Effect of levelling machines on some maize varieties productivity

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Abstract:

In order to optimize the maize productivity and quality, various aspects of production chains should be considered in an integrated way, including crucial steps to improve the maize yield. This study is aimed to identify the effect of levelling machines on maize varieties . Two types of levelling machines (LLM and TLM), for three maize varieties of FU, ZP and SA. The experiments were conducted using a split-plot RCBD with three replicates. The SA variety was significantly superior to the other two varieties of FU and ZP in all studied parameters. For LLM the plant height, ripening days number, chlorophyll index in leaves, grains number in the ear, 500 grains weight, grains yield and biological yield were 188.15 cm, 99.58 day, 47.71 %, 503.2 grain ear^{-1}, 140.48g, 7.389 tha^{-1} and 18.619 tha^{-1}. respectively under the same operating conditions for TLM. The results showed that the SA variety was significantly better than the ZP and FU in all studied conditions. The interaction among LLM levelling machine, and SA variety gave the best results in all studied parameters .

Keywords: Maize (*Zea mays L.*), machines, levelling, FU, ZP and SA varieties.

Introduction

Maize (*Zea mays L.*) is a cereal crop, ranking third after wheat and rice and it is grown for human consumption its by products are used as animal feed, also grains used in many industries to produce various food products (Alaamer et al.,2023a). The Agriculture Ministry has taken it upon itself to encourage farmers to utilize arable land by cultivating corn according to scientific principles to increase productivity and meet the growing demand for this crop in most poultry projects and starch and dextrin factories, this is because maize grains is the primary source for ensuring these projects sustainability. In this context, the Agriculture Ministry has been keen to provide comprehensive and unlimited support to increase the area allocated to cultivating this crop using scientific and technical methods to increase its productivity, address shortages, and avoid imports (Aljibouri et al.,2022). The maize production system still suffers from significant shortcomings due to farmers' reliance on old, traditional methods and the lack modern scientific methods adoption, which has resulted in a decrease in grain yield in unit area (Bedasa, and Tekalign, 2023; Feleke et al.,2023; Tefera, and Awoke, 2025) . Agricultural mechanization has emerged as a decisive factor in improving productivity and developing sustainable agriculture, particularly in tillage, leveling, and soil preparation for planting. This, in turn, impacts water availability and its uniform distribution in the root zone. (Jebur, and AL-Halfi, 2022; Hachim, and Jebur, 2022).

Study of Shtewy et al.,(2020); Alsharifi et al,(2022) that most studies have focused on

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using modern technologies in the maize production cycle at the lowest cost and to ensure food security, given that corn is a key crop for most developing countries. Takeshima et al.,(2020); Saldani and Shtewy (2024), production stagnation and low input use efficiency in corn cultivation are particularly sensitive that stumbled on productivity. Shathar and Alsharifi (2023), soil leveling is a fundamental and effective step in modern agricultural practices with good soil and crop management soil leveling has a significant impact on all agricultural operations, such as sowing, fertilization, and irrigation methods, this is achieved through the homogeneous distribution for these operations. It has been stated Miao et al.,(2021), that the use of laser leveling technology and the adoption of high-yielding varieties represent a significant development, reflected in increased corn yields resulting from the high effect for soil leveling and the suitable moisture availability in the root zone, which contributes to the seeds uniform distribution , efficient use of water and nutrients, increased the yield, and reduced economic losses. Jat et al.,(2014); Coa et al (2021) selected variety has a significant impact on the type and quality of the product due to the genetic traits it possesses, enabling it to withstand environmental conditions such as drought. Water movement on the soil surface is improved by leveling the soil to change its topography and make its surface desirable, thus improving the irrigation process.

Precision laser leveling plays a key role in soil leveling, similar to scrapers or blades, resulting in more precise soil leveling, the leveling process is carried out to achieve several key objectives, including: controlling the irrigation water quantity ensuring its and uniform distribution, improving crop productivity, increasing germination rates, adjusting fertilizer application, controlling weeds. This results in improved vegetative growth and an increased overall yield (Surendran-Padmaja et al.,2025). Most farmers level the soil before planting to ensure smooth water flow and reduce the added water depth (Chen et al.,2024;Alaamer et al.,2026). Leveling is of particular importance in farming systems for most crops, all services that encourage farmers to carry out leveling operations are provided for reasons related to agricultural processes i.e., most importantly sowing, fertilization, and irrigation methods. Varieties can participate to allowance of all exertion factors such as drought and heat, as well as favors their management and shortening their growth cycles (Martey et al.,2020; Majebele et al.,2025), several factors affect crop yields, including failure to follow scientific principles, high seed prices, and the undesirable characteristics for selected varieties to cultivation (Lamichhane et al.,2022). irrigated agriculture still consumes about 70% from the water, so the leveling process is extremely important to determine the water consumed amount with a regular distribution (Naresh et al.,2014; Benaly et al.,2025). This situation puts increasing pressure on productivity and food security. Therefore, great economic maize and nutritional importance, despite advanced agricultural capabilities, there is a large gap between the actual and potential production for the maize crop, which is limited to the variety chosen for cultivation (Alyal et al., 2020; Gebrechorkos et al.,2025). Most farmers resort to adopting modern technological methods to increase the agricultural production (quantity and quality) thus ensuring food security. The current study focused on the leveling machinery use and its effect on the growth characteristics and yield of some local maize varieties.

