



Effects of Organic and Inorganic Fertilizers Applications Levels on Greenhouse Tomato (*Solanum lycopersicum*) Yield and Soil Quality in Khost Province

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Author's contribution

This work was carried out by author RH. Author RH designed the research, analyzed, interpreted and prepared the manuscript. Author HKH Edited and revised the manuscript according to the reviewers comments. Both authors read and approved the final manuscript.

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ABSTRACT

The study was carried out to determine the effect of organic and inorganic fertilizers on tomato yield and soil quality. The study was performed in a randomized complete block design consisting of 7 treatments with 3 replications in the research farm, Shaikh Zayed University, Khost, Afghanistan. The fertilizers treatments were T1, organic fertilizer (5 t/ha); T2, organic fertilizer (10 t/ha); T3, urea (150 Kg/ha); T4, urea (200 Kg/ha); T5, mixed fertilizers (organic fertilizer 3 t/ha + urea (100 Kg/ha); T6, mixed fertilizers (organic fertilizer 6 t/ha + urea (70 Kg/ha) and T7 a control. Results indicate that applications of inorganic fertilizers with a combination of organic fertilizers increased tomato yield and improves the nutrient status of the soil. T5 showed the highest yield of tomato and followed by T4 treatment, which were 33.1 and 31.7 t/ha respectively. The lower yield were obtained in T7 and T1 treatments. The highest plant heights (205.0 and 199.0 cm) were obtained in T5 and T4 respectively, while the lowest plant heights were obtained in T1 treatment and followed by T7 treatment. Similarly, we found that a combination of both inorganic and organic fertilizers application also is the best strategy to improve soil nutrients, maintain soil fertility. Soil P₂O₅ and K₂O, where the highest amounts were obtained in T5 and followed by T6, which were

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26.5, 22.5 and 44.5 and 41.5 mg/L respectively. The control treatment had the lowest amount of P_2O_5 and K_2O . Therefore, this study suggests that an appropriate amount of organic fertilizer with inorganic fertilizer not only increased tomato yield but also improve soil fertility.

Keywords: Organic fertilizer; inorganic fertilizer; tomato yield; soil properties.

1. INTRODUCTION

Generally, food security in world is very important because the large population and the better living standard need more food. In conventional farming, farmers using inorganic fertilizers for nutrient availability to increase crop production. However, for long term of period the usage of inorganic fertilizer could reduce soil fertility and crop productivity [1,2]. Food security is strongly affected by soil degradation [3], and will increase the CO_2 emission to atmosphere. These CO_2 is directly correlated with global warming. Therefore, in recent years' soil quality and its importance for sustainable agricultural development has received growing attention [4]. Soil chemical and physical properties directly affect plant production. Different farming practices influence crop yield, such as; conventional farming system promote mineralization process and increased vegetable yield. However, in this system using chemical fertilizers can weaken the agro ecosystem [5]. Organic farming system aims to producing healthy food and sustaining healthy ecosystems. In this farming system farmers using compost, green manure, and crop rotation including legumes instead of chemical fertilizers to maintain soil fertility and high yield [6,7]. Due to high cost of inorganic fertilizers small and marginal farmers cannot apply these fertilizers in their field.

On the other hand, organic manure application can enrich soil and hence ensure crop yields. Study shown that manure applications can increase soil organic matter (SOM) and crop yields and sustain soil fertility as well [8]. For this purpose, the practice of returning plant residues and organic mulches to farm field has become one of the main sources of organic fertilizers required by cropland. Adding crop residue like green manure or weed mulch can reduce soil erosion and improve soil physical properties [9], enhance SOM and fertility, increase of nutrient recycling [10], and decrease global warming potential [11].

The agricultural sector is the most important component of the country's economic

development. 80% of the population is engaged in agriculture and they grow various types of crops in different area. Generally, Afghanistan soil quality is lower as compare to other Asian countries. Unfortunately, due to the insufficient soil and different crops information, farmers are not able to decide growing different types of crops and have no plan for soil sustainability. Afghanistan's soils are formed under arid and semi-arid climatic conditions, classified mostly as clay loam and sandy loam textures. Afghanistan soil has high amount of calcium carbonate and low soil organic matter content, ranging from 0.2 to 2.5%. Soil fertility tests have shown low levels of nitrogen, variable levels for phosphorus, and adequate levels of potassium [12]. To obtain optimum yield farmers have to apply inorganic fertilizers in their field and as result soil degradation occurred. While, some farmers due to economic problem they may not apply inorganic fertilizers and as a result, they obtain low yield.

