Response of different NPK fertilizer applications on yield and yield components on selected (Zea mays L.) hybrids

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Abstract

This study was conducted in the fall of 2023 in the Erbil and Sulimani governorates to investigate the effects of different NPK fertilizer application methods on the kernel yield and its components for three hybrid varieties. The experiment was organized using a split-plot design with three replications, where the NPK fertilizer treatments were assigned to the main plots, and the hybrid varieties were allocated to the subplots. The methods applications of NPK fertilizer encompassed four strategies: F1= without fertilizer (control), F2= broadcasting application, F3= liquid application and F4= foliar application. Fertilizer treatments showed highly significant impacts on most yield components at both locations, as well as on their average. The differences among hybrids were highly significant for most trails at both locations and their average. The total kernel yield t/ha was affected more by hybrids at both locations and their average, and the affected of fertilizer treatments was significant at both locations and their average. It was not significant for 1000 kernel weight at both location and their average except at first location only.

Key words: NPK Fertilizer treatment, Kernel yield, Yield components, Maize hybrids.

Introduction

Corn, also referred to as maize, is a vital cereal crop from the Poaceae family, cultivated globally. It serves as a food source for humans and animal feed, while also providing raw materials for various industries, including the production of corn starch, syrup, oil, and bioethanol or biofuel [1]. Maintaining healthy soil is crucial for producing high-quality crops. Nutrient elements are essential for regulating plant growth and development, and soils that lack diversity may have nutrient deficiencies, which can disrupt the plant's physiological processes [2.[

Nitrogen is a crucial nutrient for plants, playing a key role in both the vegetative and generative phases, particularly in crops like maize that serve as indicators of nutrient status.

Phosphorus is another critical nutrient that significantly influences maize growth. It is involved in enzymatic reactions, supports cell division, and contributes to seed and fruit development, as well as the overall maturation of the crop.

Potassium also plays a significant role in maize growth, this element happens in the soil only in inorganic form and exerts a profound influence on the synthesis of a lot of organic constituents in plants. It is essential in all cell metabolic processes. Exactly, it is important in synthesis of carbohydrate (CHO), proteins, fat and oils, it is also significant in translocation of synthesized constituents and in the development of chlorophyll [3.[

Recently, the foliar application of nutrients has converted an important practice in the crop production while soil application of fertilizers

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remains the elementary method of feeding the majority of crop plants [4 .[

Proper management of NPK fertilizers is crucial for enhancing maize yield. Choosing the right fertilization method for nitrogen, phosphorus, and potassium is essential to achieving optimal yields while minimizing negative environmental impacts [5]. Selecting efficient fertilization techniques and suitable hybrids can significantly improve both maize yield and grain quality. As a result, this study was conducted to identify the best hybrid and assess the effects of nitrogen fertilization methods on maize yield and grain quality [3.[

Foliar fertilization is a widely practiced agricultural technique that has been researched for over 40 years. Applying essential nutrients like NPK through foliar spraying has been shown to enhance the yield and quality of various crops [6.[

Foliar application of crop growth indorsing chemicals also rises the growth and development of plants [7 .[

Several studies have indicated that maize hybrids vary in productivity and their response to nutrient applications, as reported by [8] and [9.[

There are differential response of maize hybrids regarding to leaf area index, leaf area duration, net assimilation rate and crop growth rate [10] and [11]. Maize hybrids differed in their grain and stover yields [12.[

The aim of this study was to investigate the soil fertility conditions that would optimize maize growth through broadcasting, foliar and liquid applications of NPK complex fertilizers .

Material and Methods

Experiment Location:

This study investigates the interactive effects of fertilizer application methods and various maize hybrids (Zea mays L.) on yield and its components at two locations in Erbil, situated in northern Iraq. A field experiment was conducted at Gerda Rasha, College of Agricultural Engineering Sciences, University of Salahaddin (Latitude: 36° 11' 356" N, Longitude: 44° 01' 987" E, Elevation: 418 masl), located 5 km south of Erbil city, and at Qliasan Agriculture Research Station, Faculty of Agricultural Sciences, University of Sulimani (Latitude: 35° 34' 3" N, Longitude: 45° 21' 992" E, Elevation: 765 masl), 2 km northwest of Sulaymaniyah City, during the summer season of 2023.

