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Efficacy of some bio-fertilizer types on growth and yield of Radish (*Raphanus sativus*)

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Abstract:

Experiment was conducted at unheated green house directorate of agricultural researches - plant breeding center, Al-Tuwaitha station, 40 km southeast of Baghdad, this study was carried out to evaluation efficiency two of biofertilizers agents it is both irradiated isolation Trichoderma harzianium fungi (T.26) and unirradiated Azotobacter chroococcum bacteria and interactions between them on growth and yield of radish cv. long scarlet. The experiment included 4 treatments within randomized complete block design with three replicates.

The results showed that the plant height was significantly increased by application of biofertilizers and it was maximum under microorganism combination treatment (T3) i.e. T. harzianum + A. chroococcum (1 gm) that gave (14.99, 25.51, 63.67) cm for each period respectively. Also the same treatment gave highest number of leaves, Root length and root diameter were significantly influenced by biofertilizers.

Highest root length (48.98 cm) was recorded with T. harzianum + A. chroococcum. This treatment was the best for fresh and dry weight of plant and gave highest values in all indicators that have been measured. The study showed that combination application of T. harzianum + A. chroococcum was found more beneficial and

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significantly improved growth and yield of radish grown under unheated green house condition.

Key words: Radish, biofertilizers, *Azotobacter, Trichoderma*, Growth, Yield.

INTRODUCTION

Radish (*Raphanus sativus* L.) belongs to the family Brasicacceae. It is a popular root vegetable in both tropical and temperate regions, it is grown for tuberous root which is used either cooked or row also is a good source for vitamins especially vitamin c and some important minerals such as calcium, potassium and phosphorus. The roots are also useful in urinary complaints and piles. The leaves of radish are good source for extraction of protein on a commercial scale and radish seeds are potential source of nondrying fatty oil suitable for soap making illuminating and edible purposes.Being a short duration and quick growing crop, the root growth should be rapid and uninterrupted. Hence, for the production of good quality radish, optimum nutrition with organic, inorganic and biofertilizers are essential for sustainable production. (1, 2, 3).

In view of higher cost of synthetic fertilizers and its contribution to poor health of soil and water it becomes imperative to go for alternative and cheaper source like biofertilizers. With this background, the present investigation was carried out to study the effect of biofertilizers on growth and yield of radish under field condition.

A major focus in the coming decades would be on safe and eco-friendly methods by exploiting the beneficial micro-organisms in sustainable crop production (4) beneficial microbes associate with plants in several ways. Some may inhabit the rhizosphere, taking advantage of root exudates; others may live on root or leaf surfaces and some may colonize intracellular spaces and vascular tissues inside the plant (5).

Such microorganisms, in general, consist of diverse naturally occurring microbes whose inoculation to the soil ecosystem advances soil physicochemical properties, soil microbes' biodiversity, soil health, plant growth, development, prevent diseases and crop productivity (6, 7).

Nitrogen fixing microorganisms are genera Azotobacter that generate ammonia for their own use and provide the plant with nitrogen as an exchange for carbon and protected habitat (8).

Azotobacter belongs to the family of Azotobacteraceae which include various gram negative, aerobic, heterotrophic, catalase positive, free living diazotrophic bacteria. Beside nitrogen fixation they are well known for the abilities of IAA production and siderophore production (9).

T. harzianum is a fungal genus found in many regions of the world (10). These fungi grow as symbiotic relationships with plants and they promote abundant root growth so that they have plenty of roots to grow. *Trichoderma* species have been widely studied for their capacity to enhance plant growth, produce antibiotics, parasitize other fungi and compete with deleterious plant microorganisms so that they are used as biofertilizers (11, 12). Recently, several attempts have been undertaken to apply *Trichoderma* spp. as bio stimulants of seedling establishment, enhancement of plant growth (13, 14).

The techniques of mutations radiological the most important means to obtain the suitable mutations, mutation is the change in the DNA segments which produces an error during the copies of DNA thus change in the order of nucleotide bases in DNA, the use of gamma rays can cause some mutations to cell genes through mechanical processing of DNA within cells thus changing the molecular construction through structural change to the genes.

MATERIAL AND METHODS

The unheated green house experiment was conducted at Agricultural Researches Center- plant breeding center atomic energy location, southeast of Baghdad.

