

Growth and Development for Maize (*Zea Mays* L.) as Influenced by Kinetin and EM

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Abstract—The experiment was conducted in the field of Al-Jelawya, Babylon, Iraq for the Autumn season (2019), according to the Randomized Complete Block Design (RCBD) with arrangement of split plots, with three replicates, The main plots included kinetin at levels (0, 15, 30, 45mg/L) which are symbolized by (K1, K2, K3, k4) respectively. The sub plot contained on the effective microorganisms application at 1.0% conc. (control, foliar application, foliar and soil application, soil application) which are symbolized by (EM1, EM2, EM3, EM4). The results are as follows: The kinetin treatment (15mg/L) was excelled in the traits of flag leaf area 0.610m², chlorophyll 42.17 spad, Row No/ear 15.55 Row/ear, grain No/ear 37.73 grain/ear, grain yield 5.87 ton/ha and grain oil 4.77% oil. While the effective microorganisms treatment (soil application) was excelled in the traits of flag leaf area 0.561m², grian No/row 36.23 grain/Row, 1000 grain weight 238.9g, grain yield 5.21 ton/ha. The interaction treatment (15mg/L x soil application) was excelled for the traits flag leaf area 0.704m², chlorophyll content 44.00 spad, grain No/Row 38.47 grain/row, grain yield 6.21 ton/ha and % grain oil content 5.17%.

Index Terms—Kinetin, effective, microorganisms, maize

I. INTRODUCTION

Millions of people around the world are depending on maize as a major source of food. Beside it is used for fodder production and other industries [1]. In Iraq, maize is widely cultivated crop it can be grown in two seasons [2]. Nowadays there are a need to available technological methods to facilitate the production of this crop in Iraq, and to a promising approaches, that may satisfy growing food need. Augmentation of crop production can be achieved by many approaches including the use of growth promoting hormones. Kinetin, a cytokinin known to significantly improve growth, development and productivity of maize [3] another approach of supplying growth promoting agent is through utilization of Effective Microorganism (EM) that have recently been used to improve plant growth and productivity [4]. Significant increase was obtained in leaf area, chlorophyll content by using EM on maize plants [5] statistical increase was also shown in certain yield, yield component) of maize crop with application of EM [6]. Kinetin boosted the growth parameters (leaf area, chlorophyll content) of maize plants [7] on the other hand

(yield and its component) were significantly increased by the treatment of kinetin to maize plan [8]. Therefore, the present study was conducted to develop a growth and production system for efficient use of kinetin and EM in maize crop grown under the middle area of Iraq.

II. MATERIALS AND METHOD

This investigation was conducted in the field of Jelawya / Musaiab / Babylon in Iraq in the autumn growth season of 2019 to find out the effect of foliar application of Kinetin (0, 15, 30 and 45 ppm) and EM (control, foliar treatment, foliar + soil treatment and soil treatment at 1.0%) on growth and development and productivity of maize (*Zea mays* L.) in a split plot in RCBD design with three replicates. Maize seeds were planted 25cm a part within rows 75cm spaced between rows. Plants were received the same agricultural practices. Treatments were done in the commencement of Stem elongation stage and early in the morning to ensure the absorption process. In the end of the growing season the following traits were measured flag leaf area, chlorophyll Content, raw No /ear, grain No/ear, 1000 grain weight grain Yield, Protein Content and oil Content. Chlorophyll was estimated using spad 502 Device while the protein percentage was measured using microkeldahyl (Hart and fisher, 1971). protein %= N rate x6.25, as for the oil percentage it was measured by soxhelet device. (Rusko uski, 1957). Data were analyzed using ANOVA table Means were compared with LSD at 0.05% according to GenStat program.

III. RESULTS

In this study the effect of applying kinetin and EM of stem elongation stage of maize grown in fall of 2019 was investigated. The data obtained are presented in the following tables. Flag leaf area (m²):

TABLE I. EFFECT OF KINETIN AND EM ON FLAG LEAF AREA/M² OF MAIZE CV (ABKAROV)

K EM	EM1	EM2	EM3	EM4	Mean
K 1	0.455	0.461	0.457	0.474	0.462
K 2	0.532	0.594	0.611	0.704	0.610
K 3	0.587	0.637	0.574	0.660	0.614
K 4	0.534	0.556	0.481	0.438	0.502
Mean	0.527	0.562	0.531	0.561	
L.S.D=0.05	K=0.016	EM=0.018	Interaction=0.037		

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In Table I, the effects of kinetin and EM on flag leaf area were presented. K3 boosted statistically the mean of this trait (0.614m²) as compared to all other levels except for K2 (0.610m²) Em2 is also significantly increased the mean of the trait under study (0.562m²) comparing to other levels except for EM 4 that recorded (0.561m²). Interaction of (K2. EM4) gave higher mean (0.704m²) comparing with (K4. EM4) which gave the lowest mean (0.438m²).