Material and methods

Study site

Al-Hashimiyah City, the district center of Babylon Governorate, is situated in the Middle Euphrates region, approximately 130 km south of

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Baghdad. Known for its fertile agricultural lands, the area is renowned for its orchards and cultivation of strategic crops such as wheat (Triticum aestivum L.), barley (Hordeum vulgare L.), and corn (Zea mays L.) (Fig. 1).

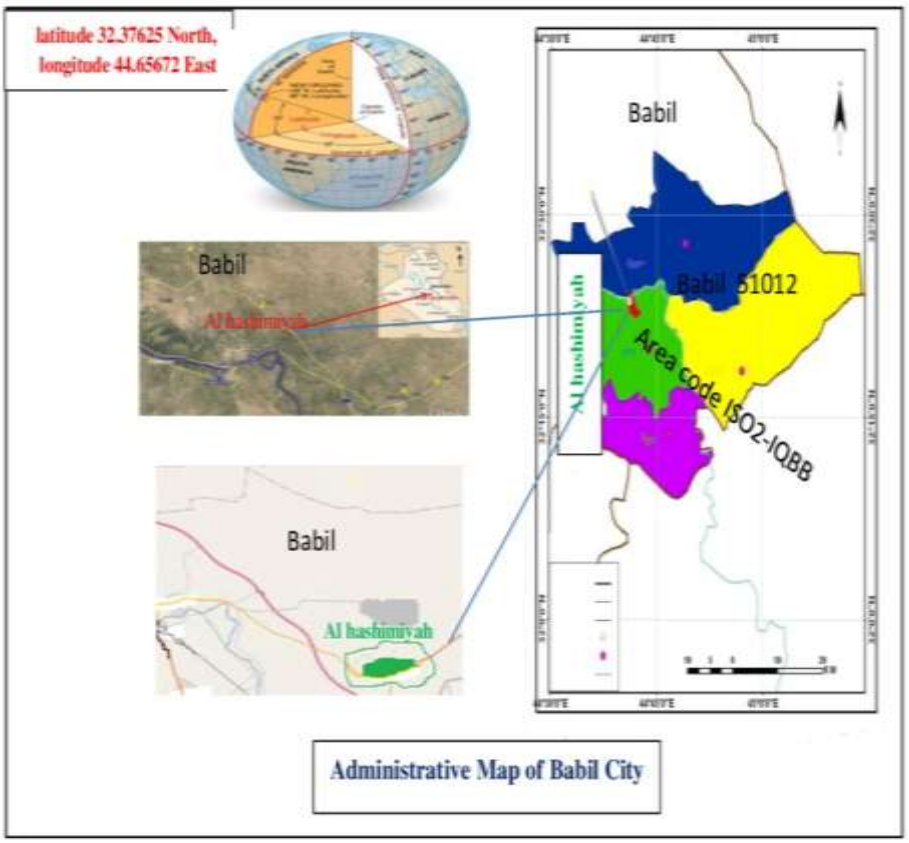

Figure .1 Study site

A field experiment was conducted during the 2025 summer growing season in a farmer's field under the Al-Hashimiyah Agriculture Directorate, Babylon Governorate, to evaluate yellow corn (Zea mays L.) production under specified experimental conditions..

Field soil preparation

Prior to planting, soil samples were collected from nine randomly selected locations (0-20 cm depth) with three replicates each for comprehensive physicochemical analysis (Nayyef, and Al-Laghawi,2024; Nayyef et al.,2025). The sampling area was determined based on experimental requirements, with results presented in Table 1.

