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Effect of Different Phosphorous Levels on Growth, Yield and Quality of Spring Planted Sunflower

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Abstract: The experiment was conducted to study the effect of various phosphorous levels on the yield and yield components of sunflower variety "Hysun-33" at the Agronomic Research Area, Faculty of Agriculture, Gomal University, Dera Ismail Khan during the year 2010. The phosphorous levels studied were 0 (N :P_2O_5: K_2O), 0 (P_2O_5), 10, 20, 30, 40, 50, 60 P_2O_5 Kg/ha. The results showed significant effect of P_2O_5 @ 50 kg/ha and 60 kg/ha as compare to lower doses of phosphorous. All varying levels of phosphorous affected the head diameter, number of seeds per head, 1000-seeds weight, achene's yield and achene's oil content but significant positive effect was observed where P_2O_5 @ 60 kg/ha N @ 50 kg/ha and K_2O 15 kg/ha was applied. However, number of plants, remained non-significant. It is, therefore, recommended to apply phosphorous @ 60 kg/ha for obtaining higher yield of sunflower.

Key words: *Helinathus annuus*, phosphorus levels, growth, yield, oil contents

INTRODUCTION

Sunflower is the fourth oil grain crop grown worldwide by area (Fagundes *et al*., 2007). Pakistan is facing an acute shortage of edible oil. Demand of edible oil in Pakistan is increasing with the increase in population, whereas, production of edible oil is decreasing every year. The share of domestic production of edible oil is 565 million tones, import is 2489 million tones, 82% of oil is imported, valued 142.1 billion rupees. Anonymous (2009). In domestic production, major share comes from cotton seed contributing 53% of local production, sunflower contributes 33%, rape seed 9% and canola shares 5%. Sunflower, rape seed mustard and canola are the potential crops, which can fulfill some requirements of edible oil in the country (Anonymous, 2010). Big gap exist between potential yield and national average yield of sunflower. About 69% of the yield potential has not yet been achieved (Anonymous, 2009). Sunflower is one of the most important non-conventional oilseed crops due to its high quality edible oil (25.48%). In Pakistan, sunflower is grown on an area of 319.74 thousand hectares with the total production of 420.487 thousand tones and an average seed yield of 1315 kg/ha (Anonymous, 2009). The current yield level is very low as compare to the potential yield of many sunflower hybrids.

Among various factors responsible for low yield, management of fertilizers may be of much importance. (Aslam *et al*., 2011). It has also been highlighted in various findings that almost 90% of Pakistan soils are deficient in phosphorous content (Shaheen *et al*., 2011). The application of nutrients, particularly nitrogen and phosphorus, plays a vital role in boosting up production, but maximum inherent potential of variety can only be achieved when nutrients are applied in balance form (Ali *et al*., 2004). Biomass accumulation in sunflower is correlated with nutrient uptake.

Moreover, the major portion of applied P fertilizers is bound in soils as P compounds of variable adsorption strength, reducing the effectiveness of P fertilization (Gahoonia *et al*., 2000). Phosphorous requirement for crops is enormous, specifically for the development of meristematic tissues, which are briskly dividing and expanding in size (Brady and Weil, 2002). Phosphorous deficiency trims down the yield from 10 to 15% (Shenoy and Kalagudi, 2005). Kumar *et al*. (1995) declared that in various P doses, 60 and 90 kg P/ha emerged to be the ideal as for as plant height is concerned. Turk *et al*. (2002) conveyed that almost all the growth and agronomic parameters were significantly affected by rate of phosphorous application in comparison to zero P. Similarly, Malik *et al*. (2004) observed increment in yield and decline in oil content of sunflower seed with the use of Phosphorous in his crop sowing program.

The formation of seed is especially depressed in plants suffering from P deficiency. Thus, not only low yield, but also poor quality fruit and seed are obtained from phosphorous deficient crop. There are different views of scientists about role of phosphorous on oil percentage of crops. Cheema *et al*. (2001) decreased oil contents by applying huge phosphorous levels, whilst Lickfett *et al*.

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(1999) enhanced oil% age with high rates of phosphorous fertilizer. However, Nandhagopal *et al.* (1995) stated non significant influence of P on oil percentage.

The present study was, therefore, undertaken to determine the effect of varying levels of phosphorous on growth, yield and quality of spring sunflower under the agro-ecology of Dera Ismail Khan.

