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Effect of seaweed extract on productivity and quality dynamics of onion cv. Sukhsagar

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ABSTRACT

A study on the effect of seaweed extract on productivity and quality dynamics of onion cv. Sukhsagar was framed and enlarged during November - March, accompanied by two seasons (2021-2022 and 2022-2023) at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, under new alluvial plains of West Bengal. The experiment was headed by Randomized Block Design assimilated with 10 treatments of 3 replications *viz*., (T_1- spray with Seaweed Extract (SWE) (15%) @ 1 ml l^{-1}, T_2 - spray with SWE (15%) @ 2 ml l^{-1}, T_3 - spray with SWE (15%) @ 3 ml l^{-1}, T_4 - soil application of Seaweed Granules (SWG) (5%) @ 3 kg ha^{-1}, T_5 - soil application of SWG (5%) @ 4 kg ha^{-1}, T_6 - soil application of SWG (5%) @ 5 kg ha^{-1}, T_7 - spray with SWE (15%) @ 1 ml l^{-1} + soil application of SWG (5%) @ 3 kg ha^{-1}, T_8 - spray with SWE (15%) @ 2 ml l^{-1} + soil application of SWG (5%) @ 4 kg ha^{-1}, T_9 - spray with SWE (15%) @ 3 ml l^{-1} + soil application of SWG (5%) @ 5 kg ha^{-1} and T_{10} - control (spray with distilled water). Among all the treatments, T_9 (spray with SWE (15%) @ 3 ml l^{-1} + soil application of SWG (5%) showed the best response in terms of mean maximum plant height (59.20 cm), leaf length (57.77 cm), neck thickness (3.12 cm), No. of leaves $plant^{-1}$ (5.20), bulb yield (4.07 kg $plot^{-1}$), projected bulb yield (16.96 t ha^{-1}), dry matter content (6.85%), total soluble solids (11.58ºBrix), titratable acidity (0.42 mg 100 g^{-1}), ascorbic acid (7.90 mg 100 g^{-1}), total sugars (9.87%), reducing sugar (4.46%), net profit (Rs. 2,03,042 ha^{-1}) and benefit: cost ratio (1.98: 1).

Key words*:* Benefit: cost ratio, biostimulant, dry matter content, seaweed granules, quality, yield.

INTRODUCTION

Onion is undoubtedly preserving the supreme position by winning the attribute in her bag, "The Queen of the Kitchen" (Selvaraj, 17), among the commercial vegetable cum spices not only in any area but throughout the whole world. It also achieved another unparalleled feather on her crown with its indelible economical as well as nutritional importance at the same time and has made herself the irresistible one in both local and international markets being incomparable with its unique flavour and odour. The main nutrients of 100 g of raw onions are - moisture 86.60 g, protein 1.20 g, carbohydrates 11.10 g, sugars 4.20 g, fiber 0.60 g, fat 0.10 g, energy 50 kcal, vitamin C 11 mg, B_9 64 mg, B_6 0.06 mg, potassium 276 mg, phosphorus 50 mg, calcium 50 g, iron 0.70 mg, thiamine 0.08 mg, niacin 0.40 mg and total folic acid 6 mg (Basak, 5). It also possesses several medicinal and therapeutic properties (Vohra *et al.*, 18), which are effective against diabetes, common cold, heart disease and osteoporosis. Beneficial effects of seaweed extract on plant growth, yield and quality in terms of better shoot and root formation, improved water and nutrient uptake capacity, frost and saline resistance, biocontrol and resistance toward phytopathogenic organisms, remediation of pollutants of contaminated soil and fertilization is well known throughout the world. The most used seaweeds in agriculture are brown seaweeds, including species of the genera *Ascophyllum*, *Fucus* and *Laminaria* species. According to Nabti *et al.* (14), seaweeds are rich in lipids, proteins, carbohydrates, phytohormones, amino acids, antimicrobial compounds, minerals and other diverse compounds. Seaweeds have beneficial effects such as stimulation of seed germination, enhancement of health and plants' growth. Dwelling on the factors mentioned above, the present study was undertaken in the New alluvial zone of West Bengal.