Khost province is located in the southeastern part of Afghanistan and is one of the most important agricultural regions. The province covers an area of 4029 km^2 and where about 14911 ha of land area is dominated by the different cropping system. Farmers grow different crops like wheat, rice, corn and different kind of vegetables. Farmers using chemical fertilizers in their field, however, the input of fertilizers are not enough. Organic fertilizers are known to improve soil quality and good alternative source of chemical fertilizers. In this region, the use of organic fertilizer is rare, because farmers using organic sources such as crop residues and animal dung for animal feeding and fuel respectively [12,13].

To reduce these problems organic manure applications along with inorganic fertilizers might reduce soil degradation and increase crop yield. There is little information available how organic manure application effects on soil parameter and crop yield in Khost province [14]. Therefore, the objectives of this study are to evaluate the use of organic and inorganic fertilizers impact on tomato production and soil properties, and to find out the best organic and inorganic fertilizers combination

would improve soil quality and increase tomato crop production.

2. MATERIALS AND METHODS

2.1 Site Description and Experimental Design

Experiment was conducted in agriculture research farm, Shaikh Zayed University, Khost, Afghanistan. Fig. 1 illustrates the geographical location of the study site. The mean annual temperature and rainfall in 2020 is shown in Fig. 2. The three factors experiment was design as a randomized block design with three replications. Each plot was 10 m² (2 × 5 m). The three factors experiment consisted of 7 treatments is presented in Table 1. Organic fertilizer (of) cow manure including with 2 levels (5 t/ha and 10 t/ha), two levels of (150 kg/ ha and 200 kg/ha) inorganic fertilizer was applied in the form of urea (46%N). The combination of organic and inorganic fertilizers was two levels (3t +100 kg/ha and 6t + 70 kg/ha) applied.

2.2 Farming Practices and Measurement

Tomato seeds were sown in nursery seed bed tray. Weeding, mulching and watering in seedbeds were done as needed. Seedlings germinated within a week and transplanted (25 days) in the field. Plant spacing kept at (90 cm × 90 cm) in the field plots. Plastic wires are placed with each plant for supporting and tomato fruits harvested when needed. Organic fertilizers were applied before tomato seedling transplanting. Chemical fertilizers were applied 2 times during growing season.

The plant height (from the soil surface to the top of the plant) was recorded by using measuring scale from each replicate plot. Fruits length was recorded at each week interval. For tomato total yield fruit fresh weight recorded and it achieved from each plot was gathered and on the basis of yield/plot, and then the yield/ha was calculated. For dry matter and water content the tomato plant residue was dried at 65°C for 72 h and weighed. Data were collected from five plants of seven planted in each plot (one replication).

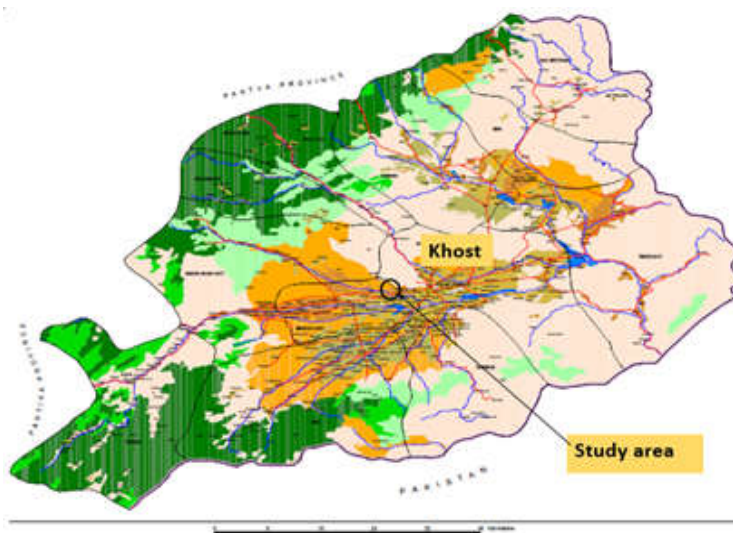


Fig. 1. Geographical location of the study site in Khost, Afghanistan

Table 1. Fertilizer treatments and doses

Treatments (T)	Fertilizers dose /ha
Organic fertilizer (OF) (T1)	5 ton
Organic fertilizer (T2)	10 ton
Inorganic fertilizer (T3)	Urea (150 Kg/ha)
Inorganic fertilizer (T4)	Urea (200 Kg/ha)
Mixed fertilizers (T5)	3 ton + Urea (100 Kg/ha)
Mixed fertilizers (T6)	6 ton + Urea (70 Kg/ha)
Control (T7)	No- fertilizers

Before planting and after harvesting we obtained soil samples from each plot up to 5-cm depth. Soil samples were measured for NO₃-N, water soluble P₂O₅, water soluble K₂O using a rapid soil diagnosis kit “lamotte field kit”. pH and EC measured by multi- parameter tester 35 series.

