Effect of Planting Time and Nitrogen Levels on various yield Components of Sunflower (*Helianthus annus* L.)

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Abstract A field experiment was planned to check the effect of different planting times and different nitrogen rates on yield and yield components of sunflower hybrid FH-331. The experiment was conducted at Research Area of Agronomy Farm, University of Agriculture, Faisalabad in split plot design having three replications, keeping different planting times i.e. (15 January, 25 January and 05 February) in the main plots and different nitrogen rates (100 kg ha^{-1}, 150 kg ha^{-1} and 200 kg ha^{-1}) in sub plots. The net plot size was 6 m x 3m. The statistical analysis of data revealed that different planting dates and nitrogen rates showed significant response regarding yield. Maximum plant height (198 cm) was recorded where nitrogen was applied at the rate of 200 kg ha^{-1} at the sowing date (SD_2) of 25 January. 1000 achene weight was maximum (66 g) at the nitrogen level of N_3 (200 kg $ha^{-1)}$ while number of achenes per head (1417**)** was at SD_2 and N_3 (200 kg ha^{-1}). Biological yield was maximum at nitrogen level of 200 kg ha^{-1} where 2nd sowing date was 25 January. Maximum oil contents was produced at N_1 (100 kg ha^{-1}) nitrogen level. While stem diameter was maximum (2.02 cm) at 2nd sowing date (25 January). Head diameter was maximum at nitrogen level of N_3 (200 kg h^{-1}). Achene yield was maximum at the 2nd sowing date (25 January) and N_3 nitrogen level of (200 kg ha^{-1}). Nitrogen application also showed significantly best response regarding achene yield. The achene yield (3.20 t ha^{-1}) was maximum at N_3 (200 kg ha^{-1}) and 2nd sowing date (SD_2) of 25 January.
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1. Introduction

Sunflower (*Helianthus annus* L.) is the member of compositae family. Sunflower was used as an ornamental plant but in recent days it has gained the value as an important oilseed crop. The vegetable oil plays a key role in the budget of a country. Because of the lesser yield and production of sunflower in our country, the demands of vegetable oil are meet through import. Pakistan is third largest importer of vegetable oil by spending amount of foreign exchange on the import of this vegetable oil. At present Pakistan is producing 30 percent vegetable oil of its necessities and the left over 70 percent is fulfilled by imports. Oilseed crops have a vital importance in food and economy with reference to agriculture. Amongst oilseeds sunflower can never be neglected as it is adapted to environmental conditions of Pakistan and rich in nutrition. Locally, the edible oil production stood at 7, 78,000 instead of 20, 68,000 tons (estimated) three years back from now (Govt. of Pakistan, 2009). It is short duration crop of 90-120 days. It is grown easily twice a year in spring and autumn season. It is drought resistant and is being grown with increasing success in many semi-arid environments. Vitamins like A, D, E and K, make it fairly edible oil. Its seed contains high oil content ranging from 40 to 47 percent. The protein content of sunflower cake ranges from 20-40% (Gandhi et al., 2008).

Sunflower is a short duration crop so it has vital importance and it ranks second to the soybean in worldwide vegetable oil production. There are many problems with the production of sunflower crop like insect-pest attack, soil fertility, and improper sowing date but the major problems are of improper sowing dates and nitrogen fertility. Because of the improper use of fertilizer and improper sowing time, the yield of sunflower affected. Nitrogen is vital and most important nutrient for the functioning and production of sunflower. Increase in the seed yield of sunflower observed in different experiments by applying proper dose of nitrogen. Efficiency of all growth parameters and physiological processes is improved by providing optimum nitrogen (Munir *et al.,* 2007; Ahmed *et al.,* 2009). Nitrogen has positive relation with the leaf area and leaf area index, as total leaf area of crop increases

with nitrogen and photosynthetic rate. Basha (2000) observed maximum seed yield of sunflower in response to nitrogen. A significant increase in seed and oil yield were observed by applying highest dose of nitrogen fertilizer. Lawlor (2002) pointed out that nitrogen is crucial for the vegetative and reproductive growth of plant and high yield can be possible under adequate nitrogen supply. Nitrogen fertilization has serious effect on seed yield, as well as on head of sunflower (Scheiner *et al.,* 2002). Cechin and Fatima-Fumis (2004) observed that growth and dry matter production of sunflower increased by nitrogen application, and it can be observed one month after sowing.

When the sowing is delayed, yield and yield enhancing components of the crop get reduced under the subtropical environmental conditions (Ahmad *et al.,* 2005). Crop duration, rate of assimilation, leaf area and crop growth are the elementary factors of the output of sunflower. With rise in leaf area and crop growth duration, there will be maximum net assimilation rate which eventually will increase the final seed yield of the crop. Spring planted sunflower is considered by larger leaf area and extra net assimilation rate which gives to the grater seed yield (Reddy *et al.,* 2003). When the time of sowing is delayed, the crop faces very high temperature throughout its vegetative growth period which finally enhanced the plant growth and minimized the growth period. The decrease in growing period minimized the extent of light capture and ultimately reduces the crop dry mass (Barros *et al.,* 2004). The sunflower has been renowned as a crop with great potentials that can effectively come across future oil necessities (Bakht *et al.,* 2010).The planting time significantly influence the grain yield and quality (Refay, 2010). The sunflower has been renowned as a crop with great potentials that can effectively come across future oil necessities (Bakht *et al.,* 2010).The planting time significantly influence the grain yield and quality (Refay, 2010). The present study was therefore conducted determine the effect of different sowing dates on the yield and yield components of sunflower and the optimum level of nitrogen for sunflower crop.