MATERIALS AND METHODS

The current extensive investigation was undertaken during November-March accompanied by two seasons (2021-2022 and 2022-2023) at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal in the New Alluvial Zone of West Bengal, located at 23.5° N latitude and 89° E longitude, with an altitude of 9.75 m above the mean sea level. A well-drained clay loam with 55% sand, 28.60% silt and 16.40% clay in the 0-15

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cm layer of soil, having soil pH 6.8 with good water holding capacity, was used as the soil in the exploration field. The experiment was followed with Randomized Block Design (RBD) with a factorial organization with three replications, comprising 10 treatments *viz.*, (T_1- spray with seaweed extract (SWE -15%) @ 1ml l^{-1}, T_2 - spray with SWE (15%) @ 2 ml l^{-1}, T_3 - spray with SWE (15%) @ 3 ml l^{-1}, T_4 -soil application of SWG (5%) @ 3 kg ha^{-1}, T_5 - soil application of Seaweed Granules (SWG 5%) @ 4 kg ha^{-1}, T_6 –soil application of SWG (5%) @ 5 kg ha^{-1}, T_7 - spray with SWE (15%) @ 1ml l^{-1} + soil application of SWG (5%) @ 3 kg ha^{-1}, T_8 - spray with SWE (15%) @ 2 ml l^{-1} + soil application of SWG (5%) @ 4 kg ha^{-1}, T_9 - spray with SWE (15%) @ 3ml l^{-1} + soil application of SWG (5%) @ 5 kg ha^{-1} and T_{10} - control (spray with distilled water). Onion seeds were sown in the nursery bed by the middle of November. Banana leaves were used as a mulching material for getting a better moisturized seed bed, to get control over weeds, and to accelerate germination. Healthy seedlings (4 weeks) were transplanted in the main field during morning hours on 15th December.

The experiment occurred in 30 plots of 1.6 m x 1.5 m dimension with 30 cm wide ridges around the plots. Fifty cm wide irrigation channels were also made. Transplanting of seedlings was done at a spacing of 10 cm x 10 cm accommodating two hundred forty seedlings in each plot. Organic manure like well rotten Farm Yard Manure (10 t ha^{-1}) was applied by broadcasting and mixed thoroughly 10 days before final bed preparation. The necessary package of practices were followed. In each plot, per replication, five plants were tagged to record various characters like plant height (cm), leaf length (cm), leaf width (cm), neck thickness (cm) and number of leaves $plant^{-1}$ at 30, 60 and 90 days after transplant (DAT). At the mature stage, the tops of the plants were turned to light yellow colour and drooping, bulbs were harvested. Equatorial diameter of bulb (cm), bulb weight $plant^{-1}$ (g), bulb yield (kg $plot^{-1}$) and projected bulb yield (t ha^{-1}) were recorded. The selected bulbs were kept for the analysis of dry matter content (%) {Dry weight (%) =A/B x 100, Where, A = sample weight of cured onion bulb (g), B = weight of the sample after drying (g)}, total soluble solids (TSS) (ºBrix), titratable acidity (mg 100 g^{-1}), ascorbic acid (mg 100 g^{-1}) {Ascorbic acid (mg 100 g^{-1}) = (burette reading × dye factor × volume made up) × 100/(Volume of sample taken for estimation ×weight of sample)}, total sugar (%) {Total sugars (%) = (Factor × volume made up)/(Burette reading × Weight of sample)×100, reducing sugar (%) {Reducing sugar (%) = (Factor × Volume made up)/(Burette reading × Weight of sample)×100. The benefit-cost (B: C) ratio {B: C ratio = (Net income (Rs. ha^{-1})/ (Total cost of cultivation (Rs. ha^{-1})} was calculated by dividing the net return by the cost of production. The significance of different treatment variation was tested by Fisher & Snedecor's 'F' test at a probability of 0.05%. Statistical analysis was done as per the standard procedures (Gomez and Goemz, 9) and the collected data table were analyzed with the help of OPSTAT program.

