



## Impact of organic and inorganic fertilizers on maize crop an experimental study

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Maize is a major crop grown and consumed around the world, and it requires a lot of fertilizers. However, existing inorganic fertilizers on the market are frequently out of reach for small-scale farmers, resulting in lower maize yields in the country. There is a surplus of unutilized animal manure that, when treated, can be used to boost maize yields. An experiment was conducted to check the impact of different levels of organic and inorganic fertilizers on the yield and yielding components of maize (*Zea mays* L.) at Pakistan Council of Scientific and Industrial Research (PCSIR), Lahore during crop season 2018. RCBD (Randomized Complete Block Design) with four replications was used to perform the experiment on two maize varieties i.e. Iqbal and Azam. The current study results showed highest maize production, maximum cobs, number of grains, plant population, plant height, harvest index and grains number and weight when the plots were fertilized with F4 (half N as FYM (19.05 t/ha + 100 kg N/ha as urea)) followed by F5 (half N as P.M (8.07 t/ha + 100 kg N/ha as urea)), F3 (whole N as poultry manure), F2 (whole N as farmyard manure), F1 (whole N as urea) and F6 (control). Iqbal variety produced more grain yield (5633 kg/ha) than Azam (5536 kg/ha). The study concluded that Iqbal is best variety for obtaining high production with combine applications of organic and inorganic fertilizers.

**Keywords:** Maize; Organic farming, Organic fertilizers, Inorganic fertilizers; Crop productivity; Pakistan

### INTRODUCTION

Maize (*Zea mays* L.) belongs to Gramineae family is one of the most widely distributed third important cereal crop of the world (Kaul et al. 2011) especially Pakistan after rice and wheat (Azizian and Sepaskhah, 2014). It is cultivated in different regions of the world for fodder, feed and food purpose. It consists of various vitamins, minerals (3%), protein (10%), starch (72-79%), fiber (4-8.5%), fat (4%) (Ahmad et al. 2017), ash (1.7%), oil (4.8%), and sugar (3%) (Chaudhry, 1983; Anjum et al. 2018). Maize is used for three things: as a staple human food, as livestock feed, and as a raw material for many industrial products. The current maize consumption pattern is fish, poultry, pig

feed (52%), cattle feed and starch (11%), seed and brewery industry (1%), and human consumption (24%). Its consumption is increasing in industries as domestic feed (Khaliq et al. 2011). It contributes 0.6% to GDP and 3.4% to the value added in agriculture.

This multipurpose crop or C4 plant is cultivated on an area of 1,418 thousand hectares with 5,970kgs/ha yield and production increased by 7.4% to 8.465 million tonnes compared to last year's production of 7.883 million tonnes in years 2020-2021. The productivity of crop is increasing day by day due to availability of seeds, diseases and insect pest resistant varieties (FAO, 2021).

To maintain highly fertilized soil for intensive cropping,

the soil should be managed through a plant nutrient management system. Fertilizers applications play a significant role in enhancing the maize production, efficiency of water, and growth and development of maize crop by enhancing the soil fertility. Biofortification of maize crops can be achieved by adding organic manure together inorganic fertilizers in the soil. It has been established that fertilizers play a crucial role in photosynthesis, stomata opening, and water storage control in leaves. Maize production can further increase by the application of fertilizers (organic and inorganic) in the soil which significantly reduce due to deficiency of chemicals. Number of leaves, fruit and leaf size of the crop significantly reduce which ultimately affects the photosynthetic activity of the crop (Lal, 1997). Soil aeration, tillage, water holding capacity and population of microorganisms increase in the soil which ultimately help in availability of nutrients to crops/plants (Choudhary and Bailey, 1994; He and Li, 2004; Saha et al. 2008). The enzymes in the soil also play important role in crop production which directly or indirectly affected by the use of chemicals (organic, inorganic) (Chaudhary et al. 1998; Yang et al. 2008; Zhu et al. 2008). By keeping in view, the importance of such study, the current study was designed/conducted to determine the impact of organic and inorganic fertilizers on maize crop.