August and January are the year's hottest and coldest months (Fig.1a and 1b). To guarantee that the water would be administered uniformly, the experiment field was thoroughly leveled and plowed twice before planting. Plots measuring 3m by 3m were created based on the experimental design. The blocks were enclosed by a buffer zone that was 2m wide in order to prevent interaction between treatments. There are four planting rows in each plot .

In the growing season of 2021, hybrids of maize (Zea mays L.) were sown straight on August 1st. Within and between rows, plants were spaced 25 cm by 75 cm, resulting in a plant population of 53333 plants per hectare. All plots were treated with 80 kg ha-1 NPK excepted control plots. Plots were hand-weeded as necessary during the cropping season, and diseases and insects were closely monitored.

Foliar application treatments

NPK fertilizer was applied to the plants via foliar spraying, using the concentrations outlined in the study. The application began when the plants had 16 leaves, and was carried out with a 16-liter backpack sprayer until the leaves were fully wetted. An adhesive spreading agent was included at a rate of 10 cm^3 per 100 liters of water.

Hybrids of maize:

Consens maize hybrid

Likely a commercial hybrid developed by a seed company. Focus on high yield under optimal growing conditions. Suitable for regions with specific climate patterns. Possible emphasis on resistance to common maize diseases and pests. Adapted for regions where it can maximize yield potential. Used in areas where maize is a staple crop or a primary livestock feed source.

AS 702 maize hybrid

A hybrid developed by Advanta Seeds (or a similar agricultural biotech company). Known for excellent grain quality and high production. Performs well under irrigated and rain-fed conditions. Tolerant to common maize diseases like rust and leaf blight. Exhibits drought tolerance to some extent. Versatile for a range of soil types and climates. Good choice for farmers aiming for consistent yields with minimal risk from diseases.

AS 705 maize hybrid

Also developed by Advanta Seeds or a comparable agricultural organization. Superior grain yield potential. High resistance to fungal diseases such as leaf spot and downy mildew. Short to medium crop duration, depending on the variety and local climate. Preferred by farmers in regions with moderate drought risk and high disease pressure. Suitable for mechanized farming due to uniform plant height and grain quality.

Soil analysis

For laboratory analysis, a soil sample was taken from the same profiles at a depth of 30 cm. For the experimental sites, a composite soil sample weighing roughly 5 kg was obtained by combining subsamples to create representative soil samples. After removing plant roots and other debris, the composite soil sample was air-dried and gently crushed before being sieved using a 2 mm stainless steel sieve and stored for the planned physiochemical investigation.

Particle size distribution was evaluated for textural class assessment using the international pipette method [13]. Using the pH model of the WTW 330i and the Ec-meter model of the WTW 330i, [14]measured the electrical conductivity (Ec) and hydrogen ion concentration (pH) in a suspended ratio of 1:10, soil to H2O. The percentage of organic carbon (O.C.) in the soil was.

The Walkley-Black wet oxidation method [13] was used to determine it. Then, using the formula % organic matter = % organic carbon×1.724 (factor), the percentage of organic matter was determined. The sample's calcium carbonate content, CaCO3% (g.kg-1), was measured using a 23c method created by the US Salinity Laboratory Staff in 1954 and detailed in [13]. (Table 1) The findings from the analysis of the soil parameters are shown .

