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Influence of fertility levels and cytokinin on yield attributes and yields of sunflower (*Helianthus annuus* L.)

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Abstract
A field experiment was conducted at Campus Farm of M. S. Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha during summer season of 2019. The experiment was laid out in factorial randomized complete block design with combination of six fertility levels *viz*. 100% recommended dose of fertilizer (80:60:40 kg N, P_2O_5 and K_2O/ha), 100% RDF + *Azotobacter* @ 5 kg/ha, 100% RDF + *Azotobacter* @ 5kg/ha + S @ 30 kg/ha, 125% RDF, 125% RDF + *Azotobacter* @ 5kg/ha, 125% RDF + *Azotobacter* @ 5kg/ha + S @ 30kg/ha and two cytokinin levels *viz.* no cytokinin and cytokinin 50 ppm comprising of twelve treatments in three replications. The experimental results revealed that among the nutrient management treatments, the highest capitulum diameter (15.02 cm), number of seeds/capitulam (894.5), head diameter (15.02 cm), test weight (44.33 g), seed yield (2.43 t/ha) and stalk yield (3.58 t/ha) were obtained when the crop was fertilized with 125% RDF + *Azotobacter* @ 5kg/ha + S @ 30kg/ha. The foliar spray of 50 ppm cytokinin resulted in increase in head diameter (14.44 cm), number of seeds/capitulam (890.0), test weight (43.06 g), seed yield (2.36 t/ha) and stalk yield (3.353 t/ha) and harvest index (41.25%) over no application of cytokinin. It is concluded that interaction effect of 125% RDF + *Azotobacter* @ 5kg/ha + S @ 30 kg/ha along with 50 ppm cytokinin positively increased the seed yield (2.77 t/ha). It is recommended as suitable production technology for sunflower cultivation under South Odisha condition.

Keywords: Sunflower, *Azotobacter*, cytokinin, sulphur

Introduction
Sunflower (*Helianthus annuus* L.) is the fourth major oil seed crop grown widely all over the world (Jehan *et al*., 2015) [1]. It plays a major role in covering up the oil scarcity in India. The farmers are motivated to cultivate sunflower by its virtue of lesser duration, suitable to different soil types, photoinsensivity nature and availability of hybrids. Sunflower as deep-rooted crop responses to nutrients very well. Macro nutrients are responsible for obtaining increased yield and oil content of sunflower (Ijaz *et al*., 2017) [7]. Nitrogen plays a major role in increasing the metabolic activities which results in enhancement of growth and yield of the crop (Banerjee *et al*., 2014) [6]. Phosphorous is next important nutrient which helps in root development, size of the seed and grain yield of hybrid and regarded as chief nutrient in increasing the quality of the crop (Waqas *et al*., 2017) [5]. The partial effect on yield of sunflower with application of potassium is noticed by Amanullah and Khan (2011) [9]. Sulphur plays an important role in synthesizing the proteins, proteolytic enzymes, amino acids and seed chemical composition and also helps in improving the oil content in sunflower (Vala *et al.*, 2014) [3]. The bio-fertilizer *Azotobacter* plays a major role in fixing the atmospheric nitrogen which is much important for increasing growth and yield. Application of cytokinin enhances the fruit number, seed count, test weight and seed yield (Gora *et al.*, 2018) [12]. The application of optimum NPK plays a significant role in improving the plant height, yield and oil content (Wahyu and Donald, 2019) [2]. Keeping the above points in mind, the present study was conducted to find the influence of fertility levels and cytokinin on productivity of sunflower to devise a suitable production technology in South Odisha.

Material and Methods
A field experiment was conducted during summer season of 2019 at college farm of M.S Swaminathan School of Agriculture, Centurion University of Technology and Management, Paralakhemundi, Odisha. During the period of experimentation, the average maximum and minimum temperature ranged from 26.5 to 38.9 °C and 14.2 to 27.4 °C, respectively. The total rainfall received during the crop growing period was 128.6 mm.

