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Studies on Effect of Farm Yard Manure and Fertilizers on Growth and Yield of Garlic *(Allium sativum L.)* cv. G-363

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Abstract: This study was conducted during the winter season of 2020–2021 at the Research Farm of the Department of Horticulture, Faculty of Plant Sciences, Afghanistan National Agriculture Science & Technology University (ANSTU) in Kandahar, Afghanistan. The experiment evaluated the response of garlic (Allium sativum L.) to different applications of NPK fertilizers and their combinations with farmyard manure (FYM) in terms of growth and yield. The experiment included nine treatments, each occupying an area of 2.25 m², arranged in a randomized block design with three replications. Fertilizer treatments included applications of 160:80:80 kg/ha NPK and 140:70:70 kg/ha NPK, along with combinations of these with 10 t/ha and 15 t/ha of FYM. Data analyzed using SAS software revealed that both chemical fertilizers (NPK) and their combinations with FYM significantly influenced growth parameters and yield. The highest plant height (30.02 cm), bulb weight (40.71 g), and average yield (10.69 t/ha) were recorded in treatment T3 (FYM 15 t/ha + 160:80:80 kg/ha NPK). The maximum leaf length (25.19 cm) was observed in treatment T6 (FYM 10 t/ha + 160:80:80 kg/ha NPK). Growth data collected at different intervals (30, 50, 70, 90, and 110 days after sowing) indicated that the maximum leaf length (32.41 cm), number of leaves (8.69), and plant height (40.26 cm) were recorded at 110 days after sowing. Growth and yield parameters were also analyzed across three replications. Among these, replication one (R1) exhibited the best growth parameters, including a leaf length of 25.36 cm, number of leaves of 6.47, and plant height of 30.67 cm. Replication three (R3) showed the highest yield at 9.69 t/ha.

Keywords: Allium sativum L., FYM, Growth, Yield, Fertilizers, Garlic cv. G-363.

1. Introduction

Garlic, a member of the Alliaceae family, traces its origins to the thin, rocky soils of the region now known as Afghanistan (Rubatzky & Yamaguchi, 1997). As a sexually sterile crop, garlic is propagated clonally using cloves small bulbils found within its bulbs, which can range from 5 to 40 per bulb. Globally, India ranks as the second-largest garlic producer. Renowned for its rich nutritional content, garlic is a valuable source of sugar, protein, phosphate, potassium, Sulphur, iodine, fiber, and vitamins. Its distinct flavor has made it a staple spice and seasoning, with both the green tops and bulbs widely utilized in pickles, curry powders, vegetable and meat dishes, as well as tomato ketchup, particularly in India and other parts of Asia and the Middle East. Fresh garlic contains 0.1 to 0.25% volatile oils, which contribute to its

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characteristic aroma and flavor. As noted by Devendra et al. (2014), garlic oil is highly valued for its culinary versatility, being used in soups, sauces, canned foods, and meat dishes.

Botanically, garlic (*Allium sativum* L.) belongs to the genus Allium within the Alliaceae family and the order Asparagales. It comprises two subspecies: ssp. sativum (common garlic) and ssp. asiae mediae (Central Asian garlic), each further divided into non-bolting (var. vulgare) and bolting (var. sagitatum) variants (Moravcevic et al., 2017). Garlic is one of the most important Allium crops globally, appreciated for its production potential and economic significance (Diriba et al., 2013). The cloves are primarily used for flavoring foods, with their pungency attributed to Sulphur compounds like allicin. In tropical regions, fresh green tops are consumed either raw or cooked, while immature bulbs are often added to salads. In addition to its culinary importance, garlic holds medicinal value and is extensively grown as a spice crop.

Sulphur plays a critical role in the growth and pungency of garlic plants. It is essential for developing the characteristic flavors of Allium crops and promoting healthy plant growth (Randle, 1997). Lancaster et al. (2001) reported that onions grown with inadequate Sulphur levels produce softer bulbs compared to those cultivated with sufficient Sulphur supply. While organic fertilizers are often recommended for sustainable agriculture, they have limitations, including low nutrient density, limited availability, and the labor-intensive nature of their application. Traditional organic inputs such as crop residues and animal manure are often insufficient to meet the nutrient demands of crops on a large scale. Therefore, a combined application of organic and inorganic fertilizers is recommended to optimize nutrient availability (Palm et al., 1997).

