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Effect of Seaweed Sap Foliar Application on AGR, CGR and RGR of Maize (*Zea mays* L.) Cultivars

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ABSTRACT: A field experiment was conducted during *zaid* season of 2020 and 2021 at crop research farm in Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj on sandy loam soil to investigate the response of seaweed sap foliar application on maize cultivars under eastern Uttar Pradesh condition. For maize production in India, main constraints is with limited resources increase production and productivity. Cultivar with more productivity potential and to achieve production, fulfill crop nutrient requirement prepare suitable soil and plant environment through seaweed now a day's scientifically recommended. The experiment was laid out in Split Plot Design along with two factor *viz.*, four maize cultivar (VMH-27, VMH-53, VLMH-57 and VLQPMH-59) as main plot and two seaweed (*Kappaphycus* sp. & *Sargassum* sp) sap at different concentration (5%, 7.5% & 10%) as sub-plot factor treatment along with one water spray and their combination of 28 treatments replicated thrice. Study revealed from pooled analysis of both the years that maximum accumulate growth rate (AGR) (0.69, 4.60 and 1.41 g/days), crop growth rate (CGR) (6.87, 46.05 and 14.13 g/m^2/day) at 20-40, 40-60 DAS and 80 DAS-At harvest and relative growth rate (RGR) (0.149, 0.008) at 20-40 DAS and 80 DAS-At harvest were recorded under cultivar V3: VLMH-57 which was found statistically superior among rest of cultivars, respectively. While in case of seaweed sap foliar application maximum accumulate growth rate (AGR) (0.72, 4.54, 2.94 and 1.05 g/days), crop growth rate (CGR) (7.17, 45.39, 29.39 and 10.50 g/m^2/day) and relative growth rate (RGR) (0.153, 0.022) were recorded statistically superior by S_7: S-Seaweed sap 10% foliar application at 20-40 DAS, and 40-60 DAS, respectively. It is clearly concluded that from the experiment the maize cultivars V_3: VLMH-57 sprayed with S_7: S-Seaweed sap 10% concentration significantly affect growth indices and produced maximum vegetative growth.

Keywords: Cultivars, growth indices, AGR, CGR, RGR, Seaweed.

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop in world ranking third after wheat and rice. It is a member of family Gramineae (*Poaeceae*) sub family *Panicoideae*. The importance of maize lies in its wide industrial applications besides serving as human food and animal feed. Globally, maize is referred as 'Miracle crop' or 'Queen of the Cereals' due to its high productivity potential compared to other Poaceae family members (Singh *et al.*, 2021). Maize is the third most important food grain in India after rice and wheat. Maize was grown in Uttar Pradesh, during 2015-16 over an area of 20,000 ha with productivity of 2610 kg/ha (Anonymous, 2016). However its area fluctuates between 10,000-20,000 ha. The main reasons for fluctuation in acreage and production of this crop are: deficit or excess moisture, prevailing high temperatures, cloudiness which favour incidence of insect pests, weeds, diseases and restricts sunshine hours for photosynthesis, rainfall which washes off the pollens and leaches the fertilizers nutrients.

Cultivars is one of the most important aspects of management in agricultural system, which can affect yield through influencing emergence date, plant density, normal growth, pollination and maturing date. Maize has the advantage to develop both in winter and pre-rainstorm seasons due to its facultative nature to day-length. It becomes challenging to meet out the increasing demand of maize in sustainable manner without impairing the soil fertility, as it is a very heavy feeder of nutrients due to C4 type plant, hence the nutrient requirement is very high. But in Indian situation, farmers socio economic condition is so poor that they are unable to full fill the nutrient demand of crop for getting maximum yield. A major barrier is farmers' lack of information and awareness about the production and benefits of these novel and early maturing varieties with good agronomic practises and