## MATERIALS AND METHODS

### Study site and experimental design

The current experimental study was conducted at Pakistan Council of Scientific and Industrial Research (PCSIR), Lahore, Pakistan during summer season of 2018 to evaluate the impact of organic and inorganic fertilizers on maize crop. The experiment was designed using RCBD (Randomized Complete Block Design) with a split arrangement having three replications and a net plot size of 8.0 4.9 m.

### Treatment

Two maize varieties (V1: Iqbal and V2: Azam) were sown in main plots.

Different fertilizer levels were given in subplots such as

F1 = whole N as urea

F2 = whole N as farmyard manure (FYM) (34.38 t/ha)

F3 = whole N as poultry manure (P.M) (13.00 t/ha)

F4 = half N as FYM (19.05 t/ha + 100 kg N/ha as urea)

F5 = half N as P.M (8.07 t/ha + 100 kg N/ha as urea)

F6 = Control

In the fertilizer treatments, whole N indicated 200 kg N/ha, while half N indicated 100 kg N/ha. The experiment was designed by following the procedure of early researchers (Salah et al. 2011; Anjum et al. 2018).

### Crop management strategy and final harvest data

Crop was sown manually on July 29, 2018 using a dibbler, keeping recommended distance between ridges and

plants (P x P = 20 cm, R x R = 70 cm), and using a seed rate of 25 kg/ha. All recommended agronomic practices such as fertilizers NPK (TSP, SOP, TSP, Urea, PM, FYM), water, weed and diseases management were applied timely. Half the amount of N from urea and full amount of PM, FYM, P, and K were applied at the sowing time while the remaining half amount of the urea was applied at time of 2<sup>nd</sup> irrigation. Before conducting the experimental trial, a soil sample was taken and analyzed for physicochemical properties.

### Harvest data recording

Maize completed its physiological maturity at 1<sup>st</sup> week of November, 2018. The parameters (tasseling, silking, leaf area index (LAI), total dry matter (TDM) (gm<sup>-2</sup>), plant population (m<sup>-2</sup>), number of grains (m<sup>-2</sup>), grain weight (g), grain yield (kg/ha) and harvest index (%)) were recorded during the study period. An area of 1 m<sup>2</sup> was used as the final harvest plot to count the number of plants per plot. Ten cobs per plot were randomly selected to count the number of grains and average number of grains (m<sup>-2</sup>). After threshing of crop, one thousand grains were taken from each plot to calculate the weight, total grain weight from each plot and grain yield per hectare was also calculated. The harvest index (%) and quality parameters such as protein% and grain oil% were also recorded by following the procedure of Nasim et al. (2012).

### Data analysis

The collected data were statistically analyzed by using the computer statistical program MSTA T-C. Analysis of variance technique applied to test the overall significance of the data, while to compare the differences among treatment means the least significance difference (LSD) test at P = 0.05 was used (Steel et al. 1997).

## RESULTS AND

**Table 1: An analysis of the chemical makeup of the experiment site**

Parameters	Value	Unit
Soil texture	Silty clay loam	
Soil pH	7.6	
Soil electrical conductivity (EC)	1.9	dS m <sup>-1</sup>
Organic matter (OM)	1.33	%
Phosphorus	0.89	ppm
Nitrogen	0.09	%
Potassium	1.69	ppm
Mn	27.01	ppm
Zn	52.03	ppm
Fe	2565	ppm
Cu	11.67	ppm

An analysis of the chemical makeup of the experimental site was carried out prior to sowing of the maize. All the parameter such as soil texture, soil pH, structure, EC, OM, and concentration of micronutrients

and macronutrients etc. were determined. Soil was silty clay loamy soil with 7.6 pH and 1.9 dS m<sup>-1</sup> EC. The concentration of nitrogen, potassium, phosphorus, zinc and copper was 0.09%, 1.69ppm, 0.89ppm, 52.03ppm and 11.67ppm, respectively (Table 1).

