EFFECT OF TILLAGE AND FERTILIZER APPLICATION ON GROWTH OF CONVENTIONAL AND HYBRID MAIZE

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ABSTRACT: The growing importance of maize has motivated researchers to focus on optimizing production technologies, such as tillage and fertilizer usage. To this end, a study was conducted in RCBD design using three tillage systems, namely deep tillage, traditional tillage, and minimum tillage, and two fertilizer levels (recommended and 50% increase over recommended NPK) on non-Hybrid C-20 and Hybrid FHY-399 varieties. Growth parameters were documented at maturity. The data showed that tillage methods had a major impact on plant growth and yield parameters, with the exception of number of cobs per plant, which was non-significant with maximum values in deep tillage. Fertilizer had a major impact on growth parameters, with the greatest effect occurring when the NPK fertilizer level was increased by 50% above the recommended level. The interaction between tillage methods and fertilizer levels was found to be statistically insignificant for maize growth except at 1000 grains per acre. The treatment combination of deep tillage + 50% increase over recommended NPK fertilizer level yielded the highest value of 1000-grain weight. Based on the findings, it is proposed that additional research be performed with no fertilizer, and a rate of fertilizer twice the recommended rate.

Key words: Tillage, Deep Tillage, Chemical Fertilizers, Conventional Maize, Hybrid Maize, Yield.

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INTRODUCTION

Agriculture research aims to improve crop productivity. The role of soil physical properties in maximizing production has long been recognized in this context. To improve the physical condition of the soil, many management activities such as tillage, irrigation, mulching, fertilization, and manuring are used. Tillage is by far the most effective and widely used method for improving soil physical condition, contributing up to 20% to crop production (Scarpare *et al.,* 2019). Tillage affects crop growth and yield by altering soil structure and removing moisture, which is dependent on soil fertility, tillage type, and climatic conditions. Tillage has an environmental impact on the long-term use of soil capital due to its effects on soil properties (Hontoria *et al.,* 2016). The role of tillage in crop production is somewhat contentious; however, there is growing interest and focus on the use of minimal and no tillage to manage erosion processes, increase summer crop water use quality, and improve crop production (Weidhuner *et al.,* 2021 , Pittelkow *et al.,* 2015)

Fertilizers are a critical component of farm inputs for the agricultural production. The growing importance of maize in recent years has resulted in the creation of a vigorous maize-breeding and management programme that includes fertilizer application and plant protection steps, among the numerous factors affecting its output, the most important of which is fertilizer efficiency. Even the best strains can fail to express their genetic potential if they are not fertilized properly. Pakistani soils are characterized by a deficiency of organic matter, nitrogen, and phosphorus, most likely as a result of arid to semiarid climate conditions and high temperatures. Since maize is a short-lived crop, it has a high demand for readily available plant nutrients. The most important input for increasing maize production is the application of N, P, and K fertilizers (Borges and Mallarino, 2003). NPK application has an effect on vegetative growth, protein synthesis, and nutrient uptake (Marschner, 1986). The imbalance fertilization is a big constraint for low yield. A well-balanced and suggested use of N, P, and K is critical for growing cereal yield. According to estimates, a 30-35% rise in crop yield has been observed, as well as an improvement in grain quality due to the proper application of fertilizer (Gill, 2019). Balanced fertilization and nutrition are essential and prerequisites for achieving adequate yields and quality of production of food barley (Chala G, 2017). With these factors in mind, the aim of the current investigation is to determine the impact of tillage and fertilizer on the growth of two maize varieties.

MATERIALS AND METHODS

This research was carried out at the University of Agriculture, Research Area, Institute of Soil and Environmental Sciences, Faisalabad, to determine the

effects of tillage and the application of various fertilizer rates. The first level was recommended NPK fertilizer doses of 200-125-60 NPK kg/ha (F-1), and the second level was a 50% increase over recommended fertilizer doses with 300-1875-90 NPK kg/ha (F-2), which were applied to the growth of two maize varieties, hybrid (FHY-399) and non-hybrid (FHY-391) (C-20). The study included twelve treatment combinations, each repeated three times, in a completely randomized block design.

