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Response of Cucumber Plants to PGPR Bacteria (*Azospirillum brasilense*, *Pseudomonas Fluorescens* and *Bacillus Megaterium*) and Bread Yeast (*Saccharomyces cerevisiae*)

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ABSTRACT

This investigation was conducted out at the Directorate of Diyala agriculture, Baqubah nursery, Iraq during January 2019 to, May 2019 to assess the response of Cucumber (*Cucumis sativus* L.) to PGPR bacteria containing (Azospirillum *brasilense*, *Pseudomonas fluorescens* and *Bacillus megaterium*) as commercial formulation and different levels of bread yeast (*Saccharomyces cerevisiae*) viz. 0,4,8 and 12%. The experiment was laid out in Randomized Complete Block Design consisting of 8 treatments with three replicates for each treatment. The results showed that using PGPR + yeast 8% and PGPR + yeast 12% gave significant increment in most studied traits compared to the other treatments such as the total number of fruits (183 and 178), plant height (200.5 and 201.8 cm), total weight of fruits/kg (18.9 and 20.056 kg) and total weight of fruits ton/hectare (37.8 and 40.11 ton/hectare) respectively.

Keywords: *Cucumis sativus*, *Azospirillum brasilense*, *Pseudomonas fluorescens*, *Bacillus megaterium* and *Saccharomyces cerevisiae*

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INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important crops that grown in Iraq. Cucumber crop belongs to the Cucurbitaceae family, it is cultivated for fresh fruits or pickles [1]. The cucumber crop grows in spring and autumn seasons in the fields or green houses as well as plastic tunnels In Iraq and there are several ways to application of chemical fertilizers on cucumber crop such as added before planting or with irrigation water or as foliar spraying [2]. Excessive use of chemical fertilizers not only affects fruit quality, but also causes environmental pollution [3]. Few of Iraqi farmers are using organic fertilizers and barely they use bio fertilizers in the soil, due to just they depend on chemical fertilizers. Bio-fertilizers are living microorganisms which colonize the rhizosphere zone and play important role in facilitating uptake of the essential nutrients required by the plant. Plant growth promoting rhizobacteria (PGPR) are free living bacteria and inhabiting in rhizosphere region, that have a positive impact on the growth and development of the plant [4,5]. The contribution of PGPR in plant growth through the mechanisms that include the activation of plant defense responses [6,7].The competition with deleterious microorganisms [8] and secretion of plant growth regulating substances such as auxins, cytokinins and bacterial volatiles [9,10,11,12]. There are diverse genera of bacteria such as Azospirillum, Pseudomonas and Bacillus belong to PGPR that have been recognized from different plants such as a barley, rice and bean [13,14,15]. Azospirillum possess the ability to fix atmospheric nitrogen to enhance plant growth [16], besides it has several mechanisms, including minimizing the negative effects of biotic and abiotic stresses, favouring beneficial mycorrhizal- plant associations, nutrient solubilisation, phytohormone production and Fe sequestration [17]. Several Pseudomonas species are the most efficient microbes in phosphorus- solubilizing, act as important bio fertilizers in improving soil nutrient, suppression of soil borne pathogens and secretion of plant growth regulators [18,19]. It has been found that *Bacillus megaterium* is one of the most efficient microbes in phosphorus- solubilizing [20]. *B. megaterium* **is** widespread in soil [21]. It possesses a high capacity for the production of exoenzymes and some very useful enzymes [22]. The bread yeast *Saccharomyces cerevisiae* is a kind of bio-fertilizers used in soil fertilization or as a foliar application on the shoots of vegetable plants [23], due to its content of stimulative growth regulators compounds such as cytokines, gibberellins, auxins and nutrient elements, these growth regulators compounds act improving plant cell division and growth [24], it also contains amino acids, proteins, vitamins and sugar [25]. The objective of this study was to assess the beneficial effects of foliar spraying of different levels of active yeast suspension and adding bio-fertilizers that included *Azospirillum brasilense*, *Pseudomonas fluorescens* and *Bacillus megaterium* on vegetative traits of Cucumber.

