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Investigating the effect of applying liquid organic fertilizer and different amounts of nitrogen on sugarcane yield

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ABSTRACT

Maintaining appropriate quantities of organic matter in the soil is one of the core tenets of sustainable agriculture. The use of organic fertilizers in agriculture can affect the physical properties of the soil in addition to increasing its fertility. A study was carried out at Imam Khomeini cultivation and Industry in crop year 2020 to evaluate the effects of different amounts of urea fertilizer and liquid organic fertilizer on the growth and yield parameters of sugarcane of the CP48-103 type in a Raton field. The study used three replications, five treatments, and a fully randomized block design. The treatments involved varying dosages of chemical fertilizer urea. Every two weeks, measurements of the sugarcane were taken to do both quantitative and qualitative analyses. The number of stalks per hectare, stalk diameter, percentage of sugar extraction, and stalk yield per hectare during harvest were all noted after the study period. The experiment's findings demonstrate that adding urea (nitrogen fertilizer) to liquid organic fertilizer in four phases at realistic proportions did not lessen the quantity of nitrogen that sugarcane plants needed to grow. Additionally, the yield of sugarcane stalks (tons per hectare) increased by 4.9% when liquid organic fertilizer was used in conjunction with 100% urea chemical fertilizer as compared to treatment 1. This improvement in yield per unit area was evident at the high agricultural level. As a result, the results show that adding liquid organic fertilizer can improve sugarcane plants' overall performance.

Keywords: Liquid fertilizer, sugarcane yield, urea fertilizer

INTRODUCTION

Organic fertilizers are nutrient-rich materials with a specific chemical composition that can supply plants with the necessary nutrients for optimal growth (Moller and Schultheiss, 2015; Rajan and Anandhan, 2015). Organic fertilizers were primarily produced through the process of composting animal manure, human waste, or plant materials such as straw and garden waste. This involved the fermentation of these substances by microorganisms at elevated temperatures (Chew *et al.*, 2019; Rahimi Jamnani *et al.*, 2019). Due to their positive effects on soil structure, nutrient provision, and introduction of beneficial microorganisms, organic fertilizers have gained significant popularity in the agricultural system. Their utilization has been widely adopted to enhance soil fertility and crop productivity (Brar *et al.*, 2015; Maltas *et al.*, 2018). On the other hand, some studies have indicated that the prolonged use of chemical fertilizers can lead to a decline in soil organic matter (OM) content and alter the activity of soil organisms. This, in turn, can trigger changes in the microbial composition of the soil and cause a decrease in the abundance and diversity of soil invertebrates. These effects are attributed to environmental limitations and reductions in soil pH (Fauci and Dick, 1994; Davies *et al.*, 2022). According to Tao *et al.* (2016), soil organic matter, specifically empty fruit bunches, plays a crucial role in promoting soil ecosystem functioning through the stimulation of soil fauna feeding activity. While numerous studies have examined the impact of

