IJPS INTERNATIONAL JOURNAL OF PLANT SCIENCES
ISSN-0973-1547 Volume 16 | AAEBSSD | 2021 | 17-22
DOI: 10.15740/HAS/IJPS/16.AAEBSSD/17-22
Visit us - www.researchjournal.co.in

RESEARCH ARTICLE

Effect of nano nitrogen on yield attributes of sweet corn (*Zea mays* Saccharata) and economics

■ I. Sarwar, V.B. Gedam, R.H. Shinde and A.S. Bade

SUMMARY

A field experiment was conducted at Agronomy Farm, RCSM College of Agriculture, Kolhapur (M.S.), India during *Kharif*, 2020 in black Vertisol soil using split plot design with four replications. The main plot factors consist of time of application *viz.,* T_1: 15 days after sowing (DAS), T_2: 30 DAS and T_3: 45 DAS and sub plot factors consist of doses of nano nitrogen (N) fertilizers *viz.,* N_1: 1.00 litre per ha, N_2: 1.25 litre per ha and N_3: 1.50 litre per ha making total nine treatment combinations. The results of main plot showed that length of cob (20.56 cm), diameter of cob (19.71 cm), weight of cob per plant (222.29 g), number of grains per cob (402.07), green cob yield per ha (138.32 q), green fodder yield per ha (359.75 q), protein content in grain (9.74%) and crude protein in stover (5.18%) were significantly maximum when foliar spray was done at 15 days after sowing (DAS). The gross monetary return (Rs. 5,93,172.04 ha^{-1}) and net monetary return (Rs. 3,78,016.10 ha^{-1}) were significantly maximum with foliar spray at 15 DAS (T_1) over later spraying at 30 DAS (T_2) and 45 DAS (T_3). While, in sub-plot length of cob (18.55 cm), diameter of cob (16.83 cm), weight of cob per plant (208.65 g), number of grains per cob (371.25), green cob yield per ha (125.96 q), green fodder yield per ha (344.39 q), protein content in grain (9.29%) and crude protein in stover (5.10%) were obtained from treatment N_3 (1.5 litre ha^{-1}) which was on par with treatment N_2 (1.25 litre ha^{-1}) and significantly superior over N_1 (1 litre ha^{-1}). The highest value of the gross monetary return (Rs. 5,80,827.23 ha^{-1}) and net monetary return (Rs. 3,59,534.55 ha^{-1}) were obtained from treatment N_3 (1.5 litre ha^{-1}) which was at par with treatment N_2 (1.25 litre ha^{-1}) and significantly superior over treatment N_1 (1.00 litre ha^{-1}).

Key Words : Sweet corn (Sugar-75), Nano-nitrogen (NN), Yield, Gross return, Net return, B:C ratio

How to cite this article : Sarwar, I., Gedam, V. B., Shinde, R.H. and Bade, A.S. (2021). Effect of nano nitrogen on yield attributes of sweet corn (*Zea mays* Saccharata) and economics. *Internat. J. Plant Sci.*, **16** (AAEBSSD): 17-22, **DOI: 10.15740/HAS/IJPS/16.AAEBSSD/17-22,**

Article chronicle : Received : 07.07.2021; **Revised :** 10.07.2021; **Accepted :** 15.07.2021

MEMBERS OF THE RESEARCH FORUM

Author to be contacted :
V. B. Gedam, Department of Agronomy, RCSM College of Agriculture, **Kolhapur (M.S.) India**
Email : vbgedam@gmail.com

Address of the Co-authors:
I. Sarwar, R.H. Shinde and A.S. Bade, Department of Agronomy, RCSM College of Agriculture, **Kolhapur (M.S.) India**

Maize (*Zea mays* L.) is one of the most versatile emerging crops having wider adaptability under diverse agro-climatic conditions. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the other cereals (Anonymous, 2017). Maize being the economical crop which make it the first choice for poor and underprivileged

population. Nutritional and clinical benefits of the maize if exploited well with the strategic interventions through value added maize product development, utilization and commercialization will support in ensuring better health of the Indian population. Availability of values added food products of maize on industrial level will ensure better nutritional and livelihood security. Commercialization, promotion and adoption of maize based values added food products will not only ensure higher return to farmers but also generate employment for women and youth with improved dietary diversity in food choices to the consumers (Muradia *et al.,* 2016). Among all the types of maize, sweet corn (*Zea mays* convar. *saccharata* var. rugosa; also called sugar corn and pole corn) is distinguished from other maize varieties by its delicious taste and high sugar content (14 - 20%), when cob is in milk or immature stage. Sweet corn is a good source of energy and about 20 per cent of the dry matter is sugar, compared with only 3 per cent in dent maize at ear stage (Kipps, 1959).

