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Effect of foliar N application concentrations and times on sunflower (*Helianthus annus* L.) yield

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Abstract:

In order to investigate the effect of foliar nitrogen application concentrations and times on sunflower (Helianthus annus. L) yield an experiment was conducted on completely randomized design with three replications at students experimental farm, Department of Agronomy, Sindh Agriculture University, Tandojam Pakistan during February 2013. Foliar N conc. 1.0% and 1.5% significantly affected and higher values found for plant height, stem girth, head diameter, seed weight head^{-1}, seed index and seed yield whereas more seed head^{-1} were found at N conc. 1.5% and the poor performance of sunflower traits observed in non treated plots. In case of application times all traits better performed at N applied at 40 and 60 days after emergence (DAE) and lower values of traits observed at early applied N at 20 (DAE).Interactively tallest plants observed at foliar application 1.5 and 60 (DAE) and other traits viz. stem girth, head diameters, seeds head^{-1} values, seed weight head^{-1}, seed index and seed yield were

superior at interaction of 1.0%,1.5% and 20,60 (DAE),whereas the lowest interactive values found in traits at control non treated plot and 20, 40 and 60 (DAE) N application times.

Key words: Sunflower, Nitrogen, Foliar application, Time of application, Yield

Introduction

Sunflower (*Helianthus annuus* L.) is one of the most important oilseed that originally belonged to subtropical and temperate zones (Usman, *et al.,* 2010) crop and it is widely adaptable and more drought tolerant than other crops (Ahmad *et al.,* 2010). In Pakistan, sunflower occupies an important place among oil seed crops because of short duration, having ability to adapt wide range of climate and soil conditions (Thavaprakash *et al.,* 2003). In vegetable oil production, sunflower has emerged as an economically important crop (Malik *et al.,* 2004; Ahmad *et al.,* 2009). The low productivity is mainly due to poor soils, lack of proper production technology, unavailability of inputs, and marketing problems (Anwar-ul-Haq *et al.,* 2006; Arshad *et al.,* 2009). Due to high unsaturated fatty acids, sunflower (*Helianthus annuus, L.*) is considered one of the major sources of edible vegetable oils in the world (Leland, 1996). So, there is need to increase the oil yield to enhance food security. The nutrition especially with nitrogen is one of the important factors to increase sunflower seed yield. Nutrients play an important role in crop growth and development. Among the nutrients, nitrogen is one of the major nutrients that enhance the metabolic processes that based on protein, leads to increases in vegetative, reproductive growth and yield of the crop (Zubillaga *et al.,* 2002; Koutroubas *et al.,* 2008). Nitrogen play an imperative role in maximization of crop yields (Massignam *et al.,* 2009) and improves the yield as well as

quality of all crops (Bell *et al.,* 1995; Dreccer *et al.,*2000; Ullah *et al*., 2010). Additionally, higher rates of N increases photosynthetic processes, leaf area production, leaf area duration as well as net assimilation rate (Ahmad *et al.,* 2009; Munir *et al.,* 2007). However nitrogen deficiency generally results in stunted growth and chlorotic leaves caused by poor assimilate formation that leads to premature flowering and shortening of the growth cycle Limitation of nitrogen in any phase of the plant growth, causes reduction in yield ported that nitrogen fertilization had a positive and significant effect on seed yield, seed weight, pods plant^{-1} and number of seeds plant^{1}.

The aim of this study was to assess the response of sunflower to foliage nitrogen application concentrations and to assess the impact of foliar nitrogen application times on sunflower traits

Materials and methods

Field experiment

The field experiment was laid down at Student Farm, Department of Agronomy, Sindh Agriculture University, Tandojam during February 2013 to assess the effect of foliar nitrogen application concentrations on sunflower (*Helianthus annus*. L) yield. The experiment laid out three replicated, experiment design randomized complete block design (RCBD) factorial, with net plot size 3x4 = (12 m^2), variety Ho-1 was sown treatments as Two factors (A and B) i.e Four Foliar nitrogen concentrations control (no fertilizer applied), 0.50 % N, 1.00 % N and 1.50 % N as factor A and different foliar fertilizer application times viz. 20, 40 and 60 DAE (Days After Emergence) were kept as factor B in conducted experiment.

