Varieties-Dependent Responses of Maize to Humic Acid and Magnesium Combinations

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Abstract :

A field experiment was conducted during fall 2025 to investigate the influence of humic acid and magnesium application on maize yield. Six maize varieties were used: Al-Furat, Drakma, 6777 DKC, Jameson, Consens, and Gloria, with seven combinations of humic acid (H) and magnesium (Mg): H0MG0, H30MG0, H0MG80, H10MG40, H20MG60, H30MG80, and H40MG100 (kg ha^{-1}), applied using a Randomized Complete Block Design with a split-plot arrangement and three replications. The results indicated a significant effect of varieties on maize yield traits and their components. Gloria variety exhibited the highest ear length (24.29 cm), while Consens variety gave the highest kernels per ear (603.86 kernels), 500-kernel weight (184.88 g), yield (12.93 tons ha^{-1}), biological yield (25.91 tons ha^{-1}), and harvest index (49.38). Treatment H40MG100 was superior, giving the highest ear length (27.15 cm), kernels per ear (614.37 kernels), 500-kernel weight (186.88 g), yield (13.17 tons ha^{-1}), biological yield (26.78 tons ha^{-1}), and harvest index (48.98). Treatment H40MG100 did not differ significantly from H30MG80 for the main studied traits. The interaction H30MG80 × Gloria showed the highest ear length (29.47 cm), while H40MG100 × Consens gave the highest kernels per ear (674.52 kernels), 500-kernel weight (227.09 g), yield (17.50 tons ha^{-1}), biological yield (28.29 tons ha^{-1}), and harvest index (61.85). The combined application of humic acid and magnesium improved maize productivity, and H30MG80 may provide a lower-input alternative to H40MG100 where the two treatments do not differ significantly. These findings support more efficient and sustainable maize production.

Keywords: Maize, varieties, humic and magnesium combination, yield, biological yield.

Introduction:

Maize (*Zea mays* L.) is an important field crop of significant economic importance in Iraq and worldwide, due to its crucial role in supporting food security, livestock production, and processing industries [4]. Its productivity depends primarily on two factors: the genetic variation among cultivated varieties and their efficiency in utilizing available soil nutrients, particularly under the prevailing environmental conditions in the study area, which are characterized by the low availability of some essential elements [34]. Maize varieties differ in their utilization capabilities, making variety analysis a fundamental factor when evaluating any fertilizer treatment. Several researchers have indicated that varietal response plays a decisive role in determining the yield achieved [14]. In this context, the use

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loss in the soil, as well as enhance the utilization of other nutrients. However, the effectiveness of this mixture may vary depending on the cultivated variety due to genetic variations in nutrient response efficiency. Although separate evidence exists regarding the benefits of humic acid or magnesium in maize, understanding remains limited concerning their integrated effects across different varieties, particularly on traits related to dry matter partitioning and harvest index, which are more informative for understanding the mechanism of yield improvement than measuring total production. Therefore, this research aims to investigate the effect of adding treatments of humic acid and magnesium on the yield characteristics and components of yellow corn varieties under the conditions of Babylon Governorate, and to determine the optimal combination of humic acid and magnesium that achieves the highest yield per unit area.

a depth of 0.3 m from the soil surface to estimate its physical and chemical properties before planting, as shown in Table (1).

Table 1. Physical and Chemical Properties of the Experimental Field during fall 2025, taken at a depth of 30 cm.

