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Dragon Fruits And Strawberries In The Same Field, A New Paradigm In The Farming Of Sundarban, West Bengal, India

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Abstract

This study focuses on the successful mixed cultivation of exotic strawberries (Fragaria × ananassa) from the Rosaceae family and dragon fruits (Hylocereus lemairei) in the southern regions of the Sundarbans, West Bengal, India. By leveraging the available agricultural land in the challenging Sundarbans ecosystem, this innovative approach optimizes production through a harmonious mixed cropping system. A decade ago, strawberry farming was predominantly confined to the hill areas of India (Awasthi, 2010)[1]. The agricultural landscape in South 24 Parganas, Sundarbans, is undergoing a transformative shift with the simultaneous cultivation of dragon fruits and strawberries in the same field. This paper explores the evolving trend of this mixed cultivation system, with a specific focus on determining the optimal soil mixture through experimentation in various pots. The identified optimal soil mixture is then implemented in the field after successful trials in different parts of Sundarbans. Additionally, the paper discusses the benefits, challenges, and opportunities associated with this innovative farming model. By showcasing the advantages of integrating these two commercially viable crops and highlighting the refined soil mixture, the study aims to inspire farmers and stakeholders to adopt similar approaches. This collective effort contributes to the sustainability and economic prosperity of the Sundarbans region.

Key words: Dragon fruits, Sundarban, Strawberry,

Introduction:

The Sundarbans, a UNESCO World Heritage Site, is characterized by its intricate network of waterways, mangrove forests, and diverse wildlife. Traditional agriculture in this region primarily involves paddy cultivation and fishing. However, exploring alternative crops such as dragon fruits and strawberries could diversify the agricultural landscape, improve local livelihoods, and contribute to sustainable development.Strawberries are renowned for their luscious aroma and flavor. This sweet fruit is originally from temperate regions in the Northern Hemisphere but is now grown extensively across the globe. The principal objective of this eco-friendly approach is to boost the nutritional value of strawberries while

avoiding the harmful effects of chemical fertilizers. In this experiment, various biofertilizers, such as vermicompost, cow dung, cocopeat, and neem cakes, are employed in different proportions across experimental plots to determine the most effective method for commercial strawberry production.The soil mixture in set F comprises vermicompost, neem cake, cocopeat, bone dust and cow dung .The direct application of vermicompost significantly influences the essential elements, vitamins, and enzyme content of strawberries. Neem cake serves as a natural pesticide and soil pH regulator. It enriches the soil by providing micro and macronutrients and is a valuable source of nitrogen, phosphorus, and potassium. It plays a vital role in providing sustained nitrogen availability to the soil due to its nitrogen inhibitor properties, promoting better plant growth and development (Hashemimajd et al., 2004)[2]. Cocopeat enhances water retention and soil aeration, facilitating robust root growth and inhibiting weed growth (Solaimalai et al., 2001)[3]. Cow dung also enhances soil porosity and is rich in organic matter. Studies have shown that organically cultivated strawberries exhibit greater vegetative growth and increased yield compared to conventionally cultivated ones (Palomaki et al., 2002[4], Shehata et al., 2011[5]). The introduction of plant growth-promoting bio-fertilizers enhances the efficiency of organic manure utilization and stimulates strawberry growth and yield (Karlidag et al., 2009)[7]. Glinicki et al. (2011)[8] found that NPK fertilization combined with microbial inoculation has a positive impact on strawberry plant growth.Manickam (1993)[9] has reported that the combination of organic fertilizer with added nitrogen leads to increased plant yields. Adhikari et al. (1997)[10] observed a direct correlation between microbial activities and yield, which are affected by the declining organic status of the soil.Dragon fruit pulp has a high water content, is rich in fiber, and contains numerous nutrients, including vitamins, minerals, and antioxidants. Dragon fruit plants remain unproductive from December to May, during which time strawberries can be successfully cultivated as companion intercrops. Farmers adopting this companion cultivation system have been shown to generate higher income than those practicing sole cropping.