MATERIALS AND METHODS

Collection of Cucumber seeds, bread yeast and PGPR bacteria

Cucumber seeds that belong to local variety (Alfred) were obtained from Baqubah nursery, bread yeast from the market, whereas PGPR bacteria as commercial formulation that included (, *A. brasilense*, *P. fluorescens* and *B. megaterium*) was obtained from a ministry of science and technology.

Field experiment

The present study was carried out in the Directorate of Diyala agriculture, Baqubah nursery, Iraq during the season 2019. Seeds of Cucumber cv. Alfred were sown in cork dishes on 25/1/2019 then the seedlings were transferred to the field on 3/3/2019 in rows with distances between them 100 cm and between plants were 50 cm with cultivation depth 7 cm which arranged in Randomized Complete Block Design (RCBD) with three

replicates where each replicate contain ten plants with eight treatments which included T1 yeast 0%, T2 yeast 4%,T3 yeast 8% ,T4 yeast 12%,T5 bio-fertilizers with yeast 0%,T6 bio-fertilizers with yeast 4% ,T7 bio-fertilizers with yeast 8% ,T8 bio-fertilizers with yeast 12%. The experimental field with area 315 m^2 (35×9) was prepared for cultivation by plowing, disking and ridging, then taking soil samples representing the depth of plowing (0 - 0.15 m) in order to record the physical and chemical properties of the soil, as set out in (Table 1). Seedlings were inoculated by soaking their roots in the bacterial suspension for five minutes before transplanting, the bacterial suspension consists of 100 g /1.5-liter distilled water, whereas the active yeast suspension with different concentrations (0,4,8 and 12%) was sprayed on the plants at 1.5 liter/ treatment on 15/4/2019. The water irrigation was pumped through the drip irrigation system, NPK fertilizer (15-30-15) was applied at a rate of 1.5 liter on 18/4/2019 and re applied at a rate of 1.5 liter with 0.5 liter of humic acid on 28/4/2019. The following measurements were recorded for 10 random plants per treatment such as total number of fruits, plant height/plant, total chlorophyll, total weight of fruits / kg and total weight of fruits ton / hectares.

Preparation of yeast suspension

Dry yeast suspension was prepared by dissolving 4,8 and 12 g of yeast each of them in a liter of distilled water, followed by adding 2 g sucrose to activate of yeast and kept 19 hours at a room temperature before using [26].

Statistical analysis

the data was analyzed by one way Analysis of Variance (ANOVA) [27].

Table 1: The physical and chemical properties of the soil before planting

Measurements	Value	Unit of measurement
Clay	328.1	g / kg soil
Silt	280.1	g / kg soil
Sand	391.8	g / kg soil
Texture of soil	Mixed clay	-
CaCO3	276.13	g / kg soil
Organic matter	1.4	%
N	34.89	mg / kg soil
P	8.13	mg / kg soil
K	347.30	mg / kg soil
Ca	17.45	mill mole / liter
Mg	16.05	mill mole / liter
Na	2.36	mill mole / liter
HCO3	7.9	mill mole / liter
Cl	14.5	mill mole / liter
So_4	20.85	mill mole / liter
Co_3	0.0	mill mole / liter
Ec	5.93	ds Siemens \ m
PH	7.82	-

