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Gherkin cultivation with different levels of inorganic fertilizers in the sandy regosols of Batticaloa district

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Abstract
This experiment was conducted to assess the optimum fertilizer level for gherkin (*Cucumis anguria* L.) in the sandy regosols of Batticaloa district. A field experiment using twelve treatments with four replications was conducted following Randomized Complete Block Design at university farm, Eastern University, Sri Lanka from August to October, 2024. The treatments included, T1 – 100% of the Tamil Nadu Agricultural University recommendation (TNAU), T2 –75% TNAU, T3- 50% TNAU, T4- 25% TNAU, T5 – 100% Department of Agriculture recommendations (DOA), T6 – 75% DOA, T7 – 50% DOA, T8 – 25% DOA, T9 – 100% Modified application rate of the DOA recommendation (MDOA), T10 – 75% MDOA, T11-50% MDOA and T12-25% MDOA. According to the findings T1 (100% TNAU) reduced the vine length, leaf number, leaf area, and yield by 7%, 8%, 36%, and 13.7%, respectively compared to T5. This hindered performance might be associated with the high nitrogen level in T1 (150 kg/ha). However, T2, T10 and T11 improved the overall crop performance compared to T5. Treatments such as T6, T7, and T8 performed less than T5, could be due to the absence of TSP in top dressing applications. The highest crop performance was recorded in T9, which increased vine length (33%), leaf count (53%), branch count (80.7%), leaf area (40.6%), fresh weight (77.6%), and dry weight of shoot (193.6%) compared to T5. Moreover, T9 reached 50% flowering in 21 days and produced a yield of 38.2 t/ha, showing a 229% increase over T5. The great performance of T9 (100% MDOA) may be attributed to the addition of TSP in both the first and second top dressings, which is absent in the DOA recommendation. Adoption of the fertilizer application rate used in T9 could therefore support better soil nutrient balance while maximizing gherkin productivity.

Keywords: Chandani variety, gherkin, inorganic fertilizers, sandy regosols

Introduction
Gherkin (*Cucumis anguria* L.), a mostly consumed vegetable, belongs to the family Cucurbitaceae (Oliveira *et al*., 2020). Originating in Africa, gherkin is particularly used in the Northern and Northeastern regions of Brazil (Neelambika *et al*., 2024; Leite *et al*., 2019) [14]. Gherkin, also referred to as the "pickling cucumber," and a significant vegetable crop. It is an annual, monoecious vine that either trails or climbs. Its unripe fruits are primarily used for pickling (Bindiya *et al*., 2012) [3]. The gherkin plant produces yellow color flowers and greenish fruits filled with small, smooth, white seeds measuring 3 to 5 mm in length. Young fruits are versatile and can be eaten raw, cooked, pickled, or used in curries (Mounika *et al*., 2019) [17].
In Sri Lanka, around 10,000 farmers cultivate gherkin, commonly in the districts of Ampara, Monaragala, Badulla, Kurunegala, Matale, Anuradhapura, Mahaweli System B, Polonnaruwa, (Silva *et al*., 2010) [23]. It is cultivated on a commercial scale and is one of Sri Lanka's primary vegetable exports, available in both processed and semi-processed forms. Pickling-type gherkins have been cultivated in Sri Lanka for the export market since 1988, with production expanding across several agro-ecological regions (Uthpala *et al*, 2019) [26]. The gherkin fruits are exported to countries such as South Korea, New Zealand, Japan, Australia, Holland, and Russia (Godagampala *et al*., 2013) [9].
During 2018–2019, a total of 34,864 metric tons of cucumbers and gherkins were harvested from 25,555 hectares of cultivated land in the country (Sandamali *et al*., 2022) [22]. Gherkin grows well even in soils that are not highly fertile and is particularly well-suited to sandy soils. In many production areas, farmers cultivate gherkin without applying fertilizers, depending instead on the residual fertility left by previously grown crops. Nonetheless, in nutrient-poor soils, the use of fertilizers is recommended to improve crop performance and yield (Oliveira *et al*., 2009). In this context, this study was designed to assess the effect of different levels of inorganic fertilizer on gherkin cultivation.