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Table 1. Analysis of soil physical and chemical characteristics

Depth	**Texture %**			
0-20 (cm)	**Clay**	**Silt**	**Sand**	
	66	19	15	Silt Clay loam
	Soil physical properties			
	Pb (Mg m^{-3})	**TSP (%)**	**SPR (Kpa)**	
	1.22		1455.09	field capacity %
	1.26		1567.82	33.12
	1.30		1605.44	32.43
VA				
0-20	**Soil chemical properties**			
	E.C (ds\cm^3)	**HP**	True Density (Mg.m-3)	
	2.34	7.42	2.55	
	Soluble cation meq\I			
	Na	**K**	**Ca+Mg**	
	8.21	12.16	55.15	
	O.C (%)	CEC Meq\100 g)	CaCo3 (%)	O.M (%)
	0.55	31.88	4	0.65

The soil was prepared by plowing using a moldboard plow and the tiller was set to a depth of 20 cm to stir the soil, the soil was smoothed using double disc combs. The soil was leveled using leveling equipment arranged according to a randomized complete block design arranged in split plot with three replications. The field is then divided into several experimental plots with 36 experimental units measuring 3x3.5 m2, with a distance of 75 cm between the experimental units and 1 m between the sectors, 20 cm between one hole. A locally developed fertilizer application machine is used to apply a triple phosphate fertilizer at a rate of 120 kg ha^{-1} at a time and to a depth of 8 cm before planting (Amer et al.,2025). The planter type sowing machine, was set at 100 kg ha^{-1} for the FU variety with a leveling machines LLM and TLM, then the same process was repeated for the SA, and ZP varieties.

Experimental field topography

Topography directly influences soil formation through slope, as there is a direct relationship between surface slope and water flow velocity. This affects the water infiltration amount, soil dryness, vegetation density, and organic matter content. Soils in sloping areas are also characterized by their shallowness and limited depth. Soil topography has a significant impact on the crops nutrient content. Also soil slope and inclination affect the nutrient

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content; therefore, leveling the soil increases crop growth rate.(Shathar et al.,2024). The selected experimental soil consisted of scattered clumps at heights that affected both seed distribution and water level (Fig.2).

The readings obtained using a level device (Fig. 3), difference between front (F.S) and back (B.S) readings.

