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Research Article

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Effect of seed presoaking in gibberellic acid on growth, flowering, and yield of cucumber (*Cucumis sativus* L.) plants

A. A. Sanusi

Department of Plant Production, Faculty of Agriculture, University of Sirte, Libya

ABSTRACT

A field experiment was carried out in the region of Serti, Libya follows completely randomized design with five replicate to evaluate the potential of seed presoaking in different concentrations of gibberellins (0, 5µg/ml, 10 µg/ml and 20µg/ml) on cucumber growth, flowering, and yield. Application of gibberellin (GA_3) significantly increased epicotyls length, and plant height (cm) during flowering and at the end of the experimental period compared to the control plants. Moreover, application of GA_3concentration inducing flowering decreased staminate flower number and increased pistillate flower number. Additionally, the promotive effect of GA3 concentration on plant growth and flowering attributes was accompanied byincreased yield and its components. The treatment of 10µg/ml GA can be used to increase growth and yield attributes in cucumber.

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***Corresponding Author:**
A. A. Sanusi
Email: sasogo2016@outlook.com

KEYWORDS: Gibberellic acid, cucumber, growth, yield

INTRODUCTION

Cucumber (*Cucumissativus* L., Cucurbitaceae) is one of the most important, popular and gainful vegetable plants worldwide.The fruits are extremely nutritive and have very high moisture(95%), extremely small calories (about 15 calories per cup), rich in minerals and vitamins. They contain an elevated quantity of many phytochemicals and antioxidants, among other trace elements [1]. Cucumber is used in folk medicine for many diseases [2]. Also, cucumber has been used as skin protector [3]. Besides their cooling impact on skin, cucumber slices present a lot of profit to the eyes [4]. Now a day, it is broadly used to manufacture different cosmetics interns as face cream and shampoo etc. Cucumber exhibits an attractive variety of floral morphology. Similarly, flower maleness considerably decrease the fruit yield [5]. Adjacent to the maleness problem, cucumber production, particularly throughout late summer, faces numerous problems, including low fruit setting that will affect the yield and the quality [6].

In current years, growth regulating substances (GRS) has been applied in many plants to manipulate the growth and yield. GRS acting a vital function to adjust morpho-physiological aspects of the crops. They should be applied in best concentrations, stage of use, species specificity, seasons etc [5,7,8]. Along with the GRS, gibberellic acid (GA_3) is identified as environmental signals which persuade numerous developmental processes in crops, as seed germination, stem elongation, flowering induction, and fruit set establishment in addition to declining leaf chlorosis [5,8-11]. Furthermore, GA_3 has the larger significance of sex alteration in different cucurbitaceous plants [5,8,12]. The low concentration of GA_3usually delayed the appearance of the first staminate flower and enhances the initiation of pistillate flower [5,8,13]. Although, the GA_3 has to be judiciously designed in terms of precise concentration and stage of application that comprise the main impediments in GA_3 applicability. Keeping this view, the current study was undertaken to assess the role of GA_3 concentration on rising cucumber plant growth, flowering and yield.

MATERIALS AND METHODS

The current study was done at the private farm in Sirte city, Libya during 2013 season. The field experiment was laid out in a completely randomized design with four treatments, i.e., 0, 5, 10, and 20µg/ml GA_3. The treatments were replicated fifth in experimental design. The soil of the experimental plot was sandy loam with moderate fertility.

The seed of Bata Alpha cultivar of cucumber was disinfected by soaking in ethanol 70% for 5 min., then washed three times with distilled water, and, then divided into four groups, for soaking treatments. The sterilized seeds were soaked for 4 hr in aerated GA_3 solutions as well as control. The treated seeds were sown on

10th April in the experimental field at the spacing of 50 x 50 cm. The recommended doses of manures and chemical fertilizers were added following the recommendation of the Ministry of Agriculture, Libya. Throughout the cropping period, all the cultural practices were carried out at typical intervals with the necessity of plant. The plant samples were collected for determination growth, flowering parameters as well as yield and its components.