Nanotechnology is working with smallest possible particles which raise hopes for improving the agricultural productivity through encountering problems unsolved conventionally. The term "Nanotechnology" has originated from Greek word 'nanos' which means dwarf. Nanotechnology is defined as understanding and control of matter at dimensions of roughly 100nm, where unique physical properties make novel application possible (EPA, 2007). Nanotechnology is making its way in agriculture throughout the world. Traditional farming techniques have attained saturation and neither able to increase productivity nor able to restore ecosystems damaged by existing technologies. The global requirement of food is increasing rapidly. Nanotechnology would prove a boon for the modern agriculture farming by improving the efficiency of nutrient uptake employing nano-fertilizers, control of pest and pathogen using nano-pesticides etc (Manikandan *et al.*, 2018). The basis of work of the nano fertilizer is the rapid supply of the nutrients and increased the duration of the fertilizer effect. Nanotechnology has a significant impact on improving the solubility of other soil elements, displacing and replacing insoluble elements, reducing nutrient mineralization, increasing bioavailability and easily absorbed by the plants (Naderi and Danesh-Shahraki, 2013).

Keeping these aspects as maize or sweet corn being an important crop, demerits of mineral fertilizer and efficiency of nano fertilizer, a field experiment entitled "Standardization of nano nitrogen fertilizer for boosting the productivity of sweet corn (*Zea mays* Saccharata) in *Kharif* season" was conducted at PG Research Farm, RCSM College of Agriculture, Kolhapur, MH, India.

MATERIAL AND METHODS

The Kolhapur falls under the Sub-montane zone of NARP and is situated at an elevation of 548 meters above the mean sea level on 16^0 42'.548 North latitude and 74^0 14'.329 East longitudinal. The experimental plot was medium black clay (vertisol) with 90 cm depth, low in available Nitrogen (197.16 kg ha^{-1}), medium in available phosphorus (40.19 kg ha^{-1}) and very high available potassium (297.04 kg ha^{-1}). The status of organic carbon content (0.59%) was high. The electrical conductivity and pH values were 0.28 dSm^{-1} and 7.90, respectively. The experiment was carried out under split plot design with four replications and two factors, where main plot factors consist of time of application *viz.,* T_1: 15 days after sowing (DAS), T_2: 30 DAS and T_3: 45 DAS and sub plot factors consist of doses of nano nitrogen (NN) fertilizers *viz.,* N_1: 1.00 litre per ha, N_2: 1.25 litre per ha and N_3: 1.50 litre per ha making total nine treatment combinations. The variety sugar 75 was used for the experiment @ 15 kg ha^{-1}. The recommended dose of inorganic mineral fertilizers @ 120:60:40 NPK kg ha^{-1} was also given. The inorganic mineral fertilizers were applied as per the recommended dose, where in half dose of nitrogenous fertilizer and full dose of phosphatic and potassic fertilizers were applied at the time of sowing as basal dose. The gross and net plot size were 6.00 m × 4.00 m and 4.5 m × 3.2 m, respectively. The periodical observations of crop growth attributes and yield were recorded after seed emergence w.e.f. 30 DAS on 15 days interval upto harvest and at harvest *viz*., plant population, plant height (cm), number of functional leaves $plant^{-1}$, leaf area $plant^{-1}$ (dm^2), dry matter accumulation $plant^{-1}$(g), grain yield (q ha^{-1}) and stover yield (q ha^{-1}). The protein content in grain and stover were also calculated. The experimental data was statistically analyzed by using a standard method of "analysis of variance" as reported by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Yield:

The data in Table 1 showed that yield contributing characters of main plot like length of cob (20.56 cm), diameter of cob (19.71 cm), weight of cob per plant (222.29 g), number of grains per cob (402.07, green cob yield per ha (138.32 q) and green fodder yield per ha (359.75 q) were significantly maximum when spraying was done at 15 DAS (T_1) over later spraying at 30 DAS (T_2) and 45 DAS (T_3). While in the sub plot, the yield contributing character of sub plot *viz.,* length of cob (18.55 cm), diameter of cob (16.83 cm), weight of cob per plant (208.65 g), number of grains per cob (371.25), green cob yield per ha (125.96 q) and green fodder yield per ha (344.39 q) obtained from treatment N_3 (1.5 litre ha^{-1}) were maximum, which was on par with treatment N_2 (1.25 litre ha^{-1}) and significantly superior over N_1 (1 litre ha^{-1}). The reason may be high dose of nano nitrogen fertilizer gave more area for various metabolic process in the plant thereby increasing the rate of photosynthesis and its role in stimulating the enzyme involved in influencing these traits by increasing the activity of chemical reactions and reducing the impact of free radicles that negatively affect the efficiency of work of some organelles in the plant thus increasing the overall yield of crop was observed by (Sorooshzadah *et al.,* 2012). It may also be possible that the early application of the nano form of N fertilizer might have boosted the maize plant which began to depend more on photosynthesis than seed as food source after 15 days of sowing as also the other growth attributes have significantly influenced the from source to sink similar findings are noted by (Amuamuha *et al.,* 2012). There may be some another reason that higher dose of nano nitrogen fertilizer helped in increasing the size and efficacy of the source, which caused an increasing in the representation of nutrients that helped to form a good downstream and then a heaver grain weight (Sharifi and Namvar, 2016). Jian *et al.* (2008), Fan *et al.* (2012), Prasad *et al.* (2012), Morteza *et al.* (2013), Kole *et al.* (2013), Manikandan and Subramanian (2016), Hagab *et al.* (2018), Anupama *et al.* (2020) and Al-Juthery *et al.* (2019) reported similar findings.

Quality:

The Table 2 showed that main plot treatment, foliar spray at 15 DAS (T_1) has significantly higher per cent of protein content in grain (9.74%) and stover (5.18%) over spraying at 30 DAS (T_2) and 45 DAS (T_3). The least protein content was obtained when spraying was done at 45 DAS (T_3) which was on par with foliar spray at 30 DAS (T_2). While, in sub plot treatment N_3 (1.5 litre ha^{-1}) had maximum per cent of protein content which was on par with treatment N_2 (1.25 litre ha^{-1}) and superior over N_1 (1.00 litre ha^{-1}) for the protein content in grain (9.29%) and stover (5.10%). The least significant value of protein content was observed in N_1 (1.00 litre ha^{-1}). The reason may be high dose of nano nitrogen fertilizer provided more surface area and more availability of

Table 1: Effect of time of application (T) and dose of nano nitrogen fertilizer on yield attributing characters of sweet corn (Sugar-75)

Treatments	Length of cob (cm)	Diameter of cob (cm)	Weight of cob (g)	Number of grains Per cob	Green cob yield per ha (q)	Green fodder yield per ha (q)
Time of application (T) (Main plot treatment)						
15 DAS (T_1)	20.56	19.71	222.29	402.07	138.32	359.75
30 DAS (T_2)	17.28	15.55	192.64	343.54	112.63	319.99
45 DAS (T_3)	14.37	11.93	177.29	329.33	107.43	305.68
S.Em ±	0.80	0.68	7.51	9.02	3.74	10.37
CD at 5%	2.76	2.34	25.99	31.22	12.96	35.88
Dose of nano nitrogen fertilizer (N) (Sub plot treatment)						
NN @ 1.00 L ha^{-1} (N_1)	15.82	14.21	183.94	339.37	112.59	312.14
NN @ 1.25 L ha^{-1} (N_2)	17.84	16.16	199.63	364.33	119.83	328.88
NN @ 1.5 L ha^{-1} (N_3)	18.55	16.83	208.65	371.25	125.96	344.39
S.Em ±	0.50	0.38	3.98	6.43	2.17	6.70
CD at 5%	1.49	1.12	11.81	19.12	6.46	19.92
Interaction (T × N)						
S.Em ±	0.87	0.65	6.89	11.14	3.76	11.61
CD at 5%	2.58	1.95	20.46	33.11	11.18	34.50

nutrients to the crop plant which help to increase the quality parameters of the plant (such as protein, oil content, sugar content) by enhancing the rate of reaction or synthesis process in the plant system (Singh and Kumar, 2017). Further, accumulation of nitrogen in the sink rather than in the vegetative part increased the nitrogen thereby increasing the protein content in grain than stover similar results were reported by (Shivay *et. al*., 2002). The reason may also be significant concentration of N, P, and K thus protein content is attributed with high dose of nano nitrogen and mineral fertilizers which may have provided most of the nutrients especially the major ones are reported by (Sharifi and Taghizaden, 2016). Similar results were reported by Prasad *et al.* (2012), Suriyaprabha *et al.* (2012), Anonymous (2016), El-Metwally *et al.* (2018), Al-Saray

