±	0.6	0.6	0.4	1.5	2.0
W1	26.6	45.9	7.9	38.4	110.1
W2	22.8	35.2	7.2	34.9	92.2
W3	23.2	40.0	7.9	34.2	96.1
SE±	0.9	1.4	0.5	1.2	2.8
V1	23.6	40.2	7.6	35.2	99.6
V2	24.8	40.5	7.8	36.4	99.4
SE±	0.8	0.6	0.3	0.5	1.5
Mean	24.2	40.4	7.7	35.8	99.5
C.V%	20.3	47.6	19.6	9.1	8.8

Table 2b. Main effects of sowing date (SD) and skipping of irrigation (W) on dry weights (g) of leaves/plant, stems, roots heads and the plant of the two sunflower cultivars (V) when they attained their maximum values during 2006/07 season.

Treatment	Days after sowing				
	75 Leaves	75 Stems	75 Roots	90 Heads	90 Total dry wt
SD1	22.6	40.2	6.8	66.4	115.8
SD2	20.0	41.9	7.5	28.8	77.3
SD3	17.9	34.1	6.5	31.3	75.9
SE±	0.9	1.5	0.3	0.8	1.8
W1	26.5	47.9	8.3	59.5	121.6
W2	18.7	33.7	6.1	33.4	73.2
W3	15.3	34.6	6.1	33.6	74.1
SE±	0.6	1.5	0.3	1.5	1.6
V1	18.5	34.1	6.5	40.8	82.6
V2	21.8	43.4	7.3	43.5	96.7
SE±	0.7	1.4	0.3	1.5	1.7
Mean	20.2	38.7	6.9	42.2	89.6
C.V%	20.0	21.7	21.6	12.0	11.5

These results were in line with those of Mello *et al.* (2006),who reported that October sowing produced heavier dry weights of leaves and stems compared with November and December sowing. Also, they reported that October sowing had a longer cycle and a higher plant height (172cm) compared to November (125cm) and December (150 cm) sowings. They attributed that to the prevailing climatic conditions of lower temperature, insolation and photoperiod during the crop growth period. However, they reported heavier dry weights of heads and whole plant in December sowing. El-Wahab *et al.* (1992), reported that May sowing (early sowing) gave the greatest total plant dry weight compared with late sowings (June to November) in the first season, but no consistent trend was observed in the

second one. Moreover, Shivakumr *et al.* (2001), reported that weekly surface irrigation produced maximum root length, volume and dry weight compared with irrigation at 0.5, 0.6 and 0.8 evaporation.

Table 3. Interaction effects of sowing date (SD), skipping of irrigation (W) and cultivar (V) on plant height, LAI and total dry weight of sunflower during 2005/2006 season.

Treatment	Plant height (cm)	LAI	Total dry weight (g)
	90	60	75 days
SD1XW1	166.9	4.8	132.5
SD1XW2	163.3	4.2	106.0
SD1XW3	163.5	4.7	115.9
SD2XW1	152.6	4.6	103.5
SD2XW2	146.9	2.9	95.3
SD2XW3	155.6	4.3	93.2
SD3XW1	147.3	3.7	94.4
SD3XW2	138.1	2.2	75.3
SD3XW3	141.9	3.3	79.2
SE±	2.2	0.1	5.0
SD1XV1	166.0	4.5	116.6
SD1XV2	163.1	4.7	119.7
SD2XV1	160.0	3.9	97.9
SD2XV2	143.2	4.0	96.8
SD3XV1	146.6	2.8	84.2
SD3XV2	138.3	3.1	81.7
SE±	1.8	0.1	2.5
W1XV1	160.9	4.2	112.9
W1XV2	150.3	4.2	107.4
W2XV1	153.3	3.0	90.4
W2XV2	145.6	3.2	94.0
W3XV1	158.5	3.9	95.4
W3XV2	148.8	4.3	96.8
SE±	1.8	0.1	2.5
Mean	152.9	3.8	99.5
C.V%	4.1	12.4	8.8

2- **Skipping of irrigation**

Skipping of irrigation had marked effects on plant height, LAI and dry weight of the different plant parts (Table 3) . The frequent watering (W1) produced significantly (P=0.05) taller plants than those receiving skipped irrigation at bud or at flowering stages 75 DAS in the first season (Table 1).

Skipping of irrigation produced significant (P=0.05) effects on LAI. Differences were significant (P=0.05) between plants of the frequent irrigation (W1) and those of the skipped irrigation at bud stage (W2) and those of the skipped irrigation at flowering stage (W3) especially, at 75 DAS in both seasons. Similarly, differences were large between LAI produced by the skipped irrigations W2 and W3 at 60 and 75 DAS (Fig.1b).