Growth Parameters

Ten cucumber plants were randomly chosen from the middle part of each experimental plot at 30 days from sowing (DFS), leaving two rows from each side to avoid border effects. Epicotyl length (cm), alternatively, plant height at flowering and at the end of the experiment as well as a branches number per plant was determined.

Flowering Parameters

Flowering date, deliberate as the number of days from planting until the appearance of the first flower, the first pistillate flower as well as the percentage of pistillate and staminate flowers were recorded.

Yield and its Components

Harvesting was done based on the marketable maturity index. The harvesting was done by hand pickings at regular intervals from 55 days from sowing. Five plants were tagged arbitrarily in every treatment for recording the observations on the following parameters; fruit number per plant, mean fruit length (cm), mean fruit weight, and total yield (ton/hectare).

Statistical Analysis

The data were analyzed follow Analysis of Variance (ANOVA) method and mean separations were adjusted by the Multiple Comparison tests [14] using the statistical computer programme MSTAT-C v.1.2. Means were compared by using the LSD test at 5% level of significance.

RESULTS AND DISCUSSION

Growth Parameters

All growth parameters were variable influenced by the application of GA_3 concentration (Table, 1; Figure, 1). The greatest epicotyls length (37%), plant height during flowering (80%) and plant height at the end of the experiment (33%) was recorded with an application of 10µg/ml GA_3; meanwhile,

Table 1: Variance analysis of some growth characters for "Alpha Beta" cucumber cultivar under the treatment with different concentrations of gibberellin (GA_3)

Source	Epicotyl length	Plant height during flowering (cm)	Plant height at the end of the season (cm)	Number of plant branches
Rep.	0.084	358.923	6.392	0.083
GA3 Treat				
A[1] vs. others	0.816***	446.195**	221.018*	0.284
B[2] vs. C[3]&D[4]	1.212***	467.160**	1068.760***	3.294**
C vs D	0.12	211.939*	217.202	0.735
Error	0.035	27.014	25.812*	0.211

*Significance at significant at level of <0.05, **significance at significant level <0.01, ***significance at significant level <0.001

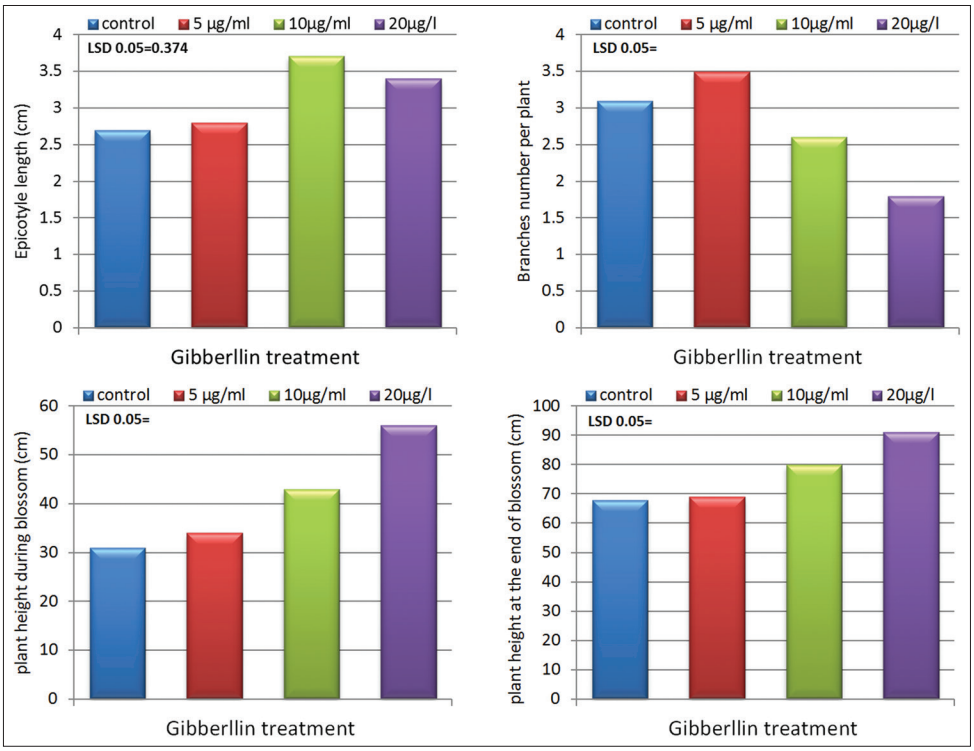

Figure 1: Effect of different concentrations of GA_3 on growth attribute of cucumber plants