Methods used for calculating agronomic parameters

Plant height (cm): it was measured at the time of harvest 15 representative plants were measured in each experimental unit and height measured from ground level to the tip of the disk.
Stem girth (cm): it was measured with the measuring tape at top, middle and bottom of stem at the time of harvest and average was calculated.
Head diameter (cm): Radius was measured with measuring tape.
Seeds head^{-1}: seeds from the 15 disks were was collected and then average seeds head^{-1} was calculated.
Seed weight head^{-1} (g): the seeds were collected from each disk and weighed on top loading digital balance.
Seed index (1000 seed weight, g): a sample of thousand seed were taken from each plot and weighed on an electric balance.
Seed yield (kg ha^{-1}): the 1 m^2 areas was harvested and threshed. The seeds were cleaned, dried and weighed to record the seed yield and then seed yield kg ha^{-1} was calculated.

Statistical analysis

In order to check the normality of data, analysis of variance, and mean comparison MSTAT-C software were used. The means of the treatments were compared using the least significant difference (LSD) test at $P< 0.05$

Results and discussion

Plant height (cm)

The results for plant height as affected by different foliar nitrogen concentrations and application times DAS (days after sowing) and their interaction was presented in table no. 1 and showed statistically significant response for plant height cm. The results for foliar nitrogen concentration showed that mean maximum plant height values (171.7 and 175.6) were recorded

at application 1.0% and 1.5% nitrogen concentration where as the minimum value (134.3) was recorded at in control non treated plot. The mean results for plant height influenced by application times was found as maximum at (164.0 and 166.2) at 40 and 60 DAE (days after emergence) where as the lower value (149.9) was recorded at 20 DAE (days after emergence), respectively. The interactive effect for plant height showed that highest plant height (183.0 cm) were observed at foliar application 1.5 x 60 days after emergence whereas the lowest values (133.6, 134.1 and 135.2) were recorded in control non treated plot x 20, 40 and 60 DAE (days after emergence), respectively.Significant improvement in plant height of sunflower was reported as a result of foliar fertilization (Tuncay *et al.*, 2004) and Ramesh and Thirumurugan (2001) also stated that foliar applications of 2percent DAP and 1 percent Kcl along with benzyladenine 25 ppm had significantly increased the plant height in soybean.

Stem girth (cm)

The results for stem girth affected by different foliar nitrogen concentrations and application times and their interaction presented in table no. 2 showed significant response. The results revealed that mean maximum stem girth (9.07 and 9.37) for nitrogen concentration was observed at foliar nitrogen 1.0% and 1.5% whereas the minimum (4.34) mean stem girth was observed in control non treated plot. Mean results for stem girth in response to application timings showed that the highest mean value (8.30 and 8.43) were observed at 40 and 60 DAE (days after emergence) application times whereas the minimum value (6.16) was recorded at 20 DAE (days after emergence).The data further revealed that maximum interactive response for stem girth to nitrogen concentration and times values were 10.04, 10.16, 10.47 and 10.56 were recorded at interaction of 1.0% and 1.5% x 20 and 60 DAE (days after emergence) whereas the lower value (4.33, 4.35 and 4.34)

were recorded at control non treated plot x 20, 40 and 60 DAS. Application of B (0.5%) as foliar spray at early, mid and late whorl stage.

Head diameter (cm)

The results for head diameter affected by various foliar nitrogen concentrations, nitrogen application times and their interaction presented in table no. 3 showed significant response for head diameter cm. The results revealed that mean maximum head diameter (17.95 and 18.60) was recorded at foliar nitrogen concentration 1.0% and 1.5% and minimum mean for head diameter (10.14) was observed in control non treated plot. The mean results for head diameter influenced by application times were maximum recorded (16.48 and 16.70) at 40 and 60 DAE (days after emergence) and minimum value (13.32) was observed at 20 DAE (days after emergence).The interactive response for head diameter significantly affected by foliar concentrations and application times. The maximum head diameters (19.16, 20.29 and 20.47) were recorded at foliar nitrogen 1.0% and 1.5 x 40 and 60 DAE (days after whereas the lower interactive values is (10.11, 10.20 and 10.11) values were recorded in control non treated plots x 20, 40 and 60 DAE. Similarly the researchers also indicated that the nitrogen increases seed and oil yields by influencing a number of growth parameters such as seed head^{-1} and seed weight and by producing more vigorous growth and development (Wagh *et al.,* 1991; Faizani *et al.,* 1990; El–Naggar, 1991; Sarmah *et al.,* 1992).

