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TO STUDY THE EFFECT OF ORGANIC AND BIOFERTILIZER SOURCES OF NUTRIENTS ON GROWTH AND YEILD OF GARLIC (ALLIUM SATIVUM L.) CV. YAMUNA SAFED 2 (G-50)

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ABSTRACT

A field experiment was conducted during 2024–2025 at the vegetable farm of Kulbhaskar Ashram Post Graduate College, Prayagraj (U.P.), under the Department of Horticulture. The study was titled "To Study the Effect of Organic and Biofertilizer Sources ofNutrients Growth and Yield of Garlic (Allium sativum L.) cv. Yamuna Safed-2 (G-20)." The experiment followed a Randomized Block Design (RBD) and included Thirteen Treatments (T13), each representing a different combination of organic and biofertilizer sources. Each treatment was replicated three times.Among the treatments, the combination of 25 t FYM + 8 t Vermicompost + Azotobacter + PSB/ha (applied after transplanting) showed the most promising resultsFresh weight of top (46.11) ,Fresh weight of bulb (11.77) , Fresh weight of whole plant (57.88), polar diameter (5.24 cm) and equatorial diameter of (4.68 cm), cloves per bulb (23.30), and the highest bulb yield of (187.54 q/ha), highest bulb yield(4.55kg/plot).In contrast, the control treatment (T_1), representing traditional farmers' practices, recorded the lowest values across all growth and yield parameters. Based on the results, the use of NPK at 100:60:60 kg/ha was found to be a beneficial nutrient management strategy for enhancing garlic production in the Prayagraj region.

Keywords : *Garlic, organic biofertilizer , growth, yield*

INTRODUCTION

Garlic (*Allium sativam L.)* is a member of the Amaryllidaceae family. It is Native to Central Asia and having a chromosome number 2n=16. The Mediterranean area is thought to be its secondary point of origin.china is the world largest producer of garlic. According to Anonymous (2021), it produces 29.02 million metric tonnes and covers 16.68 lakh hectares worldwide. China has far more landmass and output than its closest rivals, Egypt, South Korea, India, and the Russian Federation. It's grown in India on an area 3.93 lakh hectares of land, producing 3.20 million MT (Anonymous, 2021).When compared to other bulbous crops, garlic has more nutrients. With significant amounts of fat, vitamin C, and sulphur, it is also a good source of minerals (0.3%), proteins (6.3%), carbohydrate (29%), and essential oils (0.1–0.4%)(MAJID et al.,2017).When the garlic bulb is crushed, the enzyme allinase breaks down the colourless, odourless, water-soluble amino acids called allin to generate allcin, which is mostly composed of the odoriferous Garlic is said to include diallyl-diasulphide as a key flavour ingredient. Supplementing with garlic extract decreased vascular calcification in people with elevated blood cholesterol(Valls et al.,2022). Compost, manure, and crop wastes are examples of organic fertilizers that come from natural sources and are known to enhance soil structure, increase microbial activity, and give plants a slow release of nutrients.(Singh et al.,2020).

Organic fertilizers provide micronutrients like zinc, boron, and iron together with vital nutrients like potassium, phosphorus, and nitrogen for garlic development. Additionally, by increasing the amount of organic matter in the soil, these fertilizers improve the general health of the soil. Improved root development, disease prevention, and better nutrient cycling are all facilitated by the increased microbial activity in soils enhanced with organic matter. This frequently leads to reduced biological activity, reduced water retention, and compacted soil, all of which are detrimental to plant growth. Additionally, overuse of synthetic fertilizers has been connected to environmental problems such groundwater contamination, nutrient runoff, and the emission of greenhouse gasses like nitrous oxide.

As garlic is a heavy nitrogen feeder, nitrogen fixation plays a crucial role in its growth. Nitrogen-fixing bacteria convert atmospheric nitrogen into a form that plants can absorb, helping reduce the need for synthetic nitrogen fertilizers. Phosphorus is vital for root development and energy transfer within plants, and phosphorus-solubilizing bacteria can enhance its availability to garlic.

Table 1. Details about Treatments

Treatment symbol	**Treatment**
T1	Control N:P:K (100:60:60)kg/ha
T2	25t FYM + 5t vermi compost + azotobacter ha^{-1}
T3	25t FYM + 8t vermi compost + azotobacter ha^{-1}
T4	30t FYM + 5t vermi compost + azotobacter ha^{-1}
T5	30t FYM + 8t vermi compost + azotobacter ha^{-1}
T6	25t FYM+ 5t vermi compost + psb ha^{-1}
T7	25t FYM+ 8t vermi compost + psb ha^{-1}
T8	30t FYM + 5t vermi compost +psb ha^{-1}
T9	30t FYM +8t Vermi compost + psb ha $^{-1}$
T10	25t FYM+ 5t vermi compost + azotobacter + psb ha^{-1}
T11	25t FYM +8t vermi compost +azotobactor +psb ha-^{1}
T12	30t FYM+ 5t vermi compost + azotobacter + psb ha^{-1}
T13	30t FYM+ 8t vermi compost + azotobacter + psb ha^{-1}

Mycorrhizal fungi, by forming symbiotic relationships with plant roots, expand the surface area for nutrient and water absorption, which improves the plant's resilience to environmental stressors.(Altaf et al.,2021)

MATERIALS AND METHODS

The experiment was conducted at the farm of Department of Horticulture, Kulbhaskar Ashram Post Graduate College, Prayagraj, Uttar Pradesh during rabi season 2024-2025. Prayagraj, located at 25.45°N latitude and 81.84°E longitude at an elevation of 98 meters, experiences a subtropical climate with three distinct seasons: summer (April–June), monsoon (July–September), and winter (December–February). Summers are hot, with temperatures reaching up to 45°C, while winters are mild, with lows rarely falling below 10°C. The monsoon season, accounting for about 88% of the annual rainfall, brings significant precipitation, especially in July and August. The normal annual rainfall ranges from 850 to 1100 mm, decreasing from southeast to northwest. The average annual relative humidity approximately 62%.The experiment was laid out with 13 treatments of garlic in randomized block design of 20 x 15 cm spacing with three replications and the net plot size it 2 x 1.5m . Transplanting was done on 15 NOV 2024 in main field. During the life cycle of the plants, hoeing, weeding and irrigation were provided at proper time so as facilitate better growth and development of crop. The observation was recorded i.e., Fresh weight of top, Fresh weight of bulb ,Fresh weight of plants,Polar diameter of (cm), Equatorial diameter of (cm), Number of cloves per plant, Bulb yield (kg/plot), Bulb yield (q/ha).

