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Phenolgical traits and yield of different maize genotypes as influenced by nitrogen application methods

Iqra Nawaz, Shazma Anwar, Junaid Ahmad*, Maleeha Mehboob, Ihsan Ullah, Abid Ullah, Atif Ur Rahman, Saboor Shah

Department of Agronomy, Faculty of Crop Production Sciences, The University of Agriculture, Peshawar, Pakistan

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Abstract

Selection of appropriate variety and proper method of nitrogen application has key role in improving farmer outcome and yield sustainability of maize. Therefore, an experiment to study varying nitrogen application methods on yield of maize varieties were carried out in Baffa research station district Mansehra during year 2018. The experiment was laid out in randomized complete block design with split plot arrangement with three replications. Four different varieties (BMS1, Azam, Jalal and Iqbal) and four nitrogen levels (control, soil application, 95% soil + 5 % foliar, 90% soil + 10 % foliar) were used in experiment. Varieties were allotted to main plots while nitrogen was applied to sub plots. The experimental results showed that taller plants (200 cm), highest biological yield (12664 kg ha^{-1}) and highest grain yield were reported by Azam (3765 kg ha^{-1}).Among N application, 90% soil + 10 % foliar delayed the days to tasseling (50 days), days to silking (58 days), taller plants (202 cm), higher biological yield (12096 kg ha^{-1}) and higher grain yield (3729 kg ha^{-1}). Therefore, it can be concluded from the results that Azam variety produced higher yield and N applied through 90% soil + 10 % foliar reported maximum yield of maize crop. So, the application of N in the form of 90% soil + 10 % foliar should be applied to maize OPV Azam for higher grain yield under the agro climatic conditions of Mansehra Pakistan.

* **Corresponding Author:** Junaid Ahmad ✉ Junaid.agri@aup.edu.pk

Introduction

Maize (*Zea mays* L.) belongs to family poaceae is an annual, cross pollinated and determinate major kharif cereal crop. The crop is grown in temperate, subtropical and tropical regions of the world. Production wise leading countries are USA, China, Brazil, Mexico, Yugoslavia, Rumania, Argentina and Italy. Maize is not only important to subsistence farmers but it is also of huge important commercial farmers, produced worldwide more than any other cereal (Zhang *et al.*, 2016). In developed countries maize is mainly grown for animal feed, industrial products such as glucose, dextrose, and starch and specialized foods. Apart from its multipurpose uses, maize is getting popularity in the present-day world for its non-cholesterol oil content (Enyisi *et al.*, 2014). Maize grain has a high nutritive value consisting of protein (10.4%), fat (4.5%), starch (71.8%), ash (17%), oil (4.8%), fiber (8.5%), vitamins and minerals like calcium, phosphorous and sulfur (Ullah *et al.*, 2010).About two-third of the total world production of maize is used for livestock feed or for commercial starch and oil production (Ibrahim and Khan, 2018). The increasing use of maize gives prominent place in agriculture economy. Pakistan is increasingly gaining an important position in maize crop husbandry because of its higher yield potential and short growth duration. It constitutes 6.4 % of the total grain production in the country (Khalil and Jan, 2002).

Nitrogen (N) fertilizer plays a vital role in optimizing the trade-off between grain yield and profit (Jin*et al.*, 2012). Hence, effective management of nitrogen fertilization is a leading challenge for enhancing maize productivity, and environmental sustainability (Srivastava *et al.*, 2017). Nitrogen is a major nutrient for crop production as it directly affects the dry matter production by influencing the leaf area and photosynthetic efficiency; hence an optimum rate of application of nitrogenis necessary to prevent retardation of plant growth and yield (Tafteh and Sepaskhah, 2012). N deficiency inhibits growth of a plantand also decreases the shoot to root ratio (Akmal *et al.*, 2015).Besides this, N deficiency also reduces the radiation use efficiency, radiation interception, dry matter partitioning, and growth of reproductive organs (Marschner, 2012). Moreover, N deficiency delays both reproductive and vegetative phenological development, reducesleaf emergence rate, grain yield, and yield components (Shahrokhnia and Sepaskhah, 2016).