the maximum branch number per plant (12%) was obtained by application of 5μg/ml GA, as relative to untreated control plants or the other GA concentration.

There are numerous reports showing that GA_3 promote the growth of intact plants [5,8,15,16]. In this concern, [10,11] found that the exogenous application of GA_3concentration on cucumber plants significantly increased growth parameter and seed germination compared the treatment of the control. The encouragement on growth either in terms of a boost in the epicotyls length and plant height has been thought to be by rising plasticity of the cell wall afterward hydrolysis of starch to sugars that lowers the water potential of cells, leading to the entrance of water into the cell causing elongation. These osmotically driven responses under the influence of GA_3 might have recognized to rise in photosynthetic activity, accelerated translocation and efficiency of utilizing photosynthetic products, so resulting in improved cell elongation and rapid cell division in the growing portion [17].

Flowering Characters

Data presented in Table (2) and figure (2) showed that flowering behavior in cucumber was influenced by various doses of GA_3. Among all the treatments, 10 μg/ml was found to be most effective in reducing number of days required for appearance of first flower formation, which followed by 5 μg/ml, and 20 μg/ml GA, while maximum time taken for flowering was observed in control. Similarly, the minimum number of the male flower was produced in plants sprayed with 10 μg/ml. The maximum female flowers number was examined in the treatment of 10 μg/ml GA, while minimum numbers of female flowers were counted under the control condition.

Exogenous application of GAs has been reported in many plants [5,8,9,18,19]. Early flowering of treated plants, possibly owing to stimulation of tendency of femaleness in the plant resulted from the early induction of flowers [5,8] and contribute an extremely vital function in the regulation of flowering [20-23].

These results are owing to the genetic factors related to cultivar and environmental conditions during flowering in addition to the plant hormonal balance where genetically there are monoecious, gynoecious, and romonoecious and hermaphrodite species [24]. [25] indicated that there are two major genes that control sex expression in cucumber which are M "gives pistillate flowers in its existing form (M) and give hermaphrodite flowers in its recessive form (m)" and F (prevailing over M gene)

Table 2: Variance analysis of some flowering characters for "Alpha Beta" cucumber cultivar under the treatment with different concentrations of gibberellin (GA_3)

Source	Flowering date	First pistillate flower node	Pistillate flower (%)	Staminate flower (%)
Rep.	5.083	1.083	0.003	0.446
GA3 Treat				
A[1] vs. others	28.444***	5.444***	0.002	9.849
B[2] vs. C[3]&D[4]	3.555*	0.222	0.007*	77.211**
C vs D	16.667***	0.666	0.001	4.167
Error	0.306	0.194	0.001	4.146

*Significance at significant at level of <0.05, **significance at significant level <0.01, ***significance at significant level <0.001

