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Research Article

Performance Evaluation of Cucumber (*Cucumis sativus*.L) Genotypes for Growth and Yield Under Sodic Soil

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Abstract

Cucumber (*Cucumis sativus* L.) is the fourth most important vegetable crop worldwide. Sodic stress inhibits almost all growth phases and yield components of cucumber. The present study has been formulated to evaluate the effect of sodic stress on the growth and yield of cucumber. The study was conducted at the Department of Vegetable Science Horticultural College and Research Institute for Women, TamilNadu Agricultural University, Tiruchirapalli, TamilNadu during 2024-2025. Five genotypes (treatments) namely CBE CS 05 (Paravai Local), CBE CS 07 (Piraittur Local), CBE CS 19 (Namanasamuthiram Local), CBE CS 37 (Namakkal Local) and CBE CS 38 (Vadalur Local) selected from the findings of the previous research were assessed for the performance in terms of growth and yield under sodic soil followed by confirmatory trial. The design adopted was Randomised Block Design with four replications. The study revealed that the genotype, CBE CS 37 (Namakkal Local) has been observed to be the best genotype for productivity, recording the maximum number of fruits per vine (20.00), highest fruit yield (2.88 kg/vine) and longest vine (171.2 cm). Its high yield has been found to be associated with its superior fruit-bearing capacity and adequate individual fruit weight.

Keywords: Sodic Stress; Cucumber; Genotypes; Sex Expression; Growth; Yield

Introduction

One third of irrigated lands all over the world are significantly affected by sodicity. Soil sodicity imposes a great challenge for vegetable-crops production in arid and semiarid regions. Developing tolerant plants to increase the productivity of these lands is considered a great challenge. Sodicity is a serious problem causing decrease of crop productivity through its negative effect on seed germination and seedling growth. It affects plant growth through disturbing plant osmosis, imbalance nutrition channels and ionic toxicity. The alteration in these main mechanisms leads to metabolic and physiological changes and poses a negative impact on seed's germination, seedling's growth as evident from retarded shoot and root length, fresh and dry weight, chlorophyll content and its synthesis. The most prominent effect of sodicity stress is noticed on photosynthetic pigments in plants including chlorophyll a, b and carotenoids.

Sodicity stress not only affects the photosynthetic pigments and chlorophyll synthesis but also interferes with plant's metabolic and physiological activities in plants through altering primary and secondary metabolites fluxes. Furthermore, the carbohydrates and protein contents are found to vary in plants under sodic stress. In particular, proline as an osmoregulator metabolite is associated with various stresses such as drought and allele chemical stresses. Furthermore, the alteration in secondary metabolomics pool such as polyphenolics, flavonoids, saponins, anthocyanins and tannins is reported in many plants subjected to sodic stress. This metabolomics alteration (positive or negative) under sodic stress is controlled by many factors including plant species, developmental stages, magnitude and duration of stress itself. In most studies, the precursors of secondary metabolites are channelized, leading to an increase in flavonoids and phenolics contents. Although sodic stress is well evaluated in a number of crops, unfortunately there is limited information regarding the impact of sodicity on metabolomic changes and metabolomics pathways of the stressful plants during their growth under sodic stress.

Cucumber (*Cucumis sativus* L.) is the fourth most important vegetable crop worldwide. Sodic stress inhibits almost all growth phases and yield components of cucumber. Accumulation of Na+ ions in cucumber tissues disturbs the absorption of other ions causing ionic imbalance which affect stomatal opening. Nevertheless, high levels of sodium in soil inhibit water uptake in the root medium exposing cucumber to osmotic stress. Osmotic stress broadly interrupts metabolic pathways by altering enzymatic activity. Both, ionic and osmotic stresses induce ROS in cucumber tissues. ROS directly constrain photosynthesis by decreasing levels of total chlorophyll and degrading PSII as well as corrupting thylakoid membranes. Ultimately, sodium induced stress inhibits cucumber seed germination, root and shoot growth and development, fruit quality and yield production.

Evaluation of cucumber under sodicity may be achieved through having a complete picture of their metabolites under stress condition. Gaining information considering their metabolomic pathways under sodic stress may be very valuable for breeders to breed more tolerant varieties of cucumber. Hence, the present study has been formulated to evaluate the effect of sodic stress on the growth and yield of cucumber.

