

INFLUENCE OF BIOFERTILIZERS ON PLANT GROWTH, FRUIT YIELD AND QUALITY OF OKRA (*Abelmoschus esculentus*.L.) CV. MAHI-45.

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ABSTRACT

An experiment was conducted to determine the effect of three biofertilizers (*Azotobacter*), *Azospirillum*, *Glomus mosseae* and their interaction on growth, fruit yield and quality of okra (*Abelmoschus esculentus*.L.) cv. Mahi-45 in the Department of Horticulture, Sam Higginbottom Institute of Agriculture Technology and Science, Allahabad, India during the summer season 2013. Eight treatments were included in the trial viz; T₁ (Control); T₂ (*Azotobacter*); T₃ (*Azospirillum*); T₄ Mycorrhizae (*Glomus mosseae*); T₅ (*Azotobacter* + *Azospirillum*); T₆ (*Azotobacter* + *Glomus mosseae*); T₇ (*Azospirillum*+ *Glomus mosseae*) and T₈ (*Azotobacter* + *Azospirillum*+ *Glomus mosseae*) were tested in three replication. The experiment design was randomized complete block design. This study showed all biofertilizers treatments and their interaction significant effect in plant height (cm), number of branches per plant, number of leaves per plant, fruit length (cm), fruit diameter (cm), number of fruits per plant, fruit yield per plant (g) and fruit yield (t/ha) compare with control treatment. Also this study showed that the treatment (T₈) significant effect on all parameters which study where recorded (150 cm), (4.33), (35), (13.25 cm), (1.85 cm), (33), (487.28 g) and (14.66 t/ha) respectively.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench), is an economically important vegetable crop grown in tropical and sub-tropical parts of the world. India ranks first in the world with 3.5 million tonnes (70% of the total world production) of okra produced from over 0.35 million hectare (1). Okra is known by many local names in different parts of the world. It is quite popular in India because of easy cultivation, dependable yield and adaptability to varying moisture conditions. Even within India, different names have been given in different regional languages (6). Okra is cultivated for its fibrous fruits or pods containing round, white seeds. Bio-fertilizers, in strict sense, are not fertilizers, which directly give nutrition to crop plants. These are cultures of microorganisms like bacteria, fungi, packed in a carrier material. Thus, the critical input in biofertilizer is the microorganisms. They help plants indirectly through better Nitrogen (N) fixation or improving the nutrient availability in the soil. The term "Biofertilizer" or more appropriately a "Microbial inoculants" can generally be defined as preparation containing live or latent cells of efficient strains of Nitrogen fixing, Phosphate solubilising or cellulolytic microorganisms used for application to seeds, soil or composting areas with the objective of increasing the number of such microorganisms and accelerate those microbial process which augment the availability of nutrients that can be easily assimilated by plants. Biofertilizer can provide an economically viable support to small and marginal farmers for realizing the ultimate goal of increasing productivity (3).

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Biofertilizer are low cost, effective and renewable source of plant nutrients to supplement chemical fertilizers. Microorganisms, which can be used as biofertilizer, include bacteria, fungi and blue green algae. These organisms are added to the rhizosphere of the plant to enhance their activity in the soil. Sustainable crop production depends much on good soil health. Keeping in view the benefits of biofertilizers, the experiment was conducted to find out the suitable biofertilizer for better growth, yield and quality of okra.