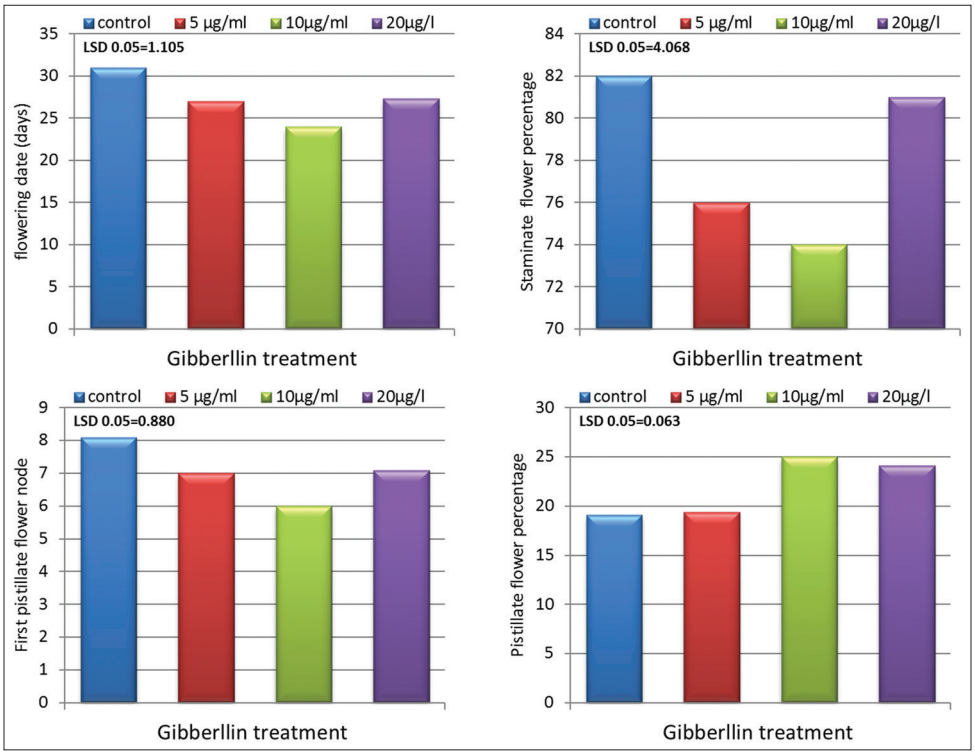

Figure 2: Effect of different concentrations of GA_3 on a flowering attribute of cucumber plants

"it gives pistillate flower in its prevailing form (F),and gives staminate flowers in recessive form (f)", and so phenotypic genetic structures M-F-, M-ff, mmff, and mmF- pistillate plants, single-sex and single-dwelling plants, both masculine and hermaphrodite plants, and masculine plants correspondingly. Consistent with the impact of environmental factors on the sex ratio of cucumber it was found that the long day and relatively high temperatures increase the number of staminate flowers over the number of pistillate flowers on the plant, and vice versa, the short day and the moderate heat increase the number of pistillate flowers compared to the number of staminate flowers on plants [26].GA_3 reduced the male flower initiation with the most favorable doses in the current investigation that might be owing to the reality that they are at the optimum level known to reduce the mobilization of photosynthates. Comparable results were also previously indicated by [5,8,27].

Yield and Yield Attributing Parameters

Data pertaining from Table (3) and Figure (3) reported that the diverse doses of GA_3 application were given considerable influences throughout the experimental year. In the current table and figure data obviously designate that 10µl/ml GA_3 was significantly enhanced concerning yield contributing parameters with the judgment of other doses, while lower yield was recorded under control treatment.

The most important enhancement in fruit formation might be owing to GA_3 increases the metabolic activity of plant that resulted in augmentation of reproductive phase in cucumber and increased the yield and its components. These results are in close agreement with the conclusion of [5,8,28]. In this concern, [11] found that treatment of cucumber plants with GA increased yield and improved its components as well as shortened the fruit maturation period growth, s.

It was found that the treatment with effective concentration of GA_3 (10 µg/ml) leads to an increase in cucumber yield, this increase may be attributed to several reasons reported by [29]; (a) treatment with GA_3concentration at 10µg/ml produced a high number of pistillate flowers (80.4%) relative to the rest of the treatments including the treatment of the control that produced 75% staminate flowers, this provides a superior chance to give a big quantity of elevated dynamic pollen grains that increases the occasion of achievement of the excellent fertilization for pistillate flowers, (b) the effect of GA_3treatment on the vitality and the quantity of pollen grains and consequently excellent fruits setting, (c) GA_3motivatesynthesis of protein, RNA, DNA,

Table 3: Variance analysis of yield and its components for "Alpha Beta" Cucumber cultivar under the treatment with different concentrations of gibberellin (GA_3)