RESULTS AND DISCUSSION

Growth and Yield Parameters

Observations on Fresh weight of top, bulb and whole plants (g), Polar Diameter of Bulb (cm), Equatorial Diameter of Bulb (cm), Cloves Per Bulb , Bulb Yield per plot (kg) and ha (q)were recorded at different stages of growth, are presented as follows The Effect of different organic manures and bio-fertilizers on vegetative attributes from 30, 60 , 90 and 120 DAS has been

Fresh weight of top , bulb and whole plants (g)-It is indicates that maximum fresh weight of top, bulb and whole plants (g) at 30, 60 ,90 and 120 DAS (1.75, 6.99, 20.96, 46.11) for top , (0.47,1.03,4.53,11.77) for bulb, (2.22, 8.02, 25.76, 57.88) for whole plants was found with the treatment T11(25 t FYM +8 t Vermicompost + Azotobacter +PSB /ha) followed by (30 t FYM +5 t Vermicompost + Azotobacter +PSB/ha) under T12. while the minimum girth of plants at 30,60,90,120 DAS (1.24 ,4.97, 14.92, 32.82)for top, (0.18, 0.39, 3.38, 8.66)for bulb, (1.42, 5.36, 18.30, 41.48)for whole plants.

Polar Diameter of Bulb (cm)- The maximum number of diameter of bulb was recorded intreatment T11 (25 t FYM +8 t Vermicompost + Azotobacter +PSB /ha)(5.24) , followed by (30 tFYM +5 t Vermicompost + Azotobacter +PSB/ha)(4.68) under T12. While minimum wasrecorded in control treatment T1 (control) (4.34) polar diameter of bulb. Similar result found Yogita and Ram (2012) in onion reported similar kind of results.

Equatorial Diameter of Bulb (cm) - The maximum number of diameter of bulb was recorded in treatment T11 (25 t FYM +8 t Vermicompost + Azotobacter +PSB /ha)(4.68) , followed by (30 t FYM +5 t Vermicompost + Azotobacter +PSB/ha)(4.62) under T12. While minimum was recorded in control treatment T1 (control) (3.75). Similar result found Yogita and Ram (2012) in onion reported similar kind of results.

Cloves Per Bulb - The maximum number of cloves per bulb was recorded in treatment T11 (25 t FYM +8 Vermicompost + Azotobacter +PSB /ha)(23.30) cloves per bulbWhile minimum was recorded in control treatment T1 (control) (17.15) cloves per bulbSimilar result found Yogita and Ram (2012) in onion and reported similar kind of results.

Bulb Yield per plot (kg) and ha (q) - The maximum number of bulbper plot (kg) andha (q) and was recorded in treatment T11 (25 t FYM +8 t Vermicompost + Azotobacter +PSB /ha) (4.55 Kg/plot), (187.54) q/haand followed by T12. While minimum was recorded in control treatment T1 (control) 3.66 bulb/kg, 122.00 ha/q. Similar result found Yogita and Ram (2012) in onion reported similar kind of results.

Graph - 1

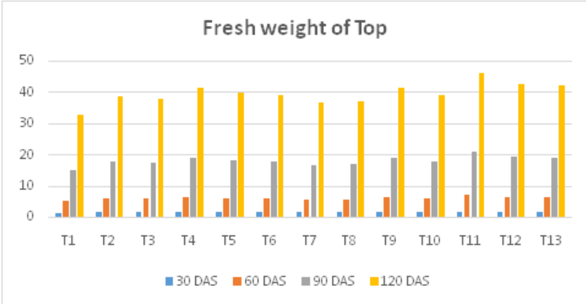
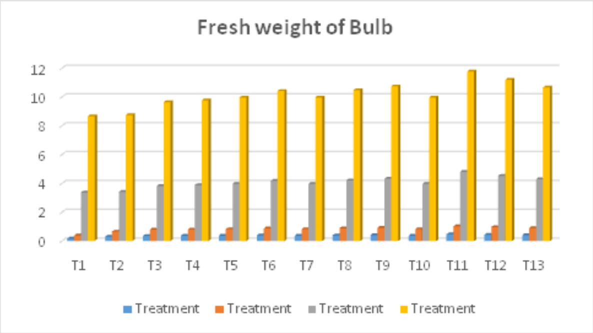


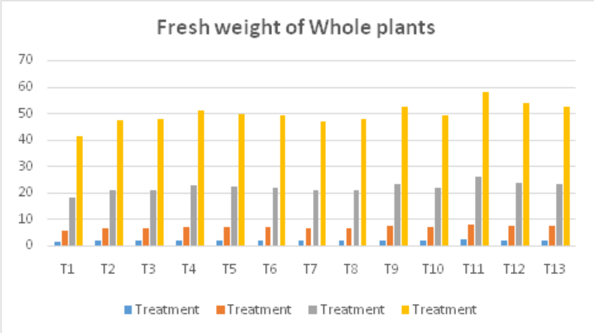
Table 2: Effect of organic and biofertilizers on Vegetative character of garlic.

