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Influence of seaweed sap (biozyme) on performance of maize (*Zea mays* L.) hybrids during *rabi* season in New Alluvial Zone of West Bengal

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ABSTRACT

The present study was conducted during two consecutive rabi seasons of 2016-17 and 2017-18 at the Central Research Farm, Gayeshpur, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal, India. Objectives are to identify the suitable maize hybrid during rabi season for New Alluvial Zone of West Bengal and also to find out the dose of seaweed sap (Biozyme) for maize hybrids and their interaction effect of maize hybrids with seaweed sap (Biozyme) on growth and yield. The experiment was laid out in split plot design with three maize hybrids (Kaveri 50, P 3396 and HQPM 1) in the main plots and four levels of seaweed sap (biozyme) in sub-plots, no biozyme or water spray; 1 ml l^{-1}; 2 ml l^{-1} and 3 ml l^{-1} of water was sprayed twice at 25 and 50 Days After Sowing (DAS) in addition to recommend dose of fertilizer. Growth parameters like plant height, number of green leaves/plants, Leaf Area Index (LAI), dry aerial biomass of maize hybrids varied significantly at 50 DAS onwards and the maximum values of those parameters including Crop Growth Rate (CGR) and Relative Growth Rate (RGR) were recorded in the hybrid P 3396 while HQPM 1 gave the least value at all the growth stages. Plant height, green leaves $plant^{-1}$ and LAI increased gradually with the increase of biozyme from 1 ml l^{-1} to 3 ml l^{-1} at 50 DAS onwards and attained maximum at 3 ml l^{-1} while the higher dry aerial biomass, CGR and RGR was obtained with biozyme at 2 ml l^{-1} of water. Among the hybrids significantly highest grain yield (8.12 t ha^{-1}) and HI (41.92%) were obtained from P3396 whereas Kaveri 50 gave highest stover yield (11.97 t ha^{-1}). In case of see weed sap (biozyme) 2 ml l^{-1} resulted significantly the maximum grain yield, stover yield and harvest index (7.22, 11.83 t ha^{-1}, 37.47%, respectively) and the least value of all the above was obtained in HQPM 1. Regarding interaction of variety and biozyme, the effect was significant and the maximum grain yield (8.55 t ha^{-1}) and harvest index (42.85%) were observed in the combination of P 3396 x biozyme (2 ml l^{-1}) while highest stover yield (12.35 t ha^{-1}) was recorded from Kaveri 50 x biozyme (2 ml l^{-1}).

***Keywords*:** Yield, maize hybrids, seaweed sap

Maize (*Zea mays* L.) is considered as the third most staple food crop of the country both in area and production followed by rice and wheat. The productivity of maize in India is less as compare to the world productivity and unavailability of suitable genotype under various agroclimatic conditions of India may be one of the reasons. Adoption of hybrid varieties of maize that are high yielding and have shown better adaptability under proper management practices offers possibility of increasing maize production in India. Biozyme is an innovation in Biotechnology Research and is an eco-friendly, non-toxic commercial plant nutrients rich product which influences plants growth and yield even at low concentrations. It is an organic storehouse of naturally occurring nutrients derived from Norwayian seaweed (*Ascophyllum nodosum*). It also contains plant hormones (Auxins, Cytokynins, Gibberellins), macronutrients (Mg, S & minimum N P K), micronutrients (B, Fe, Mn, Zn) and other compounds like carbohydrates, amino acids, algenic acid, 3vitamins, vitamin precursors, organic smolites (Betaines), hydrolysed proteins and enzymes (Kumar and Mohan, 2000). Sap of Norwayan seaweed (*Ascophyllym nodosum*) or biozyme plays an important role in physiological growth of crops. It increases the leaf size of plants because of increased hormonal action in treated plants as the sap has been found to contain biologically active cytokinins, which promote cell division (Abdel-Mawgoud *et al*., 2010; Khan *et al*., 2012). With the above background, present experiment is set with the following objectives -to identify the suitable maize hybrid during rabi season for New Alluvial Zone of West Bengal, to find out the optimum planting geometry and dose of seaweed sap (Biozyme) for maize hybrids and to observe the interaction effect of maize hybrids with seaweed sap (Biozyme) on plant growth parameters and yield.

