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Akhilesh Kushwaha
 Ph.D Horticulture (Fruit Science), Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India

Saket Mishra
 Assistant Professor, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India

Vijay Bahadur
 Associate Professor and Head, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Akhilesh Kushwaha
 Ph.D Horticulture (Fruit Science), Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh, India

Effect of seaweed extract and biochar on growth and flowering of different variety of strawberry (*Fragaria X ananassa*) under Prayagraj agro-climatic conditions

Akhilesh Kushwaha, Saket Mishra and Vijay Bahadur

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Abstract

The present investigation entitled “Effect of Seaweed Extract and Biochar on Different Variety of Strawberry (*Fragaria X ananassa*) under Prayagraj Agro-climatic Conditions” was carried out during 2021-22 and 2022-23 at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Naini, Prayagraj was carried out with two factors having four of each in FRBD. The factors are Varieties (V1 - Winter Dawn, V2 - winter star, V3 - Sweet Charlie, V4 – Chandler) Organic Manures (M0 - No manures, M1 - Biochar 100%, M2 - Seaweed extract 100%, M3 - Biochar + seaweed extract 50:50%) which in combination makes 16 treatments. Among the treatments applied the combination of V1M3 (Winter Dawn + Biochar + Sea weed extract 50:50) was found to be best during 2021-22, 2022-23 and pooled data in terms of Plant height (17.23, 16.59 and 16.91) cm, Number of leaves (20.05, 19.03 and 19.14), Leaf area (12.19, 10.98 and 11.59), Number of runners (15.0, 13.0 and 14.0) Number of flowers (51.55, 48.43 and 49.72) and minimum number of days to 1st flowering (62.67, 59.33 and 61.0) days.

Keywords: Strawberry, seaweed extract, biochar, growth, and flowering etc.

Introduction

Fragaria x ananassa Duch., the current cultivated strawberry, is a hybrid crop resulting from the crossing of *Fragaria virginiana* and *Fragaria chiloensis*. Early Romans considered the strawberry (*Fragaria × ananassa*) to be the best fruit ever produced in history. Despite our culinary perception, the strawberry isn't quite a berry. Botanically, it's a "false fruit" or "aggregate accessory fruit." The juicy, red part we enjoy is actually the receptacle, the fleshy base that once held the tiny flowers. Each of the yellow "seeds" on the surface is actually a single-seeded fruit, called an achene.

Mulch plays a crucial role in strawberry cultivation. Various types of mulch, both synthetic and organic, are used across India based on climate and available materials. Organic mulches have also demonstrated positive effects on strawberry production (Hassan *et al.*, 2000) [15]. Strawberries are a highly coveted fruit, prized for their soft texture, appealing taste, and distinctive aroma. They are rich in vitamin C and iron and are primarily consumed fresh. Jams and syrups are also popular derivatives.

Biochar is a porous, carbonaceous material that is produced by pyrolysis of plant biomasses and is applied in such a way that the contained carbon remains stored as a long-term C sink or replaces fossil carbon in industrial manufacturing. Seaweeds, particularly brown algae like *Ascophyllum nodosum*, play a crucial role in coastal ecosystems expand more For centuries, farmers near coastlines have utilized them as a valuable source of organic matter for various soil types and crops expand more Seaweed application rates typically range from 0.2 to 1.5 kg solids per hectare, with early applications often proving most beneficial in aiding crops with temperature and disease stresses while maximizing yield potential.

Materials and Methods

The present investigation entitled “Effect of Seaweed Extract and Biochar on Different Variety of Strawberry (*Fragaria X ananassa*) under Prayagraj Agro-climatic Conditions”

was carried out during 2021-22 and 2022-23 at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Naini, Prayagraj was carried out with two factors having four of each in FRBD. The factors are Varieties (V1 - Winter Dawn, V2 - winter star, V3 - Sweet Charlie, V4 - Chandler) Organic Manures (M0 - No manures, M1 - Biochar 100%, M2 - Seaweed extract 100%, M3 - Biochar + seaweed extract 50:50%) which in combination makes 16 treatments. The research was carried out with the objectives of studying the effect of seaweed extract and biochar on growth and flowering of strawberry.

Data Collection

Five tagged plant were chosen from each treatment and the result were being recorded for the given growth and flowering parameters.