2. Matrials And Methods

The experiment was conducted at Agronomic Research Area, University of Agriculture, Faisalabad (31°.26" N, 73°.06" E and Altitude 184.4 m). The analysis of soil was carried out before sowing the crop (Table 1).

The experiment was conducted during the spring season of 2014. The experiment was laid out in randomized complete block design with split plot arrangement with three replications. The main plots consisted of the sowing date treatments, while nitrogen levels were in the sub plots. There were three sowing dates i.e. (15 January, 25 January and 05 February) and three nitrogen (N) levels i.e. (100 kg ha^{-1}, 150 kg ha^{-1} and 200 kg ha^{-1}). Prior to planting, deep ploughing was done with chisel plough and three cultivations were done with the help of common cultivator at the experimental site. After field preparation flat sowing was done with hand drill. The net plot size was 6 m x 3 m. After germination and seedling establishment, plants were thinned to one plant per hill. Crop was irrigated with canal water using surface irrigation method. To control weeds, the plots were hoed twice. Following hoeing the crop was earthed up manually to protect it from lodging. The nitrogen was applied in the form of urea in four splits and amount was according to the treatments. The first split was applied at the time of sowing, second at the time of first irrigation, third at the time of second irrigation and forth at flowering stage.

Treatments:

Factor A: Sowing date (Main plot), SD_1: 15-Jan. 2014, SD_2: 25-Jan. 2014, SD_3: 05-Feb. 2014 **Factor B:** Nitrogen Level (kg ha^{-1}) (Sub Plot), N_1: 100, N_2: 150, N_3: 200

Table 1. Chemical Analysis of Soil

Soil Properties	
A. **Physical Properties**	
Soil type	Sandy clay loam
B. Chemical Properties	
PH	7.56%
Organic Matter	0.87%
Total Soluble Salts	12.22%
Nitrogen	0.062%
Phosphorus	6.90 ppm
Potassium	193 ppm

Observations: In the experimental trials, the plot area was utilized for growth and developmental studies and for the final harvest data.

Final Harvest

At final harvest, one row with a length of 6 m from each plot was harvested. A subsample of plants was obtained to measure the yield components. All the heads including sub sample were threshed manually to estimate achene yield of entire plot and converted into tons ha^{-1}. For the measurement of achene moisture, the subsample of 500 g was weighed, dried and then weighed again, so the final yield was corrected to 10% moisture. The following data were collected according to standard procedure: Plant height at Maturity (cm), Number of plants per plot at harvest, Stem diameter (cm)., Head diameter (cm), Number of achene per head, 1000-achene weight (g), Achene yield (t ha^{-1}), Biological Yield (kg ha^{-1}), Harvest index (%), Achene oil contents (%). The oil contents were determined by

soxhlet fat extraction method (Kiriamiti *et al.,* 2001). First of all, seeds were dried at 105°C in an oven for about 8 hour (Kiriamiti *et al.,* 2001) and for moisture content analysis; seeds were weighed prior and after drying of seeds. For analysis, two gram seed per thimble were ground in a coffee mill. The thimbles were weighed separately and the ground seeds were added and final weight was recorded. The thimbles were then placed in extractors. Six dry and clean 250 ml round bottom flasks were weighed and their weight recorded (Kiriamiti *et al.,* 2001), Solvent (petroleum ether) was added to flasks, they were connected to the extractor and placed on heating mantles, connected with condensers, these flasks were heated and extraction was continued for at least 6 hour, then after the 6 hour the extraction was allowed to stopped and remove the thimbles and reheated the flasks, all the solvent could be collected into the Soxhlet extractors. Finally, the apparatus allowed cooling down and flasks are dried again at l05°C for one hour. All the oil was then weighed together and the percent oil content was collected by using following equation as suggested by Scheiner *et al.,* 2002).

$$\% \text{ Oil} = \frac{\text{Wt. of flask + oil - Wt. of flask}}{\text{Wt. of flask + seed - Wt. of flask.}} \times 100$$

Statistical analysis

The experimental data were statistically analyzed using the computer program MSTAT-C (Steel *et al.*, 1997). Analysis of variance technique was employed to test the overall significance of the data, while the least significance difference (LSD) test at P = 0.05 was used to compare the differences among treatments means for different yield and yield components. The factors consisted of three sowing times; 15 January, 25 January and 05 February, which were the main plots and the three nitrogen levels, i.e. 100 kg ha^{-1}, 150 kg ha^{-1} and 200 kg ha^{-1}, which were part of the sub plots.

3. Results And Discussion

In the present study, a field experiment was performed to estimate the influence of three nitrogen levels. Three sowing dates on yield and yield components of sunflower hybrid FH-331 that was sown in the year 2014 at agronomic research farm, University of Agriculture, Faisalabad. The obtained results were explained as.

