Research Article

The Production Competition of Hybrid and Local Maize Varieties Under the Same Dosage of Different Nutrients Application in Clay Soil

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Abstract | A research trial at farmer's field was conducted to study the production competition of hybrid (CS-200, cv) and local variety (Azam cv.) under the same application of fertilizer treatment and dozes during summer 2015. The field experiment was laid out in randomized complete block design with split plot arrangements having two maize varieties in main pot and six levels of fertilizer treatments in sub pots repeated four times. Fertilizers treatments were made from the application of Nitrogen (N), Phosphorus (P_2O_5) and farmyard manure (FYM) which was collected from cattle barnyard. A total of six fertilizer treatments were used viz T_1 = control (no application of inputs), T_2 = 130 kg N ha^{-1}, T_3 = 130 kg N ha^{-1} + 90 kg P_2O_5 ha^{-1} T_4 = FYM @ 20000 kg ha^{-1}, T_5 = 130 kg N ha^{-1} + 90 kg P_2O_5 ha^{-1} + FYM @ 20000 kg ha^{-1} and T_6 = 65 kg N ha^{-1} + 45 kg P_2O_5 ha^{-1} + FYM @ 20000 kg ha^{-1}. The results indicated that both maize varieties (hybrid and local) showed different responses to different fertilizer treatments application but combined used of farm yard manure, N and P_2O_5 in (T_5) and (T_6) significantly increased yield and yield traits of Hybrid CS-200 and Azam variety than rest of the fertilizers treatments. The significantly maximum plant height of Azam cv. (260 cm) and hybrid (247cm) were recorded in treatment T5 (N- P_2O_5@ 130-90 kg per hectare + 20 ton per hectare FYM) followed by T6 (50-45) kg N, P_2O_5 ha^{-1} + FYM @ 20000 kg ha^{-1}. The Azam plants were taller than hybrid. The treatment (T_5) significantly yielded more grain (6806 kg ha^{-1}) and (5106 Kg ha^{-1}) from hybrid (CS-200) and a local maize Azam cultivar, respectively. Similarly, stover yield of hybrid (10378 Kg ha^{-1}) and Azam (7708 Kg ha^{-1}) were more in T_5 than the other treatments. So, it is concluded that the combined application of farmyard manure and balanced inorganic fertilizer (Nitrogen + Phosphorus) gave significant yield production in terms of grain and biological yield in clay soil.

Received | March 10, 2016; **Accepted** | October 07, 2018; **Published** | November 16, 2018
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Citation | Ali, S., Z.U. Jan, Z. Shah, M.J. Khan, F.U. Khan, I. Rahman and S. Fahad. 2018. The production competition of hybrid and local maize varieties under the same dosage of different nutrients application in clay soil. *Sarhad Journal of Agriculture,* 34(4): 790-796.
DOI | http://dx.doi.org/10.17582/journal.sja/2018/34.4.790.796
Keywords | Maize varieties yield, Farmyard Manure, Nitrogen, Phosphorus, Clay Soil

Introduction

Maize (Zea mays L.) belongs to the family Poaceae and is annual cross pollinated, determinate and having C4 carbon fixation pathway. The maize was discovered by Columbus in Haiti (1492) that people identified the maize as MAHIZ, and Maya people were responsible for its name and diffusion. The Indians peoples used maize for bread and these breads are eaten with fish, vegetables and milk

etc. In Spain, the maize was introduced by Columbus and spared to France then Italy, Venetian dealers spared it to the adjacent countries like Turkey, Egypt, Balkan States and also introduced into China. In Pakistan, maize was cultivated on an area of 1191 thousand hectares in 2015-16, showing a decrease of 0.3 percent over previous year's its production was 5271 thousand tons (PBS, 2015-16). Total cultivated area by maize in KPK, during 2015-16 was 447980 hectares and its production was 849203 tons (Agriculture Statistics, Khyber Pakhtunkhwa (KPK) 2015-16). Maize is the most important cereal crop of Pakistan as well as worldwide and ranked 3rd after wheat and rice while in KPK it is 2nd in rank. It is grown in both irrigated and rain fed areas of KPK, mostly in northern belt of KPK and Pakistan. Maize is used as a source of food for human beings, and feed for livestock and poultry in developed and developing world. Maize have a large number of dietetic importance as it contains sugar 4.5 %, 11.6- 20.0 % (moisture), 1.10 – 2.95% (Ash), 4.50 – 9.87 % (protein), 2.17-4.43 (fat), 2.10- 26.70% (fiber) and 44.60- 69.60% (carbohydrate) (Enyisi et al., 2014).

