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Research Article

Phenotypic and Nutritional Divergence of Maize Varieties with Varying Nitrogen Regimes under Rainfed Conditions of Rawalakot

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Abstract

Nitrogen plays significant role in enhancing the production and quality of maize (*Zea mays* L.). The maximum potential of maize production is attained by adopting improved varieties and appropriate nitrogen (N) fertilization. An experiment was conducted on phenotypic divergence of dual purpose maize under varying nitrogen regimes during 2022 at Chota Galla research farm University of Poonch Rawalakot. Treatments comprised of three maize varieties (Islamabad gold, SGS-2002 and Kashmir gold), four nitrogen levels (0, 50, 100 and 150 kg N ha^{-1}). The experiment was laid out in randomized complete block design (RCBD) with split plot arrangement. The statistical analysis demonstrated that highest plant height (271 cm), leaf area (3894.7 cm^2), thousand grain weight (286 g), biological yield (16888 kg ha^{-1}), grain yield (4930 kg ha^{-1}), crude protein (14.7 %) and ash content (9.8 %), were recorded at 150 kg ha^{-1} for SGS-2002 variety. The nitrogen fertilization exhibited prominent results in terms of agronomic and quality traits of maize. Therefore, it is recommended to apply N @ 150 kg N ha^{-1} and SGS-2002 variety for obtaining maximum yield and better quality attributes of dual purpose maize under rainfed conditions of Rawalakot.

Keywords: Fertilizer; Maize; Varieties; Yield.

Introduction

Maize the "queen of cereals" is an important dual-purpose crop, belongs to family Poaceae and occupies third position in cereals (Begam *et al*., 2018). Maize (*Zea mays* L.) is widely cultivated in the world (Adhikari *et al*., 2023) while, its cultivation has significantly increased from last decades. The use of nitrogen (N) fertilizer has been broadly applied to achieve more biomass and grain yields (Saudy and Mohamed, 2023).. Maize being efficient crop is highly palatable, produced more biomass which is used as food, feed, fiber and forage. Maize is the most nutritious crop contains proteins, minerals and soluble sugars that leads to more digestibility and make suitable for preservation as

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silage (Arya *et al*., 2020)**.** Maize crop has wider adaptability under different agro-climatic conditions and is appropriate crop for fodder production (Diedhiou *et al*., 2022).

The worldwide cultivation of maize is 197 million hectares with production of 1161 million tones in 2022. In Pakistan, it plays an important role in the economy of country contributing 3.2 % value addition in agriculture, 0.7 % of national gross domestic product and cultivated on an area of 1720 thousand hectares with production of 10.183 million tones (GOP, 2023). The area under maize cultivation in Pakistan comprises 66 % irrigated while 34 % under rainfed conditions. Moreover, in Azad Jammu and Kashmir, it was cultivated on an area of 99.63 hectares with production of 1.82 million tones (Bureau of Statistics, AJK, 2020). It is rich source of carbohydrate (Tolera and Debele, 2020). In Pakistan per hectare yield of maize is low and the most limiting factor for low yield is N application (Ali and Anjum, 2017). In the early phases of maize, N fertilizer has strong influence on growth and development. The recommended amount of N fertilization produces good quality biomass for fresh forage during vegetative phase (Shrestha *et al*., 2018). The utilization of N increases fodder nutritive value by increasing crude protein. Nitrogen management in maize production system is biggest concerns since it is primary and most important nutrient for development and growth of the crop (Biswas and Ma, 2016).

Nitrogen is important for boosting soil and crop production (Imran *et al*., 2015). The effect of fertilization especially N is significant in maize production, N fertilizer has widely been excessively applied to achieve higher grain yields. The utilization of precipitation during maize growing season is efficiently improved by an appropriate N management . Additionally, the N deficiency results in lower yield (Reddy *et al*., 2019). The yield and yield components of maize were affected by nitrogen fertilization. The N is main nutrient for biochemical reaction leads to enhancing yield and quality (Paul *et al*., 2019).

In fact, such constraints faced by farmers in rainfed conditions, the present study was executed for maize production as dual-purpose (grain and forage) under varying nitrogen regimes to conclude suitable N level for maximum production and nutritional traits of maize varieties of dual-purpose maize.

Methodology

The field trial was figure out at farm area of University of Poonch Rawalakot, Azad Jammu and Kashmir, Pakistan (33.85° N, 73.76°E) which is located at an altitude of 1638 meters (Jamil *et al*., 2021). The field study was performed during season of 2022. The soil in this area was identified as Thermic Lithic Eutrudepts, and the climate is considered temperate according to the Koppen classification system (Geiger, 1954). The area experienced an annual rainfall of 700-800 mm whereas; the average temperature ranges from 5°C to 28°C. A physico-chemical analysis conducted before seeding illustrated that the soil in the experimental field had silt-loam texture and slightly alkaline pH of around 8. The soil contained 5.1 mg kg^{-1} of phosphorus (P), 120 $mg.kg^{-1}$ of potassium (K), and had an electrical conductivity (EC) of 1.03 $dS.m^{-1}$.