Studies have shown that organic fertilizers like wood ash, poultry manure, and fermented slurry contribute to garlic production with low moisture content, enhanced pungency, and improved mineral composition (Babatunde et al., 2009). Research by Jones et al. (2007) revealed that the Sulphur content in garlic bulbs ranged from 4.0 g/kg with NPK fertilizers to 15.2 g/kg with wood ash. Exclusive reliance on organic farming is not sustainable for commercial agriculture, as it often falls short of meeting the nutrient demands of high-yielding crops. Vegetable crops, in particular, exhibit rapid growth and high productivity, responding favorably to fertilizer and manure applications tailored to their specific nutrient requirements. For example, bulb-forming crops like garlic require higher potassium levels to support their development.

Soil quality in tropical and subtropical regions is typically low in organic matter due to rapid mineralization caused by plowing and favorable climatic conditions. Intensive farming practices further deplete soil organic matter, necessitating the use of organic amendments such as compost, oil cakes, green manures, and farmyard manure to replenish soil fertility. However, organic fertilizers alone cannot meet the specific nutrient demands of crops, including potassium, phosphate, and nitrogen. An integrated approach to soil fertility management, combining organic and inorganic inputs in balanced proportions, is crucial for sustainable agricultural productivity. Excessive use of chemical fertilizers, however, can lead to soil contamination and degradation. Therefore, prudent management of both organic and inorganic fertilizers is essential to maintain soil health, enhance agricultural output, and ensure environmental sustainability.

In Afghanistan, farmers face significant challenges in cultivating garlic due to limited awareness of modern agricultural practices, including the introduction of new garlic varieties, proper fertilizer dosages, and efficient irrigation systems. This lack of knowledge often results in low yields and pest infestations, particularly in Kandahar, Helmand, Zabul, and Uruzgan provinces (RADP-S USAID, 2017). Traditional garlic cultivation in Kandahar involves raised beds, which are labor-intensive and inefficient in terms of land and water use. Modern methods, such as plot-based systems, could offer more affordable and sustainable alternatives.

This study was conducted in Kandahar province to assess the impact of different levels of FYM and NPK fertilizers on the growth and yield of garlic under sandy loam soil conditions. It aimed to identify the optimal fertilizer doses for maximizing garlic production while addressing the unique agro-climatic challenges of the region. The findings are expected to bridge the gap between traditional practices and modern agricultural techniques, providing a framework for improving garlic cultivation in Afghanistan.

2. Materials and Methods

A field experiment was conducted during the winter season of 2020–2021 at the Research Farm of ANASTU in Kandahar, Afghanistan, using garlic cultivar G–363. The experiment was designed as a randomized block design (RBD) with nine treatments, three replications, and a total of 27 plots. Each plot measured 2.25 m² (1.5 m × 1.5 m), with a spacing of 10 cm × 15 cm between plants and rows, respectively. The experiment utilized basal applications of farmyard manure (FYM) at rates of 10 and 15 t/ha and NPK fertilizers at rates of 140:70:70 kg/ha and 160:80:80 kg/ha.

The parameters measured included plant height, leaf length, number of leaves per plant, polar and equatorial bulb diameters (cm), fresh bulb weight (g), and yield (t/ha). Yield performance was specifically assessed using the treatment with FYM at 15 t/ha combined with nitrogen at 160 kg/ha, phosphorus (P_2O_5) at 80 kg/ha, and potassium (K_2O) at 80 kg/ha. Data collection was performed on ten randomly selected plants per treatment, and the data were analyzed using SAS software.

The experimental field was laid out with precise dimensions and irrigation systems. Each bund measured 0.30 m in width, with main irrigation channels spaced 1.00 m apart and sub-irrigation channels at 0.50 m intervals. The total experimental field spanned 16.5 m in length and 7.3 m in width, covering a gross cultivated area of 120.45 m², while the net cultivated area (calculated as 2.25 m² × 27 plots) totaled 60.75 m². A total of 4050 plants were included in the experiment, with 150 plants per plot.