TABLE II. EFFECT OF KINETIN AND EM ON CHLOROPHYLL CONTENT (SPAD) LEAVES OF MAIZE CV. ABKAROV

K EM	EM1	EM2	EM3	EM4	Mean
K 1	39.67	37.33	39.67	38.67	38.83
K 2	39.67	41.67	43.33	44.00	42.17
K 3	39.00	37.33	39.00	39.33	38.67
K 4	37.33	42.00	41.00	36.67	39.25
Mean	38.92	39.58	40.75	39.67	
L.S.D	0.05	K= 2.49	EM = 1.44	Interaction = 2.88	

Leaf chlorophyll content was significantly increased by K2 (42.17 spad) as compared to the other levels. K3 however, recorded the lowest average (38.67 spad) (Table II). As for EM treatment, EM3 significantly alleviated the mean of this quality (40.75 spad) as compared to all other levels. The interaction results show that (K2. EM 4) increased significantly leaf chlorophyll content (44.00 spad) comparing to other treatments. lowest content, hence, was due to treatment with (K4. EM4).

TABLE III. EFFECT OF KINETIN AND EM ON ROW NO/EAR OF MAIZE CV. ABKAROV

K EM	EM1	EM2	EM3	EM4	Mean
K 1	13.40	15.07	13.80	14.97	14.31
K 2	14.97	15.87	16.43	14.93	15.55
K 3	14.33	14.20	15.20	13.60	14.33
K 4	14.03	13.03	13.93	13.93	13.73
Mean	14.18	14.54	14.84	14.36	
L.S.D	0.05	K= 0.28	EM = 0.41	Interaction = 0.83	

Row number/ear was influenced by the treatment with kinetin and EM (Table III). Higher means were recorded by K2 and EM3 which recorded (15.55) and (14.84) respectively. As compared to other levels except for EM2 which show non-significant difference with EM3. On the other hand the interaction treatment (K2. EM3) gave the highest mean (16.43) in comparing to that of the interactions.

TABLE IV. EFFECT OF KINETIN AND EM ON GRAIN. NO/ROW OF MAIZE CV. ABKAROV

K EM	EM1	EM2	EM3	EM4	Mean
K 1	34.17	32.93	34.77	36.60	34.62
K 2	37.50	38.40	36.57	38.47	37.73
K 3	32.80	32.67	31.30	38.27	33.76
K 4	29.27	27.93	30.87	31.57	29.91
Mean	33.43	32.98	33.38	36.23	
L.S.D	0.05	K= 1.48	EM = 1.43	Interaction = 2.86	

Data in Table IV reflects the effect of kinetin and EM on number of grain/row – The highest mean recorded by K2 (37.73 grain/row), whereas, K4 gave the lower mean (29.91 grain/row). EM4, hence, recorded the higher mean (36.23 grain/row) with statistical differences with the other levels. EM2 recorded the lower mean (32.98 grain/row) K2. EM4 treatment significantly alleviated the mean of this quality (38.47 grain/row) as compared to the other interaction treatments, the lowest mean (27.93 grain/row). However, was due to (K4. EM2) interaction treatment.

TABLE V. EFFECT OF KINETIN AND EM ON 1000 GRAIN WEIGHT (GM) OF MAIZE CV. ABKAROV

K EM	EM1	EM2	EM3	EM4	Mean
K 1	217.1	216.3	214.8	209.5	214.4
K 2	206.7	213.1	213.1	243.7	219.2
K 3	226.6	233.6	235.4	229.7	231.3
K 4	285.8	252.4	273.1	272.7	271.0
Mean	234.0	228.9	234.1	238.9	
L.S.D	0.05	K= 5.18	EM = 5.25	Interaction = 10.51	

Significant increase of 1000 grain weight by K4 treatment (271.0gm) in comparing to the other levels is given in Table V. Data in this table reflect that EM4 is also significantly augmented the mean of this trait (238.9 gm) with no significant differences with EM3 and EM2. As for interaction treatments, however, K4. EM1 recorded the higher value (285.8gm) while K2. EM1 resulted in (206.7).

TABLE VI. EFFECT OF KINETIN AND EM ON GRAIN PROTEIN CONTENT % OF MAIZE CV. ABKAROV

K EM	EM1	EM2	EM3	EM4	Mean
K 1	10.43	10.03	10.17	10.33	10.24
K 2	11.33	11.30	11.17	11.07	11.22
K 3	11.00	11.37	10.03	10.20	10.65
K 4	11.50	12.10	11.30	12.57	11.87
Mean	11.07	11.20	10.67	11.04	
L.S.D	0.05	K= 0.31	EM = 0.59	Interaction = 1.17	

Data in Table VI show that K4 significantly raised the mean of protein content (11.87%) as compared to the other treatment levels, and K1 recorded the lowest mean (10.24%). EM2 resulted in higher protein content (11.20%) while lower protein content (10.67%) recorded by EM3. High protein content in grain was due to the interaction (K4. EM4) that resulted in (12.57%), whereas (K1. EM2) recorded the lowest content. 10.03%.