Materials and methods
The experiment was conducted at the University Farm of Eastern University, Sri Lanka, Vantharumoolai (7° 48'36.64" N, 81° 35'30.76" E), from August to October 2024, located in the Low Country Dry Zone (DL2). The study used a randomized complete block design (RCBD) with twelve different level of NPK fertilizer treatments and four replications where each replication consist of 9 plants. The treatments included T1 – 100% of the Tamil Nadu Agricultural University recommendation (TNAU), T2 –75% TNAU, T3- 50% TNAU, T4- 25% TNAU, T5 – 100% Department of Agriculture recommendations (DOA), T6 – 75% DOA, T7 – 50% DOA, T8 – 25% DOA, T9 – 100% Modified application rate of the DOA recommendation (MDOA), T10 – 75% MDOA, T11-50% MDOA and T12-25% MDOA. In the MDOA treatment, Triple Super Phosphate (TSP) was applied in both top dressings, like the basal application value, unlike the DOA recommendation where TSP is not included in the top dressings.
Land preparation involved creating blocks and experimental units. Urea, TSP, and MOP were applied according to the treatments. Seeds were sown in plug trays with a 1:1 compost-soil mixture and transplanted to field after seedling

emergence. Fertilizers were applied in three equal splits (basal, first top dressing and second top dressing) during the crop cycle, with basal application 2 days before planting. Harvesting occurred six times, focusing on Grade 3 fruits (32–45 mm diameter) as per export standards to ensure proper marketing. Measured parameters included vine length, number of leaves and branches, chlorophyll content, leaf area, shoot fresh and dry weights, number of fruits per vine, total number of fruits and total yield. Data was analyzed using Minitab 17, and treatment means were compared with Tukey's test at a 5% significance level. The Treatments are shown in table.1

Table1: Treatment code and Description

Treatment code	Description
T1	100% TNAU Basal (kg/ha): 150 N: 75 P: 100 K 1st top dressing (kg/ha): 150 N: 75 P: 100 K 2nd top dressing (kg/ha): 150 N: 75 P: 100 K
T2	75% TNAU Basal (kg/ha): 112.5 N: 56.25 P: 75 K 1st top dressing (kg/ha): 112.5 N: 56.25 P: 75 K 2nd top dressing (kg/ha): 112.5 N: 56.25 P: 75 K
T3	50% TNAU Basal (kg/ha): 75 N: 37.5 P: 50 K 1st top dressing (kg/ha): 75 N: 37.5 P: 50 K 2nd top dressing (kg/ha): 75 N: 37.5 P: 50 K
T4	25% TNAU Basal (kg/ha): 37.5 N: 18.75 P: 25 K 1st top dressing (kg/ha): 37. 5 N: 18.75 P: 25 K 2nd top dressing (kg/ha): 37.5 N: 18.75 P: 25 K
T5	100% DOA Basal (kg/ha): 75 N: 200 P: 60 K 1st top dressing (kg/ha): 75 N: -: 60 K 2nd top dressing (kg/ha): 75 N: -: 60 K
T6	75% DOA Basal (kg/ha): 56.25 N: 150 P: 45 K 1st top dressing (kg/ha): 56.25 N: -: 45 K 2nd top dressing (kg/ha): 56.25 N: -: 45 K
T7	50% DOA Basal (kg/ha): 37.5 N: 100 P: 30 K 1st top dressing (kg/ha): 37.5 N: -: 30 K 2nd top dressing (kg/ha): 37.5 N: -: 30 K
T8	25% DOA Basal (kg/ha): 18.75 N: 50 P: 15 K 1st top dressing (kg/ha): 18.75 N: -: 15 K 2nd top dressing (kg/ha): 18.75 N: -: 15 K
T9	100% MDOA Basal (kg/ha): 75 N: 200 P: 60 K 1st top dressing (kg/ha): 75 N: 200 P: 60 K 2nd top dressing (kg/ha): 75 N: 200 P: 60 K
T10	75% MDOA Basal (kg/ha): 56.25 N: 150 P: 45 K 1st top dressing (kg/ha): 56.25 N: 150 P: 45 K 2nd top dressing (kg/ha): 56.25 N: 150 P: 45 K
T11	50% MDOA Basal (kg/ha): 37.5 N: 100 P: 30 K 1st top dressing (kg/ha): 37.5 N: 100 P: 30 K 2nd top dressing (kg/ha): 37.5 N: 100 P: 30 K
T12	25% MDOA Basal (kg/ha): 18.75 N: 50 P: 15 K 1st top dressing (kg/ha): 18.75 N: 50 P: 15 K 2nd top dressing (kg/ha): 18.75 N: 50 P: 15 K

Vine length (cm)

As presented in Table 2, vine length varied significantly ($P<0.05$) across treatments. At 8 WAP, T9 exhibited the highest vine length (151.3 cm) followed by T2 (123.13 cm), T3 (117.96 cm), and T10 (114.7 cm). Moreover, T8 recorded the lowest vine length (53.25 cm).

