The Pharma Innovation Journal 2022; 11(11): 1974-1978

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(11): 1974-1978

www.thepharmajournal.com
Received: 20-09-2022
Accepted: 24-10-2022

S Kaviyazhagan
Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

P Anandan
Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

P Stalin
Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Corresponding Author:
S Kaviyazhagan
Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India

Nitrogen scheduling and conjoined application of nano and granular urea on growth characters, growth analysis and yield of sweet corn (*Zea mays* var *saccharata*)

S Kaviyazhagan, P Anandan and P Stalin

Abstract
Field experiment was carried out at Chettikuttai Village of Harur taluk, Dharmapuri district, Tamil Nadu during July- October 2021 to study the "Nitrogen scheduling and conjoined application of nano as well as granular forms of urea in sweet corn (*Zea mays* var *saccharata*)". The soil of the experimental field was sandy clay loam in texture with a pH of 7.7. The experiment was laid out in randomized block design with ten treatments and replicated thrice. Among the different treatments, application of 25% N as granular urea (GU) at basal + 25% N as nano urea (NU) at 4 leaf stage + 25% N as nano urea at 8 leaf stage + 25% N as nano urea at tasseling stage (T_8) proved superiority by registering better growth characters like plant height (197.9 cm) and dry matter production (10567 kg ha^{-1}), growth analysis *viz.*, Leaf Area Index (LAI) (7.05), Crop Growth Rate (CGR) (10.58gm^{-2} day^{-1}), Absolute Growth Rate (AGR) (105.836 g plant^{-1} day^{-1}), Relative Growth Rate (RGR) (0.01690 g g^{-1} day^{-1}) and Net Assimilation Rate (NAR) (0.1420 g m^{-2} day^{-1}) and Green cob yield (8809 kg ha^{-1}) and Green fodder yield (13650 kg ha^{-1}). This was statistically comparable with the 20% N as granular urea at basal + 20% N as nano urea at 4 leaf stage + 40% N as nano urea at 8 leaf stage + 20% N as nano urea at tasseling stage (T_5). However, the treatment control (T_1- without N) registered low values on all the above traits.

Keywords: Sweet corn, nano urea, growth, yield, LAI, CGR, AGR, RGR and NAR

Introduction
Sweet corn (*Zea mays* var *saccharata*) also called as sugar corn is a type of maize with high sugar content belongs to the family poaceace, it is one of the warm season crop. It is a variety of maize, but it differs from all other type of corn because it produces and retains a high amount of sugar content in kernels (Zohair, 2010) [20]. Unlike field corn types, which are picked when the kernels are dried and completely matured, sweet corn varieties are harvested when the kernels are still in milky stage. Sweet corn is harvested when immature and eaten as a vegetable, rather than a grain (Carla *et al.*, 2021) [18]. There is a great scope for commercial sweet corn production due to increasing demand of sweet corn in the market. Sweet corn being a C_4 plant has enormous potential for cultivation and well responds to applied inputs. Generally corn as a typical cereal crop responds favorably to fertilizer application. The Plants require a specific amount of some nutrients in a specific form to be added in time for their growth and development (Sharma *et al.*, 2017) [15]. Nitrogen is an essential primary nutrient for plant growth. The most commonly used source of nitrogen is urea (46% N). However, soil nitrogen concentration is reduced due to leaching, use efficiency of nitrogen is also low in urea application (Subbaiya *et al*., 2012) [19].

The use of chemical fertilizers causes major environmental problems such as heavy metal accumulation in soil and plant systems (Abdel *et al.*, 2017) [1]. Therefore modern ideas of nano fertilizers are the most advanced technology in the way of supplying mineral nutrients to crops. Compared to chemical fertilizers their supplemental pattern of nutrients for plant needs minimizes leaching and improves fertilizer use efficiency (Subbarao *et al.*, 2013) [17]. Regarding N fertilizers, the application of nanotechnology can provide fertilizers that release N when crops need, It eventually leads to increase in N efficiency through decreases in N leaching and emissions and long-term incorporation by soil microorganisms (Davarpanah *et al.*, 2017) [9]. With this background, the current experiment was carried out to "study the Nitrogen scheduling and conjoined application of nano and granular forms of urea in sweet corn" with the following objective, to study the impact of nano urea on growth characters and yield of sweet corn.

