COMPARATIVE EVALUATION OF MAIZE (*ZEA MAYS* L.) CULTIVAR PERFORMANCE IN VARIED SOIL NITROGEN ENVIRONMENTS WITHIN NIGERIA'S DERIVED SAVANNA AGROECOLOGY ZONE

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Abstract

Maize (Zea mays L.) plays a crucial role as a staple cereal globally supplying more than 30% of total dietary calories. In the Derived Savanna Agroecology zone of Nigeria, resource-constrained farmers involved in maize cultivation face the challenge of low soil nitrogen, leading to a notable reduction in maize grain yield. Hence, this study aimed to assess the phenotypic variations among selected maize cultivars and identify those exhibiting tolerance to low soil nitrogen with potential high grain yield across varying nitrogen environments. Seven maize cultivars assigned to subplots were evaluated across four distinct soil nitrogen environments (0, 30, 90, and 150 kg N ha^{-1}) as the main plot at the Teaching and Research Farm of Ladoke Akintola University of Technology in Ogbomoso during the 2021 and 2022 main planting season. The experiment was arranged as split-plot, laid out in a randomized complete block design with six replicates. Agronomic and yield data were collected and subjected to analysis of variance. Rank summation index was used to determine superior cultivars and low nitrogen based index was used to identify cultivars tolerant to low soil nitrogen. The year effect, cultivar, soil nitrogen environments and their interactions mean squares showed significant ($P < 0.01$) differences for grain yield and other measured agronomic traits. The mean grain yields across soil nitrogen environments in two years ranged from 1729.6 to 4475.3 kg ha^{-1}. Pioneer 30Y87 and Sammaz 52 were selected for grain yield superiority and tolerance to low soil nitrogen. These cultivars can be recommended to resource-limited farmers across the Derived Savanna Agroecology zone for improved growth and productivity.

Keywords: Derived Savanna Agroecology; Grain yield; Maize cultivar; Soil nitrogen; Variation

Introduction

Maize (*Zea mays* L.) holds significant importance as a staple food globally, contributing, along with rice and wheat, to over 30% of the food caloric intake of about 4.6 billion people in 94 developing countries (Nyirenda *et al*., 2021; Erenstein *et al*., 2022). Across the countries, there is a growing demand for maize, and meeting this demand is becoming progressively challenging as a result of the impacts of abiotic and biotic stress factors (Shiferaw *et al*., 2011; Krishna *et al*., 2023). Abiotic stresses, such as heat, drought, flood, low soil nitrogen, salinity and heavy metals limits maize productivity and sustainability (Gong *et al*., 2014; Vaughan *et al*., 2018). About 90% of arable lands are prone to one or more of the above stresses (Reis *et al*., 2012) and their synergistic effects can lead to 100% yield loss (Badu-Apraku *et al*., 2011).

The importance nitrogen (N) in maize production cannot be overemphasized because inadequate management of N limits growth and development. This essential plant nutrient is required in plant metabolism as it participate in protein and chlorophyll synthesis used during photosynthesis (Yousaf *et al*., 2021; Zhang *et al*., 2023). Hence, N fertilizer application in maize cultivation is a necessity, however, the total available N in savanna soils is generally low (Wang *et al*, 2019).

The significance of maize as a staple food and a crucial raw material adds to its widespread cultivation in the Derived Savanna Agroecology zone of Nigeria (Sadiq *et al*., 2013; Adiaha, 2017). In this zone, maize is usually produced on small-scale with little or zero soil nutrient inputs as most farmers cannot afford to purchase N fertilizers. This may be attributed to the high cost of fertilizers which makes it uneconomical for farmers to apply as well as the non-availability of fertilizer when needed (Adekiya *et al*., 2020).

Farmers could mitigate the impact of low soil N on maize production by applying organic fertilizers and rotating maize with N fixing legumes. The major challenge with rotating maize with legumes is the fallow period required to grow the legumes since farmers would want to continuously use their lands for maize production. Also, composting may be considered but it requires the addition of nitrogenous base to improve the contents of N produced. In view of this, few farmers can produce adequate and quality compost for their fields (Rufino *et al*., 2006). Low soil N thus remains a great challenge to maize production and annual yield loss resulting from the impact of low soil N ranged between 10 to 50% (Tofa *et al*., 2022).