MATERIALS AND METHODS

The field experiment was conducted during the winter seasons (November-March) of 2016-17 and 2017-18 at the Central Research Farm, Gayeshpur,

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Bidhan Chandra Krishi Viswavidyalaya, encompassing the New Alluvial Zone of West Bengal, India situated at an altitude of 9.75 m above mean sea level and intersected by 22.58^0 N latitude, 88.31^0 E longitude. The soil of the experimental field was sandy loam in texture having pH 6.72 and 6.71, organic carbon 0.57 and 0.56%, available nitrogen 198.26 and 197.37 kg ha^{-1}, available phosphorus 31.73 and 31.32 kg ha^{-1} and available potassium 172.52 and 171.80 kg ha^{-1}, during year1 and year 2 of the study period. Average weather situation during the cropping season (November-February) in both years was as- Maximum temperature varies from 29.3 to 24^0C and Minimum 17.8 to 8.8^0C and Relative Humidity varies from 93.8 to 89.9 (Max) whereas 58.7 to 45.6 (Min). In 2nd year total 52 mm rainfall was received during November and December. The experiment was conducted in split-plot design having 3 hybrid maize varieties namely Kaveri 50, P 3396 and HQPM 1 in the main plot and 4 Biozyme treatments like B_0 = No seaweed sap or water spray (Control), B_1 = Application of seaweed sap (Biozyme) @ 1 ml l^{-1} ofwater (at 25 & 50 DAS), B_2 = Application of seaweed sap (Biozyme) @ 2 ml l^{-1} of water (at 25 & 50 DAS) and B_3 = Application of seaweed sap (Biozyme) @ 3 ml l^{-1} of water (at 25 & 50 DAS) in sub-plots which was replicated thrice. 60×20 cm spacing was given. * Recommended dose of fertilizer (RDF) was given at all the treatments @150:75:75 N, P_2O_5, K_2O Kg ha^{-1}(Source: BCKV Bulletin). Growth parameters were recorded in 25 days interval (25DAS, 50DAS, 75DAS and 100DAS) and thereby growth analysis was done, and yield data was recorded at harvest.

Statistical analysis

Data recorded on various parameters were analyzed by 'Analysis of Variance' (ANOVA) as split plot design (Gomez and Gomez, 2010). The significance of difference for sources were tested by error mean square by Fisher Snedecor's 'F' test at probability level of 5% (P = 0.05). For comparison of 'F' value and computation of critical difference (C.D.) at 5% level of significance, Fisher and Yates (1963) table were consulted. For pooled analysis of the two experimentation years, the F-test was used to test the homogeneity of error variance with F-value computed as the ratio of two variances, i.e., large error variance in the numerator and the small error variance in the denominator (Gomez and Gomez, 2010). Accordingly, pooled analysis of recorded data was done and presented to discuss and to draw logical conclusions.

RESULTS AND DISCUSSION

Growth parameters

Pooled data of various parameters on growth of maize such as plant height, number of green leaf plant^{-1}, leaf area index, dry aerial biomass are presented in table 1 and in case of crop growth rate (CGR) and relative growth rate (RGR) are in Table 2.