Treatment	Fresh weight of Top (DAS)				Fresh weight of Bulb (DAS)				Fresh weight of Whole plants (DAS)			
	30	60	90	120	30	60	90	120	30	60	90	120
T1- Control NPK-100:60:60 kg/ha	1.24	4.97	14.92	32.82	0.18	0.39	3.38	8.66	1.42	5.36	18.30	41.48
T2- 25t FYM +5 t Vermicompost + Azotobacter/ha	1.47	5.87	17.60	38.72	0.30	0.66	3.42	8.74	1.77	6.53	21.02	47.46
T3- 25t FYM +8 t Vermicompost + Azotobacter/ha	1.44	5.75	17.24	37.93	0.36	0.79	3.83	9.64	1.80	6.54	21.07	47.57
T4- 30t FYM +5 t Vermicompost + Azotobacter/ha	1.56	6.25	18.76	41.27	0.37	0.81	3.88	9.77	1.93	7.06	22.64	51.04
T5- 30t FYM +8 t Vermicompost + Azotobacter/ha	1.51	6.04	18.12	39.86	0.38	0.83	3.98	9.97	1.89	6.87	22.10	49.83
T6- 25t FYM +5 t Vermicompost + PSB/ha	1.47	5.89	17.68	38.90	0.40	0.88	4.18	10.42	1.87	6.77	21.86	49.31
T7- 25t FYM +8 t Vermicompost + PSB/ha	1.39	5.56	16.68	36.70	0.38	0.83	3.98	9.97	1.77	6.39	20.66	46.66
T8- 30t FYM +5 t Vermicompost + PSB/ha	1.40	5.61	16.84	37.05	0.40	0.89	4.21	10.47	1.81	6.50	21.05	47.52
T9- 3t FYM +8 t Vermicompost + PSB/ha	1.57	6.28	18.84	41.45	0.42	0.92	4.33	10.74	1.99	7.20	23.17	52.19
T10-25tFYM +5 t Vermicompost + Azotobacter + PSB/ha	1.48	5.91	17.72	38.98	0.38	0.83	3.97	9.97	1.85	6.74	21.69	48.95
T11-25tFYM +8 t Vermicompost + Azotobacter +PSB /ha	1.75	6.99	20.96	46.11	0.47	1.03	4.80	11.77	2.22	8.02	25.76	57.88

Graph - 2



Graph - 3

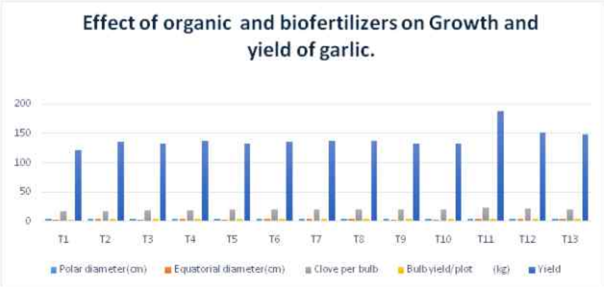


GRAPHS 1,2,3 : Effect of organic and biofertilizers on Vegetative character of garlic.

Table 3: Effect of organic and biofertilizers on growth and yield of garlic.

Treatments	Polar diameter(cm)	Equatorial diameter(cm)	Clove per bulb	Bulb yield/plot (kg)	Yield (q/ha)
T1- Control NPK-100:60:60 kg/ha	4.34	3.75	17.15	3.66	122.00
T2- 25t FYM +5 t Vermicompost + Azotobacter/ha	4.53	3.97	17.30	4.05	135.00
T3- 25t FYM +8 t Vermicompost + Azotobacter/ha	4.45	3.89	19.09	3.99	133.33
T4- 30t FYM +5 t Vermicompost + Azotobacter/ha	4.61	4.05	19.34	4.10	137.01
T5- 30t FYM +8 t Vermicompost + Azotobacter/ha	4.43	3.87	19.73	3.99	133.00
T6- 25t FYM +5 t Vermicompost + PSB/ha	4.58	4.02	20.63	4.08	136.00
T7- 25t FYM +8 t Vermicompost + PSB/ha	4.70	4.14	19.73	4.11	137.00
T8- 30t FYM +5 t Vermicompost + PSB/ha	4.63	4.07	20.74	4.12	137.67
T9- 3t FYM +8 t Vermicompost + PSB/ha	4.45	3.89	21.27	3.98	133.32
T10-25tFYM +5 t Vermicompost + Azotobacter + PSB/ha	4.42	3.86	19.73	3.96	132.62
T11-25tFYM +8 t Vermicompost + Azotobacter +PSB /ha	5.24	4.68	23.30	4.55	187.54
T12-30tFYM +5 t Vermicompost + Azotobacter +PSB/ha	5.18	4.62	22.16	4.47	150.85
T13-30tFYM +8 t Vermicompost + Azotobacter +PSB/ha	5.15	4.59	21.13	4.44	148.79
S.E(m)	0.20	0.195	0.913	0.05	5.04
C. D. (P = 0.05)	0.55	0.551	2.582	0.14	14.27

GRAPH 4: Effect of organic and biofertilizers on growth and yield of garlic.



CONCLUSION

(G-20). Among all treatments, T_{11} (25 t FYM + 8 t Vermicompost + Azotobacter + PSB/ha) delivered the best performance, showing the highest fresh weights of the top (46.11),fresh weights of the bulb (11.77 g),whole plant (57.88 g) along with superior polar (5.24 cm) and equatorial (4.68 cm) bulb diameters, the highest number of cloves per bulb (23.30), and the maximum yield (4.55 kg/plot ,187.54 q/ha). This suggests that a combination of FYM, vermicompost, and biofertilizers greatly improves nutrient availability, plant development, and soil health. On the other hand, the control plot, which followed traditional practices, recorded the lowest performance. Hence, the integrated use of organic and bio-based inputs is a promising, eco-friendly approach to enhance garlic productivity in the climatic conditions of Prayagraj.