Traits	Value
pH	7.5*
E.C.	2.69 DSM m^{-1}
Available nitrogen	60 mg/kg^{-1}
Available phosphorus	10.3 mg/kg^{-1}
Available potassium	74 mg/kg^{-1}
Soluble magnesium	4 $milliequivalent\ liter^{-1}$
Organic matter	0.97 %
Soil fractions	
Silt	32%
Clay	37%

of humic acid has emerged as a modern organic amendment that contributes to improving nutrient availability and increasing plant utilization efficiency. This directly translates into improved yield components and, consequently, increased maize productivity [16]. On the other hand, magnesium is an essential nutrient of particular importance in kernel formation and filling. It plays a vital physiological role in the translocation of carbon dioxide products from the vegetative parts to the kernels, thus affecting kernel weight and total yield. Several studies have shown that magnesium supplementation improves the yield characteristics and components of yellow corn [11]. Furthermore, the combined application of humic acid and magnesium as a single mixture is a modern trend in integrated fertilization management. This mixture is expected to improve magnesium uptake efficiency and reduce its fixation or

Materials and Methods

A field experiment was conducted during fall 2025 in a demonstration field belonging to Al-Mahannawiyah extension farm, located approximately 21 km north of Babylon Governorate, at 31°38′N latitude and 44°21′E longitude. Soil samples were taken from the field before planting at

Sand	31%
Soil texture	clay mixed

*The soil was analyzed in the Soil Laboratory, Department of Soil and Water Resources, College of Agriculture, Tikrit University.

rows were planted in each experimental unit, with a spacing of 0.7 m between rows and 0.25 m between plants. Two seeds were placed in each spot at a depth of 3–5 cm on 25 July 2025. Twenty days after planting, the seedlings were thinned to one plant, weeds were removed manually, and the corn stalk borer was controlled using granular diazinon pesticide with a concentration of 10% [33]. Urea fertilizer (46%) was added at a rate of 250 kg ha^{-1} in two applications, the first when the plants reached the sixth-leaf stage and the second at the twelfth-leaf stage, broadcast between the planting rows. Irrigation continued according to the plants' needs [9]. Five plants were randomly selected from the two middle rows of each experimental unit, and the traits of ear length (cm), 500-kernel weight (g), kernels per ear (kernels ear^{-1}), yield (ton ha^{-1}), biological yield (ton ha^{-1}), and harvest index were studied. All trait data were statistically analyzed according to the design used by SAS. Each replicate contained 42 experimental units, while the total number of experimental units was 126. Arithmetic means were compared using Duncan's multiple range test at a probability level of 0.05 [8]. The field experiment was conducted in fall 2025; references dated 2026 cited in the manuscript were incorporated during manuscript preparation and therefore refer to the literature available at the time of manuscript preparation, not to the experimental period.

The experiment included six maize varieties: Al-Furat, Drakma, 6777 DKC, Jameson, Consens, and Gloria, obtained from agricultural companies accredited by the Iraqi Ministry of Agriculture. The experiment also included seven humic acid and magnesium combination treatments consisting of 0 kg ha^{-1} humic acid and 0 kg ha^{-1} magnesium (H0MG0), 30 kg ha^{-1} humic acid and 0 kg ha^{-1} magnesium (H30MG0), 0 kg ha^{-1} humic acid and 80 kg ha^{-1} magnesium (H0MG80), 10 kg ha^{-1} humic acid and 40 kg ha^{-1} magnesium (H10MG40), 20 kg ha^{-1} humic acid and 60 kg ha^{-1} magnesium (H20MG60), 30 kg ha^{-1} humic acid and 80 kg ha^{-1} magnesium (H30MG80), and 40 kg ha^{-1} humic acid and 100 kg ha^{-1} magnesium (H40MG100). The experimental field was plowed twice perpendicularly using a moldboard plow and soil was smoothed with a disc plow. After leveling and dividing the field, magnesium was added in the form of hydrated magnesium sulfate ($MgSO_4 \cdot 7H_2O$), with a magnesium content of 9.8%, and humic acid of German origin, with a humic acid content of 85%. The treatments were applied to the soil, and DAP fertilizer was added at a rate of 400 kg ha^{-1}. The experiment was conducted according to a Randomized Complete Block Design (RCBD) with three replications. The area of the main plot was 36 m^2, and the area of the experimental unit was 2 × 3 m^2. Four

Results and Discussion:

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increasing kernel number, kernel weight, and biological yield [12, 24]. The varieties also showed significant variation for all studied traits. These differences may be attributed to physiological variation among maize varieties in carbon metabolism efficiency, nutrient absorption capacity, sink strength, and the duration and efficiency of kernel filling, all of which affect kernel number and weight [29]. These results are consistent with [28].

