International Journal of
Emerging Research in Management &Technology
ISSN: 2278-9359 (Volume-4, Issue-10)

Research Article

October 2015

Morpho-Physiological Indices and Carbohydrate Accumulation of Two Rice Cultivars as Influenced by Sea Weed Extract Application

Prinka Goyal, S. K. Thind
Department of Botany, College of Basic Sciences and Humanities,
Punjab Agricultural University, Ludhiana,
Punjab, India

Abstract-

The lab experiment was conducted to assess the effect of sea weed extract (SWE) on two rice cultivars (PR 116 and Nagina 22) in factorial in completely randomized design (CRD) with three replications. The application of SWE @ 10.0%, 12.5% and 15.0% w/v as soil drench was given at 3 DAS. Examination of morpho-physiological parameters showed that application of SWE enhanced biomass production, total leaf area, plant vigour and relative growth rate in selected cutivars. It showed no stimulatory effect on number of leaves at lower concentrations in both cultivars. The maximum fresh and dry weight was recorded in rice cultivar PR 116 followed by Nagina 22. Relative growth rate and vigour index were recorded maximum when higher concentration of SWE viz. 15% was applied than low concentration viz. 10% and 12.5%. The carbohydrate content was recorded low in rice cultivar Nagina 22 as compared to PR 116. The application of SWE at all concentrations enhancedsugar and starch content in both cultivars but effect was found to be more pronounced in PR 116.

Key words: Biomass, relative growth rate, sea weed extract, sugar and vigour

I. INTRODUCTION

Among cereal crops, rice (*Oryza sativa* L.) is one of the most important staple food of half the world's population and grown across the world [5]. It was mostly grown under submerged soil conditions and required more water compared with other crops [1]. The current trend in agriculture focused on reducing the use of chemical fertilizers and pesticides due to their adverseeffects on environment. The site specific nutrient management (SSNM) allowed discriminate use of nutrients by preventing excessive and/or inadequate nutrient inputs and helped to maintainsoil health over a long period of time [13]. Therefore, emphasis should be given to optimize the use of chemical fertilizers either by combining chemical fertilizers with organic manures or using biofertilizers from natural resource to sustain productivity of commercially important crops [11, 14]. In recent years, the use of seaweeds as biofertilizers or biostimulantshad allowed for substitution in place of conventional synthetic, in agriculture and horticulture to increase plant growth and productivity [16]. Various studies had revealed a wide range of beneficial effects of seaweed extract on seed germination, seedling vigour, biomass production, plant performance and establishment[12, 14]. Thus present study was designed to determine the effect of SWE on some morpho-physiological parameters and carbohydrate accumulation of rice.

II. MATERIAL AND METHODS

A. Experimental Site and Treatments

The present investigation was conducted in lab of Department of Botany, Punjab Agricultural University, Ludhiana. It is situated at 30º-54º`N latitude, 75º-45`E longitude and at a mean height of 247 meters above sea level. The seeds of two rice cvs PR 116 and Nagina 22 were procured from the Director Seed, PAU Ludhiana, Punjab. These were surface sterilized with 0.1 % mercuric chloride for 2-3 min to avoid any fungal infection. Twenty seeds of each cultivar were sown in pots and maintained in growth chamberat day/night temperature of 32˚ /28^{o}C under a 14-h-light/10-h-dark cycle. The humidity and air temperature of the growth chamber were maintained constant during experiments. After three days, application of SWE @ 10%, 12.5 % and 15 % (w/v) was given as soil drench in factorial completely randomized design (CRD) in three replications.

B. Observations

Randomly five plants were selected in each pot @ 14 DAS for recording observations on morphological parameters (fresh weight, dry weight, total leaf area and leaf number), physiological parameters (vigour index and relative growth rate) and carbohydrate content(sugar and starch). Fresh flag leaf samples were used to estimate morphological and physiological parameters. To estimate carbohydrate content, dried leaf samples were used.The seedling fresh weight was recorded in milligrams with the help of balance. These seedlings were dried in oven at 60^{0}C for 3 days and dry weight was recorded by using balance. The number of leaves was counted and their average was recorded. The leaf area was calculated by using formula given by [2]. Vigour index of seeds was calculated as Germination (%) x Epicotyl length (cm). The Relative growth rate was calculated as:

© 2015, IJERMT All Rights Reserved

$$RGR = \frac{Dw}{t} \times \frac{1}{W0}$$

Wo = Initial dry weight (mg)

D_W = Change in dry weight (mg) in time 't'

t = Time interval (in days)

Total soluble sugars were estimated by method as given by [4]. The total soluble sugars were extracted from dried leaves using 80% ethyl alcohol. Absorbance was taken at 490 nm in spectrophotometer. The quantity of sugars was calculated against the standard curve prepared by using pure glucose (10-100µg) and expressed as mg g^{-1} dryweight.The residue left after sugar extraction was used for starch estimation [7]. The residue was washed 4-5 times with 80% ethanol to remove all traces of soluble sugars. The absorbance was read at 630 nm and quantity of sugars was calculated against the standard curve prepared by using pure glucose (10-100µg). The quantity of sugar was multiplied with 0.9 factor (constant) to estimate starch content and expressed as mg g^{-1} dryweight.

C. Statistical Analysis

Analysis of variance (ANOVA) was conducted to evaluate differences between treatments and cultivars using CPCS1 software. The means were separated using least significant difference (LSD) at 5% level of significance.

III. RESULTS AND DISCUSSION

A. Fresh and Dry Weight

The ratio of fresh to dry biomass represents an index of cell water content. From among the studied cultivars, PR 116 (107.00, 28.58) had more biomass than that of the Nagina 22 (97.00, 21.33) under control conditions. Application of SWE significantly increased fresh and dry weight from 100.00 to 116.20 and 24.66 to 37.95 respectively as compared to control in selected cultivars (Table 1). The maximum fresh (101.40) and dry weight (30.80) was recorded in PR 116 when higher concentration of SWE viz. 15% was appliedas compared to lower concentrations viz. 10% and 12.5%. Same results were confirmed by Jeannin*et al* (1991) in maize seedlings in which application of SWE enhanced total fresh matter production by 15 – 25 per cent over the control. Reference[15] reported that spraying the plants with SWE increased the growth parameters shoot length and dry weight of plants under water deficit conditions.

B. Numberof Leaves

The number of leaves indicates the physiological stage of plant. The significant differences in leaf number were observed in both the cultivars (Table 1). Results showed that application of SWE at higher concentration had significantly increased leaf number while the lower concentrations viz. 10% and 12.5% showed no stimulatory effect on number of leaves. The ameliorating role of SWE may be due to the high level of cytokinins, auxins, other growth hormones and other nutrients. The maximum leaves number per plant was recorded in cultivar PR 116 (2.70) followed by Nagina 22 (2.30). Same results were confirmed by [14] and [9] by application of *Sargassumcrassifolium* on tomato and *A nodosum* on Arabidopsis plants respectively.

C. Total Leaf Area

Total leaf area varied significantly among the rice cultivars (Table 1). In comparison among the cultivars, PR 116 possessed more total leaf area as compared to Nagina 22 under the control conditions. The minimum total leaf area (3.34) was recorded in cultivar Nagina 22. Results revealed that application of SWE was significantly increased total leaf area in contrast to control. This effect was a result of significant increase in number of leaves per shoot and size of individual leaves. The maximum total leaf area was recorded in cultivar PR 116 (5.23) followed by Nagina 22 (4.65) when higher concentration of SWE (15%) was applied. These results were in conformity with the reports of [10],who conducted an experiment of foliar application of seaweed of *Dictyotadichotoma* on *Abelmoschusesculants.*

D. Relative Growth Rate

RGR represents the speed of plant growth or dry matter accumulation. It is a prominent indicator of plant strategy with respect to productivity as related to environmental stress and disturbance regimes.The present investigation revealed that RGR varied significantly among studied cultivars (Table 2). TheRGR was recorded low in Nagina 22 (0.204) under control conditions. The application of SWE at all concentrations showed positive effect on relative growth rate in both cultivars but the effect was found to be more pronounced in PR 116. Same results were obtained by [14] in which application of *Sargassumcrassifolium*extract enhanced root dry matter accumulation in tomato seedlings.