Mostly maize varieties are markedly differing in response to N fertilization (Ahmad *et al.*, 2018). Efficient use of N in maize production requires the ability to adjust the quantity of nitrogen applied in relation to the variation in local soils. It is, therefore, important to identify maize varieties that are responsive and efficient in N use. Radiation use efficiency (RUE) is important growth parameters and is relatively simple, stable and works well in situations with diversified climatic conditions (Shahid *et al.*, 2016). Optimum plants with sufficient inputs might play significant role in production due to efficient utilization of resources e.g. light, CO_2 and water etc. Assuming biotic and abiotic stresses constant, drymatter yield is equal to amount of radiation absorbed by the canopy (Srivastava *et al.*, 2017; Shah *et al.*, 2016).

Due to environmental and economic concerns with Nfertilizers, improvement in nitrogen fertilizer application to maize varieties has become a desirable option for sustainable maize production. Keeping in view the importance of balanced N supply, best synchronized with local OPV, the present study was conducted to find out the impact of N rates on the performance of maize cultivars.

Materials and methods

Experiment entitled “Influence of varying nitrogen levels application on yield and yield components of maize genotypes” was conducted during kharif 2018 at Agriculture Research Station Baffa district Mansehra. The experiment was comprised of main plot factor (varieties) and sub plot factor (nitrogen levels). The experiment was laid out in randomized complete block design with split plot arrangement having three replicates using the following factors: Factor A: Varieties (Main plot factor) V_1:BMS1, V_2:

Azam, V_3: Jalal, V_4: Iqbal. Factor B: Nitrogen Levels (Sub plot factor) No: control, N_1: Soil application, N_2:95% soil + 5 % foliar, N_3:90% soil + 10 % foliar. Each experimental unit consisted of six rows having 0.75m row to row with 3m length of the row. Urea was used as a source of nitrogen, applied half at seedbed preparation and half after 30 days. Thinning was carried out at the four-leaf stage of the crop. Recommended irrigation schedule was followed; however, changes were made according to weather condition as and when needed. Weeds were controlled manually. Two hoeing were carried out to keep the crop free of weeds. Earthing up was carried out at knee stage to reduce lodging. Standard plant protection measures were adopted; including Chloropyrifos spray. Experimental trails were harvested at maturity (about 30-35% grain moisture content) as indicated by the appearance of a black abscission layer at the base of grains.

Statistical analysis

The data were statistically analyzed by using analysis of variance techniques appropriate for randomized complete block design with split plot arrangement. Means were compared using LSD test at 0.05 level of probability using software statistics 8.1, when the F-values are significant (Jan *et al.*, 2009).

Results and discussion

Days to tasseling

Analysis of the data revealed that days to tasseling was only significantly influenced by various N application methods while cultivars and their interactive response V × N found non-significant. Delaying in days to tasseling by application of N sources could be due to better soil conditions and availability of more nutrients, resulted in comparatively better crop growth and development than control plots (Li, 2003).

Table 1. Days to tasseling, days to silking, days to maturity, plant height (cm), biological yield and grain yield (kg ha^{-1}) of different maize genotypes as influenced by nitrogen application methods.

Nitrogen methods	Days to tasseling	Days to silking	Days to maturity	Plant height	Biological yield	Grain yield
Control	48 b	55 b	98 c	188 c	9280 b	2951 b
Soil Application	49 ab	56 b	102 b	195 b	11185 a	3111 b
95% Soil + 5% Foliar	49 ab	57 ab	106 a	199 ab	11383 a	3185 b
90% Soil + 10% Folair	50 a	58 a	105 ab	202 a	12096 a	3730 a
LSD (0.05)	1.31	1.67	2.69	5.11	1313	518
Varieties						
Jalal	49	56	102 b	194 b	10222 c	2866 b
Iqbal	49	57	101 b	198 ab	10045 c	3222 b
BMS1	48	56	103 ab	192 b	11012 b	3123 b
Azam	49	57	105 a	200 a	12664 a	3765 a
LSD (0.05)	ns	ns	2.69	5.11	1313	518
Interaction	ns	ns	*	ns	ns	ns

These findings are also in line with Dahal*et al.* (2014) and Khan *et al.* (2014) who observed delayed tasseling in maize with nitrogen application. Similarly Shah *et al.* (2009) also investigated delayed in maize phenology with increase in N rate.

