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Influence of seaweed extract granules and humic acid granules on growth parameters of buckwheat (*Fagopyrum esculentum* Moench)

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Abstract

A present investigation was carried out during the *Rabi Season* of 2024 at Himalayan University farm, Jollang, Itanagar, to evaluate the influence of seaweed extract granules and humic acid granules on productivity and quality of buckwheat (*Fagopyrum esculentum* Moench.) The experiment was laid out in a Randomized Block Design (RBD) with eight treatments and three replication. The study recorded significance difference among treatments in terms of plant height, leaf length, leaf width, and dry weight at 30, 60 and 90 DAS. The result revealed that the treatment T₅ – 100% RDF + SWEG @ 40 kg/ha significantly outperformed other treatments in terms of plant height, leaf length, leaf width, and dry weight, thus indicating the synergistic role of 100% RDF + SWEG @ 40kg/ha in enhancing crop performance.

Keywords: Seaweed Extract Granules (SWEG), Humic Acid Granules (HAG), Buckwheat, Recommended Dose of Fertilizer (RDF), Randomized block Design (RBD)

1. Introduction

Buckwheat (*fagopyrum esculentum* Moench) is a fast-growing, short-duration pseudocereal belonging to the family polygonaceae, is a nutritionally valuable and climate - resilient crop widely cultivated in temperate and subtropical regions of Asia and Europe. Unlike true cereals, buckwheat is a dicotyledonous crop with a short growth duration (70-90 days), making it highly suitable for inclusion in crop rotation and contingency cropping system, particularly in hill and tribal agriculture. It is specially grown in ecological fragile and low-input zones in northeastern states of India, including Arunachal Pradesh, Sikkim, and parts of Uttarakhand and Himachal Pradesh (Campbell, 1997; Joshi *et al.*, 2011) ^[3, 10].

Buckwheat is known for its superior nutritional quality compared to conventional cereal. It is a rich source of high-quality protein containing all essential amino acids, including lysine and arginine, which are often deficient in cereal protein (Ikeda *et al.*, 1999) ^[9]. Additionally, buckwheat grain are gluten-free, high in dietary fiber, and are known to contain bioactive compounds such as rutin and quercetin, which exhibit antioxidant, anti-inflammatory, and anticarcinogenic properties (Li & Zhang, 2001; Fabian *et al.*, 2003; Alvarez-Jubete *et al.*, 2009) ^[13, 1].

In terms of agronomy, buckwheat requires minimal input and is tolerant to poor soils, drought, and marginal conditions. However its productivity remains suboptimal due to poor soil fertility, lack of improved agronomic practices, and limited use of bioenhancers. To address these constraints, sustainable and eco-friendly agronomic interventions like Seaweed Extract Granules (SWEG) and Humic Acid Granules (HAG) are gaining attention for their potential in improving crop performance under low-input systems.

Seaweed extract have been widely used in agriculture as natural biostimulants due to their rich content of plant growth regulators (auxins, cytokinins, gibberellins), amino acids, vitamins, and trace minerals (Bhosale *et al.*, 2020) ^[2]. Extracts from marine macroalgae such as *Ascophyllum nodosum*, *Sargassum*, and *Kappaphycus* have been found to improve germination, root growth, photosynthetic efficiency, and overall plant biomass in various crops including cereals and vegetables (Verkleij, 1992; Khan *et al.*, 2009) ^[21, 11].

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SWEG, as a granular formulation of seaweed extract, offers ease of application, controlled release, and longer field efficacy compared to foliar sprays. In cereals and pseudocereals like buckwheat, SWEG has been associated with enhanced root and shoot vigor, nutrient uptake, and yield parameters when applied either as a basal dose or during early vegetative growth (Kumar *et al.*, 2019) ^[12]. Seaweed bioactives also enhance plant defense mechanisms and stress tolerance, especially under water-deficient and nutrient-deficient conditions (Sharma *et al.*, 2014) ^[19].