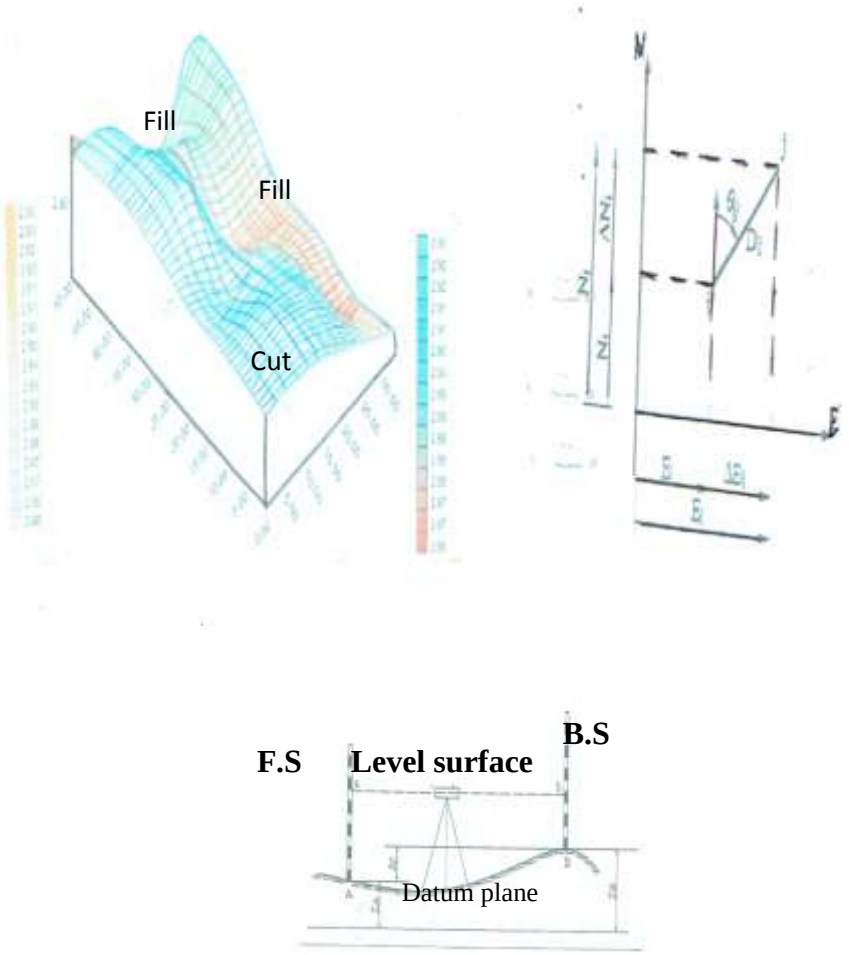

Fig.2. Soil topography, and readings taking method

Topographic surveying

Points identified and readings taken, using the theodolite (Transit), Figure 3

$$L_{TU=} L \times \cos Bearing \quad (1)$$

$$D_{PU=} L \times \sin Bearing \quad (2)$$

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The leveling device was attached on the MF- 285S tractor. The field was surveyed to determine elevations, depressions, and field characteristics using a MAST (This device consists of a graduated rod for measuring elevation and depressions via a hydraulic piston that controls the raising and lowering of the receiver as needed by connecting the hydraulic device to a P.T.O unit for tractor). Therefore, a virtual field diagram or network is created (Fig.3), showing the rises and falls by setting the zero level in the transmitter and determining the tractor path.

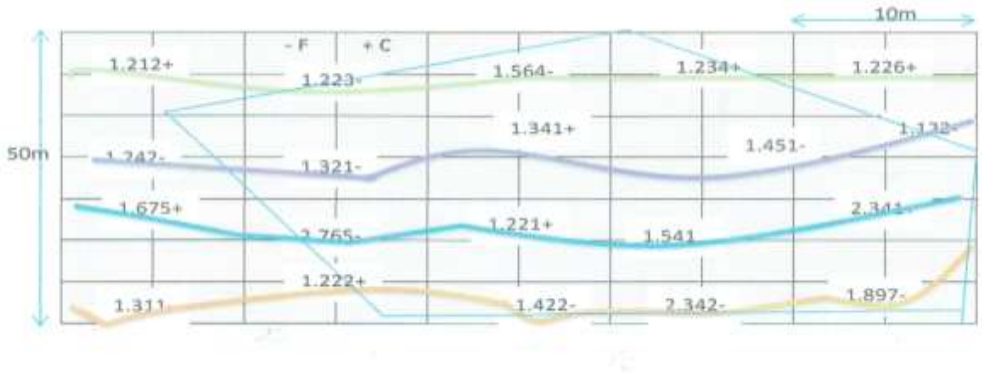

Fig .3. Network diagram for MAST before making leveling process.

The experiment includes two factors

i) The first factor comprising of four different maize varieties. Those are Furat, and Saginto

Furat (FU)

The Furat maize variety, Dutch hybrid approved by the Iraqi Agriculture Ministry, exceedingly cultivated in focal and southern Iraq, is describe by its discriminatory long and plump cob morphology. This variety has show freaked agronomic execution under Iraqi growing provision, specifically in semi-arid climates, combining high yield possibility with notable drought tolerance .Purity ratio 99% and germination ratio 93%.

Saginto (SA)

The Saginto maize variety, a German hybrid approved by the Iraqi Ministry of Agriculture. It is characterized by its long, thick cop and high yield. Its cultivation is concentrated in central and southern Iraq, and it has proven tolerant of all the region's climatic conditions. Purity ratio 99% and germination ratio 94%.

ZP

This variety is characterized by its medium-length cob and average productivity. It also tolerates drought and salinity. Serbian hybrid, the growing conditions for this variety are limited to protected areas, but thanks to breeding and improvement, it has become possible to cultivate it in temperate regions. Purity ratio 99% and germination ratio 92%.

ii) Levelling machines;

Levelling is a necessary and complementary process to preparing the soil for planting. It contributes to the water regular distribution , saves watering time, ensures uniform distribution for fertilizers, and guarantees that water reaches field parts all with equally

Laser levelling machine (LLM)

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Laser leveling is performed using a transmitter that emits a laser beam to the area surrounding the leveling machine up to a distance of 300 meters. A control box, positioned in front of the driver, operates automatically in conjunction with the other components of the leveling machine. A receiver is mounted on the cutting blade holder. A hydraulic unit, connected to the machine's hydraulic and the control box, for controls the raising and lowering of the cutting blade via laser beam (Fig .4).