Materials and Methods

During July-October, 2021 a field experiment was conducted in the farmer's field in Chettikuttai village of Harur Taluk, Dharmapuri District of Tamil Nadu. The experimental field was located at 12°8' North latitude and 78°32' East longitude with an altitude of +351.57 m above mean sea level. The texture of the experimental field soil was sandy clay loam in with a pH of 7.7. The soil was low in available nitrogen, medium in available phosphorus and potassium. The study used the popular sweet corn hybrid SUGAR-75. The experiment used randomised block design, with three replications and ten treatments. The treatment schedule were as follows: T_1 -Control (without N), T_2 -100% RDN (120 kg) as granular urea, T_3 -20% N as granular urea at basal + 20% N as granular urea at 4 leaf stage + 40% N as nano urea at 8 leaf stage + 20% N as nano urea at tasseling, T_4 -20% N as granular urea at basal + 20% N as granular urea at 4 leaf stage + 40% N as granular urea at 8 leaf stage + 20% N as nano urea at tasseling, T_5 -20% N as granular urea at basal + 20% N as nano urea at 4 leaf stage + 40% N as nano urea at 8 leaf stage + 20% N as nano urea at tasseling, T_6 -25% N as granular urea at basal + 25% N as granular urea at 4 leaf stage + 25% N as nano urea at 8 leaf stage + 25% N as nano urea at tasseling, T_7 -25% N as granular urea at basal + 25% N as granular urea at 4 leaf stage + 25% N as granular urea at 8 leaf stage + 25% N as nano urea at tasseling, T_8 -25% N as granular urea at basal + 25% N as nano urea at 4 leaf stage + 25% N as nano urea at 8 leaf stage + 25% N as nano urea at tasseling, T_9 -33% N as granular urea at basal + 34% N as granular urea at 8 leaf stage + 33% N as nano urea at tasseling and T_{10} -33% N as granular urea at basal + 34% N as nano urea at 8 leaf stage + 33% N as nano urea at tasseling. The seeds were dibbled at the rate of 12.5 kg ha^{-1} with the spacing of 60 × 20 cm.. Nano urea is foliar applied and granular urea is soil applied. The nutrition was applied as per treatment schedule Hand weeding was done at 20 DAS. Observations on growth attributes were recorded at 30, 60 DAS and at harvest and yield were recorded at harvest of sweet corn crop.

Results and Discussion

Growth characters

The conjoined application of nano urea and granular urea to sweet corn strongly influenced all growth characters. A thorough inspection of data revealed that, 25% N as GU at basal + 25% N as NU at 4 leaf stage + 25% N as NU at 8 leaf stage + 25% N as NU at tasseling stage (T_8) maximum plant heights (Table 1) of 99.2, 108.2 and 197.9 cm were observed at 30, 60 DAS and at harvest respectively, as well as dry matter production

(Table 1) of 4805, 7980 and 10567 kg ha^{-1} at 30, 60 DAS and at harvest. Foliar application of Nano fertilizer could improve growth of crops. Soil application methods allowed nutrients to enter plants through root hairs, lenticels, mucilage and exudates while foliar application of nano fertilizer is a beneficial method as it easily penetrated through stomata, hydathodes and trichomes, later transported to all parts of the plant via phloem pathway. Nano fertilizer extended the duration of nutrient release to the plant, enhances the absorption of nutrients, increase the accumulation of nitrogen in the plant, also balances the nutrient loss results in more plant height (Adibah *et al*., 2020) [3].

The dry matter production depends upon the photosynthetic ability and nutrient use efficiency of the plant. Here the combined application of conventional fertilizers and effect of nano fertilizers, all the growth characters were increased significantly. That the nano fertilizers released regularly according to the plant's need without leaching or infiltration compared with traditional fertilizers improved plant height and dry biomass. These findings were consistent with those of Vafa *et al*. (2015) [18], Abdel-Aziz *et al*. (2018) [2], and Alzreejawi and Al-Juthery, (2020) [7].

