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# Effect of Tillage, Organic and Inorganic Nitrogen on Maize Yield

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**Abstract:** Study entitled on tillage, organic and inorganic nitrogen on maize productivity was conducted at research Farm of the University of Agricultural University Peshawar in Kharif 2011. Randomized complete block design with split plot procedure having three replications was used. Three tillage practices (deep, conventional and reduce tillage) and ten fertilizer treatments combination i.e. control (no nitrogen), nitrogen only (150 kg $ha^{-1}$) farm yard manure only (150 kg N $ha^{-1}$), poultry manure only (150 kg N $ha^{-1}$), 75% N (inorganic) + 25% farmyard manure, 50% N (inorganic) + 50% farmyard manure, 25% N (inorganic) + 75% farmyard manure,75% N + 25% poultry manure, 50% N (inorganic) + 50% poultry manure and 25% N (inorganic) + 75% poultry manure. Uses of 50% N + 50% poultry manure produce maximum grain yield (4710 kg $ha^{-1}$), biological yield (16200 kg $ha^{-1}$), thousand grain weight (250 g), plant height (148 cm), CGR (19 $gm^2$ $day^{-1}$), NAR (5.5 $gm^2$ $day^{-1}$). Deep and conventional tillage produce higher NAR (5 $gm^2$ $day^{-1}$), CGR (15 $gm^2$ $day^{-1}$), grain yields (3823 kg $ha^{-1}$), biological yield (12718 kg $ha^{-1}$) and 1000 grains weight (242 g), while reduce tillage plot give low yield. Uses of 50% N + 50% poultry manure or 50% N + 50% farmyard manure and deep and conventional tillage is recommended for higher grain yield.

**Key words:** Maize (Zea mays L.) · Tillage systems · Nitrogen · Farmyard manure · Poultry manure

## INTRODUCTION

Maize (L) *is a multiuse crop, provides nourishment to the increasing day by* day populations, feed for poultry and 90% is used as a fodder/forager for livestock and industry for preparation of different products. Also in many countries 80-90% of maize is used as food in daily life [1]. In Pakistan maize was grown on an area of 974.2 ha with total production of 3707.0 tons and national average yield of 3805 kg $ha^{-1}$. whereas in Khyber Pakhtunkhwa (province of Pakistan), it is grown on about 422.9 ha with a total production of 740.5 tons and average yield of 1751 kg $ha^{-1}$ [2]. Tillage is the mechanical manipulation of soil and a tillage system is the sequence of operations that manipulates the soil to produce a crop [3]. Tillage systems could affect crop yield due to their effect on water conservation, soil chemical and physical properties [4]. Deep, conventional or minimum, has considerable positive effects on the soil. Deep and conventional tillage have been shown to improve soil porosity and aeration [5-6]. Investigated deep tillage with chisel plough enhances soil airing, wetness and soil porosity [7]. Nitrogen plays a starring role in crop lifespan. Nitrogen is one of the most limiting nutrients. As it is one of the nutrients required by plants in huge quantities. Nitrogen regulates vegetative growth and deep green color to the leaves. Its consumption and demand is constantly increasing day by day [8]. To ensure the food supply of continually increasing human population needs to strengthen determination on wise use of the existing acreage through combined/incorporated uses of appropriate fertilizer/manure especially nitrogenous fertilizer with suitable tillage implements in order to keep soil fertile and get optimal crop production. The uses of inorganic fertilizers are common but the problem is their prices which are too high for the less income farmers. Regular

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uses of inorganic fertilizer alter chemical properties of the soil e.g. rise ph. Therefore, organic manure can be used as a supplement with inorganic fertilizers [9]. Research have revealed that uses of organic materials such as cow dung, poultry manure and farmyard manure enhanced both major and minor nutrients [10-11]. Farmer's community is now switching towards organic side to fertilize their fields as a result of disadvantages of inorganic fertilizer. Organic manures are famous to supply major and minor nutrients to be used by the crop and also enhanced the soil physiochemical and biological properties. Organic manure also has disadvantages which include bulkiness (difficult to transport), slow mineralization rates (slow release) and low nutrients ratio. Study showed that either inorganic or organic fertilizer is not good / sufficient for soil nutrient management. Hence, there is need for integrated uses of organic and inorganic plant nutrient management as organic fertilizer is inexpensive, environmentally friendly and cost effective with low level of inorganic fertilizer.