The analysis of variance presented in Table 2 indicated that the effects of humic acid and magnesium combinations were highly significant for all experimental traits (ear length, kernels per ear, 500-kernel weight, yield, biological yield, and harvest index). This response may be attributed to the role of humic acid in improving nutrient absorption and root activity in maize, which increases the efficiency of carbon metabolism and the translocation of assimilates, thereby

Table 2. The analysis of variance, represented by the mean squares of the studied traits.

S.O.V.	d.f.	Ear length (cm)	Kernels per ear (kernels ear^{-1})	500 kernels weight (g)	Yield (ton ha^{-1})	Biomass (ton ha^{-1})	Harvest index
Replicate	2	5.97	161.9	9.40	0.09	0.08	2.08
Humic acid & magnesium combinations (A)	6	347.90**	52741.9*	5974.88*	80.90**	52.93*	595.49*
Error (A)	12	17.31	548.9	19.28	0.22	0.52	5.54
Varieties (B)	5	100.44*	17800.9**	2435.95*	33.92*	11.38*	280.39*
A × B	30	3.87*	2308.2*	470.12*	2.97*	0.06*	38.56*
Error	70	5.11	382.4	12.30	0.20	0.43	4.05
Total	125						

with [16]. Table 3 also showed significant differences among varieties in ear length. Gloria had the highest ear length (24.29 cm), which did not differ significantly from Consens (22.64 cm), whereas Drakma exhibited the lowest average ear length (18.29 cm). This variation may be attributed to genetic differences among varieties and their genetic predisposition to producing a specific ear length [17]. This result aligns with [23]. Moreover, Table 3 indicated a significant interaction between combinations and varieties. The interaction H30MG80 × Gloria had the highest ear length (29.47 cm),

Ear length (cm)

Table 3 indicated a significant difference among the humic acid and magnesium combinations. The combination H40MG100 had the highest ear length (27.15 cm), while H0MG0 (control) exhibited the lowest ear length (15.80 cm). This may be attributed to the role of humic acid as a root-growth stimulant, increasing nutrient and water absorption and activating physiological processes such as carbon metabolism and cell division, thus increasing ear length [25]. These results were consistent

the lowest average (12.17 cm). whereas H0MG0 × Drakma achieved

Table 3. the influence of humic acid and magnesium combination applications on maize varieties ear length (cm).

Varieties	Humic acid and magnesium combinations (kg ha^{-1})							Mean
	H0MG0	H30MG0	H0MG80	H10MG40	H20MG60	H30MG80	H40MG100	
Euphrates	17.44 k-o	17.29 k-o	18.32 j-o	21.38 e-l	21.88 d-k	24.78 a-h	26.98 a-d	**21.15 bc**
Drakma	12.17 p	15.05 m-p	16.08 l-p	19.14 i-n	19.64 h-n	21.21 f-l	24.74 a-h	**18.29 d**
DKC 6777	22.46 d-k	16.19 l-p	17.22 k-p	20.28 h-m	20.78 f-l	21.40 e-l	25.88 a-g	**20.60 c**
Jameson	13.33 op	18.35 j-o	19.38 i-n	22.44 d-k	22.94 c-j	25.84 a-g	28.04 abc	**21.48 bc**
Consens	14.50 nop	19.52 h-n	20.55 g-l	23.61 c-j	24.11 b-i	27.01 a-d	29.21 ab	**22.64 ab**
Gloria	14.87 nop	21.98 d-k	23.01 c-j	26.07 a-f	26.57 a-e	29.47 a	28.03 ab	**24.29 a**
Mean	15.80 e	18.06 d	19.09 d	22.15 c	22.65 c	24.95b	27.15 a	**$\bar{x}$= 21.40**