Seeds head^{-1}

The results for seed head^{-1} affected by various foliar nitrogen concentrations, nitrogen application times and their interaction presented in Table no. 5 that showed significant response for seed head^{-1}. The results revealed that mean seed head^{-1} foliar nitrogen concentration showed significant response. The mean

(563.7) seed head^{-1} was recorded at foliar nitrogen concentration 1.5% whereas the minimum value (237.9) was observed in control non treated plot. The mean results for N application times affected on seed head^{-1} showed significant response. The data showed that maximum (477.0 and 488.3) mean values for application times was observed at 40 and 60 DAE (days after emergence) whereas minimum value (352.8) was observed at 20 DAE (days after emergence) application times respectively. The interactive response for application dose and time were significantly affected on seed head$^{-1.}$ The higher values (584.3, 598.0, 629.7 and 637.3) were recorded at foliar nitrogen 1.0% and 1.5% x 40 and 60 DAE (days after emergence) whereas the minimum value (238.7, 238.2 and 236.8) seed head-^{1} was recorded control non treated plot x 20, 40 and 60 DAE (days after emergence). Assanlouee *et al.* (2013) investigated that the research results showed that there was a significant difference in interaction between concentration and foliar application stages of nitrogen on number of seeds in head. Hassanlouee and Farhad (2013) reported that there was a significant difference in interaction between concentration and foliar application stages of nitrogen on seeds head^{-1}. Maryam and Farhad. 2013 satated that foliar application of N with 5% urea concentration in vegetative stage increases number of seeds per head in comparison with control and other treatments about % 45 and % 28.27, respectively.

Seed weight head^{-1} (g)

The results for seed weight head affected by various foliar nitrogen concentrations, nitrogen application times and their interaction presented in table no. 6 that showed significant response for seed weight (g) head^{-1}. The mean values for foliar nitrogen significantly affected seed weight head^{-1} the maximum mean values (28.94 and 28.66) were recorded at foliar application of 1.0% and 1.5% and the minimum value (15.29) mean value was observed in control non treated plot. The

results further revealed mean for application time also significantly affected. The data showed maximum values (25.34 and 26.03) at application times at 40 and 60 DAE (days after emergence) whereas the lower value (20.79) was observed at nitrogen applied at 20 DAE (days after emergence). The interactive result vsignificantly affect on seed weight head The higher values (30.63, 30.63, 30.96 and 30.98) was found at 1.0% and 1.5% foliar nitrogen concentration x 40 and 60 DAE (days after emergence) whereas the lower value (15.09, 15.32 and 15.46) seed weight head^{-1} recorded in control plots x 20, 40 and 60 DAE (days after emergence). Similarly the researchers also indicated that the nitrogen increases seed and oil yields by influencing a number of growth parameters such as seed head^{-1} and seed weight and by producing more vigorous growth and development (Wagh *et al.,* 1991; Faizani *et al.,* 1990; El–Naggar, 1991; Sarmah *et al.,* 1992).

Seed index 1000 (seed weight, g)

The results for seed index (1000 seed weight, g) was significantly affected by nitrogen concentration, nitrogen application times and their interaction presented in table no. 7.The results showed that mean value for seed index significantly affected by different nitrogen concentrations. The higher values (49.19 and 49.54) were recorded at 1.0 and 1.5% foliar nitrogen concentrations and whereas the minimum value (22.96) was observed in control non treated plot. The mean for application times also significantly affect on seed index. The data showed that maximum seed index (42.57 and 42.92) was recorded at 40 and 60 DAE (days after emergence) and the minimum seed index (31.64) was observed at 20 DAE (days after emergence).The interactive effect of nitrogen application dose and time were significantly affected on seed index. The maximum values ranges (54.86, 55.57, 56.01 and 55.59) was recorded at foliar nitrogen 1.0% and 1.5% x application times 40 and 60 DAE (days after emergence). The minimum value range

(22.95, 22.97 and 22.95) recorded in control x 20, 40, 60 DAE (days after emergence), respectively.