Days to silking

Data concerning days to silking as affected by nitrogen application methods (N) of different maize cultivars (V) revealed that, similar to tasseling, days to silking was also significantly affected by various N application methods while cultivars and their interactive response V &N were found non-significant. Late application of foliar urea increased the vegetative growth period of maize, resulting in the late initiation of silking (Douby *et al.*, 2000). Our results are in conformity of Amanullah *et al.* (2009) who observed that maize silking was delayed significantly when urea was used as in combination of both soil and foliar.

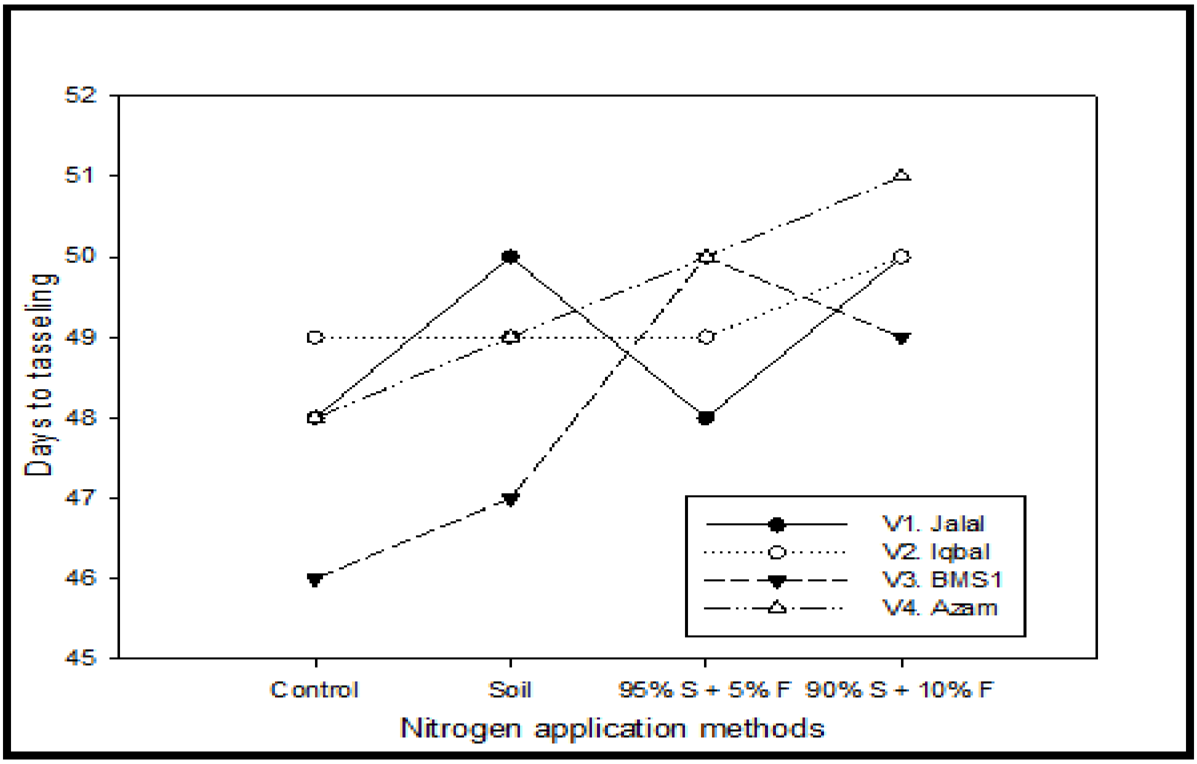

Fig. 1. Days to tasseling of different maize genotypes as influenced by nitrogen application methods.