Treatments included three maize varieties i.e. Islamabad gold (IG), SGS, 2002 and Kashmir gold (KG) along with four nitrogen levels (0, 50, 100 and 150 $kg.ha^{-1}$). The experiment was laid out in randomized complete block design (RCBD) split plot and was

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replicated thrice. The net plot size was maintained at 9m^2.The plant to plant and row to row distance was kept 30 and 75 cm respectively. The experimental block was ploughed thrice using tractor mounted plough for the preparation of fine seed bed. Each ploughing was followed by planking with wooden plank to pulverize the soil. Sowing of crops was done with single row hand drill at a row spacing of 75 cm. The recommended dose of phosphorous 60 kg ha^{-1} was incorporated as per recommendations. Approved seed rate of 30 kg ha^{-1} was used for sowing of maize varieties. The non-experimental area was kept under broadcast sowing with respective maize varieties. The agro-morphological parameters include plant height (cm), leaf area plant^{-1} (cm^2), thousand grain weight (g), biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}) along with nutritional parameters crude protein (%), ash content (%), acid detergent fiber (%) and neutral detergent fiber (%) were noted. The plant height of five randomly selected plants was recorded by placing meter scale from base to the tip of a highest leaf and average was calculated. The leaf area of five randomly selected plants from each plot was detailed at final harvesting with use of leaf area meter model no. (Ci202) and average was noted. From the grain lot, three samples of 1000 grains from each plot were weighed by using the electronic balance and their mean was recorded. The biological yield was calculated by harvesting representative sample of five plants at maturity while, grain yield was measured by weighing grains per cob of suit sample. The chopped fodder was tagged into different samples and prepared for assessment of nutritional parameters. Crude protein (%) Acid detergent fiber (%), neutral detergent fiber (%) and ash contents (%) were also determined through standard procedure (AOAC, 2012).

Statistical analysis

The recorded data were subjected to analysis of variance technique using statistical software "Statistix 8.1 version" (Reddy *et al*., 2019). The significance of the treatment means were determined by using Turkey's Honest Significant test at 5% level of probability.

Results and Discussion

Agronomic assessment

All the agronomic parameters i.e plant height (cm), leaf area (cm^2), thousand grain weight (g), biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}) of different maize varieties showed significant effect in response to varying nitrogen regimes under rainfed conditions of Rawalakot. Results showed that maximum plant height (271 cm), leaf area (3894.7 cm^2), thousand grain yield (286 g), biological yield (16888 kg ha^{-1}) and grain yield (4930 kg ha^{-1}) were recorded in SGS-2002 at 150 kg N ha^{-1} (Table 1). The agronomic parameters were seen lowest at control in Islamabad gold. The reason for higher plant height and leaf area with increased nitrogen level could be as nitrogen is basic constituent of cell that stimulates cell division, elongation and consequently impact the chlorophyll content which leads to enhanced photosynthetic efficiency resulting in more plant height and better leaf area. Our findings were in consistent with Almodares *et al*., 2019, Leghari *et al*., 2021 and Lai *et al*., 2022 who stated that plant height and leaf area increased at higher N levels. Similarly, 1000 grain weight also increased with improved

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N level. This could be due to nitrogen causing improved source efficiency (greater dry matter accumulation per unit area/time) and sink capacity (kernel weight).

Table 1. Agronomic assessment of maize varieties with varying nitrogen regimes under rainfed conditions of Rawalakot during 2022.

N. Levels	Varieties	N_0	N_1	N_2	N_3	Mean
Plant height (cm)	V_1	147.3i	159.3hi	196.0ef	218.3cd	180.2C
	V_2	172.6gh	198.3def	240.0b	271.0a	220.5A
	V_3	157.3hi	189.3fg	216.0de	234.0bc	199.1B
	Mean	159.1D	182.3C	217.3B	241.1A	
Leaf Area (cm^2)	V1	1901.3i	2675.0f	2804.7de	3507.0b	2722.0C
	V_2	2227.3g	2916.7d	3108.7c	3894.7a	3036.8A
	V_3	2035.0h	2714.0ef	2896.7d	3601.7b	2811.8B
	Mean	2054.6D	2768.6C	2936.7B	3667.8A	
1000 grain weight (g)	V_1	166.0g	210.3e	234.6d	259.3bc	217.0C
	V_2	191.3f	231.6d	258.3bc	286.3a	241.0A
	V_3	171.0g	222.3de	251.3c	270.0b	228.0B
	Mean	176.1D	221.4C	248.1B	271.8A	
Biological Yield (kg ha^{-1})	V_1	8452.0h	11311.0g	14574.0e	15200.0cd	12384.0C
	V_2	8847.0h	12916.0f	15586.0c	16888.0a	13559.0A
	V_3	8684.0h	11145.0g	14953.0de	16282.0b	12766.0B
	Mean	8661.0D	11791.0C	15038.0B	16123.0A	
Grain Yield (kg ha^{-1})	V_1	1156.7h	2508.7g	4118.7e	4625.0bc	3102.3C
	V_2	1238.0h	2947.3f	4411.3cd	4930.3a	3381.8A
	V_3	1191.3h	2764.0fg	4198.7de	4801.3ab	3238.8B
	Mean	1195.3D	2740.0C	4242.9B	4785.6A	