Statistical Analysis

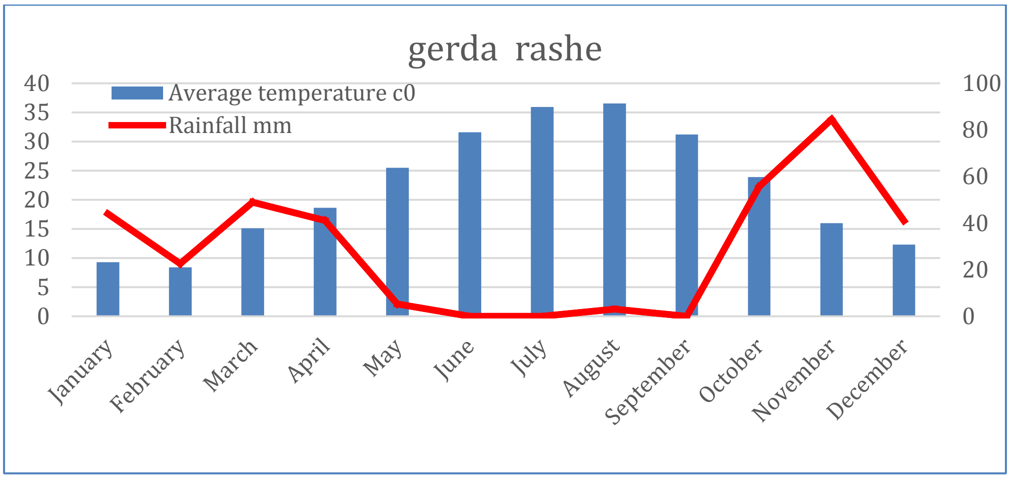
SPSS version 25 was used to do a two-way analysis of variance (ANOVA) on the data (SPSS Inc., Chicago, IL, USA). The Duncan multiple range test was used to determine mean differences at $\rho \leq 0.05$.

The present study was designed to evaluate three strategy application of NPK fertilizer and three maize hybrids with three replications. Factorial experiment within split plot was used NPK 20:20:20 fertilizer applications as the main plot was replicated three time. The four NPK fertilizer application were (F1= control non add NPK, F2= broad casting application, F3= liquid application and F4= foliar application) at 80 kg/ha as recommended in Iraq and maize hybrids were (H1= consens, H2= AS 702 and H3= AS 705 .(

Table 1. The soil's characteristics sample for the experiments of both locations.

Soil properties	Gerda Rashe	Qliasan
EC $dS.m^{-1}$	0.8	0.46
pH	7.43	7.17
N Total (%)	0.09	0.66
P Available (ppm)	9.5	5.2
K Available (ppm)	240	55
OM %	0.86	1.8
Sand %	28.3	5.92
Silt %	32.5	43.28
Clay %	39.2	50.8
Soil texture	Clay loam	Silty clay

Fig.1a. The annual distribution of monthly air temperature and precipitation at the Gerda Rashe experimental location over the year.



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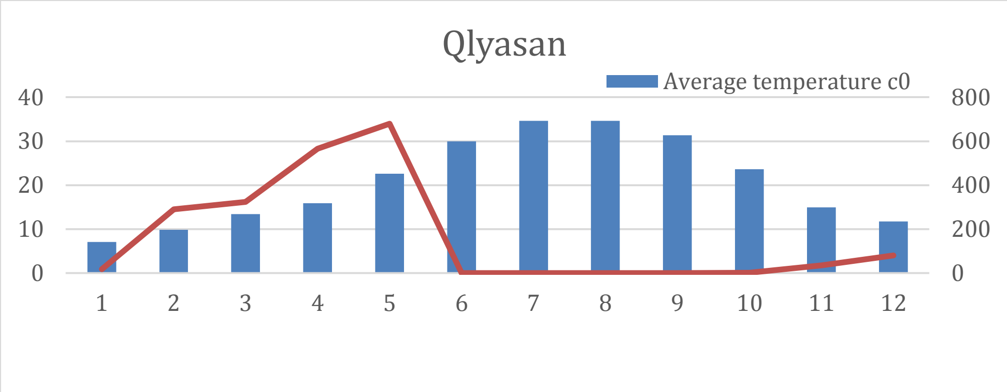

Fig.1b. The annual distribution of monthly air temperature and precipitation at the Qliasan experimental location over the year.