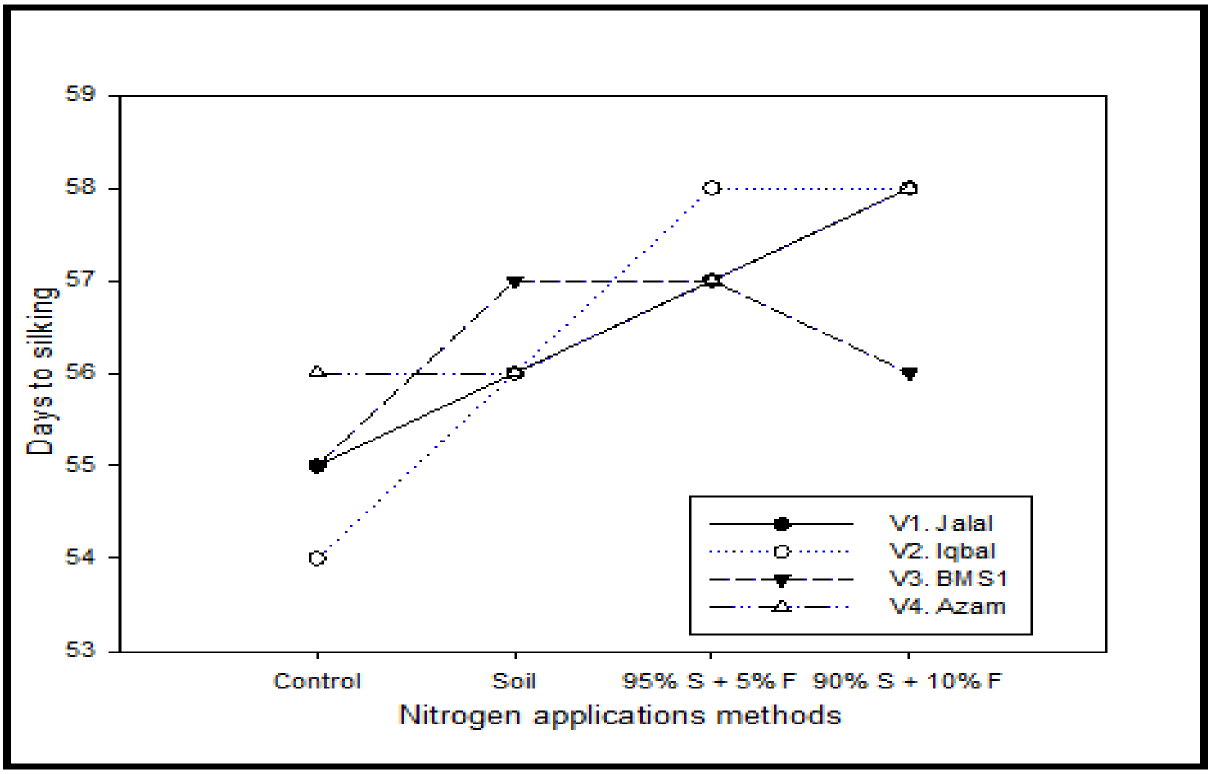

Fig. 2. Days to silking of different maize genotypes as influenced by nitrogen application methods.

Days to maturity

Days to maturity of maize cultivars were significantly affected by various N application methods. The interaction effect of varieties (V) and nitrogen application methods (N) was also found significant. Among maize cultivars, Azam took more days to maturity, followed by variety BMS1. Lowest days to maturity were taken by Iqbal variety.

