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EFFECT OF PLANT GROWTH REGULATORS AND MICRONUTRIENTS ON CORM PRODUCTION OF GLADIOLUS (*GLADIOLUS GRANDIFLORUS* L.) CV. NOVALUX

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ABSTRACT

To work out the effect of plant growth regulators and micronutrients on corm production of gladiolus (*Gladiolus grandiflorus* L.) cv. Novalux, the experiment was conducted in Factorial Randomized Block Design with 12 treatments replicated thrice at the Main Experiment Station, Department of Floriculture & Landscape, Acharya Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.) during winter season in the year 2017-18 and 2018-19. The plant growth regulators and micronutrients application significantly influenced the corm production of gladiolus. The plant growth regulators significantly affect the number of spikes per plant, number of corms per plant, Polar diameter (cm), equatorial diameter (cm), number of spikes per hectare and number of corms (lakh) per hectare was obtained with the combinations of CCC 500 ppm with $ZnSO_4$ 0.5% + $FeSO_4$ 0.2%.
Keywords **:** Gladiolus, Novalux, Bulbous plants, Plant Growth Retardants, Corm Production.

Introduction

The modern gladiolus hybrids are botanically known as *Gladiolus grandiflorus*. Gladiolus is one of the important monocotyledonous flowering perennials bulbous plants belongs to family Iridaceae and widely grown as a cut flower in the world and referred to as the “Queen of Bulbous” flowers. It has basic chromosome number n=15 and majority of South African species are diploid (2n=30). The control over flowering time and floral characteristics according to the demand of market has been achieved in many cut flowers by adopting modern production techniques including the use of plant growth regulators (PGRs). The application of plant growth retardants has become the part of their cultural practices in many ornamental plants to modify their vegetative and floral traits.GA_3 delays senescence of flowers by reducing the senescence-promoting effect of ethylene. The application of GA_3 was found to shorten number of days to flowering, increase spike length, number of flowers per spike, floret diameter, shoot elongation and vegetative growth significantly. Cycocel (Chlormequat chloride, 2-chloroethyl trimethyl ammonium chloride) is a plant growth regulator for ornamentals, including bedding plants and herbaceous crops. Cycocel enhances the crop’s aesthetic appeal and improves durability during post production shipping and handling. Cycocel is a gibberellin inhibitor. Cycocel produces earlier budded plants with multiple buds per shoot. Cycocel can be used to reduce stem elongation induction of seed germination, Enzyme production during germination CCC is required for cell division and cell elongation.

Micronutrients such as zinc is an essential element for plants which acts as a cofactor of various enzymes or as a functional structural or regulatory component of various biosynthesis like protein synthesis, photosynthesis, the synthesis of auxin, cell division, the maintenance of membrane structure RNA and ribosome functions and sexual fertilization. The micronutrients are responsible in activating several enzymes (catalase, peroxidase, alcohol dehydrogenase, carbonic dehydrogenase, etc.) and involve them self in chlorophyll synthesis and various physiological activities by which plant growth and development are encouraged (Kumar and Arora, 2000), Zinc also controls the metabolism of plant by stimulating the hydrogenase and carbonic anhydrase activities, stabilization of ribosomal fractions and synthesis of cytochrome. There are evidences that iron deficiency impairs many plants physiological processes because it is involved in chlorophyll and protein synthesis and in root tip meristem growth. Tagliavini and Rombola (2001) illustrated that iron deficiency (chlorosis) is a common disorder which affect plants. Grown on soils of high pH. Iron application through foliar spray is a common practice to cure iron-deficiency (Mortvedt, 1991).