Similar letters do not show significant differences.

for developing kernels, improving kernel set and development [1, 37]. The result was consistent with [13, 32]. Table 4 also showed a significant varietal effect. Consens recorded the highest average kernels per ear (603.86 kernels ear^{-1}), whereas Drakma recorded the lowest (527.25 kernels ear^{-1}). This difference may be attributed to genetic variation in ear sink capacity and kernel formation, as well as differences in assimilate production and partitioning among varieties [15]. This result was consistent with [6, 7, 19]. Furthermore, the interaction between combinations and varieties was significant. H40MG100 × Consens gave the highest kernels per ear (674.52 kernels ear^{-1}), while Drakma × H0MG0 gave the lowest (450.70 kernels ear^{-1}).

kernels per ear (Kernels ear^{-1})

Table 4 indicated that the humic acid and magnesium combinations had a significant effect on kernels per ear. Combination H40MG100 resulted in the highest kernels per ear (614.37 kernels ear^{-1}), which did not differ significantly from H30MG80 (610.65 kernels ear^{-1}). In contrast, kernels per ear decreased to 460.43 kernels ear^{-1} in the control (H0MG0). This response may be related to the improved assimilate supply associated with better vegetative and reproductive growth. Magnesium and humic acid can reduce kernel abortion, enhance photosynthesis and nutrient absorption, and increase sugar accumulation and kernel-filling rate; consequently, more nutrients and energy become available

Table 4. the influence of humic acid and magnesium combination applications on maize varieties kernels per ear (kernels ear-1).

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Varieties	Humic acid and magnesium combinations (kg ha^{-1})							Mean
	H0MG0	H30MG0	H0MG80	H10MG40	H20MG60	H30MG80	H40MG100	
Euphrates	476.80 pq	587.91g-j	518.50no	625.03 c-f	587.70 f-j	646.89 a-d	633.67b-e	582.31 b
Drakma	450.70 q	506.90	450.42no	543.08 lmn	587.0 g-k	577.06	575.85 h-l	527.25e
DKC 6777	457.31	586.73f-k	558.95i-m	551.82 j-n	534.81 mno	558.51i-m	551.32 j-n	542.89 d
Jameson	454.32 pq	585.01g-k	557.34j-m	600.87 e-h	626.23 cde	627.28 cde	652.06a-d	586.01 b
Consens	455.60 op	597.22e-i	553.82	619.02 d-g	659.05	667.48 ab	674.52a	603.86a
Gloria	467.71 q-p	547.53k-n	565.71h-m	554.61 j-n	572.37	586.77 f-k	598.5e-h	556.14 b
Mean	460.43 e	568.54c	534.16 d	582.44 b	594.53b	610.65a	614.37a	$\overline{x}$=574.77

Similar letters do not show significant differences.

also observed. Consens recorded the highest 500-kernel weight (184.88 g), while Drakma recorded the lowest (154.63 g). The variation among varieties in dry-matter accumulation and kernel filling is mainly attributed to genetic differences in their capacity to assimilate and partition photosynthates to the developing kernels [31]. This result was consistent with [22, 23, 27]. The interaction H40MG100 × Consens gave the highest 500-kernel weight (227.09 g), whereas H0MG0 × Drakma recorded the lowest (128.89 g).

500 kernels weight (g)

The humic acid and magnesium combinations significantly affected 500-kernel weight. Combination H40MG100 gave the highest 500-kernel weight (186.88 g), which did not differ significantly from H30MG80 (184.66 g), whereas the control H0MG0 recorded the lowest value (141.42 g) (Table 5). Humic acid may enhance the availability and uptake of essential elements such as nitrogen, phosphorus, and potassium, supporting the transfer of dry matter from source tissues to developing kernels [16]. These results were consistent with [13, 21]. A significant varietal effect was

Table 5. the influence of humic acid and magnesium combination applications on maize varieties 500 kernels weight (g).