Materials and Methods

The study was conducted at the Department of Vegetable Science Horticultural College and Research Institute for Women, TamilNadu Agricultural University, Tiruchirapalli, TamilNadu during 2024-2025. Five genotypes (treatments) namely CBE CS 05 (Paravai Local), CBE CS 07 (Piraittur Local), CBE CS 19 (Namanasamuthiram Local), CBE CS 37 (Namakkal Local) and CBE CS 38 (Vadalur Local) selected from the findings of the previous research were assessed for the performance in terms of growth and yield under sodic soil followed by confirmatory trial. The design adopted was Randomised Block Design with four replications. Observations on vine length, node at which first male flower appeared, node at which first female flower appeared, number of male flowers/vine, number of female flowers/vine, sex ratio, number of fruits /vine, number of days taken for first harvest**,** fruit length (cm), fruit girth (cm), single fruit weight (g) and fruit yield per vine (g) were recorded. The data were subjected to statistical analysis to obtain mean performance [5].

Results and Discussion

Flowering behaviour and sex expression (Table 1 and 2)

The present investigation revealed considerable variation among the cucumber genotypes for flowering behaviour and sex expression under sodic soil. The first male flower appeared at 1.3 to 2.9 nodes, whereas the first female flower appeared at 3.8 to 6.0 nodes. Such variation among genotypes indicates the existence of genetic variability for flowering behaviour, which can be effectively exploited in cucumber improvement programmes. Similar significant variation for node of first male flower, node of first female flower, days to first harvest and other quantitative characters has been reported in cucumber genotypes. Substantial variability and high heritability for node number of first male and female flowers, days to first harvest and several yield-related traits has been observed [1]. A wide range of variability was observed for node number of first male flower, node number of first female flower and sex ratio, with high heritability and genetic advance for these traits, indicating their potential for effective selection in cucumber [7]. Similarly, High genotypic and phenotypic variability for node at first female flower appearance and node at first male flower appearance, along with high heritability for flowering and earliness-related traits was reported in cucumber [9].

CBE CS 05 (Paravai Local) recorded the earliest appearance of the first male flower at 1.3 node, followed by CBE CS 07 (1.5 node), while CBE CS 37 (Namakkal Local) recorded the latest first male flower at 2.9 node. In contrast, CBE CS 37 produced the first female flower at the earliest node (3.8), whereas CBE CS 05 recorded the first female flower at the highest node (6.0). Early appearance of female flowers is desirable because it can contribute to early fruit formation and harvesting. Recent studies involving diverse bitter gourd germplasm have also emphasized node of first female flower and days to first harvest as important traits for improving earliness [10]. High heritability for node of first female flower appearance and days to first harvest, indicating the possibility of improving these traits through selection was reported in cucumber [9]. Similarly, studies on cucumber have identified node of first female flower appearance and days to first harvest as important components in the selection of superior genotypes for earliness.

The number of male and female flowers also varied substantially among the genotypes. CBE CS 05 recorded the highest number of male flowers (75.0/vine) as well as female flowers (55.1/vine). The genotype also exhibited the lowest sex ratio of 1.36:1, followed by CBE CS 07 with 1.40:1. The lower sex ratio indicates relatively greater female flower production in these genotypes. Sex expression is an important determinant of productivity in cucumber because increased female flower production can increase the potential number of fruit-bearing sites. Research on cucumber has identified sex expression as an important component of yield improvement, while recent genetic studies have specifically examined the genetic basis of sex ratio and its relationship with earliness and yield.

In contrast, CBE CS 37 recorded the highest sex ratio (1.67:1) and the lowest number of female flowers (40.6/vine). This indicates greater male flower predominance compared with the other genotypes. However, this genotype subsequently produced the highest number of fruits and fruit yield, suggesting that sex ratio alone does not determine final yield. Fruit set, fruit retention, number of fruits and individual fruit weight also contribute substantially to yield. Similar observations have been reported where number of fruits per plant and fruit weight showed strong relationships with yield, whereas sex-related traits alone were not sufficient to explain total yield variation. A significant negative association of yield with sex ratio and node number of first female flower, while number of fruits per vine and average fruit weight showed important positive associations with yield in another study [6].