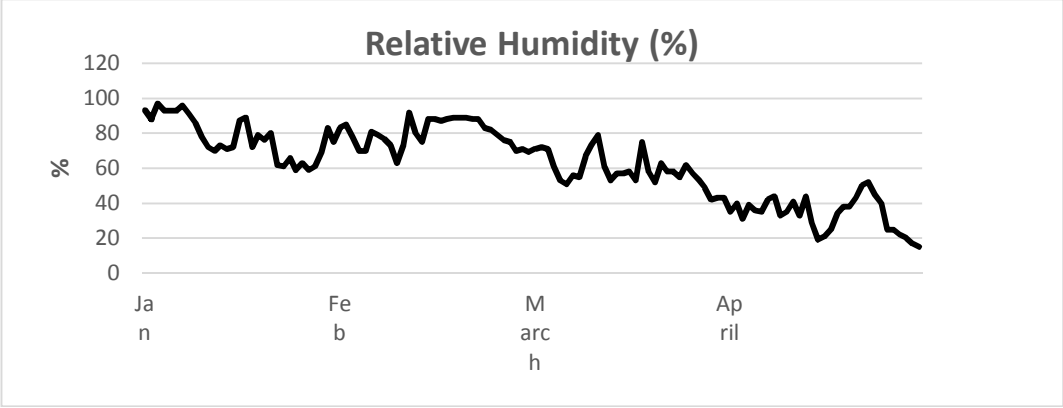

Fig. 1.

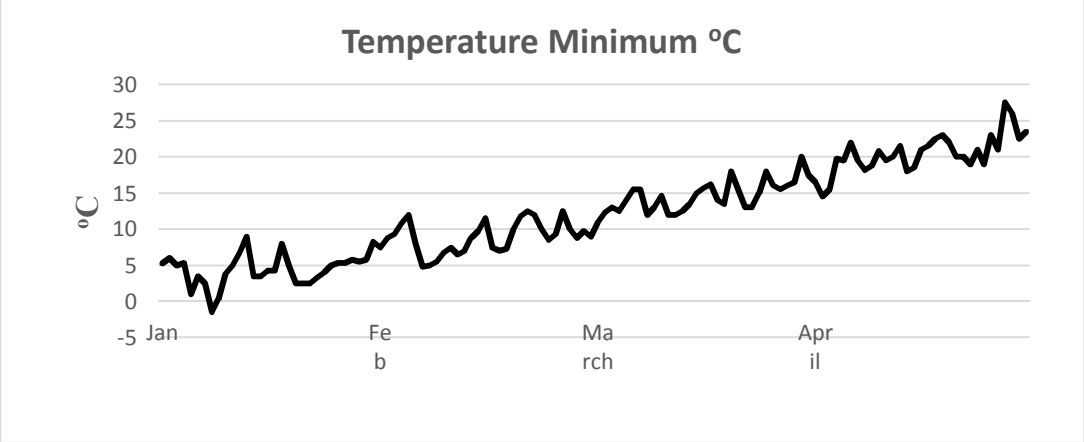

Fig. 2.

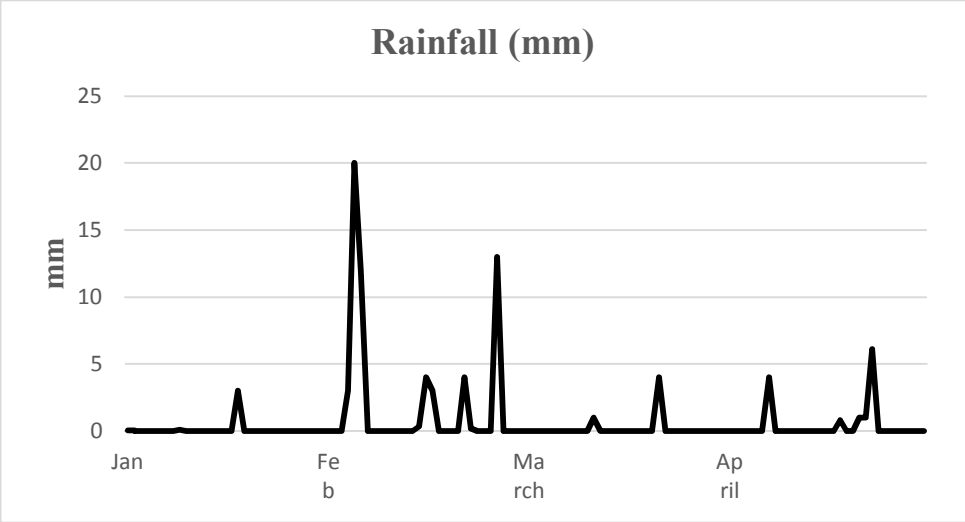

Fig. 3.

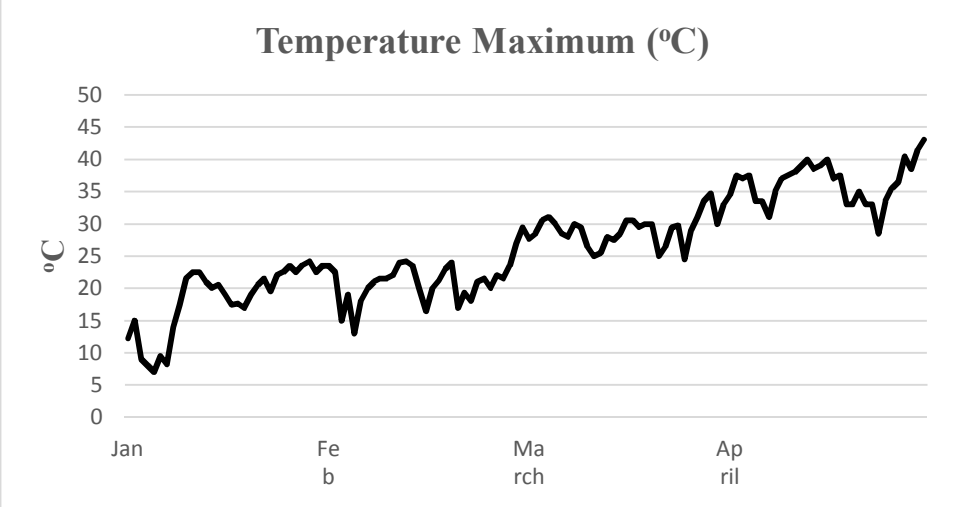

Fig. 4.