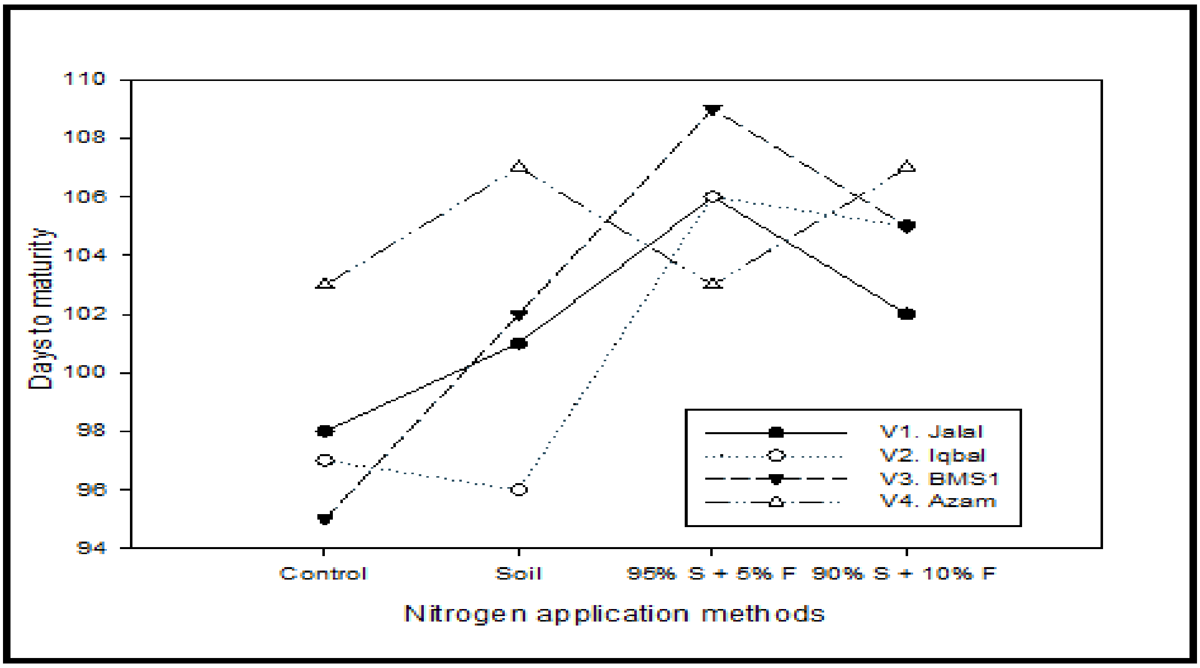

Fig. 3. Days to maturity of different maize genotypes as influenced by nitrogen application methods.

The possible reason could be the varietal differences and genetic attributes which influence the growth and eventually days to maturity (Mamudu *et al.*, 2017). These results in accordance with Khan *et al.*, (2014) and Kakar *et al.* (2014) who reported delayed maturity in case of foliar with soil applied nitrogen when compared to control plots. In case of N application methods, 95 % soil + 5 % foliar N application reported delayed maturity, followed by 90% soil + 10 % foliar N application. These results are in close conformity with those of Amanullah *et al.* (2009) and Karim *et al.* (1983) who reported delayed maturity with urea spray. The interactive response (V &N) revealed that variety BMS1 applied with N from 95 % soil + 5 % foliar delayed maturity. However, the same variety when exposed to control condition reported the earlier maturity. Similar results were also reported by Mamudu*et al.* (2017).