Treatment T9 (100% MDOA) showed 33.5% increase in vine length over T5 (100% DOA) at 8 WAP. This improvement may be attributed to the absence of TSP as a top dressing in the DOA recommendation in T5, which is included in T9. This shows the significance of applying TSP during the 4th and 5th weeks for better growth of gherkin. Similar findings were noted by Atajan and Zohan (2022), who demonstrated that the application of TSP increased seedling height by 50% compared to the control in pistachio crops.

The fact that vine length was reduced by 8% in T1 (100% TNAU) relative to T5 (100% DOA) suggests that the use of 150 kg/ha of nitrogen in 3 splits dose can have negative effects on the growth of plants. Nevertheless, T2 (75%

TNAU) and T3 (50% TNAU) raised the length of vine by 8.7 and 4.1 per cent, respectively, than T5. Such a difference can be explained by the loss of nutrients due to the excessive use of nitrogen in T1. In particular, the TNAU (T1) dose of 100 percent entails the application of 150 g of urea as a basal dose and in two top dressings, and that might be subject to nitrogen leaching or volatilization. Excessive use of nitrogen, particularly prior to the peak need of the crop, can lead to decreased use of nutrients. These results align with the observation made by Aluko *et al*. (2021) [1], who indicated that the earlier the application of nitrogen before the plant needs it, the higher the loss of nitrogen before the crop can make use of it.

The shortest vine length was recorded in T8 (25% DOA), which is probably because of the insufficient nutrient availability, as it is just a quarter of the DOA recommendation. Plant growth in treatments T6, T7, and T8 displayed a significant decrease at 8 WAP, indicating that the plants had ceased growth and the leaves had started to curl up because of low nutrient supply. The cause of this nutrient deficiency is in the lower level of fertilizer application, and in the fact that Triple Superphosphate (TSP) is not used as top dressing in these treatments. These results are comparable to the results of Malhotra *et al*. (2018) [16], who found out that phosphorus (P) deficiency slows down plant maturity, though the degree of this effect depends on the species of crops. In addition, Malhotra *et al*. (2018) [16] described that in the case of phosphorus deficiency, the shoot growth decreases more significantly compared to the root growth leading to a decrease in the shoot to root ratio.

This supports the present observation that inadequate phosphorus supplies due to omitted TSP top dressing adversely affected plant growth and vigor at later growth stages.

Table 2: Effect of different levels of inorganic fertilizers on vine length from 4 WAP to 8 WAP

Treatments	4 WAP	6 WAP	8 WAP
T1	45.35 ± 0.16 d	85.10 ± 1.07 cde	104.0 ±1.07 bc
T2	65.50 ± 2.53 b	112.3 ± 1.42 ab	123.13 ± 0.98 b
T3	61.00 ± 3.72 bc	96.75 ± 1.31 abc	117.96 ± 2.89 b
T4	43.75 ± 4.03 d	83.57 ±0.82 cdef	105.57 ± 0.76 bc
T5	55.72 ± 6.02 bcd	91.20 ± 0.78 cd	113.28 ± 1.47 b
T6	45.02 ± 0.47 d	77.35 ± 1.77 defg	66.32 ± 0.43 de
T7	42.72 ± 0.66 d	71.92 ± 0.86 efg	58.75 ± 7.53 e
T8	45.92 ± 5.42 cd	66.75 ± 0.87 g	53.25 ± 0.75 e
T9	89.75 ± 3.01 a	117.5 ±10.6 a	151.3 ± 13.3 a
T10	56.83 ± 1.15 bcd	94.35 ± 1.58 c	114.70 ± 1.27 b
T11	56.80 ± 0.45 bcd	68.00 ± 0.87 fg	115.95 ± 0.57 b
T12	42.52 ± 0.75 d	71.75 ± 0.40 efg	86.17 ± 0.38 cd
F test	*	*	*

