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Design of experimental lily plantation in Sundarbans

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Abstract
An experiment is conducted in the Sundarbans delta region to determine if lilies can be successfully grown in the area. The experiment used a uniformity trial approach to evaluate the quality of the soil, and the results show that the coastal weather, frequent cyclonic storms, humid climate, and soil condition had little to no effect on the plantation. The statistical analysis of the data collected from the plantation site shows that all the plants have matured simultaneously, indicating that plantation of lilies in the Sundarbans Delta is environmentally feasible.

Keywords: Deltaic conditions, environmental feasibility test, lily, Sundarbans

Introduction

Once in full bloom, the peach-pink coloured lily flowers are truly a sight to behold [1]. Such a site can be seen on a small plot of land in the Kakdwip region of the Sundarbans delta [2]. The experiment was designed to mimic a uniformity trial. For context, a uniformity trial is an experiment that is conducted to ascertain the quality of the soil. Only a single variety of crops are used, and the type of treatment (fertilizer or manure) utilized is also one or none. Fertility contour maps are thereby created by computing the yield of different regions of the plot [3].

To remove biases, a fallow [4] row running through the middle of the plot was selected for the experiment. Lily seeds, sown as clusters at regular intervals (Figure 1), germinated with a germination rate close to 90% [5]. No treatment had been applied to the soil when sowing the seeds. Despite intensive care, some saplings were trampled upon by local stray dogs, cranes, and birds. Care of the plantation was also impossible during waterlogged monsoon seasons, and frequent cyclonic storms [2, 6, 7]. At present, the lily stems cluster densely together, attaining an average height of 2-2.5 feet. The row consists of a total of 11 clusters. Around 10 adult stems (Table 1) can be found in each cluster on average, each stem apexing into 3-5 lily blooms (Figure 2). The plantation, now, reveals a dense and stable flowering "lily-garden" having attained maturity after 5 years of growth period.

The application of statistical methods for a feasibility study is necessary to determine the environmental impact on the existing plants. Each cluster houses approximately 12 lily stems (Table 1). And the straight-line distance between the clusters is 1 m (Figure 1). For the entire 5 years of its lifetime, the plantation has not been treated with any fertilizer or manure. A lack of nutrients in the soil as well as an unsuitable climate may have different physicochemical effects on the clusters. To determine if all the clusters exhibit similar survival rate, statistical methods such as a test for goodness-of-fit pertain to the present study.

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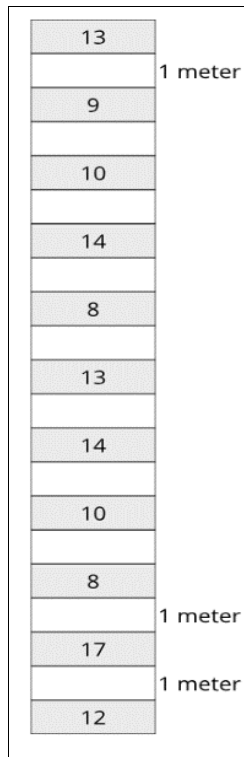**Nilabhra Rohan Das**
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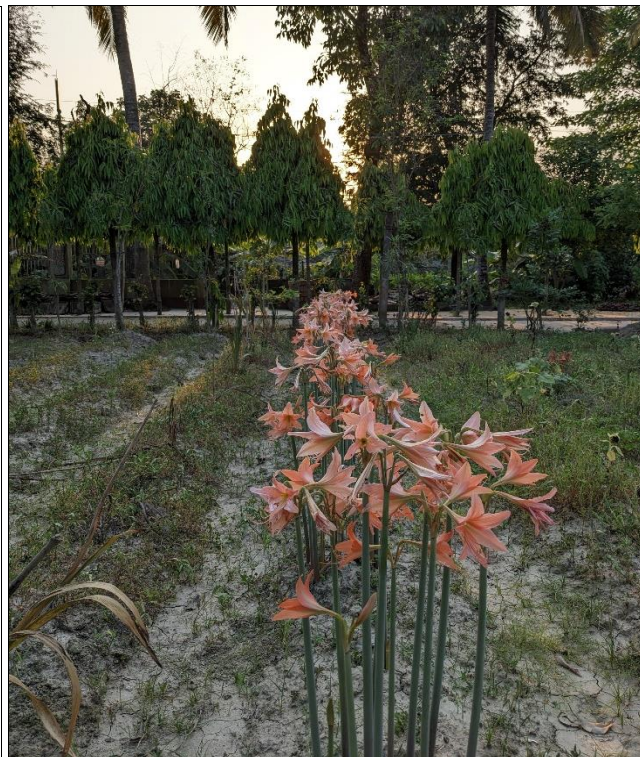
Fig 1: Design of the experiment.

