

## EFFECT OF NITROGEN AND PHOSPHORUS ON PROTEIN AND OIL CONTENT OF TWO SUNFLOWER VARIETIES

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**Abstract.** A field experiment was conducted in order to study the effect of nitrogen and phosphorus fertilizers on the protein\* and oil contents of two sunflower (*Helianthus annuus*) varieties HO-I and Peredovic. Nitrogen applied as ammonium sulphate at the rates of 0, 34 and 68 kg/ha and phosphorus ( $P_2O_5$ ) as superphosphate at the rates of 0, 28 and 56 kg/ha in a factorial set of combinations. Increased average protein percentage was obtained by increasing the rates of nitrogen. Phosphorus alone increased the average oil percentage. Nitrogen and phosphorus in combination at the rates of 68 kg/ha and 28 kg/ha respectively produced the highest mean protein percentage while 34 kg/ha of nitrogen and 28 kg/ha of phosphorus gave the highest mean oil percentage. Peredovic variety produced significantly higher oil percentage.

Interaction effects of nitrogen and phosphorus and nitrogen, phosphorus and varieties were nonsignificant in case of protein and oil percentage.

Nitrogen and phosphorus fertilization have recently become a widespread practice on the cultivated lands of Pakistan. The application of nitrogen and phosphorus not only increased the seed yield of various crops, but also affected the chemical composition of seed. The importance of sunflower crop is mainly due to its seed and its valuable constitutions such as oil and protein.

Sunflower seed oil is classed as semidrying oil equal to the best olive in its medicinal and feeding value for human consumption. It is employed for blending linseed and other drying oils in paints, varnishes and is used for soap making. It is estimated that by growing sunflower in the country a foreign exchange worth 15 million dollars can be saved. The object of this study is to find out the effect of nitrogen and phosphorus fertilizers on oil and protein contents of two sunflower varieties, HO-I and Peredovic. Very little work has been done in Pakistan in order to increase the oil and protein contents of sunflower seed in a short time, which may be achieved by applying proper amount and type of fertilizers.

Simanskii<sup>8</sup> found that nitrogen fertilizer led to an increase in protein percentage and a decrease in sugar content of the leaves at the flowering phase with the consequent reduction in oil content of seed. Gruev<sup>3</sup> reported that nitrogen used alone, reduced the oil content in seed.

Malykhin<sup>5</sup> achieved increased average oil content of sunflower by the application of superphosphate ( $P_2O_5$ ) in the row at the rate of 10 kg/ha.

### Materials and Methods

Two varieties of sunflower (*Helianthus annuus*) on the Malakander Farm, College of Agriculture, University of Peshawar, Peshawar, were fertilized in 1970. There were three replications of a factorial set of treatments using 0 (No), 34 (N1) and 68 (N2) kg nitrogen as ammonium sulphate with 0 (Po), 28

(P1) and 56 (P2) kg ( $P_2O_5$ ) as superphosphate per hectare. The N1 and N2 rates were applied in two equal increments by broadcast method while all P1 and P2 rates were applied by placement method. Some chemical and mechanical composition of the soil prior to treatment is given in Table 1. After harvesting the crop, the seed was oven-dried at 70°C for 48 hr and was then kept in a desiccator.

For protein determination, the oven-dried sample was grinded in a grinding mill, collected in a sampling jar which was kept in oven at 70°C for 24 hr and was cooled in a desiccator. One and a half gram grounded material was weighed and digested with concd  $H_2SO_4$  using potassium sulphate and copper sulphate mixture and was distilled with alkali solution according to the Kjeldahl method as described in A.O.A.C.<sup>1</sup> The protein content was calculated from: protein = Nitrogen(%)  $\times$  6.25.

A weighed quantity after grinding was transferred to an extraction apparatus using petroleum ether (b.p. 40.60°C) as an oil extraction agent. After the extraction of oil, the receiver was heated on water-bath for oil determination as reported by Bhatti and Karimullah.<sup>2</sup>

### Results and Discussion

Effects of different treatments of nitrogen and phosphorus on mean protein and oil percentage of two sunflower varieties are presented in Table 2. The average effect of nitrogen and phosphorus on protein and oil percentage in whole of the experiment are given in Table 3. The results of the statistical analysis are summarized in Table 4.

