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Effect of Freshwater Algal Extracts as Foliar Applications on Biometric Parameters of Safflower (*Carthamus tinctorious* L.)

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Abstract

The present investigation demonstrates that freshwater algal extracts, particularly those collected from the Pravara Left Canal, exert a significant positive impact on the biometric parameters of Safflower (*Carthamus tinctorius* L.) when applied as foliar sprays. Among all treatments, the 20% algal extract combined with cow urine (T6) showed the maximum improvement in plant growth attributes, including number of leaves, leaf area, number of branches, and plant height, compared to both the control and other treatments.

The enhanced growth performance is attributed to the synergistic effect of bioactive compounds present in freshwater algae such as phytohormones, amino acids, vitamins and micronutrients along with the nutrient-rich composition of cow urine. Statistical analysis using two-way ANOVA confirmed that the observed differences were highly significant ($p < 0.05$), especially in the T6 treatment, indicating the strong potential of cow urine-enriched algal extracts as natural bio-stimulants. Furthermore, algal extracts from the Pravara Left Canal proved more effective than those from the Pravara River, possibly due to variations in species composition, nutrient content and ecological conditions. These findings are consistent with earlier studies reporting the beneficial role of algal extracts in enhancing the growth of various crops, including fenugreek, spinach, chilli, tomato and alfalfa.

The study concludes that locally available freshwater algae can serve as a cost-effective, eco-friendly alternative to chemical fertilizers. Integrating these natural bio-resources into sustainable agricultural practices could improve crop productivity, reduce chemical dependency and promote environmentally friendly farming systems in the Pravara River basin and other similar agro-ecological regions.

Key words: Biofertilizer, Algae, Safflower, Biometric parameters

Introduction

Agricultural productivity in India largely depends on the availability of nutrients, soil fertility, and sustainable management of natural resources. In recent years, the excessive use of chemical fertilizers has led to several problems, including soil degradation, water pollution, reduced soil microbial activity, and declining crop productivity. This has created an urgent need to explore eco-friendly and cost-effective alternatives to synthetic fertilizers to maintain soil health and achieve sustainable agricultural growth.

Freshwater algae, which are naturally abundant in rivers, canals, ponds, and other aquatic ecosystems, are rich sources of macro- and micronutrients, phytohormones, vitamins, amino acids, and bioactive compounds that can significantly enhance plant growth and productivity. Several studies have reported that algal extracts act as natural bio-stimulants, improving seed germination, chlorophyll content, root-shoot development, nutrient uptake, and overall yield. However, the potential of freshwater algal extracts from rivers and canals in semi-arid regions like the Pravara River Basin of Ahilyanagar District, Maharashtra, remains largely unexplored.

The Pravara River and its Left Canal provide a suitable habitat for diverse algal communities, but their role as a natural resource for bio-fertilizer development has not been systematically investigated. Moreover, farmers in the Pravara Basin primarily reliable on chemical fertilizers for crop production, which increases the cost of cultivation and negatively impacts environmental sustainability. Therefore, there is a need to evaluate the effect of freshwater algal extracts collected from the Pravara River Basin as foliar applications on the biometric parameters of plants. Understanding how these extracts influence plant height, leaf area, root development, and total biomass will provide scientific insights into their potential as eco-friendly bio-fertilizers. Such research can help promote sustainable agriculture, reduce dependency on chemical inputs, and improve crop productivity in the region.

Materials and Methods

1. Collection of Fresh Water Algae

Freshwater algae were collected from the designated study area, specifically from the canals and rivers of Rahata tehsil, Ahmednagar district. To ensure the quality and integrity of the samples, algae were carefully handpicked from the water bodies. Subsequently, the collected algae were thoroughly washed with running tap water to remove any unwanted impurities, soil particles, and debris.

Following the cleaning process, the algae samples collected from different locations were carefully stored in separate, sterile plastic bags of suitable sizes to prevent contamination and mixing of samples. The bags were then sealed and transported to the laboratory for further processing and analysis. This meticulous collection and handling procedure helped ensure the accuracy and reliability of the subsequent experiments.