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EFFECT OF PLANT SPACING AND VARITIES ON GROWTH, YIELD AND QUALITY OF RADISH (RAPHANUS SATIVUS L.)

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ABSTRACT

The present study was conducted to assess the effect of different plant spacing and radish varieties on growth, yield, and quality of radish (Raphanus sativus L.) during the Rabi season of 2024–25. The experiment was laid out in a Randomized Block Design with three varieties—Pusa Chetki, Pusa Deshi, and Japanee White—combined with three spacing levels (30×15 cm, 30×20 cm, and 30×25 cm). Observations on plant height, number of leaves, root length, root diameter, yield, fiber content, and total soluble solids (TSS) were recorded and analyzed. Results showed that the variety Pusa Chetki at a spacing of 30×15 cm produced the highest root yield (532.64 q/ha), while wider spacing (30×25 cm) improved certain quality attributes such as root diameter and fiber content. It is concluded that closer spacing enhances yield, whereas wider spacing is better suited for improving root quality.

Keywords : *Radish, spacing, effect*

INTRODUCTION

Radish (Raphanus sativus L.), belonging to the family Brassicaceae, is one of the most commonly grown root vegetables worldwide. It is a cool-season crop valued for its tender, crisp roots that are consumed raw, cooked, or pickled. In India, radish is cultivated extensively across various states, with major growing regions including Uttar Pradesh, Bihar, West Bengal, and Madhya Pradesh. It is a rich source of vitamin C, calcium, potassium, and dietary fiber.

MATERIALS AND METHOD

The experiment was laid out in a Randomized Block Design (RBD) with three replications. It involved three varieties:

Table 1: Treatment details

T	Symbol	Treatment details
T1	S_1V_1	S_1= 30 x 15 V_1 = PUSA CHETKI
T2	$S_1 V_2$	S_1= 30 x 15 V_2 = PUSA DESHI
T3	S_1V_3	S_1= 30 x 15 V_3 = JAPANEE WHITE
T4	S_2V_1	S_2= 30 x 20 V_1 = PUSA CHETKI
T5	S_2V_2	S_2= 30 x 20 V_2 = PUSA DESHI
T6	S_2V_3	S_2= 30 x 20 V_3 = JAPANEE WHITE
T7	S_3V_1	S_2= 30 x 25 V_1 = PUSA CHETKI
T8	S_3V_2	S_2= 30 x 25 V_2 = PUSA DESHI
T9	S_3V_3	S_2= 30 x 25 V_3 = JAPANEE WHITE

RESULTS AND DISCUSSION

This section presents the observations recorded during the experiment and interprets the effects of different plant spacings and radish varieties on various parameters.

3.1 Growth Parameters

3.1.1 Plant Height (cm)

Plant height was significantly influenced by both plant spacing and varieties at 30, 45 days after sowing (DAS), and at harvest. Maximum plant height was recorded under 30 × 15 cm spacing (S1) at all stages (29.92 cm at harvest).Among varieties, Pusa Chetki (V1) showed the highest plant height (33.15 cm).Minimum height was observed in Japanee White (V3) under 30 × 25 cm spacing. These results indicate that closer spacing promotes vertical growth due to competition for light, while varietal differences reflect genetic potential. Jau et al. (2006) and yogendra singh et al.2021 also draw similar conclusion

Table - 2 : Effect of plant spacing, varieties on plant height (cm) in radish

Treatment	Plant height (cm)		
	30 DAS	40DAS	Harvesting stage
Spacing (S)			
S_1(30 x 15 cm)	21.95	25.80	29.92
S_2(30 x 20 cm)	19.80	24.73	28.05
S_3(30 x 25 cm)	18.80	23.30	27.65
S.Em ±	0.92	0.48	0.54
CD at $_{5\%}$	2.56	1.45	1.65

Varieties-

V1 (pusha chetki)	20.10	26.30	33.15
V2 (pusa Deshi)	20.04	25.57	30.64
V3 (japanee white)	20.06	24.75	31.02
S.Em ±	1.33	0.15	0.55
CD at $_{5\%}$	3.93	3.43	3.66
CV	3.04	3.03	3.04

3.1.2 Number of Leaves per Plant

Leaf number increased significantly with wider spacing and among varieties. Highest number of leaves (14.65) was observed in S3 (30 × 25 cm) spacing. Pusa Chetki (V1) recorded the maximum leaves per plant (14.33).Japanee White (V3) had the lowest leaf number (13.03).Wider spacing likely reduced competition, promoting leaf expansion and development.

Table - 3 : Effect of plant spacing and varieties on number of leave per plant in radish

Treatment	number of leave per plant		
	30 DAS	40DAS	Harvesting stage
Spacing (S)			
S_1(30 x 15 cm)	6.47	10.02	13.05
S_2(30 x 20 cm)	7.51	11.36	14.30
S_3(30 x 25 cm)	8.54	11.75	14.65
S.Em ±	0.14	0.22	0.24
CD at $_{5\%}$	0.44	0.65	0.73
CV	3.43	3.97	3.28

Varieties-

V1 (pusha chetki)	7.43	11.53	14.33
V2 (pusa deshi)	6.08	11.36	13.66
V3 (japanee white)	6.95	10.43	13.12
S.Em ±	0.19	0.22	0.27
CD at $_{5\%}$	0.56	0.63	0.83
CV	4.85	3.13	3.52

3.1.3 Leaf Area (cm²)

Leaf area was significantly influenced by both spacing and variety. Wider spacing (S3) resulted in maximum leaf area (177.76 cm²).Among varieties, Pusa Chetki (V1) had the largest leaf area (180.02 cm²).Minimum leaf area was found in Pusa Deshi (V2).