fertilization practices on soil nutrients, the effects of combining inorganic and organic fertilizers on soil biota are still not well understood. The influence of this fertilizer combination on soil organisms remains unclear, requiring further investigation. In a study conducted by Wahyuningsih *et al*. (2019), it was observed that the application of inorganic fertilizers (specifically urea) resulted in a notable increase in soil fauna feeding activity within a short period of time. After just 2 days of application, the feeding activity of soil fauna was significantly higher compared to the pre-application condition. According to the studies conducted by Qaswar *et al*. (2020) and Gao *et al*. (2015), it has been demonstrated that the combination of organic and inorganic fertilizers is a crucial approach in substituting a portion of inorganic chemical fertilizers and ensuring the stability of wheat and maize yields. Several studies have provided evidence that the substitution of 20%–30% of chemical fertilizers with organic fertilizers can lead to increased yields of wheat and maize, as well as enhanced soil availability and organic matter (Zhang *et al*., 2016b). The applications of organic fertilizers exhibited a considerable range of variation, with compost fresh weight typically ranging from 10.0 to 35.0 t ha^{-1} (Hannet *et al*., 2021). The application rate of compost dry matter, on the other hand, ranged between 8.8 and 14.0 t ha^{-1}, while liquid manure applications reached as high as 68.3 t ha^{-1} (Feng *et al*., 2013). Liquid organic fertilizers, in comparison to traditional organic fertilizers, offer the advantage of containing ample organic matter and soluble nutrients. This composition contributes to maintaining the sustainability of the soil and promoting the overall health of plants (Hou *et al*., 2017, Dordas *et al*., 2008). Furthermore, by integrating watering and fertilization practices, it is possible to enhance nutrient use efficiency and reduce the likelihood of nutrient loss (Toonsiri *et al*., 2016, Ceretta *et al*., 2010). The overuse of chemical fertilizers can lead to environmental pollution. To illustrate, approximately half of the nitrogen and up to 90% of phosphorus from applied fertilizers in agricultural areas are released into the atmosphere or water sources. The imbalanced soil nutrient ratios resulting from the utilization of chemical fertilizers have had detrimental effects on various organisms in natural ecosystems, including soil microbes, humans, plants, and animals (Zhao *et al*., 2016, Rostami *et al*., 2012). Maintaining adequate levels of organic matter in the soil is a fundamental principle of sustainable agriculture. Apart from enhancing soil fertility, the application of organic fertilizers in farming can also impact the physical characteristics of the soil. A study conducted at Imam Khomeini cultivation and Industry in crop year 2020 examined the impact of liquid organic fertilizer and varying quantities of urea fertilizer on the growth and yield parameters of CP48-103 sugarcane variety in a Raton field. With three replications and five treatments using varying amounts of chemical fertilizer urea, the experiment was conducted using a completely randomized block design. Measuring the sugarcane every two weeks allowed for both quantitative and qualitative evaluations. Stalk yield per hectare during harvest, percentage of sugar extraction, diameter, and number of stalks per hectare were all noted at the conclusion of the study period. The experiment's findings demonstrate that applying liquid organic fertilizer in four phases at practically significant volumes, in addition to urea (nitrogen fertilizer), had no effect on lowering the nitrogen requirements of sugarcane plants. Additionally, compared to treatment 1, the yield of sugarcane stalks (tons per hectare) improved by 4.9% with the application of liquid organic fertilizer in conjunction with 100% urea chemical fertilizer. This improvement in yield per unit area is seen at the high agricultural level. Thus, the results suggest that the use of liquid organic fertilizer can improve sugarcane plants' overall productivity.

MATERIALS AND METHODS

Meteorology of the region

The limited geographical area between 31:39 and 31:55 north latitude and the insignificant changes in the altitude of the region bring about the relative homogeneity of the climatic factors in Shoaibieh plain. Climatic classifications all more or less confirm that the region is hot and dry, and they indicate the excess amount of evaporation over atmospheric precipitation and low humidity (report Abkhan, 2019). Shuaibieh Plain is affected by the subtropical high pressure system in the summer, like most parts of Iran, which prevents rain-producing systems from entering it. In autumn, winter and early spring, with the transfer of this high pressure system to the southern areas, the area is affected by the western currents of mid-latitudes and the arrival

of Mediterranean rain systems, as well as the Sudanese low pressure and migrant low pressures from the Indian Ocean, Arabia and The Persian Gulf is freed, which causes most of the rainfall in the plain (report Abkhan, 2019). The average annual rainfall is 237 mm and its temperature regime is a maximum as in all temperate regions. August is the hottest and January is the coldest month of the year. The relative humidity regime of the region is the opposite of the temperature regime. In this way, the minimum is in the hot months and the maximum is in the cold days of the year (report Abkhan, 2019).