Table 2. Specifications(Laser leveling machine)

Parameter	
Display	Seven Segment LED, Visible in Day Light, Adjustable in Brightness
Switch	Tour Sensor Switch Suitable for Dusty Condition
System Accuracy	±5 mm
Control	Programmable
Working Mode:	10 User Modes Programmable
Indications:	Working Channel, Time & Errors (LED for Up, Down, Link & Auto)
Protection: IP65	
Connectors:	Silver coated, Chroe plated atll weather bend proof
Laser Guided Land Leveller Pro-12000 Capacity 6m Weight 4300kg Dimensions 2500 x 3200 x 6600	

Fig.4. Laser leveling machine

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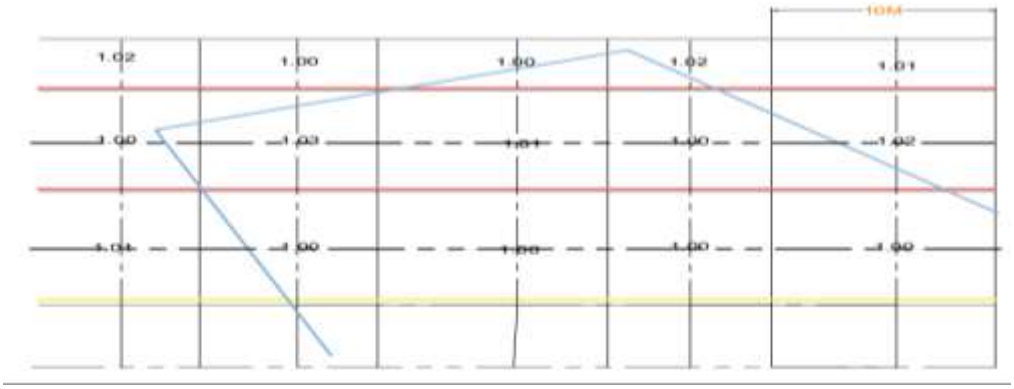

Fig .5. Readings obtained using levelling machine (Laser type)

Tablet levelling machine (TLM)

This device is attached to the tractor's hydraulic lifting device and its depth is calibrated according to the elevation and depression readings in the test field, predetermined by MAST (Fig .6).

Table 3. Specifications(Tablet leveling machine)

Parameter	
local manufacturing machine	Iraq
hanging type	Back tractor
Width	2.76m
Weight	256 kg

Fig.6. Tablet leveling machine

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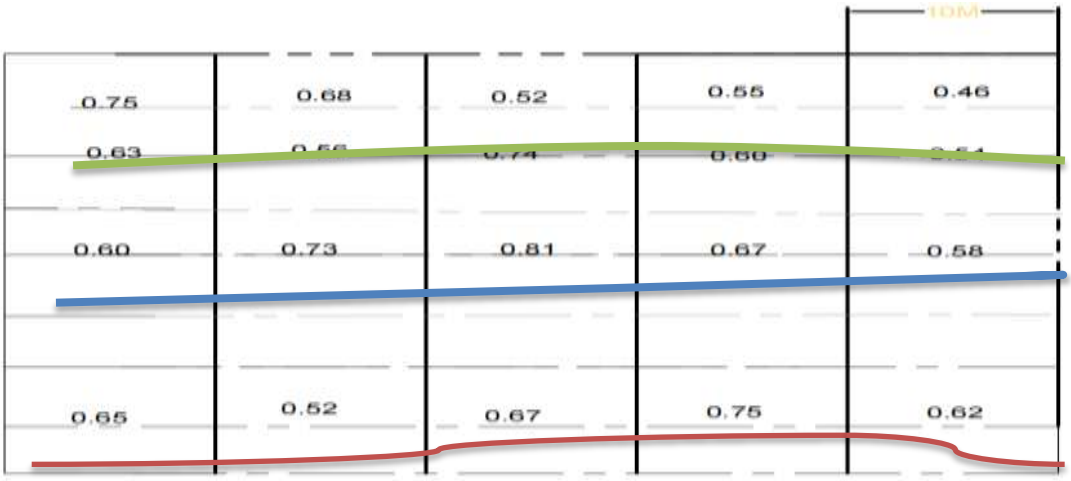

Fig .7. Readings obtained using levelling machine (Tablet type)

Studied characteristics

Vegetative growth characteristics

Plant height (PH)

It was measured after the plant reached the flowering stage (100%), using an Invar strip measurements were taken from the soil surface to the flag leaf base for ten randomly selected plants from the midlines for each experimental unit, with three replicates (Alaamer et al.,2023b).

Ripening days number (**RDN**)

Chlorophyll index in leaves (CIL)

It was calculated using a manual digital scaling device SPAD-502-meter and awarding to the method by (Mohammed et al.,2022; Alaamer et al.,2026).

Yield characteristics

Grains number in the ear (GNE)

After the plant reached physiological maturity, ten ears were taken from the midlines for each experimental unit (three replicates) and placed in husking and counting machine (Satak type), (Alsharifi et al.,2025).