MATERIALS AND METHODS

The experiment was conducted at the Agronomic Research Area, Faculty of Agriculture, Gomal University, Dera Ismail Khan during the spring 2010. The experiment was laid out in a Randomized Complete Block design with eight treatments replicated four times. The net plot size was 6x4.2 m^2. The phosphorous doses studied were (0:0:0) N:P_2O_5: K_2O kg/ha), (45: 0: 15) N: P_2O_5: K_2O kg/ha, 10, 20, 30, 40, 50 and 60 P_2O_5 kg/ha. (Khalil and Jan, 2010). A constant and recommended dose of K_2O was also added in all respective treatments. The approved Sunflower hybrid (Hysun-33) was planted in March, 2010 on a well prepared seedbed in furrows 70 cm apart with a single row flat sowing using 8 kg seed/ha. All the phosphorous and potassium was applied at the time of seedbed preparation while half dose of nitrogen was applied at the time of sowing and remaining half at earthing up. Weeds were controlled mechanically and by hand hoeing. All plots were irrigated regularly to fulfill crop water requirement. A total of 4 irrigations was applied during crop growth period.

The following parameters were studied: Number of plants (m), Plant height (cm), Head diameter (cm), Number of seeds per head, 1000-seed weight (g), stalk yield (kg/ha), Achene yield (kg/ha) and Achene oil content (%) were determined by Soxhelt fat extraction method (A.O.A.C, 1995).

Statistical analysis: The data collected were analyzed statistically using Fisher's analysis of variance technique. Least Significant Difference (LSD) test at 5% probability level was used to see significance among treatment means (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Crop parameters: Plant density per unit area is the key factor in determining the crop yield. In present study, the data regarding number of plants showed no significant difference among treatments over check (Table 1). Fertilizer application plays a little or no role in the germination of seed, as they mostly use their own stored food for germination. Saleem and Malik (2004) also confirmed non-significant effect of different phosphorous levels on number of plants per unit area.

Plant height is a function of both genetic and environmental factors. Final plant height reflects the growth trend of crop plant. Data on plant height at maturity given in Table 1 revealed that plant height was significantly affected by phosphorus levels. Maximum plant height (149.5 cm) was recorded in plot fertilized @ 60 kg P_2O_5/ha. Minimum plant height was recorded in control treatment where no fertilizer was applied. Similar results were also reported by Muralidharudu *et al.* (2003) who stated that phosphorous levels had significantly influenced plant height.

Production potential of sunflower plant is characterized by the size of its head, which is important yield contributing component. It is more or less genetically controlled character but is also influenced by the environments in which the plant is grown. The data in Table 1 showed that all fertilizer treatments differed significantly from each other. Plants fertilized with 60 kg/ha produced head size 20.50 cm. It was followed by T_7 where plants received 50 kg P_2O_5/ha. These results are in line with those documented by Nawaz *et al.* (2003) who found that phosphorous levels significantly increased head size. This increase might be due more leaf area index and more nutrients uptake by the crop from root zone.

The number of seeds per head is an important factor in determining yield of sunflower. Data regarding the number of seed per head of sunflower are presented in Table 2. The use of various phosphorous doses significantly increased the number of seeds per head. However, plants with no phosphorous fertilizer application (control) had lower number of seeds per head. Amanullah and Khan (2010) noted that sunflower yield and yield components responded positively to K and P fertilization. Similarly, Sadiq *et al.* (2000) found increase in number of heads by the application of phosphorous. This might be due to better leaf expansion, high crop growth rate as well as rapid development and growth of leaves at flowering, which significantly contributed in grain filling and number of seeds per head.

Seed weight has a direct bearing on the formation of final seed yield of a crop. Data pertaining to 1000-seed weight showed significant effect of different phosphorous levels (Table 2). Plants that received fertilizer @ 60 kg P_2O_5/ha produced the highest 1000-seed weight (56.51 g). Minimum 1000-seed weight was recorded in control plots (44 g). The reason for the improved seed size might be due to increased root length, better crop development and resultantly greater P uptake. Turk *et al.* (2002) also found that high P rates significantly increased the seed size which ultimately helped in increasing 1000-seed weight. Almost similar trend was observed by Arif *et al.* (2003) who found that by increasing NP levels in sunflower, 1000-seed weight was also increased.

The final seed yield per unit area of sunflower is a function of cumulative effects of various yield components which are influenced by various agronomic

Table 1: Effect of various phosphorous doses on number of plants (m), plant height (cm), head diameter (cm) and number of seeds per head

Treatments	No. of plants (m)	Plant height (cm)	Head diameter (cm)	No. of seeds/head
T_1 (0:0:0)	4.000^{NS}	109.0^{b}	12.50^{g}	940.5^{d}
T_2 (45:0:15)	4.000	142.5^{ab}	13.50^{f}	945.8^{d}
T_3 P @ 10 kg/ha	4.250	144.6^{a}	14.50^{ef}	949.0^{d}
T_4 P @ 20 kg/ha	4.250	146.5^{a}	15.13^{de}	1044.0^{c}
T_5 P @ 30 kg/ha	4.500	147.5^{a}	16.50^{cd}	1045.0^{c}
T_6 P @ 40 kg/ha	4.500	148.0^{a}	17.50^{bc}	1051.0^{bc}
T_7 P @ 50 kg/ha	4.750	148.3^{a}	18.50^{b}	1061.0^{ab}
T_8 P @ 60 kg/ha	5.000	149.5^{a}	20.50^{a}	1065.0^{a}
$LSD_{0.05}$	-	33.70	1.760	13.88