## MATERIALS AND METHODS

An experiment entitled on the 'effect of tillage, organic and inorganic nitrogen on maize yield' was conducted at Research Farm the University of Agricultural Peshawar (34° 00 N, 71° 30 E, 510 MASL) Pakistan during Kharif. The experiment was laid out in randomized complete block design with split plot arrangement having 3 replications. Maize variety "Azam" in plot area of 5 x 4.5 $m^2$ were sown on 4th July 2011. Row to row and plant to plant distance was kept 75 and 25 cm, respectively. Plant population of 60000 thousand plant $ha^{-1}$ was maintained by thinning. Deep tillage (DT) practices were carried out by chisel plough, conventional tillage (CT) was carried by cultivator, while reduce tillage (RT) was done by rotavator. Data recorded on crop growth rate in each subplot one meter row was harvested, sun dried and weight by electronic sensitive balance. Data was taken on the following different growth stages (i) tasseling (ii) grain fill duration and (iii) physiological maturity. The following formula was used [12].

$$CGR = \frac{W_2 - W_1}{T_2 - T_1} \times \frac{1}{GA} = g\ m^{-2}\ d^{-1}$$

One meter long row was selected in each sub plot the data was taken on the following different growth stages of the crop (i) tasseling (ii) grain fill duration and (iii) physiological maturity and net assimilation rate was calculated by the following formula.

$$NAR = \frac{W_2 - W_1}{T_2 - T_1} \times - \frac{InL_2 - InL_1}{L_2 - L_1} = gm^{-2}\ day^{-1}$$

Thousand grains was counted at random from each sub plot of each treatment and weighed. Four central rows in each sub plots were harvested, sun dried and threshed. Grain weight was taken with the help of electronic balance and then converted into kg $ha^{-1}$ by the following formula.

$$GY\ (kg\ ha^{-1}) = \frac{\text{Grains weight in four rows (kg)}}{\text{No of rows x Row length x R-R}} \text{ x } 10{,}000\ m^2$$

Crop rows harvested for grain yield was sun dried and weighed to calculate biological yield by using electronic sensitive balance and then converted into kg $ha^{-1}$ by the following formula.

$$BY\ (kg\ ha^{-1}) = \frac{\text{Weight of plant materials in four rows (kg)}}{\text{No of rows x Row length x R-R}} \text{ x } 10{,}000\ m^2$$

Statistical analysis of data was done using method suitable for RCBD with split plot arrangement. Means was match using LSD test at 5% level of probability when F values are significant [13].

## RESULTS AND DISCUSSION

**Thousand Grain Weight (g):** Thousand grain weight of maize as affected by tillage, inorganic nitrogen and organic manures are presented in Table 1. Tillage, organic and inorganic nitrogen significantly affect 1000 grains weight. Conventional tillage results in higher grain weight (242.4 g) which was statistically at par with deep tillage (240.0 g) plots. Lower grain weight was obtained from reduced tillage plots (219.4 g). Due to deep tillage the soil becomes aerated, soft and nutrients availability becomes more so that's why good crop emerged. The results are similar with the findings of [14] who suggested that higher N losses through immobilization and nitrate leaching in reduced tilled plots resulted in lighter grains as compared to conventionally ploughed plots. In N management techniques, 50% N + 50% poultry manure (250.2 g) produced heavier grains which was statistically similar with 75% N + 25% poultry manure (246.1 g) and 75% N + 25% farmyard manure (244.1 g) fertilized plots followed by 50% N + 50% farm yard manure (235.9 g). Higher grain weight from poultry manure amended plots as compared to farmyard manure and sole N applied plots was mainly

Table 1: Thousand grains weight, grains yield and biological yield of maize as affected by tillage, organic and inorganic nitrogen.