Seed yield (kg ha^{-1})

The results for Seed yield (kg ha^{-1}) was significantly affected by nitrogen concentrations, nitrogen application times and their interaction presented in table no. 8. The mean value for nitrogen concentration showed significant response to seed yield (kg ha^{-1}) of sunflower. The mean maximum values (1867 and 1893) were recorded at application of 1.0% and 1.5% nitrogen concentrations whereas the minimum value (1114) was observed in control non treated plots. The mean value for nitrogen application times was also found positive significantly response to seed yield (kg ha^{-1}). The maximum mean seed yield (1664 and 1721) was recorded at 40 and 60 DAE (days after emergence) nitrogen application times and the minimum value (1418) was observed at 20 DAE (days after emergence). The interactive effect of seed yield affected by different nitrogen application concentration x application time showed significantly response. The maximum interactive effect seed yield kg ha^{-1} (1957, 2013, 1999 and 2052) were recorded at 1.0% and 1.5% nitrogen concentration x application times 40 and 60 DAE (days after emergence) and the lowest seed yield (1111, 1116 and 1115) was recorded in control non treated plot x 20, 40 and 60 DAS, respectively. Similarly the researchers also indicated that the nitrogen increases seed and oil yields by influencing a number of growth parameters such as seed head^{-1} and seed weight and by producing more vigorous growth and development (Wagh *et al.,* 1991; Faizani *et al.,* 1990; El–Naggar, 1991; Sarmah *et al.,* 1992).

Conclusion

It is concluded from the results that all traits of sunflower had higher effect of Nitrogen concentration at the rate of 1.0 and

1.5%. The application times of 40 and 60 days after emergence (DAE) showed positive response towards the growth and yield traits of sunflower. However, interaction of Nitrogen concentrations at the rates of 1.0 and 1.5% with DAE of 40 and 60 (N concen: X DAE) had been found highly effective to get higher yields.

Table 1. Effect of foliar nitrogen concentrations and application times on plant height (cm) of sunflower

Foliar nitrogen	**Application timings**			**Mean for foliar N concentration**
	20 DAE	40 DAE	60 DAE	
Control (non treated plot)	133.6 f	134.1 f	135.2 f	134.3 C
Foliar nitrogen 0.5 %	145.3 ef	164.0 cd	166.7 bcd	158.7 B
Foliar nitrogen 1.0 %	158.7 de	176.3abc	180.0 ab	171.7 A
Foliar nitrogen 1.5 %	162.0 cd	181.7 ab	183.0 a	175.6 A
Mean for application timings	149.9 B	164.0 A	166.2 A	

	Foliar N conc.	Application timings	Foliar N conc. x applications timings
SE	2.893	2.506	5.011
LSD (5%)	8.485	7.349	14.70

DAE= Days after emergence, N= Nitrogen, SE= Standard Error, LSD= Least Significant Difference

Table 2. Effect of foliar nitrogen concentrations and application times on stem girth (cm) of sunflower

Foliar nitrogen	**Application timings**			**Mean for foliar N concentration**
	20 DAE	40 DAE	60 DAE	
Control (non treated plot)	4.333 d	4.353 d	4.337 d	4.341 C
Foliar nitrogen 0.5 %	6.220 c	8.320 b	8.670 b	7.737 B
Foliar nitrogen 1.0 %	7.010 c	10.04 a	10.16 a	9.070 A
Foliar nitrogen 1.5 %	7.070 c	10.47 a	10.56 a	9.367 A
Mean for application timings	6.158 B	8.296 A	8.432 A	

	Foliar N conc.	Application timings	Foliar N conc. x applications timings
SE	0.1663	0.1921	0.3327

LSD (5%)	0.4878	0.5633	0.9757

Note: All abbreviations are same as above.