Project execution position

This research was carried out in Shuaibieh region, Imam Khomeini Agro-Industry located at 31°39′- 31°55′ N and 48°39′- 48°48′ E in Khuzestan, Iran is one of the important farming and industries in the field of sugarcane cultivation in Iran (Fig. 1). This agriculture and industry is located in Khuzestan province and in Shuabiyeh lands, between Shatit (a branch of Karun) and Dez rivers, 30 kilometers south of Shushtar city. The approximate area of this agriculture and industry is 15.8 thousand hectares and the net area of cultivated land is 12.8 thousand hectares. The implemented area is 7.5 hectares from Raton Farm No. 14, one of the farms of Canal 5, the second administration of the first agricultural production management.

Fertilizer was prepared and sent by a private production company. The amount and method of using this fertilizer in this project was based on the advice of the company's expert. Following the farm selection, implementation of the design plan, and determination of treatment positions, the experiment was conducted using a completely randomized block design. The design included five treatments, three replications, and varying amounts of urea chemical fertilizer. (Fig. 2).

Experimental treatments include:

T0= 100% urea chemical fertilizer

T1= 100% urea chemical fertilizer + 75 lit/ha liquid organic fertilizer

T2 = 75% urea chemical fertilizer + 75 lit/ha liquid organic fertilizer

T3 = 50% urea chemical fertilizer + 75 lit/ha liquid organic fertilizer

T4 = 30% urea chemical fertilizer + 75 lit/ha liquid organic fertilizer

The amount and method of consumption are as described in Table 1.

Table 2 presents the laboratory analysis results of the liquid organic fertilizer used in the project, which was provided by the fertilizer supplier company.