Therefore, the deployment of maize cultivars that possess genes for low soil N tolerance with potential high grain yield is crucial for increased maize production and productivity. The objective of this study is to assess the phenotypic variations among selected maize cultivars and identify those exhibiting tolerance to low soil N with potential high grain yield in the Derived Savanna Agroecology zone of Nigeria.

Materials and methods

Planting material, Experimental layout and Design

The study evaluated six maize cultivars obtained across the diverse maize production Agroecology zones of Nigeria and a locally check cultivated by farmers in Ogbomoso (Table 1) The experiment was carried out at the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso (8º 10’ N longitude and 40º 10’ latitude). The climatic characteristics of the location are a bi-modal rainfall distribution with a total annual rainfall of about 1800 mm and a persistently high temperature 31°C on the average. The field used for this study had been under continuous maize cultivation over the years with little or no N fertilizer application. After each harvest, the residuals were completely removed from the field in preparation for the next planting season thereby depleting the soil of N incessantly. Before the establishment of this trial, soil samples were taken at the experimental site and the nutrient composition of the soil was determined at the Soil Laboratory of the Department of Agronomy, University of Ibadan, Ibadan, Nigeria.

The land was mechanically prepared using a tractor mounted plough and the field was subsequently partitioned into four N environments (0, 30, 90 and 150 kg N ha^{-1}). Each environment was separated by a 3 m alley and a gutter was used to break the lateral movement of N in the soil. The trial was arranged as split-plot but laid out as randomized complete block design with six replicates. The four N environments were main plot factor while the seven maize cultivars were considered as the sub-plot factor. Each experimental unit consisted of a single-row plot, 5 m long spaced at 0.75 m apart with 0.50 m spacing between hills within a row. Three seeds were sown per hole and were thinned to two plants per hill two weeks after sowing to obtain a plant density of 53,333 plants per hectare.

Basal application of P and K fertilizer at the rate of 60 kg ha^{-1} each in the 0 and 30 kg N ha^{-1} environments was achieved with the use of Single Super Phosphate and Muriate of potash respectively. No N was applied at the 0 kg N ha^{-1} environments. For, 90 and 150 kg N ha^{-1} environments, N was applied in two split doses for the efficient use of N with the first dose applied 2 weeks after sowing, while the second dose was applied 2 weeks later. Weed control was carried out using a mixture of pre- and post-emergence herbicides containing atrazine and paraquat at 5.0 L ha^{-1} at sowing and manual weeding was done regularly as and when due. Caterpillar force containing emamectin benzoate was used to control armyworm (*Spodoptera frugiperda*) by adding 10 g of the insecticide into a 16 litre capacity sprayer and applied onto the whorls of the maize plants.

Data collection and analysis

Data were recorded on the following agronomic traits for each plot; number of days to 50% anthesis and silking estimated as the numbers of days from planting to the day that 50% of plants had tassels shedding pollen and silk extrusion, respectively. The anthesis-silking interval was calculated as the difference between the number of days to 50% silking and anthesis. Plant and ear height were measured from the base of the plant to the first tassel branch and the node bearing the uppermost ear, respectively. Plant aspect scores were obtained using a scale of 1-9, where 1 denoted excellent overall phenotypic appearance of plants and 9 extremely poor overall appearance of plant. Ear aspect was also rated on a 1-9 scale, where 1 indicated well-filled ears with no insect and disease damages and 9 represented plots with ears having only one or no kernel. Root and stalk lodging was estimated as the proportion of plants that fell from the root or with stalk bending more than 45^o from the vertical position and broken stalk below the upper ear, respectively. Husk cover was rated on a scale of 1 - 5; where, 1 = very tight husk extending beyond the tip and 5 = exposed ear tip. Stay green scores were recorded on low soil N plots (0 and 30 kg N ha^{-1} environments) on a scale of 1 to 9; where 1 = almost all leaves below the ear were green and 9 = virtually all leaves below the ear were dead (Kamara *et al*., 2005). The number of ears per plant was calculated as the ratio of harvested cobs per plot to the number plants at harvest. Grain yield was measured in kilograms per hectare (kg ha^{-1}) and adjusted to 15 % moisture content, from grain weight and percent moisture as described by Kolawole *et al*. (2018) using the following equation:

$$GY\ (kg\ ha^{-}1) = GWT\ (kg\ plot^{-}1)\ X\ \frac{100 - MC}{100 - 15}\ X\ \frac{10{,}000\ m^2}{Plot\ size\ m^2}$$