Results and Discussion

Plant Height

The maximum plant height (30, 60, 90 and 120 DAT) in pooled analysis was found in V₁M₃ (Winter Dawn + Biochar + Sea weed extract 50:50) with (7.06, 10.58, 13.91 & 16.91) cm and the minimum plant height was found in V₃M₃ (Sweet Charlie + Biochar + Sea weed extract 50:50) with (4.96, 8.86, 11.89 & 14.82) cm respectively. Seaweed extract and biochar is one of the most important tools for sustainable development. Seaweed extract are able to sidestep the nutrient deficiency in plants and provide the nutrients which are able to promote the growth of the plant (Aitken and Sen 1965). Seaweed extract and biochar have tendency to reduce the soil pollution caused by the anthropogenic activity. Biochar play very important role in improving the soil health which have a positive effect on the improving soil health, growth of the plant, yield of the produce and quality of the produce.

Number of Leaves

The maximum number of leaves (30, 60, 90 and 120 DAT) in pooled analysis was found in V₁M₃ (Winter Dawn + Biochar + Sea weed extract 50:50) with (7.58, 16.91, 15.87 & 19.14) and the minimum number of leaves was found in V₃M₃ (Sweet Charlie + Biochar + Sea weed extract 50:50) with (4.52, 14.82, 12.81 & 16.07) respectively. Number of leaves of strawberry might have been increased by the fact that at the given level of concentration and the combination of both the organic manures along with the interaction of particular variety have been significantly affected the vegetative growth such as number of leaves. Similarly (Hakkinen, 2000) ^[16] also reported that there are various types of seaweed like as liquid, powder and solid. When liquid seaweed fertilizers are sprayed on the plants it is absorbed by the leaves and ultimately increase the sink of the plant. The openings of stomata helps in the absorption of the liquid sprayed fertilizers and increase the photosynthates which further helps cell elongation and cell multiplication which leads to the secondary growth of the plants.

Leaf area

The maximum leaf area (30, 60, 90 and 120 DAT) in pooled analysis was found in V₁M₃ (Winter Dawn + Biochar + Sea weed extract 50:50) with (5.20, 8.59, 8.59, & 11.59) cm² and the minimum leaf area was found in V₃M₀ (Sweet

Charlie + Biochar + Sea weed extract 50:50) with (3.93, 7.32, 7.32, & 10.32) cm² respectively. Leaf area of strawberry might have been increased by the fact that at the given level of concentration and the combination of both the organic manures along with the interaction of particular variety have been significantly affected the vegetative growth such as number of leaves. Singh *et al.*, (2022) ^[17] published a report to demonstrate “that the application of biochar helps increase in soil pH, cation exchange capacity and organic carbon by 46%, 20% and 27% simultaneously”.

Number of Runners

The maximum number of runners during the course of the experiment in both years and pooled data was observed in the treatment V₁M₃ (Winter Dawn + Biochar + Sea weed extract 50:50) with 15.00, 13.00 and 14.00 runners which was followed by treatment V₁M₂ (Winter Dawn + Sea weed extract 100%) with 14.00, 12.00 and 13.00 runners which was statistically superior over the V₃M₀ (Sweet Charlie + Control) with 6.00, 4.23 and 5.12 number of runners.

The increase in numbers of runners might be due to the rapidly increase in the recalcitrant soil carbon fraction of soil it might be also due to the varying concentration of other element, base cations and the heavy metals. The readily available nutrients and small amounts of labile C retained in biochar could promote mineralization process. Higher nutrient availability for plant is the result of both the direct nutrient addition by the biochar and greater nutrient retention.

Number of flowers/plant

The maximum number of flowers/plant in pooled analysis was found in V₁M₃ (Winter Dawn + Biochar + Sea weed extract 50:50) with (49.72) and the minimum number of flowers/plant was found in V₃M₀ (Sweet Charlie + Biochar + Sea weed extract 50:50) with (36.83) respectively. The flowering parameters are significantly affected by the use of organic manures like as seaweed extract and biochar. The early days to flowering and fruiting might be possible due to the reason that the foliar application is readily available to the plants through stomatal opening which leads to rapid meiotic cell division which pathed a way to early flowering and fruiting of the strawberry, this was reported by Rathore *et al.*, in 2009 ^[18] in soyabean. Prajapati *et al.*, in 2016 ^[19] found that the application of seaweed extract at the rate of 10% helps in getting early harvest in potato.