Materials and Methods

The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications and twelve treatments at Main Experimental Station, Horticulture, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya during the year 2017-18 and 2018-19. The treatments are G_1M_1 (water dipping + water spray), G_1M_2 (water dipping + $ZnSO_4$ 0.5%), G_1M_3 (water dipping + $FeSO_4$ 0.2%), G_1M_4 (water dipping + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.2%), G_2M_1 (GA_3 200 ppm + water spray), G_2M_2 (GA_3 200 ppm + $ZnSO_4$ 0.5%), G_2M_3 (GA_3 200 ppm + $FeSO_4$ 0.2%), G_2M_4 (GA_3 200 ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.2%), G_3M_1 (CCC 500 ppm + water spray), G_3M_2 (CCC 500 ppm + $ZnSO_4$ 0.5%), G_3M_3 (CCC 500 ppm + $FeSO_4$ 0.2%) and G_3M_4 (CCC 500 ppm + $ZnSO_4$ 0.5%+ $FeSO_4$ 0.2%).

The field are prepared by well-decomposed farmyard manure was applied before land preparation at the rate of 25t/ha and mixed well in to soil. Fertilizers were applied at the rate of 300:200:200kg NPK/ha. 50% of nitrogen and full dose of phosphorous and potash were applied as basal dose and remaining 50% of nitrogen was applied at 45 days after planting. Before planting, corms were dipped in prepared GA_3 200 ppm solution for 1 hours and CCC 500 ppm solution for 24 hours after that dried under shade. Planting was done at 40 x 20 cm spacing to a depth of 5-6cm in plots of 2.0x1.0 m size. The irrigation and weeding were done as and where required. The observation was recorded for the character viz. number of spikes per plant, number of corms per plant, polar diameter (cm), equatorial diameter (cm), number of spikes per hectare and number of corms (lakh) per hectare. The obtained data had statistically analysed adopting procedure as given by Panse and Sukhatme (1985).

Results and Discussion

The effect of plant growth regulators and micronutrients on various characters are presented in Table 1. There was significant increase in number of spikes per plant with the application of growth regulators. The maximum number of spikes per plant was obtained in CCC 500 ppm (1.63 and 1.53 during 2017-18 and 2018-19, respectively) and it was found significantly at par with the application of GA_3 200 ppm (G_2) (1.53 and 1.43) during both the years of investigation. The lowest number of spikes per plant were noticed in control (G_1) which was 1.43 and 1.33 during 2017-18 and 2018-19, respectively. There was significant increase in number of spikes per plant with the foliar application of $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% (1.63 in 2017-18 and 1.53 in 2018-19). However, it was found at par with M_3 and M_2 during both the years. Number of spikes per plant was recorded minimum under control (1.40 and 1.30 during 2017-18 and 2018-19, respectively). Data on interaction effect of growth regulators and micronutrients for number of spikes per plant was found non-significant in both the years of experimentation. The combination of CCC 500 ppm with $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% produced maximum number of spikes per plant (1.73 in 2017-18 and 1.63 in 2018-19). The minimum number of spikes per plant was recorded in control G_1M_1 (no growth regulator and no micronutrients) 1.30 in 2017-18 and 1.20 in 2018-19 during both the years of investigation. The increase in number of spikes per plant and increase in yield spike per hectare might be due to the development of large number of spikes as the result of reproductive plant growth and maximum tillers of the plant. Also, the maximum number of leaves in this treatment had accumulated more carbohydrates through photosynthesis and was used for increasing the flower yield. These results are also similar with the finding of Bhattacharjee (1984), Kumar *et al.* (2008), Sudhakar and Kumar (2012) in the gladiolus and Ganesh, (2013) in tuberose. These findings confirmed the results of present study. During both the years of investigation significant increase in number of spikes per plant and per hectare were recorded with foliar application of $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% which is followed by $FeSO_4$ 0.2%. The differences in the response of micronutrients with respect to spike length might be due to the fact that these nutrients (Fe and Zn) activate several enzymes (catalase, peroxides, alcohol dehydrogenase, carbonic dehydrogenase, tryptophan synthetic, etc.) and involve them self in chlorophyll synthesis and various physiological activities by which plant growth and development are encouraged and the greater thickness of spike might be due to Fe and Zn because these micronutrients produce more food material which subsequently increased in the quality parameters, they also help in cell division and multiplication and enhance some physiological processes which are helpful to increase diameter of spike. Similar findings are reported by Chopde *et al.* (2015) in gladiolus Dixit *et al*. (2008) in gladiolus and Ahmad *et al.* (2010) in rose, Data on interaction effect of plant growth regulators and micronutrients did not influenced number of spikes per plant and per hectare during both the years of investigation. The maximum diameter of spike, number of spikes per plant and per hectare was obtained with the combination of CCC 500 ppm + $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% and minimum was recorded in control in the same floral characters during 2017-18 and 2018-19.