50 0grains weight (500GW)

The 500-grain weight was specified by first classifing grains awarding to size and ejecting broken kernels using a Satake testing device (Alsharifi et al.,2024). robust grains were then scaled using a precision electronic balance (accuracy ±0.01 g)

Grains Yield (GY)
was calculated using the Eq.4, (Shtewy et al.,2020 : Banaj et al.,2024):

$$\mathbf{GY = GP \times PD} \quad (3)$$

where:
GY = Grain yield ($t \cdot ha^{-1}$), GP = Grain weight per plant ($kg \cdot plant^{-1}$), PD = Plant density ($plants \cdot ha^{-1}$)

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Biological yield (BY)
It was calculated using the Eq.5, after drying the sample in the oven at 70 °C until the weight stabilized.

$$BY = PDW + PD \quad (4)$$

Where; BY; biological yield $t.ha^{-1}$,PDW; plant dry weight (kg) , *PD*; plant density (ha^{-1})

Statistical Analysis:

The experimental data were analyzed using GenStat 18th edition (VSN International) with a split-plot arrangement in a randomized complete block design (RCBD). Treatment means were compared using Least Significant Difference (LSD) test at $\alpha = 0.05$ significance level.

Results and Discussion

Vegetative growth characteristics

Table . 4, demonstrate significant effects ($p < 0.05$) of maize varieties , levelling machines, and their interaction on maize vegetative growth. High effects were observed with laser levelling machine + maize variety saginto, achieving peak values (197.14 cm, 99.58 day, 53.10%). This supports with recognized levelling machines and maize varieties dynamics: balanced levelling and soil moisture availability promotes root expansion and homogeneous nutrient uptake, thereby supporting vegetative development

Table.4. Effect of levelling machines on the vegetative growth parameters for three maize varieties

Varieties	Levelling machines	Vegetative growth characteristics		
		PH	RDN	CIL
FU	LLM	180.67	99.31	42.85
	TLM	171.81	105.08	37.96
ZP	LLM	186.64	100.54	47.17
	TLM	181.42	106.78	40.85
SA	LLM	197.14	98.91	53.10
	TLM	189.46	103.11	46.79
V	FU	176.24	102.20	40.41
	ZP	184.03	103.66	44.01
	SA	193.30	101.01	49.95
LM	LLM	188.15	99.58	47.71
	TLM	180.90	104.99	41.86
LSD=0.05	V	0.971	3.138	1.041
	LM	0.504	2.055	0.813
	V*LM	1.494	3.897	N.S

Maize variety Furat ;FU, maize variety ZP ;ZP, maize variety Saginto ;SA, laser levelling machine; LLM, Tablet levelling machine; TLM, plant height ;PH**,** ripening days number; RDN, chlorophyll index in leaves ;CIL.

From Figure .8. The SA variety produced superior growth metrics (plant height: 193.30 cm; ripening days number: 101.01; chlorophyll index in

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leaves 49.95 %) surpassing FU (176.24cm, 102.20day,and 40.41%), and ZP(184.03cm, 103.66 day and44.01%). The primary cause of rapid vegetative growth is the genetic makeup for the variety (Bedasa, and Tekalign, 2023). This is what was indicated by (Shtewy et al.,(2020); Alsharifi et al, 2022), who found that the variation in growth duration depends on the plant's ability to manage enzyme activity and provide the energy necessary for photosynthesis, leaf growth, increased leaf area, and reduced senescence.

Figure 9. The LLM treatment increased vegetative growth (188.15 cm, 99.58 day, 47.71%), and TLM (180.90 cm, 104.99 day, 41.86%). This is due to the levelling machine effect on the soil by levelling its surface, improving aeration, and reducing moisture loss, which leads to increased root spread and more uniform distribution of water and fertilizers. This, in turn, results in increased vegetative growth (Chen et al.,2024). This is (Alaamer and Alsharifi .,2023) confirmed, that the leveling process plays a vital role in regulating plant growth and maintaining soil moisture, which in turn improves the plant's vegetative condition during the growing season.

