

AGRO-ECONOMIC ASSESSMENT OF DIFFERENT PHOSPHORUS LEVELS FOR DIVERSE SUNFLOWER HYBRIDS (*HELIANTHUS ANNUUS* L.)*

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ABSTRACT

A study was conducted in the Agronomy Department, University of Agriculture, Faisalabad during 2002 and 2003. Treatments comprised five phosphorus levels (0, 50, 100, 150 and 200 kg/ha) and two hybrids viz. Hysun-33 (standard height) and SF-187 (semidwarf). The average data showed that significantly higher achene yield (2881.8 kg/ha) was recorded in Hysun-33. Highest value of different growth and yield parameters differed among three phosphorus levels viz. 100, 150 and 200 kg. However, economic analysis showed that higher net income (Rs. 25962.9/ha) and benefit cost ratios (1.15) were obtained by applying 100 kg phosphorus per hectare.

KEYWORDS: *Helianthus annuus*; hybrids; phosphate fertilizers; agronomic characters; cost benefit analysis; Pakistan.

INTRODUCTION

Sunflower is extremely drought resistant crop and is being grown successfully in many semi-arid environments (12). However, being an exotic crop it is necessary to develop a suitable agro-technology to increase its production on sustained basis. Different sunflower cultivars perform differently depending on the region in which they are grown (23). Semidwarf cultivars have been reported to have a superior yielding ability due to increased reproductive development as compared to standard height varieties (11). Rooting pattern and rooting depth of semidwarf and standard height sunflower hybrids indicated that differences exist among the performance of sunflower genotypes, as the standard height hybrids extracted more water between rows than semidwarf hybrids (19). Dhoble (8) found that sunflower hybrid MSFH-1 gave significantly higher seed yield (1.153 t/ha) than BSH-1. Sunflower responds relatively better to management factors like nutrition. Biomass accumulation in sunflower is correlated with nutrient uptake throughout its life

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span (22). Phosphorus is the “master key” element in crop production (17). It is a non-renewable resource and a major plant nutrient next to N, required in adequate amount for higher crop yields as well as for proper functioning of soil biota (10). Phosphorus not only enhances the root growth but also promotes early plant maturity (15). Atteque *et al.* (3) reported that dry matter and seed yield increased with increasing phosphorus rate. Kumar *et al.* (13) noted increased plant height with increasing nitrogen alongwith phosphorus.

The present study was conducted to determine the most suitable level of phosphorus for different sunflower hybrids that may economically benefit the farmers.

MATERIALS AND METHODS

This study was conducted on a sandy clay loam soil in the research area of Agronomy Department, University of Agriculture, Faisalabad during 2002 and 2003. The climate of the region is semi-arid and sub-tropical. The experimental area is located at 73 East longitude, 31° North latitude and at an altitude of 135 meters above sea level. Soil of experimental area was quite uniform, so a composite and representative soil sample to a depth of 30 cm was obtained with soil auger, prior to sowing of crop. Soil analysis showed that it contained about 0.05 percent nitrogen, 8.90 ppm available phosphorus and 170 ppm available potassium. The treatments comprised two hybrids viz. Hysun-33, a standard height cultivar (H₁) and SF-187, a semidwarf cultivar (H₂) and five phosphorus levels (0, 50, 100, 150 and 200 kg/ha). The germination test in the laboratory showed that Hysun-33 had about 5 percent more germination than SF-187.

Layout system was RCBD with a split plot arrangement and replicated three times. Net plot size was 3.6 x 7.0 meter. Hybrids were kept in main plots and phosphorus levels (P₁ = 0, P₂ = 50, P₃ = 100, P₄ = 150 and P₅ = 300 kg/ha) in sub-plots. Before seedbed preparation, pre-soaking irrigation of 10 cm was applied. When soil reached to proper moisture level, the seedbed was prepared by cultivating the soil for 2-3 times with tractor mounted cultivator followed by planking. Sunflower cultivars were sown during second fortnight of August in 60 cm apart single rows. Sowing was done with dibbler keeping plant-to-plant distance of 22.5 cm. Nitrogen was applied @ 150 kg per hectare, half of

nitrogen plus full phosphorus at sowing while half nitrogen with first irrigation. All other agronomic practices were kept as normal and uniform for all the treatments. Data on various agronomic plant parameters were recorded using standard procedures. The pooled data were analyzed by using the methodology described in CIMMYT training manual (2). Net benefits were calculated by subtracting the total variable cost from the total benefits and benefit-cost ratio was calculated by dividing the net income by total variable cost for each treatment combination. Data collected were statistically analyzed using Fisher's analysis of variance technique and LSD test ($P = 0.05$) was used to compare the differences among treatments means (24).

