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# Effect of Nitrogen and Phosphorus Fertilizer on Sunflower Seed Yield and Other Agronomic Characters

**Einfluß von Stickstoff und Phosphorsäure auf den Samenertrag und andere Merkmale von Sonnenblumen**

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## 1. Introduction

Sunflower (Helianthus annuus L.) is a potential oil-seed crop in Iran. Sunflower, like other crops, grow and produce well only when it has an adequate supply of the essential mineral nutrients. Any sunflower grower who is seeking high production must meet the several but not excessive level of each mineral nutrient. Fertilizer use in the production of major crops is an accepted and general practice in the established agricultural areas of the world. The optimum levels of chemical fertilizers should be determined for each regions of production because soil and climatical conditions vary widely at different areas.

Information on optimum levels of fertilizers to be used for sunflower production are limited for the southern parts of the country where this study was conducted. This investigation was carried out to measure the effects of nitrogen and phosphorus fertilizers on seed yield, 100-kernel weight, oil percent, and protein percent of sunflower under arid condition.

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## 2. Material and Methods

This experiment was conducted at the experimental field of the College of Agriculture at Ahvaz. The soil characteristics were as follows:

| soil depth cm | org. matter % | K available ppm | P available ppm | N % | BC mmhos/ cm | PH | soil type |
|---|---|---|---|---|---|---|---|
| 0.50 | 0.270 | 9.700 | 0.020 | 0.009 | 2.31 | 8.07 | sandy loam |

The levels of fertilization applied were as follows:

$N_0$ = 0 Kg/ha
$N_1$ = 150 Kg/ha
$N_2$ = 300 Kg/ha
$N_3$ = 450 Kg/ha

$P_0$ = 0 Kg/ha
$P_1$ = 75 Kg/ha
$P_2$ = 150 Kg/ha
$P_3$ = 225 Kg/ha

Therefore, a total of 16 treatment combinations were used in this study. The experiment started in February 25, 1976. A factorial design with 5 blocks was used. Each experimental plot was consisted of 4 rows. Each row was 7 meters long. Distances between rows and between plants on a row were 0.60 meter and 0.30 meter, respectively. Nitrogen and phosphorus were applied in forms of Urea and Triple-Super-Phosphate. The fertilizers were applied in the following way: one half of nitrogen and all of phosphorus fertilizer applied when plants were at 4-leaf stage and the second half of nitrogen was applied when heading stage started. Sunflower variety used was Vniimk 8931 because its superiority over other varieties had been confirmed in the previous experiments (2). The plots were irrigated as needed. The experiment was protected from bird damage, an important factor limiting sunflower production. Period to harvesting, 0.50 meter was discarded from both ends of the rows and the two middle rows were only harvested for measurements. Date of harvesting was July 13, 1976.

Method of covariance analysis was used for seed yield data because the number of plants were different for experimental plots. Seed yield was accordingly adjusted (7).

Soxhelt method was used for fat extraction and protein content was measured by Kjeldal method.

## 3. Results and Discussion

Results of the analysis of variance (100-Kernel weight, oil content %, and protein %) and covariance (seed yield) are presented in Table 1.

Table 1: Analysis of variance and covariance for effects of N and P on 4 agronomic traits of sunflower, variety Vniimk 8931

| Source of variation | Df | Mean squares | | | |
|---|---|---|---|---|---|
| | | Seed yield [a] | 100-kernel Wt.[b] | oil % | protein % |
| Blocks | 4 | | | | |
| N | 3 | 0.890** | 1.573** | 59.123** | 49.953** |
| P | 3 | 0.447 | 1.240* | 14.518** | 10.460** |
| NP | 9 | 0.351 | 0.691 | 6.028** | 3.750* |
| Error | 60 | 0.208 | 0.365 | 2.020 | 1.420 |

a: ton/ha, b: gram
*: Significant at 0.05 level, **: Significant at 0.01 level.