potential yield. The terms adaptability and stability are often used interchangeably. The extent of scale or rank shift in their performance across or specific environment is minimised by diversity. As a result, it's critical to adapt these medium- and early-maturing maize types to the research area (Abduselam, *et al*., 2017). Sulochana *et al.,* (2015) reported that treatments consist of three dates of sowing (June 15, June 30 and July 15) with five maize varieties (HQPM-1, PEHM-2, Pratap Makka-5, Pratap QPM-1 and BIO-9637). The crop sown on June 15 required a significantly higher number of days and accumulated GDD to attain various phenophases compared to June 30 and July 15 sown crops. June 30 sown crop recorded grain yield (50.87 q/ha) significantly higher under June 15 and July 15 sown crops. BIO-9637 required maximum accumulated growing degree days (GDD) to attain different phenological stages of maize except knee- high stage. Among the varieties, BIO-9637 recorded grain yield (51.78 q/ha) significantly higher over HQPM-1, PEHM-2, Pratap QPM-1 and Pratap Makka-5. Another researcher group of Girshe *et al.* (2017) was also found among nine improved varieties, including BH661, BH547, BH546, Limu, G2, G3, MH140, MHQ138, M6Q, and a Local cultivar, were planted on 4.5m × 2.5m plots with 75cm × 25cm spacing. Variety BH546 has the maximum amount of gains per row (40.94). The largest cob length for the BH661 variety was 21.13 cm. A local variety had the highest plant height of 2.90 cm. The highest grain yield (10459 kg/ha) was achieved by the variety BH547. As a result, variety BH547 outperformed the others in terms of yield and other critical yield components.

Seaweeds were the microalgae found along the ocean's coast. They were typically found near the coast, adhering to whatever substratum they could find. In terms of ecology, they provide a living and feeding environment for the majority of aquatic animals. Green, brown, and red seaweeds are the three sorts. They are beneficial to the human population for a variety of reasons, including food, fertilizers, and medications (Temkar *et al*., 2018). Sea weeds have proved effective in enhancing yield, pest and frost resistance in vegetables, fruits, flowers, cereals and pulses. Increased germination percent and rate, increased seedling vigor, increased shoot and root growth, increased net carbon assimilation and ultimately total grain yield. Sea weeds (*Kppaphycus alvarezii* and *Sargassum wightii*) extricate has been discovered wealthy in supplements including plant development controllers for example IAA, kinetin, zeatine, auxin, cytokinin and gibberellins (Zodape *et al.,* 2010 and Layek *et al*., 2016). The compound auxin plays a role in physiological processes in plants, such as growth, cell division and differentiation, and protein synthesis. Cytokinin plays an important role in cell division which causes a plant response with respect to plant growth, fruit formation and sprout germination (Fatriana *et al*., 2020). Sea weed sap is a less expensive wellspring of supplement just as natural in nature which will deal with soil wellbeing and climate as well. Seaweed Liquid Fertilizer (SLF) is a blend of both plant growth regulators and organic nutrient input is eco-friendly, promoting sustainable productivity and maintaining soil health (Mohanty *et al.,* 2013 and Shah, *et al.,* 2013).

Jader *et al.* (2020) noticed that from field experiment was conducted during spring seasons of 2017 and 2018 in Iraq to study the effect of foliar spraying of seaweed extracts on growth traits and grain yield of four genotypes of yellow corn. The corn genotypes differed significantly in respect to growth and yield traits. The corn genotype 5017 produced significantly higher growth and yield traits compared to other genotypes during both the years. The spraying of corn plants with seaweed extract @ 6 ml/l produced significantly higher leaf area, length of cob, number of grains/cob and grain yield per plant in 2017 and 2018, respectively. And concluded that genotype 5017 sprayed with seaweed extract @ 6 ml/l excelled over other genotypes in respect of growth and yield.

Therefore, in view of the above, the present investigation were undertaken with an aim to evaluate the effect of seaweed sap foliar application on AGR, CGR and RGR of maize (*Zea mays* L) cultivars to encourage sustainable development under eastern Uttar Pradesh condition.