After wheat and rice, this is a fast growing crop in terms of grain yield production in Pakistan and takes 90 to 110 days for maturity. The average grain production of maize was 4426 kg hectare^{-1} (PES, 2015-16). Pakistan's soil is lacking some of the essentials plant nutrients due to which the Pakistan agriculture productions are low and due to some other factors like poor soil physical condition, high pH, nutrients insufficiencies and high clay content also contribute to low production. The improper application of fertilizers also effects the maize production in terms of grain yield and stovers (Mahmud et al., 2016; Khalid et al., 2012). The mobile nature of nitrogen in both soils and plants have a greater tendency to rapid losses of inorganic N through various ways and slow release of nitrogen from organic amendments which have probable effect on production and nitrogen use efficiency (NUE) in maize crop. Such N losses are de-nitrification, volatilization and the losses in de-nitrification are worse than the latter one (John et al., 2014). In Pakistan, the population is increasing at alarming rate and the demand of food is not fulfilling from the cultivation of local varieties of various crops. So, the farmers have great diversion to the growing of Hybrid cereals and vegetables. In addition, they are also practicing mono and intensive cropping and also not leaving their soils as fallow due to which the soils of Pakistan especially of KPK are becoming deficient in some of the essential plant nutrients. Among the essential plant nutrients, phosphorus is also deficient and un-available in Pakistan's soil due to the above facts and in addition, of high pH level means alkaline and calcareousness nature of our soil.

Further, in Pakistan about more than 50% farmers are going to apply only one kind of fertilizer to their fields either organic or inorganic. On one hand, the sole application of any kind of fertilizers cannot fulfill the nutritional requirements of the crops for getting the potential yield and on another hand, deteriorates the soil physical and chemical properties.

Keeping in view the importance of maize and various constrains in its productivity. Therefore, there is a great need of the integration of the farm yard manure, inorganic nitrogen and phosphorus for maize crop which is both environment friendly and to increase its production on sustainable basis.

Materials and Methods

Field experimental site

A field experiment was conducted to study the effect of inorganic nitrogen, phosphorus and farmyard manure on the yield and yield traits of maize verities during summer 2015 at District Charsadda, Khyber Pakhtunkhwa province of Pakistan. The experiment was laid in split plot arrangements of the randomized complete block design, the varieties were placed in main plot and fertilizer treatments in sub plots with four replications. Fertilizers treatments were made from the combination of Nitrogen (N) (Urea), Phosphorus (P_2O_5) (Single Super phosphate) and farmyard manure (FYM). FYM were collected from the cattle's barnyard and could not analyze in the laboratory. From most literature it is clear that in FYM, N content is almost ≤ 1% and PK are < 1%. A total of six treatments of fertilizer combination were used viz (1) T_1 = control (no application of inputs), (2) T_2 = 130 kg N ha^{-1}, (3) T_3 = (130-90) kg N, P_2O_5 ha^{-1} (4) T_4 = FYM @ 20000 kg ha^{-1} (5)T_5 = (130-90) kg N, P_2O_5 ha^{-1} +FYM @ 20000 kg ha^{-1} and (6) T_6 = (65-45) kg N, P_2O_5 ha^{-1} + FYM @ 20000 kg ha^{-1}. Before layout of the experiment and the fertilizers application, the field was well prepared with the help of tractor drawn cultivator and rotavator. After it, the composite sample at a depth of 0-20 cm was collected for determination of various physicochemical properties.

The size of the experimental unit/plot within each replication was 3.75m x 4m=15 m^2 with 5 rows of 4m long. The required amount of farmyard manure was applied about 15 days before sowing of maize crop to the respective plots. Phosphorus from single super phosphate (SSP) was applied just before sowing. The FYM and SSP well incorporated into the soil. Row to row and plant to plant distance was kept 3.75 cm and 25 cm respectively. Then one third of the required inorganic N from urea was applied to the respective plots just before maize sowing. Maize seed of both varieties hybrid (CS-200) and local (Azam cv) were sown on June 02, 2015. The plots were irrigated with canal water just after sowing. The plots were regularly irrigated with canal water when needed. The rest of the required N from urea i.e. two of third was applied to the respective plots with irrigation water at knee stage of the maize crop. All the cultural practices like weeding and hoeing were carried in the experiment. At physiological maturity, in each experimental unit of each replication, the crop was harvested on September 15, 2015 from center 3 rows, 1m long. The data were collected on plant height (cm), Number of Leaves, 1000 Grain weight (g), Number of Grain cob^{-1}, Grain yield (kg ha^{-1}) and stover yield (kg ha^{-1}) on the standard procedures.