The relative humidity of morning and afternoon varied from 75.71 to 95.9% and 33.86 to 64.9%, respectively. The bright sunshine hours per day fluctuated from 3.00 to 10.3 hours. The soil of experimental field was loamy in texture with slightly acidic in response with pH of 6.5. In experimental field, the available nitrogen, phosphorus and potassium were 176.0, 38.0 and 340.0 kg/ha, respectively. The experiment was laid out in factorial randomized complete block design with two factors (fertility levels and cytokinin) containing twelve treatments combination replicated thrice in the plot size of 4.8 m x 4.2 m. The factor A was comprised of six fertility levels *viz*. 100% recommended dose of fertilizer (RDF), 100% RDF + *Azotobacter* @ 5 kg/ha, 100% RDF + *Azotobacter* @ 5kg/ha + S @ 30 kg/ha, 125% RDF, 125% RDF + *Azotobacter* @ 5kg/ha, 125% RDF + *Azotobacter* @ 5kg/ha + S @ 30kg/ha. In factor B, two cytokinin levels *viz*. no cytokinin and cytokinin @ 50 parts per million (ppm) were tested with Factor A. The experimental field was properly ploughed and sunflower hybrid YSH 475 was sown on 5th January, 2019 at the spacing of 60 cm × 30 cm. The sources of fertilizers used were urea, di ammonium phosphate, muriate of potash for the treatment of 100 and 125% recommended dose of NPK levels either alone or with *Azotobacter* having no sulphur. For the nutrient management treatments containing sulphur with combination of 100 and 125% recommended dose of NPK either alone or with *Azotobacter*, the chosen fertilizers were complex fertilizer grade 20:20:0:13 as source of N, P and S, diammonium phosphate, urea and muriate of potash. The recommended fertilizer dose of 80 kg N, 60 kg P_2O_5 and 40 kg K_2O was applied to the sunflower crop as per the treatments receiving 100% recommended dose of NPK fertilizer. In the treatments of 125% recommended dose of fertilizer 100 kg N, 75 kg P_2O_5 and 50 kg K_2O was used for the purpose. In all the nutrient management treatments, full dose of P_2O_5 and half dose of K_2O were applied as basal. As per the treatment specification of 100% RDF + 30 kg S/ha and 125% RDF + 30 kg S/ha with and without *Azotobacter*, the entire dose of sulphur in addition to nitrogen and phosphorous through complex fertilizer grade containing 20% N, 20% P_2O_5, 0% K_2O and 13% S was applied as basal. The 50% N was applied as basal to the nutrient management treatments of 100 and 125% RDF either alone or with *Azotobacter* containing no sulphur. In 100% RDF + 30 kg S/ha and 100% RDF + 30 kg S/ha + *Azotobacter*, 51.57 kg N/ha was applied at the time of sowing as basal. For the treatment of 125% recommended dose of fertilizer + 30 kg S/ha and 125% RDF + 30 kg S/ha + *Azotobacter*, 57.44 kg N/ha was incorporated to soil just before sowing as basal. The fertilizers are applied to the depth of 8-10 cm and covered with soil. The bio-fertilizer *Azotobacter* was applied to the specific treatments at the time of sowing with at most care so that bio-fertilizer will not come in contact with chemical fertilizer. The remaining amount of N along with 50% K_2O was top dressed to the specific nutrient management treatments followed by earthing up at 5th week of crop age. The growth regulator benzyladenine was applied at 45 days after sowing for the treatment of 50 ppm cytokinin. The crop was grown with all recommended package and practices with no plant protection measure as crop was free from pest load. The crop was harvested when it attained full maturity as indicated by yellow colour on the backside of the capitulum. At harvest, five plants were randomly selected in each treatment for recording yield parameters like number of seeds/capitulum, capitulum diameter, test weight. The seed yield and stalk yield were recorded from each plot after perfect sun drying. The harvest index was calculated by dividing the economic yield with biological yield and the multiplied with 100 to expressed in percentage. The formula is as follows as described by Donald and Hamblin (1976) [10].

$$\text{Harvest index} = \frac{\text{Economic yield (kg/ha)}}{\text{Biological yield (Kg/ha)}} \times 100$$

The mean data were analyzed by using Microsoft Office Excel 2010 software for factorial randomized complete block design following analysis of variance procedure as suggested by Gomez and Gomez (1984) [13]. Statistical significance was tested by calculating the F value at 5% level of probability and critical difference was calculated for comparison of treatment mean.

Results and Discussion

Yield attributes

Data pertaining to yield attributes of sunflower affected by different fertility levels and cytokinin application was presented in Table 1 and 2.