Table 1: Treatments plan.

Treatments	Tillage	Fertilizer	Varieties
T_1	Deep tillage	Recommended NPK	C-20
T_2	Deep tillage	Recommended NPK	FHY-399
T_3	Deep tillage	50% increased over recommended NPK	C-20
T_4	Deep tillage	50% increased over recommended NPK	FHY-399
T_5	Conventional tillage	Recommended NPK	C-20
T_6	Conventional tillage	Recommended NPK	FHY-399
T_7	Conventional tillage	50% increased over recommended NPK	C-20
T_8	Conventional tillage	50% increased over recommended NPK	FHY-399
T_9	Minimum tillage	Recommended NPK	C-20
T_{10}	Minimum tillage	Recommended NPK	FHY-399
T_{11}	Minimum tillage	50% increased over recommended NPK	C-20
T_{12}	Minimum tillage	50% increased over recommended NPK	FHY-399

One chiselling with three shovels spaced 45 cm apart was used for deep tillage (DT), followed by a narrow tine cultivator and planking with a wooden planker. Three ploughings with a narrow tine cultivator is accompanied by planking with a wooden planker in conventional tillage (CT).

One ploughing with a narrow tine cultivator was followed by planking with a wooden planker to achieve minimum tillage (MT). Tillage methods were maintained in the main plots, while fertilizer and variety selection were held in the sub plots.

The maize crop was planted with a dibbler, with a plant-to-plant distance of 22 cm and a row-to-row distance of 70 cm. Urea, DAP, and MOP were used as N, P, and K fertilizers, respectively. P and K were applied in their totality at the time of sowing, while N was applied in splits, with half applied at the time of sowing and half applied when the crop reached a height of three feet. Canal water was applied as required for irrigation. Throughout the increasing era, plant protection measures were implemented as needed. Plant height (cm), total dry biomass (Mg ha-1), number of cobs per plant, 1000-grain weight (g), and grain yield (Mg ha -1) were all measured when the crop was harvested at maturity.

The data was statistically analyzed using a fully randomized block template with split plot. The least significant difference test was used to compare the means of the treatments (Steel and Torrie, 1980).

RESULTS

a. **Tillage, fertilizer, and variety effects on maize plant height (cm):** The height of a plant is determined by a combination of genetic and environmental factors. Plant height as a function of tillage, fertilizer, and variety was shown in Figure 1 to be higher for hybrid varieties than non-hybrids in both tillage and fertilizer treatments. In both of these maize varieties, tillage and fertilizer had a major combined (interactive) impact on plant height. In the case of non-hybrid maize varieties, the overall mean plant height (187.76 cm) was calculated with a 50% increase in fertilizer over the recommended rate (F2), followed by (182.56 cm) with the recommended NPK rate (F1). The maximum mean plant height (201.5 cm) was observed with the F2 treatment, followed by 190.76 cm with the F1 treatment in the case of hybrid maize variety.

The recommended fertilizer rates for various crops are generalized in order to increase yield. Under these soil, crop, and agro-climatic conditions, a fertilizer rate 50% higher than the recommended rate was better in the current study.

b. **Tillage, fertilizer, and variety effects on maize crop total dry matter (Mg ha-1):** The data on maize total dry matter (Fig. 2) showed that both tillage and fertilizer had a major impact on maize crop total dry matter. Tillage and fertilizer interaction was statistically important. With both tillage and fertilizer treatments, hybrid maize produced more total dry matter than non-hybrid maize. With non-hybrid maize, the maximum mean value of total dry matter (19.43 Mg ha-1) was observed when the recommended rate of fertilizer (F2) was increased by 50%, followed by 15.04 Mg ha-1 when the recommended rate of fertilizer (F1) was used. With recommended and 50% increase over recommended NPK, the maximum mean values of total dry matter

observed in hybrid maize were 25.79 and 18.36 Mg ha-1, respectively. These findings agree with those of Sharif *et al*. (1995), who found a maximum grain weight of 2.264 Mgha-1 while using 120 kg Kha-1. With 80kg K/ha and a net return of 40kg Kha-1, the maximum dry matter yield (3.055 Mgha-1) was achieved.