This systematic experimental setup ensured uniformity and provided reliable data to evaluate the impact of FYM and NPK fertilizer levels on garlic growth and yield under the agro-climatic conditions of Kandahar. The experiment included the following treatments in Table 1:

Table 1: FYM and NPK fertilizers distribution in different treatments

Treatments	FYM and NPK fertilizers
T0	Control (no application of FYM or NPK fertilizers)
T1	Farmyard manure (FYM) at 15 t/ha
T2	FYM at 15 t/ha + NPK fertilizer at 140:70:70 kg/ha
T3	FYM at 15 t/ha + NPK fertilizer at 160:80:80 kg/ha
T4	FYM at 10 t/ha
T5	FYM at 10 t/ha + NPK fertilizer at 140:70:70 kg/ha
T6	FYM at 10 t/ha + NPK fertilizer at 160:80:80 kg/ha
T7	NPK fertilizer at 140:70:70 kg/ha
T8	NPK fertilizer at 160:80:80 kg/ha

The following parameters were observed at various successive growth stages.

A. Growth Parameters

Growth observations were recorded at 20-day intervals until vegetative maturity, except for the first observation, which was taken 30 days after sowing. Data were collected across three replications for the following parameters:

1. Leaf Length (cm):

The length of leaves from four randomly selected plants in each replication was measured at 30, 50, 70, 90, and 110 days after sowing. The average leaf length for each replication was recorded and statistically analyzed.

2. Number of Leaves per Plant:

The number of leaves on four randomly selected plants was counted at 30, 50, 70, 90, and 110 days after sowing. The average number of leaves per plant in each replication was recorded and analyzed statistically.

3. Plant Height (cm):

The height of four randomly selected plants from each plot was measured in centimeters using a measuring tape, from ground level to the tip of the leaves under natural conditions. Measurements were taken at 30, 50, 70, 90, and 110 days after sowing. The average height of the plants from each replication was recorded and subjected to statistical analysis.

B. Yield and Yield-Attributing Parameters

When the crop reached maturity, bulbs were harvested, and the following yield-related parameters were recorded, averaged across three replications, and subjected to statistical analysis:

1. Fresh Bulb Weight per Plant (g):

Mature bulbs were harvested and weighed, and the average weight was analyzed.

2. Bulb Size - Equatorial Diameter (cm):

The equatorial diameter of randomly selected bulbs was measured using a Vernier caliper, averaged, and analyzed.

3. Bulb Size - Polar Diameter (cm):

The polar diameter of randomly selected bulbs was measured using a Vernier caliper, averaged, and analyzed.

4. Bulb Neck Diameter (cm):

The neck diameter of bulbs from four randomly selected plants was measured, averaged, and subjected to statistical analysis.

5. Bulb Yield per Plot (kg):

Bulbs harvested from each plot were weighed, and the yield per plot was recorded, averaged, and analyzed.

6. Bulb Yield (t/ha):
Bulb yield was calculated in tonnes per hectare based on the yield per plot, averaged across replications, and subjected to statistical analysis.

3. Results and Discussion

3.1 Length of Leaves

Fertilizer levels significantly affected leaf length, as detailed in Table 2. The highest average leaf length (25.19 cm) was observed in treatment T6 (FYM 10 t ha-1 + NPK 160:80:80 kg ha-1), which was statistically comparable to treatments T5, T2, T3, T4, and T7. All these treatments involved a combination of organic (FYM) and inorganic (NPK) fertilizers. The lowest leaf length (23.21 cm) was found in treatment T0, the control treatment with no fertilizers. Treatments T0 and T1 had similar leaf lengths of 23.21 cm and 23.55 cm, respectively. Enhanced photosynthetic activity could contribute to longer leaves, consistent with findings by Banafer et al. (2004).