MATERIALS AND METHODS

A field experiment [Influence of biofertilizers on plant growth, fruit yield and quality of Okra (*Abelmoschus esculentus* L.) cv. Mahi-45.] was carried out at Horticultural Experimental Field, Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology and Sciences Allahabad, India, during summer season of 2013. Eight treatments were included in the trial viz; T₁ (Control); T₂ (*Azotobacter*); T₃ (*Azospirillum*); T₄ Mycorrhizae (*Glomus mosseae*); T₅ (*Azotobacter* + *Azospirillum*); T₆ (*Azotobacter* + (*Glomus mosseae*); T₇ (*Azospirillum* + (*Glomus mosseae*)) and T₈ (*Azotobacter* + *Azospirillum* + (*Glomus mosseae*)) were tested in three replication. The experiment design was randomized complete block design. The seeds of Mahi-45 cultivar were produced by Mahi Seeds Pvt.Ltd. (Hyderabad). Three biofertilizers namely *Azotobacter*, *Azospirillum* and (*Glomus mosseae*) were used in present investigation. The biofertilizers used were commercial products of International Panacea Limited, New Delhi-India. Biofertilizers in case of *Azotobacter* and *Azospirillum* slurry of 20 g of the lignite based culture of *Azotobacter* and *Azospirillum* were prepared in 1000 ml of water individually and combination of 80×10^3 cfu/ g *Azotobacter* and 80×10^3 cfu/ g *Azospirillum* (10). The seeds were dipped into the solution for 5-10 minutes then planted. Mycorrhizae (*Glomus mosseae*) biofertilizer was mixed with soil before planting at 420 spore/ 2.5 g/plant (9). The size of plot was 2.25 m spacing 40 cm between plant to plant (16 plants/plot) and 30 cm between two rows. The plots were kept free from weeds throughout the growth period by weeding at regular intervals. Immediately after planting a light irrigation was done and later irrigation was done depending upon the moisture requirement of the soil. The crop was attacked by insects like grasshoppers, Jassids and White fly, controlled by spraying Quinolphas 25 EC and Endosulphos at 1ml/litre of water. Diseases like Yellow Vein Mosaic Virus (YVMS), was controlled by spraying Synthetic Engyme at 5ml/litre of water and by cultural practices. Thinning was done to maintain one plant per hill when it reaches 3-4 leaf stage. Observations were recorded on four randomly selected plants of each treatment to assess the effect of treatments on growth, development and yield of fruit. First picking was done at 50 days after sowing (DAS). Successive picking was done at two days interval. All the recorded observations were subjected to the statistical analysis. The experimental data were analyzed statistically using the method given by (4).

RESULTS AND DISCUSSION

The experimental findings of the present investigation. An endeavour has been made to elicit the influence of *Azotobacter*, *Azospirillum* and *Glomus mosseae* and their interaction on growth and fruit yield. The observations recorded at the successive stages of crop growth were analyzed statistically and are presented in the following heads.

Plant height (cm)

The plant height was influenced by different biofertilizers and the result was found to be significant. The maximum plant height 150.00cm was observed in the treatment (T₈) (*Azotobacter* + *Azospirillum* + *Glomus mosseae*) followed the treatment (T₅) (*Azotobacter* + *Azospirillum*) (125.00 cm) . The plant height was found to be minimum (60.00 cm) in the treatment (T₁) control Table. (1). The result on the plant height obtained in present experiment clearly showed that the application of biofertilizers effectively increased the plant height. Various workers have been reported increase in plant height with biofertilizers application (11).

Number of leaves per plant:

The number of leaves per plant was found to be significant among the treatments. The maximum number of leaves per plant (35.00) was observed in the treatment (T₈) (*Azotobacter* + *Azospirillum* + *Glomus mosseae*) followed the treatment (T₅) (*Azotobacter* + *Azospirillum*) (32.00) .The number of leaves per plant was found to be minimum 21.00 in the treatment (T₁) control Table (1). The increase in number of leaves per plant may be due to the maximum growth of plant stimulated through supply of adequate amount of biofertilizers.

Number of branches per plant:

The number of branches per plant was found to be differing significant among the treatments. The maximum number of branches per plant (4.33) was observed in the treatment (T₈) (*Azotobacter* + *Azospirillum* + *Glomus mosseae*) followed the treatment (T₅) (*Azotobacter* + *Azospirillum*) (3.67). The number of branches per plant was found to be minimum 1.33 in the treatment (T₁) control Table. (1). The possible reason for maximum number of branches may be due to the *Glomus mosseae* enhances fertilizer use efficiency of the crop.

Table. 1: Influence of biofertilizers and their interaction on plant growth of okra cv. Mahi-45.

TREATMENTS	PLANT HEIGHT(CM)	NO. OF LEAVES	NO. OF BRANCHES
T ₁ control	60.00	21.00	1.33
T ₂ <i>Azotobacter</i>	90.00	25.00	2.67
T ₃ <i>Azospirillum</i>	82.33	24.67	2.67
T ₄ <i>Glomus mosseae</i>	77.33	23.67	2.33
T ₅ <i>Azotobacter</i> + <i>Azospirillum</i>	125.00	32.00	3.67
T ₆ <i>Azotobacter</i> + <i>Glomus mosseae</i>	115.00	29.00	3.00
T ₇ <i>Azospirillum</i> + <i>Glomus mosseae</i>	107.67	28.00	3.00
T ₈ <i>Azotobacter</i> + <i>Azospirillum</i> + <i>Glomus mosseae</i>	150.00	35.00	4.33
F-test	S	S	S
S.Ed	210	0.45	0.30
C.D at 5%	4.50	0.96	0.65