Table 2: Effect of time of application (T) and dose of nano nitrogen fertilizer on quality attributing characters of sweet corn (Sugar-75)

Treatments	Protein content in grain (%)	Crude protein content in green stover (%)
Time of application (T) (Main plot treatment)		
15 DAS (T_1)	9.74	5.18
30 DAS (T_2)	8.86	4.92
45 DAS (T_3)	8.52	4.82
S.Em ±	0.13	0.07
CD at 5%	0.47	0.23
Dose of Nano nitrogen fertilizer (N) (Sub Plot Treatment)		
NN @ 1.00 L ha^{-1} (N_1)	8.74	4.83
NN @ 1.25 L ha^{-1} (N_2)	9.08	4.99
NN @ 1.5 L ha^{-1} (N_3)	9.29	5.10
S.Em ±	0.09	0.05
CD at 5%	0.27	0.14
Interaction (T × N)		
S.Em ±	0.16	0.08
CD at 5%	NS	NS

Table 3: Effect of time of application (T) and dose of nano nitrogen fertilizer on gross monetary, net monetary return and B:C ratio of sweet corn (Sugar-75)

Treatments	Cost of cultivation (Rs ha^{-1})	Gross monetary returns (Rs ha^{-1})	Net monetary returns (Rs ha^{-1})	B:C ratio
Time of application (T) (Main plot treatment)				
15 DAS (T_1)	222116.94	593172.04	378016.10	2.67
30 DAS (T_2)	222351.96	550890.23	328538.27	2.48
45 DAS (T_3)	222547.16	532129.87	309582.71	2.39
S.Em ±	-	10553.83	9878.69	-
CD at 5%	-	36521.05	34184.77	-
Dose of nano nitrogen fertilizer (N) (Sub plot treatment)				
NN @ 1.00 L ha^{-1} (N_1)	219158.38	533234.60	313630.60	2.44
NN @ 1.25 L ha^{-1} (N_2)	219604.00	562130.30	342971.93	2.56
NN @ 1.5 L ha^{-1} (N_3)	220049.62	580827.23	359534.55	2.64
S.Em ±	-	9517.05	9446.35	-
CD at 5%	-	28276.23	28066.54	-
Interaction (T × N)				
S.Em ±	-	16484.02	16361.55	-
CD at 5%	-	NS	NS	-
General mean	220966.9	558730.71	338712.36	2.52

and Al-Rubaee (2019), Kha *et al.* (2019), Al-Gym and Al-Asady (2020) and Melika *et al.* (2015).

Economics :

The Table 3 showed that in main plot spraying of nano nitrogen fertilizer at 15 DAS (T_1) had significantly highest gross monetary return (Rs. 5,93,172.04 ha^{-1}) and net monetary return (Rs. 3,78,016.10 ha^{-1}) over spraying at 30 DAS (T_2) and 45 DAS (T_3). The lowest value gross monetary return (Rs. 5,32,129.87 ha^{-1}) and net monetary return (Rs. 3,09,582.7 ha^{-1}) was obtained when sprayed at 45 DAS (T_3) which was on par with spraying at 30 DAS (T_2). Highest B:C ratio (2.67) was recorded by foliar spray at 15 DAS (T_1) which was followed by 30 DAS (T_2) (2.48) and lowest B:C ratio (2.39) was obtained by foliar application at 45 DAS (T_3). While in sub-plot, highest value of the gross monetary return (Rs. 5,80,827.23 ha^{-1}) and net monetary return (Rs. 3,59,534.55 ha^{-1}) were obtained from treatment N_3 (1.5 litre ha^{-1}) which was at par with treatment N_2 (1.25 litre ha^{-1}) and significantly superior over treatment N_1 (1.00 litre ha^{-1}). The significantly lowest value of gross monetary return (Rs. 5,33,234.60 ha^{-1}), net monetary return (Rs. 3,13,630.60 ha^{-1}) was obtained from treatment N_1 (1.00 litre ha^{-1}). Highest B:C ratio (2.64) was obtained from treatment N_3 (1.5 litre ha^{-1}) which was followed by treatment N_2 (1.25 litre ha^{-1}) (2.56) and lowest B:C ratio (2.44) was recorded from treatment N_1 (1.00 litre ha^{-1}). Kumar *et al.* (2014), Mehta and Bharat (2017) and Chavan and Yaspal (2019) reported similar findings.