Number of leaves

Table 3 is the count of leaves in gherkin plants exhibited statistically significant ($P<0.05$) difference among levels of fertilizer. The highest number of leaves (119) was recorded in treatment T9 (100% MDOA) then T2 (104.5) and T3 (97.25). Interestingly, T9 produced 53% more than T5 (100 percent DOA), which means that the nutrient contents were at the best with the MDOA appkication. The same results were obtained by Boroujerdnia and Ansari (2007) [4] who reported that the proper NPK fertilization increases vegetative growth by facilitating photosynthetic activity and leaf development. Out of the MDOA treatments, T10 and T11 resulted in 23.4% and 17% increase in the number of leaves respectively, compared to T12 (25 percent MDOA) which had a decrease of 10.6% of leaf number relative to T5. Conversely, the interventions by the DOA recommendation (T6, T7, and T8) caused the decreased leaf production of 9, 14, and 20%, respectively, compared to T5, suggesting that nutrient availability was not enough to promote the vegetative growth. This is in line with the explanation given by Singh *et al*. (2018) [24], who clarified that inefficient NPK concentrations impair the increase of leaves and biomass.

The TNAU recommendations indicated that T2 and T3 increased the production of leaves by 34% and 25%, respectively, over T5, and T1 decreased the production by 9 percent indicating that nutrient application of 150 kg/ha was possibly an overdose to gherkin. As shown by previous research studies by Chattoo *et al*. (2014) [5], too much nitrogen may cause nutrient toxicity and decreased crop performance. In general, the decreased number of leaves due to DOA treatments underlines the fact that sufficient amounts of nutrients are required to support active growth. These findings are consistent with those of Zhou *et al*. (2017) [33] highlights that split NPK use positively affects nutrient utilization, and affects leaf development and yielding in cucurbit crops.

Number of branches

The number of gherkin branches varied significantly ($P<0.05$) across different fertilizer levels (Table 3). By 8 WAP, T9 recorded the highest number of branches (11.75), followed by T2 (9). The lowest branch count (5) was observed in T1, T4, T5, T6, T7, and T8 and T12. 100% MDOA (T9) showed a 135% increase in branch count compared to T5 (100% DOA).

The reduced branch number in 100% TNAU may be due to phosphorus deficiency and high nitrogen in the early growing season, as 100% TNAU has less phosphorus and higher nitrogen compared to 100% DOA. Grant *et al*. (2001) [10] found that early-season phosphorus limitations can restrict crop growth, with the plant unable to recover even when phosphorus levels are later increased. This suggests that optimal nitrogen with phosphorus in the top dressings as well, as found in 100% MDOA, would promote higher gherkin production.

Leaf area (cm^2)

Leaf area shows a significant difference ($p<0.05$) in leaf area among the treatments, with T9 recording the highest leaf area (6335 cm^2), followed by T2 (5444.4 cm^2), T3 (5233.1 cm^2), and T10 (5112 cm^2) (Table 3). Anyhow, there was no significant ($P>0.05$) difference among the treatments such as T2, T3, T10 and T11. The lowest mean leaf area was observed in T8 (2595.2 cm^2). This trend suggests that modifying the DOA recommendation by incorporating TSP as a top dressing twice would improve leaf production and contribute to higher photosynthetically active area.

T9 showed a 40% increase in leaf area compared to T5 (100% DOA). The increase in leaf area due to optimam nitrogen supply throughout the growing season, stimulates leaf expansion, has been reported by Leghari *et al*. (2016) [13], Panayotova *et al*. (2013) [18], who found that nitrogen stimulates cell division and expansion.

The 100% treatment of TNAU had a reduced leaf area compared to the 100% treatment of DOA even following the top dressing of TSP which is not found in DOA. This can be explained by various responses of soils to the application of nitrogen fertilizers. The properties of soil tend to have specific optimum levels of N application to attain high efficiency. When N rates are relatively low, the gradual increases generally support urease and invertase activity, along with the availability of N, P, and K. In any case, it is stated that after reaching an optimal level of N rate, the subsequent growth in N rates can result in decreases in the following soil properties, which will eventually suppress plant growth and the expansion of leaves (Sun *et al.*, 2020) [25].