Where GWT = grain weight of harvested area in kg ha^{-1}, MC = moisture content of grain at harvest, 15% is the moisture content for storage, 10,000m2 = 1 hectare, plot size = 3.75 m^2

The data were subjected to separate and combined analysis of variance (ANOVA) for each of the years and across the years using the statistical analysis system (SAS institute, 2011). The mean values of each parameter were estimated using SAS and were compared using Duncan's Multiple Range Test. The mean values were standardized and used in the low N base index calculation to determine low N tolerant cultivars. A positive low N base index value is an indication of the tolerance of the variety to the N stress while a negative low N index value indicates susceptibility of the variety to the low N stress.

Low N base index = 2 × yield + EPP - (SG + PA + EA)

Where EPP is the number of ears per plant, SG is the stay-green characteristic, PA is the plant aspect and EA is the ear aspect.

The Rank Summation Index (RSI) (Mulumba and Mock, 1978; Kolawole and Olayinka, 2022) was used in identifying cultivars that combine high yield with other agronomic traits under low soil N environments. The correlation coefficient between every pair of measured parameter was also calculated.

Results

Results from ANOVA under low soil N across 2021 and 2022 revealed that the maize cultivars exhibited significant variation ($P < 0.01$) for all the measured traits (Table 2). The N environments (0 and 30 kg N ha^{-1}) showed significant variation for all the measured traits except for stay green characteristic, husk cover, number of ears per plant, stalk and root lodgings. The cultivar × environment interaction significantly influenced only stalk and root lodgings (Table 2).

Under high soil N (90 and 150 kg N ha^{-1}) across 2021 and 2022 the maize cultivars exhibited significant variation ($P < 0.01$) for all the measured traits except anthesis silking interval, husk cover, stalk and root lodgings (Table 3). The N environment had significant effect only on plant height. The cultivar × environment interaction significantly influenced grain yield, ear height and number of ears per plant (Table 3).

The mean values for grain yield and other agronomic traits under low soil N environments across 2021 and 2022 showed that grain yield varied from 1,729.6 to 3,530.5 Kg ha^{-1}. Pioneer 30Y87 produced the highest grain yield which was significantly higher than the grain yield of the other cultivars, while Kapam 6 produced the lowest grain yield (Table 4). The maize cultivars flowered approximately between 57 - 66 days (anthesis) and 61 - 71 days (silking) after sowing respectively. Sammaz 27 flowered early while SC719 was late. The average anthesis-silking interval was 4 days. Plant height was between 142.0 and 176.0 cm with average height of 155.0 cm while the ear height was between 59.0 and 80.0 cm and averaged at 65.0 cm. Pioneer 30Y87 had the best overall phenotypic appeal in terms of the plant and ear aspect and also had desirable stay green characteristic (Table 4).

The mean values for grain yield and other agronomic traits under high soil N environments indicated that grain yield varied between 2,121.3 and 4,475.3 Kg ha^{-1} (Table 5). The highest grain yield which was significantly ($P < 0.05$) higher than those of the other cultivars was produced by Pioneer 30Y87 while the lowest grain yield was produced by Sammaz 27. The maize cultivars flowered approximately between 57 - 67 days (anthesis) and 58 - 69 days (silking) after sowing respectively. The average anthesis-silking interval was 4 days. Plant height was between 150.0 and 187.0 cm with average height of 162.0 cm while the average ear height was 70.0 cm. Pioneer 30Y87 had the best overall appeal in terms of the plant and ear aspect (Table 5).