**Table 2: Chemical analysis of organic manures in the study area.**

Parameters	Value		Unit
	PM	FYM	
Nitrogen	1.49	0.54	%
Phosphorus	0.76	0.28	%
Moisture	48.01	75.06	%
Potassium	0.42	0.59	%
Dry matter	47.05	20.07	%

**PM=** Poultry manure, **FYM=** Farm yard manure

The percentage of nitrogen, phosphorus and potassium in poultry manure (PM) was 1.49, 0.76 and 0.42%, respectively. Dry matter carried high concentration of farm yard manure (FYM). The values of organic manures analyzed in the study area are given in table 2.

Description of environmental conditions (temperature, relative humidity and rainfall) is given in table 3.

The maize varieties had non- significant effect on the duration of 50% tasseling while organic and inorganic fertilizers significantly affected the duration of tasseling. In the current study, 51.24, 52.19, 53.33, 52.78, and 51.65 number of tasseling days were counted with the application of whole N as urea, whole N as farmyard manure, whole N as poultry manure, half N as FYM + 100 kg N/ha as urea and half N as P.M (8.07 t/ha + 100 kg N/ha as urea), respectively. Maximum 50% silking days were recorded with the application of half N as FYM (19.05 t/ha + 100 kg N/ha as urea) (F<sub>4</sub>) while lowest in control (F<sub>6</sub>). Tasseling days of Iqbal and Azam variety were 47.99 and 51.56, respectively while silking days were 51.43 and 53.25. The duration of tasseling and silking in Iqbal variety were lowered than Azam variety. Higher plant height and total dry matter (TDM) were recorded in Azam variety with lower leaf area index (Table 4).

**Table 3: The environmental conditions (temperature, humidity and rainfall) in maize crop at study area.**

Parameters	June	July	August	September	October	November
Temperature (°C)	33.49	34.46	32.34	29.71	26.33	22.41
Relative Humidity (%)	37	42	33	22	15	14
Rainfall (mm)	9.3	45.2	65.0	16.4	9.3	8.1

**Table 4: Impact of organic and inorganic fertilizers on growth and phenology of maize in study area.**

Treatments	50% tasseling (days)	50% silking (days)	Plant height (cm)	Leaf area index	TDM (g/m <sup>2</sup> )
Iqbal	47.99	51.43a	192.23a	4.49	1723.51
Azam	51.56	53.25b	195.34b	3.52	1744.41
<b>Significance</b>	<b>NS</b>	*	*	<b>NS</b>	<b>NS</b>
<b>F<sub>1</sub></b>	51.24a	53.31a	15.76bc	3.43c	1785.42a
<b>F<sub>2</sub></b>	52.19a	52.89a	187.98c	4.98bc	1656.45c
<b>F<sub>3</sub></b>	53.33a	53.76a	192.87b	4.87abc	1932.67b
<b>F<sub>4</sub></b>	52.78a	56.21a	190.67b	4.65ab	1764.87b
<b>F<sub>5</sub></b>	51.65a	54.12a	203.54a	4.45a	1857.89ab
<b>F<sub>6</sub> (Control)</b>	47.13b	50.43b	165.89d	3.87d	1154.36d
<b>Significance</b>	<b>NS</b>	*	*	*	*
Mean	51.64	53.53	159.66	4.37	1441.94

Overall effect of fertilizer application on days of silking, tasseling and plant height is given in table 6. Plant population, number of grains, grain weight, harvest index and nutrients concentration were recorded high in Iqbal variety than Azam. Non-significant effect was recorded in plant population of both varieties. The maximum number of grains were recorded with the application of F<sub>4</sub> while minimum in control treatment (F<sub>6</sub>). The percentage of protein and oil was recorded highest (12.21 and 4.87) with

application of F<sub>4</sub> while lowest in F<sub>6</sub> treatment. The main output to obtain from the sown crop is grain yield which significantly differed among sown maize varieties (Iqbal and Azam). In the current study, Iqbal produced more grain yield (5633 kg/ha) than Azam (5536 kg/ha). Mean average plant population, number of grains, grain weight, grain yield, harvest index, and protein% were 8.80, 3098.83, 0.282g, 5628.16 kg/ha, 22.01%, and 10.29%, respectively (Table 5).

