ASEAN
Journal of Scientific and Technological Reports
Online ISSN:2773-8752

Research article

Varietal Performance of Hybrid Corn Fertilized with Ammonium Fertilizers in an Alkaline Soil Under Drought Conditions

Sheryl Eden Gay Puyod[1], and Pet Roey Pascual[2]

[1] Graduate School, Cebu Technological University-Barili Campus, Barili, Cebu, Philippines
[2] Agribusiness and Development Communication, Cebu Technological University-Barili Campus, Barili, Cebu, Philippines
* Correspondence: sherylpuyod@gmail.com

Citation:
Puyod, S.E.G.; Pascual, P.R. Varietal performance of hybrid corn fertilized with ammonium fertilizers in an alkaline soil under drought conditions. *ASEAN J. Sci. Tech. Report.* **2025**, *28*(4), e257403. https://doi.org/10.55164/ajstr.v28i4.257403.

Article history:
Received: January 7, 2025
Revised: June 1, 2025
Accepted: July 1, 2025
Available online: July 25, 2025

Abstract: Nitrogen is a vital nutrient that becomes a growth-limiting factor in alkaline soils. Opting for high-quality ammonia fertilizer ensures that crops receive optimal nutrition, tailored to their specific requirements, and facilitates the easier absorption and utilization of nutrients by the soil. A field experiment was conducted to determine the response of corn varieties in alkaline soil applied with different ammonium fertilizers in terms of growth, yield, and physicochemical characteristics. The study was laid out in Randomized Complete Block Design looking into four varieties; two high yielding and two low yielding, applied with two kinds of ammonia fertilizer: di-ammonium phosphate (18-46-0, 187.5 grams/linear meter) and ammonium sulfate (21-0-0, 225 grams/linear meter) based on the 90 N recommended rate. To supplement the P and K requirement, 10 t/ha of organic fertilizer was applied to all treatments. Regarding the high-yielding varieties, one favored ammonium sulfate fertilization in terms of plant height (185.10 ± 0.59 cm), days to silking (57.70 ± 6.05 days), and tasseling (51.83 ± 0.66 days), as well as total soluble solids (1.53 ± 0.08 Brix). The other favored di-ammonium phosphate fertilization in terms of ear weight (118.21 ± 13.91 g/ear), grain weight (98.42 ± 6.35 g/ear), and ear diameter (4.09 ± 0.16 cm). On the other hand, neither of the low-yielding varieties was affected by the type of ammonium fertilizer, except for titratable acidity (34.50 ± 0.49%). Showing, therefore, high-yielding varieties being more responsive to the type of ammonium fertilizer.

Keywords: Ammonium sulfate; di-ammonium phosphate; total soluble solids; hybrid corn; drought

1. Introduction

Corn (*Zea mays* L.) ranks as one of the world's most essential crops and is regarded as the leading cereal cultivated in tropical and subtropical regions [1]. This crop holds significant economic value as it provides a rich source of energy, minerals, vitamins, and essential amino acids [2]. Corn is primarily utilized as food for humans, animal feed, seed, and as an industry in its own right, with around 20% of the population consuming it. It serves as the main component in animal feed production, making up roughly 60-70% of feed ingredients, and is also used in various food and industrial products [3]. More importantly, corn provides a livelihood for 600,000 small farming families [4].

Alkaline soils, which have a high pH, can limit nutrient absorption, posing a challenge to achieving optimal crop yields. Using high-quality fertilizers based on ammonia ensures that crops receive the optimal nutrition for their specific requirements and enables the soil to absorb and utilize these nutrients efficiently. Nitrogen is frequently a limiting factor for plant growth in both natural ecosystems and agricultural crop production. Ammonium plays a crucial role in the assimilation of nitrogen into organic compounds, regardless of whether the nitrogen comes from ammonium absorption, nitrate reduction, or nitrogen fixation [5]. Effective management of nitrogen fertilization is crucial for both productivity and profitability. However, the existing fertilization system results in the loss of about 60 to 70% of the nitrogen applied [6]. These losses are attributed to various factors, including the type of nitrogen fertilizer, application method, varietal differences, soil characteristics, and cropping systems [7].

This study was conducted to determine how varieties grown under alkaline soil respond to different ammonium fertilizers.