Soil physio-chemical analysis before the sowing of maize crop

The composite soil sample was collected from the experimental site before beginning of the experiment and was analyzed for various physicochemical properties according to the standard methods and procedures mentioned in the Soil and Laboratory Manual of Ryan et al. (2013). The textural class of the experimental site was clay with bulk density of 1.40 g cm-3. Further, the soil was alkaline in reaction and non-saline regarding salinity and sodicity. As regard organic matter content, the soil was low. Also, the soil was deficient in available P and N while K was almost near to adequate (Table 1).

Statistical Analysis

The data collected on yield and yield parameters of maize crop and was analyzed statistically by ANOVA method of Randomized Complete Block Design using Statistix-8.1 Software. The treatment means were compared from one another by using least significance difference (LSD) at 5 % level of probability (Steel and Torrie, 1980).

Table 1: *Soil physical and chemical properties before sowing.*

Soil Physical and Chemical Properties	Values
Particle type	
Clay (%)	53
Sand (%)	35
Silt (%)	22
Textural Class	Clay
Bulk Density (g cm^{-3})	1.40
$pH_{(1:5)}$	7.95
$EC_{(1:5)}$ dS m^{-1}	0.56
Organic Matter (%)	0.61
*AB-DTPA Ext. P (mg kg^{-1})	3.1
AB-DTPA Ext. K (mg kg^{-1})	118
Mineral Nitrogen (mg kg^{-1})	11

Ammonium Bicarbonate-Di-ethylene tri-Amine Penta-acetic Acid Extractable (AB-DTPA ext.);* **P: *Phosphorus;* **K:** *Potash;* **N:** *Nitrogen;* **EC:** *Electrical Conductivity.*

In 2015, the average temperature was 22.5 C with annual rainfall 460 mm. The altitude was 301 meter. The detail of weather during 2015 are shown in Figure 1.

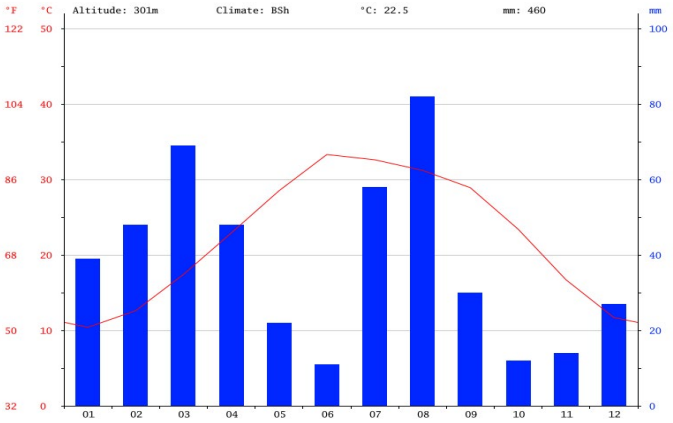

Figure 1: *Showing the weather data of the area concerned of the year 2015.*

Results and Discussion

Plant Height (cm)

The data on plant height (cm) of both maize varieties (Hybrid and Azam) were statistically analyzed and presented in (Table 2). There was non-significant ($p>0.05$) difference between the means of maize varieties regarding plant height. In case of fertilizer treatments, there was significant ($P\leq0.05$) difference among the treatment means. The maximum plant heights (260 cm) in Azam variety and (247 cm) in hybrid CS-200 were recorded in treatment (T_5) where (120-90-00) kg N-P_2O_5 ha^{-1} +FYM @ of 20000 kg ha^{-1}

Table 2: *Effect of farmyard manure and inorganic fertilizers application alone to soil and in combination on the yield and yield traits of maize varieties (Local and Hybrid).*