{V_1= Islamabad gold: V_2= SGS2002: V_3= Kashmir gold}{N_0= 0kgha^{-1}: N_1=50kg ha^{-1}: N_2= 100kg ha^{-1}& N_3= 150kgha^{-1}: values having different letters in same column varies significantly at P (0.05)

These findings were in agreement with Leghari *et al*., 2021 and Kandel *et al*., 2017 who stated that 1000 grain increased with higher N levels. Likewise, biological and grain yield also showed rise with increase in nitrogen level. The reasons could be attributed to higher N level which caused an increase in plant height, stem length, and leaf area $plant^{-1}$, which produced more assimilates for plant utilization, resulting in significant increase in biological yield while grain yield was increased due to nitrogen causing escalation in number of cobs $plant^{-1}$, grains per cob^{-1}, cob length and cob girth which resulted in better grain yield. These results were in conformation with Gaire *et al*., 2020, Sarker *et al*., 2020 and Leghari *et al*., 2021; who also stated that biological and grain yield responds positively at higher N levels.

Nutritional assessment

The maximum crude protein (14.7 %) and ash content (9.8 %) were recorded for SGS-2002 at 150 kg N ha^{-1}. The increased in crude protein could be due to nitrogen being an active ingredient of protein and building block of amino acid. As amino acid concentration

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increases ultimately the protein content also increases while rise in ash content with N was attributed to higher dry matter formation which contributed directly to mineral synthesis as a result of which ash content increased. These results were in accordance with Ibrahim *et al*., 2022, Dhital *et al*., 2022 and Swamy *et al*., 2022 who agreed that crude protein and ash content were higher at improved N levels. The minimum ADF (17.6 %) and NDF (39 %) were recorded at150 kg N ha^{-1}. The maximum ADF (32.1 %) and NDF (47.7 %) were recorded at control in SGS-2002 (Table 2). The ADF and NDF concentrations were decreased with increased in nitrogen level. The higher N level increase crude protein and water soluble contents while decrease the ADF and NDF. These results were in comparison with Amasaib *et al*., 2022 and Carpici *et al*., 2020 who argued that increase in N level decreased the concentration of ADF and NDF. The difference among varieties could be due to better genetic potential, better adaptability, timely weeding and favorable climatic conditions utilized by the variety which enables it to perform better as compared to remaining varieties.

Table 2. Nutritional assessment of maize under varying N regimes in rainfed conditions of Rawalakot during 2022.

		N. Levels				
	varieties	N_0	N_1	N_2	N_3	Mean
Crude protein (%)	V_1	5.5h	7.4fg	9.6de	11.3bc	8.4C
	V_2	7.1g	9.5de	11.6bc	14.7a	10.7A
	V_3	6.7gh	8.6ef	10.4cd	12.4b	9.5B
	Mean	6.4D	8.5C	10.5B	12.8A	
ADF (%)	V_1	27.6b	24.3de	20.3f	16.0g	26.5A
	V_2	32.1a	27.3bc	24.8d	17.6g	22.0C
	V_3	28.0b	25.3cd	22.3ef	21.9f	23.3B
	Mean	29.2A	25.6B	22.4C	18.5D	
NDF (%)	V_1	47.1ab	46.5ab	42.1c	39.4d	42.1A
	V_2	47.7a	46.2b	42.4c	39.0d	40.3C
	V_3	47.5ab	46.5ab	42.1c	39.8d	41.3B
	Mean	47.4A	46.4B	42.2C	39.4D	
Ash (%)	V_1	6.4g	7.6f	8.8cde	9.4abc	8.0C
	V_2	7.1fg	8.6de	9.4abc	9.8a	8.7A
	V_3	6.8g	8.3e	9.1bcd	9.5ab	8.4B
	Mean	6.8D	8.2C	9.1B	9.5A	

{V_1= Islamabad gold: V_2= SGS2002: V_3= Kashmir gold}{N_0= 0kgha^{-1}: N_1=50kg ha^{-1}: N_2= 100kg ha^{-1}& N_3= 150kgha^{-1}: values having different letters in same column varies significantly at P (0.05) {CP: Crude Protein: ADF: acid detergent fiber: NDF: neutral detergent fiber

The agro-morphological parameters like plant height, leaf area, thousand grain weight, biological and grain yield illustrated positive linear association with each other. Similar results were stated by Landry *et al*., 2019 for agro-morphological parameters. Likewise, crude protein, ash content, acid detergent fiber and neutral detergent fiber also exhibited positive association with one another.

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Conclusion

This study concluded that the variety SGS-2002 along with 150 kg N ha^{-1} application presented best results for agronomic and quality attributes in maize So, it is recommended to apply N @ 150 kg N ha^{-1} and variety SGS-2002 for obtaining maximum yield and better quality attributes of dual purpose maize under rainfed conditions of Rawalakot.

Conflict of Interest

The authors have not declared any conflict of interest.

Authors Contributions

All the authors contributed equally in the manuscript.

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