RESULTS AND DISCUSION

The presented data in figure (1,2,3) showed that the total number of fruits and plant height were significantly increased in treatment 7 that included (PGPR and yeast 8%) which reached 183 , 200.5 cm respectively, and treatment 8 (PGPR and yeast 12 %) which reached 178, 201.8 cm respectively, whereas no significant differences in total chlorophyll between treatments**,** figure (4 and 5) showed that a treatment 8 was significantly superior from other treatments in an increment of the total weight of fruits / kg, which reached 20.056 kg and total weight of fruits ton / hectare which reached 40.11 ton followed by treatment 7 which reached 18.9 kg and 37.8 ton respectively. From the above results, it is concluded that all growth traits of Cucumber were increased by combining between bio fertilizer that included (*A. brasilense* , *P. fluorescens* and *B. megaterium*) with bread yeast at concentration 8 and 12 %, this is agreeing with [28]**.** [29,24,30] who reported that enhancement of cucumber growth traits may refer to the ability of yeast to increase the production of plant growth regulators, such as Cytokinins, Auxins and Gibberellins which work to improve the plant cell division and its growth. Spraying of yeast led to significantly increased in the yield and vegetative growth of cucumber [31]. [32] reported that the foliar application of yeast suspension at rates of 3 and 6 g/ L^{-1} on cabbage plants led to record of highest values of vegetative growth traits as compared with non-spraying 0 g / L^{-1}. Spraying of bread yeast resulted in significant positive differences in all yield traits of cucumber in as compared to the control (untreated) [33]. [34] reported that spraying of yeast at 20 g/l on cucumber plants gave significant differences in most studied characteristics compared to untreated control such as an increase of total yield to 16.780 and 16.527 ton/ feddan in two seasons. The response of Cucumber plants to the yeast may be due to yeast content from proteins, vitamins, free amino acids and the different elements such as P, K, Mn, CA, Mg, BA, Zn and Fe, which may play a role in the growth enhancement [35]**.** The bio fertilizers that included *Pseudomonas fluorescens* combined with *Azotobacter chroococcum* led to enhancing of growth performance, nutrition, and increment in broccoli and cabbage yield [36,37]. [38] reported that Azospirillum plays a major role in promoting root growth and enhancing plant growth characteristics through IAA production, also Azospirillum

inoculation led to increase plant height, leaves number, stem diameter, plant dry weight, length and density of roots and fine root hairs and yield of some cereal crops. Application of *Azospirillum brasilense* on tomato resulted increased seedling dry weight, leaves number and circumference of stem [39]. Inoculation of maize with Azospirillum strains led to the emergence and development of seedling in early time and increased leaf surface area [40] .[16,41] reported that inoculation of *Azospirillum brasilense* led to enhancement of growth parameters of wheat that included germination, flowering, dry weight of shoots and roots seedling development and yield. Tomato seedlings inoculation with *Azospirillum brasilense* strains (Sp245 and Sp7) resulted in increase of plant height, fresh and dry seedling biomass, root length and the leaf area [42]. [43] reported that significant increases in surface of leaf area, dry shoot weight, dry root weight, and root length of tomato plants inoculated with *Azospirillum brasilense* . The improvement of tomato seedling growth could be linked to the performance of the bacteria through production of growth regulators that change root morphology and leading to enhanced nutrient absorption and water [44]. [45] reported that application of *Pseudomonas fluorescens* with spent mushroom compost in solarized soil resulted to increase of tomato plant vigour in vegetative growth characteristics and reduced the Fusarium wilt disease. [22] reported that Bacillus *megaterium* led to an increase of germination, height and weight of soybean plants. *Bacillus megaterium* has excellent potential to improve tomato and cucumber during an increase the yield, growth and mineral contents [46]. Inoculation of *Pseudomonas fluorescens* and spent mushroom compost possess a major impact on the number and weight of tomato fruits with a cost-benefit ratio as compared to the control treatment [3]. Application of *B. megaterium* resulted in enhancement of cabbage transplant growth through increase of fresh shoot weight, fresh root weight, dry root weight, root diameter and root length [47]. [48] reported that all cauliflower growth characteristics have been improved by the use of plant growth promoting rhizobacteria (PGPR) that included (*Bacillus megaterium*, *Azospirillum brasilense* and *Pseudomonas fluorescens*) with a gradual rise in nitrogen and phosphorus concentrations from 25% to 100% compared to the use of chemical fertilizer alone.

CONCLUSION

The combination between foliar spraying of active dry yeast as stimulated doses (8 and 12 %) with PGPR bacteria that included (*A. brasilense*, *P. fluorescens* and *B. megaterium*) were significantly superior in vegetative growth traits of cucumber plants