Stover yield (Kg ha^{-1})	Grain yield (Kg ha^{-1})	1000 weight (g)	Grain cob^{-1} (No)	Total leaves (No)	Plant height cm	Treatments (T)	
2516 f	1750 e	223 e	185 f	9 d	176 e	T1	Hybrid Maize CS-200
6736 c	4253 c	275 d	396 c	12 b	223 bc	T2	
7433 b	4533 b	301 c	448 b	12 b	226 bc	T3	
5105 d	3547 d	258 d	287 e	10 c	216 c	T4	
10378 a	6806 a	347 a	559 a	13 a	247 a	T5	
9685 a	6443 a	337 b	511 a	13 a	243 b	T6	
2100 f	1403 e	171 f	210 f	10 c	158 f	T1	Maize Azam Veriaty
5900 d	4671 b	303 c	259 e	12 b	218 c	T2	
6427 c	4331 c	339 b	268 de	12 b	232 bc	T3	
4220 e	2860 d	231 e	246 e	10 c	204 d	T4	
7708 a	5306 a	439 a	322 a	13 a	260 a	T5	
6704 b	4480 c	420 a	313 a	13 a	241 b	T6	
840	521	23	55	0.65	10		LSD (0.05)

T_1: *Control (no application of inputs),* **T_2:** *130 kg N ha^{-1},* **T_3:** *(130-90) kg N, P_2O_5 ha^{-1},* **T_4:** *FYM @ 20000 kg ha^{-1},* **T_5:** *(130-90) kg N, P_2O_5 ha^{-1} +FYM @ 20000 kg ha^{-1} and* **T_6:** *(65-45) kg N, P_2O_5 ha^{-1} + FYM @ 20000 kg ha^{-1}.*

applied. The significant lowest plant height (158 cm) in local Azam variety and 178 cm hybrid was recorded in treatment one (T_1) mean no application of input.

In hybrid variety, the treatment T_4 and T_2 were at par with each other. Similar results were had by Zerihun et al. (2013) and Muthaura et al. (2017) and stated that the application of organic and inorganic fertilizers in combination increased soil moisture, germination and growth. Zhang et al. (2010) reported that the balance application of nutrients of different fertilizer sources of either organic or inorganic accelerated the plant height in term of growth of the crops.

Number of leaves plant^{-1}

The data on number of leaves of hybrid (CS-200) and local (Azam) maize varieties were subjected to statistical analysis as shown in Table 2. The interactions between maize varieties and treatments were non-significant. In case of fertilizer treatments, the means were significant ($P \leq 0.05$). The maximum number of leaves (13) were recorded in treatment five T_5 (120-90-00) kg N-P_2O_5 ha^{-1} +FYM @ of 20000 kg ha^{-1} in both hybrid (Cs-200) and local (Azam) variety which were at par with treatment T_6. The minimum number of leaves (9) of hybrid and (10) of Azam variety were produced in treatment T_1. These results are supported by Zerihun et al. (2013) who observed the maximum number of leaves, leaf area index, higher light interception and dry matter which variably promotes plant growth. Kiari, S.A. (2014) investigated that the deficiency of nitrogen leads to reduce the number of leaves and chlorophyll in plants. Gastal (2002) and Bado et al. (2013) reported that the optimum and balance supply of nitrogen and other nutrients from the combination of organic and inorganic sources may leads to numerous leaves and branches/tillers.

1000- Grain weight (g)

The collected data on thousand grains weight of maize varieties (hybrid (Cs-200) and local (Azam) are presented in (Table 2). It is to mention that there was significant difference ($P < 0.05$) among the fertilizer treatments means of the varieties. The supreme 1000-grain weight (439 g) was noted in treatment five T_5 in Azam variety where applied the NP at the rate of (120-90) kg ha-^{1} and FYM at the rate of 20000 kg ha^{-1}. Also, the Hybrid maize (CS-200) produced maximum (347 g) of 1000- grain weight in the treatment five. The lowest 1000-grain weight (210g) was observed in treatment one (T_1) in Azam (local) variety followed by 223 g in T_1 of hybrid variety. These results are encouraged by Garg and Bahla (2008), Abera et al. (2015) and Muthaura et al. (2017). They reported that the application of FYM along with inorganic inputs significantly increased the plant growth, seed size in term of 1000 -grain mass.