Fig. 1 Effect of tillage, fertilizer and variety on plant height (cm) of Maize

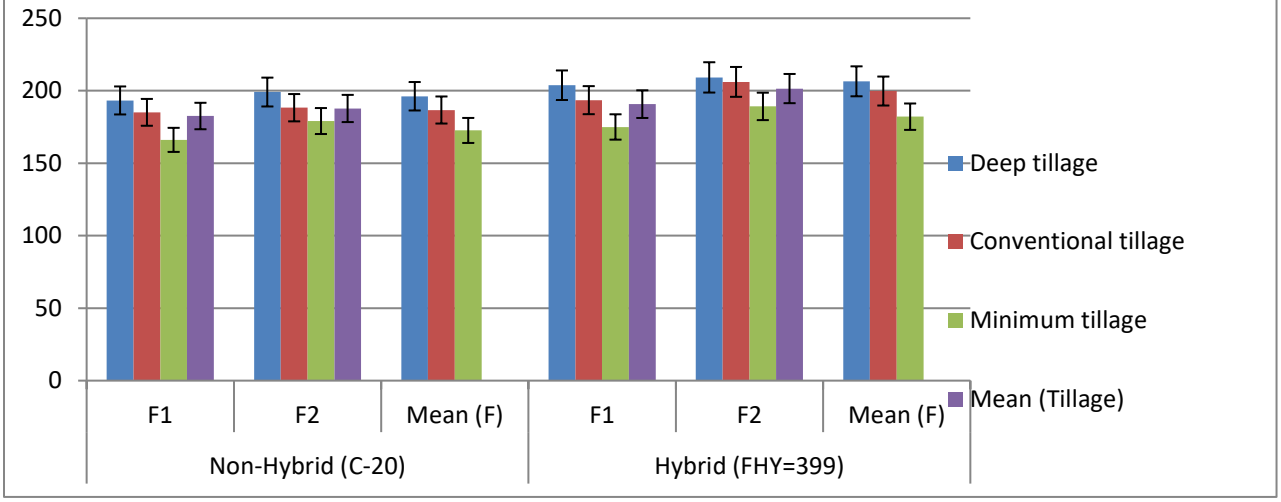
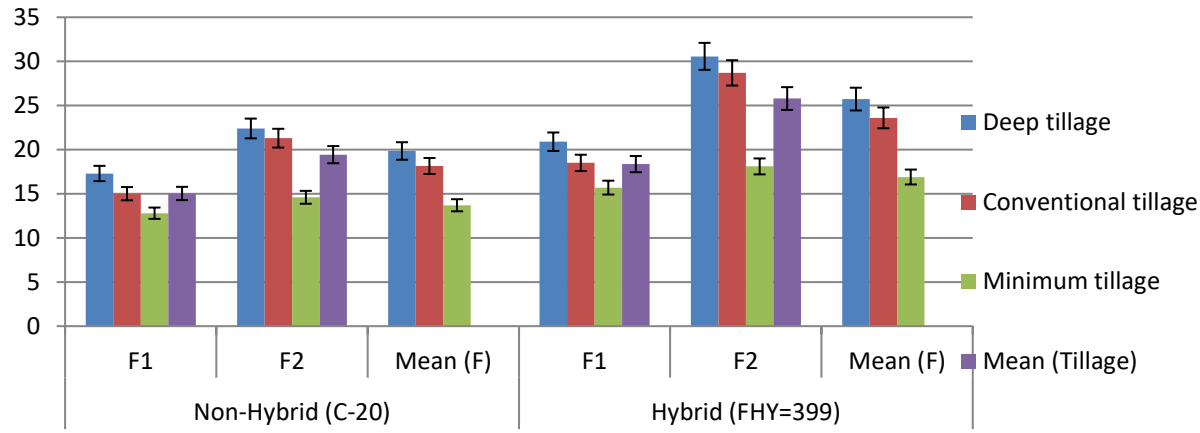