Different maize hybrids significantly influenced the plant height of maize plant at all the date of observations except 25 DAS in both the years as well as in pooled analysis (Table 1). Pooled data revealed that hybrid 'P 3396' exhibited the maximum plant height (78.19, 139.72 and 216.65 cm during 50, 75 and 100 DAS respectively) followed by Kaveri 50 and HQPM 1. The variation in the height among the different maize hybrids recorded during different growth stages of the crop might be due to differences in their genetic characteristics which includes rapid growth rates, tallness or shortness of the species and the maturity period too. The results are in agreement with the findings of Konuskan (2000) and Gozubenli *et al*., (2001) who reported that variation in plant height of maize hybrids was due to its genetic makeup. Application of seaweed sap (biozyme) influenced the plant height of maize significantly at all the dates of observations except 25 DAS and plant height increased with the gradual increase in the dose of biozyme in both the years as well as in pooled analysis. At 50 DAS onwards, maximum plant height was observed with the B_3 treatment (76.08, 143.46 and 214.96 cm during 50, 75 and 100 DAS respectively), followed by B_2 and B_1 treatment while the least plant height was recorded in water spray plots (B_0). Interaction of maize hybrids and application of biozyme exhibited significant effect at all the growth stages except 25 and 50 DAS at which no significant response could be observed during both the years of study and in pooled data. However, maximum plant height was recorded from the treatment combination of P 3396 hybrid and biozyme (B_3 treatment) at all the growth stages. This might be due to better individual effect of the said hybrid and biozyme dose. This increase in plant height with higher doses of biozyme might be owing to more availability of plant growth promoting substances and nutrients in the seaweed sap (biozyme). Similar result was also reported by Kavitha *et al*. (2008) in rice and Shah *et al*. (2013) in wheat with the application of seaweed extract (Phytozyme).

Different maize hybrids elucidated significant effect on the number of green leaves at almost all the stages of crop growth except 25 DAS, at which no significant differences in number of green leaves were found in pooled data (Table 1). Number of green leaves plant^{-1} was increased gradually with the advancement of age attaining maximum at 100 DAS and then decreased gradually till the maturity irrespective of hybrids. Similar result was also recorded by Singh (2014) wherein it was observed that the number of green leaves/plants was

Table 1: Effect of hybrids and seaweed sap (Biozyme) on plant height (cm), no. of green leaves plant^{-1}, dry aerial biomass (g $^{m-2}$) and LAI of maize crop