| Tillage | Thousand grains weight (g) | Grains yield (Kg $ha^{-1}$) | Biological yield practices (Kg $ha^{-1}$) |
|---|---|---|---|
| Cultivator | 219.4b | 3556.4b | 11587b |
| Rotavator | 242.4a | 3700a | 12718a |
| Chisel plough | 240.0a | 3823a | 12390ab |
| $LSD_{(0.05)}$ | 12.8 | 129.5 | 443.8 |
| Nitrogen | | | |
| Control | 220.4 d | 2387.0 f | 9112.2 c |
| Nitrogen (N) | 234.2bcd | 4049.3 c | 13344.9 b |
| Farmyard manure (FYM) | 222.4 cd | 3119.3 e | 10433.5 c |
| Poultry manure (PM) | 223.4 cd | 3022.8 e | 9386.9 c |
| 25% N + 75% FYM | 227.3 cd | 3490.0 d | 10651.9 c |
| 50% N + 50% FYM | 235.9 abc | 4528.3 ab | 15838.0 a |
| 75% N + 25% FYM | 244.1 ab | 4236.0 c | 12845.4 b |
| 25% N + 75% PM | 235.2 abc | 3082.3 e | 9270.1 c |
| 50% N + 50% PM | 250.2 a | 4710.0 a | 16200.4 a |
| 75% N + 25% PM | 246.1 ab | 4307.7 bc | 13598.3 b |
| LSD (0.05) | 14.2 | 310.3 | 1869.6 |
| Tillage x Nitrogen | | | |
| Sig. level | Ns | Ns | Ns |

due to rapid mineralization and timely release of major and minor nutrients from poultry manure. The results are in similarity with the findings of [15] who suggested that poultry manure with inorganic nitrogen fertilizer could be good for improving maize yield components. Control plots resulted in lower 1000 grain weight (220.4 g).

**Grain Yield (kg $ha^{-1}$):** Data regarding grain yield of maize as affected by tillage, inorganic nitrogen and organic manures are presented in Table 1. Tillage, organic and inorganic nitrogen significantly affect grain yield. Deep tillage results in higher grain yield (3823.4 kg $ha^{-1}$) which was statistically similar with conventional tillage (3700.0 kg $ha^{-1}$) plots. Lower grain yield was obtained from deep tillage plots (3556.4 kg $ha^{-1}$). As we know in deep tillage plot nutrients become more due to it crop become established and leaf area in deep tillage plot become high because of this more photosynthesis will occurs and as a result more grain produce in deep tillage plot. Here our findings are similar with the findings of [16] who reported that tillage practices are involving in retention of moisture and residues on the surface and increase in yield of maize. In N management techniques, 50% N + 50% poultry manure (4710.0 kg $ha^{-1}$) produced heavier grains which was statistically similar with 50% N + 50% farmyard manure (4528.3 kg $ha^{-1}$) and 75% N + 25% poultry manure (4307.7 kg $ha^{-1}$) fertilized plots followed by 75% N + 25% farmyard manure (4236.0 kg $ha^{-1}$). The possible reason for the higher grain yields in organic nitrogen amended with mineral nitrogen plots could be efficient uptake of N by maize crop through improving the organic matter decomposition process [17]. Soil microbes initially got starter N from urea, enhanced mineralization and ensured availability of N throughout the growing season and thus resulted in more grain yield in organic manure incorporated plots as compared to sole mineral N application control plots [18] achieved results in line with ours and attributed higher maize grain yield in organic manure incorporated plots to improved soil water content, more nutrient availability, higher microbial activities and protection from erosion. Control plots resulted in lower grain yield (2387.0 kg $ha^{-1}$).

**Biological Yield (kg $ha^{-1}$):** The biological yield of maize as affected by tillage, mineral N and organic manures are presented in Table 1. Tillage, organic and inorganic nitrogen significantly affected biological yield. Conventional tillage resulted in higher biological yield (12718.2 kg $ha^{-1}$) which was statistically similar with deep tillage (12389.8 kg $ha^{-1}$) plots. Lower biological yield was obtained from the plot in which we done reduce tillage (11889.5 kg $ha^{-1}$). In conventional tillage plot plants growth become more and leaf area is high. Our results are similar with those obtained by [19] who suggested that maize stem and root growth were higher in conventionally tilled plots as compared to zero tillage plots. In N management techniques, 50% N + 50% poultry manure (16200.4 kg $ha^{-1}$) produce higher biological yield which was statistically similar with 50% N+ 50% farmyard manure (15838.0 kg $ha^{-1}$) followed by 75% N + 25% poultry manure(13598.3 kg $ha^{-1}$) followed by 75% N + 25% farmyard manure (12845 kg $ha^{-1}$). It may be due to the fact that incorporation of 50% poultry manure and 50% Urea resulted in more leaves, plant heights and ear