Humic substances, particularly humic acids, are complex organic molecules derived from the microbial decomposition of plant and animal residues. They are major components of soil organic matter and have been recognized for their positive influence on soil structure, nutrient availability, and microbial activity (Nardi *et al.*, 2002) ^[14]. HAG formulations, which deliver humic acid in granular form, enhance soil cation exchange capacity, stimulate root elongation, and improve nutrient uptake, particularly of phosphorus, iron, and micronutrients (Canellas *et al.*, 2008) ^[4]. When used in pseudocereals like buckwheat, HAG helps to maintain pH balance, enhance water holding capacity, and promotes better nutrient use efficiency, especially under low-fertility or degraded soils (Sharif *et al.*, 2002; Selim *et al.*, 2013) ^[18].

2. Materials and Methods

The experiment was carried out at agriculture field, Jollang, college of Agriculture, Himalayan University, during the period of Rabi season. The experimental farm is situated at 27.074684 N latitude and 93.652878 E longitude with an average elevation

of 320 meters. It was undertaken with the objective to analyze the different buckwheat varieties and to assess their performance in Rabi season. The treatment include, T₁- Control, T₂- 100% RDF, T₃- 100% RDF + SWEG @ 20 kg/ha, T₄- 100 RDF + SWEG @ 30 kg/ha, T₅- 100% RDF + SWEG @ 40 kg/ha, T₆- 80% RDF + HAG @ 20 kg/ha, T₇- 80% RDF + HAG @ 30 kg/ha, T₈- 80% RDF + HAG @ 40 kg/ha. The experimental design was carried out in Randomized Block Design with three row replication. Each replication consisted of eight different plots where seeds were treated with the respective treatments. Standard agronomic practices were followed throughout the cropping season to ensure optimal crop management.

2.1 Weather and Climate

The climatic condition of Jollang was humid subtropical climate with moderate temperature ranging from 12°C and 28°C during the cropping season. The crop was sown on October 28 2024 during Rabi season. The relative humidity levels remained same, averaging between 70- 80%. The site received light to moderate post-monsoon rainfall during the experimental period of 90-120 mm, The region received an average of 5 to 8 hours of bright sunshine per day, contributing to enhanced photosynthetic activity and overall crop vigor. The mean minimum and maximum temperature recorded during the cropping season was 10.4 °C and 25.8 °C, respectively. The meterological data of weather parameters recorded during the period of experimentation from October to February of the year 2024-2025 were obtained from meterological observatory and have been presented in the table.

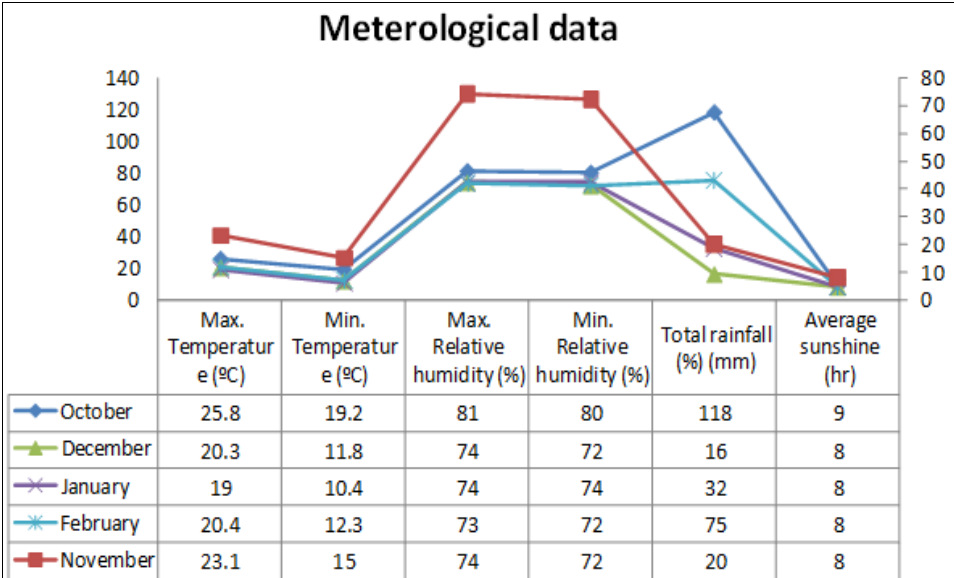


Fig 1: Meterological data of weather parameters and total rainfall during the cropping season (Rabi 2024-2025)

2.2 Crop Growth Parameters

Plant height

Plant height was taken in cm from the growth level to the tip of the plant from randomly selected 5 (five) plants in each individual plot and these plants were tagged for subsequent observation. A total of 5 (five) observation 30 DAS, 60 DAS and 90 DAS were recorded from the same plants in each plot and the average height of plant in each treatment was worked out for each observation.