Basins built of brick were prepared with height of (0.6 m), width of (1.25 m), length of (5.0 m) and side-slope of 10%, lined with salt resistant cement , covered with polyethylene nylon to prevent erosion caused by salts, a perforated plastic tube with diameter 4 inch put at the low corner to the bottom of the basin to help in the discharge of excess water after watering (drainage), and basins filled with revier bottom sand with the physical and chemical specifications set out in (Table 1) was washed with tap water several times to get rid of the salt sticking out. Soil covered with polyethylene transparent thickness of 0.8 micrometer was sterilized by solar for the period from mid-january 2015 until mid April 2015, then after the cover lifted was sterilized chemically using fungicides and insecticides Koldonol 50% and Fjordane 10% consequently and according to the manufacturer's recommendations. Insect traps stickers were hanged in different places of the greenhouse to determine the insects entering the greenhouse to deal with them immediately before further infestation. The seeds of radish cv. long scarlet were purchased from Iraqi market. These Seeds were planted in the pre-prepared basins in a distance of 15 cm between plants and 45 cm between lines, the number of seeds were 30 per each experimental unit and up to three replicates per treatment.

Table 1: Some Physical and Chemical Specifications in Soil

Type analysis		**Measuring unit**	**Analysis results**
pH			7.45
Ec		dSm^{-1}	1.04
positive and negative Ions dissolved $Mg.L^{-1}$	Ca^{++}	$Mg.L^{-1}$	118
	Na^{++}	$Mg.L^{-1}$	95
	K^{+}	$Mg.L^{-1}$	105
	Mg++	$Mg.L^{-1}$	74

	Cl^-	$Mg.L^{-1}$	120
	HCO_3	$Mg.L^{-1}$	68
	Carbonate minerals	$Gm.kg^{-1}$	250
Available nitrogen		$Mg.L^{-1}$	26
	Proportion of silt	$Gm.kg^{-1}$	172
	Proportion of clay	$Gm.kg^{-1}$	46
	Proportion of sand	$Gm.kg^{-1}$	782
	Soil texture		Sandy loam

These were arranged in 4 treatments and replicated thrice following Randomized Complete Block Design. Thinning was done at 10 days after sowing by rotation one seedling per hill. The biofertilizers under study represented by inoculants of *A. chroococcum* (T1), *T. harzianum* (T2), and combinations of T. *harzianum* + *A. chroococcum* (T3) and control treatment without inoculums (T4).

The microbial inoculants used in the study are as follows: *A. chroococcum*. The final product had a population of $8×10^7$ cfu. g^{-1} carrier and was applied as soil application at the rate of 10 kg/ha.

Irradiated isolation of. *T. harzianum* (T.26) have been prepared by using gamma rays produced from Cobalt-60 (Co60) with note program that included irradiated in different dose 20, 40, 60 and 80 K rad and elected mutagens isolation dose 60 K rad and this dose selected for optimum dose of induced mutation in *Trichoderma* because it achieved results in previous researches. The final product had a population of $4×10^6$ cfu. g^{-1} and the inoculum was added at the rate of 5 kg/ha. These types of microbes obtained from the laboratories of the agricultural research center.

After sowing the observations were taken on their vegetative growth and yield parameters. The recorded observations were statistically analyzed using analysis of variance and the mean values were compared at 5% level of significance in Genstat analysis program.

RESULTS AND DISCUSSION

The results showed that application of biofertilizers improved plant height in comparison to control, in general (Table 2). Among the various biofertilizers, combined application of *T. harzianum* + *A. chroococcum* (T3) followed by *A. chroococcum* (T1) were the best for improvement of plant growth paramerters at 30 , 45 and 60 days after sowing(DAS) ,Table (2).

The effects due to *T. harzianum* + *A. chroococcum* (T3) were significant. In case of number of leaves per plant at 30, 45 and 60 DAS, treatment with *A. chroococcum* (T1) showed the maximum number of leaves per plant followed by *T. harzianum* (T2) however their effects were statistically at par. Application of (T3) Plant height at 30, 45 and 60 DAS was the highest (14.99, 25.51 and 63.67 cm) each of them respectively, while in control treatment (T4) recorded (7.11, 15.93 and 46.58 cm) each of them respectively, While in measuring of leaves number the same treatment (T3) gives (5.08, 19.82 and 23.33 leave. Plant) each of them respectively, While in control treatment (T4) recorded (3.40, 8.91 and 14.82 leave. Plant) each of them respectively, the results of this research confirmed the potential use of the *T. harzianum* for plant growth promotion as reported previously (16).

