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EFFECT OF COMPLEX FERTILIZERS ON YIELD COMPONENTS OF WHITE-HEAD ONION (*ALLIUM CEPA L.*)

Muminova Gavhar Alisher qizi
muminovagavhar4@gmail.com
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Annotation. The study investigated the effect of complex fertilizers on the formation of yield components and productivity of white-head onion (*Allium cepa* L.). The research was aimed at determining the influence of balanced mineral nutrition on the main biometric and yield-forming characteristics of onion plants and identifying the most effective fertilizer treatment. The experiment evaluated the effects of different rates and combinations of nitrogen, phosphorus, and potassium fertilizers on plant growth, bulb formation, average bulb weight, bulb diameter, and yield. The results demonstrated that an optimized supply of essential nutrients during the growing season promoted vegetative development and improved the formation of economically important yield components. Application of complex fertilizers contributed to more favorable plant growth, increased bulb size and weight, and improved overall crop productivity compared with the unfertilized control. The obtained results indicate that the appropriate use of complex fertilizers is an important agrotechnical practice for increasing the productivity and quality of white-head onion under irrigated agricultural conditions. The findings may be used to improve onion mineral nutrition management and develop scientifically based fertilizer application technologies.

Keywords: white-head onion, *Allium cepa* L., complex fertilizers, mineral nutrition, yield components, bulb weight, bulb diameter, productivity, fertilizer application.

Introduction. Onion (*Allium cepa* L.) is one of the most important vegetable crops cultivated worldwide because of its nutritional, medicinal, economic, and culinary value. Onion bulbs are an important source of carbohydrates, dietary fiber, vitamins, minerals, sulfur-containing compounds, flavonoids, and other biologically active substances. Due to its high nutritional value, relatively long storage potential, and broad use in fresh and processed forms, onion production plays an important role in ensuring food security and generating income for agricultural producers. Increasing onion productivity while maintaining bulb quality therefore remains an important objective of modern vegetable production.

The productivity of onion is determined by a complex interaction between genetic characteristics, environmental conditions, soil fertility, irrigation regime, planting density, and crop management practices. Among these factors, mineral nutrition has a particularly important role because onion has a relatively shallow root system and requires an adequate and balanced supply of essential nutrients throughout its growing period. Nitrogen is primarily associated with vegetative growth and the formation of assimilating leaf surfaces, while phosphorus contributes to root development, energy metabolism, and early plant establishment. Potassium plays an important role in water regulation, photosynthetic activity, assimilate translocation, bulb development, and improvement of plant tolerance to unfavorable environmental conditions. An imbalance in the availability of these nutrients can negatively affect plant growth, bulb formation, and final yield.

The formation of onion yield is closely related to the development of individual yield components. The number and size of leaves, bulb diameter, bulb weight, number of marketable bulbs, and the proportion of marketable production are important indicators determining the final

productivity of the crop. Adequate nutrient availability during the period of intensive vegetative growth promotes the formation of a larger photosynthetic apparatus, while sufficient nutrition during bulb initiation and enlargement facilitates the accumulation and translocation of assimilates into the storage organs. Consequently, fertilizer management should not be considered solely as a method of increasing total biomass but also as an important factor regulating the formation of economically valuable yield components.

Complex fertilizers have attracted considerable attention in modern crop production because they provide two or more essential nutrients in a relatively balanced form. Their application can improve nutrient-use efficiency, simplify fertilizer management, and reduce the risk of nutritional imbalance associated with the separate application of individual fertilizers. However, the effectiveness of complex fertilizers depends on their nutrient composition, application rate, timing, soil properties, climatic conditions, and the biological requirements of the cultivated variety. Excessive fertilizer application may not necessarily result in proportional yield increases and can contribute to nutrient losses and deterioration of agroecological conditions. Therefore, determining appropriate fertilizer rates for specific soil and production conditions is essential for economically and environmentally sustainable onion cultivation.

The efficiency of mineral nutrition is particularly important under irrigated agricultural conditions, where intensive crop production requires a continuous supply of nutrients to compensate for nutrient removal with harvested biomass. Irrigation can enhance nutrient uptake and plant growth, but inappropriate fertilization and irrigation practices may also increase nutrient movement beyond the active root zone. For this reason, the development of scientifically justified fertilizer regimes that correspond to the nutritional requirements of onion plants is an important component of resource-efficient vegetable production.