Results and Discussion

Mean squares variance analyses for grain yield and its component

Data in table (2) explain the ANOVA table of studied characters for both locations and their average. The mean squares due to fertilizer was highly significant for No. of kernels per row and kernel weight per plant, while it was significant for the other characters except 1000 kernel weight. The mean squares due to hybrids was highly significant for cob length, cob weight, No. of kernels per ear and No. of rows per ear, but it was significant for the other characters. Regarding to the mean squares for interaction between fertilizer and hybrids it was highly significant for cob length and not significant for the other characters at Gerda Rasha location. At Qliasan location the mean squares for fertilizer was highly significant for cob weight and No. of kernels per ear, while it was significant for the other characters except 1000 kernel weight and cob length which were not significant. Regarding to the mean squares for hybrids, highly significant mean squares was noticed for cob weight, kernel weight per plant and kernel yield, but significant mean squares due to hybrids for No. of kernels per row was observed, while for the other characters it was not significant. The mean squares for inter action between fertilizer and hybrids was highly significant for cob weight, kernel weight per plant, No. of kernels per ear and kernel yield, while it was significant for 1000 kernel weight and No. of row per ear and not significant for the other characters.

Concerning to the average of both locations, the mean squares for location was highly significant for cob length, cob weight, kernel weight per plant and kernel yield but it was significant for 1000 kernel weight and not significant for other characters. The mean squares due to fertilizer was highly significant for all characters except kernel yield which was significant and 1000 kernel weight which was not significant. Table (2) presents the means of several grain traits influenced by the three maize hybrids studied at average of both locations. The ANOVA revealed highly significant differences in most aspects across the averages of both locations. These variations can be attributed to the genetic composition of the hybrids, which typically responds positively to the surrounding environmental conditions. Fan and Moshe, (2002),[18] reported that results of the analysis of variance for the different measured indices were highly affected by soil fertilization. This genetic advantage can directly and indirectly enhance the traits under study, leading to increased yields. Similar results recorded by [15 .[

Table 2. Mean Squares variance Analyses for yield and Its Component at both Locations and Their Average.

S.O.V.	D.F	1000 kernel weights (g)	Cob length (cm)	Cob weight (g)	Kernel weight (g) plant^{-1}	no. kernel ear^{-1}	No. kernel row^{-1}	No. row ear^{-1}	Kernel yield t ha^{-1}
Gerda resha									
Block	2	64544.5	1.271	6.333	834.333	9216.694	20.528	3.25	3.212
FERTILIZER	3	75378.37	6.562*	336.768*	2496.63**	9027.037*	48.843**	3.148*	7.135*
E(a)	6	46756.06	1.215	54.407	230.296	1878.954	3.231	0.398	0.984
HYBRIDS	2	103813.3*	38.771**	498.583**	2918.583*	29104.11**	33.444*	36.583**	8.332*
Fertilizer *hybrids	6	27739.03	7.798*	343.324**	1087.88	5042.593	14.704	1.843	2.529
E(b)	16	21311.49	2.239	39.389	796.389	2324.597	8.306	1.652	1.977
Qliasan									
Block	2	5520.517	565239.6	102.111	72.444	80.528	7.111	1.583	0.206
FERTILIZER	3	5204.887	35032.51	238.324**	1561.704*	9932.963**	66.102*	7.481*	4.441*
E(a)	6	7327.263	36555.57	10.629	303.148	939.824	12.741	0.842	0.861
HYBRIDS	2	3274.901	44027.68	117.694**	1008.861**	3919.694*	39.361*	18.083**	2.865**
Fertilizer *hybrids	6	11744.442*	27041.66	109.991**	1112.120**	4355.546**	11.657	8.565*	3.164**
E(b)	16	3151.456	36992.3	18.708	106.472	991.583	7.917	2.736	0.303
Average of both location									
Location	1	565239.6*	159.014**	1780.056**	31668.06**	3813.556	24.5	0.5	3.212**
Block/L(EA)	4	35032.51	3.243	54.222	453.389	4648.611	13.819	2.417	7.135
FERTILIZER	3	36555.57	11.565**	564.259**	3331.574**	16938.7**	107.889**	7.648**	0.984*
FERTILIZER *L	3	44027.68	0.689	10.833	726.759	2021.296	7.056	2.981	8.332
E(b)/L	12	27041.66	1.113	32.518	266.722	1409.389	7.986	0.620	2.529
HYBRIDS	2	36992.3	27.733**	519.389**	3447.597**	22204.63**	72.681**	47.041**	1.977**
HYBRIDS *L	2	70095.92	20.920	96.889	479.847	10819.18	0.125	7.625	3.212
Fertilizer *hybrids	6	19834.47	5.520*	276.870**	912.171	3794.718	22.792*	3.856	7.135
FERTILIZER*HYBRIDS *L	6	19649	4.568	176.444	1287.829	5603.421	3.569	6.551	0.984