Fig. 1. Location of the study area

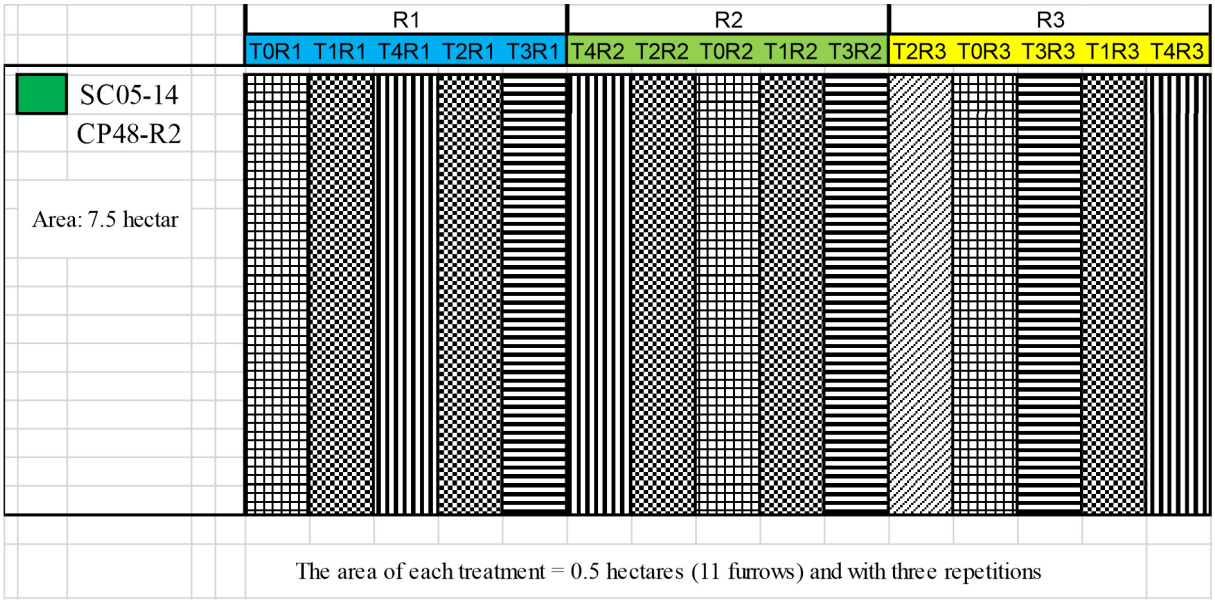

Fig. 2. Schematic project

Table 1. Amount of liquid organic fertilizer consumption

Amount of consumption per hectare	Consumption time
8 liters per 200 liters of water (spraying solution)	The first stage after clawing 30.03.2022
20 liters (fertilizer)	The second stage one month later, the first stage on 25.04.2022
25 liters (irrigation fertilizer)	The third stage one month after the second stage 16.05.2022
20 liters (irrigation fertilizer)	The fourth stage, one month after the third stage, 18.06.2022

Table 2. Analysis of liquid organic fertilizer elements

Cadmium	Nickel	Ammonium nitrate	Mg	K	P	Ammonia	Salt	N	C	Element
0	0	25	8	11	6	12	1.2	33	5	%

The total amount of liquid organic fertilizer used is 73 liters per hectare, and in this study, liquid organic fertilizer and soluble urea fertilizer tanks are seen separately.

In order to investigate the effect of this fertilizer, the height of the sugarcane stalk (longitudinal growth) was measured in the index reed plants every two weeks. The trend of sugarcane growth in different weeks after the end of the crop control period is shown in (Fig. 3). Other traits were measured including the number of stalks per hectare, stalk diameter, percentage of sugar extraction and stalk yield per hectare at harvest time. In this way, in each treatment, 3-meter long plots were implemented at the position of the index reed plant and all reeds were cut. After counting the number of stems, 20 stems were separated to measure the diameter, weight and percentage of sugar extraction. The stem yield per hectare was obtained by a harvester and by filling a tractor basket in the middle of each treatment.

RESULTS AND DISCUSSION

The results of this research showed that a combination of liquid organic fertilizers and nitrogen levels can have a positive effect on sugarcane yield. Liquid organic fertilizers, derived from organic sources, can increase soil fertility and nutrient availability and provide essential elements for plant growth. Nitrogen, in appropriate amounts, is especially important for sugarcane, as it plays an important role in promoting vegetative growth and increasing yield. When liquid organic fertilizer and nitrogen levels are properly balanced and applied, they can synergistically help improve sugarcane productivity. Organic fertilizer can increase soil