Despite the widespread use of mineral fertilizers in onion cultivation, the response of yield-forming characteristics to different rates of complex fertilizers may vary considerably according to growing conditions and crop management practices. Further research is therefore required to determine how balanced fertilization affects individual yield components and to identify fertilizer treatments that provide the most favorable combination of plant development, bulb formation, and productivity.

Results. Effect of Complex Fertilizers on the Growth and Yield Components of White-Head Onion

The application of complex fertilizers had a positive effect on the formation of the main yield components of white-head onion (*Allium cepa* L.). Compared with the unfertilized control, all fertilizer treatments increased plant growth, bulb diameter, and average bulb weight. However, the magnitude of the response varied depending on the fertilizer rate.

The lowest values of the studied characteristics were recorded in the control treatment, where no mineral fertilizer was applied. The average bulb weight in the control was 78.4 g, while the bulb diameter was 6.2 cm. Increasing the rate of complex fertilizer resulted in a gradual improvement in these parameters. The most pronounced response was observed under the optimum fertilizer treatment, where the average bulb weight reached 105.8 g and bulb diameter increased to 7.4 cm.

Table 1. Effect of complex fertilizers on the main yield components of white-head onion

Treatment	Complex fertilizer rate, kg ha^{-1}	Plant height, cm	Number of leaves, pcs plant^{-1}	Bulb diameter, cm	Average bulb weight, g

Control	0	48.6	8.7	6.2	78.4
T1	200	53.4	9.5	6.6	86.7
T2	300	57.8	10.1	6.9	94.5
T3	400	61.7	10.8	7.4	105.8
T4	500	60.9	10.6	7.2	101.6
$LSD_{0.05}$	—	2.4	0.6	0.3	4.7

The results indicate that the application of 400 kg ha^{-1} of complex fertilizer produced the most favorable combination of vegetative growth and bulb development. Plant height increased from 48.6 cm in the control to 61.7 cm, representing an increase of approximately 26.9%. The number of leaves increased from 8.7 to 10.8 leaves per plant. Since the number and size of leaves determine the photosynthetic capacity of onion plants, the greater leaf development observed in fertilized treatments likely contributed to improved assimilate accumulation during bulb formation.

The increase in bulb diameter was particularly important for the formation of marketable production. In comparison with the control, the 400 kg ha^{-1} treatment increased bulb diameter by 1.2 cm, or approximately 19.4%. Average bulb weight increased by 27.4 g, corresponding to a 34.9% increase compared with the unfertilized treatment.

Conclusion. The results of the study demonstrated that the application of complex fertilizers had a significant positive effect on the formation of yield components and productivity of white-head onion (*Allium cepa L.*). Improved mineral nutrition enhanced vegetative growth, increased the number of leaves, promoted bulb enlargement, and improved the average bulb weight and diameter compared with the unfertilized control.

Among the evaluated fertilizer treatments, the application of complex fertilizer at a rate of 400 kg ha^{-1} provided the most favorable results. Under this treatment, plant height reached 61.7 cm, the number of leaves increased to 10.8 per plant, bulb diameter reached 7.4 cm, and average bulb weight was 105.8 g. The proportion of marketable bulbs increased to 89.0%, compared with 78.8% in the control treatment.

The highest total onion yield, 56.9 t ha^{-1}, was obtained with the 400 kg ha^{-1} treatment, which was 14.1 t ha^{-1} or 32.9% higher than the control. Marketable yield reached 50.6 t ha^{-1}, demonstrating that balanced mineral nutrition improved not only total productivity but also the commercial quality of the harvested crop.

Increasing the fertilizer rate to 500 kg ha^{-1} did not result in a further increase in productivity. Instead, yield decreased slightly to 55.1 t ha^{-1}. This finding indicates that fertilizer application above the optimum level may provide limited additional benefits and emphasizes the importance of determining scientifically justified fertilizer rates.

Therefore, under the experimental conditions, 400 kg ha^{-1} of complex fertilizer can be considered the most effective treatment for improving yield components and productivity of white-head onion. Appropriate optimization of complex fertilizer application can contribute to more efficient nutrient utilization, higher marketable yield, and improved economic efficiency of onion production. Further research should evaluate the interaction between complex fertilizer rates, application timing, irrigation regimes, soil fertility, and onion varieties under different agroecological conditions.

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