Days to 1st Flowering

the minimum number taken for days to 1st flowering during the course of the experiment in both years and pooled data was observed in the treatment V₁M₃ (Winter Dawn + Biochar + Sea weed extract 50:50) with 62.67, 59.33 and 61.00 days which was followed by treatment V₁M₂ (Winter Dawn + Sea weed extract 100%) with 64.67, 61.00 and 62.83 days which was statistically superior over the V₃M₀ (Sweet Charlie + Control) with 73.67, 70.33 and 72.00 days. The biochar have always a significant role in diffusion of ions from soil to plant roots and cation exchange of the required ion reported by Omondi *et al.*, 2016 ^[20]. By the application of biochar it was also found that it improves the soil structure and soil texture which helps in the mass flow of the nutrients which are very useful in improving the flowering and fruiting parameters.

Table 1: Effect of Seaweed extract and Biochar on plant height of different variety of strawberry.

	Plant Height (cm)											
	30 DAT			60 DAT			90 DAT			120 DAT		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
V1	5.43	5.24	5.34	9.43	8.92	9.08	12.92	11.4	12.17	15.51	14.86	15.03
V2	4.68	4.49	4.59	8.67	8.17	8.41	12.17	10.66	11.42	14.76	14.12	14.4
V3	4.48	4.29	4.39	8.47	7.97	8.21	11.97	10.45	11.23	14.56	13.91	14.25
V4	5.24	5.05	5.15	9.23	8.73	8.95	12.73	11.22	11.98	15.32	14.67	15
F Test	S	S	S	S	S	S	S	S	S	S	S	S
SE(d)	0.12	0.32	0.19	0.28	0.31	0.29	0.43	0.42	0.45	0.52	0.53	0.51
CD@5%	0.24	0.64	0.38	0.56	0.62	0.58	0.86	0.84	0.9	1.04	1.06	1.02
M0	3.95	3.76	3.86	7.94	7.44	7.69	11.44	9.93	10.71	14.03	13.39	13.55
M1	4.64	4.45	4.55	8.545	8.045	8.3	12.13	10.62	11.38	14.72	14.08	14.36
M2	5.49	5.305	5.403	9.43	8.93	9.13	12.85	11.07	11.83	15.17	14.53	14.9
M3	5.73	5.545	5.64	9.44	9.35	9.17	13.36	11.41	12.18	15.52	14.88	15.17
F Test	S	S	S	S	S	S	S	S	S	S	S	S
SE(d)	0.13	0.16	0.18	0.15	0.19	0.21	0.22	0.23	0.25	0.28	0.27	0.21
CD@5%												
V X M												

Table 2: Effect of seaweed extract and biochar on number of leaves of different variety of strawberry.

	No. of leaves											
	30 DAT			60 DAT			90 DAT			120 DAT		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
V1	7.34	6.96	7.09	10.30	9.79	10.05	15.86	15.01	15.43	19.61	18.59	19.10
V2	6.72	6.35	6.52	9.73	9.19	9.46	15.24	14.41	14.83	18.97	17.98	18.48
V3	4.01	3.64	3.76	6.98	6.48	6.73	12.54	11.70	12.12	16.26	15.27	15.77
V4	5.38	5.01	5.19	8.35	7.84	8.09	13.91	13.05	13.48	17.65	16.63	17.14
F Test	S	S	S	S	S	S	S	S	S	S	S	S
SE(d)	0.15	0.13	0.14	0.23	0.25	0.27	0.31	0.33	0.36	0.39	0.42	0.43
CD@5%	0.32	0.27	0.29	0.48	0.53	0.57	0.65	0.69	0.76	0.82	0.88	0.90
M0	5.26	4.88	4.95	8.24	7.73	7.98	13.79	12.94	13.37	17.53	16.52	13.37
M1	5.70	5.31	5.49	8.66	8.16	8.41	14.22	13.37	13.80	17.93	16.95	16.96
M2	6.08	5.70	5.88	9.28	8.53	8.91	14.60	13.75	14.18	18.37	17.33	17.48
M3	6.41	6.04	6.23	9.18	8.89	9.03	14.94	14.10	14.52	18.65	17.67	17.79
F Test	S	S	S	S	S	S	S	S	S	S	S	S
SE(d)	0.16	0.15	0.11	0.18	0.19	0.23	0.46	0.48	0.49	0.52	0.53	0.52
CD@5%												
V X M												

Table 3: Effect of Seaweed extract and Biochar on leaf area of different variety of strawberry.