Number of fruits per plant

From data represented in Table (2) can be observe that different biofertilizers had significant influence on total number of fruits per plant. It is recorded that the treatment (T₈) (*Azotobacter* + *Azospirillum* + *Glomus mosseae*) have maximum number of fruits per plant (33.00) followed by the treatment (T₅) (*Azotobacter* + *Azospirillum*) (29.00). The number of fruits per plant was found to be minimum 18.00 in treatment (T₁) control. Increased the number of fruits per plant obtained in present experiment clearly showed that the application of biofertilizers

effectively affected the number of fruits per plant. Various workers have been reported increase in number of fruits per plant with biofertilizers application (2).

Fruit length (cm)

From data represented in Table (2) it has been observed that different biofertilizers had significant influence on fruit length. It is recorded that the treatment (T₈) (*Azotobacter* + *Azospirillum* + *Glomus mosseae*) have maximum fruit length 13.25 cm followed the treatment (T₅) (*Azotobacter* + *Azospirillum*) (11.37 cm). The fruit length was found to be minimum 7.87 cm in treatment (T₁) control Table (2). The biofertilizers application was found to be very effective to influence the size of fruit. The results are conformation with the application of biofertilizers by (8).

Fruit diameter (cm)

From data represented in Table (2) it has been observed that different biofertilizers had significant influence on fruit diameter. It is recorded that the treatment (T₈) (*Azotobacter* + *Azospirillum* + *Glomus mosseae*) have maximum fruit diameter 1.85 cm followed the treatment (T₅) (*Azotobacter* + *Azospirillum*) (1.70 cm). The fruit diameter was found to be minimum 1.18 cm in treatment (T₁) control Table (2). The biofertilizers application was found to be very effective to influence the size of fruit. The results are conformation with the application of biofertilizers by (5).

Table 2: Influence of biofertilizers and their interaction on quality of okra of okra cv. Mahi-45.

TREATMENTS	NO. OF FRUITS	FRUIT LENGTH (CM)	FRUIT DIAMETER (CM)
T ₁ control	18.00	7.87	1.18
T ₂ <i>Azotobacter</i>	24.00	10.15	1.53
T ₃ <i>Azospirillum</i>	23.00	10.00	1.40
T ₄ <i>Glomus mosseae</i>	21.00	9.73	1.35
T ₅ <i>Azotobacter</i> + <i>Azospirillum</i>	29.00	11.37	1.70
T ₆ <i>Azotobacter</i> + <i>Glomus mosseae</i>	28.00	11.10	1.65
T ₇ <i>Azospirillum</i> + <i>Glomus mosseae</i>	27.00	10.73	1.60
T ₈ <i>Azotobacter</i> + <i>Azospirillum</i> + <i>Glomus mosseae</i>	33.00	13.25	1.85
F-test	S	S	S
S.Ed	0.38	0.06	0.02
C.D at 5%	0.82	0.12	0.04

Fruit yield per plant (g):

From data represented in Table (3) it has been observed that different biofertilizers had significant influence on fruit yield per plant. The significantly maximum fruit yield per plant (487.32 g) was observed in the treatment (T₈) (*Azotobacter* + *Azospirillum* + *Glomus mosseae*) followed the treatment (T₅) (*Azotobacter* + *Azospirillum*) (362.68 g). The fruit yield per plant was found to be minimum (162.87 g) in the treatment (T₁) control. The results are confirmation the result of application of biofertilizers by (12). Increase in yield with the application of *Azospirillum* was reported by (7).

Fruit yield t/ha

From data represented in Table (3) it has been observed that different biofertilizers had significant influence on fruit yield t/ha. The significantly maximum

fruit yield t/ha (43.86 t/ha) was observed in the treatment (T₈) (*Azotobacter* + *Azospirillum* + *Glomus mosseae*) followed the treatment (T₅) (*Azotobacter* + *Azospirillum*) (32.64 t/ha). The fruit yield t/ha was found to be minimum (14.66 t/ha) in the treatment (T₁) control (Table. 3). The results are conformation with the application of biofertilizers by (12). Increase in yield with the application of *Azospirillum* was conformation by (7).