3.1.4 Fresh and Dry Weight of Shoot

Shoot biomass showed a clear response to spacing and variety:Fresh weight was highest in S3 (121.99 g) and in V1 (199.61 g).Dry weight followed a similar pattern, with V1 and S3 performing best.This suggests that wider spacing supports more vegetative growth, especially in vigorous varieties like Pusa Chetki.

3.2 Yield Parameters -

3.2.1 Root Length and Diameter

Both root length and diameter were significantly affected:Longest roots (24.04 cm) were recorded in S3 and in Pusa Chetki (23.41 cm).Maximum root diameter (4.16 cm) was observed in Japanee White (V3) and with wider spacing.This shows that wider spacing helps roots expand both vertically and radially, though yield per hectare may be compromised.

3.2.2 Days to Harvest-

Earliest maturity (54.24 days) was observed in Pusa Chetki with S3 spacing.Pusa Deshi took the longest to mature.

3.2.3 Root Weight and Yield -

Highest individual root weight (190.30 g) was recorded with 30 × 25 cm spacing (S3) and Pusa Chetki. However, the maximum root yield per hectare (532.64 q/ha) was found with closer spacing (30 × 15 cm) due to higher plant population. Yogendra singh et al.2021 also draw similar conclusion.

CONCLUSION

The present study clearly demonstrates that both plant spacing and varietal selection significantly influence the growth, yield, and quality parameters of radish (Raphanus sativus L.). Among the varieties tested, Pusa Chetki consistently outperformed others in terms of plant height, leaf area, root length, root weight, and yield per hectare. Similarly, closer spacing of 30 × 15 cm resulted in significantly higher root yield (532.64 q/ha) due to increased plant density, whereas wider spacing of 30 × 25 cm improved root diameter, leaf size, and quality attributes such as fiber content and TSS. Thus, it can be concluded that for maximizing yield, Pusa Chetki at 30 × 15 cm spacing is the most effective combination under the agro-climatic conditions of Prayagraj. However, for better quality and root development, wider spacing may be adopted. These findings can serve as a useful guideline for commercial radish growers aiming for either yield maximization or quality improvement.Yogendra singh et al.2021 also draw similar conclusion.

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INTEGRATED EFFECT OF PHOSPHORUS AND BIOFERTILIZERS ON GROWTH, YIELD, AND QUALITY OF PEA (*PISUM SATIVUM* L.) CV. KASHI PRAGATI

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ABSTRACT

A field experiment was conducted during the Rabi season of 2024–2025 at the Horticulture Research Farm, Kulbhaskar Ashram Post Graduate College, Prayagraj, Uttar Pradesh, to investigate the effect of phosphorus and biofertilizers on the yield and quality of pea (*Pisumsativum* L.) cv. Kashi Pragati. The experiment comprised eight treatments laid out in a randomized block design with three replications. The treatments included different combinations of phosphorus levels (0 and 50% RDF) and biofertilizers (Phosphate Solubilizing Bacteria and Rhizobium). The results revealed that combined application of 50% recommended dose of phosphorus with PSB and Rhizobium significantly improved plant height, nodulation, pod yield, and quality attributes of pea. The study highlights the potential of integrated nutrient management using biofertilizers and phosphorus in enhancing pea productivity and quality while reducing chemical input.

Keywords : *Pea , integrated, biofertilizers*

INTRODUCTION

Pea (*Pisumsativum* L.) is a highly nutritious winter legume crop cultivated widely for its fresh green pods, dry seeds, and foliage used as fodder. In India, it is mostly grown in the northern plains as a Rabi crop. It is a rich source of digestible protein, carbohydrates, vitamins (A, B, C), and minerals, making it a valuable dietary component (Choudhary, 1967). However, the productivity of peas remains suboptimal due to imbalanced nutrient management, especially phosphorus deficiency (Mishra & Srivastava, 1991). Phosphorus is a crucial macronutrient that enhances root development, energy transfer, photosynthesis, and nodule formation in legumes (Sharma &Mittra, 1991). Despite its importance, a large portion (93–99%) of soil phosphorus remains unavailable to plants due to fixation (Verma, 1993; Prasad & Power, 1997). Only about 25% of applied phosphorus is utilized by crops in a season, while the rest is lost or converted to insoluble forms (Gaur, 2006). To overcome this, phosphate solubilizing bacteria (PSB) have emerged as an eco-friendly alternative that enhances phosphorus availability through the secretion of organic acids and enzymes (Narula, 2000; Mahdi et al., 2011). Similarly, Rhizobium inoculation supports biological nitrogen fixation in legumes and contributes to better growth, yield, and quality (Singh & Singh, 2006; Abdel-Lattief, 2008). Previous studies have shown that the combined application of phosphorus and biofertilizers leads to improved nodulation, nutrient uptake, yield attributes, and pod quality in pea and other leguminous crops (Kumar et al., 2012; Dhage et al., 2010). Considering the above, the present study entitled “Effect of Phosphorus and Biofertilizers on Yield and Quality of Pea (*Pisumsativum* L.) cv. Kashi Pragati” was taken.

2. MATERIALS AND METHODS

2.1 Experimental Site and Climate

The field experiment was conducted at the Vegetable Research Farm, Department of Horticulture, Kulbhaskar Ashram Post Graduate College, Prayagraj (U.P.), during the Rabi season of 2024–2025. The region is situated between 24°47'N to 25°47'N latitude and 81°01'E to 82°21'E longitude at an altitude of approximately 98 meters above sea level. The climate is subtropical with hot summers, a monsoon period from June to September, and cool winters. The average annual rainfall is about 975.4 mm, mostly received during July and August.