Conclusion:

It is suggested to apply foliar spray of nano nitrogen fertilizer at 15 days after sowing with 1.25 litre per ha or 1.5 litre per ha for getting optimum yield and returns thereby maintaining the soil health.

Aknowledgement:

The authors are thankful to the Agronomy Section, RCSM College of Agriculture, Kolhapur for providing all the necessary requirement for conducting the trial.

REFERENCES

Al-Gym, A.J. K. and Al-Asady, M.H.S. (2020). Effect of the method and level of the adding NPK nanoparticles and mineral fertilizers on the growth and yield of yellow corn and the content of mineral nutrient of some plant parts. *Plant Archives,* **20** (1): 38-43.

Al-Juthery, H.W.A., Hardan, H.M., Al-Swedi, F.G.A., Obaid, M.H. and Al-Shami, Q.M.N. (2019). Effect of foliar nutrition of nano-fertilizers and amino acids on growth and yield of wheat. *IOP Conf. Series: Earth and Environmental Science* **388**.

Al-Sharay, M.K.S. and Al-Rubaee, F.W.H. (2019). 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*, **19** (2): 1473-1479.

Amuamuha, L., Pirzad, A. and Hadi, H. (2012). Effects of varying concentrations and times of nano-iron foliar application on the yield and essential oil of pot marigold. *International Research Journal of Applied and Basic Sciences*, **3** (10): 2085-2090.

Anonymous (2016). *Annual Report, 2016.* ICAR-CICR, Nagpur, Maharashtra, India, 32pp.

Anonymous (2017). Agricultural Statistics at a Glance, Government of India, Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare, Directorate of Economics and Statistics, New Delhi, India.

Anupama R., Rajeew K., Vijay P.LS. and Bandana B. (2020). Effect of plant-based nano-sized gypsum on growth parameters and yield of wheat (*Triticum aestivum* L.). *International Journal of Chemical Studies*, **8** (4): 2991-2993.

Chavan, Y.S. and Yashpal, Subash (2019). Effect of age of seedling, crop geometry and nano-fertilizers on performance of *Kharif* rice in Konkan region of Maharashtra. Krishikosh. *Trends in Biosciences*, **12** (18): 1202-1207.

El-Metwally, I. M., Doaa, M. R., Abo-Basha and Abd El-Aziz, M. E. (2018). Response of peanut plants to different foliar applications of nano-iron, manganese and zinc under sandy soil conditions. *Middle East Journal of Applied Science*, **8** (2): 474-482.

EPA (2007). Nanotechnology White Paper. US Environmental Protection Agency Report, EPA 100/B-07/001. Washington DC 20460 DC 20460, USA.

Fan, L., Wang, Y., Shaho, X. and Geng, Y. (2012). Effects of combined nitrogen fertilizer and nano-carbon application on yield and nitrogen use of rice grown on saline-alkali soil. *Journal of Food Agriculture and Environment*, **10** (1): 558-562.

Hagab, R.H., Yousra H.K. and Doaa E. (2018). Using nanotechnology for enhancing phosphorus fertilizer use efficiency in peanut bean grown in sandy soils. *J. Adv. Pharm. Edu. Res.,* **8** (3): 59-67.

Jian, L., Zhang, Y.D. and Zhang, Z.M. (2008). Study on application of nanometer biotechnology on the yield and quality of winter wheat. *Journal of Anhui Agricultural Sciences*, **36**: 15578-15580.

Kha, L. Q., Ngo, Q.V., Nguyen, H. C. and Pham, V.B. (2019). The efficacy of micronano particles across NPK doses and densities on maize growth and yield in Vietnam. *Vietnam Journal of Science, Technology and Engineering*, **61** (3).