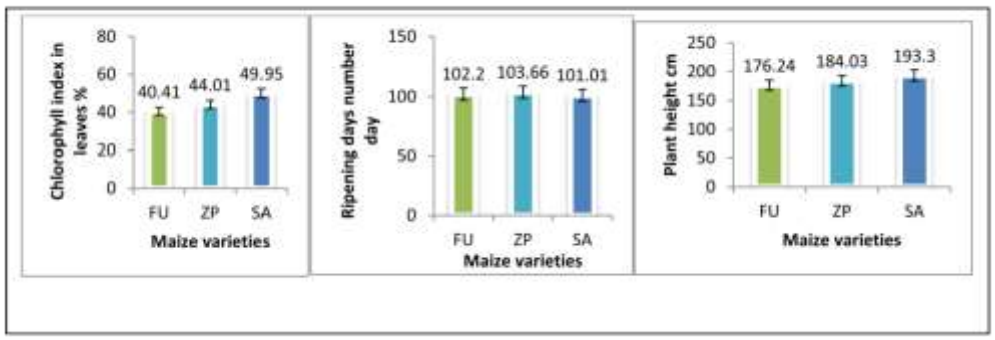

Fig.8. Effect of maize varieties on the maize vegetative growth

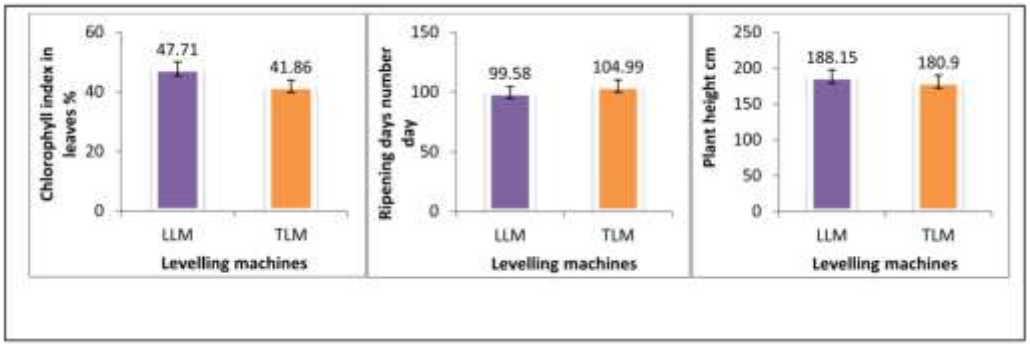

Fig.9. Effect of levelling machines on the maize vegetative growth

Yield characteristics

Table 5, demonstrate significant effects ($p < 0.05$) of maize varieties , levelling machines, and their interaction on maize yield parameters. The optimal treatment combined levelling machine LLM type with SA variety, achieving record values (568.9 grain ear^{-1}, 149.77g, 8.268 t·ha^{-1},

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20.093 tha^{-1}), demonstrating synergistic effects between levelling management and nutrient availability.

Table.5. Effect of levelling machines on the yield parameters for three maize varieties.

Varieties	Levelling machines	Yield characteristics			
		GNE	500GW	GY	BY
FU	LLM	449.1	133.26	6.166	17.263
	TLM	349.1	120.60	5.458	16.300
ZP	LLM	491.8	138.42	7.733	18.500
	TLM	374.6	127.79	6.007	17.383
SA	LLM	568.9	149.77	8.268	20.093
	TLM	426.3	133.09	6.545	18.263
V	FU	399.1	126.93	5.812	16.781
	ZP	433.2	133.11	6.870	17.942
	SA	497.6	141.43	7.406	19.178
LM	LLM	503.2	140.48	7.389	18.619
	TLM	383.3	127.16	6.003	17.315
LSD=0.05	V	10.23	1.137	0.141	0.135
	LM	9.69	1.010	0.164	0.181
	V*LM	16.78	1.845	0.244	0.243

Grains number in the ear ;GNE, 500 grains weight ;500GW, grains yield ;GY, biological yield ; BY.

Figure 10. The LLM treatment increased yield parameters, (grains number in the ear; 503.2grain ear^{-1},500 grains weight; 140.48 g, grains yield; 7.398 tha^{-1},biological yield; 18.619tha^{-1}, TLM (383.3grain ear^{-1}, 127.16 g, 6.003 tha^{-1}, 17.315 tha^{-1}). This is due to the high degree for levelling, which improves water flow and reduces the added water depth(Miao et al.,2021) . This is confirmed by (Jat et al.,2014 ; Surendran-Padmaja et al.,2025), that the leveling process plays a vital role in distributing water uniformly in the root zone and ensuring continuous soil moisture resulting from the precise leveling process (laser).