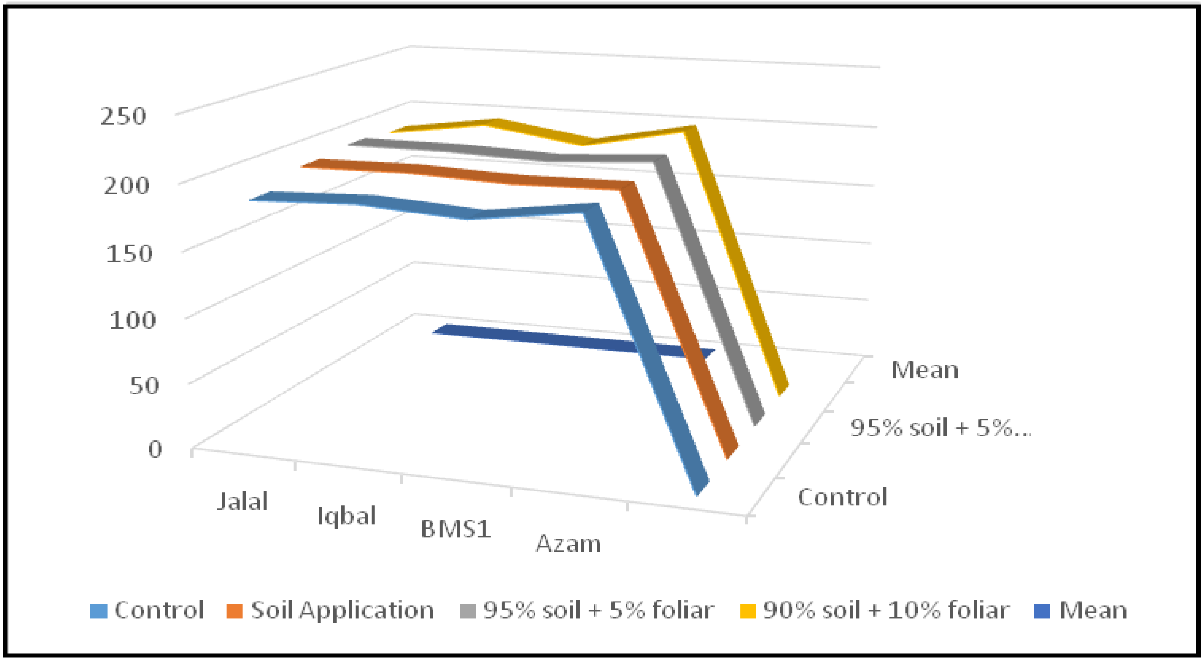

Fig. 4. Plant height of different maize genotypes as influenced by nitrogen application methods.

Plant height

The statistical analysis of data showed that plant height of various maize cultivars varied significantly. Also N application methods had significant effect on plant height while the interaction effect was found non-significant. Cultivar Azam plants were taller when compared to the other varieties under consideration. On the other hand variety BMS1 reported short stature plants. This specifies that morphological variation was observed among maize varieties on experimental field. Consider that height of maize varieties was crucial to make adoptable to local conditions and avoid logging. Our results corroborate the findings of Ahmad *et al.* (2018) and Abera*et al.* (2017) that they observed significant differences in plant height in respect to varietal change. Comparing various N application methods, N applied as 90% soil + 10 % foliar resulted in taller plants which was statistically similar with N applied as 95 % soil + 5 % foliar. Dwarf plants were observed in plots with no N application.