Agronomic Traits And Yield Components

Plant height (cm)

The height of plant is an essential agronomic character that is the feature of seed vigor, genetic makeup of a plant, soil nutrient position and the environmental conditions where it is cultivated. The data showed in the table 2 and 12 and it was recorded a significant results regarding plant height. The interactive response of nitrogen and sowing dates was not produced significant response regarding plant height. The maximum plant height (198.00 cm) was observed in sowing date (SD_2) of 25 January with the nitrogen rate (N_3) of 200 kg ha^{-1}, which is similar regarding plant height of (197.33 cm) with sowing date of (SD_1) January 15 at nitrogen level of 200 kg ha^{-1}. But smallest height of plant (179.67.00 cm) was recorded in the sowing date (SD3) of 05 February where nitrogen was applied at the rate of 100 kg ha-1 which is statistically same for plant height of (181.33cm), at the sowing date (SD_1) 15 January and nitrogen level of 100 kg ha^{-1} and similar with the plant height of (181.67 cm) at sowing date of 25 January at nitrogen rate of 100 kg ha^{-1}.The separate reaction of nitrogen fertilizer by many rates on plant height was significantly different. Though, greatest plant height (196.67 cm) was shown by N_3 treatment at the rate of (200 kg ha-1), which is statistically different with (186.33 cm) by N2 treatment at the rate of (150 kg ha^{-1}). Statistically smallest plant height (180.89 cm) was shown by N_1 treatment at the rate of (100 kg ha^{-1}).

The separate effect of sowing date on plant height was not significantly different, therefore maximum plant height (189.89 cm) was produced sowing date (SD_2) of 25 January. Statistically minimum plant height was observed (186.67 cm)

with sowing date (SD_3) of 05 February (table 2 and 12). The findings were authenticated with the results described by Cantagallo *et al.* (2004) who have also specified special effects of nitrogen on planting density of sunflower and the effects of nitrogen rates and sunflower hybrids were said to be found statistically non-significant.

Table 2. Impact of Planting Time and Nitrogen Levels on the Plant Height (cm)

Treatments	N_1	N_2	N_3	Mean
SD_1	181.33	183.33	197.33	187.33
SD_2	181.67	190	198	189.89
SD_3	179.67	185.67	194.67	186.67
Mean	180.89 C	186.33 B	196.67A	187.96

Lsd Values

Nitrogen level means = 2.36; Sowing Date means = 2.66; Interaction means = 4.10,

Number of Plants per plot at Harvest

Plant population provides a base and plays an important role in final yield of a crop. A uniform plant population was maintained by thinning at 4-5 leaf stage of the crop. However, plant population per plot at harvest was again recorded to investigate whether various sowing dates and nitrogen levels had any effect on plant survival during growth period. Table (2 and 12) represents the data about the plant population effected by different sowing dates and nitrogen levels. Planting time effect on number of plants per plot was found to be significant. Nitrogen levels did not change the planting density status. Results show that a significant difference was observed from sowing dates. Similarly interactive effect of sowing dates and nitrogen levels on plant population was also non-significant. The maximum number of plants (97.88) was recorded at sowing date (SD_2) on 25 January and minimum number of plants was at N_3 (92.56) and (93.33) was at SD_1 (15 January) while nitrogen rates shows non-significant difference. In case of delayed sowing, less germination m^{-2} was observed that was due to the temperature fluctuations because as the sowing delayed temperature reduced that cannot fulfill the demands of the seed to germinate. (Tahir *et al.,* 2009).

Table 3. Impact of Planting Time and Nitrogen Levels on the No. of Plants per Plot at Harvest

Treatments	**N_1**	**N_2**	**N_3**	**Mean**
SD_1	**93**	**93**	**94**	**93.33B**
SD_2	**98.66**	**98.33**	**96.67**	**97.88A**
SD_3	**92.33**	**93**	**92.33**	**92.56B**
Mean	**93.56**	**94.11**	**94.33**	**94**

LSD Values

Nitrogen level means = 0.97; Sowing Date means = 0.87; Interaction means = 1.69

The normal stem diameter is a very important factor that contributing in yield and plays a significant role to express the hybrid potential. The stem diameter statistically significant and shows a significant difference in different treatments .Therefore, over all stem diameter (2.170 cm.) was produced by the sowing date (SD_2) of (25 January) at the nitrogen rate of 200 kg ha^{-1} and the minimum stem diameter was produced by the sowing date (SD_1) of (15 January) at the nitrogen rates of 100 kg ha^{-1} which produced (1.707cm.) stem diameter.

The individual effect of nitrogen is also statistically different from each other. The maximum stem diameter (2.072 cm.) were found in N_3 (200 kg ha^{-1}), and the minimum stem diameter (1.761 cm.) was developed in N_1 (100 kg ha-1). The stem diameter (1.918 cm.) in N_2 (150 kg ha^{-1}) was greater than N_1 and statistically less than N_3.