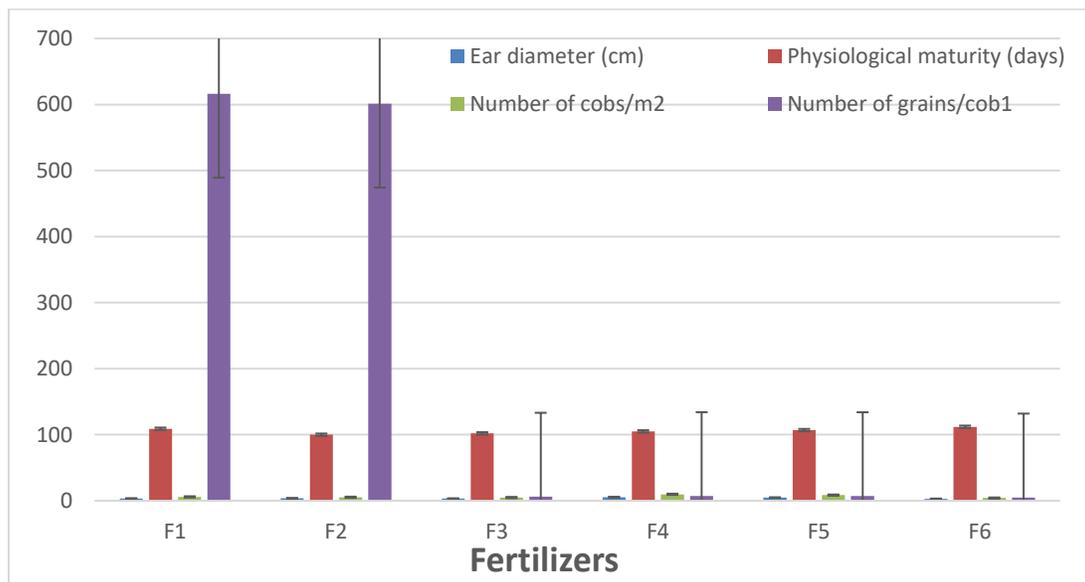
**Table 5: Impact of organic and inorganic fertilizers on yield components of maize in the study area.**

Treatments	Plant no.	No. grains	Grain wt.	Grain yield	HI %	Protein %	Oil %
Iqbal	6.65	3300a	0.421a	5633a	22.05a	11.00	4.19
Azam	6.59	3123b	0.394b	5536b	20.90b	10.05	4.10
Significance	NS	*	*	*	*	NS	NS
F <sub>1</sub>	6.54	3121a	0.272a	5671ab	23.30b	10.05b	4.81a
F <sub>2</sub>	6.61	2965c	0.292b	5421c	20.10c	9.87c	4.65b
F <sub>3</sub>	6.71	3232b	0.293a	5876c	21.33c	10.45c	4.34b
F <sub>4</sub>	6.68	3376ab	0.262a	5989b	23.29d	12.21b	4.87a
F <sub>5</sub>	6.64	3212a	0.318a	6245a	25.10a	11.10a	4.43a
F <sub>6</sub> (Control)	6.43	2687d	0.256b	4567d	18.99d	8.09d	3.23
Significance	NS	*	*	*	*	*	*
Mean	8.80	3098.83	0.282	5628.16	22.01	10.29	4.39