**Protein Percentage.** Significant differences in protein percentage between the three levels of nitrogen 0, 34 and 68 kg/ha, were found and an average increases of 7.86 and 11.5% were obtained by 34 and 68 kg/ha respectively when compared with nitrogen plots. Average protein percentage obtained from the application rate of 34 kg nitrogen did differ significantly from 68 kg/ha (Table 3). Nitrogen

\*The word 'protein' here means crude protein.

exerts the greatest effect in increasing the protein percentage, because it is an essential constituent for protein synthesis in plants. The results agree with these of Simanskii.<sup>8</sup>

No significant response to phosphorus application was detected in average protein percentage. This may be due to the fact that phosphorus increased grain yield and thus a given number of available nitrogen was spread throughout more grain giving lower protein contents or this substantial decrease may be related to the corresponding increase in oil percentage.

Significant increases in protein percentage over control were obtained when 34 and 68 kg nitrogen were applied in their possible combinations with 28 and 56 kg phosphorus ( $P_2O_5$ ) per hectare (Table 2). The highest protein percentage was recorded when the crop was manured at the highest level of nitrogen

and medium level of phosphorus (Table 2). Nitrogen and phosphorus interaction effect was nonsignificant, indicating that response to nitrogen was not dependent on the rates of phosphorus (Table 4).

Peredovic variety produced nonsignificant higher mean protein percentage (23.67%) followed by HO-I (22.08%). Maximum increase in protein percentage in Peredovic variety was achieved by the application of 68 kg nitrogen per hectare, while in HO-I by 68 kg nitrogen in combination with 28 kg phosphorus ( $P_2O_5$ ) per hectare (Table 2).

*Oil Percentage.* Nitrogen fertilizer produced nonsignificant differences in oil percentage. Application of the first 34 kg nitrogen per hectare gave an average increase of 4.13% in oil percentage over no nitrogen plots (Table 3). Doubling the level of nitrogen fertilization resulted an average decrease of 0.08% in oil percentage over no nitrogen plots. This shows that the highest level of nitrogen depressed the oil percentage. Such effect of nitrogen may be related to the corresponding increase in protein percentage. The results agree with those of Simanskii<sup>8</sup> and Gruev.<sup>3</sup>

Application rate of 28 kg of phosphorus ( $P_2O_5$ ) per hectare did not differ significantly from those 56 kg phosphorus ( $P_2O_5$ ) per hectare; but both rates gave a significant increase in average oil percentage over no phosphorus plots (Table 3). The application rate of 28 and 56 kg phosphorus ( $P_2O_5$ ) per hectare gave an average increase of 15.85 and 16.59% respectively over no phosphorus plots (Table 3). The results agree with Malykhin.<sup>5</sup> It is concluded that phosphorus play an important role in the formation of phospholipids and fat metabolism in plants and thus its contribution to the increase in oil percentage is the greatest.

Significant increase in oil percentage over control was obtained by applying medium and high rates of both nitrogen and phosphorus fertilizers in their all possible combinations. The highest oil percentage of 40.19% was obtained when the crop was manured

TABLE 1. PHYSICAL AND CHEMICAL CHARACTERISTICS OF SOIL.

Properties	Depth (cm)	
	0-22	22-44
pH of saturated soil paste	8.0	8.20
Nitrogen(%)	0.050	0.039
Organic matter(%)	0.92	0.54
Available phosphorus (p.p.m.)	10.80	9.75
Available potash (p.p.m.)	174.19	138.43
Lime(%)	10.95	12.99
*CEC meq/100 g of soil	10.30	10.80
†ECe × 10 <sup>3</sup>	1.12	1.05
Clay(%)	39.20	38.20
Silt(%)	52.60	50.30
Sand(%)	8.20	11.50
Textural class	Silty clay loam	

\*CEC, Cation exchange capacity; †ECe, electrical conductivity of saturation extract at 25°C.

TABLE 2. PROTEIN AND OIL PERCENTAGE OF TWO SUNFLOWER VARIETIES INFLUENCED BY NITROGEN AND PHOSPHORUS FERTILIZERS (mean of three replicates).