Capitulum diameter

The maximum head diameter was observed in 125% RDF of NPK + *Azotobacter* + 30 Kg S/ha (15.02 cm) being at par with 125% NPK RDF + *Azotobacter* @ 5 kg/ha (14.61 cm). The head diameter obtained with application of 125% RDF of NPK (14.53cm) did not differ significantly from 100% RDF of NPK + *Azotobacter* @ 5 kg/ha + 30 Kg S/ha (14.18cm). They were remarkably higher than 100% RDF of NPK + *Azotobacter* @ 5 kg/ha (13.39 cm) and 100% RDF of NPK (13.19 cm). Improvement in head diameter was obtained by application of higher doses of NPK in combination with *Azotobacter* and sulphur which resulted in adequate supply of nutrients to facilitate steady and timely availability of nutrients to enhance absorption and uptake to reflect the vegetative growth. Hence, increase in stem elongation and leaf expansion increased the photosynthetic efficiency that led to production of more dry matter and better translocation of reserve food material from source to developing capitulum. It resulted in increase in number of seeds/head consequently reflected the head diameter. Thus, it is been responsible for larger head diameter under 125% RDF of NPK + *Azotobacter* @ 5 kg/ha + 30 kg S/ha. The favourable effect of higher levels of NPK fertilizer (Wahyu and Donald, 2019) [2], inorganic N with Azotobacter supplemented with uniform dose of P and K (Kandekar *et al.*, 2018) [15], NPK with sulphur (Ravi kumar *et al*., 2016) [16] and bio-fertilizer with S supplemented with recommended NPK (Patra *et al.*, 2013) [4] was reported earlier by several research workers.

It was clearly indicated from the data that significant increase in capitulum diameter was noticed with foliar spray of 50 ppm cytokinin (14.44 cm) over no application of cytokinin (13.86 cm). It is ascribed to beneficial effect of cytokinin on plant growth in regulating the various physiological processes like cell division, expansion and proliferation including the apical growth in meristematic region as reported by Schaller *et al.* (2014) [14].

The interaction effect of fertility levels and cytokinin was found non-significant on capitulum diameter.

Number of seeds/capitulum

It is evident from the data that the highest number of seeds/head was recorded with 125% RDF + *Azotobacter* @ 5

kg/ha + 30 kg S/ha (894.50) being at par with 125% RDF + *Azotobacter* @ 5 kg/ha (886.48) and 125% RDF (885.0). Application of 100% RDF + *Azotobacter* @ 5 kg/ha + 30 Kg S/ha (880.17) and 100% RDF + *Azotobacter* @ 5 kg/ha (872.67) were statistically at par with 125% RDF. The minimum seeds/head was observed in 100% RDF of NPK (870.33). The enhancement of number of seeds/head in the increased fertilizer dose of NPK in combination with *Azotobacter* and sulphur was possible owing to favourable crop growth which in turn resulted in increased photosynthetic efficiency thereby facilitated the transfer of more photosynthates from source to capitulum containing more number of filled seeds. These results are in pipe line with finding of many research scientists reporting the effect of higher level of NPK (Wahyu and Donald, 2019) [2] higher level inorganic N with Azotobacter supplemented with uniform dose of P and K (Kandekar *et al.,* 2018) [15]. NPK with sulphur (Ravikumar *et al*., 2016) [16] and bio-fertilizer with S with common dose of NPK to all treatments (Patra *et al.,* 2013) [4].

The foliar spaying of 50 ppm cytokinin significantly gave the higher number of achenes/ capitulum (890.00) than that of no cytokinin application (873.05). The application of cytokinin controls cell division, differentiation and expansion thereby promotes the movement of assimilates from source to sink to enhances the sink strength for seed development to facilitate increase in achene number in the capitulum of sunflower. This result is in agreement with the finding of Patil *et al.* (2002) [11].

The interaction effect of fertility levels and cytokinin was found non-significant on number of seeds per head.

Test weight

The perusal of data on thousand seed weight indicated that there was a significant difference due to fertilizer levels. The maximum 1000 grain weight was recorded with application of 125% RDF of NPK + *Azotobacter* + 30 kg S/ha (44.33 g) which remained at par with all other treatments except 100% RDF of NPK (40.67 g). The combined use of NPK fertilizer with *Azotobacter* and S resulted in abundant supply, absorption and uptake of nutrients that favoured the increase in vegetative growth and dry matter production which in turn facilitated the photosynthetic activity for efficient partitioning of stored food material to reproductive structures at seed development stage consequently augmented the test weight. Increase in test weight of sun flower was reported by various research workers with application on NPK fertilizer (Pabitra *et al*., 2018) [17]. Bio fertilizer with higher level of nitrogen when used with uniform dose of P and K for all N levels (Kandekar *et al.,* 2018) [16], NPK with S (Ravikumar *et al*., 2016) [16] and S with bio fertilizer applied with common dose of NPK for all treatments (Patra *et al.,* 2013) [4].