2. Preparation of Algal Powder

The washed algal samples collected from the river and canal were separately subjected to shade drying in the laboratory, ensuring that the delicate algal cells were not exposed to direct sunlight or high temperatures. This gentle drying process helped preserve the biochemical integrity of the algae.

Once the algal samples were completely dry, they were ground into a fine powder using a mechanical grinder, as described by Aher and Wabale (2019). This powdering process helped increase the surface area of the algae, facilitating the extraction of bioactive compounds.

The resulting algal powder was stored in airtight plastic containers to maintain its quality and prevent contamination. These containers were then sealed and labeled, ready for further use in the preparation of algal extracts. The ultimate goal of this process was to investigate the potential of these algal extracts as a liquid biofertilizers, exploring their ability to promote plant growth and development.

3. Preparation of Algal extracts

To investigate the impact of algae on the growth and development of safflower, two types of extracts were prepared using Indian breed Khillar cattle urine and aqueous solutions. Specifically, 10 grams of algal powder were mixed with 100 ml of cow urine and aqueous solutions separately, and then boiled down to a final volume of 10 ml. This process helped to concentrate the bioactive compounds present in the algae.

Six distinct treatments were prepared in glass bottles, each with a specific composition:

- T1: Control (Distilled Water)
- T2: Control Cow Urine 20%
- T3: Aqueous Algal Extract (Pravara River) 20%
- T4: Cow Urine + Algal Extract (Pravara River) 20%

- T5: Aqueous Algal Extract (Pravara Canal) 20%
- T6: Cow Urine + Algal Extract (Pravara Canal) 20%

These treatments were then used for spraying on the experimental plot, allowing for a comprehensive evaluation of the effects of algae on safflower growth and development.

4. Testing the effect of liquid biofertilizer on safflower

Following the preparation of the algal extracts, safflower seeds were subjected to a 12-hour soaking treatment in the various concentrations. This soaking process allowed the seeds to absorb the bioactive compounds present in the algal extracts, potentially enhancing their germination and growth.

The soaked seeds were then sown in the experimental plot, which was designed to accommodate six treatments with four replications each. This experimental design enabled the researchers to evaluate the effects of the different algal extract treatments on safflower growth and development.

In addition to the seed soaking treatment, the plants in the experimental plot also received a liquid spray of the six treatments. This spray treatment was applied to the plants to provide an additional source of nutrients and bioactive compounds, potentially enhancing their growth and development.

5. Field experiment:

A field experiment was conducted at the Arts, Commerce, and Science College, Satral, during the Rabi season of 2020. The experiment aimed to evaluate the effects of different algal extract treatments on the growth and development of safflower.

The experiment was designed using a Factorial Randomized Block Design (RBD), which allowed for the evaluation of six treatments on safflower, replicated four times. This design enabled the researchers to minimize experimental error, account for any variability in the experimental conditions, and accurately assess the treatment effects.

Foliar sprays of the six treatments were applied to the safflower plants at 15-day intervals, ensuring that the plants received a consistent and controlled dose of the algal extracts. This application schedule allowed the researchers to assess the cumulative effects of the treatments on safflower growth and development over the course of the experiment.

Result and Discussion

Fresh water algal extracts of Pravara River and Pravara left canal command area were prepared with distilled water and cow urine. From both the area samples 20% algal extract from Pravara left canal in combination with cow urine showed significant positive results on biometric observations than that of Pravara River i.e. Number of leaves, leaf area, number of branches and height of the plant.

Number of leaves:

Table 1: Effect of fresh water algal extract on number of leaves of Safflower (*Carthamus tinctorius* L.)