The rank summation index of Pioneer 30Y87 and Sammaz 52 were lower compared to the other cultivars and the local check (Table 6). Pioneer 30Y87 had the overall rank sum of 7 with a grain yield of 3,530.5 kg ha^{-1} while also exhibiting low ratings for plant aspect, ear aspect and the stay green. Likewise, based on the low N index, Pioneer 30Y87 and Sammaz 52 were tolerant to low soil N because they exhibit positive low N base index values (9.78 and 1.32) while the other varieties were susceptible to low soil N (Table 7).

Plant height (r = 0.43; $P \leq 0.001$), ear height (r = 0.53; $P \leq 0.001$) and number of ears per plant (r = 0.53; $P \leq 0.001$) had positive and significantly correlations with grain yield whereas negative and significant correlation existed between grain yield and each of number of days to 50% anthesis (r = - 0.23; $P \leq 0.01$), number of days to 50 % silking (r = -0.32; $P \leq 0.001$), anthesis-silking interval (r = - 0.20; $P \leq 0.05$), stem lodging (r = - 0.40; $P \leq 0.001$), plant aspect (r = - 0.40; $P \leq 0.001$), stay green (r = - 0.34; $P \leq 0.001$), husk cover (r = - 0.42; $P \leq 0.001$) and ear aspect (r = - 0.55; $P \leq 0.001$) (Table 8).

Discussion

The maize cultivars was a significant source of variation for yield and other agronomic traits under the diverse soil nitrogen environments; an indication of differential performances under each environment. The observed variations may be a result of the diverse genetic makeups, backgrounds of the parental materials used in cultivar formation (Kolawole *et al*., 2021). Additionally, the genetic potentials of the cultivars may be influenced by the edaphic and climatic factors of the trial environments (Beyene *et al*. 2011). Furthermore, the significant variation observed between the interaction of cultivar, with the environments and years of evaluation for grain yield and other agronomic traits in this study indicates the uniqueness of each environment in terms of nutrient content in agreement with Bhadmus *et al.* (2021).

Across the four soil N environments, Pioneer 30Y87 had the highest yield ranging from 3530.5 kg ha^{-1} under low soil N to 4475.3 kg ha^{-1} under high soil N which was significantly higher than the yield of other cultivars including the local check (Oba Super 6). This result corroborates the earlier findings of Kolawole et al. (2022). Utilizing grain yield alone in selection of superior maize cultivars without considering other economic important agronomic traits may impede the effectiveness of selection. Previous report identified plant and ear aspect as important agronomic traits under low N environments contributing to grain yield (Ajala *et al*., 2018; Bhadmus *et al*., 2021; Amegbor *et al*., 2022). In this study, Pioneer 30Y87 and Sammaz 52 had desirable ear and plant aspect performance including grain yield, affirming their superiority over other cultivars evaluated. These two maize cultivars also had shorter anthesis-silking interval with a corresponding higher number of ears per plant, lower husk cover and stay green scores.

Additionally, stay green characteristic also contributed indirectly to grain yield indicating its reliability as an effective trait to be considered when selecting for maize cultivars tolerant to low soil N (Thomas and Ougham, 2014; Kobata *et al*., 2015). From this study, Pioneer 30Y87 had the highest positive low N base index value denoting tolerance to low soil N followed closely by Sammaz 52. The other maize varieties had negative low N base index values which indicate their susceptibility to low soil N.

A positive correlation with grain yield was observed for number of ears per plant, ear and plant heights, indicating that selection for these characters can help improve maize grain yield (Zsubori *et al*., 2002). A positive and significant correlation between grain yield and plant height has been reported by Nastasić *et al*. (2010). The negative correlation coefficient between anthesis-silking interval and grain yield indicates that shorter anthesis-silking interval can result in increased grain yield. The longer the interval between anthesis and silking the higher the chances of pollen abortion, unavailability and poor seed set during pollination especially in rain-fed conditions where environmental conditions might be irregular (Malik *et al*., 2005).

Conclusion

The study revealed exploitable variation among the maize cultivars across N environments and years of evaluation. Consistently, Pioneer 30Y87 and Sammaz 52 exhibited tolerance to low soil N and outperformed the local check (Oba Super 6). These varieties could be recommended to farmers in the Derived Savanna Agroecology zone of Nigeria where resource-limited farmers are faced with the challenge of low soil N.