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E(c)/L	32	12231.47	2.047	29.048	451.431	1658.09	8.111	2.194	8.332

Effect of fertilizer applications on yield and its components

Data in table (3) explain the effect of fertilizer application on studied characters at both locations and their average. Maximum values for cob length, cob weight, kernel weight per plant, No. of kernels per row, No. of rows per ear and kernel yield recorded by the application of F2 which were 18cm, 52.667g, 148.33 kernel, 27.889 kernel, 15.222 rows and 7.706 t/ha respectively, while the highest value for No. of kernels per ear recorded by F4 showing 286.333 kernels at Gerda Resha location. At Qliasan location the F2 application gave the highest values for cob weight, No. of kernels per ear and No. of kernels per row, showing 41.556g, 270.222 kernels and 27.111 kernels respectively, while the F3 application gave the maximum values for kernels weight per plant, No. of rows per ear and kernels yield recording 104.333g 15.222 rows and 5.565 t/ha respectively. Regarding to the average of both locations the F2 treatment recorded

fertilizer	1000 kernel weights (g)	Cob length (cm)	Cob weight (g)	Kernel weight (g) plant^{-1}	no. kernel ear^{-1}	No. kernel row^{-1}	No. row ear^{-1}	Kernel yield t ha^{-1}
Gerda resha								
F1	397.417	16	38.222	110.111	212.222	22.333	13.778	5.75
F2	520.928	18	52.667	148.333	262±	27.889	15.222	7.706
F3	382.075	17.333	44.111	134	267.889	25.667	14.444	7.1469
F4	375.242	17.5	42	141.556	286.333	26.222	14.556	7.5498
LSD 0.05	n.s	1.271*	8.508*	17.505**	50.001*	2.073**	0.728*	1.144*
Qliasan								
F1	402.4±	13.056	29.444	76.667	195.444	21	13.111	4.0898
F2	370.867	14.5	41.556	100.778	270.222	27.111	14.222	5.3756
F3	399.789	14.778	32.667	104.333	260.556	25.889	15.222	5.565
F4	352.333	14.611	33.556	84.444	244	23.444	14.778	4.505
LSD0.05	n.s	n.s	3.760**	20.084*	35.363**	4.117*	1.059*	1.071*
Average of both location								
F1	399.908	14.528	33.833	93.389	203.833	21.667	13.444	4.919
F2	445.897	16.25	47.111	124.556	266.111	27.5	14.722	6.5406
F3	390.932	16.056	38.389	119.167	264.222	25.778	14.833	6.356
F4	363.787	16.056	37.778	113	265.167	24.833	14.667	6.028
LSD 0.05	n.s	0.766**	4.141**	11.862**	27.267**	2.052**	0.572**	0.698*

Table 3. effect of fertilizer applications on yield and its components at both seasons and their average

exhibiting 16.25cm, 47.111g, 124.556g, 266.111 kernel, 27.50 kernels and 6.541 t/ha respectively. While the F3 treatment gave maximum value for No. rows per ear reaching

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14.833 rows. The lowest values for all characters recorded by the treatment of control F1 .