RESULTS AND DISCUSSION

1. Number of plants/m²

There was significant difference between plant population of both hybrids (Table 1). Significantly more plant population was observed in Hysun-33 than SF-187 during both the years and in two years mean as well. Plant population did not differ significantly among different phosphorus levels. Similar number of plants under all phosphorus levels might be attributed to a uniform seeding technique and maintaining inter plant spacing. More number of plants in Hysun-33 might be due to its relatively more germination capacity than SF-187.

2. Plant height

The data (Table 1) show a significant difference in plant height of sunflower hybrids during both the years. Two years average indicated that significantly taller plants (162.6 cm) were produced by Hysun-33 than SF-187. (128.0 cm). The reason is that Hysun-33 was a variety of standard height while SF-187 was a semidwarf cultivar. Similar results were reported by Tunio *et al.* (25). Mean values showed that significantly taller plants (149.7 cm) were produced by P₄ (200 kg). It was, however, statistically at par with P₃. The shortest plants (138.6 cm) were recorded in control treatment. Increase in plant height with increased phosphorus levels has also been observed by earlier workers (6, 9).

Table 1. Effect of different phosphorus levels and hybrids on number of plants, plant height and head diameter on sunflower.

Hybrids	No. of plants/m ²			Plant height (cm)			Head diameter (cm)		
	2002	2003	Mean	2002	2003	Mean	2002	2003	Mean
Hlysun-33	7.33 a	7.31 a	7.32 a	160.8 a	164.3 a	162.6 a	16.32 b	16.65	16.49
SF-187	6.96 b	6.97 b	6.97 b	127.3 b	128.8 b	128.0 b	17.21 a	17.41	17.31
LSD 5%	0.0703	0.2675	0.0878	7.655	2.205	2.57	0.2222	NS	NS
Phosphorus levels (kg/ha)									
P ₀ = 0	7.16	7.15	7.154	136.7 b	140.6 d	138.6 d	15.70 e	15.80 d	15.75 e
P ₁ = 50	7.15	7.16	7.154	140.1 b	143.5 c	141.8 c	16.06 d	16.33 cd	16.20 d
P ₂ = 100	7.15	7.14	7.142	146.3 a	147.7 b	147.0 b	16.92 c	17.00 bc	16.96c
P ₃ = 150	7.14	7.13	7.132	148.5 a	150.2 a	149.4 a	17.50 b	17.70 ab	17.60 b
P ₄ = 200	7.14	7.13	7.135	148.6 a	150.8 a	149.7 a	17.65 a	18.33 a	17.99
LSD	NS	NS	NS	6.076	1.673	2.345	0.1161	0.7465	0.2808

Mean in the same column having different letters differ significantly (P = 0.05)

NS = Non-significant.

3. Head diameter

SF-187 produced larger heads than Hysun-33 although the results were non-significant during 2003 and in pooled data. Phosphorus levels significantly affected the head diameter of sunflower (Table 1). Maximum head diameter was recorded in plots where 200 kg P was applied and minimum in control during both years and also in mean values. Osman *et al.* (16) and Akram (1) also observed increased head diameter of sunflower with application of P plus N.

4. Achenes/head

Hybrids differed significantly in number of achenes per head (Table 2). Hysun-33 produced 27 and 23.7 percent more achenes than SF-187 during 2002 and 2003, respectively. As regards phosphorus levels, P₂ (100 kg) surpassed all treatments but it was statistically at par with P₁ (150 kg) during 2003 and in mean values. Minimum achene number was recorded in control (without P). Differences in achene number were attributed to different head diameter (Table 2) under different P levels. Weiss (26) also found significant effect of phosphorus fertilizer on number of achenes per head in sunflower. Sadiq *et al.* (18) obtained maximum achene number by applying 60 kg P per hectare and minimum at 0 kg P.

5. 1000-achene weight

The data (Table 2) revealed a significant difference in 1000-achene weight of both hybrids during 2002 and 2003 and also in mean values. SF-187 and Hysun-33 produced 61.65 g and 52.04 g per 1000 achenes, respectively. It was further revealed that phosphorus levels significantly affected 1000-achene weight of sunflower. Two years average data showed that higher weight (59.67 g) was given by 150 kg P but this treatment was statistically at par with 100 and 200 kg P. Minimum weight (52.02 g) was recorded in control treatment. Similar trend was observed during 2003. During 2002 all the treatments significantly differed from each other whereas P₃ topped in 1000-achene weight. These results are supported by Singh *et al.* (21) who observed minimum 1000-achene weight at 0 kg P and maximum at 90 kg P. To improve the seed size and its proper filling in sunflower liberal supply of P was essential (20).