Table 3: Effect of different levels of inorganic fertilizers on number of leaves, number of branches, leaf area at 8 WAP

Treatments	Number of leaves	Number Of branches	Leaf area (cm^2)
T1	70.75 ± 1.49 e	5.00 ± 1.49 e	2860.5 ± 31.4 g
T2	104.50 ± 0.95 b	9.00 ± 0.00 b	5444.4 ± 29 b
T3	97.25 ± 0.94 c	8.25 ± 0.25 bc	5233.1 ± 34.9 c
T4	71.50 ± 1.89 de	5.00 ± 0.00 e	3956.6 ± 25.3 e
T5	77.75 ± 0.85 d	6.5 ± 0.28 d	4504.0 ± 26 d
T6	67.25 ± 1.25 ef	5.00 ± 0.00 e	2522.5 ± 27.6 f
T7	66.75 ± 0.94 ef	5.00 ± 0.00 e	2841.5 ± 32.5 g
T8	61.75 ± 1.65 f	5.00 ± 0.00 e	2595.2 ± 53.9 h
T9	119.00 ± 1.29 a	11.75 ± 0.25 a	6335.0 ± 20.0 a
T10	96.00 ± 1.83 c	7.75 ± 0.47 c	5112.0 ± 13.3 c
T11	91.00 ± 1.29 c	7.75 ± 0.47 c	5065.0 ± 62.1 c
T12	69.50 ± 1.04 e	5.00 ± 0.00 e	2604.0 ± 13.7 g
F test	*	*	*

Chlorophyll content

Table 3 represents that chlorophyll content was significantly influenced (P<0.05) by different fertilizer treatments. The maximum chlorophyll content was noted in T9 (96.32), followed by T2 (87.3), T3 (85.75), and T10 (83.02), while the lowest value was observed in T8 (68.57).

The reduced chlorophyll concentration was attributed to reduced nitrogen levels which was observed in T6, T7, and T8. This observation is consistent with Prsa *et al.* (2007) [20] who discovered that nitrogen deficit can affect photosynthesis as a result of alteration in enzymatic and non-enzymatic elements of photosynthetic apparatus. This is also justified by the fact that Zhang *et al.* (2017) [31] emphasize the importance of sufficient phosphorus in the early vegetative development. In general, the superior performance of T9 indicates that it offers an optimum NPK ratio to enhance seedling vigor, which is manifested by the greater chlorophyll accumulation as a result of the better availability of nitrogen and phosphorus. Similarly, Leghari *et al.* (2016) [13] asserted that chlorophyll is the one that captures the light energy during the photosynthesis process that is transformed into ATP and nitrogen helps in nutrient uptake and the overall growth of the plant.

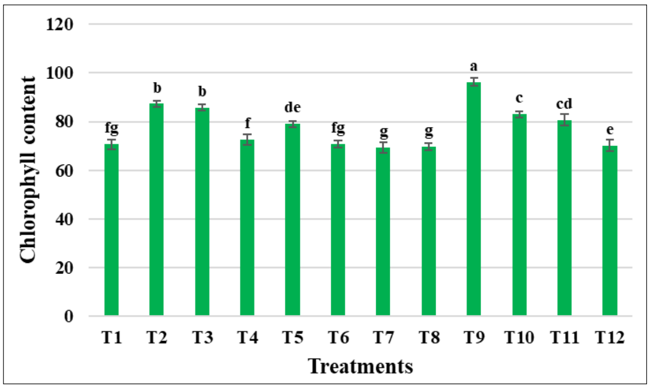

Fig 1: Effect of different levels of inorganic fertilizers on chlorophyll content at 8 WAP

Shoot fresh and dry weight (g)

A significant difference (P < 0.05) in both fresh and dry shoot weights of gherkin crops. In T9, the fresh shoot weight (514.3 g) increased by 77.6% compared to T5, with the maximum shoot dry weight (174.27 g) also recorded at T9 (Table 4). The minimum fresh and dry shoot weights were observed in T8, followed by T7 and T6, might be due to lower NPK contents due to decreased NPK levels in DOA recommendation. The increased shoot fresh and dry weights in T9 (100% MDOA) could be due to the higher production of leaves, branches, and leaf area, resulting from the optimal NPK concentration.