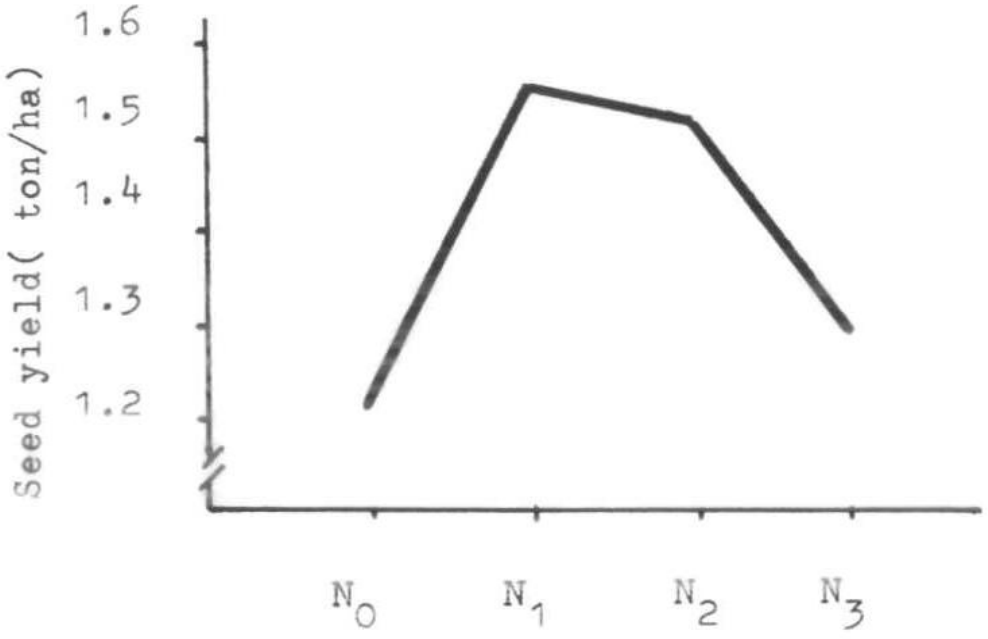


Fig. 1: Response of seed yield to N fertilizer.

Highly significant differences were found between different levels of nitrogen fertilizer for seed yield. Effects of different levels of phosphorus fertilizer and interaction effects of N × P were not significant for seed yield.

Response of seed yield to the levels of N is seen in Figure 1. Seed yield was relatively low because sowing date was delayed due to rain.

Although, there was not significant differences between adjusted mean seed yield for $N_1$, $N_2$, and $N_3$ but it appeared from the trend shown in Figure 1 that seed yield was decreased as the amount of nitrogen fertilizer went beyond 150 Kg/ha ($N_1$). Differences between $N_1$ and $N_0$ and between $N_2$ and $N_0$ were significant.

Highly significant differences were found between nitrogen levels and 100-kernel weight. Effects of different levels of phosphorus were significant. Interaction effects were not significant for this trait (Table 1). Figures 2 and 3 show the effects of N and P on 100-kernel weight, respectively.

The effects of $N_0$, $N_1$, and $N_2$ on 100-kernel weight were not significantly different. Kernel weight was significantly higher for $N_3$ as compared with $N_0$ and $N_1$. This trait showed similar response to $N_3$ and $N_2$. However, the trend in Fig. 2 indicates that as the amount of nitrogen fertilizer increased a positive response was obtained for kernel weight.

Increasing the amount of phosphorus fertilizer from $P_0$ to $P_1$ increased kernel weight significantly but this trait did not show any response byond $P_1$ (Fig. 3).

Main effects of nitrogene and phosphorus fertilizers were highly significant for percent oil and protein contents (Table 1). The interaction effects were also highly significant for oil contents and significant for protein contents.

The effects of different levels of N and P mineral fertilizer on percent oil and protein contents are shown in Table 2 and Table 3, respectively.

Table 2: The effects of different doses of N and P mineral fertilizer on percent oil content of sunflower

| | $P_0$ | $P_1$ | $P_2$ | $P_3$ | Mean |
|---|---|---|---|---|---|
| $N_0$ | 45.68 | 46.24 | 46.20 | 46.40 | 46.13 |
| $N_1$ | 47.66 | 43.80 | 44.36 | 45.16 | 45.25 |
| $N_2$ | 44.88 | 43.68 | 44.40 | 42.32 | 43.82 |
| $N_3$ | 44.44 | 42.04 | 41.72 | 40.72 | 42.23 |
| Mean | 45.77 | 43.94 | 44.17 | 43.65 | |

