Soil Environ. 32(1): 44-48, 2013
www.se.org.pk
Online ISSN: 2075-1141
Print ISSN: 2074-9546

Nitrogen and phosphorus management strategy for better growth and yield of sunflower (*Helianthus annuus* L.) hybrid

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Abstract

This study conducted during autumn season, 2010 investigated the effect of nitrogen and phosphorus on sunflower hybrid Hysun-33. The experiment was planned in randomized complete block design (factorial arrangement), with three replication, having net plot size of 3 x 7 m. The experiment comprised of 9 treatments, three levels of nitrogen and phosphorus, viz., 85, 135, 185 kg N ha^{-1}, and 50, 75, 85 kg P ha^{-1}. Nitrogen affected all estimated characters significantly, except plant population, while, phosphorus did not show significant effect on plant population and plant height. All other parameters, as leaf area plant^{-1}, head diameter, 1000- achene weight and achene yield were affected significantly by different nitrogen and phosphorus levels. Interactive effects of nitrogen and phosphorus were significant in all these cases. The highest achene's yield (2584 kg ha^{-1}) was obtained with the application of 135-75 kg NP ha^{-1}as against the lowest (1491kg ha^{-1}) at 85-50 kg NP ha^{-1}.

Key words: Growth, hybrid, leaf area, sunflower, yield

Introduction

No doubt in Pakistan, agriculture sector has made a great progress but it is still facing an acute shortage of edible oil. During the year 2009-10, 1.246 million tons of edible oil was imported by spending 77.78 billion rupees. The area under sunflower crop in 2010-11 was 448,582 hectares with seed and oil production of 643 and 244 thousand tons, respectively (GOP, 2011). The major reason of lower yield than its yield potential is lack of production technology, particularly imbalanced use of fertilizers. Sunflower crop responds positively to management factors and overall yield is correlated with nutrient uptake throughout its growth period. With the increasing rates of nitrogen, growth, achene's yield and overall achene oil yield per unit area increased but grain oil contents decreased (Chkerol, 2006). Gu and Gao (1998) observed 19.4, 15.3 and 22.7 % yield reduction of hybrid sunflower due to deficiency of nitrogen, phosphorus and potash, respectively. Malik *et al.* (2006) concluded that different combinations of NPK had significantly affected achene yield and oil content. Nasim *et al.* (2011) concluded that with the increase of nitrogen level, there is increment in the yield and yield components of sunflower. Osman *et al.* (1980) demonstrated that increasing nitrogen and phosphorus levels increased growth and yield in sunflower but increasing nitrogen rates decreased seed oil percentage.

The objectives of this study therefore, were to determine the effect of different levels of nitrogen and phosphorus on growth and yield components of sunflower hybrid for obtaining higher achene yield.

Materials and Methods

A field experiment was conducted at the research farm of University College of Agriculture, Sargodha, during autumn season 2010. Replicated three times, the experiment was laid out in randomized complete block design with factorial arrangement, having net plot size of 3 x 7 m. Sunflower hybrid Hysun-33 was sown on 75 cm spaced ridges and plant to plant distance was maintained 22 cm, using a seed rate of 5 kg ha^{-1}. The nitrogen and phosphorus levels comprised of 85, 135, 185 and 50, 75 85 kg ha^{-1}, respectively. Half of nitrogen along with full dose of phosphorus was applied by broadcast method at the time of seed bed preparation in the form of urea and diammonium phosphate, respectively, while remaining nitrogen was applied after one month of sowing. A basal dose of potassium was also given at 40 kg ha^{-1} in the form of potassium sulphate. All cultural practices like irrigations, plant protection measures and other management practices except under study were same for all the treatments. Thinning was done after two weeks of crop emergence to maintain required plant population. The observations recorded were; number of plants, plant height at maturity, number of leaves plant^{-1}, head diameter, 1000 – achene weight and achene yield. Data collected were statistically analyzed and treatment means were compared by employing least significant difference (LSD) test at 0.05% level of probability (Steel *et al*., 1997).

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Results and Discussion

Plant population (m^{-2})

The data regarding the number of plants per square meter are presented in Table 1, which showed that the interactive as well as the main effects of nitrogen and phosphorus on plant population was non-significant. However, maximum number of plants (5.92) was recorded in case of those plots which were fertilized at 135 - 75 kg NP ha^{-1} while minimum number of plants (4.94 m^{-2}) was recorded in plots fertilized at 85-75 kg NP ha^{-1}. Uniform plant population at harvest at all treatment combinations may be attributed to an even germination that is characteristic of present day sunflower hybrids. These findings are also in confirmatory to the results of Saleem and Malik (2004), and Iqbal *et al.* (2008) who reported that fertilizer application did not influence final plant population of sunflower.