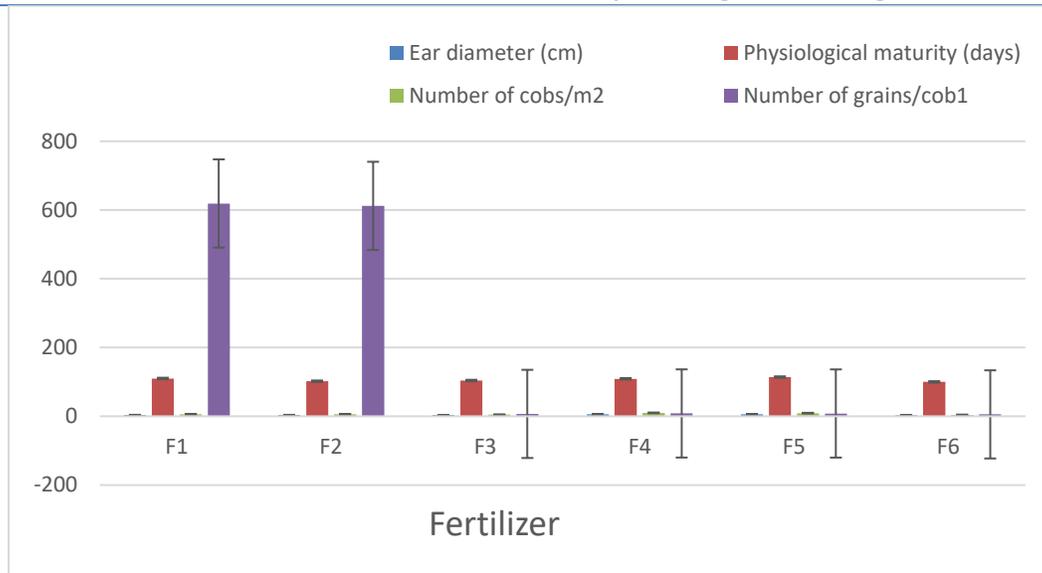
\*= Significant, NS=Non significant

**Table 6: Overall effect of fertilizer application on days of silking, tasseling and plant height.**

Treatments	Days of silking	Days of tasseling	Plant height (cm)
Iqbal	56c	52bc	159bc
Azam	54d	51bc	161bc



**Figure 1: Effect of fertilizers on ear diameters, physiological maturity, number of cobs and grains in Azam variety of maize**



**Figure 2: Effect of fertilizers on ear diameters, physiological maturity, number of cobs and grains in Iqbal variety of maize**

Effects of fertilizers on ear diameters, physiological maturity, number of cobs and number of grains in varieties are shown in figure 1 and 2.

## DISCUSSION

Maize is the main food crop grown in majority areas of the world especially Pakistan. The erratic rainfall pattern and low soil fertility are the most limiting factors for maize cultivation in the world wide (Sadou et al. 2012). Low organic matter content, poor soil fertility management practises, low fertiliser use, and monocropping are the primary causes of low soil fertility (Balogoun et al. 2013). Typical farmer maize yields are low, around 800 kg/ha (Sadou et al. 2003), and usually do not include fertiliser.

Productivity of maize can enhance by the applications of balanced and adequate nutrients (organic and inorganic). Farming is distinguished by the limited use of modern inputs such as fertilizers, improved seeds, and irrigation. Farmers typically use both organic and inorganic fertilizers, with the latter being used less frequently due to various factors such as high prices and non-availability (Endale, 2011; Ali et al. 2011). Maize cultivation in the country requires a large amount of nutrients (N and P). In order to meet the needs of the growing rural population, adequate fertilizers recommendations must be developed. It has been reported by many early scholars that high maize production can achieved through the application of high quality organic and inorganic chemicals/fertilizers. The combined applications of chemicals can enhance the soil fertility which ultimately affect the maize production (Serafim et al. 2013; Sanjivkumar, 2014; Baloch et al. 2015). Endris S, Dawid (2015), and Usman et al. (2015), had reported that applications of urea with poultry manure boosts up the soil fertility.

Negassa et al. (2004) investigated that combine applications of FYM and NP gave maximum yields as

compared to alone applications of these chemicals. The similar findings had reported by Ahmad et al. (2013). They reported that maximum yield can obtained with combined applications of 50% N from FYM and 50% NPK through inorganic fertilizers. It has been reported by some researchers that soil surface can badly affected by the excessive use of inorganic fertilizers on the same area of crops (Sigaye et al. 2020). It was recorded that plant height increased with increase in fertilizers dose. Our findings are in line with the findings of early researchers who performed an experiment in Faisalabad Pakistan. The maize yield and other traits such as ear diameters, plant height, grains number, plant population, grain yield, number of cobs/ear per plant and number of grains per cob as well as harvest index (HI) were significantly affected by fertilizers application. F4 and F5 treatments were recorded most beneficial for growth and development of both varieties.

## CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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## AUTHOR CONTRIBUTIONS

All authors have equal contribution in performing this experiment.

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