Treatment	30 DAS	60 DAS	90 DAS
T1	**27.00**	**57.33**	**58.00**
T2	31.00	77.66	82.66
T3	33.00	78.33	96.33
T4	35.66	86.33	99.66
T5	34.33	88.00	108.00
T6	**36.33**	**93.33**	**124.00**

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	2453.497	5	490.6993	5.087038477	0.0141	3.325835
Columns	12557.5	2	6278.75	65.09126687	0.0000	4.102821
Error	964.6071	10	96.46071			
Total	**15975.6**	**17**				

T1 (Control DW) showed 27 leaves per plant after 30 DAS, 57.33 at 60 DAS and 58 after 90 DAS. T2 (Control-20% CU) reported 31 leaves per plant after 30 DAS, 77.66 at 60 DAS and 82.66 after 90 DAS. T3 (20 % Aqueous algal extract-Pravara river) showed 33 number of leaves at 30 DAS, 78.33 at 60 DAS and 96.33 at 90 DAS respectively.

T4 (20% Cow urine algal extract –Pravara river) showed 35.66 number of leaves at 30 DAS, 86.33 at 60 DAS and 99.66 at 90 DAS. In T5 (Aqueous algal extract –Pravara left canal) number of leaves recorded was 34.33 at 30 DAS, 88 at 60 DAS and 108 at 90 DAS. T6 (20 % cow urine algal extract – Pravara canal) showed 36.33 number of leaves at 30 DAS, 93.33 at 60 DAS and 124 at 90 DAS.

The above results predicted that minimum number of leaves was obtained in T1 treatment whereas maximum was reported in the T6 treatment i.e. 58 after 90 DAS and 124 at 90 DAS. From the above data, it is predicted that maximum number of leaves is enhanced due to the use of algal extract in combination with cow urine than that of only algal extract. It was also reported that number of leaves was enhanced by the use of algal species collected from Pravara left canal than that of Pravara River, in both aqueous algal extract as well as cow urine algal extract samples. The two way anova reported significant results.The results obtained by Abhang (2009), 33.57% (Fenugreek), 59.53% (Spinach), 41.23% (Chilli) and 26.16% (Tomato) increase in total number of leaves treated with blue-green algal extracts which was more over the commercial doses. Patil (2010) revealed that, the treatment of *Enteromorphaintermedia* extract showed superior results regarding number of leaves (82.40) succeeded by *Charazeylanica*(74.80), *Cladophora crispate* extracts (70.84) and commercial dose (68.30) in Fenugreek.

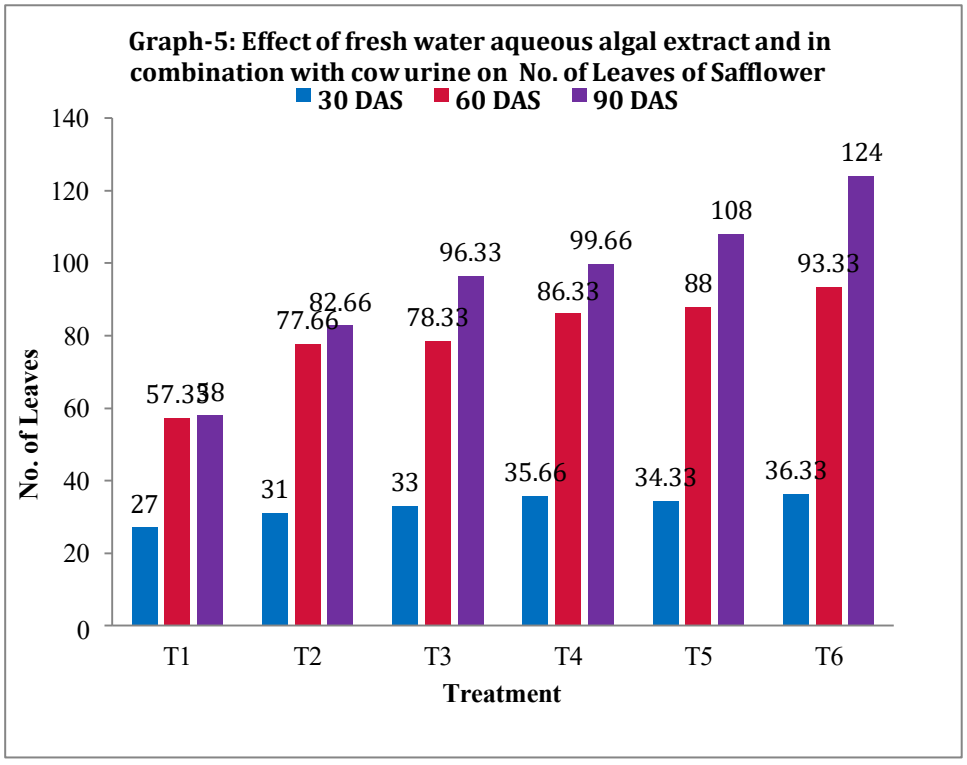


Table-2: Effect of fresh water algal extract on leaf area (cm^2) of Safflower (*Carthamus tinctorius* L.)