Number of grain cob^{-1}

Grain number cob^{-1} of hybrid and Azam verity was

given in (Table 2). There were significant (P≤0.05) difference among the mean values of fertilizers treatment. The highest number of grain cob^{-1} of 559 was recorded in treatment five T_5 where full Nitrogen, Phosphorus and FYM was applied to hybrid variety and that of 322 by Azam in the same treatment. The significantly lowest number of grain cob^{-1} of 171 of Azam variety was produced in control plot (T_1) followed by hybrid (185 grain). These results supported by Tasneem et al. (2004), Kiari (2014) and Mahmud et al. (2016). They reported that the FYM along with chemical fertilizers had significant effect on cob weigh, number of grain and yield of maize because of the balance supply and availability of plant nutrients throughout the growing period with effecting the environment and soil health.

Grain yield (kg hectare $^{-1}$)

The data on grain yield of maize crop were subjected to statistical analysis and revealed that there were significant ($p < 0.05$) differences among the maize varieties and fertilizers treatments (Table 2). The maximum grain yield of 6806 kg ha^{-1} and 5106 kg ha^{-1} were recorded in hybrid CS-200 and Azam, respectively in T5 receiving full dose of NP along with 20000 Kg ha^{-1} FYM followed by T6 of Hybrid and T2 of Azam. The significantly minimum grain yield of 1403 kg ha^{-1} of Azam was renowned in treatment T_1 followed by hybrid (1750 kg ha^{-1}) from T1. These results were also similar with the work of Tamayo et al. (1997), Ahmad et al. (1998), Nawaz et al. (2000), Ahmad et al. (2002), Tasneem et al. (2004), Jadoon et al. (2005), Amujoyegbe et al. (2017). They reported that the integrated application of FYM+ chemical fertilizers significantly improved the cob and grain yield of maize as well as wheat crop under irrigated and un-irrigated condition due to the balance supply and availability of essentials plant nutrients for the crop growth and grain filling and seed size.

Stover yield (kg ha^{-1})

Statistical analyses of the data relating to Stover yield (kg ha-1) of both maize varieties are presented in (Table 2). It was observed that there were significant ($p \leq 0.05$) differences among the means of maize varieties and the fertilizers treatments combination of organic and inorganic sources in the clay soil. The maximum stover yield of 10378 kg ha^{-1} of hybrid (CS-200) and 7708 kg ha^{-1} of Azam variety were recorded in T5 receiving full NP along with FYM followed by T6. The lowest Stover yield of 2100 kg ha^{-1} of Azam variety was recorded in the treatment T_1 (receiving no any kind of fertilizes) in azam variety followed by 2516 kg ha^{-1} in hybrid CS-200 in the same treatment. The similar findings were reported by Jadoon et al. (2005), Karki et al. (2005). They reported that the application of organic and inorganic fertilizers to maize crop increased significantly the stover yield of maize, the uptake of nitrogen and P as well.

Conclusions and Recommendations

From the results of the studies based on statistical analysis of the data it was concluded that treatment five (T_5) produced maximum yield where recommended (130 +90) kg N-P ha^{-1} and Fame yard manure at the rate of 20,000 kg ha^{-1} was applied for both hybrid CS-200 and Azam variety followed by treatment six (T_6) where half of N and P of recommended level and full FYM was used. Furthermore, it is recommended that the combined application of full NP with FYM to the maize cultivar i.e. Hybrid to get maximum return in the clay soil under the agro-climatic condition of Charsadda. If a farmer cannot afford the hybrid Maize seed, they can use the local Azam cultivar with the application of either full NP or half NP of the of the said limit along with 20-ton FYM ha^{-1} for getting economic yield in the clay soil of that area or other else. In clay soil, porosity and workability are big issues. So, with FYM application, these issues were solved.

Acknowledgements

The authors are highly thankful to the support of the staff of the Mardan Campus, the University of Agriculture, Peshawar-Pakistan. Also extend sincere thanks to a Seed Company at Mardan for providing the hybrid seed (CS-200). The authors acknowledge the cooperation of the farmer for providing field for experiment, local seed (Azam cv.), other tools, giving of irrigation as well as security to the crop.

Author's Contribution

Shamsher Ali: Conceived the idea, planned the experiments and did overall management of article.
Zakir Ullah Jan: Collected the data and analyzed the soil samples in the laboratory.
Zahir Shah, Muhammad Jamal Khan and Farman Ullah Khan: Helped in write up of article and did proof reading.
Inayat-ur-Rehman and Shah Fahad: Helped in sta-

tistical analysis.

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