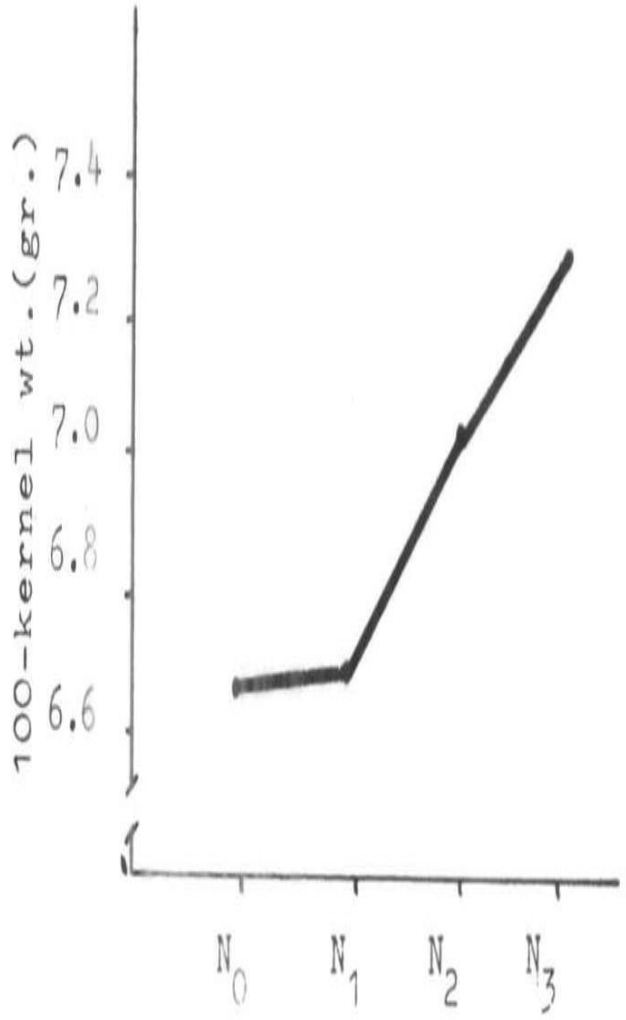


Fig. 2: Response of 100-kernel weight to N fertilizer.

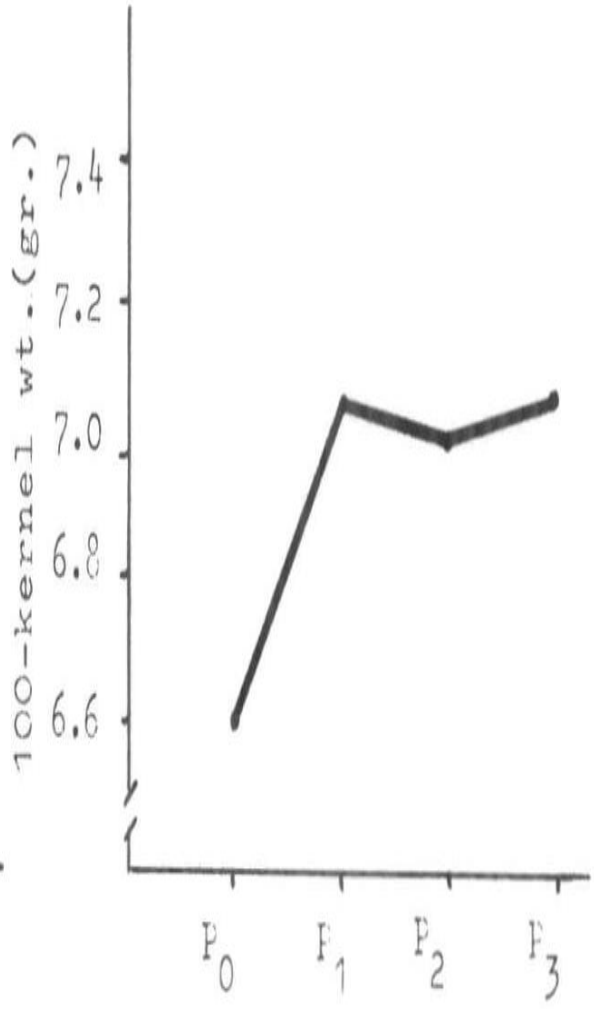


Fig. 3: Response of 100-kernel weight to P fertilizer.