Fig 2: The row of clusters of lily blooms.

Table 1: Observed number of lily stems in a cluster.

Cluster	Lily Stems		
	Adults	Infants	Total
1	11	1	12
2	16	1	17
3	8	0	8
4	8	2	10
5	14	0	14
6	13	0	13
7	6	2	8
8	13	1	14
9	10	0	10
10	8	1	9
11	13	0	13
Total	120	8	128
Mean	10.90909	0.727273	11.63636

Results and Discussion

The Chi Squared (χ^2) Test for Goodness of Fit is performed to test the null hypothesis (H_0) that the number of lily stems is the same in each cluster against the alternative hypothesis (H_1) that the null is not true.

The test statistic is given by $\chi^2 = \sum_{i=1}^{k} \frac{(O_i - E_i)^2}{E_i}$ where in the ith cluster,

O_i = Observed frequency (number of lily stems recorded in i^{th} cluster),

E_i = Expected frequency (mean number of lily stems per cluster),

k = Total number of clusters,

$$E = \frac{Total\ observed\ frequency}{Total\ number\ of\ clusters} = \frac{n}{k}$$

The χ^2 test statistic follows a χ^2 distribution with $(k-1)$ degrees of freedom [8].

Table 2: Computation of χ^2 test statistic.

Cluster	O	E	$\frac{(O-E)^2}{E}$
1	12	11.63636	0.011364
2	17	11.63636	2.472301
3	8	11.63636	1.136364
4	10	11.63636	0.230114
5	14	11.63636	0.480114
6	13	11.63636	0.159801
7	8	11.63636	1.136364
8	14	11.63636	0.480114
9	10	11.63636	0.230114
10	9	11.63636	0.597301
11	13	11.63636	0.159801
Total	128	128	7.09375

To test the hypotheses, both the adult and infant stems are considered together as mature plants to avoid complicacy of the computation.

The calculated χ^2 value comes out to be 7.09375 (Table 2). At α = 0.05 level of significance, the critical value of $\chi^2_{0.05,10} = 18.307$ for (k - 1 = 11 - 1 =) 10 degrees of freedom. Therefore, $\chi^2 = 7.09375 < 18.307 = \chi^2_{0.05,10}$. Based on the observed data, the test fails to reject the null hypothesis at the given level of significance. That is, the number of mature lily stems per cluster may be considered equal.

Conclusion

Generally found in the temperate regions of the globe in the northern hemisphere, lilies are not native to the deltaic region. Lilies thrive under the sun. The alkaline soil of the

Sundarbans along with the moist coastal climate [2] was a major concern of the experiment. However, the test for goodness of fit performed on the data collected from the plantation site of lilies reveals that all the plants have matured simultaneously. A failure of the test would have implied that each cluster could not support an equal number of lily plants. A large variance in the number of stems recorded in each cluster would have led to such a failure. However, the experiment shows that the coastal weather, frequent cyclonic storms, humid climate, and soil condition had little to no effect on the plantation leading to a hypothetical equality in the number of stems in each cluster with a high germination rate. Backed by the 5 years of survival of the plants in the present experimental setup, the result obtained from the statistical analysis provides solid ground for concluding that plantation of lilies in the Sundarbans Delta is environmentally feasible.

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