[16] discovered that foliar applications of 0.1% and 0.2% (HA) increased maize yields by 14% and 13%, respectively, compared to the control. Additionally, [17] noted that for maize, foliar fertilization should be considered as a supplement to soil-applied fertilizers due to the high nutrient

Effect of hybrids on yield and its components

The performance of hybrids due to studied characters present in table (4). Regarding to the first location, the hybrid 1gave maximum values for 1000 kernel weight, cob length and cob weight recording 663.567g, 19.083cm and 49.333g respectively, but the hybrid 2 showed the highest values for No. of kernel per row and No. of rows per ear recording 27.417 kernel and 16.00 rows respectively. The hybrid 3 gave maximum values for kernels weight per plant, No. of kernels per ear and kernel yield recording 144.583g, 299.667 kernels and 7.557 t/ha respectively. At the second location the hybrid 2 showed maximum values for kernels weight per plant, No. of kernels per ear, No. of kernels per row, No. of rows per ear and kernel yield recording 99.917g, 262.083 kernel, 26.417 kernels, 15.750 rows and 5.329 t/ha respectively, but the highest cob weight recorded by the hybrid 3 reached 36.917g. concerning to the average of both locations, the highest cob length and cob weight recorded by hybrid1 reached16.520 cm and 42.250g respectively. The hybrid 2 gave maximum values for kernels weight per plant, No. of kernels per row, No. of rows per ear and kernels yield reached 120.0843g, 265.292 kernels, 26.916 kernels, 15.875 rows and 6.405 t/ha respectively. The hybrid 3 gave the highest value for No. of kernels per ear reached 26.417 kernels. Regarding to the mean squares for hybrids, it was highly significant for all characters with the except of 1000 kernel weight which was not significant. The mean squares due to interaction between fertilizer and hybrids was highly significant for cob weight, and significant for cob lengths and No. of kernels per row, and not significant for the other characters. Soil Fertilization (SF) significantly impacted all plant growth indices at very high levels of significance, while Foliar Fertilization (FF) showed significant effects on leaf area and shoot dry weight [18], also the value of 1000 kernel weight was not significant for more factors according results showed by [15 .[

Table 4. effect of hybrids on yield and its components at both locations and their average.

HYBRIDS	1000 kernel weights (g)	Cob length (cm)	Cob weight (g)	Kernel weight (g) plant^{-1}	no. kernel ear^{-1}	No. kernel row^{-1}	No. row ear^{-1}	Kernel yield t ha^{-1}
Gerda resha								
H1	663.567	19.083	49.333	115.667	203.167	24.25	12.583	6.077
H2	525.55	15.5	37	140.25	268.5	27.417	16	7.479
H3	486.545	17.042	46.417	144.583	299.667	24.917	14.917	7.557
LSD 0.05	126.347*	1.295**	5.431**	24.424*	41.728**	2.494*	1.113**	1.217*

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Qliasan								
H1	362.842	13.958	35.167	81.75	226.417	23	13.583	4.361
H2	394.608	13.5	30.833	99.917	262.083	26.417	15.75	5.329
H3	386.592	15.25	36.917	93	239.167	23.667	13.667	4.961
LSD 0.05	n.s	n.s	3.743**	8.930**	27.253*	2.435*	1.432**	0.476**
Average of both location								
H1	513.2041	16.52	42.25	98.708	214.792	23.625	13.083	5.219
H2	460.079	14.5	33.912	120.083	265.292	26.916	15.875	6.405
H3	436.568	16.146	41.667	118.792	269.417	24.292	14.292	6.259
LSD 0.05	n.s	0.843**	3.177**	12.525**	24.003**	1.6788**	0.873**	0.629**

Effect of interaction between fertilizer applications and hybrids on yield and its components