Leaf length

Leaf length was measured from the base to the tip of the leaf on

5 randomly selected plants in each plot. These plants were tagged and measured again later. Observations were taken at 30, 60, and 90 days after sowing (DAS), and the average leaf length for each treatment was calculated at each time point.

Width of the leaf

The leaf width is measured by positioning the caliper at the widest point of the leaf and taking the measurement across it. This was done on 5 randomly selected plants from each plot. Observations were recorded at 30, 60, and 90 days after sowing (DAS), and the average leaf width was calculated for each time point.

Dry weight

The dry weight of a plant is the weight of the plant after all its water content has been removed. This is usually achieved by heating the plant material at a temperature above normal room temperature until all the moisture has been dried out.

3. Results and Discussion

The growth and development parameters of buckwheat were recorded under a Randomized Block Design (RBD) with three replications. Observations were taken for various traits such as plant height (cm), leaf length, Leaf width and dry weight. The data were statistically analyzed to compute the general mean, standard error difference (SED), and critical difference (CD) for each trait.

3.1 Plant height (cm) 30, 60, 90 DAS

Plant height of Buckwheat were recorded at 30, 60, and 90 DAS was statistically analyzed and presented in table.

At 30 days after sowing (DAS), the greatest plant height was observed in treatment T₅, which included 100% recommended dose of fertilizers (RDF) along with SWEG at 40 kg/ha, resulting in an average height of 65.9 cm. Treatment T₄, consisting of 100% RDF and SWEG at 30 kg/ha, produced a height of 64 cm, with no significant difference compared to T₅. The shortest plants, measuring 59.8 cm, were recorded in the control treatment (T₁), which did not receive any additional inputs.

At 60 DAS, the greatest plant height was observed to be statistically significant in treatment T₅ which included 100% recommended dose of fertilizers (RDF) along with SWEG at 40 kg/ha, resulting in average height of 111.5 cm. and T₄ consisting of 100% RDF and SWEG at 30 kg/ha, giving an average height of 109.3 cm. The shortest plants, measuring 92.8 cm, were recorded in the control treatment (T₁), which did not receive any additional inputs.

At 90 days after sowing (DAS), the greatest plant height was observed in treatment T₅ which included 100% recommended dose of fertilizer (RDF) along with SWEG at 40 kg/ha, which showed a significant increase in plant height with an average of 150.9 cm, and then followed by T₄ consisting of 100% RDF and SWEG at 30 kg/ha, with 148.6 cm, indicating the promotive effect of Seaweed extract granules on early vegetative growth through enhanced cell elongation and division. The lowest plant height was observed in T₁ (control), which recorded only 123.6 cm, due to the absence of any treatment, resulting in slower growth and lesser vigor during the early stage.

The maximum plant height was observed in T₂ 100% RDF + SWEG @ 40 kg/ha, where as the minimum occurred in T₁ (Control). The enhanced plant height in T₅ is largely attributed to the role of 100% RDF and SWEG at 40 kg/ha in stimulating cell division and cell elongation, particularly in stem internodes. Application of Seaweed extract granules increases plant height by 15-22% in buckwheat when applied twice at vegetative and flowering stage (Sharma *et al.*, 2021)^[19].

In contrast, the control treatment (T₁) recorded the lowest plant height, likely due to the absence of any organic agent. Seeds under this treatment experience slower germination and limited growth potential, resulting in weaker shoot development and shorter plants. The reduced height reflects lower physiological activity and suboptimal resource utilization.