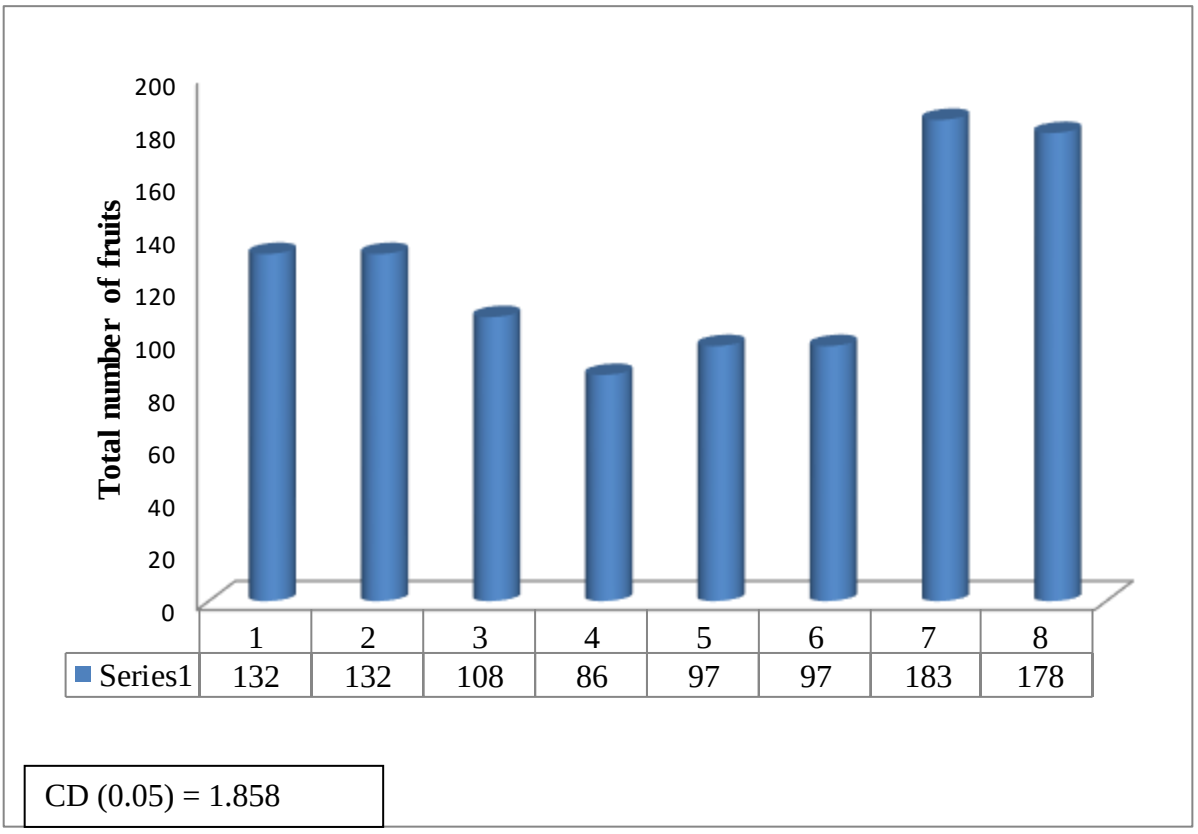

Fig 1. Effect of yeast suspension and bio fertilizers on total number of fruits

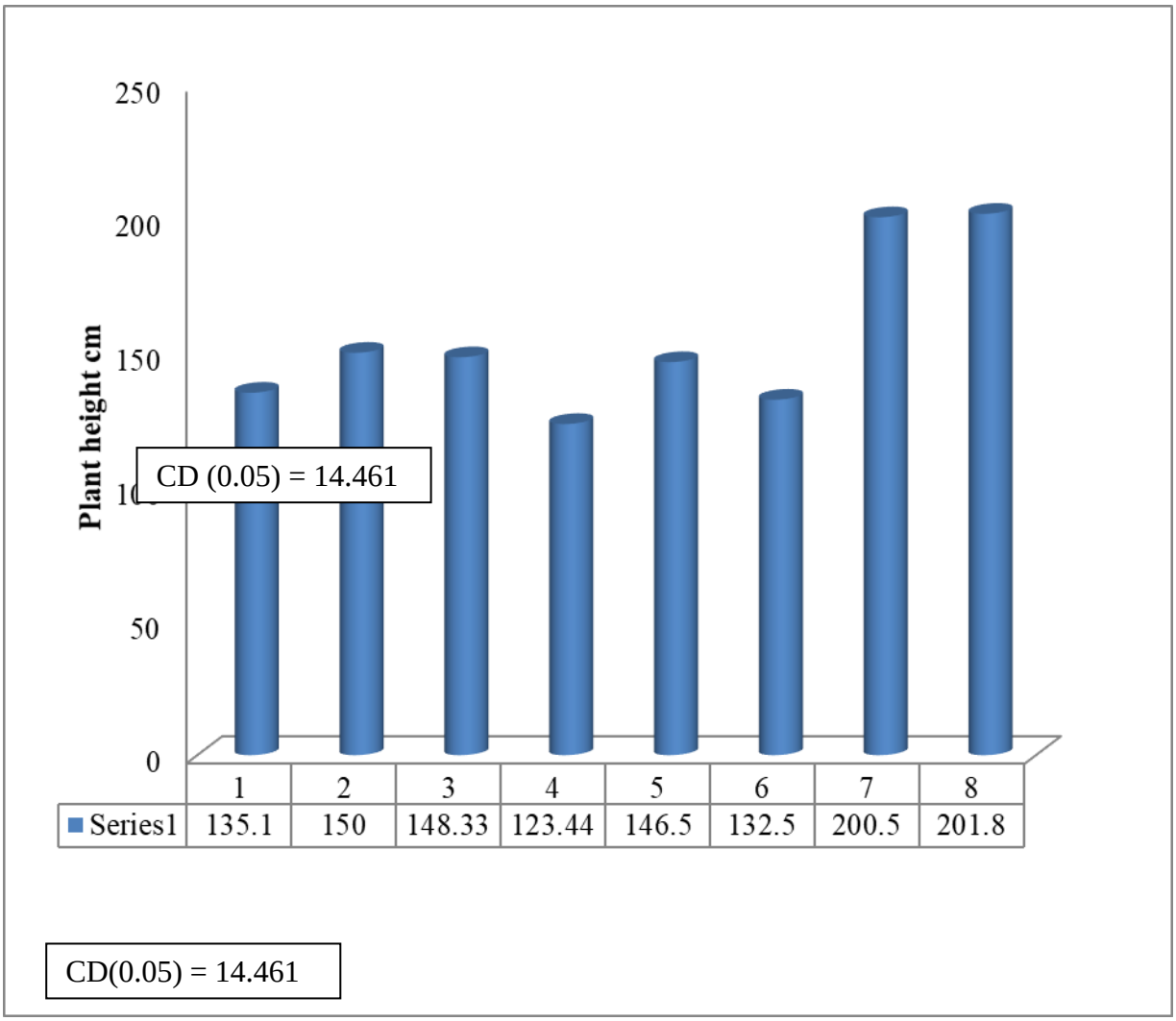

Fig 2. Effect of yeast suspension and bio fertilizers on plant length