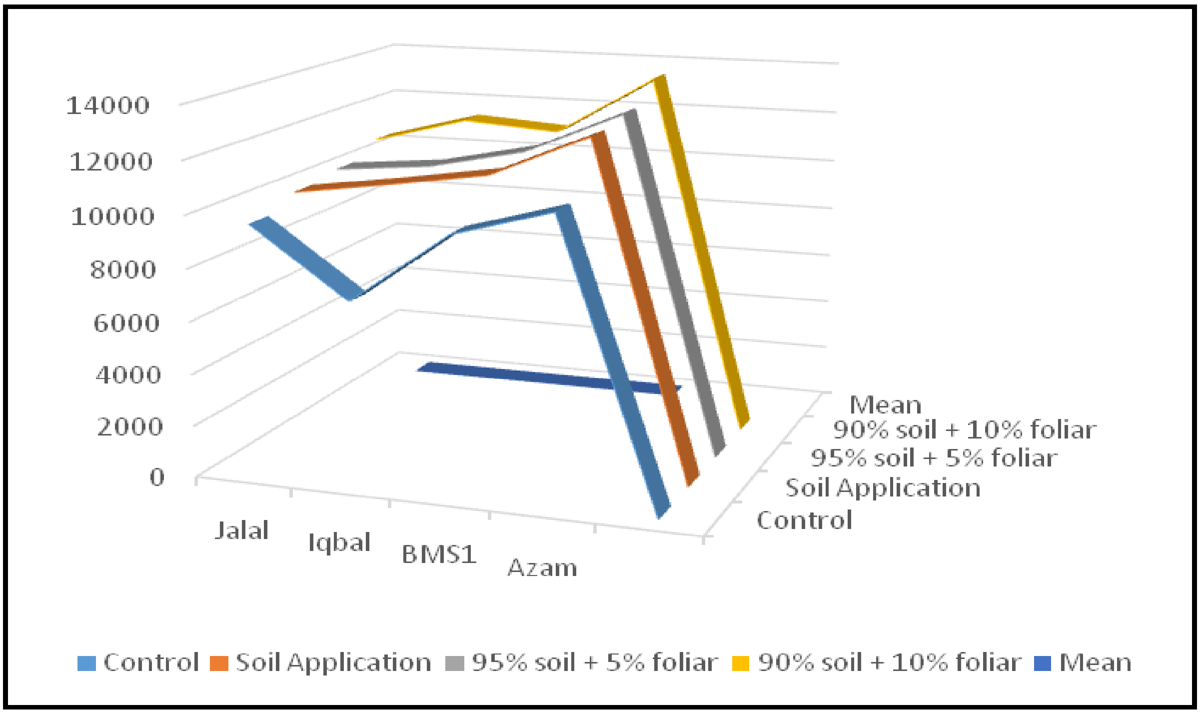

Fig. 5. Biological yield (kg ha^{-1}) of different maize genotypes as influenced by nitrogen application methods.

The increase in plant height might be due to increasing level of nitrogen as it increases cell division, cell elongation and nucleus formation. Interaction between cultivars and nitrogen levels was statistically non-significant. These results are in agreements with those of Wajid *et al.* (2007) who observed varied plant height with N application.

Biological yield

Biological yield of various maize cultivars varied significantly with N application methods while the interaction effect was found non-significant. Cultivar Azam produced highest biological yield when compared to the other varieties under consideration, followed by variety BMS1, whereas variety Iqbal reported lowest biological yield. The possible reason might be optimum utilization of solar light, higher assimilates production and its conversion to starches resulted varying with genetic potential of the variety resulted in higher biomass yield. Our results are in line with Akmal *et al.* (2010) and Ahmad *et al.* (2018) who found significant variation in the dry matter yield of maize when different cultivars were tested. Comparing various N application methods, N applied as 90% soil + 10 % foliar resulted in higher biological yield which was statistically similar with N applied as 95 % soil + 5 % foliar resulting biological yield. Lowest biological yield was observed in plots with no

N application. Difference in biological yield of maize under different fertilizer treatments was ascribed to balanced supply of nutrients from fertilizers over the growing period which influences N use efficiency (Attia *et al.*, 2015) and ultimately dry matter yield of maize. Another possible reason might be the increase in leaf parameters with N application, resulted in more light interception with more chlorophyll content and finally increased the biomass production (Akmal *et al.*, 2010). The results reported from the study were in line with Srivastava *et al.* (2017) and Kakar*et al.* (2014) who observed significantly enlarged biological yield with N application.