	30 DAS	60 DAS
T1	16.33	35.33
T2	23.16	54.33
T3	25.33	56.83
T4	35.16	72
T5	26.83	58.16
T6	43.33	85.16

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	1739.083	5	347.8167	11.97616	0.008228	5.050329
Columns	3061.449	1	3061.449	105.413	0.000151	6.607891
Error	145.2121	5	29.04242			
Total	4945.744	11				

Leaf Area:

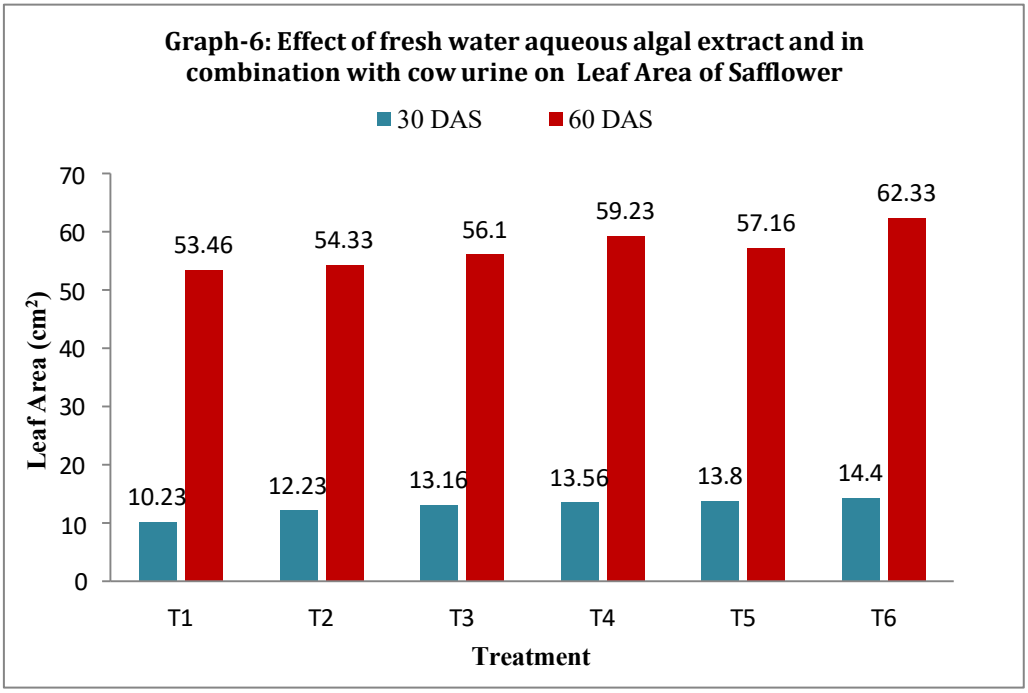
T1 (Control- DW) showed 10.23 cm^2 leaf area after 30 DAS and 35.33 cm^2 leaf area after 60 DAS. T2 (Control-20% CU) reported 23.16 cm^2 leaf area after 30 DAS and 54.33 cm^2 leaf area after 60 DAS. T3 (20 % Aqueous algal extract-Pravara river) showed 25.33 cm^2 leaf area at 30 DAS and 56.83 cm^2 leaf area at 60 DAS respectively.