MATERIALS AND METHODS

The experiment was carried out during *zaid* season of 2020 and 2021 at Crop Research Farm (CRF), Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (25° 39′42″N and 81°67′56″E and 98m altitude) on sandy clay loam soil of eastern Uttar Pradesh condition. The experimental soil initially before sowing crop was nearly neutral in soil reaction (pH – 7.28 and 7.15, low in organic carbon (0.37% and 0.29%) medium in available Nitrogen (226.49 and 210.66 kg/ha), medium in available Phosphorous (16.90 and 18.44 kg/ha) and low in available Potassium (192.20 and 196.39 kg/ha) during *zaid* seasons of 2020 and 2021. Prayagraj belongs to sub-tropical and semi-arid climatic condition, with both extremes of temperature, *i.e*., winter and summer. The summer season lasts from April to June with the maximum temperatures ranging from 40°C (104°F) to 45°C (113 °F). Monsoon begins in early July and lasts till September. The experiment was laid out in split plot design with twenty eight treatments replicated thrice. The main plot comprised of 4 cultivars *i.e.* (a) VMH-27 (b) VMH-53 (c) VLMH-57 and (d) VLQPMH-59 and in subplot 3 concentrations (5%, 7.5% and 10%) of both Seaweed sap (*Kappaphycus* sp. *& Sargassum* sp.) foliar applications along with water spray. The amount of different fertilizers required to supply the needed quantities of nutrients were calculated on per plot basis as per recommended dose of fertilizer. The growth indices *i.e.* Accumulate growth rate (AGR), Crop growth rate (CGR) and Relative growth rate (RGR) was evaluated as per standard process. Measurement of Absolute growth rate (AGR) was calculated by adopting the formula suggested by Kvet *et al.* (1971), formula: AGR (g/plant/day) = $(W2 - W1)/(T2 - T1)$ and expressed in g/plant/day. Crop growth rate (CGR) is in the increase in plant dry materials per unit area of

land per unit time. CGR values were estimated at 20-day interval as described by Watson (1952), CGR was arrived at using the formula CGR (g/m^2/day) = $[(W2 - W1)/(T2 - T1)][1/S]$, where $W1$ is total dry weight at time $T1$ and $W2$ is the total dry weight at time $T2$ and S is the ground spacing and expressed in g/m^2/day. The RGR was determined by adopting the formula suggested by Williams (1946), RGR (g/g/day) = $(\ln W1 - \ln W2)/(T1 - T2)$, where $W1$ is total dry weight at time $T1$, $W2$ is total dry weight at time $T2$, and ln is natural logarithm and expressed in g/g/day. All the data were subjected to analysis of variance (ANOVA) by using a split-plot design and main effects and interactions were tested for significance. Treatment means obtained by ANOVA were compared using critical difference (CD) at P=0.05 level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

A. Effect of seaweed sap foliar application on accumulate growth rate (AGR) of Maize cultivars

Periodical observation of data concerned with absolute growth rate (AGR, g/days) has been depicted in Table 1. The maize cultivars at initially showed significant effect on absolute growth rate at 20-40 40-60 DAS and 80 DAS-At harvest influence significantly among experimental cultivars. However at 60-80 DAS showed non-significant effect. Absolute growth rate 0.73, 4.69 and 1.49 g/plant/day were recorded significantly maximum with cultivar V_3: VLMH-57 at 20-40, 40-60 and 80 DAS-at harvest and found significantly superior among rest of the cultivars. While in case of Seaweed sap, maximum absolute growth rate 0.72, 4.54, 2.94 and 1.05 g/plant/day were recorded significantly with S_7: S-Seaweed sap 10% foliar application which was statistically at par to foliar application of S_4: K-Seaweed sap 10% at 20-40, 40-60, 60-80 DAS and 80 DAS – At harvest. Growth hormones from algae extract play a role in the absorption of nutrients by plants efficiently (Basavaraja *et al*., 2018). Availability of macro and micro nutrient components in seaweed are transferred during the generative phase and which can stimulate the formation of the corn effectively (Pal *et al*., 2015).