The individual effect of sowing date is also statistically different to one another. The maximum stem diameter (2.02 cm.) was produced by sowing date (SD_2) of (25 January) which is statistically different (1.869 cm.) stem diameter developed by sowing date (SD_3) of (05 February). The minimum stem diameter (1.862.) was developed by sowing date (SD_1) of (15 January) (table 3 and 12). The interaction between plant spacing and nitrogen levels significantly affected plant height, stem diameter, head diameter, number of seeds per head, seed yield ha^{-1} and seed oil yield ha^{-1}. Plant height reached its maxima (218 cm) with sowing sunflower on 25 cm and adding 200 kg N ha^{-1}. Al-Thabet, (2006).

Table 4. Impact of Planting Time and Nitrogen Levels on the Stem Diameter (cm)

Treatments	N_1	N_2	N_3	Mean
SD_1	1.707g	1.887d	1.993c	1.862B
SD_2	1.823e	2.067b	2.170a	2.02A
SD_3	1.753f	1.800e	2.053b	1.869B
Mean	1.761C	1.918B	2.072A	1.917

LSD Values

Nitrogen level means = 1.68; Sowing Date means = 1.62; Interaction means = 2.91

Head diameter The individual effect of nitrogen is statistically different from each other. The maximum head diameter (18.11 cm) were found in N_3 (200 kg ha^{-1}), and the minimum head diameter (15.89 cm) was developed in N_1 (100 kg ha^{-1}).The head diameter (17.11 cm) in N_2 (150 kg ha^{-1}) was greater than N_1 and statistically at par with N_3. The individual effect of sowing date is also statistically different to one another. The maximum head diameter (18.78 cm) was produced by sowing date (SD_2) of (25 January) which is statistically different (16.22 cm) head diameter developed by sowing date of (05 February). The minimum head diameter (16.11 cm) was developed by sowing date (SD_1) of ((15 January) (table 4 and 12). The significant and linear response of nitrogen on sunflower achene yield can be accounted for the positive response of agronomic characteristics to nitrogen application. Among different components, head diameter is of prime importance for yield determination. As N fertilizer rate increased, the head diameter also increased (Ozer *et al.,* 2004). Nitrogen fertilization has serious effect on seed yield, as well as on head of sunflower (Scheiner *et al.,* 2002). The enhancement in the diameter of head might be accredited to new vegetative development due to fertilizer etc. These effects authenticate the findings of Iqbal *et al.* (2008) that has also the indication concerning to helpful effects on head diameter of nitrogen of sunflower crop, while the shared things of nitrogen rates and sunflower hybrids were found to be statistically significant.

Table 5. Impact of Planting Time and Nitrogen Levels on the Head Diameter (cm)

Treatments	N_1	N_2	N_3	Mean
SD_1	5.67	16	16.67	16.11 B
SD_2	17	18.67	20.67	18.78 A
SD_3	15	16.67	17	16.22 B
Mean	15.89 B	17.11 A	18.11 A	17.04

LSD Values

Nitrogen level means1 = .02; Sowing Date means = 0.66; Interaction means = 1.77

Number of achenes per Head

The number of achene's per head statistically significant and shows a significant difference in different treatments .Therefore, over all maximum achene's per head (1142.33) was produced in the sowing date(SD_2) (25 January) at the rate of (N_3) 200 kg ha^{-1} nitrogen. The minimum number of achenes per head (998.67) was developed by the sowing date (SD_3) of 05 February at the nitrogen rate (N_1) of 100 kg ha^{-1}.The individual effect of nitrogen is also statistically different from each other. The maximum number of achene's per head (1115.44) were found in N_3 (200 kg ha^{-1}), and the minimum number of achene's per head (1023.56) was developed in N_1 (100 kg ha^{-1}). The number of achenes (1053.11) in N_2 (150 kg ha^{-1}) was greater than N_1 and statistically less than N_3 as shown in table (5).The individual effect of sowing dates is also statistically different from one another. The maximum number of achene's per head (1094.11) was produced by sowing date (SD_2) (25 January) which is statistically different (1061.33) achenes per head by sowing date (SD_3) 05 February. The minimum number of achenes per head (1044.67) was developed by 15 January sowing (SD_1). These results verifies the studies conducted by Cantagallo *et al.* (2004), who also stated that the lack of nitrogen affects the growth of both sink and source, therefore it also effect on the number of achene per head. Quantity of achenes per head is also optimistically linked with head size and ultimately contributing towards final grain yield. Privileged grain yields designed for greater N treatments are connected by means of higher grain number (Zubillaga *et al.,* 2002). The establishment of grain number around seed formation stage is dependent on the translocation of assimilates to some extent Al-Thabet (2006) also highlighted that increasing levels of nitrogen enhanced the achene number.

Table 6. Impact of Planting Time and Nitrogen Levels on the No of Achene per Head

Treatments	N_1	N_2	N_3	Mean
SD_1	1018.33 h	1028.67 g	1087.00 c	1044.67 C
SD_2	1065 f	1075 d	1142.33 a	1094.11 A
SD_3	998.67 i	1068.33 e	1117.00 b	1061.33 B
Mean	1023.56 C	1053.11 B	1115.44 A	1064.04

LSD Values

Nitrogen level means = 2.84; Sowing Date means = 4.29; Interaction means = 4.91 1000