Plant height at maturity (cm)

The Plant height data was recorded at harvest time and it revealed that the plant height was affected by different levels of nitrogen and phosphorus (Table 1). Nitrogen levels of 135 and 185 kg ha^{-1} produced statistically similar plant height, but significantly higher than 85 kg N ha^{-1}. This increase in plant height might be due to the positive effect of nitrogen element on plant growth. Increase in plant height with nitrogen application has also been reported by Abdel-Motagally and Osman (2010), and Ali *et al.* (2012). Phosphorus application had no significant effect on plant height. The interactive effects of nitrogen and phosphorus levels were also non-significant which showed that positive response of plant height to nitrogen nutrition was not dependent on phosphorus application. These results are partially in line with those reported by Gu and Gao(1998), Robinson *et al.* (1980), Osman *et al.* (1980), Poonia (2000) and Malik *et al.* (2006) who stated that nitrogen alone or in combination with phosphorus increased plant height.

Leaf area $plant^{-1}$ (cm^2)

The data regarding the leaf area $plant^{-1}$ given in Table 1 showed that the interaction between nitrogen and phosphorus was significant. Statistically maximum leaf area $plant^{-1}$ (5813.24 cm^2) was recorded at NP level of 135-75 kg ha^{-1}, which was at par with 185-100, 185-75, and 135-100 NP ha^{-1} showing the leaf area $plant^{-1}$ of 5113, 5292 and 5447 cm^2, respectively. Minimum leaf area $plant^{-1}$ (3449.0) was recorded in those plots which were fertilized at 85-50 kg NP ha^{-1}, while the interactive effects of rest of nitrogen and phosphorus levels were intermediated. These results are in line with those of Rodriguez *et al*. (1998) and Onasanya *et al*. (2009) who observed that leaf area was increased with increasing levels of nitrogen and phosphorus fertilizers application.

Head diameter (cm)

Data in Table 2 showed that nitrogen levels of 135 and 185 kg ha^{-1} produced statistically similar head diameter, but significantly higher than 85 kg N ha^{-1}.Phosphorus application had also significant effect on head diameter. Phosphorus levels of 75 and 100 kg ha^{-1} produced statistically similar head diameter, but significantly higher than 50 kg P ha^{-1}. The interaction between nitrogen and phosphorus levels was also found to be significant. The different NP combinations of 135-75, 135-100 and 185-50 and 185-75 NP kg ha^{-1} produced statistically similar head diameter. The maximum head diameter (17.87 cm) of sunflower was recorded with the application of 135-75 NP kg ha^{-1}. The minimum head diameter (13.28 cm) was recorded in case of plots which were fertilized with lowest rates of NP (85-50 kg ha^{-1}), while the rest of NP combinations were intermediated. The significant effect of nitrogen and phosphorus application on head diameter has also been reported by Osman *et al.* (1980), Malik *et al.* (2006), Nasim *et al.* (2011) and Ali *et al.* (2012). Larger heads harvested with NP application were associated with more number of grains thus giving more yield.

1000-achene weight (g)

Nitrogen and phosphorus application had a constructive behaviour for 1000-achene weight. The data presented in Table 3 showed that the interaction between nitrogen and phosphorus levels was significant. The highest 1000- achene weight (51.93 g) was recorded at NP level of 135-75 kg ha^{-1}, which was at par with 135-100, 185-75 and 185-100 kg NP ha^{-1} showing the 1000-achene weight of 51.63, 50.77 and 50.71g, respectively. While the interactive effects of rest of nitrogen and phosphorus levels were intermediated. These findings are supported by the observation of Poonia (2000), Ali *et al.* (2006) and Malik *et al.* (2006), who reported a progressive and reliable increase in achene weight with addition of fertilizer dose.

Achene yield (kg ha^{-1})

The final grain yield is a function of combined effect of all the individual yield components. It is clear from the data given in Table 3 that achene's yield was affected significantly by both the nutrients under study. Nitrogen levels of 135 and 185 kg ha^{-1} produced statistically similar achene's yield, but significantly more than those plots receiving 85 kg N ha^{-1}. Phosphorus levels also significantly influenced the achene's yield. The plots treated with 75 and 100 kg P ha^{-1} produced statistically similar achene's yield, but significantly higher than those given 50 kg P ha^{-1}.