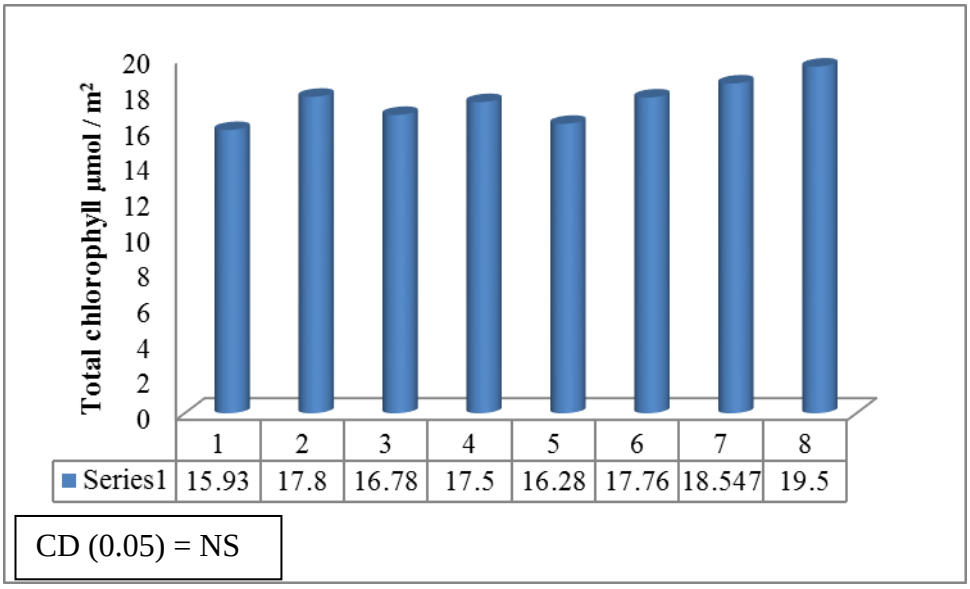

Fig 3. Effect of yeast suspension and bio fertilizers on total chlorophyll

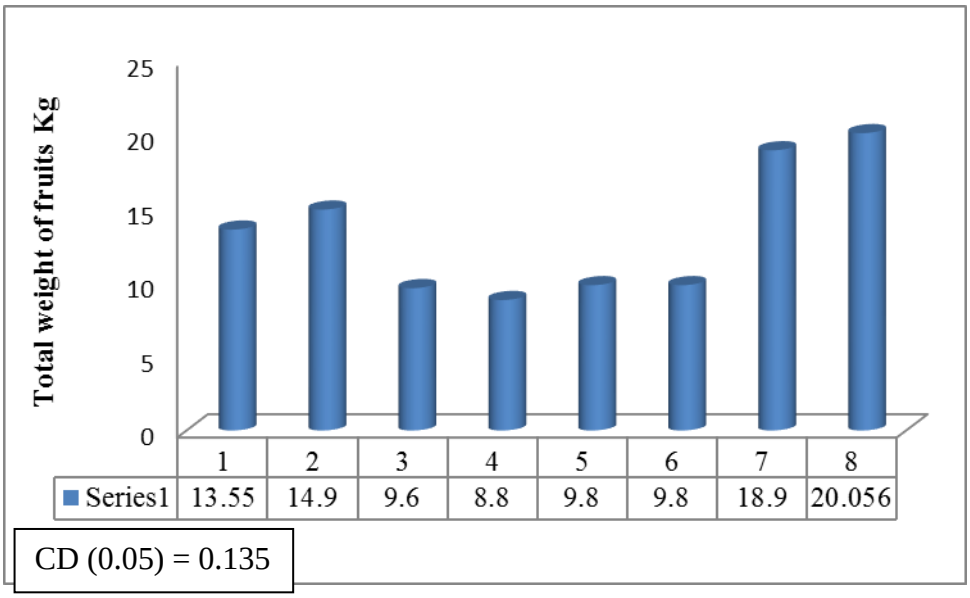

Fig 4. Effect of yeast suspension and bio fertilizers