Materials and methods:

In this study, eight distinct soil mixtures, labeled A through H, were utilized for cultivating dragon fruits and strawberries. The mixtures were prepared in earthen pots measuring 25 cm in diameter and 30 cm in height. Each pot was filled with 10 kg of the designated soil mixture, and individual dragon fruit cuttings and strawberry plants were planted separately in each pot. Three sets were prepared for each soil mixture, and after being placed under a green shade net for one week, the pots were transferred to the experimental garden. The soil mixtures are detailed as follows:
Soil mixture A: Well-draining experimental field soil without any added compost, minerals, or chemical fertilizer.
Soil mixture B: A composition of 80% field soil and 20% chemical fertilizer.
Soil mixture C: A combination of 50% field soil and 50% vermicompost.
Soil mixture D: A blend of 50% field soil and 50% cocopeat.
Soil mixture E: A mixture of 50% field soil and 50% cow dung.
Soil mixture F: A combination of 50% field soil, 10% cow dung, 10% vermicompost, 10% cocopeat, 10% bone dust, and 10% neem cake.
Soil mixture G: A composition of 50% field soil and 50% neem cake.
Soil mixture H: A mixture of 50% field soil and 50% local garden soil.
Morphological parameters of dragon fruits, such as vegetative bud initiation, cladode dimensions, arch height, areola spacing, spine count, spine length, fruit dimensions, fruiting cycles, and fruit weight, were recorded at various growth stages. Similarly, strawberry plant parameters, including plant height, plant spread, leaf count, petiole length, and fruit dimensions, were documented. Regular care, encompassing irrigation, fertilization, and pest management, was administered to all plants to minimize confounding factors.

Measurements were initiated 90 days after planting (DAP), with subsequent readings taken at 90-day intervals. The data were subjected to analysis using one-way ANOVA and Tukey's HSD test.

Following transplantation, fungicide (Trichoderma sp) was sprayed at a rate of 2g per liter every 15 days in the morning. Additionally, vermicompost, cocopeat, cow dung, and neem cake were applied to the experimental pots every 15 days. Harvesting was limited to fully ripened fruits, with nylon nets employed to protect the fruits from birds. Furthermore, content analysis of the harvested fruits from both the experimental

field and the control set was conducted by the FSSAI-certified agency Prodcontrol India Private Limited, Kolkata.

Fig:1strawberry plant with stolon,flower and fruits.

Results and Discussion:

In this study, seven experimental pots with different treatments were organized into three sets, and the progress of plant growth and yield was consistently monitored. Various plant growth-related parameters such as plant height, plant spread, number of leaves, petiole length, and yield-related metrics like average fruit weight, number of fruits per plant, and fruit yield per plant were meticulously documented. These data were subjected to rigorous statistical analysis, enabling the deduction of logical conclusions.

Treatments	Plant height(cm)	Number of leaves	Petiole length(cm)	Plants spread(cm2)
Set-A Field soil(control)	8.2	6	5.3	69.69
Set B 80% field soil and 20% chemical fertilizer	9.7	10	6.7	103.09
Set C 50% field soil and 50% vermicompost	11.9	11	8.3	135.02
Set D 50% field soil and 50% cocopeat	8.1	7	5.9	108.9
Set E 50% field soil and 50% cow dung	15.6	12	11.1	367.81
Set F 50% field soil, 10% cow dung, 10% vermicompost, 10% cocopeat, 10% bone dust, and 10% neem cake.	20.1	20	12.3	459.45
Set G 50% field soil and 50% neem cake	15.4	9	10.4	154
Set H 50% field soil and 50% local garden soil	8.9	6	5.8	70.23

Table 1: Effect of different soil mixtures on Growth Parameters of strawberry after 90 days

Parameter	F-Statistic	P-Value	LSD
Plant Height	31.33	< 0.001	2.99
Number of Leaves	21.48	< 0.001	2.29
Petiole Length	26.62	< 0.001	2.68
Plants Spread	40.02	< 0.001	13.76