Table 3: The effects of different doses of N and P mineral fertilizer on percent protein content of sunflower

| | $P_0$ | $P_1$ | $P_2$ | $P_3$ | Mean |
|---|---|---|---|---|---|
| $N_0$ | 20.80 | 19.86 | 20.10 | 20.10 | 20.21 |
| $N_1$ | 20.50 | 22.80 | 24.34 | 22.62 | 22.56 |
| $N_2$ | 21.86 | 23.78 | 23.22 | 23.18 | 23.01 |
| $N_3$ | 22.30 | 23.96 | 24.66 | 23.22 | 23.53 |
| Mean | 21.36 | 22.60 | 23.08 | 22.35 | |

The surface response of percent oil and protein contents are shown in Figure 4 and 5. In general, a negative relationship was existed between percent oil content and the amount of nitrogen fertilizer applied (Table 2 and Figure 4). However, the maximum oil content was obtained at $N_1P_0$. There was a positive relationship between percent protein content and different levels of nitrogen fertilizer applied (Table 3 and Figure 5). The maximum protein content was obtained at $N_3P_2$.

The most important traits in sunflower production are seed yield and percent oil content. Reports on the effects of mineral fertilizer on these traits are contradictory. Saric et al. (6) concluded from the data obtained in the field over five years that lower and moderate levels of nitrogen had considerably greater effect on seed and oil yields, regardless of the applied amounts of phosphorus and potassium. He also found that the application of highest levels of nitrogen had a tendency of decreasing sunflower oil yield. The results obtained from our experiment are similar to those obtained by Saric et al. On the contrary, Bamdad (1) concluded that heavy application of both nitrogen and phosphorus fertilizers should be used to maximiz sunflower seed and oil yields. In an experiment conducted by Fenton (3) it was found that nitrogen fertilizer applied up to 123 kg/ha had a highly significant increase in seed yield. Phosphorus applied had no significant effect. Licev et al. (5) also recommended mild application of nitrogen fertilizer for various chernozem soils. Hera et al. (4) found phosphorus the most important factor for yield increase in all chernozem soils.

There is no doubt that soil characteristics and climatical conditions play important roles on mineral uptake of a plant species. But different plant species react very differently on mineral fertilizer due to specific physiol-ogico-biochemical processes during the life of corresponding plant species (6).

It appears from the results obtained from our experiment and similar studies that low, or medium levels of nitrogen fertilizer would increase sunflower

seed and oil yields. Heavy application of mineral nitrogen has little or no effect on seed yield but has a tendency to lower percent oil content.

Application of phosphorus fertilizer has little or no effect on sunflower seed and oil yields.