The statistical analyses were performed using stat view (statview for windows, version 5; SAS institute, cary, nc). Analysis were performed using the Tukey–Kramer test as a post hoc test if significant differences were found between treatments in the analysis of variance.

3. RESULTS AND DISCUSSION

3.1 Tomato Yield, Plant Height and Fruit Length

Tomato yield are shown in Fig.4. The yield of tomato were greater in T5 and T4 as 33.1 and 31.7 t/ha respectively, while tomato yield was not affected in T1 treatment and had lower yield. Tomato yield in T3 and T6 were almost same and significantly increased from control treatment (T7). T5 treatment had 42.7% higher tomato yield as compare to control treatment (T7). The addition of chemical fertilizer level increased tomato yield as T4 had 6.3% higher yield as compare to T3 treatment. In our study, organic and inorganic fertilizer combination increased tomato yield, and could be interpreted as the release of nutrients in mineralization process from organic and inorganic fertilizers at different times [16]. Organic and inorganic fertilizers combination practices produced higher yield as compared to organic and inorganic fertilizers alone in in cabbage [17] and in eggplant [18]. Agbede [19] also reported that using chemical fertilizer (NPK) along with poultry manure

resulted in higher sweet potato tuber yield. Patel et al [20] also reported that spinach leaf yield significantly affected by using farm yard manure along with NPK fertilizers. These results are similar to those who found that a contribution of manure is very favorable to the high yield of industrial tomato [21]. These result suggested that an appropriate amount of organic and inorganic fertilizers levels promote mineralization process and increased plant production.

In a general way, the use of organic matter in the systems of culture should be promoted. It allows keeping soil fertility, while improving soil structure and availability of mineral elements. In this experiment, tomato yield and plant height had significantly positive correlation (Fig. 5). In this study, T5 and T4 treatments had highest plant height which were 205.0 cm and 199.0 cm respectively. Tonfack et al. [22] reported that the application of inorganic fertilizers increased fruits numbers per plant than organic fertilizers. Rinaldi et al. [23] also reported that the number of fruits per plant was not effected by different fertilizers. The combine treatment (T5) and T4 provided the highest fruit length which were 6.1 cm and 5.8 cm respectively (Fig. 7). Mixed fertilizers in T5 and using urea inT4 treatment had 27.0% and 20.8% increased fruits length as compared to control treatment (T7). Using organic fertilizer along with chemical fertilizer increased tomato yield. In general, the low amount of available N from organic fertilizers resulting from a slow rate of mineralization, make the crop yield and its components lower as compare to inorganic fertilizer [24]. Thus in our result, the highest fruit length was obtained in T5 treatment and followed by T4 treatment plot which were 6.1 cm and 5.8 cm respectively. Thus, these high length of fruit directly linked with high yield.

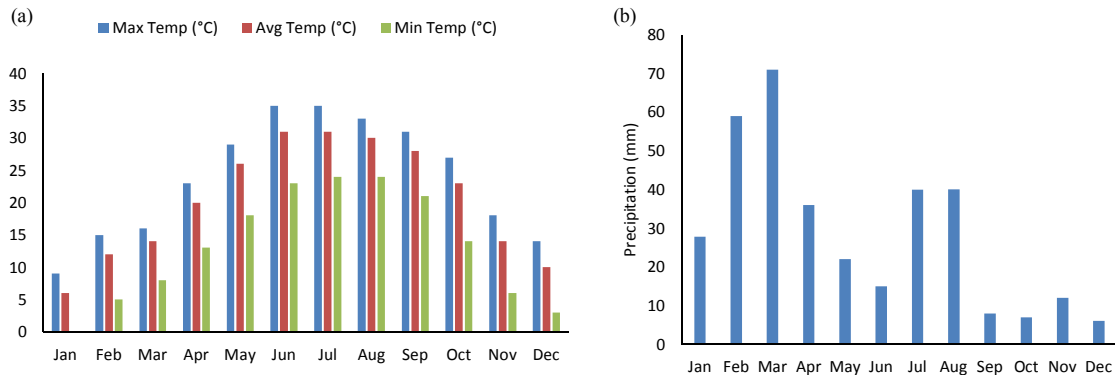


Fig. 2. Monthly temperature in (a) and average precipitation in (b) of Khost province [15]