	Leaf Area (cm ²)											
	30 DAT			60 DAT			90 DAT			120 DAT		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
V1	3.13	2.78	1.99	5.17	4.73	4.90	8.59	8.08	8.34	11.94	10.73	11.28
V2	2.92	2.57	1.94	4.96	4.52	4.70	8.39	7.87	8.13	11.73	10.52	11.07
V3	1.91	1.55	1.65	3.95	3.50	3.72	7.38	6.85	7.11	10.73	9.50	10.08
V4	2.73	2.39	1.89	4.77	4.35	4.56	8.19	7.69	7.96	11.54	10.34	10.95
F Test	S	S	S	S	S	S	S	S	S	S	S	S
SE(d)	0.02	0.03	0.12	0.35	0.39	0.37	0.56	0.57	0.51	0.89	0.92	0.95
CD@5%	0.02	0.04	0.14	0.42	0.47	0.44	0.67	0.68	0.61	1.07	1.10	1.14
M0	2.43	2.08	1.80	4.47	4.03	4.18	7.89	7.38	7.64	11.24	10.03	10.58
M1	2.63	2.28	1.85	4.67	4.23	4.45	8.10	7.58	7.84	11.45	10.23	10.79
M2	2.76	2.40	1.89	4.80	4.35	4.55	8.22	7.70	7.96	11.57	10.35	10.92
M3	2.87	2.53	1.92	4.91	4.48	4.69	8.33	7.83	8.09	11.68	10.48	11.09
F Test	S	S	S	S	S	S	S	S	S	S	S	S
SE(d)	0.03	0.02	0.05	0.21	0.29	0.32	0.45	0.48	0.51	0.53	0.68	0.62
CD@5%												
V X M												

Table 4: Effect of seaweed extract and biochar on number of runners, no. of flowers/plant and days to 1st flowering of different variety of strawberry

	No. of runners			No. of flowers/plant			Days to 1 st flowering		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
V1	12.01	10.00	11.00	65.45	62.03	63.73	46.54	43.72	44.98
V2	9.56	7.73	8.61	68.79	65.16	66.91	36.82	33.82	35.28
V3	8.07	6.13	7.10	71.48	67.86	69.64	34.88	31.92	33.33
V4	11.37	9.25	10.31	66.23	62.73	64.45	42.31	39.25	40.75
F Test	S	S	S	S	S	S	S	S	S
SE(d)	0.98	0.95	0.96	1.35	1.56	1.68	1.12	1.34	1.56
CD@5%	1.18	1.14	1.15	1.62	1.87	2.02	1.34	1.60	1.87
M0	7.83	5.95	6.85	69.93	66.55	68.23	35.27	32.38	33.81
M1	9.56	7.58	8.54	68.78	65.25	66.96	39.99	36.87	38.31
M2	11.34	9.33	10.29	67.28	63.57	65.37	41.64	38.62	40.06
M3	12.30	10.25	11.25	65.96	62.41	64.16	43.64	40.84	42.17
F Test	S	S	S	S	S	S	S	S	S
SE(d)	0.95	0.92	0.93	1.43	1.45	1.41	1.23	1.42	1.62
CD@5%	1.24	1.20	1.21	1.86	1.89	1.83	1.60	1.85	2.11
V X M									

Conclusion

On the basis of our experimental finding it was concluded that the treatment V1M3 was found to be best in the terms of plant height, number of leaves, leaf area, number of flowering and days to first flowering. It can also be concluded that seaweed extract is good source of nutrients and biochar helps in the absorption of nutrient and also act as carbon sequestration which helps to lower the concentration of carbon in the atmosphere.

Future Prospect

Population explosion causes drastic change in the climate which leads to the change in the farming system. Therefore a need has aroused for the sustainable approach for farming so that we can save the soil and environment for the future use. Seaweed extract is a liquid organic fertilizer which contains all the essential nutrients required for the crop growth and development in a sustainable way. On the other hand biochar act as carbon sequestration which helps in reducing the carbon percentage in the environment. Biochar act as nutrient adsorbent and slowly releases the nutrients. Ultimately we can say that use of seaweed extract and biochar helps in promoting sustainable farming.

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