Analysis of leaf length over different observation dates showed that the highest leaf length was at 110 days after sowing (DAS) (32.41 cm), significantly greater than at 90 DAS (28.78 cm), followed by 70 DAS (24.22 cm), 50 DAS (21.04 cm), and 30 DAS (15.37 cm), as shown in Table 3. Leaf length (LL) was measured across three replications (R1, R2, and R3), as shown in Table 4. The highest LL was noted in R1 (25.36 cm), while the lowest was in R3 (23.32 cm). Among the three replications, the highest LL was observed in R1, which was significantly higher than in R2, and R2 was significantly higher than in R3.

3.2 Number of Leaves Per Plant

Fertilizer levels significantly influenced the number of leaves, with the maximum number of leaves (6.63) observed in treatment T3 (FYM 15 t ha^{-1} + NPK 160:80:80 kg ha^{-1}), which was statistically comparable to treatments T5, T2, and T6. All these treatments involved a combination of organic (FYM) and inorganic (NPK) fertilizers. The lowest number of leaves (6.22) was found in treatment T0, the control treatment with no FYM and NPK. Treatments T0 and T7 had similar numbers of leaves, 6.22 and 6.46, respectively, which could be attributed to biochemical factors, as shown in Table 2.
Observations revealed that the maximum number of leaves was at 110 days after sowing (DAS) (8.69), significantly higher than at 90 DAS (6.87), followed by 70 DAS (6.01), 50 DAS (5.72), and 30 DAS (4.75), as explained in Table 3. These results align with findings published by Gowda MC et al. in 2007.

The number of leaves (NoL) was recorded across three replications (R1, R2, and R3). The highest NoL was noted in R1 (6.47) replication, while the lowest was in R3 (6.32). Among the three replications, R1 had significantly more leaves than R3, while R2 was statistically comparable to R3, as presented in Table 4.

3.3 Plant Height

Fertilizer levels significantly influenced plant height. The highest plant height (30.02 cm) was observed in treatment T3 (FYM 15 t ha^{-1} + NPK 160:80:80 kg ha^{-1}), which was significantly comparable to treatments T5, T2, and T6. All these treatments combined organic FYM and inorganic NPK fertilizers. The lowest plant height (28.04 cm) was found in treatment T0 which is the control treatment with no FYM and NPK. Treatments T0 and T8 had similar plant heights, 28.04 cm and 28.43 cm, respectively. These results are comparable to those reported by Ahmed et al. (2006), as shown in Table 2. Plant height (PL) was also measured and is presented in Table 3. The highest plant height was recorded at 110 days after sowing (DAS) (40.26 cm), which was significantly greater than the plant height at 90 DAS (33.65 cm), 70 DAS (28.09 cm), 50 DAS (24.65 cm), and 30 DAS (19.31 cm).

Plant height (PH) was measured across three replications (R1, R2, and R3). The highest PH was noted in R1 (30.67 cm), while the lowest was in R3 (27.88 cm). Among the three replications, the highest plant height (PH) was observed in R1, which was significantly higher than in R2, and R2 was significantly higher than in R3. These results are presented in Table 4.

Table 2: FYM and NPK's effects on leaf length, number of leaves, and plant height

Treatment	Leaf Length	Number of leaves	Plant height
T_o Control	23.21[c]	6.22[d]	28.04[b]
T_1 FYM 15 t/ha	23.55[cb]	6.22[d]	28.29[b]
T_2 FYM 15 t/ha + NPK 140: 70: 70 Kg/ha	25.15[a]	6.47[abcd]	29.84[a]
T_3 FYM 15 t/ha + NPK 160: 80: 80 Kg/ha	24.85[a]	6.63[a]	30.02[a]
T_4 FYM 10 t/ha	24.34[ab]	6.33[bcd]	29.15[ab]
T_5 FYM 10 t/ha + NPK 140: 70: 70 Kg/ha	25.02[a]	6.52[abc]	29.89[a]
T_6 FYM 10 t/ha + NPK 160: 80: 80 Kg/ha	25.19[a]	6.57[ab]	29.90[a]
T_7 NPK 140: 70: 70 Kg/ha	24.32[ab]	6.47[abcd]	29.15[ab]
T_8 NPK 160: 80: 80 Kg/ha	23.63[cb]	6.28[cd]	28.43[b]
CV%	1.980	1.980	1.980
LSD%	1.006	0.251	1.217