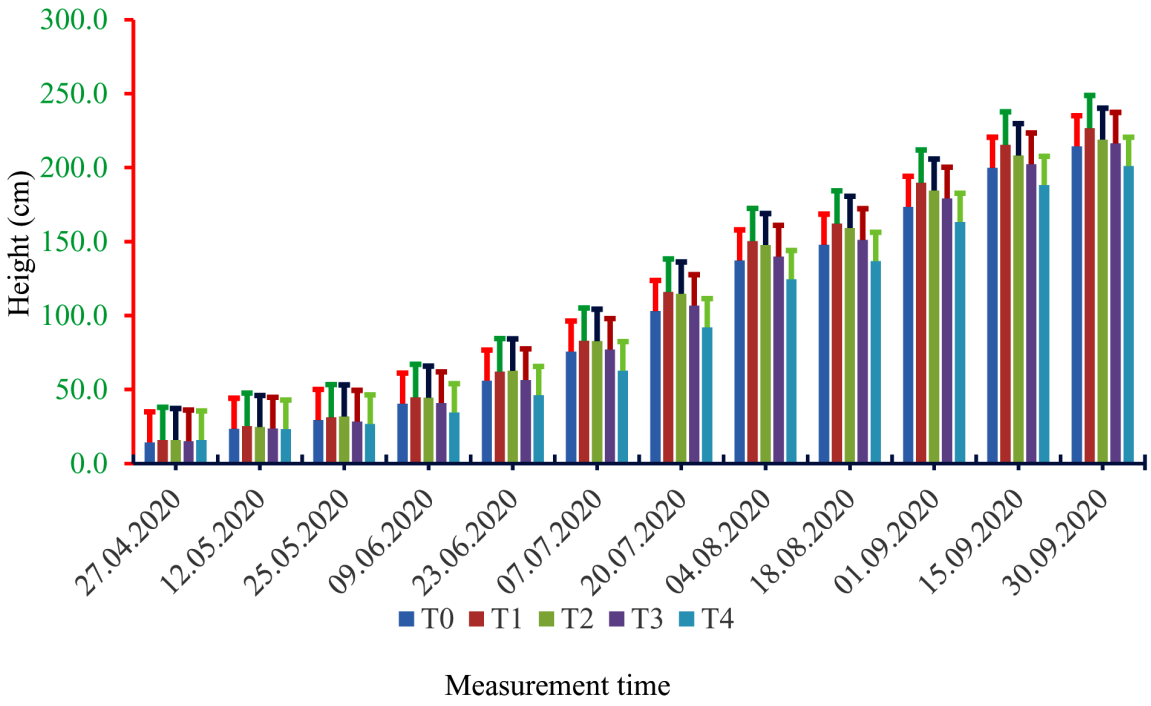

Fig. 3. Height of sugarcane in different treatments

structure and microbial activity and lead to better absorption of nutrients by plants. Nitrogen, as a key component of chlorophyll and protein, stimulates photosynthesis and overall plant growth. However, the specific effect of liquid organic fertilizer combination and nitrogen levels on sugarcane yield depends on various factors, including the specific formulation and concentration of fertilizers used, crop growth stage, environmental conditions, and other management measures. Conducting field trials and monitoring crop performance can provide more accurate and specific results on the effectiveness of this compound on sugarcane yield. Using Statistix 10 software, the findings were statistically analyzed, and the least mean test (LSD) was used to compare the means. The average comparison of the assessed qualities and the associated analysis of variance are displayed in Tables 3 and 4. Table 4 shows that, at a 5% level of significance, the T1 treatment produced the largest stem production per hectare at a rate of 104.12 tons, which was substantially greater than the yield of 93.10 tons per hectare produced by the T4 treatment. believes that the decrease in urea fertilizer consumption which is evident in the treatment results is what is responsible for this discrepancy.

Table 4. Comparison of the average yield (tons of stem per hectare) of the treatments

Treatment	Mean	Groups
1	104.12	A
3	104.78	A
0	99.25	AB
2	99.02	AB
4	93.1	B

Liquid organic fertilizer has a positive effect on sugarcane growth by improving soil fertility through increasing soil health and availability of nutrients, which had a direct effect on the number of stalks per hectare. Table 5 shows the comparison of the

Table 3. Variance analysis of yield (stems per hectare)

Sources	Degrees of freedom	sum of squares	mean square	F	P
Repetition	2	169.347	84.6734		
Treatment	4	203.173	50.7932	2.18	0.0596
Error	8	144.495	18.0619		
Total	14	517.015			

Table 5. Comparison of the average of the measured traits

Treatment	Percentage of sugar extraction	Height	Stem diameter	Number of stems	Yield (tons per hectare)
0	12.70[a]	214.33[ab]	1.915[ab]	171524[a]	99.25[ab]
1	12.53[a]	226.66[a]	1.912[ab]	181542.2[a]	104.12[a]
2	13.02[a]	218.83[ab]	1.915[a]	173952.2[a]	99.023[ab]
3	13.08[a]	216.33[ab]	1.840[ab]	163023.7[a]	101.78[a]
4	12.90[a]	201.00[b]	1.817[b]	170916.8[a]	93.1[b]
Mean	12.8	215.4	1.9	172191.8	99.5
Standard Error	0.1	4.2	0.0	2972.0	1.8
Median	12.9	216.3	1.9	171524.0	99.3
Mode	#N/A	#N/A	1.9	#N/A	#N/A
Standard Deviation	0.2	9.3	0.0	6645.6	4.1
Sample Variance	0.1	87.0	0.0	44163656.9	16.9
Kurtosis	-1.4	1.8	-2.6	1.4	1.3
Skewness	-0.6	-0.8	-0.7	0.1	-0.9