Increase in 1000 seed weight was observed with 50 ppm cytokinin (43.06 g) over no cytokinin recording 1000 grain weight of 41.72 g. Cytokinin as a phytohormone is responsible for many facets of plant growth including seed development by exporting assimilates from source to sink thus, regulates source sink relations. Patil *et al.* (2002) [11] recorded increase in sink capacity and seed set with application of cytokinin.

The interaction effect of fertility levels and cytokinin was not significantly different on test weight of sunflower.

Seed yield

The perusal of data pointed out that different fertility levels had exerted significant influence on seed yield of sunflower. Among the nutrient management treatments, application of 125% RDF + *Azotobacter* @ 5 kg/ha + 30 kg S/ha recorded the highest yield (2.43 t/ha) which remained at par with 100% RDF + *Azotobacter* @ 5 kg/ha + 30 kg S/ha (2.34 t/ha). The seed yield obtained with 125% RDF + *Azotobacter* @ 5 kg/ha (2.23 t/ha) and 125% RDF (2.22 t/ha) did not vary remarkably from 100% RDF + *Azotobacter* @ 5 kg/ha + 30 kg S/ha while they were significantly higher than 100% RDF + *Azotobacter*@ 5 kg/ha (1.89) and 100% RDF (1.88 t/ha). The lowest seed yield was noticed under 100% RDF of NPK (1.88 t/ha). Application of 125% RDF of NPK+ *Azotobacter* + 30 kg S/ha was proved to be ideal nutrient management option resulted in increasing the seed yield. It is because of the integration of NPK with *Azotobacter* and sulphur resulted in enhancement in better availability of nutrients to facilitate favourable nutritional environment in rhizosphere to enhance rapid absorption and uptake of nutrients followed by metabolism and photosynthetic activity consequently affected the efficient translocation of photosynthates from source to sink. The resultant effect on increase in yield attributes like head diameter, number of seeds/capitulum and test weight exhibited the positive reflection on seed yield. Many a research workers reported the conducive effect of increased levels of NPK fertilization (Pabitra *et al*., 2018) [17] bio-fertilizer with higher level of nitrogen when used with uniform dose of P and K for all N levels (Kandekar *et al*., 2018) [15], NPK with bio fertilizer (Pramanik and Bera, 2013) [8], NPK with S (Ravikumar *et al*., 2016) [16] and S with bio fertilizer applied with common dose of NPK for all treatments (Patra *et al.,* 2013) [4].

Significantly the higher seed yield was noticed with 50ppm cytokinin (2.36 t/ha) than that of no application of cytokinin (1.97 t/ha). It is attributed to benevolent role of cytokinin in increasing the mitotic activity of vegetative meristems and increase in the cell division activity in the receptacle tissue due to accelerated mobilization of assimilates from sources to reproductive parts leading to enlargement in capitulum size to accommodate more number of achenes in capitulum consequently increase in seed setting and test weight thereby realization of maximum seed yield. Gora *et al.* (2018) [12] opined the marked effect of foliar application of benzyladenine in improving the yield owing to enhancement in yield attributes such as number of fruits, seeds and test weight in oilseed crops.

Interaction effect of nutrient management treatments and cytokinin exhibited positive effect on seed yield of sunflower (Table 2). The maximum seed yield was noticed when crop was fertilized with 125% RDF + *Azotobacter* @ 5 kg/ha +30 kg S/ha along with 50 ppm cytokinin (2.77 t/ha) followed by 100% RDF of NPK + *Azotobacter* @ 5 kg/ha + 30 kg S/ha with 50 ppm cytokinin (2.68 t/ha) which were at par. The minimum seed yield was recorded with application of 100% RDF of NPK without application of cytokinin (1.76 t/ha). The cumulative effect of NPK, *Azotobacter* as source of biological N fixation and S with cytokinin enhanced the nutrient supply and availability in rhizosphere environment to facilitate better uptake of nutrients and water that promoted the cell division, differentiation and proliferation for production of greater amount of biomass. It led to facilitate nutrient mobilization

from vegetative part to reproductive organ thus resulted in increased head diameter, number of seeds/ head, seed filling and seed weight through increased mobilization of metabolites and it's partitioning towards seed development thus, ultimately reflected the seed yield.