RESULTS AND DISCUSSION

A number of treatments upon biostimulant bestows notable variation in vegetative parameters, depicted through Table 1 in terms of mean maximum plant height (37.00, 56.00 and 59.20 cm), leaf length (36.53, 51.85 and 57.77 cm), leaf width (2.05, 2.47 and 3.12 cm), neck thickness (2.67, 2.92 and 3.20 cm) and number of leaves $plant^{-1}$ (4.41,4.77 and 5.20) were recorded from treatment T_9 - spray with SWE (15%) @ 3 ml l^{-1} + soil application of SWG (5%) @ 5 kg ha^{-1} at 30, 60 and 90 DAT, respectively. However, in all the vegetative parameters, T_{10} - control (spray with distilled water) secured the mean minimum number of plant height (32.50, 49.30 and 52.25 cm), leaf length (31.08, 45.20 and 48.90 cm), leaf width (1.49,1.80 and 2.19 cm), neck thickness (2.18, 2.25 and 2.50 cm) and a number of leaves $plant^{-1}$ (3.22, 4.00 and 4.10) at 30,60 and 90 DAT, respectively.

Spray with SWE (15%) @ 3 ml l^{-1} as well as soil application of SWG (5%) @ 5 kg ha^{-1}, significantly increased the plant height, leaf length, width, neck thickness and number of leaves $plant^{-1}$ in all the stages these might be due to the adequate water and nutrient uptake by the roots, which increased the photosynthetic activity that leads to vegetative growth vigorously and make the plants stouter physiologically and morphology. According to Danesh *et al*. (7) and Pramanik *et al*. (16), seaweed extracts were very effective in stimulating the weight of the banana bunch and the fruit length. In contrast, a significant increase in the weight of fruit was noticed when both applications were done together (foliar application and fertigation). The maximum green gram straw yield was achieved with the application of 15% seaweed extract, improving the crop quality and nutrient uptake of (nitrogen, phosphorus and potassium), respectively. In the findings of Kumar and Thapa (12), the tomato fruit quality parameters like lycopene, anthocyanin, TSS, beta-carotene and total sugars content showed the best results with the application of seaweed extract and increased fruit yield.

Almohammedi *et al*. (4) and Abou El-Ghait *et al.* (3) support the results given above as they stated that the seaweed extract promoted root and plant growth *via* uptake of nutrients may be due to the presence of plant growth regulators at low concentrations such as cytokinins, auxins and polyamines such as putrescine and spermine, which had synergistic action with other plant growth regulators, especially auxin. Based on the

Table 1. The influence of biostimulant on growth parameters of onion (mean of 2 years).

Treatment	Plant height (cm) days after transplanting			Leaf length (cm) days after transplanting			Leaf width (cm) days after transplanting			Neck thickness (cm) days after transplanting			No. of leaves plant^{-1} days after transplanting		
	30	60	90	30	60	90	30	60	90	30	60	90	30	60	90
T_1	33.90	52.00	54.30	33.47	47.48	52.37	1.52	1.87	2.39	2.32	2.47	2.71	3.48	4.18	4.30
T_2	34.40	52.28	54.67	33.58	48.60	53.85	1.55	1.90	2.55	2.38	2.50	2.75	3.62	4.27	4.35
T_3	34.75	52.40	54.18	33.70	48.97	53.97	1.69	2.09	2.75	2.41	2.60	2.86	3.80	4.30	4.45
T_4	35.48	53.76	55.48	34.18	50.48	54.30	1.75	1.88	2.77	2.30	2.55	2.77	3.70	4.20	4.50
T_5	35.60	53.80	55.62	34.20	50.92	54.67	1.87	1.97	2.80	2.40	2.60	2.80	3.77	4.25	4.50
T_6	36.70	54.20	55.79	35.40	51.75	55.39	1.90	2.17	2.85	2.47	2.69	2.85	3.89	4.30	4.60
T_7	36.27	54.00	56.30	35.25	50.90	56.20	1.80	2.00	2.97	2.58	2.76	2.91	4.13	4.50	4.70
T_8	36.60	55.80	58.35	35.90	51.40	57.25	1.92	2.10	3.05	2.60	2.87	3.00	4.26	4.50	4.90
T_9	37.00	56.00	59.20	36.53	51.85	57.77	2.05	2.47	3.12	2.67	2.92	3.20	4.41	4.77	5.20
T_{10}	32.50	49.30	52.25	31.08	45.20	48.90	1.49	1.80	2.19	2.18	2.25	2.50	3.22	4.00	4.10
SEm (±)	0.47	0.70	0.74	0.45	0.65	0.72	0.02	0.03	0.04	0.03	0.04	0.04	0.05	0.06	0.06
$LSD_{(0.05)}$	1.40	2.10	2.21	1.36	1.96	2.17	0.07	0.10	0.12	0.10	0.11	0.12	0.16	0.17	0.18