Table 1: Effect of Seaweed extract and Humic acid granules on plant height of Buckwheat

Treatment	Plant height (cm)		
	30 DAS	60 DAS	90 DAS
T ₁ - Control	59.8	92.8	123.6
T ₂ - 100% RDF	61.7	103.2	128.4
T ₃ - 100% + SWEG @ 20kg/ha	63.5	106.1	142.8
T ₄ - 100% RDF + SWEG @ 30kg/ha	64	109.3	148.6
T ₅ - 100% RDF + SWEG @ 40kg/ha	65.9	111.5	150.9
T ₆ - 80% RDF + HAG @ 20kg/ha	63	105.06	140.4
T ₇ - 80% RDF + HAG @ 30kg/ha	62.1	104.1	130.4
T ₈ - 80% RDF + HAG @ 40kg/ha	60.7	101.6	127.4
F test	S	S	S
S.Ed±	0.841979	2.982509	1.593103
CD (P=0.05)	1.805865	6.396845	3.416865

3.2 Leaf length (cm) 30, 60, 90 DAS

Plant leaf length of Buckwheat were recorded at 30, 60, and 90 DAS was statistically analyzed and presented in table.

At 30 days after sowing (DAS), the highest plant leaf length was observed in treatment T₅ (100% RDF + SWEG @ 40 kg/ha, which showed a significant increase in plant height with an average of 8.8 cm and then followed by T₄ (100% RDF + SWEG @ 30 kg/ha) with 8.2 cm, indicating the promotive effect of Seaweed extract granules on early vegetative growth through enhanced cell elongation and division. The lowest plant height was observed in T₁ (Control), which recorded only 4.3 cm, due to the absence of any treatment, resulting in slower growth and lesser vigor during the early stage.

At 60 days after sowing (DAS), the highest plant leaf length was observed in treatment T₅ (100% RDF + SWEG @ 40 kg/ha), which showed a significant increase in plant height with an average of 12.4 cm, and then followed by T₄ (100% RDF + SWEG @ 30 kg/ha) with 11 cm, indicating the promotive effect of Seaweed extract granules on early vegetative growth through enhanced cell elongation and division. The lowest plant height was observed in T₁ (Control), which recorded only 6.9 cm, due to the absence of any seed treatment, resulting in slower growth and lesser vigor during the early stage.

At 90 days after sowing (DAS), the highest plant leaf length was observed in treatment T₅ (100% RDF + SWEG @ 40 kg/ha), which showed a significant increase in plant height with an average of 12.7 cm, and followed by T₄ (100% RDF + SWEG @ 30 kg/ha), with 11.3 cm, indicating the promotive effect of Seaweed extract granules on early vegetative growth through enhanced cell elongation and division. The lowest plant height was observed in T₁ (Control), which recorded only 7.3 cm, due to the absence of any seed treatment, resulting in slower growth and lesser vigor during the early stage.

The maximum leaf length was recorded under T₅ (100% RDF + SWEG @ 40 kg/ha), while the minimum was observed in T₁ (Control). The increased leaf length under 100% RDF + SWEG at 40 kg/ha treatment may be attributed to its strong role in promoting cell elongation and intercellular expansion in the leaf lamina. The application of Seaweed extract granules has been reported to significantly enhance leaf length in buckwheat due to its rich composition of phytohormones and micronutrients (Khan *et al.*, 2009)^[11].

Absence of any treatment or amendments (T₁), buckwheat under control conditions generally exhibits significantly lower leaf length compared to treated plots, indicating the limited physiological response and reduced nutrient uptake in untreated plants.

Table 2: Effect of Seaweed extract and Humic acid granules on leaf length of Buckwheat

Treatments	Leaf length (cm)		
	30 DAS	60 DAS	90 DAS
T ₁ - Control	4.3	6.9	7.3
T ₂ – 100% RDF	6.7	8.4	8.9
T ₃ – 100% RDF + SWEG @ 20kg/ha	7.5	9.7	10.1
T ₄ – 100% RDF + SWEG @ 30kg/ha	8.2	11	11.3
T ₅ - 100% RDF + SWEG @ 40kg/ha	8.8	12.4	12.7
T ₆ – 80% RDF + HAG @ 20kg/ha	7	8.9	9.1
T ₇ – 80% RDF + HAG @ 30kg/ha	7.3	10.1	10.3
T ₈ – 80% RDF + HAG @ 40kg/ha	7.6	10.9	11.4
F test	S	S	S
S.Ed±	1.47E-07	0.095743	0.087287
CD (P=0.05)	3.16E-07	0.205348	0.187212

3.3 Leaf width (cm) 30, 60, 90 DAS

Leaf width of Buckwheat were recorded at 30, 60, and 90 DAS was statistically analyzed and presented in table.