The data shown the growth regulators and micronutrients under the present study gave significant effect on number of corms per plant during both the years. The interaction effect was found non-significant during both years. Significantly maximum number of corms per plant was noticed with CCC 500 ppm (1.77 and 1.80 during 2017-18 and 2018-19) followed by GA_3 200 ppm (1.47 and 1.52) during 2017-18 and 2018-19, respectively. The minimum number of corms per plant was recorded 1.29 and 1.28 in 2017-18 and 2018-19, respectively in control (no growth regulator). Data pertaining to number of corms per plant as affected by various treatments of micronutrients M_4 ($ZnSO_4$ 0.5% + $FeSO_4$ 0.2%) was found significantly superior to all the other treatments in respect to number of corm production per plant during both the years (1.62 and 1.64 in 2017-18 and 2018-19, respectively) followed by $FeSO_4$ 0.2% (1.56 and 1.57 during 2017-18 and 2018-19, respectively) which was found significantly at par with M_3 ($FeSO_4$ 0.2%) during both the years. Number of corms per plant was recorded minimum under the application of control (1.41 and 1.43 during 2017-18 and 2018-19, respectively). It is clear from the data indicated in Table-4.25 that the interaction effect of growth regulators and micronutrients gave non-significant effect on the number of corms per plant in gladiolus. The combination of CCC 500 ppm with $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% (1.92 in 2017-18 and 2.03 in 2018-19) gave maximum number of corms per plant. Minimum number of corms per plant (1.27 in 2017-18 and 1.25 in 2018-19) was recorded in control (G_1M_1) during both the years of investigation. Highest number of corms per plant was recorded at CCC 500 ppm as compared to control during both the years of investigation. Similar findings to these results have been obtained in gladiolus by Lakshminarayana (2015), Bhattacharjee (1984), Ram *et al.* (2001) and Kumar (2008) in gladiolus. The micronutrients had significant effect on number of corms per plant, $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% yielded highest number of corms recorded during 2017-18 and 2018-19. Increased the number of corms per plant might be due to micronutrients like $ZnSO_4$ and $FeSO_4$. These are essential component of several dehydrogenase, proteinase, peptidase and promotes plant growth of hormones and closely associated with plant growth, all these factors contributed to cell multiplication, cell division and cell differentiation resulting in increased photosynthesis, translocation and storage of food material which enhanced the number of corms per plant. These findings also recorded by Sharma *et al.* (2004) in gladiolus and Soni *et al*. (2015) in gerbera. The interaction effect of plant growth regulator and micronutrients were found non-significant on corm and cormels per plant during both the years of study. However, the maximum value evaluated from interaction of CCC 500 ppm + $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% and lowest was recorded in control.