yield and yield attributing parameters, Table 2 unravels that the mean maximum equatorial diameter of bulb (5.30 cm), bulb weight plant^{-1} (72.69 g), bulb yield (4.07 kg plot^{-1}) and projected bulb yield (16.96 t ha^{-1}) was associated with T_9 - spray with SWE (15%) @ 3 ml l^{-1} + soil application of SWG (5%) @ 5 kg ha^{-1}, while, the mean minimum equatorial diameter of the bulb (4.07 cm), bulb weight plant^{-1} (42.29 g), bulb yield (2.78 kg plot^{-1}) and projected bulb yield (10.18 t ha^{-1}) were found in T_{10} -control (spray with double-distilled water).

Table 2. The influence of biostimulant on yield parameters of onion (mean of 2 years).

Treatment	Bulb equatorial dia. (cm)	Bulb weight (g)	Bulb yield (kg plot^{-1})	Projected bulb yield (t ha^{-1})
T_1	4.20	52.20	3.08	12.50
T_2	4.25	52.37	3.19	13.29
T_3	4.41	61.29	3.33	13.87
T_4	4.22	58.18	3.70	15.42
T_5	4.39	57.60	3.86	16.10
T_6	4.35	68.39	3.88	16.16
T_7	4.68	59.20	3.67	15.30
T_8	4.70	62.47	3.91	16.29
T_9	5.30	72.69	4.07	16.96
T_{10}	4.07	42.29	2.78	10.18
SEm (±)	0.06	0.83	0.05	0.21
$LSD_{(0.05)}$	0.19	2.49	0.15	0.62

Application of spray with SWE (15%) @ 3 ml l^{-1} as well as soil application of SWG (5%) @ 5 kg ha^{-1} showed the maximum results regarding the yield parameters. Such enhancement in yield parameters could be obtained due to either improvement in soil condition resulting in greater root growth and greater bulb size; thereby, enhancing the utilization of soil nutrients or the changes in the biotic and abiotic environment of plants, which alters the host-parasitic relationship. The presence of hormonal substances, especially, cytokinins in seaweed extract and granules helps in improving the yield attributes. Due to these reasons, the treatment T_9 increases the yield attribute characters like equatorial diameter of bulb, bulb weight plant^{-1} bulb yield and projected bulb yield. Koyama *et al*. (11) stated that the application of *Ascophyllum nodosum* enhances vegetative growth in the early stage of crop growth, followed by the reproductive development of the plant. These results conform with the findings by Carmody *et al.* (6), Patel *et al*. (15) and Eisa (8) in Fennel and Abbas *et al.* (1) in onion.

Regarding the qualitative parameters (Table 3) bespeaks dry matter content (6.85%), TSS (11.58º Brix), titratable acidity (0.42 mg 100 g^{-1}), ascorbic acid (7.90 mg 100 g^{-1}), total sugars (9.87%) and reducing sugar (4.46%) in T_9 - spray with SWE (15%) @ 3 ml l^{-1} + soil application of SWG (5%) @ 5 kg ha^{-1} registered mean maximum value. The least amount of dry matter content (3.26) and, TSS (9.20°Brix), titratable acidity (0.19 mg 100 g^{-1}), ascorbic acid (3.08 mg 100 g^{-1}), total sugars (6.60%) and reducing sugar (3.80%) accompanied with control plot. An increase

Table 3. The influence of biostimulant on quality parameters of onion (mean of 2 years).

Treatment	Dry matter content (%)	TSS (ºBrix)	Titratable acidity (mg 100 g^{-1})	Ascorbic acid (mg 100 g^{-1})	Total sugars (%)	Reducing sugar (%)
T_1	3.60	10.10	0.28	3.10	7.10	4.00
T_2	3.84	10.20	0.31	3.10	7.29	4.02
T_3	4.20	10.38	0.27	3.98	7.93	4.39
T_4	4.75	10.25	0.39	4.10	8.15	4.03
T_5	5.36	10.27	0.30	5.80	8.07	4.17
T_6	5.70	11.35	0.40	6.39	8.70	4.28
T_7	6.30	10.79	0.29	6.18	7.70	3.79
T_8	6.35	11.30	0.32	7.30	7.20	4.29
T_9	6.85	11.58	0.42	7.90	9.87	4.46
T_{10}	3.26	9.20	0.19	3.08	6.60	3.80
SEm (±)	0.10	0.14	0.01	0.06	0.11	0.05
$LSD_{(0.05)}$	0.28	0.42	0.10	0.17	0.33	0.16