Table 2:statistical analysis of data

1. Plant height (cm):Set F has the highest mean plant height, significantly different from all other sets.Set E and Set C have the next highest means, followed by Set G and Set B.Set A and Set D have the lowest means.
2. Number of leaves:Set F has the highest mean number of leaves, significantly different from all other sets.Set C and Set E have the next highest means, followed by Set B and Set G.Set A and Set H have the lowest means.
3. Petiole length (cm):Set F has the highest mean petiole length, significantly different from all other sets.Set C and Set E have the next highest means, followed by Set G and Set B.Set A and Set D have the lowest means.
4. Plants spread (cm^2):Set F has the highest mean plant spread, significantly different from all other sets.Set E has the next highest mean, followed by Set D and Set C.Set G and Set B have higher means compared to Set A and Set H.

Based on the Tukey HSD test results, Set F consistently performs the best across all variables, making it the best treatment overall

Treatments	Length of fruits(cm)	Breadth of fruits(cm)	Number of fruits/plant	Weight (g)
Set-A Field soil(control)	2.35	2.05	12.32	6.24
Set B 80% field soil and 20% chemical fertilizer	3.52	3.35	18.23	10.34
Set C 50% field soil and 50% vermicompost	3.72	3.27	20.11	11.21
Set D 50% field soil and 50% cocopeat	3.12	2.87	21.12	10.85
Set E 50% field soil and 50% cow dung	3.82	3.24	22.34	11.32
Set F 50% field soil, 10% cow dung, 10% vermicompost, 10% cocopeat, 10% bone dust, and 10% neem cake.	4.65	4.00	26.34	12.21
Set G 50% field soil and 50% neem cake	3.35	2.83	20.32	10.37
Set H 50% field soil and 50% local garden soil	2.46	2.09	13.21	7.31

Table 3: Effect of different soil mixtures on yield of strawberry after 90 days

Variable	F-statistic	p-value	LSD (Least Significant Difference)
Length of fruits (cm)	60.813	< 0.001	0.717
Breadth of fruits (cm)	86.962	< 0.001	0.681
Number of fruits/plant	186.376	< 0.001	2.562
Weight (g)	38.551	< 0.001	0.906

Table 4: statistical analysis of data

1.Length of fruits (cm):
Set F has the highest mean length of fruits, significantly different from all other sets.
Set E and Set C have the next highest means, followed by Set B and Set G.Set A and Set D have the lowest means.
2.Breadth of fruits (cm):Set F has the highest mean breadth of fruits, significantly different from all other sets.Set C and Set B have the next highest means, followed by Set E and Set G.Set A and Set H have the lowest means.

3.Number of fruits/plants:Set F has the highest mean number of fruits per plant, significantly different from all other sets.Set E and Set C have the next highest means, followed by Set G and Set B.Set A and Set H have the lowest means.
4.Weight (g):Set F has the highest mean weight of fruits, significantly different from all other sets.
Set E and Set C have the next highest means, followed by Set G and Set B.Set A and Set H have the lowest means.Based on the Tukey HSD test results, Set F consistently performs the best across all variables, making it the best treatment overall.

DRAGON FRUITS:
VEGETATIVE GROWTH PARAMETERS:

Table: 5 showing the effect of different soil mixtures on vegetative growth of dragon fruits.

veg growth data	A	B	C	D	E	F	G	H
NVB	1	0	2	1	2	3	1	1
SCL	70.1	78.1	81.1	65.1	80.4	89.5	77.6	74.3
SCD	3.2	3.2	3.5	3.1	3.4	4.8	3.2	3.4
ARCH	2.56	2.8	2.7	2.6	2.7	2.8	2.6	2.55
DIST	2.5	3.2	2.71	2.5	2.5	2.51	2.5	2.61
SNUM	3	3	4	4	4	4	4	4
SLEN	3.64	3.71	3.6	4.1	4.2	4.5	4.1	3.81

NVB-No of Veg Bud Initiation,,SCL- Length of Secondary Cladode(cm),SCD- Cladode Width(cm), ARCH-Arch Height, DIST- Distance between Aerolas(cm), SNUM- Spine number,SLEN- Length of Spine (mm)