2.2 Soil Characteristics

Before sowing, composite soil samples were collected from the experimental field to a depth of 25 cm. The soil was sandy loam in texture, slightly alkaline in reaction (pH 7.2), with medium levels of nitrogen (200 kg/ha), phosphorus (245 kg/ha), and potassium (300 kg/ha). Organic matter content was low (0.46%).

2.3 Experimental Design and Treatments

The experiment was laid out in a randomized block design (RBD) with eight treatments and three replications. The details of treatments were as follows:

Treatment	Description
T1	Control (No phosphorus, no inoculation)
T2	Control + PSB inoculation
T3	Control + Rhizobium inoculation
T4	Control + PSB + Rhizobium inoculation
T5	50% RDF of phosphorus (40 kg P O /ha)
T6	50% RDF of phosphorus + PSB inoculation
T7	50% RDF of phosphorus + Rhizobium inoculation
T8	50% RDF of phosphorus + PSB + Rhizobium inoculation

2.4 Crop and Cultivation Practices

The crop used was pea (*Pisumsativum* L.) cv. Kashi Pragati, an early-maturing variety developed by IIVR, Varanasi. Seeds were sown at a spacing of 45 cm × 10 cm on November 28, 2024, using a seed rate of 80 kg/ha. FYM at 20 t/ha was incorporated into the soil a month before sowing. The recommended dose of NPK (30:80:50 kg/ha) was applied, with phosphorus applied as Single Super Phosphate (SSP), nitrogen as urea, and potassium as Muriate of Potash. Half of the nitrogen and the full doses of phosphorus and potassium were applied as a basal dose, while the remaining nitrogen was top-dressed 30 days after sowing.

2.5 Biofertilizer Application

Phosphate Solubilizing Bacteria (PSB) and Rhizobium cultures were applied by seed treatment. 30 g jaggery was dissolved in 500 ml water and mixed with 50 g of respective culture. Seeds were coated with this mixture and dried in shade before sowing.

2.6 Observations Recorded

Observations were recorded on the following parameters:

Growth Parameters: Plant height, number of nodules per plant, effective nodules, and chlorophyll content (mg/g fresh weight). Yield Parameters: Number of pods per plant, pod length, number of seeds per pod, green pod yield (q/ha), and 100-seed weight. Quality Parameters: Total soluble solids (TSS), protein content, and ascorbic acid content. Economic Analysis: Cost of cultivation, gross return, net return, and benefit-cost ratio (B\:C).

2.7 Statistical Analysis

Data were analyzed using standard Analysis of Variance (ANOVA) for RBD. Critical Difference (CD) at 5% level of significance was used for comparing treatment means.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant Height (cm)

The plant height was significantly influenced by the application of phosphorus and biofertilizers. The maximum plant height (67.38 cm) was recorded under treatment T8 (50% RDF of phosphorus + PSB + Rhizobium), which was significantly superior to all other treatments. The increase in plant height can be attributed to improved nutrient uptake, enhanced photosynthesis, and better root development facilitated by phosphorus and microbial inoculants.

3.1.2 Number of Nodules per Plant

At 40 days after sowing, the highest number of nodules (28.80) was observed in T8, followed by T6 and T7. The lowest nodulation (13.63) was recorded in the control (T1). This increase can be explained by the synergistic effect of Rhizobium inoculation and phosphorus solubilization, which promoted root proliferation and nodule formation.

3.1.3 Effective Nodules

The number of effective nodules was also significantly highest (24.90) in T8. Rhizobium contributes to biological nitrogen fixation, and the presence of phosphorus enhances the efficiency of the nodules, indicating improved nitrogen assimilation.

3.1.4 Chlorophyll Content (mg/g FW)

The chlorophyll content, an important indicator of photosynthetic efficiency, was maximum (2.03 mg/g) in T8. Treatments T6 and T7 also showed higher values compared to the control. This improvement is due to enhanced nutrient availability and better physiological activity in the plants.

3.2 Yield Parameters

3.2.1 Number of Pods per Plant

A significant increase in the number of pods per plant was recorded in T8 (25.10), followed by T6 (22.36). The lowest number of pods (14.80) was recorded in T1. This demonstrates the importance of integrated nutrient management in improving reproductive efficiency in pea.

3.2.2 Pod Length (cm)

Maximum pod length (9.72 cm) was observed in T8, followed by T6 and T7. This may be attributed to balanced nutrient supply and enhanced metabolic activity resulting from PSB and Rhizobium application.

3.2.3 Number of Seeds per Pod

The number of seeds per pod varied significantly among treatments. The highest value (7.32) was recorded in T8, while the minimum (5.20) was observed in T1.

3.2.4 Green Pod Yield (q/ha)

The combined application of phosphorus and biofertilizers significantly influenced green pod yield. The highest yield (87.32 q/ha) was obtained from T8, which was significantly higher than all other treatments. The lowest yield (56.35 q/ha) was recorded under control (T1). This clearly shows that integrated use of 50% RDF along with PSB and Rhizobium results in higher yield potential.

Biofertilizers	Phosphorus Levels			
	Control	50%	100%	150%
Control	57.70	65.95	75.00	65.12
PSB	67.00	76.32	86.95	92.07
Rhizobium	62.06	70.25	81.42	86.01
PSB + Rhizobium	71.61	80.66	104.74	110.64
SE_{m+} = 4.18				
CD (P = 0.05) =12.11				

3.2.5 100-Seed Weight (g)

The highest 100-seed weight (16.12 g) was recorded in T8, indicating improved seed development and quality due to better nutrient availability and uptake.

3.3 Quality Parameters

3.3.1 Total Soluble Solids (TSS °Brix)

TSS content was significantly improved in biofertilizer-treated plots. The highest TSS (12.20 °Brix) was recorded in T8, indicating enhanced sugar accumulation.