B. Effect of seaweed sap foliar application on crop growth rate (CGR) of Maize cultivars

Crop growth rate (CGR) express as the gain in weight of plant per unit of land per unit of time. The data pertaining to crop growth rate computed at periodic intervals as influenced by various treatments displayed in Table 2.

Table 1: Effect of cultivars and seaweed sap on absolute growth rate (AGR) at different growth interval of maize (Two year pooled analysis).

Treatments	Absolute Growth Rate (AGR) (g/day)			
	20-40 DAS	40-60 DAS	60-80 DAS	80 DAS - At harvest
Cultivars (V)				
V_1: VMH-27	0.61	4.17	2.39	0.87
V_2: VMH-53	0.58	3.58	2.22	0.77
V_3: VLMH-57	0.69	4.60	2.19	1.41
V_4: VLQPMH-59	0.60	4.09	2.44	0.68
F-test	S	S	NS	S
SEm(±)	0.02	0.08	0.10	0.07
CD (P=0.05)	0.05	0.26	0.35	0.26
CV (%)	11.22	8.37	20.03	16.67
Seaweed sap foliar spray (S)				
S_1: Water Spray	0.48	3.51	1.59	0.71
S_2: K- Sea-weed sap 5%	0.58	4.06	1.91	0.91
S_3: K- Sea-weed sap 7.5%	0.63	4.15	2.21	0.94
S_4: K- Sea-weed sap 10%	0.68	4.46	2.83	1.05
S_5: S- Sea-weed sap 5%	0.60	3.85	2.32	0.93
S_6: S- Sea-weed sap 7.5%	0.64	4.21	2.39	0.95
S_7: S- Sea-weed sap 10%	0.72	4.54	2.94	1.05
F-test	S	S	S	S
SEm(±)	0.02	0.11	0.15	0.03
CD (P=0.05)	0.07	0.32	0.45	0.09
CV (%)	12.56	9.25	13.09	11.51
Cultivars × Seaweed sap (V × S)	NS	NS	NS	S

Note: K- Seaweed sap: *Kappaphycus alvarezii* seaweed sap; S- Seaweed sap: *Sargasssum wightii* seaweed sap

It is apparent from the data that the improved cultivars of maize exerted significant influence on crop growth rate at all the growth stages except 60 – 80 DAS. Among the different cultivars, the maximum crop growth rate 6.49, 45.19 and 13.39 g/m^2/day were recorded by cultivar V_3: VLMH-57 at 20-40 DAS, 40-60 DAS, and 80-at harvest, while at 40-60 DAS, crop growth rate with V_2: VMH-53 and V_4: VLQPMH-59 were found statistically at par with cultivar V_3: VLMH-57. Seaweed sap foliar application significantly influenced the crop growth rate throughout the stages of crop growth till harvest. The higher CGR obtained during the study under the treatments is the reflection of higher amount of dry matter accumulation in respective

periods. The highest crop growth rate (CGR) 7.17, 45.39, 29.39 and 10.5 g/m^2/day were recorded with concentration S_7: S-Seaweed sap 10% foliar application which was closely followed by foliar application of S_4: K-Seaweed sap 10% at 20-40, 40-60, 60-80 DAS and 80 DAS – at harvest. The increased Crop Growth Rate (CGR), may be due to the fact that, along with improved cultivars sea weed extract help to enhance growth by providing essential nutrient. Devi *et al*., (2015) revealed that seaweed extract mainly contains amino acids like betaines and sterols which enhance the photosynthetic activity, N metabolism and protein synthesis which boost corn production, and also availability of growth regulators in extract especially Auxin and Cytokinin which are responsible for inter-nodal elongation and cell enlargement and there by increases the growth. Similar findings also reported by Hegde *et al*. (2016).

Table 2: Effect of cultivars and seaweed sap on crop growth rate (CGR) at different growth interval of maize (Two year pooled analysis).