in dry matter content, TSS, titratable acidity, ascorbic acid, total sugars content and reducing sugar showed that the nutritional contents of onion were improved in the combined application of seaweed extract and seaweed granules applied treatments that have also been correlated with the findings of Abdel-Mawgoud *et al.* (2) and Nabti *et al.* (14). Photosynthetic activity and dry matter accumulation in plants increased due to the application of seaweed extract. The findings are in conformity with the results of Mikulewicz *et al*. (13) in onion.

Table 4 shows that the T9 recorded a maximum net return of Rs. 2,03,042 ha^{-1} and the highest benefit cost ratio of 1.98: 1. Hence, it may be recommended that the economic return and profitability of the crop can be enhanced by spraying with SWE (15%) @ 3 ml l^{-1} + soil application of SWG (5%) @ 5 kg ha^{-1}.

Contemplating all the above experiments, it may be summed up that the yield of onion crops can be enhanced by spraying with SWE (15%) @ 3 ml l^{-1} + soil application of SWG (5%) @ 5 kg ha^{-1} 30, 60, and 90 days after transplanting. However, the experiment

Table 4. The influence of biostimulant on benefit: cost ratio of onion.

Treatment	Onion bulb yield (t ha^{-1})	Gross return (Rs ha^{-1})	Cost of production (Rs ha^{-1})	Net return (Rs ha^{-1})	Benefit: cost ratio
T_1	12.50	2,25,000.00	1,00,238.00	1,24,762.00	1.24:1
T_2	13.29	2,39,220.00	1,01,238.00	1,37,982.00	1.36:1
T_3	13.87	2,49,660.00	1,01,448.00	1,48,212.00	1.46:1
T_4	15.42	2,77,560.00	1,00,338.00	1,77,222.00	1.76:1
T_5	16.10	2,89,800.00	1,01,238.00	1,88,562.00	1.85:1
T_6	16.16	2,90,880.00	1,01,188.00	1,89,692.00	1.87:1
T_7	15.30	2,75,400.00	1,01,138.00	1,74,262.00	1.74:1
T_8	16.29	2,93,220.00	1,01,338.00	1,91,882.00	1.89:1
T_9	16.96	3,05,280.00	1,02,238.00	2,03,042.00	1.98:1
T_{10}	10.18	1,83,240.00	99,438.00	83,802.00	0.84:1

Note: Rates of inputs like FYM @ Rs. 6 kg^{-1}, seaweed extract @ Rs 190 100 ml^{-1}, seaweed granules @ Rs 140 500 g^{-1} onion seeds @ Rs.2000 kg^{-1}, labour cost @ Rs. 328 day^{-1}.

(T_1 - Spray with SWE (15%) @ 1 ml l^{-1}, T_2 - Spray with SWE (15%) @ 2 ml l^{-1}, T_3 - Spray with SWE (15%) @ 3 ml l^{-1}, T_4 - Soil application of SWG (5%) @ 3 kg ha^{-1}, T_5 - Soil application of SWG (5%) @ 4 kg ha^{-1}, T_6 - Soil application of SWG (5%) @5 kg ha^{-1}, T_7 - Spray with SWE (15%) @ 1 ml l^{-1} + Soil application of SWG (5%) @ 3 kg ha^{-1}, T_8 - Spray with SWE (15%) @ 2 ml l^{-1} + Soil application of SWG (5%) @ 4 kg ha^{-1}, T_9 - Spray with SWE (15%) @ 3 ml l^{-1} + Soil application of SWG (5%) @ 5 kg ha^{-1} and T_{10} - control (spray with double-distilled water). (SWE - Seaweed Extract, SWG - Seaweed Granules).

may be carried out for at least 2-3 more years to confirm the present findings.

AUTHORS' CONTRIBUTIONS

All the field experiments and laboratory analysis (NB), Preparation of the manuscript (SS); Conceptualization of the experiments (AB, NC, DKG); Analysis of data (NB, SS); Editing of the manuscript (DKG).

DECLARATION

The authors declare that they do not have any conflict of interest.

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