T4 (20% Cow urine algal extract –Pravara river) showed 35.16 cm^2 leaf area at 30 DAS and 72.00cm^2 leaf area at 60 DAS. In T5 (Aqueous algal extract –Pravara left canal) 26.83 cm^2 leaf area at 30 DAS and 58.16 cm^2 leaf area at 60 DAS was recorded whereas T6 (20 % cow urine algal extract – Pravara Left Canal) 43.33 cm^2 leaf area at 30 DAS and 85.16 cm^2 leaf area at 60 DAS was found.

The above results predicted that minimum leaf area was obtained in T1 treatment where as maximum was reported in the T6 treatment i.e.16.33 cm^2 leaf area after 30 DAS and 85.16 cm^2 leaf area after 60 DAS.

From the above data, it is predicted that maximum leaf area is enhanced due to the use of algal extract in combination with cow urine than that of only algal extract. It was also reported that leaf area was enhanced by the use of algal species collected from Pravara left canal than that of Pravara River, in both aqueous algal extract as well as cow urine algal extract samples. The two way anova reported significant results.

The results obtained by Crouch *et al*., (1992) showed maximum increase in leaf area in tomato plants treated with 1.0% concentration of seaweed. Beckett *et al*., (1994) studied the effects of Kelpak on the yield of *Phaseolus aculifolius* Gray. and found a significant increase in leaf area (51.97%) in 0.2% seaweed concentrate (Kelpak). They observed a 62.17% increase in the leaf area of the plant by using 0.2% Kelpak. However they did not notice any significant difference in leaf area at low concentrations of nutrient solution (5% and 1%). Sekar *et al.*, (1995) *Vignaunguiculata* L. (Walp.) recorded double leaf area, by using 0.25% seaweed extract of *Ulvalactuka*as liquid fertilizer.



No. of Branches:

Table-3: Effect of fresh water algal extract on number of branches of Safflower (*Carthamus tinctorius* L.)

Treatment	60 DAS	90 DAS
T1	**10.33**	**11.33**
T2	13.00	14.00
T3	15.33	16.33
T4	19.66	20.66
T5	17.33	18.66
T6	**20.33**	**21.66**

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	154.8349	5	31	2132.711662	0.00	5.050329
Columns	3.6963	1	3.7	254.5661157	0.00	6.607891
Error	0.0726	5	0.01			
Total	**158.6038**	**11**				

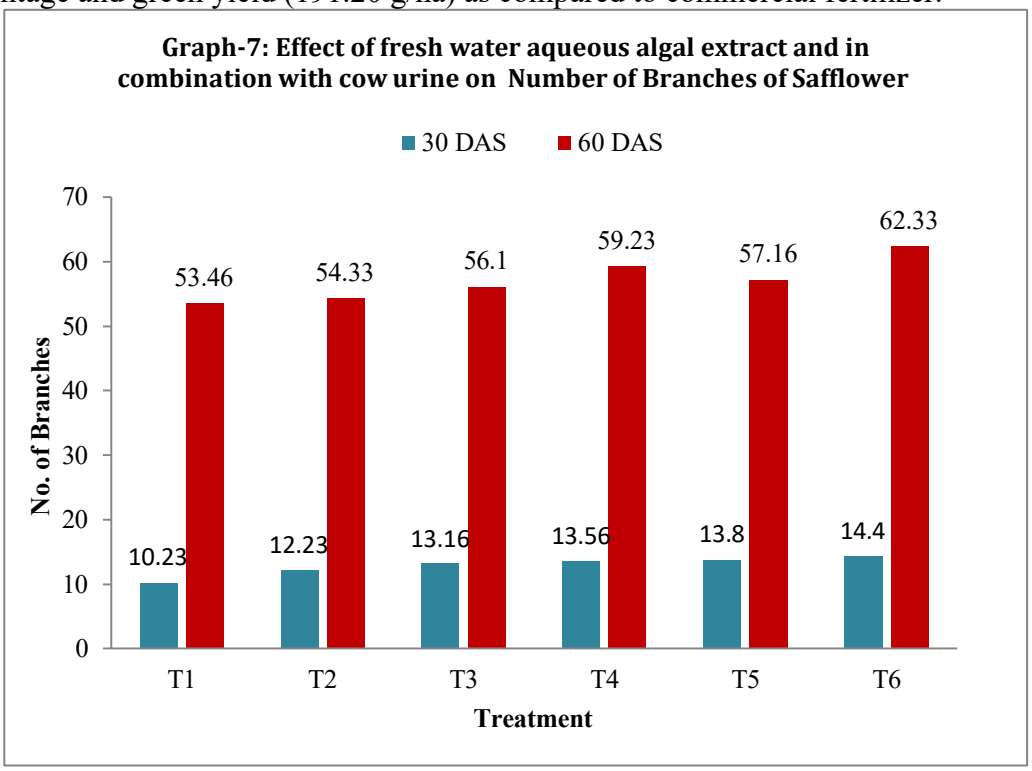
T1 (CW) showed 10.23 numbers of branches after 60 DAS and 11.33 after 90 DAS. T2 (Control-20% CU) reported 13 number of branches after 60 DAS and 14 number of branches after 90 DAS. T3 (20 % Aqueous algal extract-Pravara river) showed 15.33 number of branches at 60 DAS and 16.33 at 90 DAS respectively.