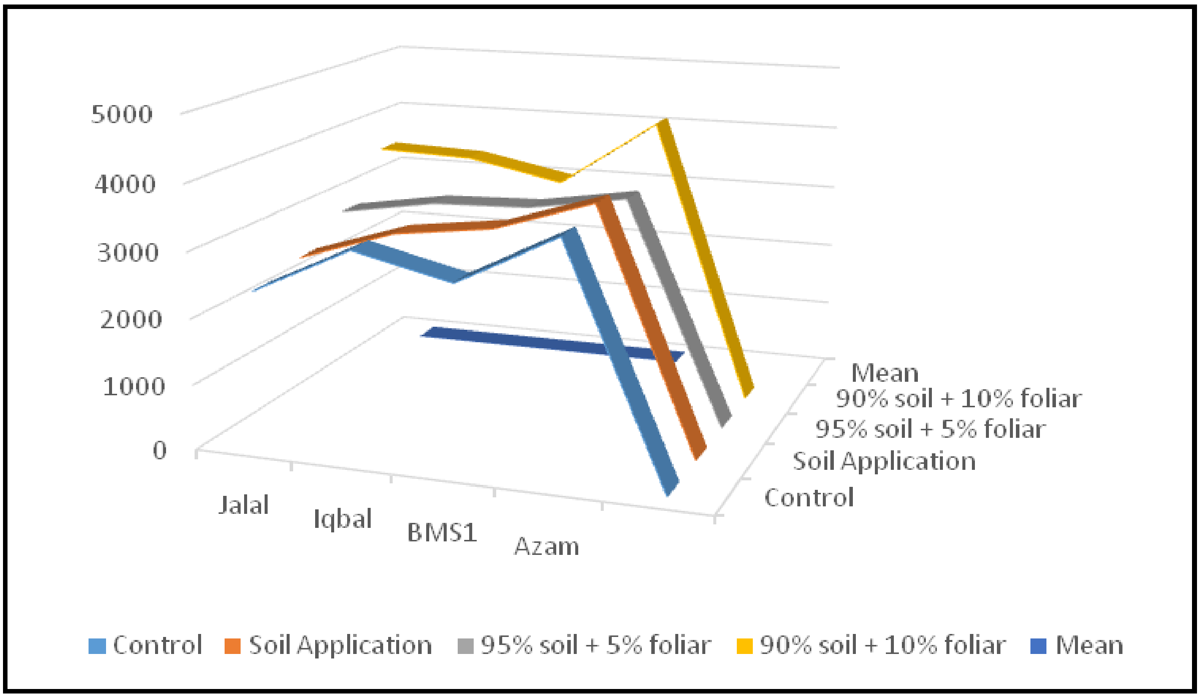

Fig. 6. Grain yield (kg ha^{-1}) of different maize genotypes as influenced by nitrogen application methods.

Grain yield

Analysis of data showed that the grain yield of various maize cultivars varied significantly. Also N application methods had significant effect on grain yield while the interactive response was found insignificant. Highest grain yield was produced by Azam, followed by variety Iqbal, whereas variety Jalal reported lowest grain yield. Efficient use of N in maize production requires the ability of the variety to adjust the quantity of nitrogen applied in relation to the variation in local soils. The similar results were therefore reported by Ahmad *et al.* (2018) and Wajid *et al.* (2007) observed that varieties differ in grain yield production as they differ in their ability to absorb nitrogen from the soil. Comparing various N application methods, N applied as 90% soil + 10 % foliar, which was statistically similar with N applied as 95 % soil + 5 % foliar. Lowest grain yield was observed in plots with no N application. The increase in maize grain yield after N application is largely due to an increase in the number of ears per plant, increase in total dry matter distributed to the grain and increase in average seed weight. The efficiency with which fertilizer-nitrogen (N) is transferred to grain-N in cereals is usually less than 50% and averages 33% worldwide (Attia *et al.*, 2015). Similar results were also reported by Bejigo (2018), Abera*et al.* (2017) and Amanullah *et al.* (2009) noted significant differences in yield and yield components of maize under exposure to varied N application.

Conclusion

It is concluded from the results that among genotypes Azam produced higher grain (3765 kg ha^{-1}) and biological yield (12664 kg ha^{-1}) significantly differs when compared to other genotypes under investigation. Application of 90% soil + 10 % foliar N resulted in higher grain (3729 kg ha^{-1}) and biological yield (12096 kg ha^{-1}) of maize crop. On the basis of conclusion, it is recommended that application of 90% soil + 10 % foliar N to Azam variety is recommended for higher grain and biological yield of maize crop under the agro-ecological conditions of districtMansehra Khyber Pakhtunkhwa- Pakistan.

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