Morphological Parameter	**ANOVA Result**	**Conclusion**
NVB	F-statistic = 17.11, p-value = 0.001	significant difference in means.
SCL	F-statistic = 10.74, p-value = 0.001	significant difference in means.
SCD	F-statistic = 15.58, p-value = 0.0001	significant difference in means.
ARCH	F-statistic = 6.66, p-value = 0.001	significant difference in means.
DIST	F-statistic = 1.81, p-value = 0.120	no significant difference.
SNUM	F-statistic = 17.10, p-value = 0.001	significant difference in means.
SLEN	F-statistic = 17.03, p-value = 0.001	significant difference in means.

Table 6: statistical analysis of vegetative data.

FLOWER PARAMETERS:

	A	B	C	D	E	F	G	H
NFB	2	2.66	3	2	4	6	3	2
ALF	19.93	22.06	23	20.93	24.13	27.16	22.2	20.1
ADF	11.73	14.13	14.66	14.1	15.53	17.76	14.53	12.1
DTA	22.33	20.33	19.66	21.33	19.33	17	21.03	23.1
LOS	12.43	13.5	17.03	13	16.73	18.3	11.63	13.13

Table 7: showing the effect of different soil mixtures on flower characters of dragon fruits

NFB- No of Flower Buds, ALF- Average Length of Flower(cm), ADF – Average Diameter of the Flower (cm), DTA - Day to Anthesis,LOS- Length of Style(cm)

Flower Characteristic	ANOVA Result	Conclusion
NFB)	F-statistic = 8.89, p-value = 0.001	significant difference in means.
(ALF)	F-statistic = 9.43, p-value = 0.001	significant difference in means.
(ADF)	F-statistic = 6.96, p-value = 0.001	significant difference in means.
(DTA)	F-statistic = 6.11, p-value = 0.001	significant difference in means.
(LOS)	F-statistic = 3.35, p-value = 0.006	significant difference in means.

Table 8:statistical analysis of flower data.

FRUIT PARAMETER:

	A	B	C	D	E	F	G	H
ALF	7.33	8.03	10.26	8.03	9.23	15.06	10.26	9
FED	6.22	6.88	7.82	6.49	7.65	11.75	6.77	6.36
NOB	13.33	15	16	17	17	22	17	16
LAB	3.23	3.73	3.16	3.1	4.13	5.2	3.46	3.8
WBB	2.3	2.5	2.36	2.1	2.53	2.66	2.2	2.1
DAM	32.66	32	30	34	30.66	26	32	30
NFC	2	3	3	2	3	3	2	2
AFY	4	10.66	9.66	5	13	14	8	6
AFW	126	147.66	165	134.66	192.66	255.33	145	135

Table 9: Showing the effect of different soil mixtures on fruit characters of dragon fruits

ALF-Average Length of Fruit, FED-Fruit Equatorial Diameter, NOB-No of Bracts, LAB-Length of Apical Bract, WBB-Width of Base of the Bract ,DAM-Days from Anthesis to Maturity, NFC-No of Fruiting Cycle, AFY-Average Fruit Yield, AFW-Average Fruit Weight

Fruit Characteristic	ANOVA Result	Conclusion
ALF	F-statistic = 17.48, p-value = 0.001	significant difference in means.
FED	F-statistic = 6.63, p-value = 0.001	significant difference in means.
NOB	F-statistic = 20.03, p-value = 0.001	significant difference in means.
LAB	F-statistic = 8.16, p-value = 0.001	significant difference in means.
WBB	F-statistic = 5.68, p-value = 0.001	significant difference in means.
DAM	F-statistic = 5.90, p-value = 0.001	significant difference in means.
NFC	F-statistic = 10.90, p-value = 0.001	significant difference in means.
AFY	F-statistic = 16.56, p-value = 0.001	significant difference in means.
AFW	F-statistic = 16.68, p-value = 0.001	significant difference in means.