Fig. 3. Different farming practices and tomato experiment site

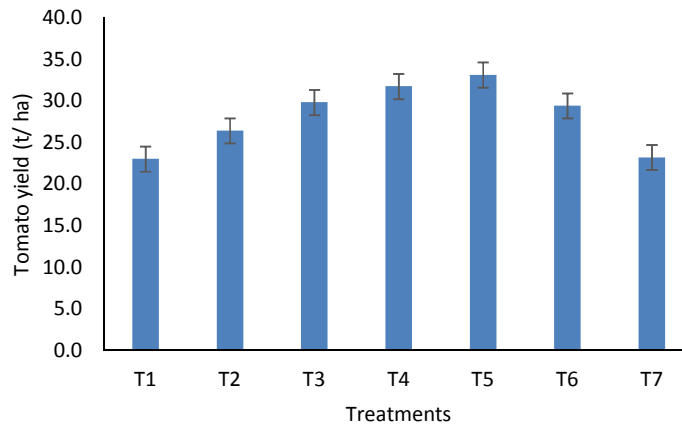


Fig. 4. Effect of organic and inorganic fertilizers level on tomato yield

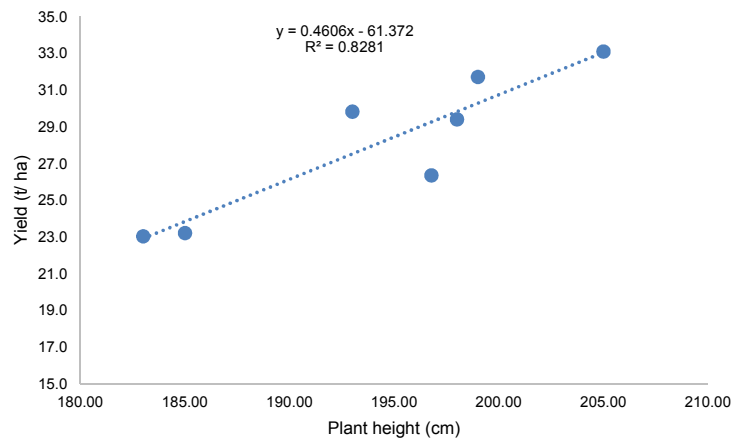


Fig. 5. Tomato plant height and yield correlation

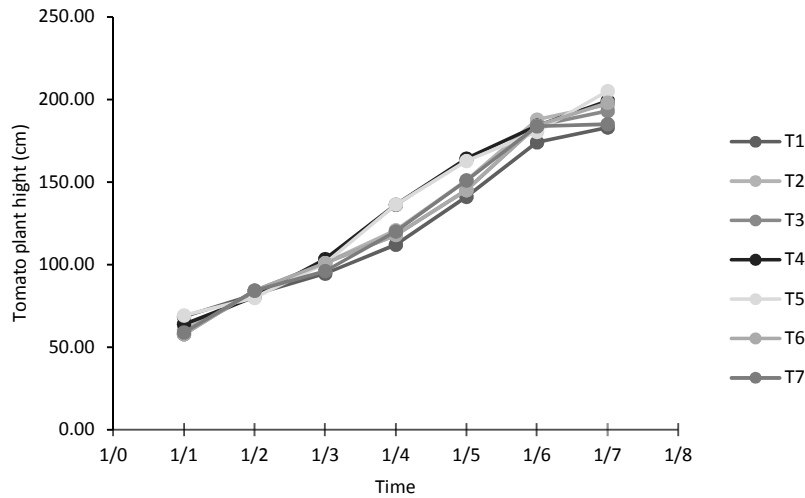


Fig. 6. Tomato plant height during growing season

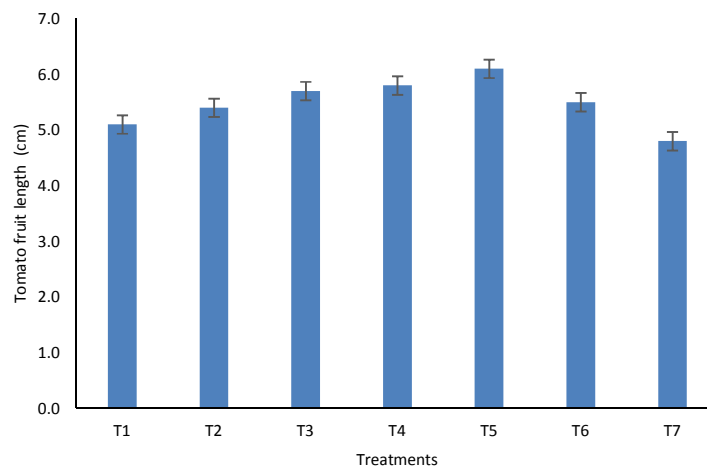


Fig. 7. Effect of organic and inorganic fertilizers level on tomato fruit length

3.2 Soil Properties

Before, planting there were no significant difference among treatments on water content, while using organic fertilizers and mixed fertilizers significantly increased soil water content after harvesting (Table 2). T2 and T5 treatments had higher water content which were 44.0 and 42.0 % respectively. After harvesting the lowest amount of water content (38%) were obtained in T7 and T4 treatments. Water content amount in T2 treatment was 15.8% higher than T7 and T4 treatments. Aggarwal et al. [25] reported that using manure and retention of crop residues increased SOC and soil moisture, and

improved yield of pearl millet (*pennisetum typhoides*). In this study, organic fertilizers, inorganic fertilizers and their combination had no significant effect on soil pH and EC. In the same region, the previous study [14] also reported that pH and EC was not effected by using chemical and organic fertilizers application in spinach production. These result suggested that pH and EC will not change in short term experiment and might need long term research [26]. After harvesting, organic fertilizer with urea increased soil P_2O_5 and K_2O level. T5 treatment had a higher concentration of soil P_2O_5 and K_2O . After harvesting, the lowest amount of P_2O_5 and K_2O were obtained in control treatment (T7). The

Table 2. Effect of organic and inorganic fertilizers level on soil chemical properties

Treatment	Water Content (%)		pH (H ₂ O)		EC (dS/m)		NO ₃ -N (mg/L)		P ₂ O ₅ (mg/L)		K ₂ O (mg/L)	
	Before planting	After harvest	Before planting	After harvest	Before planting	After harvest	Before planting	After harvest	Before planting	After harvest	Before planting	After harvest
T1	39	40	8.2	8.1	0.8	0.9	13 b	14 bc	17.5 b	20.5 b	33.0 b	35.5 bc
T2	40	44	8.2	8.2	0.6	0.7	12 b	15 b	16 c	21.5 b	32.5 b	36.5 b
T3	38	38	8.0	7.8	0.7	0.6	15 a	18 b	17 b	19.5 bc	39.0 a	38.5 b
T4	37	39	7.9	7.7	0.6	0.7	14 ab	16 b	18 b	21 b	35.0 b	33.4 c