Growth analysis

Application of 25% N as granular urea at basal + 25% N as nano urea at 4 leaf stage + 25% N as nano urea at 8 leaf stage + 25% N as nano urea at tasseling stage (T_8) maximum values of growth analysis *viz.*, LAI (Table 2), CGR (Table 2), AGR (Table 3), RGR (Table 3) and NAR (Table 3). This could be because the foliar application of nano sources of nutrient considerably improved the leaf nutrient content and consequently increased the meristematic activities and cell elongation associated with protein synthesis of leaves make a pathway to produce more functional leaves and photosynthetic activity for a longer period of time and thereby contributing higher LAI (Alyasari *et al.*, 2019) [6].

The superior crop growth rate, relative growth rate and net assimilation rate was due to the fact that nano nutrients supplied through foliage has mobilised more efficiently by the plant resulting in enhanced growth attributes and ultimately enhanced the crop growth rate, relative growth rate and net assimilation rate. Furthermore, the increase in dry matter accumulation with foliar applications of nano N nutrient resulted in the ready availability of nutrients at critical period of crop demand. The above results are also in conformity with the findings of Egli, (2019) [10] and Alimamy *et al.,* (2022) [5].

Yield

The experimental results presented in Table 4 indicate that, Nano urea application has resulted significant changes in green cob yield (8809 kg ha^{-1}) and green fodder yield (13650 kg ha^{-1}). The conjoined application of 25% N as granular urea at basal + 25% N as nano urea at 4 leaf stage + 25% N as nano urea at 8 leaf stage + 25% N as nano urea at tasseling stage (T_8) results in highest production of green cobs and green fodder over the rest of the treatments. Increase in yields of sweet corn due to foliar application of nano N was due to increased growth parameters *viz*. plant height and dry matter accumulation in plants which ultimately resulted in higher yield. This could be attributed by nano particles their distinctive, unique behavior and characteristics due to their smallness, high surface area and their ability to increase their absorption speed. Increased enzymatic activity as well as increase in the speed of biochemical reactions when it is at the nano scale level (Alamery *et al*., 2019) [4], (Lateef *et al*., 2019) [13] and (Zahraa and Ahmed, 2020) [19].

It can be concluded that 100% RDN (120 kg N ha^{-1}) applied in three equal splits followed by foliar application of along with full recommended dose of P and K (60:45 kg ha^{-1}) improved yield of sweet corn (Patel *et al*., 2021) [17]. The results showed that the application of mineral fertilizer in soil and nano fertilizers as foliar spray leads to the increase in the yield of sweet corn. The present results are confirmed with those of (Gomaa *et al.*, 2017) [12], (Muntasser *et al.,* 2019) [14], (Elavarasan *et al.*, 2021) [11].

Table 1: Effect of nano and granular urea on growth characters at different stages of sweet corn

Treatments	Plant height (cm)			Dry matter production (kg ha^{-1})		
	30 DAS	60 DAS	AT Harvest	30 DAS	60 DAS	AT Harvest
T_1 - Control (without N)	54.8	91.8	104.0	2400	3530	4416
T_2 - 100% RDN as Granular urea	63.7	105.0	120.7	2780	4309	5562
T_3 -20% N as GU at basal + 20% N as GU at 4 leaf stage + 40% N as NU at 8 leaf stage + 20% N as NU at tasseling	88.1	152.1	175.5	4110	6702	8824
T_4 -20% N as GU at basal + 20% N as GU at 4 leaf stage + 40% N as GU at 8 leaf stage + 20% N as NU at tasseling	75.0	126.0	147.8	3340	5422	7100
T_5 - 20% N as GU at basal + 20% N as NU at 4 leaf stage + 40%N as NU at 8 leaf stage +20% N as NU at tasseling	98.7	171.7	195.6	4657	7700	10199
T_6 -25% N as GU at basal + 25% N as GU at 4 leaf stage + 25% N as NU at 8 leaf stage + 25% N as NU at tasseling	90.5	157.5	180.2	4290	6990	9200
T_7 -25% N as GU at basal + 25% N as GU at 4 leaf stage + 25% N as GU at 8 leaf stage + 25% N as NU at tasseling	77.3	132.3	152.3	3502	5680	7450
T_8 -25% N as GU at basal + 25% N as NU at 4 leaf stage + 25% N as NU at 8 leaf stage + 25% N as NU at tasseling	99.2	180.2	197.9	4805	7980	10567
T_9 -33% N as GU at basal + 34% N as GU at 8 leaf stage + 33% N as NU at tasseling	72.6	120.6	140.2	3163	5150	6755
T_{10} -33% N as GU at basal + 34% N as NU at 8 leaf stage + 33% N as NU at tasseling	86.4	147.4	171.1	3941	6616	8720
SEm±	2.54	4.37	4.68	121.36	201.7	252.05
CD at 5%	7.5	12.9	14.8	361.13	599.28	748.88

