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Effect of planting dates and different levels of nitrogen on seed yield and yield components of nuts sunflower *(Helianthus annuus L.)*

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In order to study the effect of planting date and different levels of nitrogen on yield and growths of nuts sunflower (var. Doursephid), an experiment was conducted at Mahoodabad Experimental Field in Isfahan, in 2009. A split plot layout within a randomized complete block design with 3 replicates was used. The treatments in the main plots were sowing dates (May 5th and 20th and June 5th) and in the subplots treatments were nitrogen levels (0, 150, 200 and 250 kg N/ha). Results showed that the effect of planting date was significant on stem diameter, head diameter, number of grain per head, grain yield and biological yield. The effect of different levels of nitrogen was significant on plant height, stem diameter, biological yield and harvesting index. Interaction between planting date and nitrogen had significant influence on plant height, stem diameter, biological yield and harvesting index. The highest stem diameter, head diameter, grain yield and total yield was obtained in May 5th, and the highest plant height, stem diameter, head diameter, number of grain per head, 1000 grain weight and grain yield was obtained from usage of 200 kg N/ha. Results showed that 200 kg N/ha and May 5th is suitable for this variety in this region.

Key words: Planting date, nitrogen, nut sunflower, yield and yield components.

INTRODUCTION

Sunflower (*Hellianthus annuus* L.) seed is an important oilseed crop because it contains highly nutritious oil in large quantity (Shukla et al., 1992). Sunflower can be fitted well in Iran cropping pattern without bringing any major changes in cropping system management. In Iran, the high yields of grain and oil, has been the main goal of sunflower production. In general Iran has a suitable climate for this crop. Sowing date can play a major role in determining the seed yield and quality in Isafan region. Numerous research studies for different climates have shown that sowing date influences the growth, seed yield and quality of some oil crops such as rapeseed (Hocking, 2001). Degenhardt and Kondra (1981) concluded that delayed seeding resulted in significant decrease in seed yield and harvest index. Excessive nitrogen fertilization of sunflower reduced yield through an increase of plant height that makes plant lodging (Bailey, 1990). Proper nitrogen management optimizes seed yield, seed quality, farm profit, harvest index and N use efficiency and minimizing the leaching of N beyond the crop rooting-zone (Shapiro and Wortmann, 2006). Nutrients management is one of the critical inputs in achieving high

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Table 1. Soil analysis (0-30 cm).

S (%)	K a.v.a (mg/kg)	P a.v.a (mg/kg)	N (%)	OC (%)	TNV (%)	pH	EC (ds/m^{-1})	SP	Soil texture
47	397	40.2	0.09	0.89	38	7.65	1.0	55	Clay loam

seed production of sunflower. It seems that response to N is generally greater than that of other nutrients (Weiss, 2000). Many experiments and studies have shown the increase in sunflower grain yield (from 19% to 40%), in response to N fertilizer application when initial soil N level is low (Zubillaga et al., 2002). In sunflower, Bange et al. (1997) reported increase in grain yields (271 to 334 gm^{-2}) with N supply and it was because of increase of biomass (958 to 1405 gm^{-2}) with no increase in harvest index (39 to 40%). The aim of this investigation was to determine the best planting date and level of nitrogen of nuts sunflower in Isfahan climatic condition.

MATERIALS AND METHODS

An experiment was conducted at Mahoodabad Experimental Field in Isfahan, in 2009 (latitude 32° 40$^{/}$ N, longitude 51° 48$^{/}$ E, and 1570 m elevation). A split plot layout within complete randomized block design with 3 replications was used. Main plots were planting dates (May and May 20th and June 5th) and subplots were nitrogen levels (0, 150, 200 and 250 kg N/ha). One week before sowing, soil sample was taken at 0 to 30 cm. The soil texture was clay loam (Table 1). Long term average precipitation was 150 mm. In each plot, 6 lines were used rows, number 1 and 6 and also 0.5 meter from start and end of lines were omitted. The length of each line was 8 m, in this experiment a variety of nuts sunflower (Var. Dorsephid) was planted with skillful worker. The first irrigation was done just before cultivation, the second irrigation was done 5 days after first irrigation. The interval of other irrigations was 10 days. The nitrogen fertilizer from urea in two sections was used (half of it was used before planting time and half of it was used when crop had 6 to 8 leaves). For providing P element, phosphate ammonium was used (120 kg/ha). For weeds management, trifloralin (1.5 lit/ha) before sowing was used. In growth stage, hand control weeding was done repeatedly. The seeds were disinfected with fungicide before sowing (Benomile, 2/1000). Two seeds were sown, then when crop had 2 to 3 leaves, thining was done. The suitable density 80000 plants per ha was used in this experiment. When crop heads became yellow, 10 plants from line number 3 and 4 in each plot were selected and some traits such as number of grains per head, 1000 grains weight with 12 percentage humidity were measured. The equation number one that related was used. Mstat-C software and mean comparison with Duncan's test in 5% probability was used.