Fig. 2 Effect of tillage, fertilizer and variety on total dry matter (Mg ha^{-1}) of maize crop



c. **Tillage, fertilizer, and variety effects on number of cobs per plant:** Tillage, fertilizer, and variety all had important effects on the amount of cobs per plant in the maize crop, as shown in Fig 3, but the interactive effects of these treatments were statistically non-significant. With all tillage and fertilizer combinations, hybrid maize produced more cobs per plant than non-hybrid maize. The maximum mean number of cobs per plant (1.368) was observed when deep tillage was used, followed by 1.313 when traditional tillage was used, and a minimal value (1.22) was observed when non-hybrid maize was grown with minimum tillage. The highest number of cobs per plant in hybrid maize was 1.40 with deep tillage, followed by 1.37 and 1.25 with traditional and minimum tillage, respectively.

Fertilizer had a highly important impact on the amount of cobs per plant in Maize. The maximum mean value of amount of cobs per plant was observed in non-hybrid maize when the recommended rate of fertilizer (F2) was increased by 50%, followed by 1.224 in the case of recommended rate of NPK fertilizers (F1). Similarly, in the case of hybrid maize varieties, F2 had the highest mean number of cobs per plant (1.41) followed by F1 with 1.268.

d. **Tillage, fertilizer, and variety effects on 1000-grain weight (g) of maize:** Tillage and fertiliser had a

major impact on 1000-grain weight of maize, according to data provided in Fig 4. In terms of tillage, the maximum mean value of 1000-grain wt. (363.7g) was obtained using conventional tillage, followed by (362.56g) using deep tillage, and a minimum value (322.6g) using minimal tillage in the case of non-hybrid maize. In the case of hybrid maize, the highest mean 1000-grain wt. value was observed with deep tillage (399.25g), followed by 379.2 and 337.6g with conventional and minimal tillage, respectively.

Fig. 3 Effect of tillage, fertilizer and variety on number of cobs per plant of Maize