T5	39	42	8	8	0.7	0.8	15 a	22 a	20 a	26.5 a	38.5 a	44.5 a
T6	40	41	8.5	8	0.7	0.8	16 a	25 a	21 a	22.5 b	39.0 a	41.5 a
T7	39	38	8.5	8.5	0.8	0.8	14 ab	12 c	19 ab	17.8 c	37.5 a	33 c

Note: Values, in columns within treatments, followed by different letters indicate significant differences between treatments at 5% using the tukey-kramer test.

same trend was observed for soil nitrate. Soil $\text{NO}_3\text{-N}$ was obtained in T6 and followed by T5 treatments which were 25.0 and 22.0 mg/l respectively. Organic fertilizers along with chemical fertilizers showed significantly higher soil $\text{NO}_3\text{-N}$, which might be related to their additional inputs through the incorporation of organic materials in soil. The amount of P_2O_5 and K_2O in T5 and T6 were 26.5, 22.5 and 44.5, 41.5 respectively. Organic fertilizers along with chemical fertilizers showed the most favorable condition for increasing nutrients in soil. David [27] reported that using pig manure increased P and K availabilities in soil. Zsolnay & görlitz [28] also reported that incorporation of manure and crop residues in soil increased available p content in the soil. After applying organic residue into soil, temporary inorganic N decreased due to immobilization process [29]. Hashimi et al. [30] reported that 23:1 C: N ratio of weed mulch decreased inorganic N levels in soil. Cheshire et al. [31] also reported that straw mulch with a high C: N ratio decreased $\text{NO}_3\text{-N}$ concentrations due to the immobilization process. The similar result obtained from our study, that T1 and T2 treatments had lower soil $\text{NO}_3\text{-N}$ level.

4. CONCLUSION

The results suggested that using organic fertilizers along with chemical fertilizer system produced the best results on tomato plant growth and yield. Combined applications of organic and inorganic sources of nutrients are more productive and sustain soil fertility. The results also showed that organic fertilizers combination with inorganic fertilizers increased soil $\text{NO}_3\text{-N}$ and P_2O_5 levels in soil and has the potential to improve soil quality. Organic fertilizers also improve soil water content and make better environment for crop production.

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COMPETING INTERESTS

Authors has declared that no competing interests exist.

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