$$HI = \frac{\text{Economical yield}}{\text{Biological yield}} \quad (1)$$

RESULTS AND DISCUSSION

The effect of sowing date on plant height was not significant (Table 2). The difference in plant height between May 20th and June 5th was not significant (Table 3). The effect of nitrogen on plant height was significant (P<0.01) (Table 2). The highest plant height was achieved in treatment using 250 kg N/ha (191.6cm) (Table 3). Interaction between sowing date and nitrogen was significant (P<0.05) (Table 2). The highest plant height was related to treatment with using 200 kg N/ha in June 5th (Table 3). It seems that an excess of N, can delay flowering by producing more secondary branches and plant height. Also, under field conditions in Pakistan, an increase in N rates significantly prolonged crop maturation and increase plant height (Siddiqui and Oad, 2006). The effect of planting date on stem diameter was significant (P<0.05) (Table 2). The highest stem diameter was related to May 5th (29.54 mm) (Table 3). The effect of nitrogen was significant on stem diameter (P<0.01) (Table 2). There was significantly increase in stem diameter from 0 kg N/ha to 200 kg N/ha, but decreasing in stem diameter was shown from 200 kg N/ha to 250 kg N/ha (Table 3). The effect of interaction between plant height and nitrogen was significant (P<0.05) (Table 2). The highest stem diameter was achieved in May 5th with using 200 kg N/ha (31 mm) (Table 3). The effect of planting date and nitrogen on head diameter was significant (P<0.01) (Table 2). There was significantly decrease in head diameter from May 5th to June 5th. The highest head diameter was related to 200 kg N/ha (17.33 cm) and lowest head diameter was achieved in 250 kg N/ha (16.22 cm) (Table 3). The effect of planting date on number of grain per head was significant (P<0.01), but number of grain per head was not significantly influenced by nitrogen (Table 2). The difference in number of grain per head in May 5th with May 20th and June 5th was significant (Table 3).

The effect of planting date on 1000 grain weight was not significant, but 1000 grain weight, was significantly influenced by nitrogen (P<0.05) (Table 2). The highest 1000 grain weight was related to 200 kg N/ha and the lowest 1000 grain weight was achieved in 250 kg N/ha (Table 3). The effect of sowing date and nitrogen fertilizer on grain yield was significant (P<0.01) (Table 2). The highest grain yield relate to May 5th (4167 kg/ha), and the lowest grain yield was achieved in June 5th (3906 kg/ha). The highest grain yield was related to 200 kg N/ha (4107 kg/ha) and the lowest grain yield was achieved in 250 kg N/ha (4014 kg/ha) (Table 3). The interaction between planting date and nitrogen was not significant (Table 2). The highest grain yield was related to May 5th with using 200 kg N/ha (Table 3). In sunflower, Abbadi et al. (2008) indicated that an increase in N rates, increased seed yield by producing more heads per plant. The correlation between grain yield and

Table 2. Analysis of variance for experimental characteristics.

S.O.V	d.f.	Plant height	Stem diameter	Head diameter	Number of grain per head	1000 grain weight	Grain yield	Biological yield	Harvest index
Replication	2	11.209^{ns}	1.627	0.750^{ns}	16474.70^{ns}	509.151	4781.694^{ns}	3.361	0.207^{ns}
Planting date	2	6.630^{ns}	27.840*	6.33**	400114.7**	1148.51	214260.77**	2061354.1**	0.914*
Error (a)	4	3.524	2.519	0.33	14461.62	1665.84	1918.11	3.36	0.113
Nitrogen	3	12.309**	3.65**	2.324**	15625.66^{ns}	739.96*	13547.29**	425176.3**	0.158^{ns}
Planting date×nitrogen	6	2.44*	2.152*	0.074	19343.53^{ns}	380.53^{ns}	825.18	83960.33**	0.358*
Error (b)	18	0.712	0.581	0.213	14077.51	232.32	968.75	3.361	0.066

^{ns} non significant; *significant at 0.05 significance in F-tests; **significant at 0.001 significance in F-tests.

Table 3. Mean comparison of plant height (cm), stem diameter (mm), head diameter (cm), number of grain per head, 1000 grain weight (g), grain yield (kg/ha), biological yield (kg/ha) and harvesting index (%).