Earliness and days to first harvest

Significant differences were observed among the genotypes for days taken to first harvest, which ranged from 54.4 to 61.2 days. CBE CS 19 (Namanasamuthiram Local) was the earliest genotype, requiring only 54.4 days, followed by CBE CS 38 (56.7 days) and CBE CS 07 (57.2 days). CBE CS 37 was the latest, requiring 61.2 days for first harvest under sodic soil.

Earliness is an important breeding objective in cucumber because early genotypes can provide earlier marketable produce and may have an advantage in crop scheduling. Recent research involving 64 bitter gourd hybrids demonstrated significant genetic variation for days to first fruit harvest and identified the importance of sex expression and flowering behaviour in improving earliness [10].

Similar variability for days to first harvest has been reported among cucumber genotypes [9]. High heritability for days to first harvest, suggesting that this trait can be effectively utilized in selection programmes for developing early maturing cucumber genotypes.

The early harvesting behaviour of CBE CS 19 makes it a potentially useful donor for earliness. Interestingly, this genotype did not produce the highest fruit yield, emphasizing that earliness and productivity are not necessarily controlled by the same combination of traits. Similar diversity among bitter gourd genotypes for earliness and yield has been documented in germplasm evaluations. Genotypes that were promising for yield, while other lines were superior for flowering and related traits were identified in a study [4].

Genotypes	First male flower node	First female flower node	Number of male flowers/vine	Number of female flowers/vine	Sex ratio	No. of days taken for first harvest
CBE CS 05 (Paravai Local)	1.6	5.2	65.0	45.2	1.44:1	60.3
CBE CS 07 (Piraittur Local)	1.8	6.0	71.2	47.2	1.51:1	55.4
CBE CS 19 (Namanasamuthiram Local)	2.0	5.4	69.3	41.5	1.67:1	53.5
CBE CS 37 (Namakkal Local)	2.4	3.6	66.0	39.6	1.66:1	60.2
CBE CS 38 (Vadalur Local)	2.0	5.4	60.5	40.5	1.49:1	57.0
CD (0.05%)	0.84	0.72	1.60	0.71	0.42	0.76

Table 1: Flowering behaviour, sex expression and earliness of cucumber genotypes under sodic soil (Season I).

Genotypes	First male flower node	First female flower node	Number of male flowers /vine	Number of female flowers /vine	Sex ratio	No. of days taken for first harvest
CBE CS 05 (Paravai Local)	1.3	6.0	75.0	55.1	1.36:1	61.0
CBE CS 07 (Piraittur Local)	1.5	5.8	72.0	51.2	1.40:1	57.2
CBE CS 19 (Namanasamuthiram Local)	1.9	5.7	70.1	44.5	1.57:1	54.4
CBE CS 37 (Namakkal Local)	2.9	3.8	68.0	40.6	1.67:1	61.2
CBE CS 38 (Vadalur Local)	2.1	5.6	61.1	39.5	1.54:1	56.7
CD(0.05%)	0.80	0.69	1.55	0.82	0.57	0.69

Table 2: Flowering behaviour, sex expression, and earliness of cucumber genotypes under sodic soil (Season II).

Fruit characters, fruit yield and vine length of cucumber genotypes (Table 3 and 4)

Number of fruits per vine

The number of fruits per vine showed marked variation, ranging from 14.43 in CBE CS 19 to 20.00 in CBE CS 37. CBE CS 37 (Namakkal Local) recorded the maximum number of fruits (20.00/vine), followed by CBE CS 07 (16.29/vine) and CBE CS 38 (16.11/vine).

The superiority of CBE CS 37 for fruit number is particularly important because number of fruits per vine is one of the major yield-contributing traits in cucumber. Similar results were obtained by [6] where the number of fruits per vine had an important positive relationship with yield and identified it as the most important yield-attributing trait based on path analysis.

Similarly, studies on indigenous and exotic bitter gourd germplasm have reported positive correlations and direct effects of number of fruits per plant on yield, indicating that selection for higher fruit number can be effective for increasing productivity [8].

The present results are therefore in agreement with earlier findings, as CBE CS 37, which recorded the maximum number of fruits per vine, also produced the highest fruit yield.