Table 3: Leaf length, number of leaves, and height of leaves based on the days of observation

Days of observation	Leaf Length	Number of leaves	Plant Height
30 DAS	15.37[d]	4.75[e]	19.31[e]
50 DAS	21.04[c]	5.72[d]	24.65[d]
70 DAS	24.22[c]	6.01[c]	28.09[c]
90 DAS	28.78[b]	6.87[b]	33.65[b]
110 DAS	32.41[a]	8.69[a]	40.26[a]
CV%	1.980	1.980	1.980
LSD%	0.750	0.187	0.907

Table 4: Observation of different replications

Replication	Leaf Length	Number of leaves	Plant height
R_1	25.36[a]	6.47[a]	30.67[a]
R_2	24.40[b]	6.44[ab]	29.03[b]
R_3	23.32[c]	6.32[b]	27.88[c]
CV%	1.980	1.980	1.980
LSD%	0.581	0.145	0.702

3.4 Neck Diameter

Table 5 presents the findings regarding neck diameter, where the highest measurement (1.88 cm) was observed in treatment T2, which was statistically comparable to treatments T3, T5, T6, T1, T4, and T8, but significantly different from treatment T7. Treatment T7 recorded the minimum neck diameter (1.38 cm), which was not significantly different from the control treatment T0 (1.46 cm), as shown in Table 6. Similar results regarding post-harvest parameters were reported by Islah (2010), and Mallanagouda et al. (1995) investigated the effects of NPK and FYM on the growth and yield of onion, garlic, and coriander.

Neck diameter (cm) was measured across three replications (R1, R2, and R3). The highest neck diameter was noted in R2 (1.68 cm) replication, while the lowest was in R1 (1.54 cm). Among the three replications, the highest neck diameter was observed in R1, which was not significantly different from R2 and R3, as shown in Table 6.

3.5 Bulb size expressed as polar diameter (cm)

The largest bulb size, expressed as polar diameter, was observed in treatment T3 (6.01 cm), which was statistically comparable to treatments T2, T4, T5, T6, T7, and T8. Treatment T3 was significantly higher than treatments T1 and the control, while T1 was significantly higher than the control. The control treatment, T0, had the smallest bulb size in polar diameter (4.05 cm), as shown in Table 5. Similar findings were reported by Kilgori et al. (2007).

Bulb size in polar diameter (cm) was measured across three replications (R1, R2, and R3). The largest bulb size in polar diameter was noted in R3 (5.62 cm) replication, while the smallest was in R1 (5.23 cm). Among the three replications, the largest bulb size in polar diameter was observed in R3, which was not significantly different from R2 and R1, as shown in Table 6.

3.6 Equatorial bulb measurement (cm) in terms of size

The largest equatorial bulb measurement (5.05 cm) was recorded under treatment T2, which was statistically comparable to treatments T5, T3, T4, and T6. However, T2 and T5 were significantly larger than T8, T1, and T7. The control treatment had the smallest bulb size in terms of equatorial diameter (3.73 cm), as shown in Table 5. Similar results were reported by Tadila and Nigusie (2018).

Bulb size in equatorial diameter (cm) was assessed across three replications (R1, R2, and R3). The largest bulb size in equatorial diameter was observed in R1 (4.46 cm) replication, while the smallest was in R3 (4.20 cm). Among the three replications, the largest bulb size in equatorial diameter was noted in R1, which was not significantly different from R2 and R3, as detailed in Table 6.