Table 2: Effect of nano and granular urea on LAI and CGR at different stages of sweet corn

Treatments	LAI			CGR (g m^{-2} day^{-1})	
	30 DAS	60 DAS	AT Harvest	30-60 DAS	60 DAS-Harvest
T_1 - Control (without N)	2.20	2.90	3.60	3.77	3.54
T_2 - 100% RDN as Granular urea	2.85	3.63	4.19	5.10	5.01
T_3 -20% N as GU at basal + 20% N as GU at 4 leaf stage + 40% N as NU at 8 leaf stage + 20% N as NU at tasseling	4.27	5.72	5.89	8.64	8.49
T_4 -20% N as GU at basal + 20% N as GU at 4 leaf stage + 40% N as GU at 8 leaf stage + 20% N as NU at tasseling	3.53	4.66	4.90	6.94	6.71
T_5 - 20% N as GU at basal + 20% N as NU at 4 leaf stage + 40%N as NU at 8 leaf stage +20% N as NU at tasseling	4.71	6.30	6.95	10.14	10.00
T_6 - 25% N as GU at basal + 25% N as GU at 4 leaf stage + 25% N as NU at 8 leaf stage + 25% N as NU at tasseling	4.28	5.80	6.20	9.00	8.84
T_7 -25% N as GU at basal + 25% N as GU at 4 leaf stage + 25% N as GU at 8 leaf stage + 25% N as NU at tasseling	3.74	4.81	5.19	7.26	7.08
T_8 - 25% N as GU at basal + 25% N as NU at 4 leaf stage + 25% N as NU at 8 leaf stage + 25% N as NU at tasseling	4.85	6.58	7.05	10.58	10.35
T_9 - 33% N as GU at basal + 34% N as GU at 8 leaf stage + 33% N as NU at tasseling	3.42	4.39	4.76	6.62	6.42
T_{10} -33% N as GU at basal + 34% N as NU at 8 leaf stage + 33% N as NU at tasseling	4.19	5.58	5.83	8.92	8.41
SEm±	0.12	0.16	0.17	0.27	0.29
CD at 5%	0.36	0.48	0.51	0.81	0.87

Table 3: Effect of nano and granular urea on AGR, RGR and NAR at different stages of sweet corn

Treatments	AGR (g m^{-2} day^{-1})		RGR (g plant^{-1} day^{-1})		NAR (g g^{-1} day^{-1})	
	30-60 DAS	60 DAS-Harvest	30-60 DAS	60 DAS-Harvest	30-60 DAS	60 DAS-Harvest
T_1 - Control (without N)	37.67	35.44	0.01287	0.00896	0.012386	0.009126
T_2 - 100% RDN as Granular urea	50.97	50.08	0.01463	0.01020	0.013178	0.010687
T_3 - 20% N as GU at basal + 20% N as GU at 4 leaf stage + 40% N as NU at 8 leaf stage + 20% N as NU at tasseling	86.40	84.88	0.01630	0.01100	0.014983	0.012191
T_4 -20% N as GU at basal + 20% N as GU at 4 leaf stage + 40% N as GU at 8 leaf stage + 20% N as NU at tasseling	69.40	67.12	0.01613	0.01080	0.014213	0.011723
T_5 - 20% N as GU at basal + 20% N as NU at 4 leaf stage + 40%N as NU at 8 leaf stage +20% N as NU at tasseling	101.43	99.96	0.01677	0.01124	0.015502	0.012558
T_6 - 25% N as GU at basal + 25% N as GU at 4 leaf stage + 25% N as NU at 8 leaf stage + 25% N as NU at tasseling	90.00	88.40	0.01627	0.01100	0.014995	0.012284
T_7 -25% N as GU at basal + 25% N as GU at 4 leaf stage + 25% N as GU at 8 leaf stage + 25% N as NU at tasseling	72.60	70.80	0.01613	0.01084	0.014226	0.011816