Effect of the interaction between fertilizer applications and hybrids on studied characters in both location and their average present in table (5). In Gerda Rasha this effect was significant on only cob length and cob weight, maximum cob length was 20.833cm produced by the interaction between F4 and H1, while the lowest value for cob length was 14.667cm exhibited the interaction between F1 and H2. The maximum cob weight was 70g showed by the interaction between F2 and H3, but the lowest weight was 30.00g produced by the interaction of F1 and H2. In Qliasan location only five characters showed significant response to this interaction, maximum value for 1000 kernel weight was 511.933g exhibited by F1 with H2, while the lowest value was 314.233g produced by F4 with H2. The highest values for kernel weight per plant, No. of kernels per ear and kernel yield were 133.333g, 327.00 kernel and 7.111 t/ha respectively produced by the interaction between F3 and H2, while the lowest values were 64.667, 181.333 kernels and 3.449 t/ha respectively showed by F1 with H3. Regarding to the average of both locations, it was noticed that only three characters responded significantly to interaction effect. The highest values for cob length and cob weight were 17.667cm and 59.50g showed by the interaction between F2 and H3, while the lowest values were 13.083cm and 28.50g respectively produced by F1 and H2. The highest value for No. of kernels per row was 29.50 kernels produced by F2 and H2, but the lowest value was 19.00 kernels showed by the interaction between F1 and H3. [19] reported that assimilate partitioning tends to remain relatively consistent across tropical maize hybrids (varieties). According to [20], foliar nitrogen application enhances grain number (6% more than the control), 1000-seed weight, and stover yields in corn.

Overall, it was observed that hybrids produced higher values for yield and its component parameters. In this context, [21] and [22] noted that the genetic potential of maize is significantly influenced by hybrids, agro-ecological and climatic conditions, as well as cultivation practices. These findings align with the results reported by [23] and [24.[

The variation in nutrient uptake among maize hybrids may be attributed to their distinct genotypes, which result in a larger root surface area in contact with the soil. This, in turn, enhances nutrient uptake at the root-soil interface by creating a more significant diffusive gradient towards the roots [25]. Data

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in Table (5) indicates that only cob length, cob weight and no. kernel per row, at average of both locations were significantly affected by interaction between fertilizer applications and hybrids, it was observed that the combination (broadcasting × third hybrid) and (foliar × first hybrid) produced the highest value of cob length it was 17.667cm and (broadcasting × third hybrid) produced heaviest cob weight it was 59.5g and (broadcasting × second hybrid) produced highest no. kernel per ear was 29.5 respectively. Overall, the results are consistent with those reported by [4], [26], [27], and [28], as well as by [29], [30], [31 .[

Table 5. effect of interaction between fertilizer applications and hybrids on yield and its components at both locations and their average.

fertilizer / Hybrids		1000 kernel weights (g)	Cob length (cm)	Cob weight (g)	Kernel weight (g) plant^{-1}	no. kernel ear^{-1}	No. kernel row^{-1}	No. row ear^{-1}	Kernel yield t ha^{-1}
Gerda resha									
F 1	H1	618.333	18.167	42.667	103	166.667	21	11.333	5.126
	H2	506	14.667	30	113.667	223.333	26.333	15	6.062
	H3	465.333	15.667	42	113.667	246.667	19.667	15	6.062
F 2	H1	960	18.5	47.667	119.333	190	27.667	13.333	6.364
	H2	580.8	15.333	40.333	151	265	30	17.667	8.053
	H3	542.913	20.167	70	174.667	331	26	14.667	8.7
F 3	H1	525.067	18.833	49	129.667	256	25	12.667	6.915
	H2	523.767	17.167	44.667	121.667	231.667	24.667	15.333	6.49
	H3	479.467	16	38.667	150.667	316	27.333	15.333	8.035
F 4	H1	550.867	20.833	58	110.667	200	23.333	13	5.902
	H2	491.633	15.333	33	174.667	354	28.667	16	9.315
	H3	458.467	16.333	35	139.333	305	26.667	14.667	7.432
LSD 0.05		n.s	2.590*	10.864**	n.s	n.s	n.s	n.s	n.s
Qliasan									
F 1	H1	337.433	13.333	37.667	75	222±5.69	19.667	14	4.001
	H2	511.933	12	27	90.333	183±24.01	25	13	4.818
	H3	357.833	13.333	23.667	64.667	181.333	18.333	12.333	3.449
F 2	H1	357.867	14.833	38.667	82.667	231±0.58	26.333	13	4.41
	H2	341.8	13.5	37	94	275.667	29	14.667	5.0133
	H3	412.933	15.1667	49	125.667	304	26	15	6.703
F 3	H1	365.9	13.167	30	78.667	213.667	26	13.667	4.197
	H2	410.467	15.167	33	133.333	327	26.66	17	7.111
	H3	423	16	35	101	241	25	15	5.389
F 4	H1	390.167	14.5	34.333	90.667	239	20	13.667	4.838
	H2	314.233	13.333	26.333	82	262.667	25	18.333	4.3743
	H3	352.6	16	40	80.667	230.333	25.333	12.333	4.303