Table 5: Impact of NPK and FYM on neck, polar, and equatorial bulb sizes

Treatment	Bulb size polar diameter (cm)	Bulb size polar equatorial meter (cm)	Neck diameter (cm)
T_o Control	4.05^{c}	3.73^{c}	1.46^{bc}
T_1 FYM 15 t/ha	4.96^{b}	4.17^{bc}	1.57^{abc}
T_2 FYM 15 t/ha + NPK 140: 70: 70 Kg/ha	5.62^{ab}	5.05^{a}	1.88^{a}
T_3 FYM 15 t/ha + NPK 160: 80: 80 Kg/ha	6.01^{a}	4.50^{abc}	1.86^{ab}
T_4 FYM 10 t/ha	5.54^{ab}	4.43^{abc}	1.52^{abc}
T_5 FYM 10 t/ha + NPK 140: 70: 70 Kg/ha	5.84^{a}	4.58^{ab}	1.82^{ab}
T_6 FYM 10 t/ha + NPK 160: 80: 80 Kg/ha	5.80^{a}	4.43^{abc}	1.63^{abc}
T_7 NPK 140: 70: 70 Kg/ha	5.44^{ab}	3.94^{bc}	1.38^{c}
T_8 NPK 160: 80: 80 Kg/ha	5.28^{ab}	4.23^{bc}	1.48^{abc}
CV%	2.120	2.120	2.120
LSD%	0.834	0.806	0.413

Table 6: Effect different replications on bulb size polar diameter, equatorial and neck diameter

Replication	Bulb size polar diameter cm	Bulb size equatorial meter cm	Neck diameter cm
R_1	5.23^{a}	4.46^{a}	1.54^{a}
R_2	5.33^{a}	4.35^{a}	1.68^{a}
R_3	5.62^{a}	4.20^{a}	1.63^{a}
CV%	2.120	2.120	2.120
LSD%	0.482	0.465	0.238

3.7 Fresh weight of bulb (g)

Fertilizer levels had a significant impact on bulb fresh weight, as indicated in Table 7. The data showed that different treatments combining NPK with FYM at various levels greatly influenced bulb fresh weight. The highest bulb fresh weight of 40.71 g was achieved with treatment T3 (FYM 15 t/ha + NPK 160:80:80 kg/ha), which was statistically similar to treatments T7, T5, T2, T8, T6, and T1. The control treatment, T0, recorded the lowest bulb fresh weight. These findings align with those reported by Singh et al. (2004). Bulb fresh weight was measured across three replications (R1, R2, and R3). The highest bulb fresh weight was recorded in the R1 replication at 37.18 g, while the lowest was in R3 at 33.90 g. However, the differences in bulb fresh weight among the three replications were not statistically significant, as shown in Table 8.

3.8 Yield per plot (kg)

The maximum yield per plot (4.81 kg) was recorded with treatment T3 (FYM 15 t ha^{-1} + NPK 160:80:80 kg ha^{-1}), which was significantly higher than when only NPK or FYM was applied in other treatments, followed by T7, T1, T4, and T8. The minimum yield per plot was recorded in the control treatment T0 (3.35 kg), which did not receive any fertilizers. Treatments T0, T8, T4, and T1 had similar yields per plot (3.35 kg, 3.36 kg, 3.42 kg, and 3.53 kg, respectively), as shown in Table 7.

Yield per plot (kg) was assessed across three replications (R1, R2, and R3). The highest yield per plot was measured in R3 (4.36 kg) replication, while the lowest was in R1 (3.64 kg) replication. Among these three replications, R3 was significantly higher than R2, and R2 was significantly higher than R1, as detailed in Table 8.

3.9 Per-hectare yield (ha-1)

The highest yield per hectare was achieved in treatment T3 (10.69 t/ha) - FYM 15 t ha^{-1} + NPK 160:80:80 kg ha^{-1}, which was significantly higher than when only NPK or FYM was applied in treatments T7, T1, T4, and T8. The lowest yield of garlic per hectare was observed in the control treatment T0 (7.45 t/ha), which did not receive any fertilizers. Treatments T0, T8, T4, and T1 had similar yields per hectare (7.45 t/ha, 7.47 t/ha, 7.61 t/ha, and 7.85 t/ha, respectively), as detailed in Table 7.

Yield per hectare (ton) was assessed across three replications (R1, R2, and R3). The highest yield per hectare was measured in R3 (9.69 t/ha) replication, while the lowest was in R1 (8.09 t/ha) replication. Among these three replications, R3 was significantly higher than R2, and R2 was significantly higher than R1, as explained in Table 8.