Source	Number of fruits/plant	Mean fruit weight (g)	Mean fruit length (cm)	Total crop (ton/ha)
Rep.	2.333	2282.6	0.931	1.433
GA3 Treat				
A[1] vs. others	0.694	462.25	0.538	0.343
B[2] vs. C[3]&D[4]	0.222	180.5	5.335**	0.089
C vs D	6.000***	5104.167***	15.360***	1.228**
Error	0.222	158.14	0.399	0.095

*Significance at significant at level of <0.05, **significance at significant level <0.01, ***significance at significant level <0.001

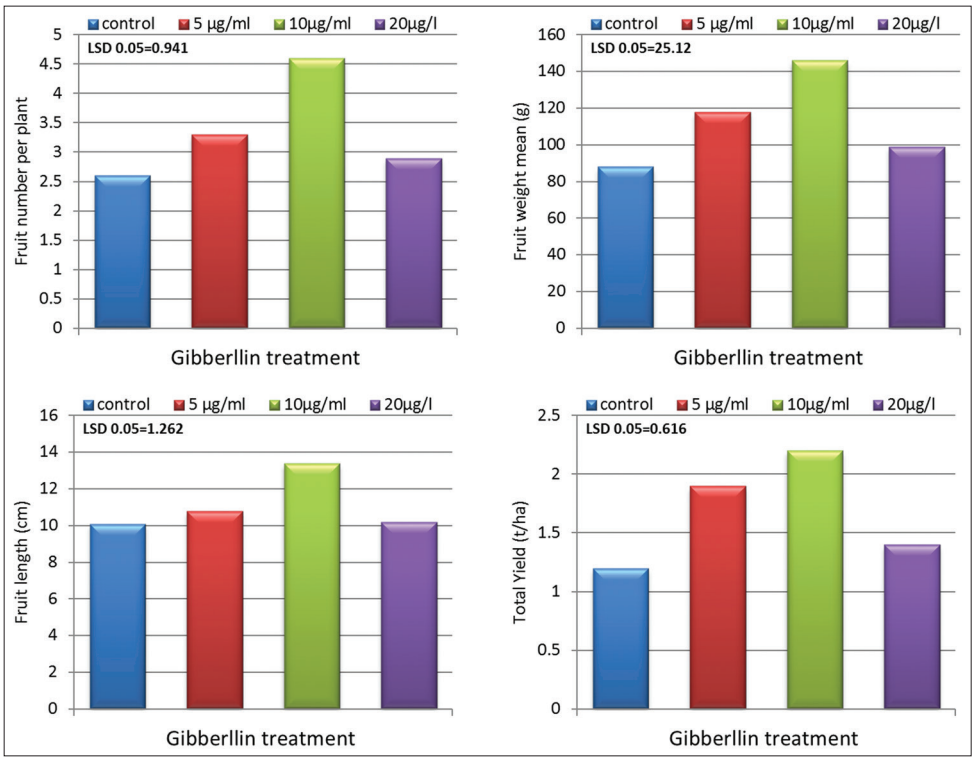

Figure 3: Effect of different concentrations of GA_3 on yield and its components of cucumber plants

ribose and multi-ribose duplication, that have a encouraging effect on the flowers production, pollination, fertilization and fruit setting; (d) GA_3 stimulates the enzymatic activity, that has a large effect on the accretion of nutrients in crops, particularly with the advanced plant ages and (e) GA_3 boost the permeability of the cells plasma membrane and so facilitate the absorption and utilization of nutrients and also facilitate the transmission of metabolic products.

CONCLUSION

On the basis of an outcome obtained from the current investigation concluded that the impact of GA_3 on growth, flowering and yield in cucumber was giving considerable impact as compared to untreated one. Amongst all the treatment, application of 10 µg/ml GA_3 was established to the majority appropriate for improving growth, flowering performance, and fruit yield.

AUTHOR CONTRIBUTION

The author designed and conducts the experiment as well as writes the manuscript

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