Table 2: Crop growth rate and net assimilation rate of maize as affected by tillage, organic and inorganic nitrogen

| Tillage Practices | Crop growth rate ($gm^2$ $day^{-1}$) | Net assimilation rate (gm2 $day^{-1}$) |
|---|---|---|
| Cultivator | 15.7 a | 5.2 a |
| Rotavator | 12.4 b | 4.1 b |
| Chisel plough | 13.5 ab | 4.9 a |
| $LSD_{(0.05)}$ | 0.5 | 0.2 |
| Nitrogen | | |
| Control | 9.1 c | 4.0 f |
| Nitrogen (N) | 14.7 b | 5.4 c |
| Farmyard manure (FYM) | 12.3 c | 4.2e |
| Poultry manure (PM) | 11.9 c | 4.11e |
| 25% N + 75% FYM | 11.4 c | 5.0 d |
| 50% N + 50% FYM | 15.6 a | 5.4 ab |
| 75% N + 25% FYM | 12.5 c | 5.2c |
| 25% N + 75% PM | 11.7 c | 4.8 e |
| 50% N + 50% PM | 19.1 a | 5.5 a |
| 75% N + 25% PM | 14.3 b | 4.5 bc |
| LSD(0.05) | 0.7 | 0.2 |
| Tillage x Nitrogen | | |
| Sig. level | *Fig.1 | *Fig 2 |

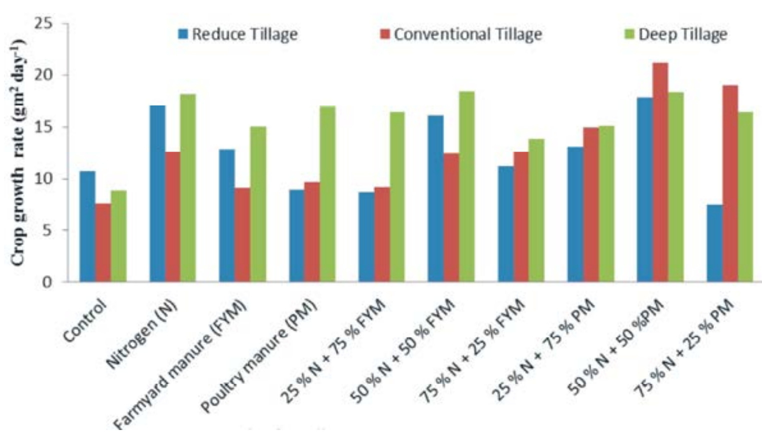


Fig. 1: Crop growth rate ($gm^2$ $day^{-1}$) of maize as affected by interaction of tillage, organic and inorganic nitrogen.

lengths. The highest biological yield in poultry manure amended with N plots might be associated with improving uptake of N by maize, availability of N throughout the growing season and suitable moisture conditions for rapid growth of maize [20]. The results further agree with the achievements of earlier scientist that organic manure has got a key role in improving soil organic matter content and increasing maize yield and total biomass [21]. Control plots resulted in lower biological yield (9112.2 kg $ha^{-1}$).

**Crop growth rate ($gm^2$ $day^{-1}$):** Data regarding to crop growth rate of maize as affected by tillage, organic and in organic nitrogen are presented in Table 2. Tillage, organic and inorganic nitrogen significantly affected crop growth rate also interaction between T x N was also significant. The maximum crop growth rate was calculated in conventional tillage plot (15.7 $gm^2$ $day^{-1}$) followed by deep tillage plot (13.5 $gm^2$ $day^{-1}$) and reduce tillage plot (12.4 $gm^2day^{-1}$) incorporation of 50% N + 50% poultry manure (19.1 $gm^2$ $day^{-1}$) produce more growth followed by 50% N + 50% farmyard manure (15.6 $gm^2$ $day^{-1}$) and nitrogen alone crop growth rate were (14.7 $gm^2$ $day^{-1}$). And 75% N + 25% poultry manure produce (14.3 $gm^2$ $day^{-1}$) crop growth rate. Our results are similar with the findings of [22] who reported that maximum net assimilation rate was observed in plot which received 50% N from Urea and 50% N from poultry manure. [23] reported that the optimum and timely availability of N affected the partitioning of assimilates between vegetative and reproductive organs. It might be due to the maximum leaf area index and crop growth rate with the same treatment, which enhanced the rate of accumulation of assimilates [24]. It might be due to better C: N ratio of poultry manure which contributes in the timely mineralization and