Treatment	25 DAS				50 DAS				75 DAS				100 DAS			
Hybrids	**Height**	**Leaves**	**Biomass**	**LAI**	**Height**	**Leaves**	**Biomass**	**LAI**	**Height**	**Leaves**	**Biomass**	**LAI**	**Height**	**Leaves**	**Biomass**	**LAI**
Kaveri 50	25.63	4.43	50.62	0.36	74.81	7.42	256.49	1.10	137.65	10.61	626.31	2.95	215.42	13.56	1043.38	4.38
P 3396	26.53	4.40	50.88	0.36	78.19	7.77	271.80	1.15	139.72	10.80	662.75	3.03	216.65	14.74	1093.28	4.50
HQPM1	25.68	4.34	45.65	0.34	65.48	6.15	158.38	0.99	124.96	9.26	518.29	2.12	193.24	11.00	904.99	3.28
SEm (±)	0.44	0.02	0.39	0.02	1.11	0.05	3.34	0.02	0.46	0.06	4.71	0.06	0.68	0.09	4.26	0.07
LSD (0.05)	NS	NS	NS	NS	3.62	0.16	10.90	0.06	1.50	0.19	15.36	0.20	2.21	0.29	13.88	0.22
Seaweed sap (Biozyme)																
B_0	25.73	4.38	49.99	0.36	69.47	6.00	216.93	0.98	126.05	9.74	562.23	2.18	203.03	10.87	959.96	3.58
B_1	26.35	4.45	50.07	0.36	71.04	6.63	221.48	1.05	129.57	10.07	601.64	2.62	205.22	11.71	985.53	3.95
B_2	25.68	4.33	50.01	0.35	74.70	7.83	239.00	1.14	137.36	10.05	631.76	2.98	210.54	14.62	1058.52	4.32
B_3	26.03	4.40	50.14	0.34	76.08	7.99	238.16	1.15	143.46	10.58	614.17	3.01	214.96	15.20	1051.53	4.38
SEm (±)	0.45	0.03	0.16	0.02	1.19	0.07	2.46	0.03	0.54	0.04	6.21	0.04	0.37	0.21	4.24	0.03
LSD (0.05)	NS	NS	NS	NS	3.41	0.20	7.06	0.08	1.54	0.11	17.82	0.11	1.09	0.60	12.15	0.08
Kaveri 50																
B_0	26.04	4.41	50.34	0.35	71.05	6.17	2.37.78	1.12	128.80	10.24	564.78	2.53	211.37	10.80	978.49	4.03
B_1	26.41	4.47	50.46	0.36	72.47	6.83	242.41	1.02	132.22	10.56	625.59	3.05	213.53	11.66	1010.01	4.44
B_2	24.13	4.44	50.91	0.36	78.05	8.30	274.17	1.17	140.66	10.78	672.39	3.08	215.74	15.04	1106.42	4.49
B_3	25.94	4.40	50.79	0.36	77.65	8.39	271.61	1.10	148.91	10.86	642.47	3.15	221.06	16.75	1078.60	4.57
P 3396																
B_0	26.34	4.47	51.19	0.37	75.24	6.91	263.11	1.04	130.30	10.48	633.34	2.65	208.83	12.96	1029.87	4.18
B_1	26.58	4.47	51.24	0.37	77.56	7.50	267.60	1.11	133.99	10.82	655.87	3.12	211.13	14.03	1053.96	4.55
B_2	27.31	4.21	50.18	0.37	80.71	8.23	283.95	1.17	144.16	10.90	692.36	3.11	220.71	15.05	1148.42	4.61
B_3	25.88	4.43	50.91	0.35	79.24	8.45	272.55	1.28	150.44	10.99	669.45	3.21	225.93	16.91	1140.87	4.67
HQPM 1																
B_0	24.79	4.27	48.45	0.35	62.11	4.93	149.90	0.77	119.05	8.51	488.56	1.37	188.89	8.84	871.52	2.54
B_1	26.06	4.40	48.51	0.35	63.10	5.56	154.44	1.02	122.49	8.82	523.47	1.68	191.00	9.45	892.63	2.86
B_2	25.61	4.33	48.95	0.33	65.35	6.97	158.87	1.09	127.26	9.81	530.54	2.74	195.17	13.77	920.71	3.85
B_3	26.26	4.36	48.71	0.32	71.35	7.13	170.32	1.08	131.04	9.89	530.59	2.67	197.89	11.95	935.10	3.89
Hybrids x Seaweed sap (Biozyme)																
SEm (±)	0.78	0.05	0.27	0.03	2.06	0.12	4.84	0.05	0.93	0.06	6.04	0.06	0.65	0.37	7.34	0.06
LSD (0.05)	NS	NS	NS	NS	NS	0.34	NS	0.15	2.66	0.17	17.34	0.17	1.86	1.05	21.05	0.17
Seaweed sap (Biozyme) x Hybrids																
SEm (±)	0.81	0.05	0.46	0.04	2.10	0.12	5.21	0.05	0.93	0.08	7.04	0.08	0.88	0.33	7.65	0.08
LSD (0.05)	NS	NS	NS	NS	NS	0.39	NS	0.16	3.01	0.26	22.91	0.26	2.85	1.07	24.91	0.26

NS: Non-Significant

Table 2: Effect of hybrids and seaweed sap (Biozyme) on crop growth rate (g $m^{-2}day^{-1}$) and relative growth rate (g g^{-1} day^{-1}) of maize crop