T4 (20% Cow urine algal extract –Pravara river) showed 19.66 number of branches at 60 DAS and 20.66 at 90 DAS. In T5 (Aqueous algal extract –Pravara left canal) number of branches was recorded 17.33 at 60 DAS and 18.66 at 90 DAS. T6 (20 % cow urine algal extract – Pravara Left Canal) 20.33 number of branches at 60 DAS and 21.66 at 90 DAS was found.

Results predicted that minimum number of branches was obtained in T1 treatment where as maximum was reported in the T6 treatment i.e.11.33 after 60 DAS and 21.66 at

90 DAS. From the above data, it is predicted that maximum number of branches is enhanced due to the use of cow urine and algal extract in combination than that of only algal extract. It was also reported that number of branches was enhanced by the use of algal species collected from Pravara left canal than that of Pravara River, in both aqueous algal extract as well as cow urine algal extract samples. The two way anova reported significant results.

Similar results were obtained by Abhang and Pingle (2012) on effect of foliar application of BGA extract on growth and yield of Fenugreek (*Trigonella foenum-graecum* L.) var. Kasturi. They shows that application of *Scytonema millei* extract recorded highest plant height, no. of branches, no. of leaves, leaf area, fresh and dry weight, moisture percentage and green yield (191.20 g/ha) as compared to commercial fertilizer.



Graph-7: Effect of fresh water aqueous algal extract and in combination with cow urine on Number of Branches of Safflower

Plant Height:

Table-4: Effect of fresh water algal extract on plant height (cm) of Safflower (*Carthamus tinctorius* L.)

Treatment	30 DAS	60 DAS
T1	**10.23**	**53.46**
T2	12.23	54.33
T3	13.16	56.10
T4	13.56	59.23
T5	13.80	57.16
T6	**14.40**	**62.33**

ANOVA

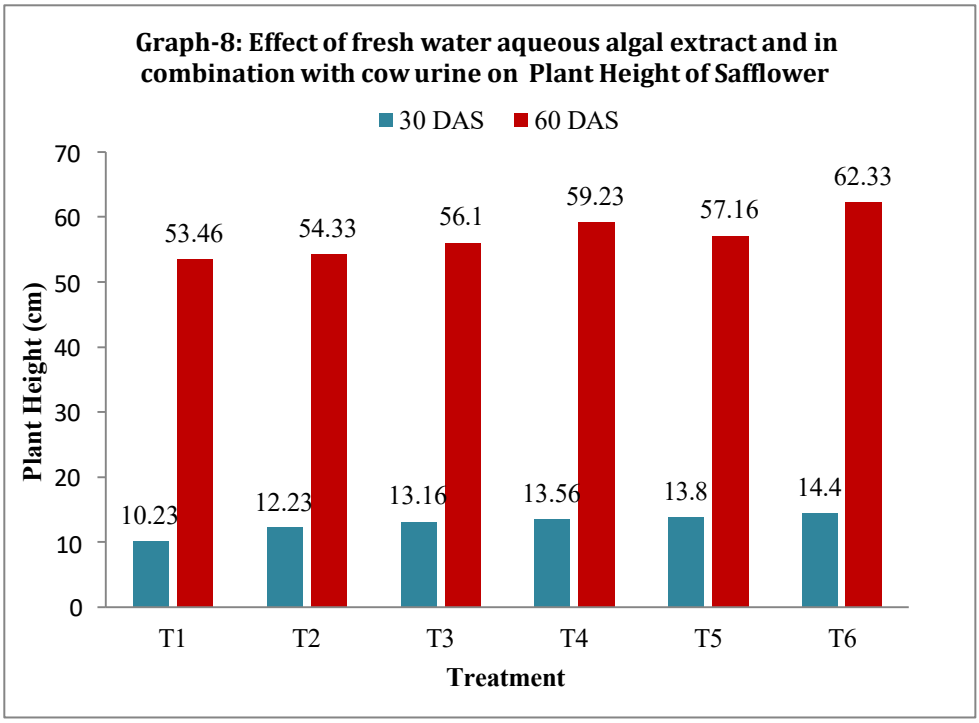
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	53.09794	5	10.61959	4.477486	0.06	5.050329
Columns	5862.246	1	5862.246	2471.67	0.00	6.607891