As per the data table 1. effect of growth regulators and micronutrients levels on Polar diameter and equatorial diameter of corm during both the years of investigation. The interaction effect of growth regulators and micronutrients was found non-significant during 2017-18 and 2018-19. During both the years, Polar diameter and equatorial diameter significantly increased with application of CCC 500 ppm (2.92 cm in 2017-18 and 3.03 cm in 2018-19, respectively) and (5.51 cm in 2017-18 and 5.72 cm in 2018-19, respectively). The polar diameter was observed minimum in control (no growth regulators) 2.23 cm in 2017-18 and 2.35 cm in 2018-19 and equatorial diameter observed minimum 4.20 cm in 2017-18 and 4.42 cm in 2018-19.The micronutrients significantly affected polar diameter and equatorial diameter of corm. The maximum polar diameter of corm (2.74 cm in 2017-18 and 2.90 cm in 2018-19) and equatorial diameter (5.18 cm in 2017-18 and 5.44 cm in 2018-19)was recorded with the application of M_4 ($ZnSO_4$ 0.5% + $FeSO_4$ 0.2%) which was found at par with M_3 during both the years. The minimum polar diameter of corm (2.50 cm and 2.62 cm) and equatorial diameter (4.71 cm and 4.94 cm) was noted with control in 2017-18 and 2018-19, respectively. Perusal of data on interactive effect of growth regulators and micronutrients indicated significant effect for polar diameter and equatorial diameter of corm. However, combination of CCC 500 ppm with $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% (G_3M_4) produced maximum polar diameter of corm (3.06 cm in 2017-18 and 3.22 cm in 2018-19) an equatorial diameter (5.77 cm in 2017-18 and 6.07 cm in 2018-19). The minimum polar diameter of corm (2.19 cm in 2017-18 and 2.30 cm in 2018-19) and equatorial diameter of corms (4.13 cm in 2017-18 and 4.33 cm in 2018-19) was obtained with control during both years, respectively. This might be due to the fact that reserve food material can be utilized for the productive purpose with restriction on vegetative plant growth due to gibberellins action of cycocel. These results are also similar with the finding of Pragya *et al.* (2010). In the view of micronutrients, The differences in the response of micronutrients with respect to due to the fact that these nutrients (Fe and Zn) activate several enzymes (catalase, peroxides, alcohol dehydrogenase, carbonic dehydrogenase, tryptophan synthetic, etc.) and involve them self in chlorophyll synthesis and various physiological activities by which plant growth and development are encouraged and the greater corm might be due to Fe and Zn because these micronutrients produce more food material which subsequently increased in the quality parameters, they also help in cell division and multiplication and enhance some physiological processes which are helpful to increase polar and equatorial diameter of corms. Similar findings are reported by Munikrishanappa *et al.* (2002). Data on interaction effect of plant growth regulators and micronutrients did not influence polar and equatorial diameter of corms during both the years of investigation. During both the years, number of spikes per hectare increased significantly with the application of CCC 500 ppm (1.63 lakh in 2017-18 and 1.53 lakh in 2018-19, respectively). This might be because reserve food material can be utilized for the productive purpose with restriction on vegetative plant growth due to gibberellins action of cycocel. The increase in number of spikes per plant and increase in yield spike per hectare might be due to the development of large number of spikes as the result of reproductive plant growth and maximum tillers of the plant. Also, the maximum number of leaves in this treatment had accumulated more carbohydrates through photosynthesis and was used for increasing the flower yield. These results are in conformity with the finding of Bhattacharjee (1984), Kumar *et al.* (2008), Sudhakar and Kumar (2012) in the gladiolus.

Number of spikes per hectare (1.63 lakh in 2017-18 and 1.53 lakh in 2018-19) increased significantly with the application of micronutrient treatment (M_4) $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% which was found at par with M_3 and M_2. The differences in the response of micronutrients with respect to spike length might be due to the fact that these nutrients (Fe and Zn) activate several enzymes (catalase, peroxides, alcohol dehydrogenase, carbonic dehydrogenase, tryptophan synthetic, etc.) and involve them self in chlorophyll synthesis and various physiological activities by which plant growth and development are encouraged and the greater thickness of spike might be due to Fe and Zn because these micronutrients produce more food material which subsequently increased in the quality parameters, they also help in cell division and multiplication and enhance some physiological processes which are helpful to increase diameter of spike. Similar findings are reported by Chopde *et al.* (2015) and Dixit *et al*. (2008) in gladiolus. An Interaction effect of growth regulators and micronutrients for number of spikes per hectare was found non-significant during both the years of investigation.