E. VigourIndex

Seedling establishment is a critical stage in crop production and considerably depends on biochemical and physiological structures of seed. In order to obtain fast and good establishment of seedling, high vigour seed is needed to provide essential nutrients for seedling until it becomes established and can photosynthesize independently. The vigour index showed a highly significant difference among cultivars (Table 2). The low seedling vigour observed low under control conditions. The results revealed thatthe application of SWE improved seedlings vigour in both cultivars although the effect was found to be more pronounced in PR 116. The maximum vigour index (690.41) was recorded in PR 116 followed by Nagina 22 (640.25) when higher concentration of SWE @ 15% was applied as compared to lower concentration. The increase in germination percentage as well as seedling vigour with increasing levels of SWE may be due to presence of phytohormones especially gibberelic acid [3,8] .Similar surveillance was also observed by[17] in the *Vignaradiata*when SLE *of Halimedamacroloba*was applied.

F. Sugar and Starch Content

The sugar and starch conent varied non significantly among studied cultivars (table 2). Results pointed out that PR 116 had more sugar (5.28) and starch content (2.01) than that of the Nagina 22 (5.25, 1.99) under control conditions. SWE application increased sugar and starch content nonsignificantly in both cultivars as compared to control. SWE @ 15% was found to be more effective to increase sugar and starch content. The maximum sugar (5.43) and starch content (2.19) was recorded in PR 116 followed by Nagina 22 (5.38, 2.15). The same trend was recorded by [6] in which application of SWE increased reducing and total sugar content of *Vigna mungo*seedlings

IV. CONCLUSION

From this study, the stimulatory effect of SWE application at different concentration was clearly observeddue to presence of growth hormones, nutrients and other important physiochemical compounds so it can be used as efficient biofertilizers for enhancing the biomass production, plant growth,vigour and sugar content.

ACKNOWLEDGEMENT

The author likes to thank Dr. (Mrs.) S.K. Thind, professor cum Head, Department of Botany for providing necessary facilities required for the present investigation and for her important suggestions and guidance. My parents (Ramesh goyal and SarojGoyal) and in laws parents (Satish Gupta and Poonam Gupta) deserve special mention for their inseparable support and sacrifices. I am grateful to my husband Mohit Gupta and my daughter Devanshi Gupta for supporting me.

REFERENCES

[1] KAnil, MYakadri and G Jayasree (2014) Influence of nitrogen levels and times of application on growthparameters of aerobic rice.*International journal of plant, animal and environmental Sciences***4**(3):231-34.
[2] V MBhan and H KPande (1966) Measurement of leaf area of rice. *Agron J***58**: 454.
[3] GBlunden, P FMorse, IMathe, JHohmann, A TCritchley and S Morrell (2010) Betaine yields from marine algal species utilized in the preparation of seaweed extracts used in agriculture. *Nat Prod Commun***5**: 581-85.
[4] MDubois, K AGilles, J KHamilton, P ARebers and FSmith (1956) Calorimetric method for the determination of sugars related substances. *Anal Chem***28**: 350-56.
[5] KJana, G KMallick, C KKund, S K Gunri and A M Puste (2015) Effect of Nutrient Management on Grain Yield of Aerobic Rice Under Irrigated Condition During Pre-Kharif Season.*IJOEAR* **1** (1): 31-34.
[6] CKalaivanan, MChandrasekaran and VVenkatesalu (2012)Effect of seaweed liquid extract of *Caulerpascalpelliformis*on growth and biochemical constituents of black gram (*Vigna mungo* (L.) Hepper). *Phykos***42** (2): 46-53.
[7] Maryada (2006) Water deficit stress tolerance in wheat (*Triticumaestivum* L.) as affected by calcium and ABA application. Ph.D Dissertation, PAU, Ludhiana.
[8] KPrasad, A KDas, M DOza, HBrahmbhatt, A KSiddhanta, RMeena, KEswaran, M RRajyaguru and P KGhosh (2010) Detection and quantification of some plant growth regulators in a seaweed-based foliar spray employing a mass spectrometric technique sans chromatographicseparation. *J Agric Food Chem***58**: 4594 – 4601.
[9] PRayorath, J MNarayanan, AFarid, WKhan, RPalanisamy, SHankins, A TCritchley and BPrithiviraj (2008) Rapid bioassays to evaluate the plant growth promoting activity of *Ascophyllumnodosum*(L.) Le Jol using a model plant *Arabidopsis thaliana* (L.) Heyah. *Journal of Applied Phycology***20**: 423-29.
[10] KSasikumar, TGovindan and CAnuradha (2011) Effect of seaweed liquid fertilizer of *Dictyotadichotoma*on growth and yield of *Abelmoschusesculentus*L. *European Journal of Experimental Biology***1**: 223-227.
[11] B SSatapathy, K BPun, T Singh and S K Rautaray (2014) Effect of liquid seaweed sap on yield and economics of summer rice. *Oryza***51** (2): 131-35.
[12] G GSelvam and KSivakumar (2014) Influence of seaweed extract as an organic fertilizer on the growth and yield of *Arachis hypogeal* L. and their elemental composition using SEM–Energy Dispersive Spectroscopic analysis. *Asian Pacific Journal of Reproduction* **3** (1): 18-22.
[13] C MSunil and B CShankaralingappa (2014) Impact of integrated package of agrotechniques on growth and yield of aerobic rice. *Agricultural Sciences***5** (1): 60-65.
[14] SSutharsan, SNishanthi and SSrikrishnah (2014)Effects of foliar application of seaweed (*Sargassumcrassifolium*) liquid extract on the performance of *Lycopersiconesculentum*Mill.*American-Eurasian J. Agric. & Environ. Sci.* **14** (12): 1386-96.