Table 3. Effect of foliar nitrogen concentrations and application times on head diameter (cm) of sunflower

Foliar nitrogen	Application timings			Mean for foliar N concentration
	20 DAE	40 DAE	60 DAE	
Control (non treated plot)	10.11 d	10.20 d	10.11 d	10.14 C
Foliar nitrogen 0.5 %	13.11 c	16.28 b	16.53 b	15.31 B
Foliar nitrogen 1.0 %	15.00 bc	19.16 a	19.70 a	17.95 A
Foliar nitrogen 1.5 %	15.04 bc	20.29 a	20.47 a	18.60 A
Mean for application timings	13.32 B	16.48 A	16.70 A	

	Foliar nitrogen conc.	Application timings	Foliar nitrogen conc. x applications timings
SE	0.3897	0.3375	0.6750
LSD (5%)	1.143	0.9899	1.980

Table 4. Effect of foliar nitrogen concentrations and application times on seeds head^{-1} of sunflower

Foliar nitrogen	Application timings			Mean for foliar N concentration
	20 DAE	40 DAE	60 DAE	
Control (non treated plot)	238.7 e	238.2 e	236.8 e	237.9 D
Foliar nitrogen 0.5 %	334.7 d	455.7 bc	481.0 b	423.8 C
Foliar nitrogen 1.0 %	414.0 c	584.3 a	598.0 a	532.1 B
Foliar nitrogen 1.5 %	424.0 c	629.7 a	637.3 a	563.7 A
Mean for application timings	352.8 B	477.0 A	488.3 A	

	Foliar N conc.	Application timings	Foliar N conc. x application timings
SE	9.662	8.368	16.74
LSD (5%)	28.34	24.54	49.08

Table 5. Effect of foliar nitrogen concentrations and application times on seeds weight head^{-1} of sunflower

Foliar nitrogen	Application timings			Mean for foliar N
	20 DAE	40 DAE	60 DAE	

				concentration
Control (non treated plot)	15.09 d	15.32 d	15.46 d	15.29 C
Foliar nitrogen 0.5 %	19.45 c	24.47 b	26.09 b	23.34 B
Foliar nitrogen 1.0 %	24.59 b	30.63 a	31.59 a	28.94 A
Foliar nitrogen 1.5 %	24.03 b	30.96 a	30.98 a	28.66 A
Mean for application timings	20.79 B	25.34 A	26.03 A	

	Foliar nitrogen conc.	Application timings	Foliar N conc. x application timings
SE	0.4381	0.3794	0.7587
LSD (5%)	1.285	1.113	2.225

Table 6. Effect of foliar nitrogen concentrations and application times on seeds index (1000 seed weight, g) of sunflower

Foliar nitrogen	**Application timings**			**Mean for foliar N concentration**
	20 DAE	40 DAE	60 DAE	
Control (non treated plot)	22.95 c	22.97 c	22.95 c	22.96 C
Foliar nitrogen 0.5 %	29.48 bc	36.45 b	37.59 b	34.51 B
Foliar nitrogen 1.0 %	37.13 b	54.86 a	55.57 a	49.19 A
Foliar nitrogen 1.5 %	37.02 b	56.01 a	55.59 a	49.54 A
Mean for application timings	31.64 B	42.57 A	42.92 A	

	Foliar nitrogen conc.	Application timings	Foliar N conc. x application timings
SE	1.471	1.274	2.548
LSD (5%)	4.315	3.737	7.474

Table 7. Effect of foliar nitrogen concentrations and application times on seed yield (kg ha^{-1}) of sunflower

Foliar nitrogen	**Application timings**			**Mean for foliar N concentration**
	20 DAE	40 DAE	60 DAE	
Control (non treated plot)	1111 d	1116 d	1115 d	1114 C
Foliar nitrogen 0.5 %	1301 c	1584 b	1703 b	1529 B
Foliar nitrogen 1.0 %	1632 b	1957 a	2013 a	1867 A
Foliar nitrogen 1.5 %	1627 b	1999 a	2052 a	1893. A
Mean for application timings	1418 B	1664 A	1721 A	

	Foliar nitrogen conc.	Application timings	Foliar N conc. x applications timings
SE	25.68	22.24	44.47
LSD (5%)	75.30	65.22	130.4

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