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Table 1: Characteristics of the evaluated maize cultivars across two years

S/N	Variety	Type	Ecology	Attribute	Year of release
1	KAPAM 6	OPV	Savanna	Drought tolerant & PVA	2018
2	SC 719	OPV	Southern, Northern, Guinea Savanna	Late maturity	2014
3	OBA 98	Hybrid	Forest and Savanna	QPM	2001
4	SAMMAZ 27	OPV	Lowland tropics	Drought and *striga* resistant	2009
5	SAMMAZ 52	OPV	Northern Guinea and Sudan Savanna	PVA	2007
6	PIONEER 30Y87	Hybrid	Forest, Savanna and guinea Savanna	Stay green trait	2014
7	OBA SUPER 6 (local check)	Hybrid	Forest and Savanna	NUE	2009

PVA = Pro -vitamin A, QPM = Quality protein maize, NUE = Nitrogen use efficiency, OPV = Open pollinated variety

Table 2: Mean square values for grain yield and other agronomic traits of the evaluated maize cultivars across 0 and 30 kg N ha^{-1}

Source	df	Grain yield (Kg/ha)	Days to 50% anthesis (days)	Days to 50% silking (days)	Anthesis silking interval (days)	Plant height (cm)	Ear height (cm)	Plant aspect (1-9)	Stay green (1 – 9)	Root lodging (%)
Replicate (R)	5	640440.4	8.4*	6.1	7.6	160	61.1	0.4	2.9**	13.9**
Cultivar (C)	6	9550497.5***	187.4***	261.9***	14.6*	2841.6***	1130.6***	9.5**	7.7***	27.0***
Environment (R)	6	2161353.8*	16.6**	48.6***	15.2*	940.8*	458.2**	1.7*	0.7	5.9
Year	1	31482379.0***	653.0***	29.9	403.6***	9072.8***	5097.9***	41.0**	0.0	23.7**
C*Environment	6	817575.8	3.2	5.4	7.3	308.5	59.1	0.91	0.2	21.4***
C*Environment*Year	6	1855022.2*	22.9***	54.3***	15.3**	792.2*	323.9**	1.4*	3.9***	9.8**
Error	130	884059.2	3.5	10.8	6.4	350.0	116.9	0.7	0.7	3.8

$^{*, **, ***}$ Significant at 0.05, 0.01 and 0.001 probability levels, respectively

Table 3: Mean square values for grain yield and other agronomic traits of the evaluated maize varieties across 90 and 150 kg N ha^{-1}

Source	df	Grain yield (Kg/ha)	Days to 50% anthesis (days)	Days to 50% silking (days)	Anthesis silking interval (days)	Plant height (cm)	Ear height (cm)	Plant aspect (1-9)	Root lodging (%)	Stalk lodging (%)	Husk cover (1-9)	Number of ears per plant	Ear aspect (1-9)
Replicate (R)	5	2765824.6^{**}	16.3^{**}	36.9	22.4	486.5	353.2^{**}	1.2	14.8	0.6	0.7	0.0	1.6
Cultivar (C)	6	12251453.8^{***}	256.1^{***}	345.9^{***}	27.6	3519.7^{***}	1603.4^{***}	17.3^{***}	8.7	10.0	0.4	0.1^{***}	13.9^{***}
Environment (R)	6	1815321.66	1.6	45.2	38.7	558.6^{*}	69.9	0.8	11.6	4.4	0.2	0.0	1.0
Year	1	55635593.8^{***}	6.5	4.0	20.7	3453.5^{**}	573.5^{*}	64.4^{***}	288.1^{***}	252.6^{***}	1.5	0.0	20.7^{***}
C*Environment	6	1962928.3^{*}	8.3	13.9	19.8	345.5	254.1^{*}	0.5	13.5	6.1	0.7	0.1^{**}	0.8
C*Environment*Year	6	6816752.4^{***}	20.3^{***}	57.0^{*}	32.5	523.3^{**}	250.4^{**}	3.5^{***}	24.9^{**}	13.3^{**}	0.6	0.0	2.9^{***}
Error	130	799281.6	4.0	28.1	32.5	223.0	99.1	0.7	7.6	4.6	0.4	0.0	0.8