Treatment	26-50 DAS		51-75 DAS		76-100 DAS	
Hybrids	**CGR**	**RGR**	**CGR**	**RGR**	**CGR**	**RGR**
Kaveri 50	9.56	0.0281	11.43	0.017	17.25	0.0106
P 3396	10.14	0.0291	12.57	0.017	17.65	0.0112
HQPM 1	5.76	0.0204	11.18	0.016	14.76	0.0101
SEm (±)	0.12	0.0004	0.20	0.0001	0.16	0.0001
LSD (0.05)	0.39	0.0013	0.65	0.0003	0.52	0.0003
Seaweed sap (Biozyme)						
B_0	8.01	0.0250	10.82	0.0168	15.58	0.0102
B_1	8.19	0.0253	11.39	0.0171	15.98	0.0105
B_2	8.89	0.0267	12.78	0.0176	17.62	0.0111
B_3	8.85	0.0265	11.91	0.0172	17.05	0.0107
SEm (±)	0.10	0.0002	0.17	0.0001	0.16	0.0001
LSD (0.05)	0.28	0.0006	0.48	0.0003	0.46	0.0003
Kaveri 50						
B_0	8.83	0.0270	10.23	0.0169	16.21	0.0103
B_1	9.01	0.0273	10.98	0.0171	16.96	0.0105
B_2	10.25	0.0291	13.08	0.0174	18.31	0.0108
B_3	10.15	0.0292	11.44	0.0175	17.53	0.0109
P 3396						
B_0	9.78	0.0284	11.86	0.0172	16.20	0.0108
B_1	9.95	0.0287	12.09	0.0175	16.46	0.0112
B_2	10.65	0.0291	13.39	0.0180	19.28	0.0116
B_3	10.17	0.0301	12.93	0.0176	18.68	0.0112
HQPM 1 14.33						
B_0	5.42	0.0195	10.38	0.0162	14.33	0.0097
B_1	5.60	0.0200	11.09	0.0166	14.53	0.0097
B_2	5.78	0.0217	11.87	0.0174	15.26	
B_3	6.25	0.0203	11.37	0.0166	14.94	
Hybrids x Seaweed sap (Biozyme)						
SEm (±)	0.19	0.0005	0.29	0.0005	0.28	
LSD (0.05)	NS	NS	NS	NS	0.80	
Seaweed sap (Biozyme) x Hybrids						
SEm (±)	0.21	0.0006	0.32	0.0007	0.29	
LSD (0.05)	NS	NS	NS	NS	0.94	

NS: Non-Significant

significantly increased up to 90 days of *kharif* maize and thereafter declined due to leaf senescence at the late maturity stage. From the data presented in Table 1, it was found that among the different hybrids, P 3396 exhibited maximum number of green leaves (7.77, 10.80 and 14.74 during 50, 75 and 100 DAS, respectively) followed by Kaveri 50 and HQPM 1 at all the dates of observation. Foliar application of seaweed sap (biozyme) elucidated a significant effect on the number of green leaves $plant^{-1}$ at all the stages of crop growth except 25 DAS. Highest number of leaves $plant^{-1}$ was observed in B_3 treatment (7.99, 10.58 and 15.20 during 50, 75 and 100 DAS, respectively) which was statistically at par with B_2 treatment and least was found in control i.e., B_0 with the same trend in both the years of study. Interaction effect of different maize hybrids

Table3: Effect of hybrids and seaweed sap (Biozyme) on grain and stover yield and harvest index of maize crop