2. Materials and Methods

2.1 Site Description

The study was conducted in the experimental area of Cebu Technological University-Barili Campus, situated approximately 10° 7 57.96′ N latitude, 123° 32′41.2′ E longitude. The experimental area has alkaline soils with distinct physical and chemical characteristics that impact crop performance and nutrient status. The color of soils ranges from dark brown to yellowish brown, with significant differences in consistency between wet and dry states—hard and compact when dry but plastic and sticky when wet. The soils contain high clay content of 46–70% and retain a water-holding capacity of more than 40%. They are alkaline with pH values always above 7.5 [8]. The field experiment was conducted from March to June 2024. This period in Cebu, Philippines, was marked by progressively worsening drought conditions, which are typical for the dry season. During March, temperatures were between 25°C and 31°C, with moderate rains amounting to around 103mm spread over only8 days, suggesting unpredictable precipitation patterns. April showed the beginning of drought stress conditions with temperatures increasing to their peak at 32°C, accompanied by considerably low rainfall of about 81 mm within just 7 days. This was a 21% drop in precipitation from March and defined water-limiting conditions. May witnessed the increase in drought stress with temperatures going into their peak season at 33°C. Even as rainfall rose to 127–147 mm over 8–9 days, the high temperatures and high evapotranspiration levels formed high water deficit conditions. The patches of rainfall formed instances of intense water stress during the inter-catch intervals. June maintained the drought trend with a prolonged high of 30°C, which was very warm for the area. Though a 65% daily average probability of rain, rainfall during the growing season averaged just 11.6 mm per day, which caused cumulative drought stress during the season [9]. These conditions were natural drought conditions for assessing hybrid corn performance in alkaline soils.

2.2 Experimental Design and Treatment

The study was conducted using a Randomized Complete Block Design with three replications. Four varieties of corn were tested, two high-yielding and two low-yielding. The high-yielding and low-yielding designation of the varieties was performed based on past yield performance. These were:

High-yielding 1- A genetically engineered hybrid corn with high grain yield potential (Generally 8–10 t/ha), featuring drought tolerance and excellent stalk strength.

High-yielding 2- A top-performing hybrid type with a yield potential of over 9 t/ha, tolerance to key pests and diseases, and excellent dryland adaptation.

Low-yielding 1 – An open-pollinated variety (OPV) with comparatively low yields (3–5 t/ha) often used for local consumption, with average yield potential and long maturity duration.

Low-yielding 2 – A conventional type with average yield performance (2.5–4 t/ha), adapted to marginal conditions but with lower productivity when under stress.

The experiment was conducted to evaluate the varietal performance of corn under alkaline soil conditions through the application of two ammonium-based fertilizers: Di-ammonium phosphate (DAP, 18-46-0) and Ammonium sulfate (AS, 21-0-0).

To provide balanced nutrition and fulfill the phosphorus (P) and potassium (K) needs of the crop, 10 t/ha of fully decomposed poultry manure was basally and uniformly applied to all treatments before sowing.

2.3 Preparation and Application of Fertilizer

Poultry manure was selected because of its high nutrient concentration and availability in the study region. The fertilizer was obtained from a nearby poultry farm and dried in sunlight for seven days to lower the moisture level and reduce pathogen load. The dried material was crushed and sieved to present a uniform particle size before use. The nutrient content was constituted by: nitrogen (N): 4%; phosphorus (P_2O_5): 3.0%; and potassium (K_2O): 2.0%. Manure from poultry was broadcast uniformly by hand and mixed with the soil one week before planting to provide time for partial decomposition and mineralization of nutrients.

Fertilizers based on ammonium—diammonium phosphate (18-46-0) and ammonium sulfate (21-0-0-—were applied during the V8 corn growth stage based on the suggested rate of nitrogen application of 90 kg N/ha..

2.4 Plot Size and Planting Arrangement

Each experimental unit was 5 linear meters long with 20 corn plants. One treatment involved a single 5-meter row. Row planting was used to allow for even spacing and ease of data collection. Each of the 5 meters wide by 16 meters long blocks consisted of eight treatments. The experiment was based on the Randomized Complete Block Design (RCBD) with three replications. Therefore, each block had all eight treatments in a randomly arranged manner, and the whole experiment was repeated three times

2.5 Land Preparation

The field was cleared by cutting all grasses and other vegetation, and was plowed to a depth of 15 to 20 cm. Plowing was done twice, followed by harrowing, which was alternated weekly to pulverize the soil, promote weed seed germination, and allow for their eventual removal. After the final harrowing, furrows were made 50 cm apart.