© 2015, IJERMT All Rights Reserved

[15] MMansori, HChernane, SLatique, ABenaliat, DHsissou andMEl Kaoua (2014) Seaweed extract effect on water deficit and antioxidative mechanisms in bean plants (*Phaseolus vulgaris* L.). *journal of appiedl phycology* DOI: 10.1007/s10811-014-0455-7.

[16] G CPopescu and M Popescu (2014) Effect of the brown alga *Ascophyllumnodosum*as biofertilizer on vegetative growth in grapevine (*Vitisvinifera*L.). *Current Trends in Natural Sciences* **3** (6): 61-67.

[17] ABabu, MJohnson and DPatric Raja (2015) Influence of *Halimedamacroloba*Decsne SLF on seed germination, growth and protein profiles of *Vignaradiata*(L.) Wilczek. var. K851.*Phykos***45** (1): 9-12.

I. INFLUENCE OF SWE APPLICATION ON BIOMASS PRODUCTION, TOTAL LEAF AREA AND LEAF NUMBER IN PR 116 AND NAGINA22 CVS. OF RICE (ORYZA SATIVA L.)

Cultivars Treatments	Fresh weight		Dry weight		Total leaf area		Number of leaves	
	PR 116	Nagina 22	PR 116	Nagina 22	PR 116	Nagina 22	PR 116	Nagina 22
Control	107.00	97.00	28.58	21.33	4.85	3.34	2.40	2.00
SWE @ 10%	110.00	100.00	31.80	24.66	4.87	3.90	2.40	2.00
SWE @ 12.5%	114.21	104.00	34.16	28.66	4.89	4.22	2.40	2.00
SWE @ 15%	116.20	106.00	37.95	30.75	5.23	4.65	2.70	2.30
CD (0.05)	T=1.2237, C=0.8653, TxC=NS		T=1.2672, C=0.8960, TxC=NS		T=NS, C=0.8650, TxC=NS		T=NS, C=NS, TxC=NS	

II. INFLUENCE OF SWE APPLICATION ON RELATIVE GROWTH RATE, PLANT VIGOUR AND CARBOHYDRATE ACCUMULATION IN PR 116 AND NAGINA22 CVS. OF RICE (*ORYZASATIVA*L.)

Cultivars Treatments	Relative growth rate		Vigour index		Sugar content		Starch content	
	PR 116	Nagina 22	PR 116	Nagina 22	PR 116	Nagina 22	PR 116	Nagina 22
Control	0.208	0.204	656.36	604.50	5.28	5.25	2.01	1.99
SWE @ 10%	0.216	0.210	664..25	611.75	5.33	5.30	2.09	2.05
SWE @ 12.5%	0.230	0.213	676.25	623.75	5.39	5.36	2.15	2.10
SWE @ 15%	0.242	0.237	690.41	640.25	5.43	5.38	2.19	2.15
CD (0.05)	T=0.1220, C=0.8632, TxC=0.1726		T=1.2233, C=0.8650, TxC=NS		T=NS, C=NS, TxC=NS		T=NS, C=NS, TxC=NS	