Significantly the maximum yield of corm per hectare was noticed with CCC 500 ppm (1.77 and 1.80 lakh during 2017-18 and 2018-19) followed by GA_3 200 ppm (1.47 and 1.52 lakh) during 2017-18 and 2018-19, respectively. The minimum yield of corm per hectare was recorded 1.29 lakh and 1.28 lakh in 2017-18 and 2018-19, respectively in control (no growth regulator). Data pertaining to number of corms per plant as affected by various micronutrients treatments were presented in Table 1. $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% (M_4) was found significantly superior to all the other treatments in respect to yield of corm per hectare during both the years (1.62 lakh and 1.64 lakh in 2017-18 and 2018-19, respectively) followed by $FeSO_4$ 0.2% (1.56 lakh and 1.57 lakh during 2017-18 and 2018-19, respectively). Yield of corm per hectare was recorded minimum under the application of control (1.41 lakh and 1.43 lakh during 2017-18 and 2018-19, respectively). It is clear from the data indicated in Table 1. that the interaction effect of growth regulator and micronutrients gave non-significant effect on the yield of corm per hectare in gladiolus. The combination of CCC 500 ppm with $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% (1.92 lakh in 2017-18 and 2.03 lakh in 2018-19) gave maximum yield of corm per hectare. Minimum yield of corm per hectare (1.27 lakh in 2017-18 and 1.25 lakh in 2018-19) was recorded with the G_1M_1 (no growth regulator and no micronutrients) during both the years of investigation. This might be due to inhibition of terminal plant growth and stimulation of meristematic cell which would have irrigated the reported corms. The maximum number of corms by application of CCC was reported by Swain (2006), Patel *et al.* (2010), Sudhakar and Kumar (2012) and Singh and Desai (2013) in tuberose are quite agreement with the present study. In the view of micronutrients data pertaining to the yield of corm produced per hectare was significantly influenced by different levels of micronutrients. The maximum yield of corm per hectare among micronutrients was registered with $ZnSO_4$ 0.5% + $FeSO_4$ 0.2%. Increased number of corms might be due to micronutrients like $ZnSO_4$ and $FeSO_4$ is essential component of several dehydrogenase, proteinase, peptidase and promotes plant growth of hormones and closely associated with plant growth, all these factors contributed to cell multiplication, cell division and cell differentiation resulting in increased photosynthesis, translocation and storage of food material which enhanced the number of corms. These findings were also recorded by Sharma *et al.* (2004) in gladiolus and Soni *et al.* (2015) in gerbera. During investigation the interaction between plant growth regulators and micronutrients on yield of the corm per hectare was found non-significant. The combination of CCC 500 ppm + $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% was registered for maximum yield of corm per hectare. The minimum yield of corm per hectare was found in control. Significantly maximum yield of corm per hectare was noticed with CCC 500 ppm (1.77 and 1.80 lakh during 2017-18 and 2018-19). This might be due to inhibition of terminal plant growth and stimulation of meristematic cell which would have irrigated the reported corms. The maximum number of corms and cormels by application of CCC was reported by Swain (2006), Patel *et al.* (2010), Sudhakar and Kumar (2012) in tuberose. $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% (M_4) was found significantly superior to all the other treatments in respect to yield of corm per hectare during both the years (1.62 lakh and 1.64 lakh in 2017-18 and 2018-19, respectively). Increased number of corms might be due to micronutrients like ZnSO4 and FeSO4 is essential component of several dehydrogenase, proteinase, peptidase and promotes plant growth of hormones and closely associated with plant growth, all these factors contributed to cell multiplication, cell division and cell differentiation resulting in increased photosynthesis, translocation and storage of food material which enhanced the number of corms. These findings were also recorded by Sharma *et al.* (2004) in gladiolus and Soni *et al.* (2015) in gerbera. The combination of CCC 500 ppm with $ZnSO_4$ 0.5% + $FeSO_4$ 0.2% (1.92 lakh in 2017-18 and 2.03 lakh in 2018-19) gave maximum yield of corm per hectare. Minimum yield of corm per hectare (1.27 lakh in 2017-18 and 1.25 lakh in 2018-19) was recorded with the G_1M_1 (no growth regulator and no micronutrients) during both the years of investigation.