Achene Weight

The normal achene weight is a very important factor that contributing in yield and plays a significant role to express the hybrid potential. The thousand achene weight per head statistically significant and shows a significant difference in different treatments as shown in the table (4.6). Therefore, over all maximum thousand achene weight (66.00 g) was produced by the sowing date (SD_1) of (15 January) at the nitrogen rate of 200 kg ha^{-1} and the minimum thousand achene yield was produces by the sowing dates of (25 January) and (05 February) at the nitrogen rate of 100 kg ha^{-1} which produced (48.33.) and (50.00 g) thousand weight achene per head, respectively. The individual effect of nitrogen is also statistically different from each other. The maximum thousand achene weight per head (64.11 g) were found in N_3 (200 kg ha^{-1}), and the minimum number of achene's per head (51.11 g) was developed in N_1 (100 kg ha^{-1}). The number of achene's (55.00 g) in N2 (150 kg ha^{-1}) was greater than N_1 and statistically less than N_3. The individual effect of sowing date is also statistically different to one another. The maximum thousand achene weight per head (58.44 g) was produced by sowing date (SD_3) of (February 05) which is statistically different (56.44 g) thousand achene weight per head developed by sowing date (SD_1) of (15 January). The minimum thousand achene weight per head (55.33 gm.) was developed by sowing date (SD_2) of (25 January).

Anwar-ul-Haq *et al.* (2006) also reported that a better yield response from com by nitrogen use under suitable soil water conditions, therefore the data concerning thousand achene weights shown that it was considerably affected by different planting densities and nitrogen rates. These results are also in conforming to Khaliq and Cheema (2005).

Table 7. Impact of Planting Time and Nitrogen Levels on the 1000 Achene Weight (g)

Treatments	N_1	N_2	N_3	Mean
SD_1	48.33e	55.00cd	66.00a	56.44B
SD_2	50.00e	53.00d	63.00b	55.33B
SD_3	55.00cd	57.00c	63.33ab	58.44A
Mean	51.11C	55.00B	64.11A	56.74

LSD Values

Nitrogen level means = 1.62; Sowing Date means = 1.62; Interaction means = 2.82

Achene Yield (t ha^{-1})

The treatment effect on achene yield was significantly different. The achene yield statistically significant and shows a significant difference in different treatments. Therefore, overall maximum achene yield (3.20) was produced at 2nd (25 January) sowing date and 3rd nitrogen level (200 kg ha^{-1}). The overall minimum achene yield (2.30) was produced at 3rd sowing date (05 February) and 1st nitrogen level (100 kg ha^{-1}) as shown in the table (4.7). The individual effect of nitrogen is also statistically different from each other. The maximum achene yield (2.97) were found in N_3 (200 kg ha^{-1}) which is statistically different from each other. The minimum achene yield (2.52) was developed in N_1 (100 kg ha^{-1}). The individual effect of sowing date is also different from one another. The maximum achene yield (3.02) was produced by (SD2) (25 January). The minimum achene yield was developed by SD_1 (15 January) (2.50). An increase in achene yield of sunflower hybrids in response to nitrogen fertilizer has also been stated by Ahmad *et al.,* 2005). It was observed a progressive and reliable rise in achene weight with addition in N dose up to 160 kg ha^{-1}. Nitrogen fertilization has serious effect on seed yield, as well as on head of sunflower (Scheiner *et al.,* 2002). Cechin and Fatima-Fumis (2004) observed that growth and dry matter production of sunflower increased by nitrogen application, and it can be observed one month after sowin.

Table 8. Impact of Planting Time and Nitrogen Levels on the achene yield (t ha^{-1})

Treatments	N_1	N_2	N_3	Mean
SD_1	2.40 f	2.43f	2.66 e	2.50 C
SD_2	2.86 cd	3.00bc	3.20 a	3.02 A
SD_3	2.30 f	2.80de	3.06 ab	2.72 B
Mean	2.52 C	2.77B	2.97 A	

LSD Values

Nitrogen level means = 0.10; Sowing Date means = 0.12; Interaction means = 0.12

Biological Yield (t ha^{-1})

The individual effect of nitrogen is also statistically different from each other. The maximum biological yield (12.44 t ha^{-1}) were found in N_3 (200 kg ha^{-1}), and the minimum biological yield (11.22 t ha^{-1}) was developed in N_1 (100 kg ha^{-1}).The biological yield (11.89 t ha^{-1}) in N_2 (150 kg ha^{-1}) was greater than N_1 and statistically at par with N_3. The individual effect of sowing date is also statistically different to one another. The maximum biological yield (12.44 t ha^{-1}) was produced by 2nd sowing date of (25 January) which is statistically different (11.67 t ha^{-1}) biological yield developed by 1st sowing date of (15 January). The minimum biological yield (11.44 t ha^{-1}) was developed by 3rd sowing date of (05 February).

Lawlor (2002) pointed out that nitrogen is crucial for the vegetative and reproductive growth of plant and high yield can be possible under adequate nitrogen supply. Nitrogen fertilization has serious effect on seed yield, as well as on head of sunflower (Scheiner *et al.,* 2002). Cechin and Fatima-Fumis (2004) observed that growth and dry matter production of sunflower increased by nitrogen application, and it can be observed one month after sowing. Efficiency of all growth parameters and physiological processes is improved bv providing optimum nitrogen. Nitrogen has positive relation with the leaf area and leaf area index, as total leaf area of crop increases with nitrogen and photosynthetic rate (Ahmad *et al*., 2005).