The skipping of irrigation applied showed significant effects on the dry weight of leaves, stems, roots and heads when they attained their maximum values. Exception was for the roots at 75 DAS, where no significant differences between the treatments were detected. Generally, the frequent watering (W1) produced significantly (P=0.05) greater weights than those of skipped irrigation at bud stage (W2) or

at flowering stage (W3) at 75 and 90 DAS during both seasons. No significant differences were detected between the weights of the two skipped regimes (W2 and W3) at almost all sampling dates (Table 2a, b). Similarly, significant differences (P=0.05) were detected between dry weights of whole plants of frequent irrigation (W1) and those of the skipped irrigation at bud and those of the skipped irrigation at flowering stage (W3). Mekki (1984), stated that plant height was not significantly affected by irrigation at depletion of 40, 60 and 80% of available soil moisture at all growth stages (45, 60, 75 and 90 DAS) during two seasons.

LAI showed a progressive increase with time and attained its maximum value at 60 – 75 DAS. Skipping of irrigation had marked effects on LAI at 60 DAS onwards, in both seasons. Frequent irrigation produced significantly (P=0.05) greater LAI than those of the two skipped irrigations. Similar results were reported by Mekki (1984), who stated that irrigating at a depletion of 40% of the available soil moisture produced significantly greater values of LAI at 90 DAS than irrigating at a depletion of 60 or 80%.

Dry matter production was greatly influenced by skipping of irrigation. Frequent watering (W1) produced significantly heavier weights and large

Table 4. Main effects of sowing date (SD) and skipping of irrigation (W) on yield and yield components of the two sunflower cultivars (V),Damazin (V1) and Hysun33 (V2) during 2005/06 season.

Treatment	Seed yield (kg/ha)	No. of seeds /m^2	Head dia (cm)	1000 seed wt (g)	Unfilled seeds (%)
SD1	2365.3	5330.0	13.4	44.6	15.4
SD2	2146.8	4923.0	13.0	43.9	15.6
SD3	2105.2	4932.0	12.9	43.3	16.4
SE±	49.2	76.5	0.1	0.8	0.3
W 1	2831.3	5826.0	15.1	49.3	13.6
W 2	2056.2	4849.1	12.3	43.3	16.6
W3	1729.8	4511.2	11.9	39.2	17.2
SE±	56.3	126.3	0.3	0.7	0.3
V1	2170.6	5056.0	13.0	42.8	16.4
V2	2241.0	5057.0	13.2	45.0	15.2
SE±	37.8	78.3	0.1	0.6	0.2
Mean	2205.8	5062.0	13.1	43.9	15.8
C.V%	10.3	9.3	5.1	8.6	7.0

LAI than those of the skipped irrigation at bud stage (W2), at 60 DAS onwards.. There is no significant irrigation effect at flowering stage (W3), at 75 and 90 DAS, during both seasons on dry matter production and LAI. These findings were in line with those of Rawson (1979) who reported that net photosynthesis declined as leaf water potential became more negative and water stress during flowering stage decreased the stored assimilates by 42% as compared to the check. Singh and Gupta (2003) reported that frequent irrigation produced higher dry matter (92.9 g/plant) than skipped irrigation at pre-flowering, flowering or grain-filling.

3- **Cultivar**

The two cultivars, Damazin (V1) and Hysun 33 (V2), reached their maximum heights within 75 and 90 DAS in the two seasons. Damazin was significantly (P=0.05) taller than Hysun 33 at all sampling dates during the first season. The reverse was true in the second season. Though there were no significant differences between the two cultivars in the first season and at 30 and 45 DAS in the second season, yet Hysun 33 produced consistently larger and greater LAI (Fig.1a, b). However, they were significantly (P=0.05) different in their dry weights of vegetative parameters when they attained their maximum values in the second season (Table 3b). Hysun33 (V2), generally, had heavier dry weights than Damazin (V1) at all sampling dates during the two seasons (Tables 3a and 3b).