T_8 - 25% N as GU at basal + 25% N as NU at 4 leaf stage + 25% N as NU at 8 leaf stage + 25% N as NU at tasseling	105.83	103.48	0.01690	0.01125	0.015553	0.012566
T_9 - 33% N as GU at basal + 34% N as GU at 8 leaf stage + 33% N as NU at tasseling	66.23	64.20	0.01520	0.01084	0.014208	0.011698
T_{10} - 33% N as GU at basal + 34% N as NU at 8 leaf stage + 33% N as NU at tasseling	89.16	84.16	0.01643	0.01104	0.014840	0.012287
SEm±	2.71	2.93	0.00006	0.00004	0.00015	0.00004
CD at 5%	8.05	8.78	0.00021	0.00012	0.00049	0.00014

Table 4: Effect of nano and granular urea on green cob yield and green fodder yield of sweet corn

Treatments	Green cob yield (kg ha^{-1})	Green fodder yield (kg ha^{-1})
T_1 - Control (without N)	3928	7450
T_2 - 100% RDN as Granular urea	6145	10156
T_3 - 20% N as GU at basal + 20% N as GU at 4 leaf stage + 40% N as NU at 8 leaf stage + 20% N as NU at tasseling	7878	12430
T_4 - 20% N as GU at basal + 20% N as GU at 4 leaf stage + 40% N as GU at 8 leaf stage + 20% N as NU at tasseling	6934	11222
T_5 - 20% N as GU at basal + 20% N as NU at 4 leaf stage + 40%N as NU at 8 leaf stage +20% N as NU at tasseling	8714	13583
T_6 - 25% N as GU at basal + 25% N as GU at 4 leaf stage + 25% N as NU at 8 leaf stage + 25% N as NU at tasseling	8026	12602
T_7 - 25% N as GU at basal + 25% N as GU at 4 leaf stage + 25% N as GU at 8 leaf stage + 25% N as NU at tasseling	7029	11276
T_8 - 25% N as GU at basal + 25% N as NU at 4 leaf stage + 25% N as NU at 8 leaf stage + 25% N as NU at tasseling	8809	13650
T_9 - 33% N as GU at basal + 34% N as GU at 8 leaf stage + 33% N as NU at tasseling	6857	11150
T_{10} - 33% N as GU at basal + 34% N as NU at 8 leaf stage + 33% N as NU at tasseling	7765	12312
SEm±	226.06	314.39
CD at 5%	671.69	994.2

Conclusion

The present study provides a new finding of the nitrogen scheduling and conjoined application of granular and nano forms of urea on sweet corn. From the above study, it can be concluded that application of 25% N as GU at basal + 25% N as NU at 4 leaf stage + 25% N as NU at 8 leaf stage + 25% N as NU at tasseling stage increased the growth and yield could provide higher productivity and profitability for sweet corn growers of Tamil Nadu.