Table 3: Influence of biofertilizers and their interaction on fruit yield of Okra of okra cv. Mahi-45.

Treatments	Fruit yield/plant(g)	Fruit yield t/ha
T ₁ control	162.87	14.66
T ₂ <i>Azotobacter</i>	279.67	25.17
T ₃ <i>Azospirillum</i>	261.42	23.53
T ₄ <i>Glomus mosseae</i>	235.23	21.17
T ₅ <i>Azotobacter</i> + <i>Azospirillum</i>	362.68	32.64
T ₆ <i>Azotobacter</i> + <i>Glomus mosseae</i>	342.55	30.83
T ₇ <i>Azospirillum</i> + <i>Glomus mosseae</i>	326.72	29.40
T ₈ <i>Azotobacter</i> + <i>Azospirillum</i> + <i>Glomus mosseae</i>	487.32	43.86
F-test	S	S
S.Ed	6.20	0.56
C.D at 5%	13.30	1.20

Discussion:

Biofertilizers enhance the nutrient availability to crop plants (by processes like fixing atmosphere N or dissolving P present in the soil); and impart better health to plants and soil thereby enhancing crop yields in a moderate way. It is a natural method without any problems like salinity and alkalinity, soil erosion etc. In view of the priority for the promotion of organic farming and reduction of chemical residues in the environment, special focus has to be given for the production of biofertilizers. No hazardous effluents are generated from a biofertilizer unit. A versatile material, biofertilizer benefits virtually any soil type. Clay soil, for example, has tiny, tightly packed particles that hamper the flow of water, nutrients, and oxygen. Biofertilizer reconfigures the clay into larger, more loosely packed particles. The larger spaces between the particles improve the flow of water, oxygen, and nutrients to roots. In addition, the roots are able to penetrate deeper into the soil and contact more nutrients. Biofertilizer also improves sandy soil, where the large spaces between loosely packed particles enable water and its dissolved nutrients to drain too quickly for optimum root absorption. Biofertilizer soaks up and holds these substances so that the roots have more time to absorb them. Biofertilizer also adds small amounts of zinc, copper, boron, and other vital nutrients to soils. Protect water quality. Because the composting process converts nitrogen into a less soluble form, it is less likely to be washed out of manure and into ground water and surface water. Excessive amounts of nitrate in drinking water can cause health problems such as blue baby syndrome and may be linked to cancer and birth defects.

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تأثير المخصبات الحيوية في النمو وإنتاجية والصفات النوعية لمحصول

الباميا (*Abelmoschus esculentus*.L) cv. Mahi-45

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الملخص

أجريت هذه الدراسة لتحديد تأثير ثلاثة من المخصبات الحيوية وهي *Azospirillum*، *Azotobacter* والمايكورايزا والتداخل بينهم في النمو، والإنتاجية والصفات النوعية لمحصول الباميا-*Abelmoschus esculentus*.L cv. Mahi-45 في قسم البستنة كلية الزراعة جامعة سام هايكن بوتوم، الله آباد الهند أثناء الموسم الصيفي لغام 2013. اختبرت ثمان معاملات في هذه الدراسة وهي T₁ المقارنة، *Azotobacter* T₂، *Azospirillum* T₃، *Azotobacter* + *Glomus* T₄، *Azospirillum* + *Glomus mosseae* T₅، *Azospirillum* + *Azotobacter* T₆، *Azospirillum* + *Glomus mosseae* T₇، *Azospirillum* + *Azotobacter* T₈. وكان التصميم المستخدم هو تصميم القطاعات العشوائية الكاملة مع ثلاثة مكررات. أظهرت الدراسة أن معاملات المخصبات الحيوية جميعها والتداخل بينهم قد تفوقت تفوقاً معنوية في طول النبات (سم)، عدد الأفرع، عدد الأوراق، طول الثمرة (سم)، قطر الثمرة (سم)، عدد الثمار في النبات الواحد، إنتاجية الثمار للنبات الواحد (غم) وإنتاجية الثمار للهكتار (طن) مقارنة بمعاملة المقارنة. كذلك بينت الدراسة أن المعاملة (T₈) تفوقت معنوياً في الصفات المدروسة جميعها، إذ سجلت 150 سم، 4.33، 35، 13.25 سم، 1.85 سم، 33، 487.28 غم و 43.86 طن/ هكتار على التوالي.

بحث مستل من رسالة الماجستير للباحث الاول.

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