Table 7: Bulb fresh weight g, yield per plot kg and yield per hectare

Treatment	Bulb Fresh weight	Yield per plot kg	Yield per hectare kg
T_o Control	25.64^b	3.35^c	7.45^c
T_1 FYM 15 t/ha	34.08^a	3.54^c	7.86^c
T_2 FYM 15 t/ha + NPK 140: 70: 70 Kg/ha	36.95^a	4.21^b	9.37^b
T_3 FYM 15 t/ha + NPK 160: 80: 80 Kg/ha	40.71^a	4.81^a	10.69^a
T_4 FYM 10 t/ha	33.78^a	3.42^c	7.61^c
T_5 FYM 10 t/ha + NPK 140: 70: 70 Kg/ha	38.28^a	4.20^b	9.34^b
T_6 FYM 10 t/ha + NPK 160: 80: 80 Kg/ha	36.46^a	4.80^a	10.66^a
T_7 NPK 140: 70: 70 Kg/ha	38.80^a	4.47^{ab}	9.93^{ab}
T_8 NPK 160: 80: 80 Kg/ha	36.68^a	3.36^c	7.47^c
CV%	2.120	2.120	2.120
LSD%	7.143	0.419	0.932

Table 8: Replications of bulb fresh weight, yield per plot and yield per hectare

Replication	Fresh weight of Bulb (gr)	Yield per plot (kg)	Yield per hectare (kg)
R_1	37.18^a	3.64^c	8.09^c
R_2	36.05^a	4.05^b	9.01^b
R_3	33.90^a	4.36^a	9.69^a
CV%	2.120	2.120	2.120
LSD%	4.124	0.242	0.538

Table 9: Meteorological observations (weekly) during the experimental period

Month /Week	Temperature by °C		Comparative humidity (%)		Precipitation (mm)
	Max.	Min.	Max.	Min.	
November 2020					
3rd	26.4	6.0	34	9	0
4th	26.8	6.7	38	10	0
December 2020					
1st	25.5	6.5	76	16	0
2nd	25.7	6.3	73	18	0
3rd	23.7	6.5	66	21	0

continued

4th	21.1	7.0	64	22	0
January 2021					
1st	12.2	-3.5	67	25	0
2nd	12.2	-3.3	65	28	0
3rd	12.6	-2.9	68	27	0
4th	14.0	-2.1	66	27	0
February 2021					
1st	23.3	3.0	49	13	0
2nd	19.3	5.3	45	16	0
3rd	16.8	2.7	49	14	0
4th	17.9	1.4	48	20	0
March 2021					
1st	22.6	4.4	58	13	0
2nd	25.7	7.2	40	12	0
3rd	25.2	10.5	49	20	0
4th	26.9	9.2	50	12	0
April 2021					
1st	26.6	8.9	31	10	0
2nd	28.7	12.3	34	13	0
3rd	32.9	14.6	38	13	0
4th	31.3	21.0	30	17	0
May 2021					
1st	35.9	23.9	45	18	0
2nd	32.6	22.8	56	22	0

Source: https://hikersbay.com

4. Conclusion

Implementing integrated nutrient management techniques typically leads to increased garlic yields. Combining organic FYM with inorganic NPK combinations proves to be the most effective approach for enhancing both yield and growth parameters in garlic. Based on the findings of our investigation, treatment T3, which involved applying 15 t ha-1 of FYM along with NPK in the ratio of 160:80:80 kg ha-1, yielded the highest at 10.69 t ha-1. Therefore, T3 emerges as the most suitable treatment for promoting growth and maximizing yield in garlic cultivation under the agro-climatic conditions of Kandahar as shown in (table.9). I suggest to research in other hilly areas of this province to let people know about the best ways of agricultural methods about garlic yield. Subsequently, it would be practical to advise farmers in this region to cultivate garlic cv. G-363 during winter and apply 15 t/ha of FYM along with 160:80:80 kg/ha of NPK, as recommended by treatment T3.

References

Ahmed Abbas, A. A., Sultan Muhammad, S. M., Muhammad Bashir, M. B., Akhtar Nawaz, A. N., & Hakim Khan, H. K. (2006). Effect of various Levels of nitrogen, phosphorus and potash on the yield of garlic. Sarhad Journal of Agriculture, Pakistan, 22 (1): P 83.