Treatment	Grain Yield (t ha^{-1})			Stover yield (t ha^{-1})			HI (%)		
Hybrids	**Year 1**	**Year 2**	**Pooled**	**Year 1**	**Year 2**	**Pooled**	**Year 1**	**Year 2**	**Pooled**
Kaveri 50	7.52	7.97	7.74	11.92	12.03	11.97	38.16	39.24	38.70
P 3396	7.97	8.26	8.12	11.03	11.18	11.10	41.88	41.96	41.92
HQPM 1	4.84	5.27	5.06	10.98	11.09	11.04	30.11	31.06	30.58
SEm (±)	0.29	0.28	0.20	0.20	0.19	0.14	0.81	0.82	0.58
LSD (0.05)	1.13	1.11	0.65	0.79	0.75	0.46	3.18	3.21	1.88
Seaweed sap (Biozyme)									
B_0	6.28	6.66	6.47	10.61	10.74	10.67	36.17	36.86	36.51
B_1	6.84	7.26	7.05	11.27	11.40	11.34	36.66	37.37	37.01
B_2	7.03	7.40	7.22	11.78	11.89	11.83	37.12	37.82	37.47
B_3	6.95	7.35	7.15	11.57	11. 71	11.64	36.92	37.64	37.28
SEm (±)	0.09	0.10	0.07	0.09	0.10	0.07	0.19	0.20	0.14
LSD (0.05)	0.26	0.29	0.20	0.26	0.29	0.20	0.56	0.59	0.40
Kaveri 50									
B_0	7.14	7.59	7.36	11.54	11.65	11.60	37.89	38.92	38.41
B_1	7.47	7.92	7.69	11.77	11.88	11.82	37.81	38.87	38.34
B_2	7.91	8.36	8.13	12.29	12.40	12.35	38.82	39.92	39.37
B_3	7.56	8.01	7.79	12.08	12.19	12.13	38.14	39.24	38.69
P 3396									
B_0	7.11	7.41	7.26	9.61	9.76	9.68	41.37	41.47	41.42
B_1	8.02	8.32	8.17	11.11	11.26	11.19	41.37	41.47	41.42
B_2	8.41	8.68	8.55	11.86	12.01	11.93	42.84	42.87	42.85
B_3	8.35	8.65	8.50	11.54	11.69	11.61	41.93	42.03	41.98
HQPM 1									
B_0	4.60	4.99	4.80	10.68	10.81	10.74	29.24	30.19	29.72
B_1	4.76	5.17	4.97	10.93	11.06	11.00	30.80	31.75	31.28
B_2	5.05	5.54	5.29	11.19	11.25	11.22	29.71	30.66	30.18
B_3	4.95	5.39	5.17	11.11	11.26	11.18	30.69	31.64	31.16
Hybrids x Seaweed sap (Biozyme)									
SEm (±)	0.16	0.17	0.12	0.18	0.17	0.12	0.33	0.34	0.24
LSD (0.05)	0.47	0.50	0.34	0.53	0.50	0.34	0.98	1.01	0.68
Seaweed sap (Biozyme) x Hybrids									
SEm (±)	0.36	0.37	0.23	0.25	0.24	0.16	1.01	1.02	0.61
LSD (0.05)	1.17	1.21	0.75	0.82	0.78	0.52	3.29	3.34	1.99

NS: Non-significant

and biozyme had significantly influenced the number of green leaves plant^{-1} at 75 and 100 DAS. At 25 DAS it was found not significant but at 50 DAS, interaction effect was significant. However, the best result was noticed in the combination of the hybrid P 3396 and B_3 treatment at all the growth stages. Similarly, a significant interaction of seaweed sap and hybrids on growth attributes was reported by Prinka and Thind (2016) on rice and Dilavarnaik *et al*. (2017) on hybrid maize.

The data on total dry aerial biomass presented in Table 1 revealed that there was a significant effect of different hybrids and biozyme treatments on all the growth stages except 25 DAS. Pooled data revealed that the hybrid P 3396 exhibited the maximum dry aerial biomass (271.80, 662.75 and 1093.28 g m^{-2} during 50, 75 and 100 DAS, respectively) might be due to higher plant height, more number of leaves, more healthy and vigorous plants which were the genetical characteristics

of the hybrid (Konuskan, 2000; Gozubenli *et al*., 2001) followed by Kaveri 50 and HQPM 1. These results are in line of the results reported by Vavaliya *et al.* (2018) where higher dry biomass was recorded in hybrid GAWMH 2 and the least in HQPM 1 at all the growth stages. In case of biozyme, values were 985.53, 1058.52 and 1051.53 over the control 959.96 g m^{-2}. Interaction effect of different hybrids and biozyme treatments was not significant at 25 and 50 DAS, while at 75 and 100 DAS those were significant. Maximum dry aerial biomass of maize crop was recorded from the hybrid P 3396 with B_2 treatment at all the growth stages of maize crop. Regarding seaweed sap (biozyme), significant influence on dry aerial biomass was observed in the biozyme applied plots over water spray (no biozyme) plots at all the growth stages (except 25 DAS) might be due to presence of plant growth regulators, micronutrients etc. present in biozyme which in turn enhanced the plant height, number of leaves $plant^{-1}$ etc. and the higher dry aerial biomass was observed from the B_2 plots. Increase of dry matter of plants was also recorded due to presence of micronutrient (Sridhar and Rengasamy, 2011) and some growth-promoting substances (Blunden, 1991) in the seaweed sap leading to increased plant height, leaf area etc. Similarly, Kavitha *et al.* (2008) observed a significantly higher total dry matter accumulation (13.38 t ha^{-1}) at harvesting stage which was recorded with the spraying of seaweed (phytozyme) at 0.3% solution twice (at 50% flowering and milk stages).