Fruit length and fruit girth

Fruit length ranged from 20.0 cm in CBE CS 07 to 21.9 cm in CBE CS 19, while fruit girth varied from 5.3 cm in CBE CS 38 to 6.0 cm in CBE CS 07.

CBE CS 19 produced the longest fruits (21.9 cm), followed by CBE CS 38 (21.8 cm) and CBE CS 05 (21.2 cm). CBE CS 07 recorded the shortest fruits (20.0 cm), although it had the highest fruit girth (6.0 cm). These differences demonstrate that fruit shape and size characteristics varied independently among the genotypes.

Substantial variability for fruit length and fruit diameter has also been documented in bitter gourd germplasm. Genetic diversity studies have reported wide ranges for fruit length, fruit diameter and individual fruit weight, confirming that these traits provide useful morphological markers for distinguishing genotypes and selecting desirable materials.

Single fruit weight

Single fruit weight ranged from 91.0 to 154.0 g. CBE CS 38 (Vadalur Local) recorded the highest single fruit weight (154.0 g), followed by CBE CS 05 (149.2 g) and CBE CS 37 (144.2 g). The lowest fruit weight was recorded in CBE CS 07 (91.0 g).

The higher individual fruit weight of CBE CS 38 contributed to its comparatively high fruit yield despite producing fewer fruits than CBE CS 37. This observation emphasizes the importance of considering both fruit number and individual fruit weight while selecting superior genotypes.

High heritability and genetic advance for average fruit weight and a positive association between fruit weight and yield was observed in a study and path analysis further indicated that average fruit weight was one of the major contributors to yield after number of fruits per vine [6].

Similarly, genetic studies have reported high heritability for average fruit weight and fruit yield, suggesting that these traits can respond effectively to selection.

Fruit yield per vine

Fruit yield per vine showed the greatest practical difference among the genotypes. CBE CS 37 (Namakkal Local) recorded the highest fruit yield (2.88 kg/vine), followed by CBE CS 38 (2.48 kg/vine) and CBE CS 05 (2.22 kg/vine). The lowest yield was recorded in CBE CS 07 (1.48 kg/vine).

The superior performance of CBE CS 37 can be attributed primarily to its highest number of fruits per vine (20.00), combined with a relatively high single fruit weight (144.2 g). This combination resulted in its highest overall productivity.

The present finding is strongly supported by [6], who identified number of fruits per vine as the most important yield-attributing trait, followed by average fruit weight. They also reported positive associations of yield with number of fruits per vine, average fruit weight, vine length and fruit length.

Similarly, studies on bitter gourd genetic variability have demonstrated significant variation for yield per vine, number of fruits per vine and fruit weight and have suggested that these traits are important selection criteria for improving yield [2].

Vine length

Vine length varied from 137.2 cm in CBE CS 07 to 171.2 cm in CBE CS 37. The longest vine was recorded in CBE CS 37, which also recorded the highest number of fruits and fruit yield.

The positive association between vine vigour and yield observed in the present study is consistent with the findings of [6] who reported a positive and significant association between vine length and yield per vine.

However, vine length should be considered along with reproductive traits rather than as an independent selection criterion. Excessive vegetative growth may not always result in higher productivity. The present material, however, showed that CBE CS 37 combined greater vine length with higher fruit number and yield, suggesting that its vegetative vigour was effectively translated into reproductive productivity.

Genotypes	No. of fruits/ vine	Fruit length (cm)	Fruit girth (cm)	Single fruit weight (g)	Fruit yield/ vine (kg)	Vine length (cm)
CBE CS 05 (Paravai Local)	13.51	20.5	5.7	150.2	2.03	166.1
CBE CS 07 (Pirattur Local)	17.80	21.0	5.8	90.3	1.61	135.3
CBE CS 19 (Namanasamuthiram Local)	13.21	21.2	5.9	115.4	1.52	150.4
CBE CS 37 (Namakkal Local)	20.12	20.3	5.1	141.3	2.84	172.0
CBE CS 38 (Vadalur Local)	15.66	22.5	5.5	155.1	2.43	153.1
CD (0.05%)	0.82	0.95	0.64	0.81	0.69	1.20

Table 3: Fruit characters, fruit yield and vine length of cucumber genotypes under sodic soil (Season I).