4. **The interaction**

The interaction effects of sowing date , skipping of irrigation and cultivar on plant height (cm), LAI and total dry weight (g) were significant (P=0.05) when they attained their maximum values (Tables 3a) . The SD1XW1 treatment produced significantly (P=0.05) taller plants (cm), greater number of leaves/plant, larger LAI and heavier dry weights (g) than other treatment combinations. The interaction of skipping of irrigation and cultivar was significant (P=0.05) and the W1with V1 and V2 treatments produced significantly (P=0.05) greater values than other treatment combinations in the first season (Table3a)

The interactions of the three factors were significant (P=0.05) as differences were observed among the treatment combinations, where SD1W1V1 and SD1W1V2 produced taller plants, greater number of leaves, larger LAI and heavier dry weight when they attained their maximum values, than all other treatment combinations in both seasons (data not shown).

b- Yield and yield components

1- Sowing date

The first sowing significantly (P=0.05) increased seed yield, number of seeds / m^2 , head diameter, 1000 – seed weight but lowered the number of unfilled seeds/head when compared to the second and third sowings (Table 4) The above mentioned results agreed with those of Luchsinger and Mastroilli. (1997) who reported that the highest seed yields were obtained by hybrids when sown in October. Delayed sowing to November, December or January significantly reduced seed yields. Ali (1990), reported that the yield of sunflower was found to increase with early sowing of mid October to mid November. Fathi and Khademolhsaeni (2006) reported that number of seeds/head and 1000- seed weight were significantly reduced as sowing was delayed from early August to late September. Also, Mohamed *et al.*, (2005) and Lopes *et al.* (2007), showed that winter sowings produced higher number of seeds / head or seeds/m^2 and 1000 – seed weight and greater head diameter than when sowing was delayed to summer ones. They attributed these decreases to the coincidence of vegetative and reproductive stages with higher temperatures prevailing at late sowings. Morover, Kandil (1977) reported that unfilled seeds / plant significantly increased when planting was delayed from early April to late June.

2**. Skipping of irrigation**

Skipping of irrigation had significant (P=0.05) effects on seed yield, number of seeds/ m^2 , head diameter, 1000-seed weight and unfilled seeds/head (%) (Table 4). The plants of the frequent irrigation (W1) significantly produced (P=0.05) higher values than those of the skipping irrigation at the bud (W2) or at the flowering stage (W3), in both seasons. However, frequent irrigation produced significantly (0.05) less percentage of unfilled seeds/head in comparison to skipping irrigation at the bud (W2) or at the flowering stages (W3). Moreover, differences were significant between yields obtained by the skipped irrigations (W2 and W3) in both seasons and for 1000 - seed weight in the first

season only. Frequent watering (W1) produced significantly (P=0.05) greater seed yield (2831 and 2575 kg/ha), had more number of seeds / m^2, wider head diameter, heavier 1000 – seed weight and lowest unfilled seeds for both seasons, respectively.

The effects of skipping of irrigation on seed yield , and yield components were reported by many workers who agreed with our findings. Osman (1989), showed that soil moisture stress suppressed plant growth and resulted in plants which had seed yield reduction by more than 50%. Ahmed *et al.* (2006) reported that the frequent irrigation (every 7 days) led to higher number of seeds /head , seed yields and lower unfilled seeds/head compared with those of every 14 or 21 days. However, Mekki (1984), disagreed with our results. He stated that the number of seeds/head and seed yield were not significantly affected by irrigation at depletion of 40, 60 and 80% of available soil moisture.

3- Cultivar.

The yield and yield components of the two cultivars Hysun 33 (V2) and Damazin were similar in both seasons .There were no significant differences between the two cultivars in yield and yield components, yet Hysun 33 produced consistently higher seed yield (2241 kg/ha) than Damazin (2170 Kg/ha), higher number of seeds/m2, wider head diameter , heavier 1000 seed weight and less unfilled seeds (Table 4)

4. The interaction

The SD1XW1 plants produced significantly (P=0.05) greater seed yields, higher number of seeds/m^2, wider head diameter (cm), heavier 1000-seed weight(g) and less unfilled seeds/head (%) than other treatment combinations, in both seasons (Table 5a ,b). Also, the interaction of sowing date X cultivars produced significantly (P=0.05) greater values than the other treatment combinations, in both seasons. Moreover, the interaction of skipping of irrigation X cultivar was significant (P=0.05) in both seasons and the W1with V1 produced significantly (P=0.05) greater seed yields and higher number of seed/m^2 than other treatment combinations, in both seasons (Tables 5a , b) .

Table 5a. Interaction effects of sowing date (SD), skipping of irrigation (W), and cultivar (V) on yield and yield components of sunflower in 2005/06 season.