$^{*, **, ***}$ Significant at 0.05, 0.01 and 0.001 probability levels, respectively

Table 4: Mean values for grain yield and other agronomic traits of the evaluated maize cultivars across 0 and 30 kg N ha^{-1}

Cultivar	Grain Yield (Kg/ha)	Days to 50% anthesis (days)	Days to 50% silking (days)	Anthesis silking interval	Plant height (cm)	Ear height (cm)	Plant aspect (1-9)	Stay green (1-9)	Root lodging- (%)	Stalk lodging (%)
Pioneer 30Y87	3530.5a	60.2e	64.2d	4.0c	141.9e	61.8c	3.7e	3.4d	0.5c	0.4c
SC 719	2485.3b	65.6a	70.8a	5.2a	176.4a	80.1a	5.2c	4.6c	0.9c	0.4c
Sammaz 52	2333.8b	61.5c	64.5d	3.1d	154.6bc	64.3b	5.0d	4.7c	1.5bc	0.6b
Oba 98	2191.5c	60.6d	64.7d	4.1bc	152.0c	64.5b	5.2c	4.6c	3.0a	0.5b
Sammaz 27	1805.7d	56.5f	60.5e	4.0c	147.2d	59.1d	5.7a	5.3a	3.4a	1.1a
Kapam 6	1729.6d	61.0d	65.6c	4.6b	157.0b	62.3bc	5.1cd	4.9b	1.8b	0.7b
Oba Super 6 (local check)	1824.7d	63.1b	68.5b	5.4a	153.0bc	64.4b	5.4b	4.8bc	1.9b	0.2d
Mean	2281.7	61.2	65.5	4.3	154.5	65.2	5.0	4.6	1.8	0.6
LSD (0.05)	221.6	0.4	0.8	0.6	4.4	2.5	0.2	0.2	0.5	0.2

Means with the same letter within the column are not significantly different at P = 0.05 by DMRT

Table 5: Mean values for grain yield and other agronomic traits of the evaluated maize cultivars across 90 and 150 kg N ha^{-1}

Cultivars	Grain yield (Kg/ha)	Number of days to 50% anthesis (days)	Number of days to 50% silking (days)	Anthesis silking interval (days)	Plant height (cm)	Ear height (cm)	Plant aspect (1-9)	Root lodging (%)	Stalk lodging (%)	Husk cover (1-5)
Pioneer 30Y87	4475.3a	60.1d	60.2c	0.1b	149.7c	65.3c	3.2d	0.9b	2.4ab	2.8ab
SC 719	3327.6b	67.0a	68.8a	1.9ab	186.5a	87.1a	5.4b	1.7ab	1.6b	2.7b
Sammaz 52	3023.0bc	62.3c	64.4b	2.1ab	162.0b	67.2bc	4.9c	2.2ab	3.0a	2.8ab
Kapam 6	2832.8bc	62.2c	64.8b	2.6ab	160.3b	67.5bc	4.8c	2.7a	2.4ab	2.8ab
Oba 98	2809.4c	61.5c	64.3b	2.8ab	157.6bc	65.8c	5.1bc	2.6a	2.2ab	3.0ab
Sammaz 27	2121.3d	56.5e	58.3c	1.8ab	151.8c	62.8c	5.9a	2.1ab	3.2a	3.1a
Oba Super 6 (local check)	3097.9bc	64.4b	67.9a	3.5a	163.8b	71.7b	5.2bc	1.9ab	1.5b	2.8ab
Mean	3098.2	62.0	64.1	2.1	161.7	69.6	4.9	2.0	2.3	2.8
LSD (0.05)	210.7	0.5	1.2	1.2	3.5	2.3	0.2	0.6	0.5	0.2

Means with the same letter within the column are not significantly different at P = 0.05 by DMRT

Table 6: Rank summation index of the evaluated maize varieties across 0 and 30 kg N ha^{-1}