Table 2. Effect of different phosphorus levels and hybrids on number of achenes/head, 1000-achene weight and achene yield of sunflower.

Hybrids	No. of achene head			1000-achene weight (g)			Achene yield (kg/ha)		
	2002	2003	Mean	2002	2003	Mean	2002	2003	Mean
Hysun-33	731.9 a	743.8 a	737.8 a	50.56 b	53.53 b	52.04 b	2774.5 a	2989.12 a	2881.8 a
SF-187	534.2 b	567.4 b	550.8 b	60.43 a	62.87 a	61.65 a	2599.6 b	2683.8 b	2641.7 b
LSD 5%	9.331	36.68	12.21	0.1217	3.507	0.6950	15.36	75.75	24.94
Phosphorus levels (kg/ha)									
P ₀ = 0	587.1 e	616.6 c	601.9 d	50.56 e	53.48 c	52.02 c	2310.8 d	2431.5 d	2371.1 d
P ₁ = 50	611.1 d	647.8 b	629.4 c	52.32 d	56.33 b	54.33 b	2513.9 c	2679.5 c	2596.8 c
P ₂ = 100	669.1 a	681.9 a	675.5 a	57.38 c	60.30 a	58.84 a	2919.7 a	3066.5 a	2993.1 a
P ₃ = 150	657.8 b	678.2 a	668.0 a	58.78 a	60.57 a	59.67 a	2931.8 a	3067.3 a	2999.6 a
P ₄ = 200	640.3 c	653.7 b	647.0 b	58.43 b	60.32 a	59.37 a	2759.0 b	2937.4 b	2848.2 b
LSD	5.571	19.60	7.583	0.1095	2.424	0.9032	35.00	81.45	32.99

Mean in the same column having different letters differ significantly (P = 0.05).

6. Achene yield

The hybrids significantly differed in achene yield during both years (Table 2). Average values showed that maximum achene yield (2881.8 kg/ha) was recorded in Hysun-33 against minimum (2641.7 kg/ha) in SF-187. Higher achene yield in Hysun-33 was attributed to its more number of plants per square meter and more number of achenes per head. Phosphorus levels also significantly affected achene yield during both years (Table 2). Two years mean values showed that higher achene yield (2999.6 kg) was recorded in P₁ followed by P₂ which were statistically at par with each other. The minimum achene yield (2371.1 kg/ha) was observed in control. Similar trend was observed during both the years. More achene yield in P₂ and P₃ treatments was due to more number of achenes per head and higher 1000-achene weight in these treatments. Increase in achene yield from P₀ to P₁ treatment was only 8.69 percent because minimum nutrient proportion is required to ensure desirable physiological conditions necessary for successful plant production (4). On the other hand, decrease in achene yield in P₄ was due to the application of large quantities of P which can adversely affect the supply of some micro-nutrients (5) required for good plant growth. Similar trend in achene yield of sunflower as a result of P fertilization was observed by previous researchers (7, 14, 18).

7. Net income

Different phosphorus levels resulted in different net income (Table 3). Treatment P₂ (100 kg P/ha) resulted in higher net income of Rs. 24770.1 and 27155.6 per hectare and benefit cost ratio (BCR) of 1.09 and 1.20 during 2002 and 2003, respectively. Minimum values were recorded in control. Malik *et al.* (14) while comparing four phosphorus levels (0, 70, 90 and 110 kg/ha) calculated higher net benefit at 90 kg P.

Table 3. Effect of different phosphorus levels on net income and benefit cost ratio of sunflower.

Phosphorus levels (kg/ha)	Net income (Rs./ha)		Benefit cost ratio	
	2002	2003	2002	2003
P ₀ = 0	17986.5	19947.9	0.92	1.02
P ₁ = 50	19730.9	22421.9	0.93	1.06
P ₂ = 100	24770.1	27155.6	1.09	1.20
P ₃ = 150	23409.8	25611.6	0.97	1.06
P ₄ = 200	19047.8	21946.8	0.74	0.85

On the basis of two years average it can be concluded that sunflower hybrid Hysun-33 should be planted to obtain higher achene yield. It should be fertilized @ 100 kg P per hectare to gain maximum economic benefits.

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