Banafer,R. N .S., Namdeo, S. L. and Asati, K. P. (2004). Effect of organic manures in combination with chemical fertilizers on growth, yield and quality of garlic. National seninar on opportunities and potentials of spices for crop diversification. P 188.

Babatunde, F. E., Mofoke, A. L. E., Udom, G. N., and Mohammed, G.U. (2009). Influence of nutrient source on the elemental composition of irrigated garlic. *Journal of Tropical Agriculture, Food, Environment and Extension,* 8: 45-50.

Devendra Singh, R. C. Nainwal, R. S. katiyar and Tewari, S. K (2014). CSIR-National Botanical Research Institute, Lucknow(UP) 226001 INDIA 783-788.

Diriba-Shiferaw, Nigussie Dechassa, KebedeWoldetsadik, Getachew Tabor and Sharma JJ., (2013). Growth and nutrients content and uptake of garlic (*Allium sativum* L.) as influenced by different types of fertilizers and soils. African journal of agricultural research, Vol.8(43), P 98,

Gowda, M.C., Vijayakumar, M. and Gowda, A.P.M (2007). Influence of integrated nutrient management on growth, yield and quality of garlic (*Allium sativum* L.) cv. G-282. Crop Res. Hisar. 33(1/3):144-147.

Islah, M. E. (2010). Response of garlic (*Allium sativum* L.) to some sources of organic fertilizers under North Sinai conditions. *Research Journal of Agriculture and Biological Sciences*, *6*(6), 928-936.

Jones, G.M., H.A., Collin, A., Tregova L., Trueman, L., Brown, R., Cosstick, J., Hughes, J., Milne, M.C., Wilkinson, A.B., Tomsett and Thomas B. (2007). The biochemical and physiological genesis of alliin in garlic. *Med Arom plant SciBiotechnol. 1: 21-24*

Kilgori, M.J, Magaji, M.D. and Yakubu, A.I. (2007). Productivity of two garlic (*Allium sativum* L.) cultivars as affected by different levels of nitrogenous and phosphorus fertilizers in Sokota, Nigeria. American-Eurasian J. Agric. and Environ. Sci., 2(2):158-162.

Lancaster, J.E., Farrant, J. and Shaw, M.L. (2001). Sulphur nutrition affects cellular sulphur, dry weight distribution, and bulb quality in onion. *Journal of the American Society for Horticultural Science,* 126: 164–168.

Moravcevic, D., Varga, J. G., Pavlovic, N., Todorovic, V., & Ugrinovic, M. (2017). Production and chemical characteristics of the populations of spring garlic (*Allium Sativum* L.) from the serbian genetic collection. *Emirates Journal of Food and Agriculture*, 227-236.

Mallanagouda, B., Sulikeri, G. S., Hulamani, N. C, Murthy, B. G. and Madalgeri, B. B. (1995). Effect of NPK and FYM on growth parameters of onion, garlic and coriander. *Current Research, University of Agri. Sci. Bangalore*, 24 (11) : 212-213.

Sanjivani R.K. (2012). Integrated Nutrient management in Garlic (*Allium Sativum* L.) Thesis, Reg. No 10/315.

Palm, C.A., Myers R.J.K. and Nandwa, S.M. (1997). Combined use of organic and inorganic nutrient sources for soil fertility maintenance and replenishment. pp. 193-217.

Randle, W. M. (1997). Genetic and environmental effects influencing flavour in onion. *ActaHorticulturae.*433: 299–311.

Rubatzky, V.E. and Yamaguchi, M. (1997). World vegetables. principles, production and nutritive values. Second edition. Chapman and hall. International Thomson Publishing New York. USA. 843p.

Singh, S. Yadav, P.K. and Singh, B. (2004). Effect of nigrogen and potassium on growth and yield of onion (*Allium cepa* L.) cv. Pusa red. Hariyana, J. Hort. Sci.33 (3 and 4): 308-309.

Tadila, G., and Nigusie, D. (2018). Effect of manure and nitrogen rates on growth and yield of garlic (*Allium* sativum L.) at Haramaya, Eastern Ethiopia.