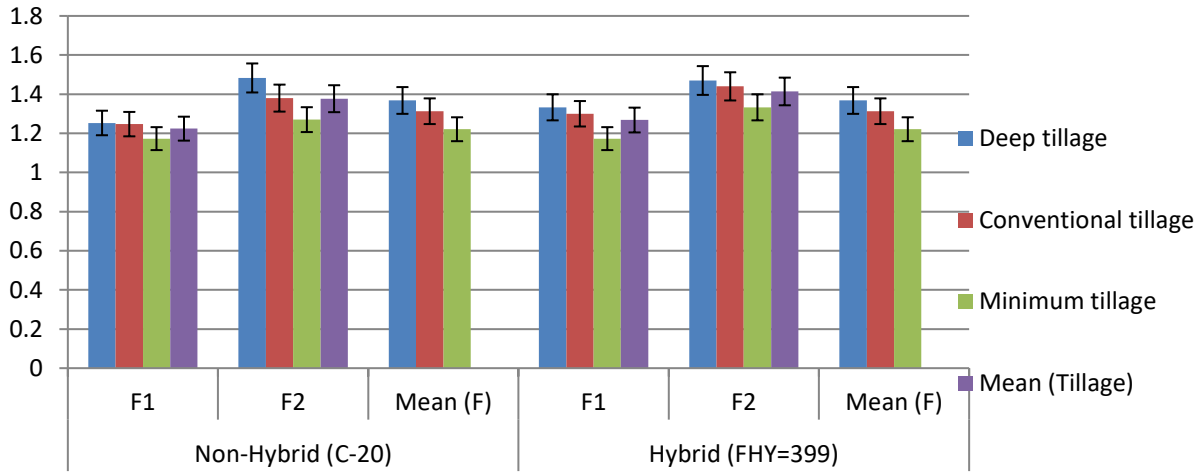
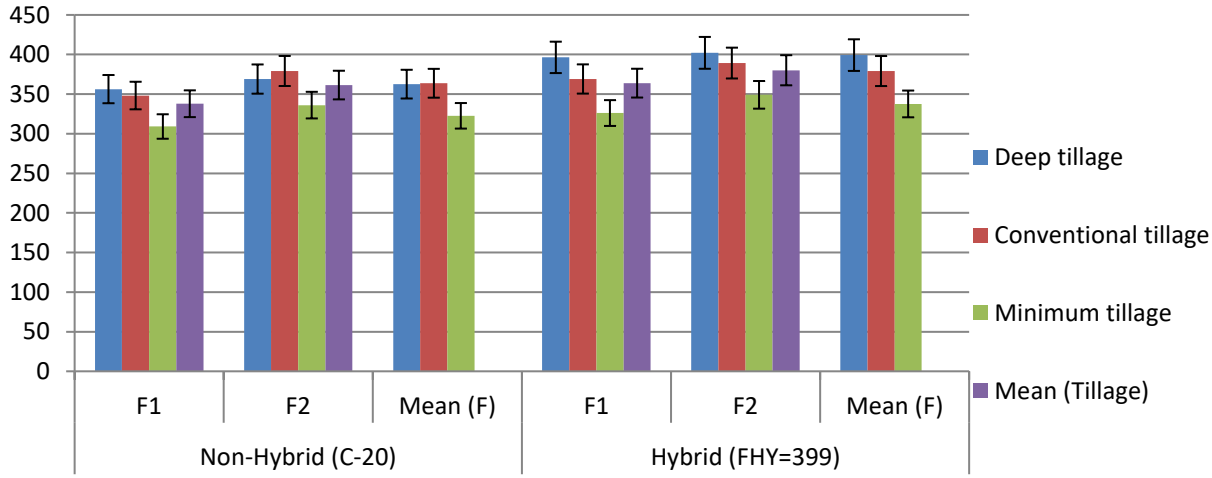
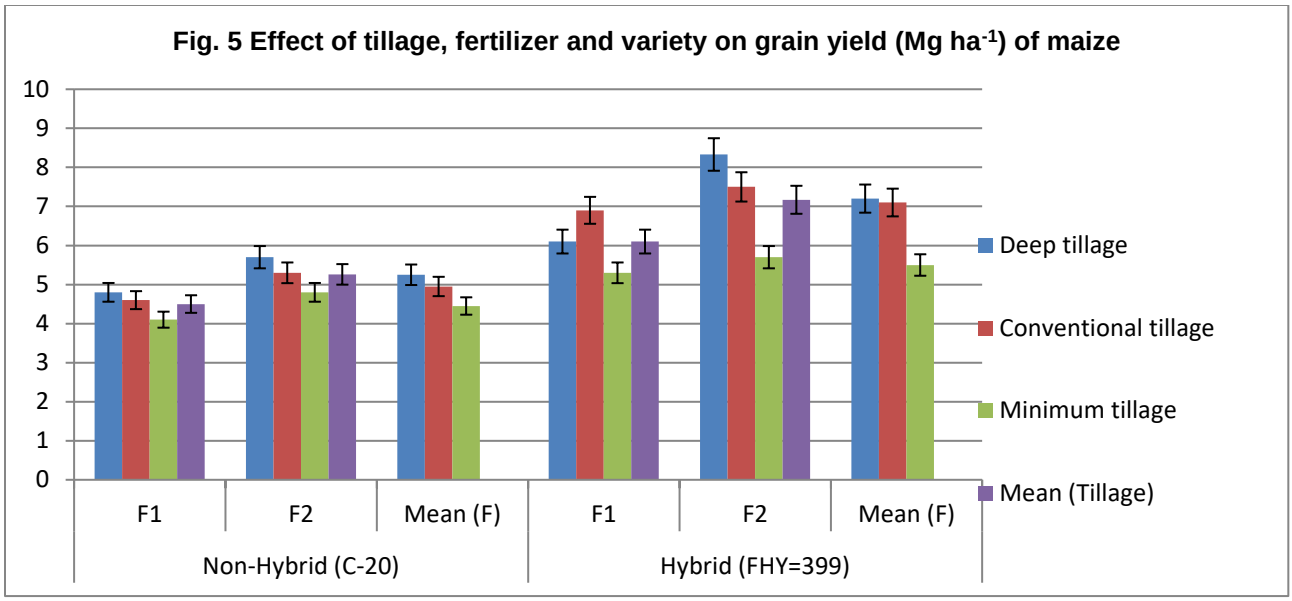