Genotypes	No. of fruits/vine	Fruit length (cm)	Fruit girth (cm)	Single fruit weight (g)	Fruit yield/vine (g)	Vine length (cm)
CBE CS 05 (Paravai Local)	14.88	21.2	5.8	149.2	2.22	165.4
CBE CS 07 (Pirattur Local)	16.29	20.0	6.0	91.0	1.48	137.2
CBE CS 19 (Namanasamuthiram Local)	14.43	21.9	5.6	113.5	1.64	153.1
CBE CS 37 (Namakkal Local)	20.00	20.7	5.4	144.2	2.88	171.2
CBE CS 38 (Vadalur Local)	16.11	21.8	5.3	154.0	2.48	155.0
CD (0.05%)	0.90	0.99	0.67	0.89	0.71	1.13

Table 4: Fruit characters, fruit yield and vine length of cucumber genotypes under sodic soil (Season II).

Association of flowering traits with yield

An important observation from the present study was the contrasting performance of CBE CS 05 and CBE CS 37. CBE CS 05 had the highest number of female flowers and the lowest sex ratio, but CBE CS 37 produced the highest number of fruits and yield despite having fewer female flowers and the highest sex ratio.

This indicates that female flower number alone is not sufficient to determine final yield. Fruit set, fruit retention, fruit number and individual fruit weight also influence yield. The findings are consistent with correlation and path-analysis studies in bitter gourd, where number of fruits per vine and average fruit weight were identified as major determinants of yield.

Recent research has also shown that the genetic improvement of cucumber requires simultaneous consideration of sex expression, earliness, fruit number, fruit weight and yield, rather than selection based on a single character [3].

Overall performance of genotypes

Considering the flowering, earliness and yield attributes together, the five genotypes exhibited distinct strengths.

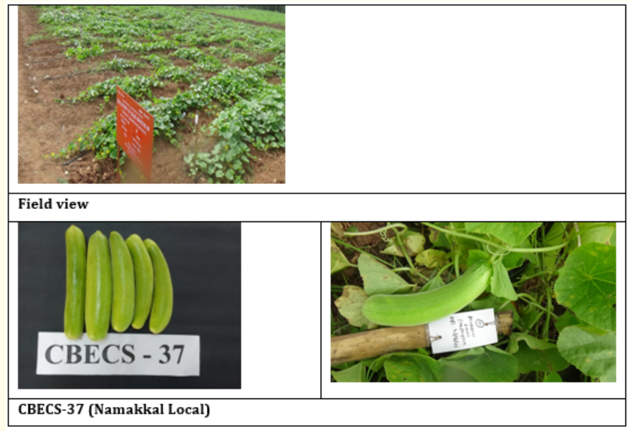
CBE CS 37 (Namakkal Local) has been observed to be the best genotype for productivity, recording the maximum number of fruits per vine (20.00), highest fruit yield (2.88 kg/vine) and longest vine (171.2 cm). Its high yield has been found to be associated with its superior fruit-bearing capacity and adequate individual fruit weight.

CBE CS 38 (Vadalur Local) was promising for fruit size and fruit weight, recording the highest single fruit weight (154.0 g), long fruits (21.8 cm) and high fruit yield (2.48 kg/vine).

CBE CS 05 (Paravai Local) was superior for favourable sex expression, with the highest number of female flowers (55.1/vine) and lowest sex ratio (1.36:1). It could therefore be useful as a parent for improving female flower production.

CBE CS 19 (Namanasamuthiram Local) was the most promising genotype for earliness, requiring only 54.4 days for first harvest. Its early maturity could be useful for breeding programmes targeting early production.

CBE CS 07 (Pirattur Local) recorded the highest fruit girth (6.0 cm) and relatively high fruit number, but its low single fruit weight resulted in the lowest fruit yield. Therefore, improvement of fruit weight would be necessary to enhance its productivity.



Figure

Conclusion

The present study indicates that CBE CS 37 should be prioritized for high-yield breeding, while CBE CS 05, CBE CS 19 and CBE CS 38 may serve as useful donors for favourable sex expression, earliness and high fruit weight, respectively. The existence of such contrasting desirable traits among the local genotypes provides useful genetic diversity for developing superior cucumber cultivars and hybrids under sodic soil.

Conflict of Interest

There is no financial interest or any conflict of interest.

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