Table 9. Impact of Planting Time and Nitrogen Levels on the Biological Yield (t ha^{-1})

Treatments	N_1	N_2	N_3	Mean
SD_1	11	11.67	12.33	11.67B
SD_2	12	12.33	13	12.44A
SD_3	10.67	11.67	12	11.44B
Mean	11.22B	11.89AB	12.44A	11.85

LSD Values

Nitrogen level means = 0.85; Sowing Date means = 0.73; Interaction means = 1.47

Harvest Index (%)

The harvest index represents the physiological competence of plants to change the fraction of photo assimilates to achene yield. It is the ratio of achene yield over biological yield. The data of the Table showed that different nitrogen levels had significant effect on harvest index. Planting time had also significantly effect on harvest index. Therefore, overall maximum Harvest index (28.00%) was produced by sowing date (SD_2) of 25 January at the nitrogen rate (N_3) of 200 kg ha^{-1} and the minimum Harvest Index (22.00%) produced by the sowing date of (SD_1), (SD_2) and (SD_3) at the nitrogen rate of 100 kg ha^{-1}. The individual effect of nitrogen is also statistically different from each other. The maximum Harvest Index (25.56%) were found in N_3 (200 kg ha^{-1}), and the minimum number of Harvest Index (22.00%) was developed in N_1 (100 kg ha^{-1}). The Harvest Index (23.22%) in N_2 (150 kg ha^{-1}) was greater than N_1 and statistically less than N_3. The individual effect of sowing date is also statistically different to one another. The maximum Harvest Index (24.67%) was produced by sowing date (SD_2) of (25 January) which is statistically different (23.22%) Harvest Index developed by sowing date (SD_1) of (15 January). The minimum Harvest Index (22.89%) was developed by sowing date of (05 February). Increases in HI with increasing rate of nitrogen was due to better crop growth rate, which gave maximum photosynthates, LAI and ultimately produced more biological yield. Superior the efficiency of converting TDM into economic yield, higher will be the value of HI.

Table 10. Impact of Planting Time and Nitrogen Levels on the Harvest Index (%)

Treatments	N_1	N_2	N_3	Mean
SD_1	22.00d	23.00bcd	24.67b	23.22B
SD_2	22.00d	24.00bc	28.00a	24.67A
SD_3	22.00d	22.67cd	24.00bc	22.89B
Mean	22.00C	23.22B	25.56A	23.59

LSD Values
Nitrogen level means = 1.06; Sowing Date means = 0.90; Interaction means = 1.84

Achene Oil Content (%) Achene oil content is also an important character of sunflower. Our basic objective is to grown sunflower to get achene oil, because sunflower oil has best quality and our country face swear shortage of this oil. So to fulfill the sunflower oil shortage we sow this crop. According to the sowing date and nitrogen rate there is no significant difference in the production of oil content in the sunflower achene but in nitrogen rate alone there is significant difference in oil content. The individual nitrogen rates are affect statistically different on achene oil content and gives different values. The maximum achene oil content (39.33) was observed in nitrogen rate of 100 kg ha^{-1} and the minimum (37.22) achene oil content was recorded at nitrogen rate of 200 kg ha^{-1} which is statistically at par with (38.11) at the nitrogen rate of (N_2) 150 kg ha^{-1}. The individual sowing date was not statistically different in different sowing dates. The maximum achene oil content (38.56) was produced with the sowing date (SD_2) of 25 January and the minimum achene oil content (38.00) was produced in the sowing date (SD_1) of 15 January as shown in the table (11 and 12). This tells us that by using higher rate of nitrogen fertilizer, it improved the achene yield and however decreases achene oil content. Such results in response to nitrogen fertilization have also described by Dreher *et al.* (1983). Several reasons have been given by different researchers for the decrease in oil contents with increasing N rates. For example, Kutcher *et al* (2005) stated that it might be due to the dilution effect of increased seed yield with increased N fertilization and the inverse relationship of protein and oil content. Jackson (2000) believed that N delayed plant maturity which results in poor seed filling and greater proportion of green seed. Holmes (1980) reported that a better supply of N increases the formation of N containing protein precursors so that protein formation competes more strongly for photosynthesis; as result less of the latter are available for fat synthesis.

Table 11. Impact of Planting Time and Nitrogen Levels on the oil contents (%)

Treatments	N_1	N_2	N_3	Mean
SD_1	39.33	38	36.67	38
SD_2	40	38.33	37.33	38.56
SD_3	38.67	38	37.67	38.11
Mean	39.33 A	38.11 B	37.22 B	38.22

LSD Values Interaction means =1.74; Nitrogen mean = 1.00; Sowing Date means = 1.1

Table 12. Analysis of variance for Impact of Planting Time and Nitrogen Levels on various yield and yield components

SOV	DF	PH	pp	SD	HD	APH	TAW	AY	BY	HI	AOC
Replication	2	4.15	0.33	.0001	1.15	38.93	6.04	0.01	0.93	0.26	0.77
Sowing Date(SD)	2	26.04	31.44	.07	20.48	3914.04	22.37	0.61	2.48	8.04	0.77
Error 1	4	4.15	0.44	.0001	0.26	10.76	1.26	0.01	0.31	0.48	0.72
Nitrogen(N)	2	578.04	1.44	.21	11.15	19803.8	400.7	0.46	3.37	29.37	10.11
SD x N	4	10.54	0.72	.009	1.59	1044.65	16.93	0.06	0.09	3.59	0.72
Error 2	12	5.31	0.91	.0002	1	7.65	2.52	0.01	0.69	1.07	0.96
Total	26	51.5	3.15	.02	3.27	1993.34	36.97	0.1	0.9	4.02	1.56

PH=Plant height at Maturity (cm), PP=Number of plants per plot at harvest, SD=Stem diameter (cm)., HD=Head diameter (cm), NAPH=umber of achene per head, TAW=1000-achene weight (g), AY=Achene yield (t ha^{-1}),BY= Biological Yield (kg ha^{-1}), HI=Harvest index (%),AOC= Achene oil contents (%)

Conclusion

The data proposed that there is extensive possibility to increase the yield potential of sunflower hybrid by different nitrogen rates and sowing dates, depends upon the predominant environment situations. It could be concluded that the application of 200 kg nitrogen ha^{-1} at the sowing date of (25 January) produced higher achene yield and this is suggested for getting maximum yield under agro environmental conditions of Faisalabad. It is

recommended that future research must be done or focus on the development, growth, and yield of sunflower.