Varieties	Humic acid and magnesium combinations (kg ha^{-1})							Mean
	H0MG0	H30MG0	H0MG80	H10MG40	H20MG60	H30MG80	H40MG100	
Euphrates	137.37 u	152.24n-q	141.62r-u	163.71jkl	175.01gh	184.12def	183.45ef	162.57e

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Drakma	128.89 v	153.26n -u	146.35p-s	156.3mn	179.33fg	158.20lm n	152.99no p	154.63e
DKC 6777	141.32s tu	139.36u	136.19u	148.16o-r	162.15j-m	204.45c	191.98bc	161.93c
Jameson	145.86 q-t	162.44j -m	153.11no	170.10hi	184.15de f	188.79de	185.75de f	170.01 b
Consens	148.81 opq	171.40h i	167.76ij	176.11gh	190.54d	199.91b	201.86a	184.88a
Gloria	139.31 tu	156.65 mn	146.35p-s	165.45ijk	179.41fg	160.24kl m	162.96j-m	158.63c
Mean	141.42f	155.82d	147.32e	163.39c	178.48b	184.66a	186.88a	$\bar{x}$=165. 43

Similar letters do not show significant differences.

yield. Consens recorded the highest yield (12.93 tons ha^{-1}), whereas Drakma recorded the lowest (9.37 tons ha^{-1}). The higher yield of Consens was associated with its greater kernels per ear (Table 4) and 500-kernel weight (Table 5), which contributed to greater grain production. These results were consistent with [22, 3, 26, 32]. The interaction between humic acid and magnesium combinations and varieties was also significant. H40MG100 × Consens had the highest yield (17.50 tons ha^{-1}), whereas H0MG0 × Drakma had the lowest (6.99 tons ha^{-1}).

Yield (ton ha^{-1})

The humic acid and magnesium combinations significantly influenced maize yield (Table 6). H40MG100 reached the highest yield (13.17 tons ha^{-1}) and was significantly higher than the other combinations except H30MG80, which recorded 12.92 tons ha^{-1}. In contrast, H0MG0 had the significantly lowest yield (7.44 tons ha^{-1}). The superiority of H40MG100 in grain yield may be attributed to its superiority in ear length (Table 3), kernels per ear (Table 4), and 500-kernel weight (Table 5). The varieties also differed significantly in maize

Table 6. the influence of humic acid and magnesium combination applications on maize varieties yield (ton ha-1).

Varieties	**Humic acid and magnesium combinations (kg ha^{-1})**							**Mean**
	H0MG0	**H30MG0**	**H0MG80**	**H10MG40**	**H20MG60**	**H30MG80**	**H40MG100**	
Euphrates	**7.48rs**	**10.22i-m**	**8.39pq**	**11.70fg**	**11.75fg**	**13.61cd**	**13.28de**	**10.92c**
Drakma	**6.99s**	**8.87op**	**7.53rs**	**9.70l- o**	**12.03f**	**10.43h-l**	**10.06i-n**	**9.37e**
DKC 6777	**7.38rs**	**9.35no**	**8.23pqr**	**9.34no**	**9.91j-n**	**13.05de**	**13.16de**	**10.06d**
Jameson	**7.57rs**	**10.85hi**	**9.75k-n**	**11.68fg**	**13.18 de**	**13.53d**	**13.84cd**	**11.49b**
Consens	**7.75 qrs**	**11.69fg**	**10.61h-k**	**12.46ef**	**14.35c**	**15.24b**	**15.56a**	**12.93a**

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Gloria	**7.45rs**	**9.80k-n**	**9.46mno**	**10.48h-l**	**11.73fg**	**10.74hij**	**11.16gh**	**10.12d**
Mean	**7.4f**	**10.13d**	**9.00 e**	**10.89c**	**12.16b**	**12.92a**	**13.17a**	**$\bar{x}$=10.82**

Similar letters do not show significant differences.

biomass accumulation [10, 36]. Maize varieties also differed significantly in biomass. Consens recorded the highest biomass (25.91 tons ha^{-1}), whereas Drakma showed the lowest (23.85 tons ha^{-1}). Such differences may result from genetic variation in growth characteristics, nutrient storage, water and nutrient uptake efficiency, and tolerance to environmental stress [30, 35]. The interaction between combinations and varieties was significant. H40MG100 × Consens presented the highest biomass (28.29 tons ha^{-1}), while H0MG0 × Drakma recorded the lowest (21.90 tons ha^{-1}).