Table10:statistical analysis of fruit data.

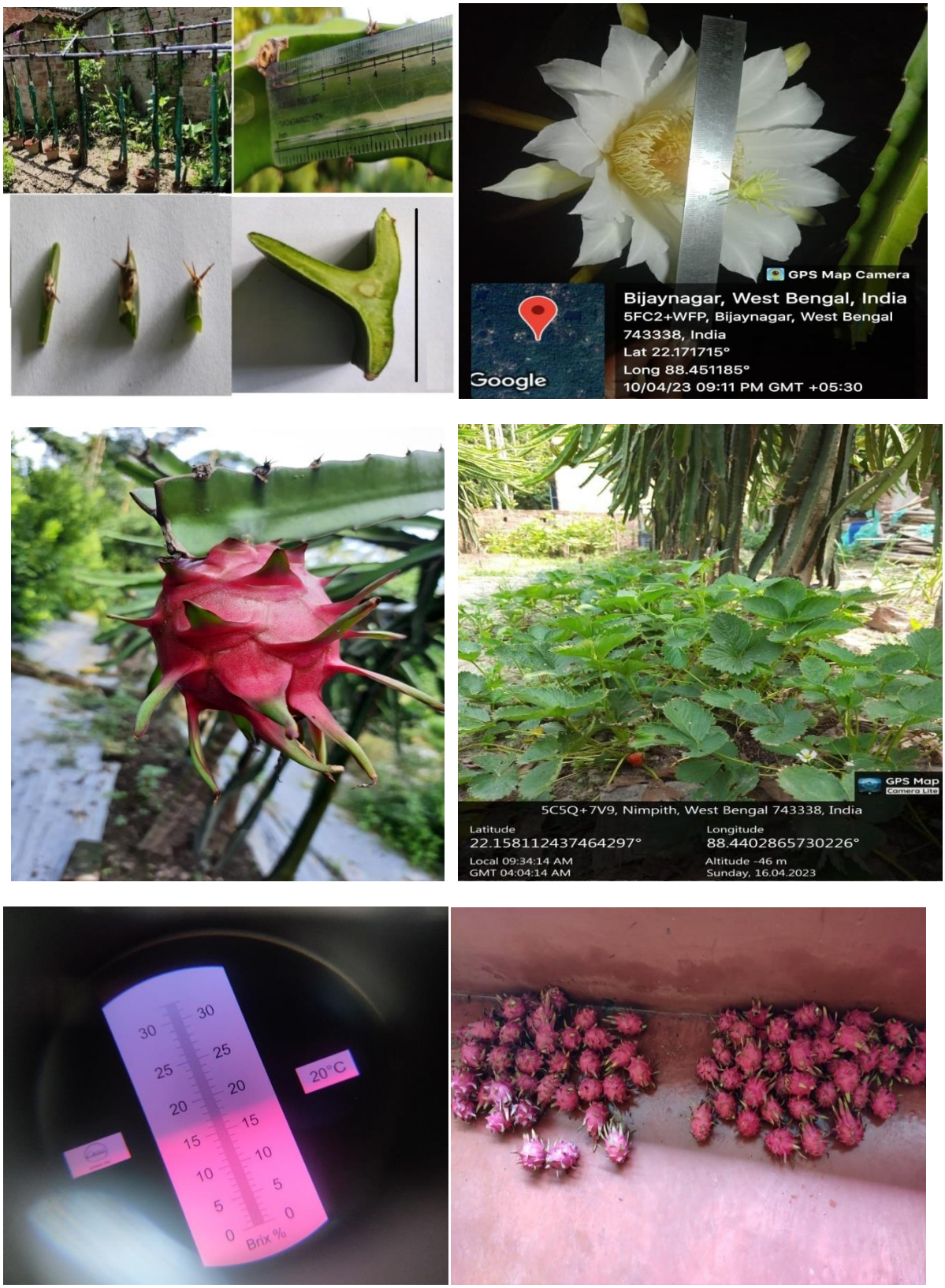

Fig 2: strawberry and dragon fruits in the same field.