At 30 days after sowing (DAS), the greatest width leaves was observed in treatment T₅ (100% RDF + SWEG @ 40 kg/ha), which showed a significant increase in plant height with an average of 4.3 cm, and followed by T₄ (100% RDF + SWEG @ 30 kg/ha), with 3.8 cm, indicating the promotive effect of Seaweed extract granules on early vegetative growth through enhanced cell elongation and division. The lowest plant height was observed in T₁ (Control), which recorded only 2.03 cm, due to the absence of any seed treatment, resulting in slower growth and lesser vigor during the early stage.

At 60 days after sowing (DAS), the greatest width leaves was observed in treatment T₅ (100% RDF + SWEG @ 40 kg/ha), which showed a significant increase in plant height with an average of 6.1 cm. and then followed by T₄ (100% RDF + SWEG @ 30 kg/ha), with 5.6 cm, indicating the promotive effect of Seaweed extract granules on early vegetative growth through enhanced cell elongation and division. The lowest plant height was observed in T₁ (Control), which recorded only 3.2 cm, due to the absence of any seed treatment, resulting in slower growth and lesser vigor during the early stage.

At 90 days after sowing (DAS), the greatest width of leaves was observed in treatment T₅ (100% RDF + SWEG @ 40 kg/ha), which showed a significant increase in plant height with an average of 6.3 cm, and followed by T₄ (100% RDF + SWEG @ 30 kg/ha), with 5.8 cm, indicating the promotive effect of Seaweed extract granules on early vegetative growth through enhanced cell elongation and division. The lowest plant height was observed in T₁ (control), which recorded only 3.5 cm, due to the absence of any seed treatment, resulting in slower growth and lesser vigor during the early stage.

The widest leaves were recorded in T₅ (100% RDF + SWEG @ 40 kg/ha), where as the narrowest leaves were observed in T₁ (Control). The application of Seaweed extract granules has been reported to significantly enhance the leaf width of buckwheat, as it promotes cell division, leaf expansion, and chlorophyll synthesis due to the presence of natural growth hormones and micronutrients.

In contrast, the control group showed restricted leaf expansion due to limited hormonal stimulation. The smaller width in T₁ is due to the absence of biostimulant or organic amendments like Seaweed extract or Humic acid resulted in reduced vegetative growth parameters, including leaf width.

Table 3: Effect of Seaweed extract and Humic acid granules on width of leaves

Treatments	Width of leaves		
	30 DAS	60 DAS	90 DAS
T ₁ - Control	2.03	3.2	3.5
T ₂ – 100% RDF	2.6	4.1	4.4
T ₃ – 100% RDF + SWEG @ 20kg/ha	3.2	4.8	5
T ₄ – 100% RDF + SWEG @ 30kg/ha	3.8	5.6	5.8
T ₅ - 100% RDF + SWEG @ 40kg/ha	4.3	6.1	6.3
T ₆ – 80% RDF + HAG @ 20kg/ha	2.8	4.4	4.6
T ₇ – 80% RDF + HAG @ 30kg/ha	3.4	5	5.2
T ₈ – 80% RDF + HAG @ 40kg/ha	3.6	5.4	5.7
F test	S	S	S
S.Ed±	0.060749	0.016667	0.057735
CD (P=0.05)	0.130294	0.035746	0.123829

3.4 Dry Weight (kg/ha) 30, 60, 90 DAS

Dry weight of buckwheat crop recorded after 30, 60, 90 DAS and this was statistically analyzed and presented in table.

At 30 days after sowing (DAS), the greatest dry weight was observed in treatment T₅ (100% RDF + SWEG @ 40 kg/ha), which showed a significant increase in plant with an average of 5.7 kg/ha, and followed by T₄ (100% RDF + SWEG @ 30 kg/ha), with 5.6 kg/ha, indicating the promotive effect of Seaweed extract granules on early vegetative growth through enhanced cell elongation and division. The lowest plant height was observed in T₁ (Control), which recorded only 3.1, due to the absence of any seed treatment, resulting in slower growth and lesser vigor during the early stage.