Figures in the same column sharing the same letter do not differ statistically at p<0.05 by LSD test

Table 2: Effect of various phosphorous doses on 1000-seeds weight (g), stalk yield (kg/ha) and achene yield (kg/ha) and achene oil content (%) of sunflower

Treatments	1000-Seeds weight (g)	Stalk yield (kg/ha)	Achene yield (kg/ha)	Achene oil content (%)
T_1 (0:0:0)	44.00^{e}	9504^{e}	2638.0^{e}	39.05^{b}
T_2 (45:0:15)	47.46^{de}	10000de	2775.0^{de}	39.31^{ab}
T_3 P @ 10 kg/ha	49.99^{cd}	10270^{cd}	2933.00^{cd}	39.96^{ab}
T_4 P @ 20 kg/ha	51.25^{bcd}	10320^{cd}	3095.00^{bc}	40.56^{ab}
T_5 P @ 30 kg/ha	51.88^{ad}	10550^{bcd}	3154.00^{ab}	41.10^{ab}
T_6 P @ 40 kg/ha	53.18^{abc}	10850^{abc}	3214.00^{ab}	41.49^{ab}
T_7 P @ 50 kg/ha	55.21^{ab}	11030^{ab}	3302.00^{ab}	42.02^{ab}
T_8 P @ 60 kg/ha	56.51^{a}	11390^{a}	3373.00^{a}	42.53^{a}
$LSD_{0.05}$	4.588	586.7	203.8	2.984

Figures in the same column sharing the same letter do not differ statistically at p<0.05 by LSD test

practices and under the particular set of environmental conditions. Seed yield is controlled by a large number of internal and external factors and any variation in them is liable to bring about variation in yield. Final achene yield is a cumulative effect of various yield components like head diameter, number of achenes per head and 1000-seed weight. The data regarding final achene yield are presented in Table 2. It is clear that different fertilizer levels had significant effect on achene yield. Maximum achene yield of 3373 kg/ha was recorded in plots where phosphorus was applied @ 60 kg/ha while minimum achene yield (2638 kg/ha) was recorded in control treatment. The increase in achene yield might be due to increase in head diameter and 1000-seed weight. Sarkar *et al.* (1995) reported significant increase in sunflower yield with an increase in P_2O_5 level up to 60 kg/ha. Agrawal *et al.* (2000) studied the effect of P fertilizer on yield and uptake (N, P, S) of sunflower. They reported that seed and straw yields were increased up to the highest rate of P. McKenzie *et al.* (2003) and Turk *et al.* (2002) also found that high rates of phosphorus increased seed yield significantly which confirms the present findings. Kumaresan *et al.* (2001) revealed that SSP at 75% recommended level of P_2O_5 improved the quality parameters and seed yield of sunflower. Aulakh *et al.* (1996) observed that yield generally increased with up to 60 kg N and 60 kg P_2O_5/ha and then decreased at the highest fertilizer rates.

The data regarding stalk yield are given in Table 2, which indicated that stalk yield of sunflower was significantly affected by phosphorus levels. The minimum stalk yield (9504 kg/ha) was recorded in control treatment, whereas maximum stalk yield of 11390 kg/ha was recorded when maximum dose of phosphorous was applied. Singh *et al.* (1998) observed significant stalk increase by applying 60 kg P_2O_5/ha. This was probably due to availability of sufficient amount of phosphorous during crop growth and developmental stages, which boosted stalk yield significantly.

Quality of sunflower is determined by its oil contents. Data revealed slight increase in oil contents with gradual increase in fertilizer levels but it did not reach the level of significance. It is generally considered that phosphorous is involved in synthesis of fatty acids, so a little increase in the oil contents of sunflower with increasing P rate may be due to this fact. The maximum oil content% age was observed in T_8 where phosphorus was applied @ 60 kg/ha and minimum in control treatment. These results are also supported by Nandhagopal *et al.* (1995) who reported no effect of P level on oil concentration. Malik *et al.* (2004) found that increasing levels of P increased yield and yield components but decreased the seed oil content. Cheema *et al.* (2001) reported reduced oil contents at high rate of P. Bhagat *et al.* (2005) recorded increment in oil content by the application of phosphorous. Brennan and Bolland (2004) found that levels and sources of P did not affect the oil concentration. Zakaria *et al.* (2006) also found that oil concentration increases with increasing P level.

Conclusion: The study arrived at conclusion that the application of 60 kg P_2O_5 along with 50 kg nitrogen and 15 kg K_2O per hectare is the optimum dose for spring planted sunflower under the agro-ecological conditions of Dera Ismail Khan.

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