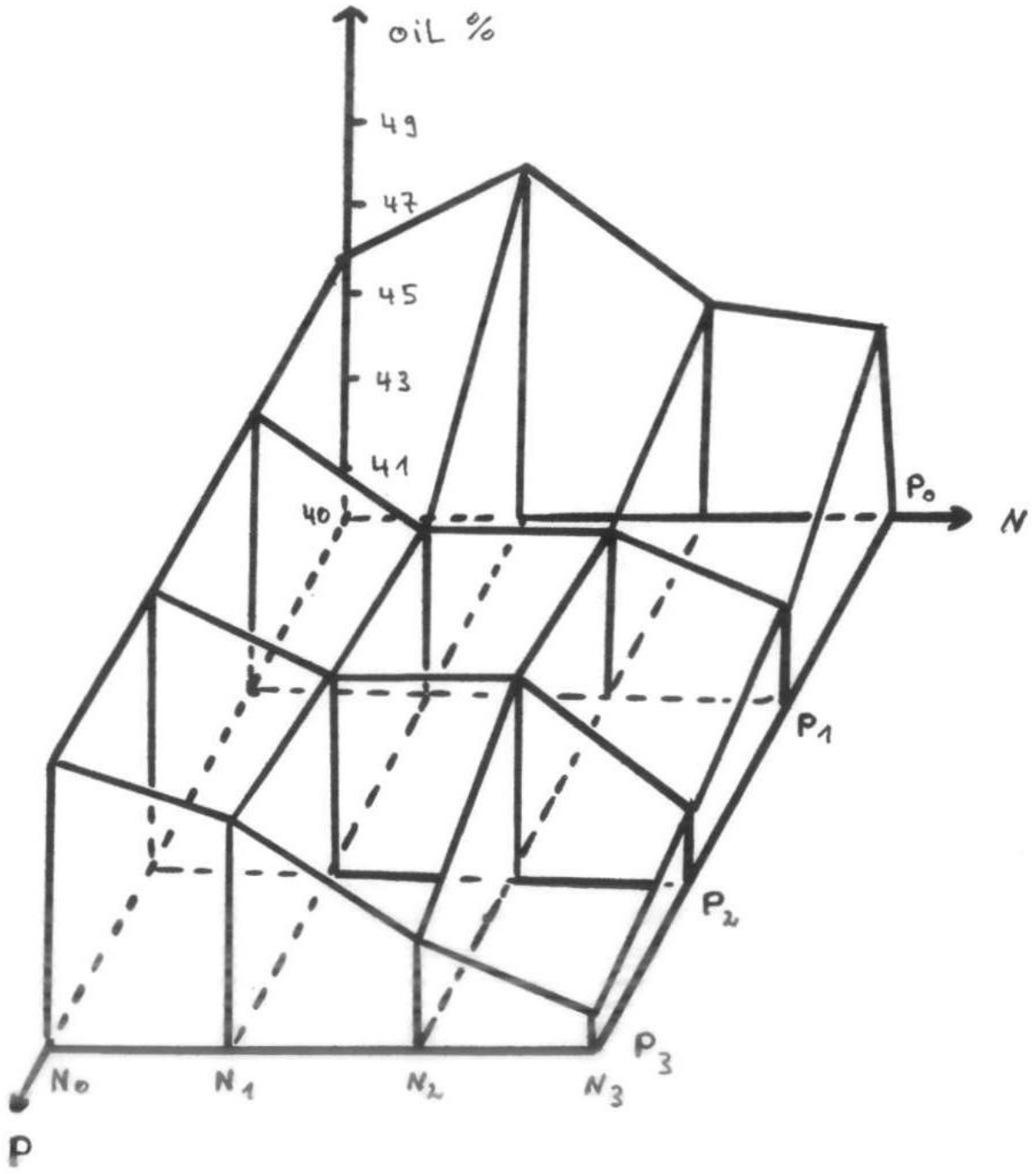


Fig. 4: Surface response of percent of oil content to N and P fertilizer.