Treatments	Crop Growth Rate (CGR) (g/m^2/day)			
	20-40 DAS	40-60 DAS	60-80 DAS	80 DAS - At harvest
Cultivars (V)				
V_1: VMH-27	6.12	41.68	23.89	8.65
V_2: VMH-53	5.75	35.82	22.24	7.68
V_3: VLMH-57	6.87	46.05	21.86	14.13
V_4: VLQPMH-59	6.04	40.94	24.41	6.80
F-test	S	S	NS	S
SEm(±)	0.15	0.75	1.01	0.75
CD (P=0.05)	0.53	2.60	3.49	2.58
CV (%)	11.22	8.37	20.03	16.67
Seaweed sap foliar spray (S)				
S_1: Water Spray	4.81	35.13	15.85	7.06
S_2: K- Sea-weed sap 5%	5.84	40.65	19.08	9.05
S_3: K- Sea-weed sap 7.5%	6.28	41.48	22.06	9.35
S_4: K- Sea-weed sap 10%	6.83	44.59	28.26	10.49
S_5: S- Sea-weed sap 5%	6.02	38.55	23.19	9.26
S_6: S- Sea-weed sap 7.5%	6.44	42.07	23.87	9.51
S_7: S- Sea-weed sap 10%	7.17	45.39	29.39	10.50
F-test	S	S	S	S
SEm(±)	0.22	1.10	1.54	0.31
CD (P=0.05)	0.65	3.18	4.46	0.90
CV (%)	12.56	9.25	23.09	11.51
Cultivars × Seaweed sap (V × S)	NS	NS	NS	S

Note: K- Seaweed sap: *Kappaphycus alvarezii* seaweed sap; S- Seaweed sap: *Sargasssum wightii* seaweed sap

C. Effect of seaweed sap foliar application on relative growth rate (RGR) of Maize cultivars

Relative growth rate (RGR) express is an index of the amount of growing material incorporated per unit dry weight of plant per unit of time. The data pertaining to relative growth rate was computed at periodic intervals as influenced by various treatments displayed in Table 3. Perusal of the data revealed that the improved cultivars of maize exerted non-significant influence on relative growth rate at all the growth stages except 20-40 DAS interval. Among the different cultivars, V_3: VLMH-57 was significantly recorded higher value of relative growth rate as compared to other cultivars at 20-40 DAS which was followed by V_1: VMH-27. Seaweed sap foliar application significantly influenced the relative growth rate (RGR) at 20-40 DAS.

The highest relative growth rate (RGR) (0.153) was recorded under foliar application of S_7: S-Seaweed sap 10% which was significantly superior among all rest of the foliar application except it was followed by foliar application of S_3: K-Seaweed sap 7.5%, S_4: K-Seaweed sap 10% and S_6: S-Seaweed sap 7.5% at 20-40 DAS. The highest RGR was registered for application of S_7: S-Seaweed sap 10% which enhance growth on vegetative stage. By the application of seaweed sap presence of plant growth regulators it has increased the power of source and thus help to increased the transport of assimilates to the sink including roots and young leaves. The results are in good agreement with findings of Singh *et al*. (2016).

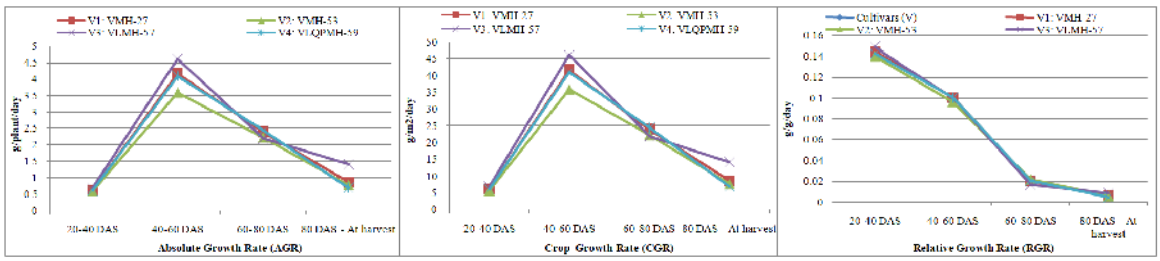

Fig. 1. Effect of cultivars on growth indices AGR, CGR and RGR.