Biomass (ton ha^{-1})

The humic acid and magnesium combinations significantly affected maize biomass (Table 7). H40MG100 provided the highest biomass (26.78 tons ha^{-1}), which did not differ significantly from H30MG80 (26.69 tons ha^{-1}). Conversely, the control H0MG0 recorded the significantly lowest biomass (22.44 tons ha^{-1}). This may be attributed to the ability of humic acid to improve nutrient absorption, stimulate root growth, enhance plant enzyme and hormone activity, and improve soil properties, thereby promoting plant growth and

Table 7. the influence of humic acid and magnesium combination applications on maize varieties biomass (ton ha-1).

Varieties	**Humic acid and magnesium combinations (kg ha^{-1})**							**Mean**
	H0MG0	**H30MG0**	**H0MG80**	**H10MG40**	**H20MG60**	**H30MG80**	**H40MG100**	
Euphrates	22.42nop	23.83i-m	23.09 l-p	24.53h-k	25.48d-h	26.61bcd	26.77bcd	24.68bc
Drakma	21.90p	22.94l-p	22.20op	23.64j-n	24.59g-k	25.81c-h	25.87b-g	23.85d
DKC 6777	21.99p	23.34k-o	22.59m-p	24.04i-l	24.98e-i	26.11b-f	26.25b-e	24.19d
Jameson	22.84l-p	24.14i-l	23.42k-o	24.86f-j	25.81c-h	26.94bc	27.12b	25.02b
Consens	23.49k-o	24.87f-j	24.12i-l	25.57d-h	26.52bcd	28.20a	28.29a	25.91a
Gloria	22.03p	23.42k-o	22.68m-p	24.13i-l	25.07e-i	26.20b-e	26.38bcd	24.27cd
Mean	22.44f	23.76d	23.02e	24.46c	25.41b	26.69a	26.78a	$\bar{x}$= 24.65

Similar letters do not show significant differences.

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(49.38), while Drakma recorded the lowest (39.11). This variation is consistent with differences in grain yield (Table 6) and biomass (Table 7) and reflects differences among genotypes in assimilate partitioning [22]. The interaction between combinations and varieties was significant. H40MG100 × Consens showed the highest harvest index (61.85), whereas H0MG0 × Drakma recorded the lowest (31.93).

Harvest index affected significantly by the combination of humic and magnesium (Table 8). The result indicated a significant difference among humic and magnesium combinations in harvest index. Combination H40MG100 reported highest harvest index (48.98), and it was not significantly different compared with combination H30MG80 and H20MG60 which reported 48.28 and 47.78 respectively. Moreover, the combination of H0MG0 (control) exhibited the lowest harvest index (33.23). The credit of adding humic acid and magnesium improved maize roots absorb essential nutrients necessary for increasing yield (sink) and that contributed to increasing the harvest index. The result was consistent with [13]. The varieties affected the harvest index significantly (Table 8). Variety Consens recorded the highest harvest index (49.38) while variety Drakma presented the lowest harvest index (39.11). The variation among varieties is attributed to their differences in yield (Table 6) and biomass (Table 7). This result aligns with [22]. The interaction between the combinations of humic and magnesium and varieties indicated a significant difference in harvest index (Table 8). The interaction H40MG100 × Consens showed a significant highest harvest index (61.85) compared with the other