3.3.2 Protein Content (%)

T8 also recorded the highest protein content (25.36%), which could be attributed to enhanced nitrogen fixation and uptake due to Rhizobium activity.

3.3.3 Ascorbic Acid (mg/100g)

The ascorbic acid content was highest

(22.10 mg/100g) in T8, showing that integrated nutrient management not only boosts yield but also improves the nutritional quality of pods.

3.4 Economic Analysis

The highest net return (₹1,14,700/ha) and benefit-cost ratio (2.91) were observed under T8, making it the most economically viable treatment. This shows that the integrated use of phosphorus at 50% RDF with PSB and Rhizobium offers a cost-effective solution for sustainable pea production.

CONCLUSION

The results of the present study clearly indicate that the combined application of phosphorus at 50% of the recommended dose along with PSB and Rhizobium (T8) significantly enhanced the growth, yield, quality, and economic returns of pea (Pisumsativum L.) cv. Kashi Pragati. This integrated nutrient management approach improved plant height, nodulation, chlorophyll content, number of pods per plant, pod length, and green pod yield. It also enhanced quality attributes like protein content, TSS, and ascorbic acid. Economically, T8 produced the highest net returns and benefit-cost ratio. Therefore, the integrated application of phosphorus and biofertilizers is recommended as a sustainable and cost-effective nutrient management strategy for maximizing the productivity and quality of pea while reducing dependency on chemical fertilizers.

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MEASURING STUDENTS UNDERSTANDING OF ENTREPRENEURIAL AND BUSINESS DEVELOPMENT PROCESSES: A SURVEY

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ABSTRACT

The present study is an attempt to evaluate the understanding of entrepreneurial and business development processes in B.Sc. (Ag.) 4th semester students at Tilak Dhari PG College, Jaunpur, during the academic session 2023–24. By using a structured questionnaire, data were collected from 177 students to assess their knowledge before and after classroom instruction. Results revealed a significant improvement in comprehension levels, with the proportion of students exhibiting high understanding increasing from 28.8% to 52.5%. Correlation analysis showed a positive relationship ($r = 0.164$, $p = 0.029$) between pre- and post-classroom knowledge levels, indicating that students with a stronger initial understanding benefited more from the curriculum. The findings emphasize the importance of integrating entrepreneurial education into agricultural studies to foster innovation, enhance agribusiness competencies and prepare students for future challenges.

Keywords : *Entrepreneurship, business development, agricultural education, learning outcomes, agribusiness, curriculum assessment.*

INTRODUCTION

Entrepreneurship and business development are vital for addressing modern agricultural challenges and leveraging opportunities for growth. The agriculture sector, a cornerstone of India's economy, employs a majority of the population yet remains vulnerable to issues like low productivity, market inefficiencies and environmental concerns. In this context, integrating entrepreneurial education into agricultural studies is essential for fostering innovation and resilience in the sector (Singh & Singh, 2020). This study explores the understanding of entrepreneurial and business development processes in B.Sc. (Ag.) 4th semester students at Tilak Dhari PG College, Jaunpur, with the aim of evaluating their preparedness for future challenges in agribusiness and rural development.

Entrepreneurship in agriculture extends beyond launching businesses; it involves problem-solving, opportunity identification and risk management across the agricultural value chain. At the undergraduate level, students encounter foundational knowledge and applied skills, making this phase a crucial period for developing entrepreneurial competencies (Kumar et al., 2018). The 4th semester B.Sc. (Ag.) curriculum offers a unique point for intervention, where students balance theoretical learning with emerging practical applications. This setting provides a fertile ground for cultivating entrepreneurial attitudes and business acumen essential for agribusiness success.

The significance of entrepreneurial education lies in transforming students into job creators rather than job seekers. Agricultural entrepreneurship addresses critical challenges like limited access to markets, declining profitability and climate-induced risks. Equipping students with a deep understanding of business processes—ranging from financial management and resource optimization to market analysis and value chain integration—prepares them to contribute meaningfully to sustainable agricultural practices (FAO, 2021). Such skillsets are particularly crucial in India, where rural regions like Jaunpur depend, heavily on agriculture for socio-economic stability.

Tilak Dhari PG College, a premier institution in eastern Uttar Pradesh, plays an instrumental role in shaping future agricultural leaders. Its curriculum is designed to integrate conventional agricultural knowledge with emerging entrepreneurial frameworks. Assessing the readiness of B.Sc. (Ag.) students to embrace entrepreneurial ventures is essential for aligning education with the sector's demands. Socio-economic factors, prior exposure to entrepreneurial practices and the efficacy of the academic curriculum are key determinants of students' entrepreneurial inclinations (Chand *et al.,* 2019).

In the case of agriculture students, entrepreneurship begins with identifying opportunities—whether in organic farming, agri-tech innovations like precision agriculture, or digital marketing platforms. Business development entails planning, executing and managing these opportunities sustainably. Both processes demand a combination of analytical thinking, creativity and practical application—qualities that can be cultivated through targeted educational interventions and experiential learning opportunities (Sharma & Gupta, 2020).

Experiential learning, such as internships, field visits and case studies, is pivotal in nurturing entrepreneurial skills. Through hands-on experiences, students can address real world challenges and devise innovative solutions. Institutions like Tilak Dhari PG College have the potential to bridge theoretical and practical learning through initiatives that encourage entrepreneurial exploration (Singh *et al.,* 2022). Additionally, external factors, including policy frameworks, market dynamics and technological advancements, significantly influence students' entrepreneurial mindsets.

The agrarian context of Jaunpur provides a unique lens for studying agricultural entrepreneurship. The regional challenges, such as fragmented landholdings, traditional farming methods and limited market access, contrast with opportunities for innovation and modernization. B.Sc. (Ag.) students who understand entrepreneurial processes can develop solutions tailored to these local challenges, fostering regional economic growth and sustainability (Saxena, 2020).