Error	11.85887	5	2.371775
Total	5927.203	11	

T1 (Control- DW) showed 10.23 cm of plant height after 30 DAS and 53.46 cm after 60 DAS. T2 (Control-20% CU) reported 12.23 cm of plant height after 30 DAS and 54.33 cm plant height after 60 DAS. T3 (20 % Aqueous algal extract-Pravara river) showed 13.16 cm of plant height at 30 DAS and 56.1 at 60 DAS respectively.

T4 (20% Cow urine algal extract –Pravara river) showed plant height of 13.56cm at 30 DAS and 59.23 cm at 60 DAS. In T5 (Aqueous algal extract –Pravara left canal) plant height was recorded 13.8cm at 30 DAS and 57.16cmat 60 DAS. In T6 (20 % cow urine algal extract – Pravara left canal) 14.4 cm plant height at 30 DAS and 62.33 cm at 60 DAS was found.

The above results predicted that minimum plant height was obtained in T1 treatment where as maximum was reported in the T6 treatment i.e.53.46cm after 30 DAS and 62.33 cm after 60 DAS. From the above data, it is predicted that maximum plant height is enhanced due to the use of cow urine and algal extract in combination than that of only algal extract. It was also reported that plant height was enhanced by the use of algal species collected from Pravara left canal than that of Pravara River, in both aqueous algal extract as well as cow urine algal extract samples. The two way anova reported significant results.



Conclusion

The present investigation clearly demonstrates that freshwater algal extracts, particularly those collected from the Pravara Left Canal, have a significant positive impact on the biometric parameters of safflower (Carthamus tinctorius L.) when applied as foliar sprays. Among all treatments, the 20% algal extract prepared in combination with cow urine (T6) showed the highest improvement in plant growth characteristics, including the number of leaves, leaf area, number of branches, and plant height, compared to both the control and other treatments. The enhanced growth performance can be attributed to the

synergistic effect of the bioactive compounds present in freshwater algae—such as phytohormones, amino acids, vitamins, and micronutrients—together with the nutrient-rich composition of cow urine. The statistical analysis (Two-way ANOVA) confirmed that these effects were highly significant, especially in T6 treatment, indicating the potential of cow urine-enriched algal extracts as bio-stimulants.

Furthermore, algal extracts derived from the Pravara Left Canal proved to be more effective than those from the Pravara River, suggesting possible variations in algal species composition, nutrient content, and environmental factors. These findings are supported by earlier studies, which also reported positive influences of algal extracts on various crops, including fenugreek, spinach, chilli, tomato, and alfalfa. The study establishes that locally available freshwater algae can serve as a cost-effective, eco-friendly alternative to chemical fertilizers. Integrating these natural bio-resources into agricultural practices could help enhance crop productivity, reduce chemical dependency, and promote sustainable farming systems in the Pravara River Basin and other similar agro-ecological regions.

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