Treatment	Seed yield (kg/ha)	No. of seeds/m^2	Head diameter (cm)	1000seed weight (g)	Unfilled seeds(%)
SD1XW1	2947.8	6012	15.3	49.7	13.1
SD1XW2	2274.4	5268	12.7	43.6	15.6
SD1XW3	1873.8	4712	12.2	40.4	17.5
SD2XW1	2736.2	5656	15.2	49.1	13.1
SD2XW2	1979.5	4679	12.1	42.8	17.0
SD2XW3	1724.7	4435	11.7	39.8	16.7
SD3XW1	2809.9	5809	14.7	49.1	14.5
SD3XW2	1914.7	4601b	12.2	43.5	17.2
SD3XW3	1590.9	4385	11.8	37.4	17.4
SE±	73.1	229.3	0.3	1.5	0.4
SD1XV1	2292.9	5291	13.3	43.3	16.1
SD1XV2	2437.8	5370	13.5	45.9	14.7
SD2XV1	2138.3	4967	12.9	43.0	16.3
SD2XV2	2155.3	4880	13.0	45.0	14.9
SD3XV1	2080.5	4911	12.8	42.3	16.7
SD3XV2	2129.8	4953	13.0	44.4	16.0
SE±	65.4	135.7	0.2	1.1	0.3
W1XV1	3044.1	6199	15.0	49.9	13.8
W1XV2	2618.5	5453	15.1	48.8	13.3
W2XV1	1809.7	4591	12.4	40.1	17.5
W2XV2	2302.7	5108	12.2	46.4	15.7
W3XV1	1657.9	4380	11.6	38.5	17.9
W3XV2	1801.7	4642	12.1	39.9	16.5
SE±	65.4	135.7	0.2	1.1	0.3
Mean	2205.8	5062	13.1	43.92	15.8
C.V%	10.3	9.3	5.1	8.6	7.0

The interaction of the three factors was significant (P=0.05) as differences were observed among the treatment combinations. The SD1W1V1 significantly (P=0.05) produced greater values of seed yield, higher number of seeds / m^2, head diameters , heavier 1000 - seed weights and less unfilled seeds/head , in both seasons (data not shown).

The interaction effects of season and sowing date, season and skipping of irrigation and season and cultivar on yield and yield component were significant. Treatments of Se1 XSD1 or Se1XW1 generally, gave significantly (P=0.05) greater values for yield and its components. Moreover, Se1 XV2 out yielded the V1 in all parameters.

Table5b. Interaction effects of sowing date (SD), skipping of irrigation (W), and cultivar (V) on yield and yield components of sunflower in 2006/07 season.

Treatment	Seed yield (kg/ha)	No. of seeds/m^2	Head diameter (cm)	1000 seed weight (g)	Unfilled seeds (%)
SD1XW1	2953.2	6113	15.2	47.8	12.2
SD1XW2	2299.3	5291	13.0	44.2	14.5
SD1XW3	1650.9	4439	12.8	39.9	15.0
SD2XW1	2456.6	5433	14.3	46.0	10.8
SD2XW2	1688.9	4722	12.4	36.7	16.6
SD2XW3	1533.3	4290	12.4	36.0	13.6
SD3XW1	2314.3	5202	13.8	45.5	13.2
SD3XW2	1661.6	4551	12.4	38.2	15.8
SD3XW3	1641.4	4654	12.6	36.2	15.9
SE±	148.0	286.1	0.3	1.4	1.2
SD1XV1	2185.3	5091	13.6	42.2	13.0
SD1XV2	2416.1	5470	13.8	45.7	14.9
SD2XV1	1956.3	4982	12.9	39.3	12.5
SD2XV2	1829.5	4648	13.2	39.8	14.8
SD3XV1	1865.6	4712	12.9	40.2	14.8
SD3XV2	1879.3	4892	12.9	39.8	15.1
SE±	117.2	194.1	0.3	1.2	1.3
W1XV1	2809.1	6058	14.6	46.7	10.6
W1XV2	2340.3	5107	14.3	46.2	13.5
W2XV1	1648.0	4461	12.2	37.8	15.2
W2XV2	2118.5	5247	12.9	41.6	16.0
W3XV1	1550.1	4266	12.5	37.2	14.4
W3XV2	1666.8	4656	12.7	37.5	15.3
SE±	117.2	194.1	0.3	1.2	1.3
Mean	2022.2	4966	13.2	41.6	14.2
C.V%	20.2	13.5	6.5	9.7	30.7

The seed yield and 1000- seed weight of the first season were significantly (P=0.05) higher than those in the second season. However, the reverse was true for unfilled seeds (%). Although no significant differences were detected for number of seeds/m^2 or head diameter (cm), plants of the first season outyielded those of the second one. The hybrid Hysun 33 outyielded Damazin in all parameters. The seed yield produced by hybrid was 2241 and 2042 in first and second season respectively and were 2171 and 2002 for Damazin. The seed yield of Damazin were similar in both seasons while the production of the hybrid in the first season was higher by about % than that at the second one.