2.6 Seed Preparation and Sowing

Seeds were obtained from trusted sources and soaked in coconut water for 24 hours before sowing. Following the soaking process, the seeds were sown directly into the field at a rate of 2 to 3 seeds per hill. One week after emergence, the plants were thinned to one seedling per hill to ensure optimal growth conditions.

2.7 Management and Pest Control

The corn was watered daily, and weeding was carried out throughout the study period. Cartap hydrochloride was applied as a last resort to control insect pests during the reproductive growth stage of the target pests. Harvesting was done at the physiologically mature stage, 120 days after planting (DAP).

2.8 Data Gathered

The data of the following parameters were collected in this study:

- Plant height (cm)- measured with a tape measure from the base of the plant to the base of the tassel at 30 DAP and 60 DAP
- Days to tasseling- recorded by counting the number of days from sowing until 85% of the plants had developed tassels
- Days to silking- recorded by counting the number of days from sowing until 85% of the plants had developed silks.
- Ear weight and weight of grains/ear- weighed using a digital balance to measure the ear and the grains.
- Ear diameter (cm)- measured with a caliper at the ear's broadest point, usually around the center.
- Total Soluble Solids (TSS, °Brix)- five grams of blended kernels homogenized with 50mL distilled water were measured by digital refractometer (Hanna brand, HI-96801, USA)
- Titrability acid (%)- five ml of juice from blended samples prepared from TSS diluted with 45ml distilled water was measured and put into an Erlenmeyer flask and added with 2 drops of 1% phenolphthalein indicator, this was titrated with 0.1% NaOH until paint pink color was achieved using a Cordial 1642TF Glass burette and the volume of NaOH was recorded. TA was calculated as described by [10].

3. Results and Discussion

3.1 Agronomic Characteristics

The agronomic characteristics of the combined effect of variety and fertilizer showed that at 30 and 60 DAP, high-yielding variety 1 (V1) fertilized with Ammonium sulfate (F2) produced the tallest plant height, with a height of 95.15 cm and 185.10 cm which is significantly taller compared to those fertilized with Di- ammonium Phosphate (F1) (Table 1). These findings concur with those reported in [11], which demonstrated that maize treated with ammonium sulfate exhibited increased plant height. Furthermore, applying ammonium sulfate increased the heights of maize plants compared to those applied with other ammonium fertilizers [12].

Table 1. Plant Height at 30 and 60 Days after Planting as Affected by Ammonium Fertilization and Corn Varieties.

Varieties	Ammonium Fertilizers			
	Di-ammonium Phosphate (F1)	Ammonium Sulfate (F2)	Di-ammonium Phosphate (F1)	Ammonium Sulfate (F2)
	30 DAP	30 DAP	60 DAP	60 DAP
High-yielding 1 (V1)	87.38^{c}	95.15^{a}	170.75^{c}	185.10^{a}
High-yielding 2 (V3)	83.15^{d}	89.50^{b}	169.80^{d}	179.25^{b}
Low-yielding 1 (V2)	72.63^{f}	74.73^{e}	146.67^{f}	154.44^{e}
Low-yielding 2 (V4)	74.50^{e}	76.01^{g}	150.40^{g}	150.51^{g}
CV (%)	1.30		0.95	

Moreover, high-yielding variety 1 (V1) fertilized with Ammonium Sulfate (F2) also exhibited a faster time to tassel (51.83 days) and silk (57.70 days), indicating earlier development (**Table 2**). Ammonium Sulfate (F2) fertilization resulted in superior agronomic performance across all varieties compared to Di-ammonium Phosphate (F1). The high-yielding varieties, particularly variety 1 (V1), showed the most significant positive response, demonstrating the highest plant height and the earliest time to silk and tassel. The results suggest that the choice of ammonium fertilizer plays a critical role in optimizing corn performance, especially in challenging soil conditions. Ammonium sulfate provides critical plant nitrogen and sulfur nutrients compared with other N fertilizers, such as urea, diammonium phosphate, and ammonium nitrate [13]. Sulfur (S) is an essential element for crops and is vital to ensuring food security [14]. It plays a vital role in many physiological processes.

Such as photosynthesis, enzyme regulation, protein and lipid synthesis, stress resistance, and other metabolic pathways [15-19].

Table 2. Days to Tasseling and Silking as Affected by Ammonium Fertilization and Corn Varieties.