Stalk yield

It is observed from data that stover yield was significantly affected by various nutrient management treatments. The maximum stalk yield was recorded with application 125% RDF of NPK + *Azotobacter* + 30 kg S/ha (3.58 t/ha) being at par with 125% RDF of NPK (3.35 t/ha). The minimum stalk yield was noticed with 100% RDF of NPK (2.90 t/ha). Sufficient supply of nutrients under 125% RDF of NPK+ *Azotobacter* +30 kg S/ha was found ideal for better photosynthetic activity leading to higher plant height, base diameter, number of leaves/plant, leaf area and dry matter accumulation which resulted in enhancement of stalk yield. Similar results with use of increased levels of NPK (Waqus *et al.* 2017) [5], S with bio-fertilizer applied with common dose of NPK for all treatments (Patra *et al.*, 2013) [4], bio-fertilizer with hormone brassinolide applied with common dose of 80:100:100 NPK kg/ha Pramanik and Bera, (2013) [8] are also reported by various research workers.

Data on stover yield revealed that the application of 50 ppm cytokinin in producing significantly superior stover yield (3.35 t/ha) over no application of cytokinin (3.02 t/ha). It is ascribed to key role of cytokinin in regulating the cell proliferation by promoting cell division and proliferation there by influencing the shoot growth, leaf production and canopy development to influence the dry matter accumulation through enhanced photosynthetic activity and mobilization of assimilates from source to sink that resulted in increase in stover yield. The favourable effect of benzyladenine in improving the vegetative growth and dry matter accumulation was reported by Gora *et al*. (2018) [12].

Interaction effect of fertilizer levels and cytokinin on stalk yield of sunflower did not differ significantly among the treatments.

Harvest index

Perusal of data on harvest index indicated that there were no significant differences due to the different fertility levels. The maximum harvest index was noticed with the application of 100% RDF + *Azotobacter* @ 5 kg/ha + 30 kg S/ha (42.62%) followed by 125% RDF + *Azotobacter* @ 5 kg/ha (40.59%) while the lower harvest index recorded with 100% RDF of NPK (39.38%). The improvement in harvest by those treatments is result of appreciable increase in economic yield with comparatively less production of stover yield.

Significant difference was noticed on harvest index with cytokinin application. The foliar application of 50 ppm cytokinin enhanced the harvest index (41.25%) compared with no use of cytokinin (39.53%).

Interaction effect of fertilizer levels and cytokinin on harvest index of sunflower was found to be non – significant.

Table 1: Influence of fertility levels and cytokinin on yield attributes and yields of sunflower

Treatments	Head diameter (cm)	Seeds / head	1000 seed weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
100% RDF of NPK	13.19	870.33	40.67	1.88	2.90	39.38
100% RDF of NPK + *Azotobacter* @5 kg/ha	13.39	872.67	41.33	1.89	2.90	39.51
100% RDF of NPK + *Azotobacter* @ 5 kg/ha + 30Kg S/ha	14.18	880.17	42.5	2.34	3.12	42.62
125% RDF of NPK	14.53	885.00	42.67	2.22	3.35	39.94
125% NPK RDF of + *Azotobacter* @ 5 kg/ha	14.61	886.48	42.83	2.22	3.25	40.59
125% RDF of NPK+ *Azotobacter* +30 Kg S/ha	15.02	894.50	44.33	2.43	3.58	40.31
S. Em (±)	0.15	4.53	1.17	0.05	0.09	0.74
CD (P=0.05)	0.43	13.28	3.44	0.14	0.26	NS
Cytokinin 50 ppm	14.44	890.00	43.06	2.39	3.35	41.25
No cytokinin	13.86	873.05	41.72	1.97	3.02	39.53
S. Em (±)	0.08	2.61	0.68	0.03	0.05	0.43
CD (P=0.05)	0.25	7.67	1.99	0.08	0.15	1.25
Interaction						
S. Em (±)	0.21	6.4	1.67	0.07	0.13	1.05
CD (P=0.05)	NS	NS	NS	0.20	NS	NS

Table 2: Interaction effect of nutrient management and cytokinin treatments on seed yield of sunflower