NUTRITIONAL PARAMETERS AS PER REQUIREMENT				
Sl. No	Parameters under test	Unit/100g	Results	
			Experimental pot	Control
1	Moisture	%	87	11.2
2	Ash content	%	0.23	0.65
3	Total calorie, Kcal	Kcal	70	62
4	total fat	g	0.4	.38
5	saturated fat	g	0	0.51
6	Monounsaturated fat	g	0	0.066
7	Polyunsaturated fat	g	0	0.166
8	total carbohydrate	g	11	12
9	dietary fibre	g	6	2
10	Cholesterol	mg	0	0
11	protein	g	2	1.25
12	calcium	mg	8.5	9
13	sodium	mg	4	2
14	Magnesium	mg	16	10
15	Potassium	mg	10	0
16	Iron	mg	19	0.6
17	Phosphorous	mg	22.5	23
18	zinc	mg	NA	NA
19	vitamin C	mg	34.2	30
20	Vitamin B1	%	2.7	2.7
21	Vitamin B2	%	2.9	0.8
22	Vitamin B3	%	0.8	0.4
23	Sugar	g	11	9.1
24	TOTAL COLIFORMS	Cfu/g	ABSENT	ABSENT
25	MOULD & YEAST	Cfu/g	42	38
26	ESCHERICHIA COLI	Cfu/g	ABSENT	ABSENT
27	AEROBIC PLATE COUNT	Cfu/g	141	95

Table 11: Content analysis of dragon fruit from control and experimental pot

NUTRITIONAL PARAMETERS AS PER REQUIREMENT				
Sl. No	Parameters under test	Unit/100g	Results	
			Experimental pot	Control
1	Moisture	%	5.54	3.75
2	Ash content	%	0.12	0.36
3	Total calorie, Kcal	Kcal	49	32
4	total fat	g	0.6	2.5
5	saturated fat	g	0	0.7
6	Monounsaturated fat	g	0	0
7	Polyunsaturated fat	g	0	0
8	total carbohydrate	g	12	1.8
9	dietary fibre	g	3	0.5
10	Cholesterol	mg	0	0
11	protein	g	1	0.5
12	calcium	mg	2	1.2
13	sodium	mg	20	10
14	Magnesium	mg	13	11
15	Potassium	mg	153	100
16	Iron	mg	8	0.41
17	Phosphorous	mg	0	0
18	zinc	mg	NA	NA
19	vitamin C	mg	100	58.8
20	Vitamin A	%	1	0.5
21	Vitamin B2	%	0.8	0.125
22	Vitamin B3	%	0.4	0.022
23	Sugar	g	9	1
24	TOTAL COLIFORMS	Cfu/g	ABSENT	ABSENT
25	MOULD & YEAST	Cfu/g	25	45
26	ESCHERICHIA COLI	Cfu/g	ABSENT	ABSENT
27	AEROBIC PLATE COUNT	Cfu/g	110	56

Table 12: Content analysis of strawberry from control and experimental pot

The content analysis of the fruits collected from both the control and experimental pots revealed, comparative analysis of dietary fibre, protein, calcium, Sodium, magnesium, potassium, iron and the different vitamins. unit /100 gm of the fruit in the experimental set and control (Table 11 and 12).

Conclusion:

From the above data, it is revealed that vermicompost,neem cake,cocopeat,micronutrients and cow dung composition give the maximum outcome of both strawberry and dragon fruits. Both are exotic, neutraceutical and have medicinal value during non productive season of dragon fruits Strawberry could be taken up successfully as a companion crop.Fertilizer requirement and soil p.H are the same for the optimum growth of both plants.No need to prepare soil separately.After investment in the first year, they can get a return of up to 30 years.In the hostile ecosystem of Sundarban, natural calamities like flood and storm is very common every year. It has been proved that dragon fruit plants can withstand waterlogged conditions for up to 7 days using special techniques. Shortly, it is expected that both the neutraceutical fruits will lead the farmers to earn a good income and also prevent them from being migrant laborers.

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