Maize hybrids influenced the leaf area index (LAI) of maize significantly at 50 DAS onwards (Table 1). Hybrid P 3396 recorded the highest LAI (4.50) than the other two hybrids and the least results were obtained from HQPM 1 at all the growth stages. Maximum LAI was recorded in P 3396 might be due to the higher plant height accounted for more number of green leaves $plant^{-1}$ which in turn contributed for the higher LAI. Data pertaining to LAI of *rabi* maize hybrids clearly indicated that there existed a significant difference on LAI due to application of biozyme and highest LAI (4.38) was observed in B_3 treatment. LAI was increased with the gradual increase of concentration of biozyme from 1 ml l^{-1} to 3 ml l^{-1} might be attributed to higher number of leaves $plant^{-1}$ caused by the presence of more amount of growth promoting substances, micronutrients, vitamins, amino acids, minerals etc. in higher doses of biozyme. Kavitha *et al*. (2008) also observed a significantly higher LAI (6.38) with the spraying of phytozyme at 0.3% solution twice (at 50% flowering and milk stages). Interaction effect of different maize hybrids and foliar application of biozyme had significantly influenced the LAI of maize plant at 75 and 100 DAS only and the best result was recorded from hybrid P 3396 and foliar application of biozyme at the rate of 3 ml l^{-1}.

Regardless of treatments, CGR increased progressively with the advancement of age, reaching at peak during 76-100 DAS. Crop growth rate (CGR) of maize was significantly influenced by the different hybrids and the CGR was maximum in the hybrid P 3396 followed by Kaveri 50 hybrid while HQPM 1 gave the least performance (Table 2). These results are in line of the results reported by Vavaliya *et al.* (2018) where higher CGR was recorded in the hybrid GAWMH 2 and the least in HQPM 1. Higher dry aerial biomass accumulation was recorded in the hybrid P 3396, which in turn might be contributed to the higher CGR in the said hybrid P 3396. Regarding the effect of foliar application of biozyme, maximum CGR was observed from the B2 treatment plots followed by B_3 and B_1 while the least CGR was recorded in control plot and that results might be due to higher dry biomass accumulation which ultimately contributed to CGR. Interaction effect between different maize hybrids and foliar spray of biozyme on CGR was significant only at 76-100 DAS and highest CGR (19.28 g m^{-2} day^{-1}) was recorded from the combination of the hybrid P 3396 and biozyme spray at the rate of 2 ml l^{-1}.

RGR of maize crop was more at early stage (26-50 DAS) irrespective of treatments and thereafter showed a decreasing trend with the advancement of plant age (Table 2). The decrease in RGR was probably due to the increase of metabolically active tissue, which contributed less to the plant growth (Tajul *et al*., 2013). Maize hybrid P 3396 produced significantly highest RGR followed by Kaveri 50 and the least RGR was obtained in HQPM 1 at all the growth stages of the crop.Vavaliya *et al.* (2018) also observed higher RGR in the maize hybrid GAWMH 2 and the least RGR in HQPM 1. Foliar application of biozyme had significant effect on RGR and the maximum RGR was observed in the B_2 plots might be attributed to the increase of metabolically active tissue due to seaweed sap (biozyme). The interaction effect of maize hybrids and biozyme was significant only at 76-100 DAS stage and the best result was obtained from the combination of the hybrid P 3396 and application of biozyme at the rate of 2 ml l^{-1}.