Fig. 4 Effect of tillage, fertilizer and variety on 1000-grain weight (g) of maize



e. **Tillage, fertilizer, and variety effects on grain yield of maize (Mg ha^{-1}):** The effect of tillage, fertilizer, and variety on maize grain yield was shown in Fig 5 with data on grain yield. With both fertilizer and tillage treatments, hybrid maize yielded more 1000-grain wt. than non-hybrid maize. Fertilizer had a big impact on maize grain yield. The highest mean grain yield (5.26Mg ha-1) was achieved with a 50% increase over recommended NPK fertilizer (F2), followed by (4.5Mg ha-1) with non-hybrid maize and recommended NPK fertilizer (F1). In the case of hybrid maize, the highest mean grain yield (7.17 Mg ha-1) was reported when F2 was used, followed by (6.1 Mg ha-1) when F1 was used.



DISCUSSIONS

a. **Tillage, fertilizer, and variety effects on maize plant height (cm):** Increased nitrogen and phosphorous rates had a major impact on plant height, stem diameter, LAI, and dry matter yield, as stated by (Anjum *et al.,* 2020). Increased fertilizer levels resulted in the highest green biomass. in These findings are consistent with those of Gul *et al.* (2015), who found that fertilizer levels F3 (90: 60: 40) and F2 (75: 50: 30) applied at the same time resulted in significant increases in plant height, leaf area index, dry matter production at various growth stages, cob length, number of cobs plant1, number of grains cob-1, and 100-seed weight over time.

In terms of tillage systems, deep tillage produced the highest plant height (196.2 cm), followed by 186.7 cm for traditional tillage, and 172.6 cm for non-hybrid maize with minimal tillage. In hybrid maize, the maximum plant height (206.5 cm) was achieved with deep tillage, followed by 199.8 cm with traditional tillage, and 182.1 cm with minimum tillage. Deep tillage resulted in taller plants, which may be attributed to improved root growth, better aeration, and more water content, as well as the exploration of a larger volume of soil for nutrients. These findings corroborate those of Shahzad *et al.,* (2015), who found that deep tillage resulted in the highest plant height, stem diameter, cob diameter, cob length, and number of grain rows per cob.

b. **Tillage, fertilizer, and variety effects on maize crop total dry matter (Mg ha-1):** In non-hybrid maize, the maximum mean value of total dry matter observed with deep tillage was 19.85 Mg ha-1, followed by 18.15 Mg ha-1, and the minimum mean value observed with minimum tillage was 13.7 Mg ha-1. Deep tillage yielded the highest mean total dry matter value of 25.37 Mg ha-1 in hybrid maize, followed by 23.6 and 16.9 Mg ha-1 in traditional and minimum tillage, respectively. These findings corroborate those of Shahzad *et al.,* (2015), who found that shoot dry matter was significantly higher in the tilled treatment than in the low-tillage treatment, as well as that deep tillage increased shoot weight. According to Shahid *et al.,* (2015), tillage regimes had a major impact on harvest index, with the highest harvest index (39.58%) reported in deep tillage, which was statistically comparable to traditional tillage (38.83%).