Table 6. Interaction effects of season (Se), sowing date (SD), skipping of irrigation (w) and cultivar (V) on yield and yield components of sunflower in 2005/07 seasons.

Treatment	Seed yield (Kg/ha)	No. of seeds/m^2	Head diameter (cm)	1000 seed weight (g)	Unfilled seeds (%)
Se 1X SD1	2365.3	5330	13.4	44.5	15.4
Se 1X SD2	2146.7	4923	13.0	43.9	15.6
Se 1X SD3	2105.2	4932	12.9	43.3	16.4
Se 2X SD1	2301.1	5281	13.7	44.0	13.9
Se 2X SD2	1892.9	4815	13.0	39.6	13.6
Se 2X SD2	1872.5	4902	12.9	40.0	14.9
SE±	64.1	144.1	0.2	0.8	0.5
Se 1XW1	2831.2	5826	15.1	49.3	13.6
Se 1XW2	2056.2	4849	12.3	43.2	16.6
Se 1XW3	1729.8	4511	11.9	39.2	17.2
Se 2XW1	2574.7	5583	14.4	46.4	12.1
Se 2XW2	1883.3	4854	12.6	39.7	15.6
Se 2XW3	1608.5	4461	12.6	37.4	14.8
SE±	64.1	144.1	0.2	0.8	0.5
Se 1XV1	2170.1	5056	13.0	42.8	16.4
Se 1XV2	2240.9	5067	13.2	45.0	15.2
Se 2XV1	2002.4	4929	13.1	40.6	13.4
Se 2XV2	2041.9	5003	13.3	41.8	14.9
SE±	54.8	96.7	0.1	0.7	0.5
Mean	2114.0	5014	13.2	42.5	14.9
C.V%	15.6	11.6	5.9	9.1	21.2

RECOMMENDATION

Based on the findings of this study, it can be recommended that October , 20^{th} is an optimum sowing date for hybrid hysun 33 (winter sunflower) in Sudan, and for maximum seed yield, the crop should not be subjected to water stress during the bud formation or the flowering stage.

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أثر موعد الزراعة وحذف رية واحدة علي نمو و إنتاجية محصول زهرة الشمس الشتوي

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الخلاصة

أجريت التجارب الحقلية لهذه الدراسة في كل من مزرعة كلية الزراعة والموارد الطبيعية ، ابوحراز والمزرعة التجريبية لكلية العلوم الزراعية ، جامعة الجزيرة ، وادمدني ، السودان، خلال 2006/2005 و 2007/ 2006 لدراسة تاثير مواعيد الزراعة و حذف رية علي نمو و إنتاجية محصول زهره الشمس (*Helianthus annuus* L). اشتملت الدراسة علي المعاملات : أ/ ثلاثة مواعيد للزراعه (20 أكتوبر ، 20 نوفمبر و20 ديسمبر) ب/ ثلاثة نظم رى (رى منتظم وحذف رية عند ظهور البراعم أوعند بداية الأزهار) وصنفين : Hysun 33 (هجين) و Damazin (مفتوح التلقيح). سجلت الزراعة المبكرة (20 أكتوبر) أعلي طول نبات ومعامل مساحة ورقية ووزن جاف مقارنة بالزراعات الأخرى (20 نوفمبر و20 ديسمبر). كما سجلت زيادة معنوية في إنتاجية الحبوب بحوالي 10% و 18.2 % عن الزراعة في 20 نوفمبر او20 ديسمبرعلي التوالي. النباتات المجهدة مائيا عند ظهور البراعم أو الأزهار كانت أقصر وذات صفات خضرية اقل و محصول حبوب اقل بحوالي 27.4 % الي 32.1 % و 39% الي 42 % مقارنة بالنباتات التي لم تجهد مائيا للموسميين علي التوالي. يعزى الإنخفاض في المحصول للإنخفاض في قيم كل من وزن ال 1000 حبة وعدد الحبوب / لوحدة المساحة. أعطي الهجين Hysun 33 أعطى إنتاجية مقارنا بالصنف دمازين. توصي الدراسة بزراعة الصنف الهجين Hysun 33 في 20 إكتوبر وبعدد 8 ريات تحت ظروف وسط السودان (الجزيرة) للحصول علي نباتات ذات نمو خضرى جيد وعلي أعلي إنتاج لمحصول زهرة الشمس الشتوى.