averages of the measured traits and the averages of the traits with the same letters do not have statistically significant differences. The highest percentage of sugar extraction (cane sugar quality) related to treatments 2 and 3 is 13.02 and 13.08, respectively, which indicates the highest quality among the treatments and this can be related to the reduction in the amount of nitrogen fertilizer used. be On the other hand, with a further decrease in the amount of nitrogen fertilizer consumption, the qualitative trend has not shown a significant decrease. The maximum stem diameter of treatment 2 is 1.915 cm compared to treatment 4 at 1.817 cm, which has a statistically significant difference, but the number of stems per hectare did not show a significant difference in all treatments. Treatment 1 compared to other treatments because liquid organic fertilizer in combination with urea fertilizer through improving the soil and increasing the nutrients required by the sugarcane plant increases the growth and tillering which leads to an increase in the number of stems per hectare and also increases the leaf area as a result of growth Better increases the photosynthesis of the sugarcane plant, which ultimately leads to an increase in yield. Therefore, the use of any of the fertilizers (liquid organic or urea) alone cannot lead to better sugarcane yield, therefore, a balanced combination of both fertilizers and their application at the right time will increase sugarcane yield. The results showed that the combination of liquid organic fertilizer and urea fertilizer can affect sugarcane. Using a combination of organic and inorganic fertilizers is a common practice in agricultural systems to provide balanced nutrients for crops. Liquid organic fertilizers can help improve soil fertility, nutrient availability, and overall soil health. They can increase microbial activity, improve nutrient cycling, and release nutrients from organic matter in the soil. This can help to sustainably supply essential nutrients to sugarcane plants. On the other hand, urea fertilizer is a nitrogen fertilizer that is usually used in sugarcane production. Nitrogen is a vital nutrient for sugarcane growth and plays an important role in stem and leaf growth. Urea is a source of nitrogen that can stimulate plant growth and increase sugarcane yield. By combining liquid organic fertilizer and urea fertilizer, you can take advantage of the benefits of both organic and mineral fertilizers. Organic fertilizers can increase soil health and nutrient availability over the long term, while according to research Davies *et al*. (2020) urea fertilizers can provide rapid nitrogen release for immediate plant uptake. However, it is important to note that the optimal combination and application rate of these fertilizers may vary depending on factors such as soil conditions, weather, crop requirements, and other management practices.

CONCLUSION

The experiment's findings indicate that combining urea (nitrogen fertilizer) with liquid organic fertilizer in four phases, using realistic proportions, did not reduce the nitrogen requirements for sugarcane growth. This suggests that the addition of urea did not result in a decreased demand for nitrogen by the sugarcane plants. Furthermore, when liquid organic fertilizer was used alongside 100% urea fertilizer, there was a 4.9% improvement in the yield of sugarcane stalks (measured in tons per hectare) compared to

treatment 1. This increase in yield per unit area was particularly noticeable at a high agricultural level. Liquid organic fertilizers have certain properties that make them beneficial, including their ability to enhance soil health and nutrient availability. They can be easily applied, especially when combined with chemical fertilizers through irrigation. Based on these advantages, it is recommended to apply liquid organic fertilizer concurrently with urea throughout the sugarcane growing season. The suggested application rate is 100 liters of liquid organic fertilizer per hectare and 25 liters per stage of growth. Overall, these findings support the use of a combination of liquid organic fertilizer and urea fertilizer in sugarcane cultivation, as it can enhance yield and provide the necessary nutrients for optimal plant growth. However, it's important to consider specific local conditions and consult with agricultural experts or follow regional guidelines to determine the most appropriate fertilizer application strategy for sugarcane production.

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