Treatment	Plant height	Stem diameter	Head diameter	Number of grain per head	1000 grain weight	Grain yield	Biological yield	Harvest index
Planting time(T)								
May 5th	187.5^{a}	29.54^{a}	17.08^{a}	12451^{a}	60.96^{a}	4167^{a}	14430^{a}	28.94^{ab}
May 20th	190.7^{a}	28.17^{ab}	16.92^{a}	1020^{b}	58.07^{a}	4086^{b}	13940^{b}	29.26^{a}
June 5th	191.9^{a}	26.50^{b}	15.75^{b}	882.8^{c}	60.73^{a}	3906^{c}	13610^{c}	28.71^{b}
Nitrogen (N)								
0 kg.ha	188.2^{c}	23.38^{ab}	16.33^{b}	1054^{a}	63.36^{a}	4047^{b}	13910^{c}	29.04^{ab}
150 kg.ha	190.5^{c}	27.79^{bc}	16.44^{b}	1031^{a}	60.84^{ab}	4044^{bc}	13970^{b}	28.95^{ab}
200 kg.ha	190.8^{a}	28.78^{a}	17.33^{a}	1091^{a}	67.57^{b}	4107^{a}	14300^{a}	28.79^{b}
250 kg.ha	191.6^{b}	27.33^{c}	16.22^{b}	1000^{a}	60.04^{a}	4014^{c}	13790^{d}	29.09^{a}
T × N								
T1N1	190.5^{bc}	29.80^{ab}	16.67^{bc}	1424^{a}	50.43^{ab}	4158^{ab}	14220^{bc}	29.24^{a}
T1N2	191.5^{abc}	29.70^{ab}	17.00^{b}	1189^{ab}	51.10^{ab}	4168^{ab}	14400^{b}	28.95^{a}
T1N3	192.8^{ab}	31.00^{a}	18.00^{a}	1204^{ab}	54.77^{ab}	4209^{a}	15000^{a}	28.24^{a}
T1N4	191.2^{abc}	27.67^{bc}	16.67^{bc}	1161^{abc}	64.73^{ab}	4134^{bc}	14100^{bcd}	29.32^{a}
T2N1	189.1^{c}	28.33^{abc}	16.68^{bc}	996.7^{bcd}	79.33^{a}	4090de	13890^{bcd}	29.27^{a}
T2N2	189.8^{bc}	27.33^{bc}	16.66^{bc}	1015^{bcd}	62.70^{ab}	4067de	14000^{bcd}	29.04^{a}
T2N3	191.1^{abc}	28.33^{abc}	17.67^{a}	1057^{bcd}	31.50^{b}	4160^{ab}	14100^{bcd}	29.50^{a}
T2N4	191.1^{abc}	28.67^{abc}	16.67^{bc}	1012^{bcd}	62.73^{ab}	4026^{e}	13780^{cd}	29.22^{a}
T3N1	191.1^{bc}	27.00^{bc}	15.67^{d}	861.7^{d}	78.30^{a}	3893^{fg}	13610^{cd}	28.60^{a}
T3N2	190.2^{bc}	26.33^{c}	15.68^{d}	890.0^{cd}	77.73^{a}	3899^{fg}	13510^{d}	28.85^{a}
T3N3	194.5^{a}	27.00^{bc}	16.33^{c}	951.3^{bcd}	62.43^{ab}	3951^{f}	13800^{bcd}	28.63^{a}
T3N4	191.8^{abc}	25.67^{c}	15.33^{d}	828.0^{d}	76.67^{d}	38.81^{g}	13500^{d}	28.75^{a}

Common letters within each column do not differ significantly.

number of grain per head (r =0.663**) and also correlation between grain yield and 1000 grain weight (r=0.848**) indicated the positive and significant of number of grain per head and 1000 grain weight on grain yield. The effect of sowing date and nitrogen fertilizer on biological yield was significant ($P<0.01$) (Table 2). There was significant decrease in total yield from May 5th to June 5th. The highest biological yield was achieved in 200 kg N/ha (14300 kg/ha), and the lowest biological yield was related to 250 kg N/ha (13790 kg/ha) (Table 3). The interaction between planting date and nitrogen was significant ($P<0.01$) (Table 2). The highest biological yield was related to May 5th with using 200 kg N/ha (Table 3). The effect of planting date on harvest index was significant ($P<0.05$), but nitrogen fertilizer had no significant influenced on this trait (Table 2). The highest harvest index was related to May 20th and the lowest harvest index was achieved in June 5th (Table 3). The difference between May 5th and June 5th was not significant (Table 3). Diepenbrock (2001) reported that harvest index of oil crops is a major parameter that limits seed yield, and it is also true for nut sunflower. Bange et al. (1997) did not observe any effect of N supply on harvest index in sunflower and the range of biomass production in his study was 958-1400 gm^{-2}. The interaction between planting date and nitrogen on harvest index was significant ($P<0.01$) (Table 2). The highest harvest index was related to May 20th with using 200 kg N/ha (Table 3). The correlation between grain yield and harvest index (r=0.383*) was positive and significant, that indicated the positive effect of grain yield on harvest index. Concerning the influence of the planting time, we observed an increase in grain yield in the early sowing than the later one in experimental field. So that the choice of the planting date reveals a decisive factor for good performance and successful management of the crop production. The late-sown crops accumulated more biomass than those planting early, may be related to unfavorable temperatures during vegetative and early generative development.

Conclusions

The highest stem diameter, head diameter, grain yield and biological yield was obtained in May 5th, and the highest plant height, stem diameter, head diameter, number of grain per head, 1000 grain weight and grain yield was obtained from usage of 200 kg N/ha. Results showed that 200 kg N/ha and May 5th is suitable for this variety in the region.

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