TABLE VII. EFFECT OF KINETIN AND EM ON GRAIN OIL CONTENT % OF MAIZE CV. ABKAROV

K EM	EM1	EM2	EM3	EM4	Mean
K 1	2.63	2.47	2.17	2.10	2.34
K 2	4.50	4.60	4.80	5.17	4.77
K 3	4.40	4.67	4.60	5.13	4.70
K 4	4.07	3.17	3.10	3.10	3.36
Mean	3.90	3.73	3.67	3.88	
L.S.D	0.05	K= 0.087	EM = 0.103	Interaction = 0.207	

From Table VII, it could be observed that K2 significantly increased the oil content of the grain (4.77%) as compared to other levels of this factor. EM1 also increased the oil content (3.90%), this figure, hence, is significantly differ from the other figures given by the other EM levels. High oil content is given by (K2. EM4) treatment of interaction (5.17%) while the lowest value recorded by (K1. EM4) that gave (2.10%).

TABLE VIII. EFFECT OF KINETIN AND EM ON GRAIN YIELD (TON/HECTAR) OF MAIZE CV. ABKAROV

K EM	EM1	EM2	EM3	EM4	Mean
K 1	3.16	4.54	3.83	3.62	3.79
K 2	5.77	5.76	5.75	6.21	5.87
K 3	4.65	4.48	5.80	5.82	5.18
K 4	4.53	4.41	4.40	5.18	4.63
Mean	4.53	4.79	4.95	5.21	
L.S.D 0.05 K= 0.59 EM = 0.58 Interaction = 1.15					

Results of grain yield as affected by kinetin and EM is given in Table VIII. The data presented in this table show that K2 increased significantly the mean of grain yield / hectare. (5.87 ton. hect) In comparing with other levels of this factor. Control treatment, on the other hand, resulted in lower yield (3.79 ton. hect.). Grain yield was statistically alleviated by EM4 (5.21 ton. hect.) as compared to the other levels, but, there was no significant differences between means given by EM4 and EM3. Interaction treatment (K2. EM4) recorded the highest mean of grain yield (6.21 ton. ha.) while (K1. EM1) recorded lower yield (3.16 ton. hect.).

IV. DISCUSSION

Earlier studies showed that there are different effects of Kinetin in enhancing plant growth and development [9]. Also, some reviews gave the positive effect of EM on plant [10]. Studies of combining both these factors are rare. In this study, we investigated the influence of Kinetin and EM on maize plants grown in fall season of 2019. The data given in this study confirmed that a significant influenced of the trial factors were obvious. Foliar application of Kinetin (15mg/L). Soil treatment (1.0%) of EM at stem elongation stage boosted significantly flag leaf area, Chlorophyll content, grain No/Row, grain yield and grain oil content). The Known effect of Kinetin in increasing cell division was reported by [11]. Chlorophyll Content is also Known to be enhanced by Kinetin (Rao *et al.*, 2002). The increase in means of our work could be attributed to the effect of Kinetin in enhancing cell division and enlargement and chlorophyll content of leaf and finally increases growth and development rates that lead in the end to increase plant Yield. These findings are in agreement with those reported by [12] EM application Leads to activate number of microorganism in soil [13]. And formation of Chlorophyll [7], and increases protein Content in plant [10]. In general enhancing plant growth and production [14].

In our investigation the outstanding influence of EM on Inducing growth qualities and ultimately product could be attributed to its encouraging action of formation of Chlorophyll and photosynthetic activity. Photosynthetic rates and activating soil beneficial microorganisms in providing water and nutrients to the plants. Therefore boosting plant growth, development and productivity. Our findings agreed with the results of [14] work. In this work it is clear that the kineten and EM have increased flag leaf area, chlorophyll content and the weight of 1000 grain (Table I, II and V). This may indicate to a potential photosynthetic rate and in the end increasing of food materials production in the main source in the plant that could mean continuous and potential providing of growth materials to the main sink in the plant (grain). Therefore, this resulted in increasing rates of plant productivity and the yield per [15], [16] (Table VIII).

V. CONCLUSION

We conclude from the experiment that the adding of Kinetin at a concentration of (15mg/L) and the treatment of effective microorganisms (soil application) had a significant effect on the Maize (*Zea mays* L.), where it significantly excelled in most studied traits

CONFLICT OF INTEREST

The author declares no conflict of interest.

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