Yield and harvest index

Significant difference on grain yield, stover yield and harvest index among the different maize hybrids was observed (Table 3). Maximum grain yield was obtained from the hybrid P 3396 (7.97, 8.26 and 8.12 t ha^{-1} during 2016-17, 2017-18 and pooled data respectively) which was statistically at par with Kaveri

50 and lowest (4.84, 5.27 and 5.06 t ha^{-1} during 2016-17, 2017-18 and pooled data respectively) in HQPM 1 in both the years. On the other hand stover yield was higher in Kaveri 50 followed by P 3396 and the least value was obtained in HQPM 1. It may be due to the varietal characteristics. Data revealed that maximum stover yield (11.92, 12.03 and 11.97 t ha^{-1} during 2016-17, 2017-18 and pooled data respectively) was obtained from the hybrid Kaveri 50 followed by P 3396 while the lowest stover yield was recorded in HQPM 1. Pooled data of two years revealed that maximum harvest index of 41.92% was recorded in the hybrid P 3396 followed by Kaveri 50 (38.70%) and HQPM 1 (30.58%). Biozyme application significantly influenced grain and stover yields and also harvest index (HI) and the maximum values were recorded from the B_2 plot. Biozyme treated plots exhibited higher grain yield of maize than water spray (control plot). Pal *et al.* (2015) reveled that application of seaweed sap significantly influenced the growth and yield of maize during *rabi* season. Data pertaining to grain yield of maize, revealed that application of biozyme in B_2 treatment produced significantly highest grain yield of maize (7.03, 7.40 and 7.22 t ha^{-1} during 2016-17, 2017- 18 and pooled respectively) while B_3 and B_1 were statistically at par. The lowest grain yield (6.28, 6.66 and 6.47 t ha^{-1} during 2016-17, 2017- 18 and pooled respectively) was obtained from B_0. Maximum HI was obtained from the plots applied with biozyme at B_2 treatment (37.12, 37.82 and 37.47 % during 2016-17, 2017-18 and pooled data respectively) followed by that of B_3 and B_1 and least performance recorded from B_0. In sub-plots, biozyme applied plots recorded higher grain yield, stover yield and harvest index over control plots might be due to the presence of growth promoting substances like IAA, IBA, gibbrellins, cytokinin, micronutrients, vitamins and amino acids and the minerals in the seaweed sap which enhanced the growth attributes and the chlorophyll content of leaves for more production of photosynthates, ultimately resulted increased yields of the crop. Similar findings were also reported by Mondal *et al.* (2015). Maximum yield was obtained from the plots applied with biozyme at 2 ml l^{-1} and further increase in the dose of biozyme caused yield reduction might be due to the higher salt index in higher concentration of seaweed sap (biozyme) and similar report was also revealed by Beckett and Van Staden (1990). Interaction effect of different hybrids and foliar application of biozyme on grain yield of maize was found significant and the best result (8.41, 8.68 and 8.55 t ha^{-1} during 2016-17, 2017-18 and pooled data respectively) was obtained from the hybrid P 3396 from B_2 followed by B_3, B_1 and B_0. Similarly, a significant interaction of seaweed sap and hybrids on grain yield was reported by Prinka and Thind (2016) on rice and Dilavarnaik *et al*., (2017) on hybrid maize. Regarding interaction effect of different hybrids and biozyme on stover yield of maize, in both the years and pooled data, significantly higher stover yield was noticed in the hybrid Kaveri 50 receiving foliar application of biozyme at the rate 2 ml l^{-1}. Harvest Index (HI) of maize was also significantly affected by the interaction of maize hybrids and biozyme application in both the years of experimentation and in pooled data. Maximum HI was observed in the combination of the hybrid P 3396 and application of biozyme at the rate of 2 ml l^{-1}.

It can be concluded that maize hybrid P 3396 receiving foliar application of seaweed sap (biozyme) at the rate of 2 ml l^{-1} of water showed its superiority with regards to growth parameters as well as grain yield during *rabi* season for the new alluvial zone of West Bengal.

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