The marked difference between Consens and Drakma across the yield-related traits indicates a clear genotype-dependent response. Consens combined a higher kernel number per ear (603.86 kernels ear^{-1}), greater 500-kernel weight (184.88 g), higher biomass (25.91 tons ha^{-1}), and higher harvest index (49.38) than Drakma, which recorded 527.25 kernels ear^{-1}, 154.63 g, 23.85 tons ha^{-1}, and 39.11, respectively. This pattern suggests that the superiority of Consens was associated with greater sink capacity, more effective assimilate partitioning toward the ear, and more efficient conversion of accumulated biomass into grain. In contrast, the lower performance of Drakma may reflect differences in root nutrient uptake, photosynthetic efficiency, duration of kernel filling, and genetic capacity for dry-matter accumulation and translocation. Genotype-by-trait interactions reported in maize also support the importance of genetic differences in determining the efficiency with which available nutrients are converted into yield [29, 30].

Harvest index was significantly affected by the humic acid and magnesium combinations (Table 8). H40MG100 recorded the highest harvest index (48.98), which did not differ significantly from H30MG80 and H20MG60, which recorded 48.28 and 47.78, respectively. The control H0MG0 exhibited the lowest harvest index (33.23). The combined application of humic acid and magnesium may improve root absorption of essential nutrients and increase assimilate allocation to the grain sink, thereby increasing harvest index [13]. The varieties also affected harvest index significantly. Consens recorded the highest harvest index

harvest index (31.93).

interactions while the interaction H0MG0 × Drakma recorded the lowest

Table 8. The influence of humic acid and magnesium combination applications on maize varieties harvest index.

Varieties	Humic acid and magnesium combinations (kg ha^{-1})							Mean
	H0MG0	H30MG0	H0MG80	H10MG40	H20MG60	H30MG80	H40MG100	
Euphrates	33.37qr	42.87j-n	36.35pq	47.68d-h	46.13f-j	51.15cd	49.63def	43.88c
Drakma	31.93r	38.69op	33.92qr	41.01l-o	48.91def	40.43l-o	38.88nop	39.11e
DKC 6777	34.17qr	40.04l-p	36.42pq	38.85op	39.66m-p	49.97def	50.14de	41.32d
Jameson	33.14qr	44.95 g-k	41.64k-o	47.00e-i	51.05cd	50.22de	51.04cd	45.58b
Consens	32.98qr	47.03e-i	43.99h-l	48.73d-g	54.12bc	54.07b	55.01a	49.38a
Gloria	33.82qr	41.82 k-o	41.72k-o	43.44i-m	46.79e-i	41.01k-o	42.31k-o	41.56 d
Mean	33.23e	42.57c	39.01d	44.45b	47.78a	48.28a	48.98a	$\bar{x}$=43.44

Similar letters do not show significant differences.

appears to be a promising strategy for enhancing maize productivity.

The results indicate that the combinations H30MG80 and H40MG100 were the most effective, as they produced the highest mean values for most studied traits without significant differences between them. Consens variety was superior in most yield related traits, including kernels per ear, 500 kernel weight, yield, biomass, and harvest index, whereas the Gloria variety performed better in ear length. In terms of interaction effects, H30MG80 × Gloria exhibited the greatest ear length, while H40MG100 × Consens achieved the best performance for the major yield components. Overall, the combined application of humic acid and magnesium, particularly with the

The results indicate that H30MG80 and H40MG100 were the most effective combinations, as they produced the highest mean values for most studied traits without significant differences between them. Therefore, H30MG80, which uses lower amounts of humic acid and magnesium, can be considered a lower-input alternative to H40MG100 for the studied conditions. Consens was superior in most yield-related traits, including kernels per ear, 500-kernel weight, yield, biomass, and harvest index, whereas Gloria performed better in ear length. The interaction H30MG80 × Gloria exhibited the greatest ear length, while H40MG100 × Consens achieved the best performance for the major yield components. Overall, the combined application of humic acid and magnesium, particularly with Consens,

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Consens variety, appears to be a promising strategy for enhancing crop productivity.

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