Table 1: Effect of plant growth regulators and micronutrients on corm production of gladiolus (*Gladiolus grandiflorus* L.) cv. Novalux

Treatment	Number of spikes per plant		number of corms per plant		Polar diameter (cm)		Equatorial diameter (cm)		Number of spikes per hectare		Number of corms (lakh) per hectare	
	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
G_1	1.43	1.33	1.29	1.28	1.43	1.33	1.29	1.28	2.23	2.35	4.20	4.42
G_2	1.53	1.43	1.47	1.52	1.53	1.43	1.47	1.52	2.76	2.90	5.21	5.48
G_3	1.63	1.53	1.77	1.80	1.63	1.53	1.77	1.80	2.92	3.03	5.51	5.72
SEm±	**0.041**	**0.041**	**0.025**	**0.032**	**0.041**	**0.041**	**0.025**	**0.032**	**0.028**	**0.028**	**0.053**	**0.057**
C.D.(P=0.05)	**0.120**	**0.120**	**0.073**	**0.093**	**0.120**	**0.120**	**0.073**	**0.093**	**0.082**	**0.083**	**0.156**	**0.168**
M_1	1.40	1.30	1.41	1.43	1.40	1.30	1.41	1.43	2.50	2.62	4.71	4.94
M_2	1.50	1.40	1.44	1.49	1.50	1.40	1.44	1.49	2.63	2.71	4.96	5.11
M_3	1.57	1.47	1.56	1.57	1.57	1.47	1.56	1.57	2.67	2.81	5.04	5.31
M_4	1.63	1.53	1.62	1.64	1.63	1.53	1.62	1.64	2.74	2.90	5.18	5.44
SEm±	**0.047**	**0.047**	**0.029**	**0.037**	**0.047**	**0.047**	**0.029**	**0.037**	**0.032**	**0.032**	**0.061**	**0.066**
C.D.(P=0.05)	**0.139**	**0.139**	**0.084**	**0.107**	**0.139**	**0.139**	**0.084**	**0.107**	**0.095**	**0.096**	**0.180**	**0.194**
G_1M_1	1.30	1.20	1.27	1.25	1.30	1.20	1.27	1.25	2.19	2.30	4.13	4.33
G_1M_2	1.40	1.30	1.27	1.28	1.40	1.30	1.27	1.28	2.21	2.31	4.17	4.37
G_1M_3	1.47	1.37	1.28	1.28	1.47	1.37	1.28	1.28	2.23	2.35	4.20	4.43
G_1M_4	1.53	1.43	1.36	1.29	1.53	1.43	1.36	1.29	2.28	2.44	4.30	4.53
G_2M_1	1.40	1.30	1.35	1.41	1.40	1.30	1.35	1.41	2.56	2.69	4.83	5.07
G_2M_2	1.50	1.40	1.37	1.49	1.50	1.40	1.37	1.49	2.76	2.92	5.20	5.50
G_2M_3	1.57	1.47	1.56	1.57	1.57	1.47	1.56	1.57	2.83	2.97	5.33	5.60
G_2M_4	1.63	1.53	1.59	1.60	1.63	1.53	1.59	1.60	2.90	3.04	5.47	5.73
G_3M_1	1.50	1.40	1.61	1.63	1.50	1.40	1.61	1.63	2.74	2.88	5.17	5.43
G_3M_2	1.60	1.50	1.68	1.69	1.60	1.50	1.68	1.69	2.92	2.90	5.50	5.47
G_3M_3	1.67	1.57	1.85	1.87	1.67	1.57	1.85	1.87	2.97	3.13	5.60	5.90
G_3M_4	1.73	1.63	1.92	2.03	1.73	1.63	1.92	2.03	3.06	3.22	5.77	6.07
SEm±	**0.082**	**0.082**	**0.050**	**0.063**	**0.082**	**0.082**	**0.050**	**0.063**	**0.056**	**0.056**	**0.106**	**0.115**
C.D.(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

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