Varieties	Ammonium Fertilizer			
	Di-ammonium Phosphate (F1)	Ammonium sulfate (F2)	Di-ammonium Phosphate (F1)	Ammonium sulfate (F2)
	Days to Tasseling		Days to Silking	
High-yielding 1 (V1)	53.43^{g}	51.83^{h}	64.97^{f}	57.70^{g}
High-yielding 2 (V3)	57.67^{e}	55.90^{f}	69.50^{e}	68.40^{e}
Low-yielding 1 (V2)	69.82^{a}	68.60^{ab}	78.30^{a}	70.67^{d}
Low-yielding 2 (V4)	62.53^{d}	65.60^{c}	72.53^{c}	76.27^{b}
CV (%)	1.07		0.89	

3.2 Yield Performance

The result showed that high yielding variety 2 (V3) fertilized with Di-ammonium Phosphate (F1) resulted to highest ear weight (118.21 g/ear), heaviest grain weight (98.42 g/ear) and largest ear diameter (4.09 cm), suggesting this combination exhibit the most excellent responsiveness to ammonium fertilization, leading to superior ear and grain weights as well as larger ear diameters (**Table 3**). This agrees with the findings of other studies that the increased yield of maize cultivar is due to the nitrogen and phosphorus held by the doses of Di-Ammonium Phosphate (DAP) [20]. The cultivar receiving DAP fertilizer significantly produced heavier fresh and dry weights. Nitrogen is an integral component of many compounds, associated with photosynthetic activity and a major yield-determining factor required for maize production [21]. Its quantity availability during the growing season is crucial for the highest possible yield of maize. Phosphorus is another essential nutrient required to increase maize yield; the lack of phosphorus is as significant as the lack of nitrogen in limiting maize performance [22]. Phosphorus is essential for grain formation, ripening, and the reproductive parts of the maize plant [23].

Table 3. Yield Performance as Affected by Ammonium Fertilization and Corn Varieties.

	Ear Weight (g/ear)		Grain Weight (g/ear)		Ear Diameter	
	Di-ammonium Phosphate (F1)	Ammonium sulfate (F2)	Di-ammonium Phosphate (F1)	Ammonium sulfate (F2)	Di-ammonium Phosphate (F1)	Ammonium sulfate (F2)
High-yielding 1 (V1)	109.17^{b}	102.98^{d}	83.93^{b}	77.41^{d}	3.96^{ab}	3.89^{b}
High-yielding 2 (V3)	118.21^{a}	107.13^{bc}	98.42^{a}	80.07^{c}	4.09^{a}	3.71^{cd}
Low-yielding 1 (V2)	89.90^{e}	81.22^{f}	70.92^{f}	63.37^{g}	3.60^{d}	3.67^{d}
Low-yielding 2 (V4)	85.15^{fg}	77.08^{g}	76.18^{e}	54.43^{h}	3.83^{bc}	3.43^{e}
CV (%)	5.50		6.39		2.12	

3.3 Physico-chemical Properties

The results indicate that high-yielding variety 1 (V1) fertilized with Ammonium Sulfate (F2) promotes higher TSS but harms the low-yielding varieties (V2 and V4). This conforms to other studies that the highest TSS of fruit was obtained by using ammonium sulfate. Mineral nutrient, especially sulfur and nitrogen supplied by ammonium sulphate, promotes the photosynthetic rate of the chloroplast, phloem transport of photosynthates to sink tissues, and finally improve the quality and yield of the fruit, which is associated with high sugar content [24]. In contrast, fertilizing Di-ammonium Phosphate (F1) leads to higher TA levels, particularly in the low-yielding variety 2 (V4), which shows an exceptionally high TA content. This suggests that while Ammonium Sulfate may enhance sugar content, Di-ammonium Phosphate tends to promote greater acid accumulation, potentially affecting the flavor and storage characteristics of the corn varieties. Phosphorus from fertilizers like DAP can enhance the production of organic acids in plants. The increased production of organic acids can raise the acidity level in certain plant tissues, which may extend to fruits or kernels, such as corn [25].

Table 4. Physico-chemical Properties as Affected by Ammonium Fertilization and Corn Varieties.

	Ammonium Fertilizers			
	Di-ammonium Phosphate (F1)	**Ammonium sulfate (F2)**	**Di-ammonium Phosphate (F1)**	**Ammonium sulfate (F2)**
Varieties	TSS		TA	
High-yielding 1 (V1)	1.17^{b}	1.53^{a}	22.67^{a}	15.20^{b}
High-yielding 2 (V3)	0.47^{e}	0.67^{d}	27.67^{a}	13.63^{bc}
Low-yielding 1 (V2)	0.83^{c}	0.23^{fg}	16.90^{b}	11.17^{c}
Low-yielding 2 (V4)	0.30^{f}	0.10^{g}	34.50^{a}	24.50^{a}
CV (%)	13.3		14.9	

4. Conclusions

High-yielding varieties are more sensitive to the type of fertilizer, which affects either growth or yield characteristics. Ammonium sulfate fertilizer affects mainly plant growth and the soluble solid content. While di-ammonium phosphate fertilizer greatly influences yield and yield components. However, the type of nitrogen fertilizer employed has less of an impact on low-yielding maize cultivars.