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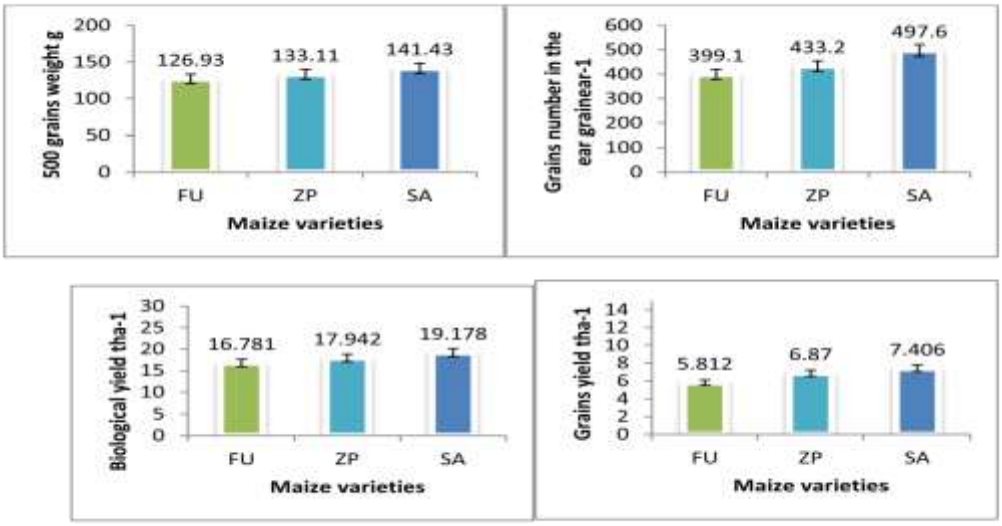

Fig.10. Effect of maize varieties on the maize yield parameters

Figure 11. Among maize varieties treatments, the SA variety greatest performance, producing 497.6 grain ear^{-1}, 141.43 g, 7.406 t·ha^{-1}, 19.178 tha^{-1}, significantly exceeding FU (399.1 grain ear^{-1}, 126.93 g, 5.812 t·ha^{-1}, 16.781 tha^{-1}), and ZP (433.2 grain ear^{-1}, 133.11 g, 6.870 t·ha^{-1}, 17.942 tha^{-1}. Increased in yield parameters is due to genetic differences among corn varieties ((Banaj et al.,2024; Gebrechorkos et al.,2025), this also centered (Martey et al.,2020; Majebele et al.,2025), that the selected variety, which gives the highest growth characteristics, is reflected in the values highest for final productivity .

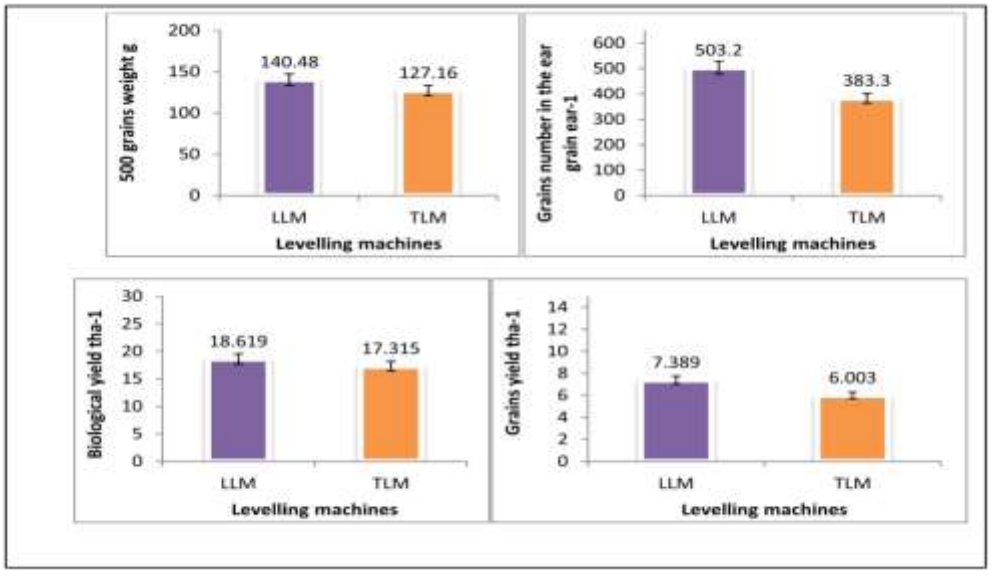

Fig.11. Effect of levelling machines on the maize yield parameters

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Conclusions

The study demonstrated that a SA variety significantly outperformed FU, and ZP across all measured growth and yield parameters. Among levelling treatments, the LLM showed superior results compared to TLM. The high effect of Laser levelling machine with SA variety, produced optimal execution, proposition this incorporation as the most effective management strategy for maize cultivation under similar conditions.

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