References

1. Abdel WMM, El-attar AB, Mahmoud AA. Economic evaluation of nano and organic fertilizers as an alternative source to chemical fertilizers on *Carum carvi* L. plant yield and components. Agriculture. 2017;63(1):33-49.
2. Abdel-Aziz HMM, Hasaneen MNA, Aya MO. Foliar application of nano chitosan NPK fertilizer improves the yield of wheat plants grown on two different soils. Egyptian Journal of Experimental Biology. 2018;14(1):63-72.
3. Adibah FSF S, Jahan, Md. Fatihah HNN. Betaine-rich Nano fertilizer improves growth parameters of *Zea mays var. saccharata and Arabidopsis* thaliana under salt stress. Bulgarian Journal of Agricultural Science. 2020;26(1):177–185.
4. Alamery AA, Lateef SM, Almosawy AN, Alhassaany MH, Almosawy MM. Effect of Phosphate Bio Fertilizers on Increasing the Efficiency of the Use of Phosphate Mineral Fertilizers and its Effect on some growth Properties of Broccoli (*Brassica oleracea var. italic*). Plant Archieves. 2019;18(2):2003-2007.
5. Alimamy Kamara S, Naresh Kumar, Ramesh Harit, Manoj Shrivastava, Bidisha Chakrabarti, Kalikinkar Bandyopadhyay. Influence of weather and nutrients (FYM, N and P) on RGR, LAD, NAR and CGR to determine the productivity of maize, wheat and green gram in a cropping system. Journal of Agrometeorology. 2022;24(1):26-32.
6. Alyasari JW, Safi MQ, Alamery AA, Abudahi YM, Jawad NN, Almosawy HM. Role of nano-particles fertilizers on growth of corn (*Zea mays* L.) c.v. 5018. IOP Conf. Series: Earth and Environmental Science; c2019. p. 388. doi:10.1088/1755-1315/388/1/012087.
7. Alzreejawi SAM, Al-Juthery HWA. Effect of Spray with Nano NPK, Complete Micro Fertilizers and Nano Amino Acids on Some Growth and Yield Indicators of Maize (*Zea mays* L.). IOP Conf. Series: Earth and Environmental Science; c2020. p. 553. doi:10.1088/1755-1315/553/1/012010.
8. Carla do Carmo Milagres, Paulo Cezar Rezende Fontes, July Anne Amaral de Abreu, José Maria da Silva, Mairon Neves de Figueiredo. Plant growth stage and leaf part to diagnose sweet corn nitrogen status using chlorophyll sensor and scanner image analysis**.** Journal of Plant Nutrition. 2021. DOI: 10.1080/01904167.2021.1921197.
9. Davarpanah S, Ali Tehranifar, Gholamhossein Davarynejad. Effects of Foliar Nano-nitrogen and Urea Fertilizers on the Physical and Chemical Properties of Pomegranate (*Punica granatum* cv. Ardestani) Fruits. Hortscience. 2017;52(2):288–294.
10. Egli DB. Crop growth rate and the establishment of sink size: a comparison of maize and soybean, Journal of Crop Improvement. 2019. DOI:10.1080/15427528.2019.1597797.
11. Elavarasan E, Ravikumar C, Sudhagar Rao GB, Senthilvalavan P, Manivannan R. Significance of Nano

N, P, K and $ZnSo_4$ fertilizers on soil fertility, nutrient uptake and yield of rice production. International Journal of Botany Studies. 2021;6(6):166-170.

12. Gomaa MA, Radwan FI, Kandil EE, Al- Challabi DHH. Comparison of some New Maize Hybrids Response to Mineral Fertilization and some Nanofertilizers. Alexandria Science Exchange Journal. 2017;38:506-514.
13. Lateef SM, Alamery AA, Alhassaany MH, Almosawy AN, Almosawy MM. Role of Bio Fertilizers and Phosphate levels on some growth and yield Properties of Broccoli (*Brassica oleracea* var *italica*). Plant Archives. 2019;19(2):1564-1568.
14. Muntasser Khudhur Sahi Al-Saray and Faiz Abdul Wahid Hamoud Al-Rubaee. Effect of Nano-Nitrogen and Manufacture Organic Fertilizer as Supplementary Fertilizer in the Yield and Its component For Three Synthetics Of Maize (*Zea mays* L.). Plant Archives. 2019;19:1473-1479.
15. Sharma A, Singh SV, Patel A, Yadav RA. Growth and yield of scented rice (*Oryza sativa* L.) as influenced by integrated nutrient management practices. Research on Crops. 2017;18:409-14.
16. Subbaiya R, Priyanka M, Selvam MM. Formulation of green nanofertilizer to enhance the plant growth through slow and sustained release of nitrogen. Journal of Pharmacy Research. 2012;5(11):5178-5183.
17. Subbarao CV, Kartheek G, Sirisha D. Slow release of potash fertilizer through polymer coating. International Journal of Applied science and engineering. 2013;11(1):25-30.
18. Vafa ZN, Sirousmehr AR, Ghanbari A, Khammari L, Falahi N. Effects of nano zinc and humic acid on quantitative and qualitative characteristics of savory (*Satureja hortensis* L.). International Journal of Biosciences. 2015;6(3):124–136.
19. Zahraa Mohsen Alassafi, Ahmed Najm Almosawy. Effect of optimus plus nanoparticles in some characteristics of the growth and yield of corn (*Zea mays* L.). Journal of Plant Archives. 2020;20(2):5455-5458.
20. Zohair Mahmoud Mirdad. Influence of Cultivars, Plant Spacings, and Mineral NPK Fertilizers Application on Vegetative Growth, Yield and Its Components and Kernels Quality of Sweet Corn (*Zea mays* var. *rugusa* L.). Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdulaziz University, Jeddah, Saudi Arabia; c2010.