Table (2). Effect of biofertilizers on plant height, leaves number and length of leaves of radish

Treat.	Plant height (cm)			Number of leaves			Length of leaves (cm)		
	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS	30 DAS	45 DAS	60 DAS
T1	11.54	22.45	57.19	4.72	15.44	18.96	7.27	15.28	15.33
T2	10.07	19.85	53.14	4.15	14.71	17.19	7.11	15.02	15.17
T3	14.99	25.51	63.67	5.08	19.82	23.33	7.92	17.11	17.34
T4	7.11	15.93	46.58	3.40	8.91	14.82	5.46	13.01	13.82
Mean	10.93	20.94	55.15	4.34	14.72	18.58	6.94	15.11	15.42
L.S.D	1.04	2.15	6.56	0.63	2.07	2.19	1.12	1.23	1.14

T1=*Trichoderma harzianum*, T2= *Azotobacter chroococcum*, T3= *Trichoderma harzianum*+ *Azotobacter chroococcum*, T4=Control.

In parameter of length of leaves, combination treatment between fungi and bacteria (T3) increased the length of leaves which recorded highest value compared with other treatment which has given (7.92, 17.11 and 17.34 cm) each of them respectively while control treatment gives lowest value which has given (5.46, 13.01 and 13.82 cm) each of them respectively.

Data presented in Table 2 show that inoculation of radish seeds that the variety long scarlet with the different biofertilizers types increased significantly highest when application of *T. harzianum*+ *A. chroococcum* (T3) followed by *A. chroococcum* (T1) on the process of growth and on yield among the treatments studied.

In total plant fresh weight combination treatment between fungi and bacteria (T3) gives (540.37) g compared with control treatment which gives (260.56) g, the same treatment gives highest value in all of the root fresh weight, root dry weight, root length, root diameter and leaf Fresh and dry weight which recorded (540.37 g , 82.51 g , 9.45 g , 48.98 cm , 18.82 cm , 457.86 g, 24.10 g) for each of them respectively followed by *A. chroococcum* (T1) While in control treatment (T4) gives lowest value (260.56 g , 34.58 g , 2.93 g , 19.40 cm , 14.91 cm , 225.98 g, 13.82 g) in same parameters respectively.

The results are in conformity with the finding of (6) when Inoculate of rice plant with Azotobacter.

The result obtained in this study clearly indicate that radish respond well to application of *T. harzianum*+ *A. chroococcum* (T3) This is consistent with what was found(17) When inoculated sour orange seeds with *T. harzianum* This may be due to the ability of these microorganisms on production of plant hormones(18).

Table (3). Effect of biofertilizers on weight of plant, roots, leaves and root length and diameter of radish (after 60 days).

Treat.	Total plant Fresh weight (g)	Root fresh Weight)g(	Root Dry weight (g)	Root length (cm)	Root diameter (cm)			Leaf weight (g)	
					Upper side	middle side	Lower side	Fresh weight	Dry weight
T1	348.65	52.66	5.51	35.82	15.44	8.23	1.14	295.99	20.33
T2	290.89	58.63	6.85	32.80	14.71	7.95	1.02	232.36	17.92
T3	540.37	82.51	9.45	48.98	18.82	8.37	1.21	457.86	24.10
T4	260.56	34.58	2.93	19.40	14.91	6.82	0.92	225.98	13.82
Mean	360.12	57.10	6.19	34.25	15.97	7.84	1.07	303.05	19.04
L.S.D (0.05)	28.36	11.67	1.85	11.08	2.75	1.32	0.15	25.68	2.44

T1=*Trichoderma harzianum*, T2= *Azotobacter chroococcum*, T3= *Trichoderma harzianum*+ *Azotobacter chroococcum*, T4=Control.

CONCLUSION:

It is concluded that application of T. *harzianum* + A. *chroococcum* was found more beneficial and significantly improved growth parameters and yield in radish grown under field condition.

Our dependence on chemical fertilizers has encouraged successful of harmful chemicals industries which are not only hazardous for human consumption but can also disturb the ecological balance. Biofertilizers can help in solve the problem of feeding the increasing global population. It is important to realize the useful aspects of biofertilizers and implement its application to modern agricultural practices. The new technology developed using the powerful tool of molecular biotechnology to enhance the biological pathways of production of phytohormones. However, the lack of awareness regarding improved protocols of biofertilizers applications to the field is one of the few reasons why many useful PGPR and PGPF are still beyond the knowledge of ecologists and agriculturists. The success of the science related to biofertilizers depends on inventions of innovative strategies related to the functions of PGPRs and their proper application to the field of agriculture.

The major challenge in this area of research lies in the fact that along with the identification of various strains of PGPR and PGPF its properties are essential to explain the actual mechanism of functioning of PGPR and PGPF for their efficacy toward exploitation in sustainable agriculture (19).

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