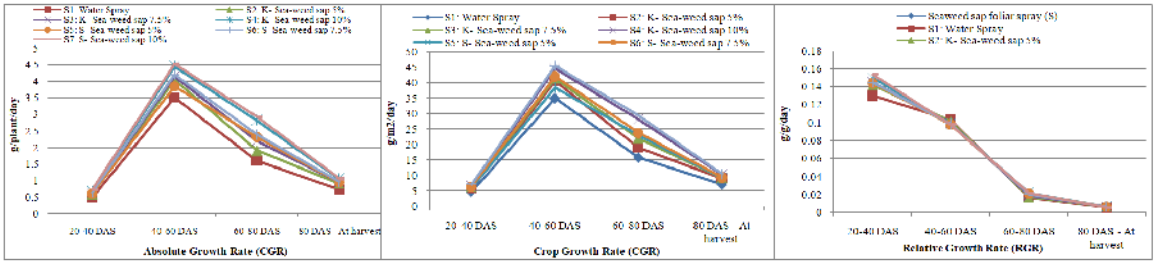

Fig. 2. Effect of seaweed sap on growth indices AGR, CGR and RGR.

Table 3: Effect of cultivars and seaweed sap on Relative Growth Rate (CGR) at different growth interval of maize (Two year pooled analysis).

Treatments	Relative Growth Rate (RGR) (g/g/day)			
	20-40 DAS	40-60 DAS	60-80 DAS	80 DAS - At harvest
Cultivars (V)				
V_1: VMH-27	0.1443	0.1007	0.0199	0.0056
V_2: VMH-53	0.1401	0.0964	0.0213	0.0056
V_3: VLMH-57	0.1494	0.1005	0.0169	0.0086
V_4: VLQPMH-59	0.1425	0.1003	0.0207	0.0046
F-test	S	NS	S	S
SEm(±)	0.0015	0.0016	0.0008	0.0004
CD (P=0.05)	0.0052	0.0057	0.0028	0.0015
CV (%)	4.8062	7.5388	18.585	32.401
Seaweed sap foliar spray (S)				
S_1: Water Spray	0.1299	0.1030	0.0168	0.0059
S_2: K- Sea-weed sap 5%	0.1421	0.1015	0.0171	0.0063
S_3: K- Sea-weed sap 7.5%	0.1449	0.0993	0.0188	0.0062
S_4: K- Sea-weed sap 10%	0.1498	0.0987	0.0218	0.0061
S_5: S- Sea-weed sap 5%	0.1439	0.0976	0.0210	0.0063
S_6: S- Sea-weed sap 7.5%	0.1446	0.0985	0.0200	0.0061
S_7: S- Sea-weed sap 10%	0.1534	0.0977	0.0222	0.0059
F-test	S	NS	S	NS
SEm(±)	0.0025	0.0023	0.0013	0.0002
CD (P=0.05)	0.0071	0.0066	0.0037	0.0005
CV (%)	5.9005	7.9789	22.321	10.066
Cultivars × Seaweed sap (V × S)	NS	NS	NS	S

Note: K- Seaweed sap: *Kappaphycus alvarezii* seaweed sap; S- Seaweed sap: *Sargasssum wightii* seaweed sap

CONCLUSION

The research findings on the basis of two years experimentation reveal that the different cultivars of maize along with seaweed foliar application have the potential to influence yield of maize. Hence, it can be concluded from the two year experiment that the maize cultivars V_3: VLMH-57 sprayed with S_7: S-Seaweed sap 10% concentration significantly affect growth indices and produced maximum vegetative growth.

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Conflict of Interest. None.

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