Treatments	Cytokinin 50 ppm	No cytokinin	Mean
100% NPK	2.00	1.76	1.88
100% NPK + *Azotobacter* @ 5 kg/ha	1.88	1.91	1.89
100% NPK + *Azotobacter* + 30Kg S/ha	2.68	2.00	2.34
125% NPK	2.40	2.04	2.22
125% NPK + *Azotobacter*	2.41	2.03	2.22
125% NPK + *Azotobacter* +30 Kg S/ha	2.77	2.09	2.43
Mean	2.36	1.97	2.16
Interaction			
S. Em (±)	0.07		
CD (P=0.05)	0.20		

Conclusion

Application of 125% recommended dose of NPK + *Azotobacter* @ 5 kg/ha + 30 kg S/ha along with 50 ppm cytokinin produced maximum yield attributes and yield in sunflower which is preferred as suitable production technology for South Odisha condition.

References

1. Jehan B, Mohammad S, Mohammad Y. Effect of various levels of NPK on crop growth and yield of sunflower hybrids grown under autumn seasons. Pak. J Bot. 2015; 47(SI):171-180.
2. Wahyu H, Donald S. Study of NPK fertilizer effect on sunflower growth and yield. Int. Conf. on Biol and Appl. Sci. 2019; 2120(1):30031-3003.
3. Vala GS, Vaghani JJ, Gohil VN. Effect of sulphur on yield and oil content of sunflower. Agric. Res. Station. 2014; 33:9-17.
4. Patra PA, Partha SP, Hasim R, Sukanta S, Babulal T. Response of sunflower to different ratios of nitrogen, phosphorus, potassium fertilizer. Journal of Pharmacognosy and Phytochemistry. 2018; 7(4):2898-2901.
5. Waqas M, Ghazanfar U, Abdul AK, Ejaz AK, Kashif W, Taseer AK. Effects of fertilizers (NPK) on growth indices, yield and quality of hybrid sunflower. Int. J Biol. Biotech. 2017; 14(1):101-107.
6. Banerjee H, Dutta SK, Pramanik SJ, Ray K, Phonglosa A, Bhattacharyya K. Productivity and profitability of spring planted sunflower hybrid with nitrogen, Phosphorus and Potassium fertilizer. Annals of Plant and Soil Research. 2014; 16(3):250-256.
7. Ijaz A, Sultan AJ, Ahmad S, Muhammad A, Fida M, Fazal M. Response of sunflower varieties to NPK fertilization. Pure Appl. Biol. 2017; 6(1):272-277.
8. Pramanik K, Bera AK. Effect of biofertilizers and phytohormone on growth, productivity and quality of sunflower (*Helianthus annuus* L). Journal of Crop and Weed. 2013; 9(2):122-127.
9. Amanullah, Khan MW. Interactive Effect of potassium and phosphorus on grain quality and profitability of sunflower in Northwest Pakistan. Pedosphere. 2011; 21(4):532-538.
10. Donald CM, Hamblin J. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. Advances in Agronomy. 1976; 28:361-405.
11. Patil RR, Deotale RD, Hatmode CN, Band Pallavi E, Basole Vandana D, Khobragade TR. Influence of 6-benzyladenine on morpho physiology parameters of soybean. Journal of Soils and Crops. 2002; 12:296-300.
12. Gora MK, Harikesh J, Kailash CJ, Hemraj J, Ashish S. Potentiate the productivity of oilseed crops by plant hormone benzyladenine, (Synthetic cytokinin): A review. Journal of Pharmacognosy and Phytochemistry. 2018; 7(4):3383-3385.
13. Gomez KA, Gomez AA. Statistical procedures for Agricultural Research. Second Edition (IRRI John Wiley & Sons Publication: New York), 1984.
14. Schaller GE, Street IH, Kieber JJ. Cytokinin and the cell cycle. Current Opinion in Plant Biology. 2014; 21C:7-15.
15. Khandekar SD, Ghotmukale A, Dambale AS, Suryawanshi SB. Response of kharif sunflower to biofertilizers and different fertilizer levels. International Journal of Current Microbiology and Applied Sciences. 2018; 6:1558-1563.
16. Ravi kumar C, Ganapathy M, Vaiyapuri V. Effect of sulphur fertilization on growth, yield and nutrient uptake of sunflower in north cauvery deltaic region. International Journal of Current research reviews. 2016; 8(22):13-17.
17. Pabitra A, Partha SP, Hasim R, Sukanta S, Babulal T. Response of sunflower to different ratios of nitrogen, phosphorus, potassium fertilizer. Journal of Pharmacognosy and Phytochemistry. 2018; 7(4):2898-2901.