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LSD 0.05		97.173*	n.s	7.487**	17.861**	54.507**	n.s	n.s*	0.953**
Average of both location									
F	H1	477.883	15.75	40.167	89	194.333	20.333	12.667	4.564
1	H2	508.967	13.083	28.5	102	203.167	25.667	14	5.440
	H3	411.583	14.75	32.833	89.167	214	19	13.667	4.756
F	H1	658.933	16.667	43.167	101	210.5	27	13.167	5.387
2	H2	461.3	14.417	38.667	122.5	270.333	29.5	16.167	6.533
	H3	477.923	17.667	59.5	150.167	317.5	26	14.833	7.702
F	H1	445.483	16	39.5	104.167	234.833	25.5	13.167	5.556
3	H2	467.117	16.167	38.833	127.5	279.333	25.667	16.167	6.801
	H3	451.233	16	36.833	125.833	278.5	26.167	15.167	6.712
F	H1	470.517	17.667	46.167	100.667	219.5	21.667	13.333	5.370
4	H2	402.933	14.333	29.667	128.333	308.333	26.833	17.167	6.845
	H3	405.533	16.167	37.5	110	267.667	20.333	13.5	5.868
LSD 0.05		n.s	1.687	6.354**	n.s	n.s	3.358*	n.s	n.s

Effect of locations on yield and its components

Table 6. showed the change in the kernel yield and its components by locations. This effect was highly significant for cob length, cob weight, and kernel yield, while it was significant for 1000 kernel weight, but did not significant for No. of kernels per ear, No. of kernels per row and No. of rows per ear. It was observed that the Gerda Rasha location outyielded the Qliasan location by 45.550, 20.877, 28.898, 45.812 and 44.103% for the trails 1000 kernel weight, cob length, kernel weight per plant and kernel yield respectively .

Table 6. effect of locations on yield and its components.

location	1000 kernel weights (g)	Cob length (cm)	Cob weight (g)	Kernel weight plant^{-1} (g)	no. kernel ear^{-1}	No. kernel row^{-1}	No. row ear^{-1}	Kernel yield t ha^{-1}
Gerda Rasha	558.554	17.208	44.25	133.5	257.111	25.527	14.5	7.038
Qliasan	381.135	14.236	34.306	91.556	242.556	24.361	14.333	4.884
LSD O.O5	122.467*	1.178**	4.818**	13.932**	N.S	N.S	N.S	0.855**

Conclusion

The present study showed that different methods application of NPK fertilizer had significant effect on maize yield and its components both at broadcasting at the Gerda Rashe location, while at broadcasting and liquid fertilizer at Qlyasan location. The finding of this study could be useful to improve growth and achieve more yield and quality improvement of maize crops. Using broadcasting and liquid NPK fertilizer is recommended for maize production in terms of economic viability as compared to the traditional methods. The present study showed that growing maize hybrids with different

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methods of fertilizer application get the higher growth parameters, yield and its components and N, P and K uptake in kernels .

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