on total weight of fruits/kg

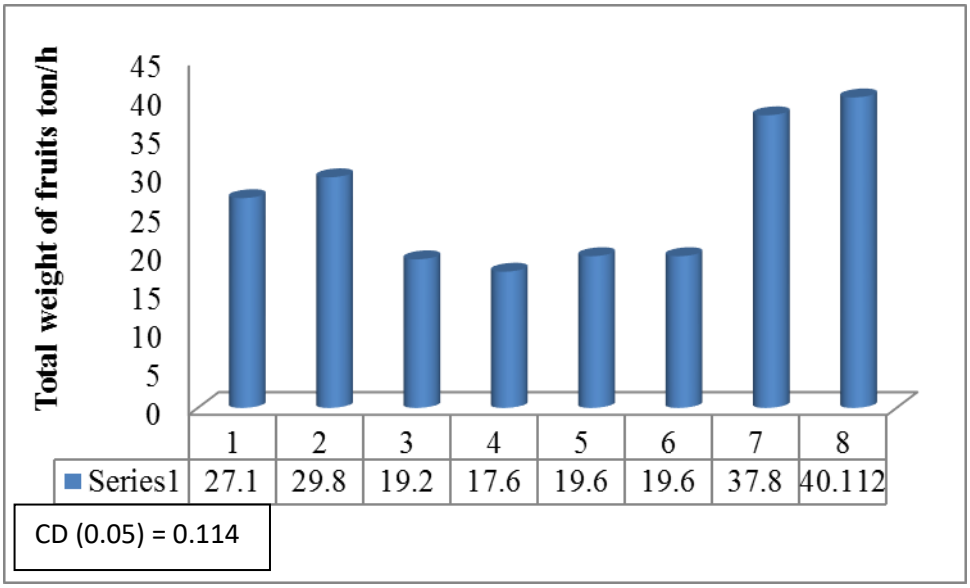

Fig 5. Effect of yeast suspension and bio fertilizers on total weight of fruits ton/ hectare

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