Fertilizer treatments (kg/ha)	Protein(%)			Oil (%)		
	HO - I	Peredovic	Mean	HO - I	Peredovic	Mean
N <sub>0</sub> P <sub>0</sub> (0-0)	21.33	21.59	21.41	27.76	37.12	32.44
N <sub>0</sub> P <sub>1</sub> (0-28)	20.17	22.35	21.26	33.31	39.37	36.34
N <sub>0</sub> P <sub>2</sub> (0-56)	21.15	22.41	21.78	35.34	40.61	37.97
N <sub>1</sub> P <sub>0</sub> (34-0)	22.54	23.70	23.12	29.41	36.38	32.89
N <sub>1</sub> P <sub>1</sub> (34-28)	21.88	24.07	22.97	33.52	46.86	40.19
N <sub>1</sub> P <sub>2</sub> (34-56)	22.38	24.50	23.44	34.31	41.86	38.08
N <sub>2</sub> P <sub>0</sub> (68-0)	23.20	25.01	24.10	29.40	35.20	32.30
N <sub>2</sub> P <sub>1</sub> (68-28)	23.61	24.87	24.24	32.18	40.96	36.57
N <sub>2</sub> P <sub>2</sub> (68-56)	22.52	24.61	23.56	34.42	41.15	37.78
Mean	22.08	23.67		32.18	39.94	

Varieties

S.E.  
LSD at 5% level.  
LSD at 1% level.

Nonsignificant

0.57  
—  
—

Significant at 5% level

0.78  
4.73  
10.91

TABLE 3. AVERAGE EFFECTS OF NITROGEN AND PHOSPHORUS ON PROTEIN AND OIL PERCENTAGE OF TWO SUNFLOWER VARIETIES.

Fertilizer treatments (kg/ha)	Protein (%)	Percentage increase over control	Oil (%)	Percentage increase over control
N <sub>0</sub> —no nitrogen	21.48	—	35.58	
N <sub>1</sub> —34 kg nitrogen	23.17	7.86	37.05	4.13
N <sub>2</sub> —68 kg nitrogen	23.94	11.54	35.55	-0.08
S.E. of mean	0.20		0.49	
LSD at 5%	0.54		1.35	
LSD at 1%	0.72		1.77	
P <sub>0</sub> —no phosphorus	22.87	—	32.54	
P <sub>1</sub> —28 kg P <sub>2</sub> O <sub>5</sub>	22.82	-0.21	37.70	15.85
P <sub>2</sub> —56 kg P <sub>2</sub> O <sub>5</sub>	22.92	0.21	37.94	16.59
S.E. of mean	0.20		0.49	
LSD at 5%	0.54		1.35	
LSD at 1%	0.72		1.77	

TABLE 4. SUMMARY OF STATISTICAL ANALYSIS SHOWING F VALUES AND ERROR VARIANCE FOR PROTEIN AND OIL PERCENTAGE OF SUNFLOWER.

Source of variance	df	Protein (%)	Oil (%)
Replications	2	0.64	0.15
Varieties	1	3.87	48.85
Error <sup>a</sup>	2	8.80	16.64
N	2	36.58*	3.08
P	2	0.06	38.84*
V × N	2	0.56	1.84
V × P	2	1.14	2.28
N × P	4	0.94	2.20
V × N × P	4	0.79	1.82
Error <sup>b</sup>	32	0.78	4.30

\*Significant at 1% level; a, error for varieties; and b, error for treatments.

at 34 kg nitrogen in combination with 28 kg phosphorus (P<sub>2</sub>O<sub>5</sub>) per hectare (Table 2). The nitrogen and phosphorus interaction effect was nonsignificant,

showing that response to phosphorus was not dependent on the rates of nitrogen.

Statistical analysis showed significant difference in oil percentage to exist among the testing varieties, which may be attributed to their genetic characters. Peredovic variety produced the highest mean oil percentage of 39.94% while HO-I produced 32.18% (Table 2). Peredovic variety produced the highest oil percentage of 46.86% by the application of 34 kg nitrogen in combination with 28 kg phosphorus (P<sub>2</sub>O<sub>5</sub>) per hectare, while HO-I gave 35.34% when 56 kg phosphorus (P<sub>2</sub>O<sub>5</sub>) per hectare was applied alone (Table 2).

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