5. Acknowledgements

The authors wish to acknowledge the support provided by Department of Science and Technology-Science Education Institute-STRAND-N Scholarship and Cebu Technological University-Barili Campus Graduate School.

Author Contributions: Conceptualization, P.R.P.; methodology, S.E.G.P.; software, S.E.G.P., and P.R.P.; validation, S.E.G.P.; formal analysis, S.E.G.P.; investigation, S.E.G.P.; resources, S.E.G.P.; data curation, S.E.G.P.; writing- original draft preparation, S.E.G.P.; writing- review and editing, S.E.G.P., and P.R.P.; visualization, S.E.G.P.; supervision, P.R.P.; project administration, S.E.G.P.; funding acquisition, S.E.G.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research was made possible through the support of the Department of Science and Technology- Science Education Institute (DOST-SEI) under the STRAND-N Scholarship Program, and the Graduate School of Cebu Technological University- Barili Campus.

Conflicts of Interest: The author declares no conflict of interest , as the funding agency did not influence the study's design, methodology, data analysis, or conclusions.

References

[1] Mahmood, Y. A.; Ahmed, F. W.; Mohammed, I. Q.; Wheib, K. A. Effect of Organic, Mineral Fertilizers, and Foliar Application of Humic Acid on Growth and Yield of Corn (Zea mays L.). *Indian J. Ecol.* **2020**, *47*(10), 39-44.

[2] Hossain, M. S.; Majumder, A. K. Impact of Climate Change on Agricultural Production and Food Security: A Review on Coastal Regions of Bangladesh. *Int. J. Agric. Res. Innov. Technol.* **2018**, *8*(1), 62-69. http://dx.doi.org/10.22004/ag.econ.305449

[3] Loy, D. D.; Lundy, E. L. Nutritional Properties and Feeding Value of Corn and Its Coproducts. In *Corn*; AACC International Press, **2019**; pp 633-659. https://doi.org/10.1016/B978-0-12-811971-6.00023-1

[4] Department of Agriculture - Bureau of Agricultural Research through the UPLB Foundation, Inc. in Collaboration with the Philippine Council for Agriculture and Fisheries. **2022**.

[5] Ohyama, T. Nitrogen as a Major Essential Element of Plants. *Nitrogen Assim. Plants* **2010**, *37*, 1-17. ISBN: 978-81-308-0406-4

[6] Morales, H.; Perfecto, I.; Ferguson, B. Traditional Fertilization and Its Effect on Corn Insect Populations in the Guatemalan Highlands. *Agric. Ecosyst. Environ.* **2001**, *84*(2), 145-155. https://doi.org/10.1016/S0167-8809(00)00200-0

[7] Wang, Q.; Li, F.; Zhao, L.; Zhang, E.; Shi, S.; Zhao, W.; Song, W.; Vance, M. M. Effects of Irrigation and Nitrogen Application Rates on Nitrate Nitrogen Distribution and Fertilizer Nitrogen Loss, Wheat Yield, and Nitrogen Uptake on a Recently Reclaimed Sandy Farmland. *Plant Soil* **2010**, *337*, 325-339. https://doi.org/10.1007/s11104-010-0530-z

[8] Enojada, G. R.; Asio, V. B. Morphological, Physical, and Chemical Characteristics of Soils Derived from Limestone Rocks in Barili, Cebu. *J. Agric. Technol. Manag.* **2018**.

[9] Wanderlog Weather (https://wanderlog.com/weather/188/6/cebu-city-weather

[10] Acedo, A. L., Jr.; Data, E. S.; Quevedo, M. A. Genotypic Variations in Quality and Shelf-Life of Fresh Roots of Philippine Sweet Potato Grown in Two Planting Seasons. *J. Sci. Food Agric.* **1996**, *72*(2), 209-212. https://doi.org/10.1002/(SICI)1097-0010(199610)72:2<209::AID-JSFA640>3.0.CO;2-N

[11] Sadak, S. M.; Abdelhamid, M. T.; Schmidhalter, U. Effect of Foliar Application of Amino Acids on Plant Yield and Some Physiological Parameters in Bean Plants Irrigated with Seawater. *Acta Biol. Colomb.* **2015**, *20*(1), 141-152.