Table 4: Effect of different levels of inorganic fertilizers on shoot fresh and dry weight (g)

Treatments	Shoot fresh weight (g)	Shoot dry weight (g)
T1	248.82 ± 9.91ef	58.87 ± 9.75 f
T2	356.5 ± 12.80 b	77.92 ± 7.68 b
T3	350.1 ± 11.3 bc	71.80 ± 7.84 c
T4	262.7 ± 15.2 def	64.42 ± 5.43de
T5	289.53 ± 9.72 cde	59.35 ± 5.23 f
T6	230.1 ± 13.8 ef	58.15 ± 5.16 fg
T7	226.2 ± 11.4 f	54.50 ± 6.36 gh
T8	223.88 ± 18.4 f	52.92 ± 6.75 h
T9	514.3 ± 12.3 a	174.27 ± 9.32 a
T10	312.5 ± 11.8 bcd	67.87 ± 4.46 d
T11	290.7 ± 13.5 cde	64.52 ± 3.54 de
T12	233.2 ± 3.25 ef	61.47 ± 4.14 ef
F-test	*	*

Number of days for 50% flowering

There was a significant difference (P < 0.05) in the number of days required to trigger 50 percent flowering in the treatments. Treatments T1, T5, T6, T7, T8 and T12 showed the longest period (26 days) with non-significant differences (P > 0.05) among them (Figure 1). The lack of triple superphosphate (TSP) as top dressing and the lower concentration of nitrogen (N) in flowering (T5, T6, T7, and T8) further demonstrates the importance of N and phosphorus (P) in flowering. The same was observed by Ye *et al.* (2019) [30] who mentioned that P and N application accelerated flowering by 3-4 days in paddy. This is consistent with Kolar and Senkoya (2008), who articulated that in the case of low N availability, plants can hasten their life cycle to maximize biological yield instead of fruit/pod production.

The time taken to 50 percent flowering showed the minimum in T9 (21 days) and T2 (22 days) and no significant difference (P > 0.05) between T2, T3, and T10. High N dosage with 100% TNAU (T1) reduced flowering by five days. A comparable effect has been observed by Liu *et al*. (2013) [15] and Vidal *et al*. (2014) [27], who reported that an increased N level can inhibit rice flowering by 1 to 4 days. Moreover, the delayed flowering is also correlated with severe N deficiency (Marin *et al*., 2011). These results demonstrate the importance of ensuring that the N levels are kept to the optimum to maximize flowering and maximize yield. According to Ye *et al*. (2019) [30], potassium (K) usage promoted early flowering by 1-3 days, and increased K rates promoted early flowering. In 100% TNAU (T1) which had high K compared to 100% MDOA T9, however, flowering was retarded. The delay may be attributed to the increased levels of nitrogen (N) in 100% TNAU that favors the observation of Ye *et al*. (2019) [30] who discovered that plants are more responsive to N than K or phosphorus (P) in the regulation of flowering.

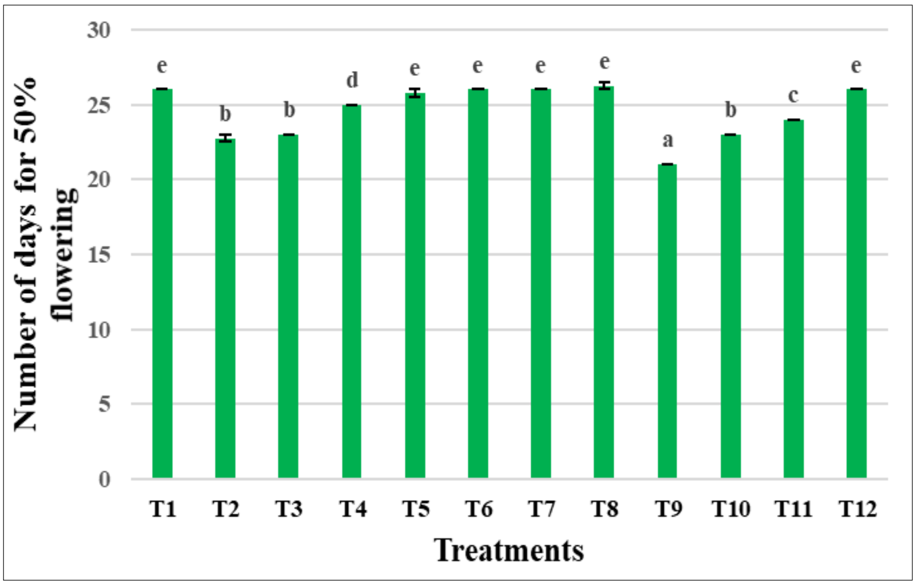

Fig 2: Effect of different levels of inorganic fertilizers on number of days for 50% flowering.