At 60 days after sowing (DAS), the greatest dry weight was observed in treatment T₅ (100% RDF + SWEG @ 40 kg/ha), which showed a significant increase in plant height with an average of 9.6 kg/ha, and then followed by T₄ (100% RDF + SWEG @ 30 kg/ha), with 9.2 kg/ha, indicating the promotive effect of Seaweed extract granules on early vegetative growth through enhanced cell elongation and division. The lowest plant height was observed in T₁ (Control), which recorded only 3.5 kg/ha, due to the absence of any seed treatment, resulting in slower growth and lesser vigor during the early stage.

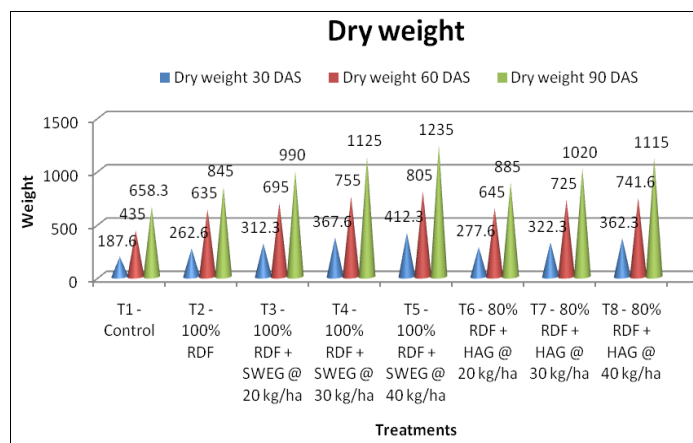
At 90 days after sowing (DAS), the greatest dry weight was observed in treatment T₅ (100% RDF + SWEG @ 40 kg/ha), which showed a significant increase in plant height with an average of 15.2/ha, and then followed by T₄ (100% RDF + SWEG @ 30 kg/ha), with 13.9 kg/ha, indicating the promotive effect of Seaweed extract granules on early vegetative growth through enhanced cell elongation and division. The lowest plant height was observed in T₁ (Control), which recorded only 5.9 kg/ha, due to the absence of any seed treatment, resulting in slower growth and lesser vigor during the early stage.

The highest dry weight was observed in T₅ (100% RDF + SWEG @ 40 kg/ha), while the lowest was recorded in T₁ (control). The application of Seaweed extract granules has been reported to significantly enhance the dry weight of buckwheat due to improved nutrient uptake, root development, and photosynthetic efficiency (Das *et al.*, 2023).

On the other hand, plants grown under T₁ (Control), where no seed treatment was applied, showed reduced dry weight. Sah observed the lowest dry weight of buckwheat under control treatment, where no external inputs like fertilizers or biostimulants were applied. This was attributed to limited nutrient availability and poor physiological response in untreated plots.

Table 4: Effect of Seaweed extract and Humic acid granules on Dry Weight

Treatments	30DAS (kg/ha)	60DAS (kg/ha)	90DAS (kg/ha)
T ₁ - Control	187.6	435	658.3
T ₂ - 100% RDF	262.6	635	845
T ₃ - 100% RDF + SWEG @ 20kg/ha	312.3	695	990
T ₄ - 100% RDF + SWEG @ 30kg/ha	367.6	755	1125
T ₅ - 100% RDF + SWEG @ 40kg/ha	412.3	805	1235
T ₆ - 80% RDF + HAG @ 20kg/ha	277.6	645	885
T ₇ - 80% RDF + HAG @ 30kg/ha	322.3	725	1020
T ₈ - 80% RDF + HAG @ 40kg/ha	362.3	741.6	1115
F test	S	S	S
S.Ed±	0.25198	1.66667	1.66667
CD (P=0.05)	0.54044	3.57464	3.57464