[12] Siam, H. S.; Abd-El-Kader, M. G.; El-Alia, H. I. Yield and Yield Components of Maize as Affected by Different Sources and Application Rates of Nitrogen Fertilizer. *Res. J. Agric. Biol. Sci.* **2008**, *4*(5), 399-412. INSInet Publication

[13] Chien, S. H.; Gearhart, M. M.; Villagarcía, S. Comparison of Ammonium Sulfate with Other Nitrogen and Sulfur Fertilizers in Increasing Crop Production and Minimizing Environmental Impact: A Review. *Soil Sci.* **2011**, *176*(7), 327-335. https://doi.org/10.1097/SS.0b013e31821f0816

[14] Feinberg, A.; Stenke, A.; Peter, T.; et al. Reductions in the Deposition of Sulfur and Selenium to Agricultural Soils Pose Risk of Future Nutrient Deficiencies. *Commun. Earth Environ.* **2021**, *2*, 101. https://doi.org/10.1038/s43247-021-00172-0

[15] Bouranis, D. L.; Malagoli, M.; Avice, J.-C.; Bloem, E. Advances in Plant Sulfur Research. *Plants* **2020**, *9*(2), 256. https://doi.org/10.3390/plants9020256

[16] Droux, M. Sulfur Assimilation and the Role of Sulfur in Plant Metabolism: A Survey. *Photosynth. Res.* **2004**, *79*(3), 331-348. https://doi.org/10.1023/B:PRES.0000017196.95499.11

[17] Li, Q.; Gao, Y.; Yang, A. Sulfur Homeostasis in Plants. *Int. J. Mol. Sci.* **2020**, *21*(23), 8926. https://doi.org/10.3390/ijms21238926

[18] Narayan, O. P.; Kumar, P.; Yadav, B.; Dua, M.; Johri, A. K. Sulfur Nutrition and Its Role in Plant Growth and Development. *Plant Signal. Behav.* **2023**, *18*(1), 2030082. https://doi.org/10.1080/15592324.2022.2030082

[19] Kopriva, S.; Malagoli, M.; Takahashi, H. Sulfur Nutrition: Impacts on Plant Development, Metabolism, and Stress Responses. *J. Exp. Bot.* **2019**, *70*(16), 4069-4073. https://doi.org/10.1093/jxb/erz319

[20] Hussein, O. A. K.; Gadallah, A. F. I.; Ibrahim, M. E. M. Enhancement of Production and Quality of Sugarcane Using Nitrogen and Vinasses. *Egypt. Sugar J.* **2023**, *20*(0), 63-76. https://doi.org/10.21608/esugj.2023.215818.1040

[21] Khan, F.; Khan, S.; Hussain, S.; Fahad, S.; Faisal, S. Different Strategies for Maintaining Carbon Sequestration in Crop Lands. *Sci. Agric.* **2014**, *2*, 62-76

[22] Onasanya, R. O.; Aiyelari, O. P.; Onasanya, A.; Oikeh, S.; Nwilene, F. E.; Oyelakin, O. O. Growth and Yield Response of Maize (Zea mays L.) to Different Rates of Nitrogen and Phosphorus Fertilizers in Southern Nigeria. *World J. Agric. Sci.* **2009**, *5*(4), 400-407.

[23] Ibrahim, S. A.; Kandil, H. Growth, Yield, and Chemical Constituents of Corn (Zea Mays L.) as Affected by Nitrogen and Phosphorus Fertilization under Different Irrigation Intervals. *J. Appl. Sci. Res.* **2007**, *3*(10), 1112-1120. INSInet Publication

[24] Aryakia, E.; Roosta, H. R.; Rahmizade, N. Effects of Cow Manure, Ammonium Sulfate and Potassium Sulfate on Physico-Chemical Indices of Fruit and Leaf of Mazafati Date (Phoenix dactylifera L.). *J. Hortic.Sci.* **2017**, *31*(3), 457-468. https://doi.org/10.22067/jhorts4.v31i3.36474

[25] Fageria, N. K.; Baligar, V. C.; Li, Y. C. The Role of Nutrient-Efficient Plants in Improving Crop Yields in the Twenty-First Century. *J. Plant Nutr.* **2008**, *31*(6), 1121-1157. https://doi.org/10.1080/01904160802116068