Cultivar	Grain yield (Kg/ha)	Anthesis silking interval (days)	Plant aspect (1 – 9)	Stray green (1 – 9)	Ear aspect (1 – 9)	Rank sum
Pioneer 30Y87	3,530.5	4.0	3.7	3.4	3.6	7
Sammaz 52	2,333.8	3.1	5.0	4.7	4.7	12
SC 719	2,485.3	5.2	5.2	4.6	5.5	19
Oba 98	2,191.5	4.1	5.2	4.6	5.2	19
Kapam 6	1,729.6	4.6	5.1	4.9	5.4	25
Sammaz 27	1,805.7	4.0	5.7	5.3	5.7	29
Oba Super 6 (local check)	1,824.7	5.4	5.4	4.8	5.5	29

Table 7: Low N base index of the evaluated maize cultivars across 0 and 30 kg N ha^{-1}

Cultivar	Grain yield (Kg/ha)	Number of ears per plant	Ear aspect (1-9)	Stay green (1-9)	Anthesis-silking interval (days)	Plant aspect (1 – 9)	Low N base index
Pioneer 30Y87	3530.5	0.7	3.6	3.4	4	3.7	9.78
Sammaz 52	2333.8	0.7	4.7	4.7	3.1	5	1.32
Oba 98	2191.5	0.8	5.2	4.6	4.1	5.2	0.09
SC 719	2485.3	0.8	5.5	4.6	5.2	5.2	-0.77
Sammaz 27	1805.7	0.9	5.7	5.3	4	5.7	-2.36
Oba Super 6	1824.7	0.8	5.5	4.8	5.4	5.4	-3.79
Kapam 6	1729.6	0.7	5.4	4.9	4.6	5.1	-3.96
Mean	2281.7	0.8	5.1	4.6	4.3	5.0	
Stdev	626.0	0.1	0.7	0.6	0.8	0.6	

Stdev = Standard deviation

Table 8: Correlation coefficients (r) between yield and other agronomic traits of the evaluated maize cultivar across 0 and 30 kg N ha^{-1}

	Grain yield (kg/ha)	Number of days to anthesis (days)	Number of days to silking (days)	Anthesis-Silking interval (days)	Plant height (cm)	Ear height (cm)	Plant Aspect (1 – 9)	Stay green (1 - 9)	Root lodging (%)	Stalk lodging (%)	Husk Cover (1 -5)	Number of ears per plant
Number of days to anthesis	-0.23^{**}											
Number of days to silking	-0.32^{***}	0.75^{***}										
Anthesis-silking interval	-0.20^{*}	-0.09	0.58^{***}									
Plant height	0.43^{***}	-0.00	-0.02	-0.03								
Ear height	0.53^{***}	-0.03	-0.02	0.00	0.72^{***}							
Plant Aspect	-0.40^{***}	-0.11	0.20^{*}	0.43^{***}	-0.05	-0.07						
Stay green	-0.34^{***}	-0.12	-0.06	0.06	0.05	0.08	0.30^{***}					
Root lodging	-0.10	-0.35^{***}	-0.32^{***}	-0.06	0.08	0.04	0.09	0.19^{*}				
Stalk lodging	-0.16^{*}	-0.01	-0.20^{*}	-0.28^{**}	-0.09	-0.18^{*}	0.07	0.07	-0.11			
Husk Cover	-0.42^{***}	-0.12	-0.10	0.00	-0.18^{*}	-0.27^{**}	0.21^{**}	0.26^{**}	0.20^{*}	0.10		
Number of ears per plant	0.53^{***}	-0.07	-0.17^{*}	-0.17^{*}	0.07	0.17^{*}	-0.31^{***}	-0.21^{**}	-0.17^{*}	-0.1	-0.31^{***}	
Ear Aspect	-0.55^{***}	0.0	0.33^{***}	0.50^{***}	-0.10	-0.18^{*}	0.71^{***}	0.31^{***}	0.14	0.04	0.31^{***}	-0.36^{***}

$^{*, **, ***}$ Significant at 0.05, 0.01 and 0.001 probability levels, respectively