**Fig 2:** Effect of different treatment of Seaweed extract granules and Humic acid granules on dry weight of Buckwheat

4. Conclusion

The present investigation revealed that the combined application of 100% Recommended Dose of Fertilizer (RDF) along with Seaweed Extract Granules (SWEG) at 40 kg/ha significantly enhanced the growth, yield attributes, and overall productivity of buckwheat (*Fagopyrum esculentum* Moench) under the agro-climatic conditions of Jollang, Itanagar during the Rabi season. Among all the treatments, 100% RDF + SWEG @ 40 kg/ha (T₅), consistently recorded the highest values for plant height (150.9 cm), leaf length (12.7 cm), leaf width (6.3 cm) and dry weight (1235 kg/ha) at 90 DAS, demonstrating its superior performance. This integrated nutrient management approach effectively improved soil-plant health, resulting in better crop establishment and yield potential. Therefore, the combination of 100% RDF with SWEG at 40 kg/ha can be recommended as the most effective and sustainable nutrient management practice for enhancing buckwheat cultivation in similar agro-ecological zones.

5. References

- Alvarez-Jubete L, Arendt EK, Gallagher E. Nutritive value of pseudocereals and their increasing use as functional gluten-free ingredients. *Trends Food Sci Technol*. 2009;20(11-12):581-90.
- Bhosale PS, Patil AA, Kadam MR. Seaweed extracts: A sustainable plant growth regulator. *J Pharmacogn Phytochem*. 2020;9(4):1355-9.
- Campbell CG. Buckwheat: *Fagopyrum esculentum* Moench. Rome: IPGRI; 1997.
- Canellas LP, Olivares FL, et al. Humic acids as plant growth promoters. *Chem Biol Technol Agric*. 2008;20(4):457-62.

- Das A, Patel DP, Munda GC, Ngachan SV. Organic agriculture for sustainable hill farming. *Indian J Agron*. 2019;64(Special Issue):1-10.
- Daur I, Abusuwar AO, Mohammad FS. Effect of humic acid on growth and quality of maize forage. *Pak J Bot*. 2011;43(4):2235-40.
- Fabjan N, Rode J, Kosir IJ, Wang Z, Zhang Z, Kreft I. Tartary buckwheat as a source of dietary rutin and quercitrin. *J Agric Food Chem*. 2003;51:6452-5.
- Goswami P, Sharma S, Singh B. Potential of buckwheat in functional food formulation. *J Food Sci Nutr*. 2020;8(1):45-52.
- Ikeda K, Asami Y, Hatanaka M. Buckwheat as a dietary source of functional food. *Fagopyrum*. 1999;16:91-6.
- Joshi VK, Sharma S, Rana N. Buckwheat: A potential source of nutraceuticals. *Int J Food Ferment Technol*. 2011;1(1):27-36.
- Khan W, et al. Seaweed extracts as biostimulants of plant growth and development. *J Plant Growth Regul*. 2009;28(4):386-99.
- Kumar M, Patel HR, Patel SS. Response of seaweed extract and humic acid on growth and yield of cereal crops. *Int J Chem Stud*. 2019;7(5):1341-4.
- Li SQ, Zhang QH. Advances in the development of functional foods from buckwheat. *Crit Rev Food Sci Nutr*. 2001;41(6):451-64.
- Nardi S, Pizzeghello D, et al. Hormone-like activity of humic substances. *Soil Biol Biochem*. 2001;34(11):1527-36.
- Parmar DK, Thakur NS, Sharma GD. Effect of humic acid on growth and yield of small millets. *Green Farming*. 2021;12(1):30-4.
- Patil RK, Bhatt BP, Ram RB. Bio-input application in hill agriculture: Enhancing productivity of pseudocereals. *Indian J Agron*. 2022;67(3):245-51.
- Rathore SS, et al. Effect of seaweed extract on the growth, yield and quality of tomato. *Indian J Agric Sci*. 2009;79(2):91-3.
- Selim ME, Mosa AA, El-Ghamry AM. Effect of humic acid and plant residues on soil properties and productivity of wheat. *Arch Agron Soil Sci*. 2013;59(5):625-34.
- Sharma HSS, Fleming C, Selby C. Biostimulants activity of brown seaweed species on root and plant growth. *Ann Appl Biol*. 2014;165(2):228-41.
- Tiwari A, Meena RL, Kumar V. Effect of bio-stimulants on yield and economics of blackgram. *Int J Curr Microbiol Appl Sci*. 2020;9(10):2043-9.
- Verkleij FN. Seaweed extracts in agriculture and horticulture: a review. *Biol Agric Hort*. 1992;8(4):309-24.