Kipps, M.S. (1959.) *Production of field crops.* Tata McGraw-Hill Publishing Co. Ltd. Bombay and New Delhi.

Kole, C., Phullara, K., Kelim, M. R. and Poonam, C. (2013). Nanotechnology can boost crop productivity and quality. First evidence from increased plant biomass, fruit yield and phytomedicine content in bitter melon (*Momordica charantia*). *BMC Biotechnology* **13** (1): 37.

Kumar, R., Pandey, D.S. and Singh, I.P. (2014). Nano-technology for better fertilizer use (Research Experiences at Pantnagar). *Research Bulletin no*. **201**.

Manikandan, A. and Subramanian, K.S. (2016). Evaluation of Zeolite based Nitrogen Nano-fertilizers on Maize growth, yield and quality. *International Journal of Plant & Soil Science* **9** (4): 1-9.

Manikandan, T., Suresh, K., Amit, K., Poonam, T. and Shailesndra, K. (2018). Agro-nanotechnology: A future technology for sustainable agriculture. *Int. J. Curr. Microbiol. App. Sci*., Special Issue-**7**: 196-200.

Mehta, Swati and Rajeev, Bharat (2017). Effect of integrated use of Nano and Non-nano fertilizers on quality and productivity of wheat (*Triticum aestivum* L.). *Int. J. Curr. Microbiol. App. Sci.,* **8** (12): 598-606.

Melika, T., Hania, A.Q., Alimohammad, A.Q. and Mahedieh, Y. (2015). The effect of zinc-oixe nanoparticles on the growth parameters of corn (SC 704). *Stem Fellowship J.,* **1**(1): 17-20.

Morteza, E., Moaveni, P., Farahani, H. A. and Kiyani, M. (2013). Study of photosynthetic pigments changes of maize (*Zea mays* L.) under nano TiO_2 spraying at various growth stages. *Springer Plus,* **2**(1): 1-5.

Muradia, L.K., Wadhwani, R., Bajpai, P. and Shekhawat, S. (2016). Maize utilization in India: An Overview. *American Journal of Food and Nutrition*, **4** (6): 169-176.

Naderi, M.R. and Danesh-Shahraki, A. (2013). Nanofertilizers and their roles in sustainable agriculture. *Int. J. Agric. Crop Sci.*, **5**(19): 2229-2232.

Panse, V.G. and Sukhatme, P.V. (1967). *Statistical Method for Agricultural Research workers.* ICAR., New Delhi.

Prasad, T.N.V.K.V., Sudhakar, P., Sreenivasulu, Y., Latha, P., Munaswamy, V., Raja Reddy, K., Sreeprasad, T.S., Sajanlal, P.R. and Pradee, T. (2012). Effect of nanoscale zinc oxide particles on the germination, growth and yield of peanut. *Journal of Plant Nutrition*, **35 (**6): 905-927.

Sharifi, R.S. and Namvar, A. (2016). Effects of time and rate of nitrogen application on phenology and some agronomical traits of maize (*Zea mays* L.). *J. Bioscience*, **62** (1): 35-45.

Sharifi, R. S. and Taghizadeh (2016). Response of maize (*Zea mays* L.) cultivars to different levels of nitrogen fertilizer. *J. Food Agric. Env.*, **7** (3-4): 518-521.

Shivay, Y.S., Singh, R.P. and Shivakumar, B.G. (2002). Effect of nitrogen on yield attributes, yield and quality of maize (*Zea mays* L.) in different cropping systems. *Indian Journal of Agricultural Sciences*, **72**:161-163.

Singh, M. D. and Kumar, A. B. N. (2017). Bio efficiency of nano zinc sulphide (ZnS) on growth, yield of sunflower (*Helianthus annus* L.) and nutrition status in the soil. *International Journal of Agricultural Sciences*, **9**(6): 3795-3798.

Sorooshzadeh, A., Hazrati, S., Orak, H., Govahi, M. and Ramazani, A. (2012). Foliar application of nano-silver influence growth of saffron under flooding stress. *Brno, Czech Republic, EU.*, **10**: 23-25.

Suriyaprabha, R., Karunakaran, G., Yuvakkumar, R. and Prabu, P. (2012). Growth and physiological responses of maize (*Zea mays* L.) to porous silica nanoparticles in soil. *Journal of Nanoparticle Research* **14** (12).