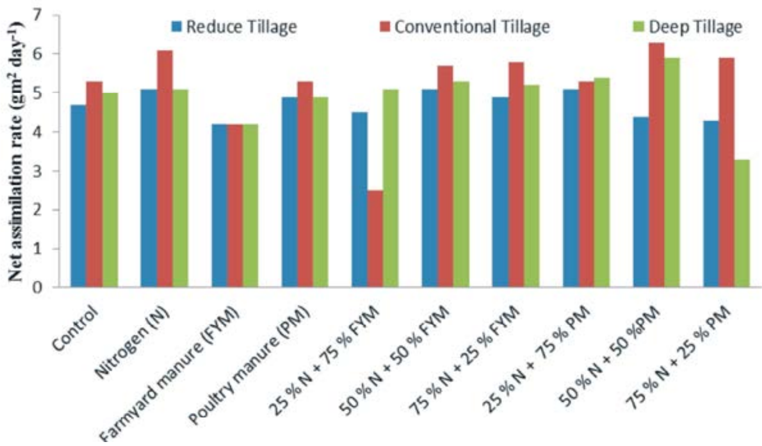


Fig. 2: Net assimilation rate (gm$^2$ day$^{-1}$) of maize as affected by interaction of tillage, organic and inorganic nitrogen

availability of nutrients to the plant for proper growth and nourishment [25] On the other hand, decomposition rate of farmyard manure is slow than the poultry manure and their effect in this regard can be observed by checking the crop growth and net assimilation rate. Progressive increase in net assimilation rate with increasing level of N was also observed by [26]. In control plot the rate of crop growth was low.

**Net Assimilation Rate (gm$^2$ day$^{-1}$):** The net assimilation rate of maize as affected by tillage, organic and inorganic nitrogen are presented in Table 2. Tillage, organic and inorganic nitrogen significantly affect net assimilation rate also interaction between T x N was also significant. In conventional tillage plot net assimilation rate were high (5.2 gm$^2$ day$^{-1}$) followed by deep tillage plot (4.9 gm$^2$ day$^{-1}$) and reduce tillage plot (4.12 gm$^2$ day$^{-1}$) in N management technique 50% N + 50% farmyard manure (5.5 gm$^2$ day$^{-1}$) higher assimilation rate which was statistically similar with 50% N + 50% farmyard manure (5.4 gm$^2$ day$^{-1}$) followed by 75% N + 25% farmyard manure (5.2 gm$^2$ day$^{-1}$). Our results are similar with the findings of [21] who reported that maximum net assimilation rate was observed in plot which received 50% N from Urea and 50% N from poultry manure [23] who, reported that the optimum and timely availability of N affected the partitioning of assimilates between vegetative and reproductive organs. It might be due to the maximum leaf area index and crop growth rate with the same treatment, which enhanced the rate of accumulation of assimilates [22]. It might be due to better C: N ratio of poultry manure which contributes in the timely mineralization and availability of nutrients to the plant for proper growth and nourishment [24]. On the other hand, decomposition rate of farm yard manure is slow than the poultry manure and their effect in this regard can be observed by checking the crop growth and net assimilation rate. Progressive increase in net assimilation rate with increasing level of N was also observed by [25]. In control plot rate of net assimilation was low.

## CONCLUSION AND RECOMMENDATIONS

It can be concluded form above results obtained that application of N through inorganic + organic fertilizers helps increasing the crop yield more as compared to the application of either of them separately. Moreover, application of poultry manure and farm yard manure give similar crop yield.

- When both organic as well as inorganic fertilizers are available then these should be applied in combination providing 50% N from poultry manure or farm yard manure and remaining from the inorganic nitrogen.
- Deep and conventional tillage is recommended for higher grain yield.

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