Table 1: Plant population and Plant height of sunflower hybrid as affected by different levels of nitrogen and phosphorus

Fertilizer levels N/ P level	Plant population (m^{-2})				Plant height (cm)			
	P1	P2	P3	Mean	P1	P2	P3	Mean
	50 kg ha^{-1}	75 kg ha^{-1}	100 kg ha^{-1}		50 kg ha^{-1}	75 kg ha^{-1}	100 kg ha^{-1}	
N1 = 85 kg N ha^{-1}	4.94	5.88	5.54	5.45	155.37	160.57	166.63	160.85 b
N2 = 135 kg N ha^{-1}	4.97	5.92	5.9	5.59	177.63	193.66	189.24	186.84 a
N3 = 185 kg N ha^{-1}	5.04	5.84	5.63	5.5	188.78	189.24	186.3	188.10 a
Mean	4.98	5.88	5.69		173.92	181.15	180.52	

Any two means not sharing a letter are significantly different at 5% level of probability (LSD)

Table 2. Leaf area $plant^{-1}$ and head diameter of sunflower hybrid as affected by different levels of nitrogen and phosphorus

Fertilizer levels N/ P level	Leaf area $plant^{-1}$ (cm^2)				Head diameter (cm)			
	P1	P2	P3	Mean	P1	P2	P3	Mean
	50 kg ha^{-1}	75 kg ha^{-1}	100 kg ha^{-1}		50 kg ha^{-1}	75 kg ha^{-1}	100 kg ha^{-1}	
N1 = 85 kg N ha^{-1}	3449 d	3581 d	4013 c	3681.2 b	13.28 e	13.31e	14.67 d	13.75 b
N2 = 135 kg N ha^{-1}	4915 b	5813.2 a	5447 a	5391.7 a	15.55 c	17.87 a	17.75a	17.05 a
N3 = 185 kg N ha^{-1}	5202 a	5292.0 a	5113 a	5202.3 a	17.13 ab	17.21 ab	16.50b	16.94 a
Mean	4522 b	4895.5 a	4857 a		15.32 b	16.13 a	16.30 a	

Any two means not sharing a letter are significantly different at 5% level of probability (LSD)

Table 3: 1000-achene weight and achene's yield as affected by different levels of nitrogen and phosphorus

Fertilizer levels N/ P level	1000-achene's weight (g)				Achene's yield (kg ha^{-1})			
	P1	P2	P3	Mean	P1	P2	P3	Mean
	50 kg ha^{-1}	75 kg ha^{-1}	100 kg ha^{-1}		50 kg ha^{-1}	75 kg ha^{-1}	100 kg ha^{-1}	
N1 = 85 kg N ha^{-1}	39.32 f	41.22 e	43.50 d	41.34 b	1491 f	1759 e	1945 d	1731 b
N2 = 135 kg N ha^{-1}	45.67 c	51.93 a	51.63 a	49.74 a	2119 c	2584 a	2496 ab	2399 a
N3 = 185 kg N ha^{-1}	47.91 b	50.77 ab	50.71 ab	49.79 a	2415 ab	2498 ab	2368 b	2427 a
	44.3 b	47.97 a	48.61 a		2008 b	2280 a	2269 a	

Any two means not sharing a letter are significantly different at 5% level of probability (LSD)

The interactive effect of nitrogen and phosphorus on achene's yield was significant. The highest achene's yield (2584 kg ha^{-1}) was recorded with NP combination of 135+75 kg ha^{-1}, which was at par with 135-100, 185-50 and 185-75 kg NP ha^{-1} showing the achene yield of 2696, 2415 and 2498 kg ha^{-1}, respectively. Other NP combinations produced significantly lower achene yield than above mentioned combinations. Lowest achene's yield (1491 kg ha^{-1}) was recorded in case of those plots which were fertilized at the rate of 85-50 kg ha^{-1}. These results are in conformity with those reported by Singh and Singh, (1980). Singh *et al.* (1975), Al- Thabet (2006), Malik *et al.* (2006), Ekin (2010), Abdel-Motagally and Osman, (2010) and Osman and Ewed (2010). Increase in achene yield can be attributed to improvement in light interception and improved leaf area resulting in a better crop growth. Increase in fertilizer availability resulted in higher achene yield that was closely related to the improvement in yield components such as head diameter (Ali *et al.,* 2012), 1000-achene weight (Malik *et al.*, 2006).

Conclusion

Application of nitrogen and phosphorus @ 135+75 kg ha^{-1} seems to be the best fertilizer combination for obtaining maximum achene's yield of sunflower under the irrigation conditions of Sargodha.

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