c. **Tillage, fertilizer, and variety effects on number of cobs per plant:** The maximum mean value of amount of cobs per plant was observed in non-hybrid maize when the recommended rate of fertilizer (F2) was increased by 50%, followed by 1.224 in the case of recommended rate of NPK fertilizers (F1). Similarly, in the case of hybrid maize varieties, F2 had the highest mean number of cobs per plant (1.41) followed by F1 with 1.268. These findings were in line with those of Shahid *et al.,* (2015), who found that deep tillage at 200 kgha-1 nitrogen application resulted in the highest number of plants at harvest (7.93), number of grain rows per cob (17.70), number of grains per row (34.31), number of grains per cob (678.58), and cob weight (187.50 g). These findings are consistent with those of Khan *et al.* (1999), who studied the effects of various NPK fertilizer levels on conventional maize. The application of NPK of 120-120-90 kg/ha yielded the highest number of cobs per plant (2.07) and the highest number of grains per cob (374.3), 1000-grain wt. (220.65g), biological yield (15.42 t/ha), and grain yield (48.08 t/ha), and suggested the same amount of

fertilizers for maize production in Pakistani soils. Tillage systems and nitrogen levels increased algometric traits, grain and dry matter yield, and net returns of maize in both years, according to Wasaya *et al.,* (2017). When compared to moldboard tilled plots, chisel tilled plots had higher leaf area index, length, and crop growth rate, resulting in 23 and 8% higher grain and dry matter yields, respectively.

d. **Tillage, fertilizer, and variety effects on 1000-grain weight (g) of maize**: Our findings contradict those of Wasaya *et al.,* (2017) and Shahid *et al.,* (2015), who claimed that deep tillage and fertilizer application had an effect on grain yield. In terms of fertilizer, it resulted in a large rise in the 1000-grain weight of maize. In non-hybrid maize, the maximum mean value of 1000 grain weight (361.43g) was observed with 50% increase over recommended NPK fertilizer (F2), followed by 337.86g with recommended NPK fertilizer (F1), while in hybrid maize, the maximum mean value of 1000 grain weight (380.12g) was observed with F2 followed by (363.8g) with F1 care. These findings corroborate those of Awdalla *et al.,* (2018), who conducted a field experiment over two consecutive seasons in 2015 and 2016 to assess the effect of three NPK levels, namely 80/6/10, 120/12/20, and 140/18/30kg N, P2O5, and K2O/fad, on four maize hybrids, namely white single cross 10, white three way cross 128, yellow single cross 168, and yellow three way 168. The maximum NPK dose resulted in the best growth characteristics, yield and yield elements, and NPK uptake. The row count per ear, the grain count per row, and the NPK concentration in grains and stover. When supplied with 140/18/30kg N, P2O5, and K2O/fad, the white single cross 10 provided the highest values for growth, yield, and yield components traits. The lowest values were obtained when 80/6/10kg N, P2O5, and K2O/fad were issued.

e. **Tillage, fertilizer, and variety effects on grain yield of maize (Mg ha^{-1}):** The results are consistent with those of Duggul (1990), who investigated the effects of NPK treatments of 0-200 kg N, 0-100 kg P2O5, and 0-100 K2O/ha on maize. The fertilizer 200-100-100 kg NPK/ha produced the highest yield. The addition of fertilizer resulted in a linear increase in yield. Different fertiliser treatments had a big impact on plant height and grain weight. In terms of the impact of tillage, deep tillage resulted in the highest mean grain yield (5.25 Mg ha-1), followed by 4.95 and 4.45 Mg ha-1 in traditional and minimal tillage, respectively, in non-hybrid. In the case of hybrid maize, deep tillage produced the highest grain yield of 7.2 Mg ha-1, followed by 7.1 and 5.5 Mg ha-1 with traditional and minimal tillage, respectively. These findings corroborate those of Anjum *et al.,* 2019, who recorded that maize hybrids sown in deep tillage produced the highest grain yield (7.2 t ha-1), number of grains cob-1 (528), 1000-grain weight (265 g), plant height (205 cm), plant population (7.2 plants m-2), stem diameter (1.58 cm), cob length (19.1 cm), biological yield (19.5 t ha-1), and harvest index (37.0%).

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