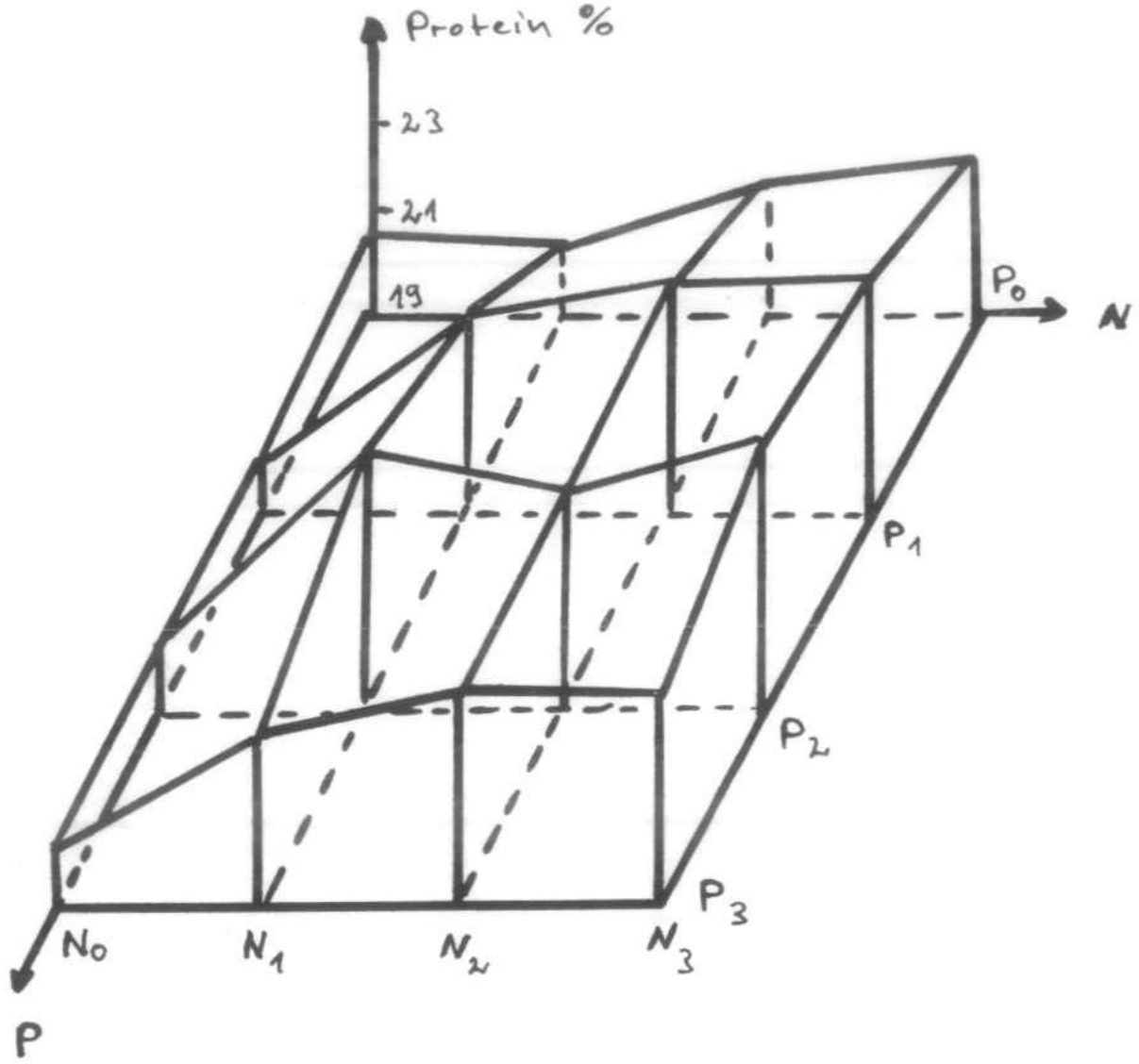


Fig. 5: Surface response of percent protein content to N and P fertilizer.

## 4. Summary

The purpose of this experiment was to examine the effect of nitrogen and phosphorus mineral fertilizer on sunflower seed yield, 100-Kernel weight, percent oil content, and percent protein content. The levels of fertilization applied (Kg/ha) were: $N_0 = 0$, $N_1 = 150$, $N_2 = 300$, $N_3 = 450$, $P_0 = 0$, $P_1 = 75$, $P_2 = 150$, $P_3 = 225$. A factorial design with 5 blocks was used. Sunflower variety employed was Vniimk 8931. One half of N and all of P fertilizer were applied when plants were at four-leaf stage. The second half of N was applied when heading stage started.

Highly significant differences were found between different levels of N for seed yield. Effects of different doses of P and interaction effect of N × P were not significant for seed yield.

Significant differences were observed between N levels and between P levels for 100-Kernel weight. Interaction effect of N × P was not significant for this trait.

Main effects of N and P and their interaction were significant for both percent oil and percent protein content.

It was concluded that lower and moderate levels of N had considerably greater effect on seed yield, regardless of the applied amount of P fertilizer.

Kernel weight was increased at higher levels and moderate level of N and P fertilizer, respectively.

In general, percent oil content was negatively and percent protein content was positively related to the amount of N fertilizer applied. However, the maximum oil content and protein content were obtained at $N_1P_0$ and $N_3P_2$, respectively.


**Zusammenfassung**

Ziel des Versuches war, den Einfluß von N- und P-Mineraldüngern auf Samenertrag, 100-Korngewicht, prozentualen Öl- und Proteingehalt von Sonnenblumen zu bestimmen.

Folgende Düngerstufen wurden angewandt: $N_0 = 0$, $N_1 = 150$, $N_2 = 300$, $N_3 = 450$, $P_0 = 0$, $P_1 = 75$, $P_2 = 150$ und $P_3 = 225$ kg/ha. Der Versuch wurde in fünffacher Wiederholung angelegt. Es wurde die Sorte VNIIMK 8931 verwandt. Im 4-Blattstadium der Pflanzen wurde die Hälfte der N-Menge und die gesamte P-Menge, und während der Blütenbildung wurde die restliche Hälfte des N-Düngers gegeben.

Die verschiedenen N-Mengen beeinflußten den Samenertrag hochsignifikant. Der Einfluß der verschiedenen P-Mengen und die Interaktionen zwischen N und P waren nicht signifikant.

Die unterschiedlichen N- und P-Stufen veränderten das 100-Korngewicht signifikant. Der Einfluß der beiden Nährstoffe und deren Interaktionen auf den Öl- und Proteingehalt war statistisch nicht zu sichern.

Ohne Berücksichtigung der P-Düngung erhöhten niedrige und mittlere N-Gaben den Samenertrag bemerkenswert. Ein hohes 100-Korngewicht wurde durch die Düngerstufen $N_3$ und $P_1$ erzielt.

Im allgemeinen wurde durch die N-Düngung der Ölgehalt negativ und der Proteingehalt positiv beeinflußt. Der höchste Öl- und Proteingehalt wurde bei $N_1P_0$ bzw. $N_3P_2$ erreicht.

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