Total number of fruits and total yield (t/ha)

The impact of various inorganic fertilizers on the number of fruits per vine, total number of fruits and yield (t/ha) of Cucumis anguria L were revealed in Table 5. The findings identified that T9 was exceedingly (P < 0.05) higher than other interventions as regards yield potential of gherkin plants. In T9 (the highest total number of fruits per vine and yield was 21.75 and 38.2 tons/ha respectively), followed by T2 (30.07 tons/ha), and T3 (27.04 tons/ha).

The reduced yield with T1 (100% TNAU) by 13.7% compared to T5 (100% DOA) might be due to high level of N application throughout the experiment by 3 split applications along with N and P that is reduced to its half of the N. Throughout the experiment T9 (100% MDOA) gives higher yield of gherkin. These findings are in line with the findings of Waseem *et al*. (2008) [29], who stated that optimal yields in cucumber with the application of 80 kg N ha^{-1}, while higher nitrogen levels reduced yield. A similar observation was made by Wang & Li (2004) [28], who found that the maximum yield of green cabbage was noted at 180 kg N/ha, yielding 17.6 Mt/ha. However, with increased nitrogen rate up to 270 kg/ha, the yield reduced to 15.0 Mt/ha.

Treatment	Number of fruits / vines	Total number of fruits	Total yield(t/ha)
T1	10.00 ± 0.40	47.5 ± 0.64	10.00 ± 0.40 g
T2	16.50 ± 1.65	80.0 ± 0.40	30.07 ±0.05 b
T3	16.27 ± 1.6	77.0 ± 1.08	27.04 ± 0.02 c
T4	11.27 ± 1.05	57.0 ± 1.58	11.3 ± 0.25 f
T5	13.23 ± 1.05	61.0 ± 1.29	11.6 ± 0.12 f
T6	9.75 ± 1.74	42.75 ± 0.47	7.47 ± 0.19 h
T7	9.75 ± 1.25	40.0 ± 0.81	7.51 ± 0.08 h
T8	8.25 ± 1.85	39.25 ± 0.47	7.51 ± 0.01 h
T9	21.75 ± 1.55	95.5 ± 0.64	38.20 ± 0.41 a
T10	15.5 ± 1.28	68.75 ± 0.47	18.35 ± 0.25 d
T11	12.5 ± 0.94	63.25 ± 0.47	17.27 ± 0.05 e
T12	10.25 ± 0.62	45.25 ± 0.75	9.78 ± 0.29 g
F test	*	*	*

The reduced yield observed in T6, T7, and T8 was likely due to the early dying of plants, while the reduced yield in T1 may be attributed to the high nitrogen application throughout the experiment. This aligns with the findings of Islam *et al*. (2018) [11], who reported that excessive nitrogen application is toxic to plants, inhibiting growth, causing early plant death, that reduced reducing the number of gherkin pickings.

Zhao *et al*. (2014) [32] explained that the lower N application pattern provided high yields than applying higher N rates. This aligns with the results of the present study, where T9 (100% MDOA) with a lower nitrogen rate than T1(100% TANU) still produced a superior overall performance. Reduced yield in crops with high Nitrogen are commonly caused by physiological disorders related to the excessive uptake of N and soil degradation (Qiao *et al*., 2012) [21].

Conclusion

The results showed that treatment 9, which was 100% of the modified DOA recommendation, showed the most substantial improvements in growth and yield parameters among all treatments. Treatment 9 increased the vine length by 33.5%, the number of leaves by 53%, and the number of branches by 80.7% Compared to T5 (100% DOA), T9 also significantly reduced the days required to achieve 50% flowering to 21 days, followed by T2 (75% TNAU recommendation) at 22 days, whereas T1 (control) required 26 days. In terms of yield, T9 achieved the highest yield (38.2 tons/ha), followed by T2 (30.07 tons/ha) and these yields were 229% and 159% higher than the T5 (11.6 tons/ha), respectively. In conclusion, the application of 100% of the modified DOA fertilizer recommendation (T9) was the most effective treatment, significantly enhancing growth, flowering, and yield performance of *Cucumis anguria* L. under field conditions in Sri Lanka.

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