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References

1. Ahmad, G., A. Jan., F. Subhan, M. Akbar and Z. Shah. 2005. Exploring the optimum plant population and nitrogen requirements for higher yield of sunflower hybrid Gulshan-98. Sarhad J. Agric., 21: 373-375.
2. Ahmed, S., R. Ahmad, M.Y. Ashraf, M. Ashraf and E.A. Waraich. 2009. Sunflower *(Helianthus annuus* L.) response to drought stress at germination and seedling growth stages. Pak. J. Bot. 41: 647-654.
3. 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.
4. Anwar-ul-Haq, A., M.A. Rashid, M.A. Butt, M. Akhter, M. Aslam and A. Saeed. 2006. Evaluation of sunflower (.*Helianthus annuus* L.) hybrids for yield and yield components in central Punjab. J. Agri. Res. 44: 277-285.
5. Bakht, J., M. Shafi, M. Yousaf, Raziuddin and M.A. Khan. 2010. Effect of irrigation on physiology and yield of sunflower hybrids. Pak. J. Bot., 42(2): 1317-1326.
6. Barros, J.F.C., C., M. Decarvalh and G. Basch. 2004. Response of sunflower (Helianthus annus L.) to sowing date and plant density under Mediterranean condition. Europ. J. Agron., 21: 347-356.
7. Basha, H. A. 2000. Response of two sunflower cultivars to hill spacing and nitrogen fertilizer levels under sandy soil conditions. Zagazig J. Agric. Res., 27: 617-633.
8. Cantagallo, J.E., D. Medan and AJ. Hall. 2004. Grain number in sunflower as affected by shading during floret growth, anthesis and grain setting. Field Crops Res., 85: 191-202
9. Cechin, I., and T. de Fatima-Fumis. 2004. Effect of nitrogen supply on growth and photosynthesis of sunflower plants grown in the green house. Plant Sci., 166: 1379-1385.
10. Gandhi, A.P., K. Jha and V. Gupta. 2008, Studies on the production of defatted sunflower meal with low polyphenol and phytate contents and its nutritional profile. ASEAN Food Journal, 15 (1): 97-100.
11. Iqbal, J., B. Hussain, M.F. Saleem, M.A. Munir and M. Aslam. 2008. Bio-economics of autumn planted sunflower *(Helianthus annuus* L.) hybrids under different NPK applications. Pak. J. Agri. Sci. 45: 19-24.
12. Jackson, G. D. 2000. Effects of nitrogen and sulphur on canola yield and nutrient uptake. Agron. J., 92: 644-649.
13. Khaliq, A. and Z.A. Cheema. 2005. Influence of irrigation and nitrogen management on some agronomic traits and yield of hybrid sunflower. Int. J. Agric. Biol., 7: 915-919.
14. Kiriamiti, H.K., E. Rascol, A. Marty and J.S. Condoret. 2001. Extraction rates of oil from high oleic sunflower seeds with supercritical carbon dioxide. Chem. Engine. Proc., 41: 711-718.
15. Kutcher, H. R., S. S. Malhi and K.S. Gill. 2005. Topography and management of nitrogen and fungicide affects diseases and productivity of canola. Agron. J., 97: 533-541.
16. Lawlor, D.W. 2002. Carbon and nitrogen assimilation in relation to yield: mechanisms are the key to understanding production systems, J. Exp. Botany 53: 773-787.
17. McGraw Hill Book Co. New York. 1997.
18. Munir, M.A., M.A. Malik and M.F. Saleem. 2007. Impact of integration of crop manuring and nitrogen application on growth, yield and quality of spring planted sunflower *(.Helianthus annuus* L.). Pak. J. Bot. 39: 441-449.
19. Ozer, H., T. Polat and E. Ozturk. 2004. Response of irrigated sunflower *(Helianthns annuus* L.) hybrids to N fertilization, growth, yield and yield components. AUE, Turkey, Plant Soil Environ., 50: 205-211.
20. Reddy, B.V.S., P. Sanjana Reddy, F. Bidinger and M. Blummel. 2003. Crop management factors influencing yield and quality of crop residues. Field Crop Res. 48: 57-77.
21. Refay, Y.A. 2010. Root yield and quality traits of three sugar beet (Beta vulgaris L.) varieties in relation to sowing date and stand densities. World J. Agric. Sci., 6(5): 589-591.
22. Scheiner, J. D., F. H. Guterrez-Boem and R. S. Lavado. 2002. Sunflower nitrogen requirement and 15 N fertilizer recovery in western Pampas, Argentina. Eur. J. Agron. 17: 73-79.
23. Steel RGD. Torrie JH. Dickey DA. Principles and Procedures of Statistics: A biometrical approach.
24. Zubillaga M.M., J.P. Aristi and R.S. Lavado. 2002. Effect of phosphorus and nitrogen fertilization on sunflower *(Helianthus annuus* L.) nitrogen uptake and yield. J. Agron. Crop Sci. 188-. 267-274.

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