National programs like *Start-up India* and *Aatmanirbhar Bharat* emphasize the role of young entrepreneurs in driving India's self-reliance and innovation goals. Agriculture-focused entrepreneurship aligns with these initiatives, enabling young graduates to contribute to food security, economic development and technological advancements in farming practices (Government of India, 2021). Educational institutions, therefore, hold the responsibility of preparing students to take on these roles effectively. Conducting a survey to assess students' understanding of entrepreneurial and business development processes post-classroom syllabus completion is an effective method for evaluating learning outcomes and identifying areas for improvement.

MATERIALS AND METHODS

This study employed a survey-based research design to evaluate the understanding of entrepreneurial and business development processes in B.Sc. (Ag.) 4th semester students at Tilak Dhari PG College, Jaunpur, during the academic session 2023–24. The primary objective was to assess the learning outcomes of the classroom syllabus and identify potential areas for improvement. The target population consisted of 177 students enrolled in the programme during the specified session.

A structured questionnaire served as the primary data collection tool, designed to measure students' comprehension of entrepreneurial and business development concepts. The questionnaire was divided into three sections: demographic information, an assessment of entrepreneurial knowledge and feedback on the effectiveness of the course. It incorporated multiple-choice and open-ended questions to allow for both quantitative and qualitative analyses. The instrument was validated by a panel of subject experts to ensure its reliability and alignment with the research objectives.

The survey included specific items to measure key aspects of entrepreneurial knowledge and skills, as detailed in the table below:

Particulars	Score-1	Score-2	Score-3	Score-4	Score-5
Awareness of Entrepreneurship	Very Low	Low	Moderate	High	Very High
Understanding of Business Concepts	Poor	Fair	Average	Good	Excellent
Knowledge of Famous Entrepreneurs	Very Low	Low	Moderate	High	Very High
Knowledge of Prominent Businessmen	Very Low	Low	Moderate	High	Very High
Knowledge of Agri-Enterprises	Very Low	Low	Moderate	High	Very High
Use of Technology in Business	Not at All	Rarely	Occasionally	Often	Always
Awareness of Traits of Entrepreneurs	Very Low	Low	Moderate	High	Very High
Adoption of Innovations	Never	Rarely	Occasionally	Frequently	Always
Supply Chain Awareness	Poor	Fair	Average	Good	Excellent
Awareness of Total Quality Management	Poor	Fair	Average	Good	Excellent

The survey was conducted immediately after the syllabus was completed to ensure that the students' knowledge was fresh. A single-phase survey administration was carried out during a scheduled classroom session, where students were briefed on the purpose of the study and assured of anonymity and confidentiality. Participation was voluntary, with all 177 students agreeing to take part.

Data analysis utilized both descriptive and inferential statistical techniques. Descriptive statistics, such as mean and percentage, were employed to summarize responses, while inferential analysis was used to identify trends and relationships in the data. The study adhered to ethical guidelines, obtaining informed consent from participants and maintaining confidentiality throughout the research process.

RESULTS AND DISCUSSION

The findings of the study provide a comprehensive view of the students' understanding of entrepreneurial and business development processes before and after the classroom syllabus completion. The results reveal significant improvement in students' knowledge and skills, highlighting the effectiveness of the curriculum.

Understanding Level: Pre-Classroom and Post-Classroom

Understanding Level (P**re classroom)**

Particulars	Frequency	Percent
Low level (Below 9.28)	21	11.9
Medium Level (Between 9.28 - 15.92)	105	59.3
High Level (Above 15.92)	51	28.8
Total	**177**	**100.0**

The pre-classroom data indicates that a majority of students (59.3%) had a medium level of understanding, while a smaller proportion exhibited either low or high levels of comprehension. This demonstrates a general but incomplete awareness of entrepreneurial concepts prior to formal instruction.

Understanding level (Post classroom)

Particular	Frequency	Percent
Low level (Below 21.35)	11	6.2
Medium Level (Between 21.35 - 23.75)	73	41.2
High Level (Above 23.75)	93	52.5
Total	177	100.0

Post-classroom results indicate a marked improvement, with over half of the students (52.5%) achieving a high level of understanding. The percentage of students at the low level decreased significantly, reflecting the impact of the course in enhancing entrepreneurial knowledge.

The structured classroom instruction significantly enhanced the students' comprehension of entrepreneurial and business development concepts. The shift in understanding levels, as evidenced by the decrease in low-level learners (from 11.9% to 6.2%) and the increase in high-level learners (from 28.8% to 52.5%), reflects the effectiveness of the curriculum.

Correlation Analysis

The Pearson correlation analysis between pre-classroom and post-classroom understanding levels shows a statistically significant positive relationship (r = 0.164, p = 0.029). This suggests that students with a higher initial understanding benefited more from the classroom instruction, indicating the fact that the course was effectively built upon prior knowledge.

Correlations			
		Understanding Level (pre classroom)	Understanding level (Post classroom)
Understanding Level (pre classroom)	Pearson Correlation	1	.164*
	Sig. (2-tailed)		.029
	N	177	177
Understanding level (Post classroom)	Pearson Correlation	.164*	1
	Sig. (2-tailed)	.029	
	N	177	177
*. Correlation is significant at the 0.05 level (2-tailed).			

The correlation analysis highlights that while the course benefitted all students, those with a stronger foundational understanding made relatively greater progress. This underscores the importance of pre-course assessments to identify initial knowledge gaps and tailor instruction accordingly.

CONCLUSION

The study highlights the critical role of structured classroom instruction in enhancing the entrepreneurial and business development competencies of B.Sc. (Ag.) students at Tilak Dhari PG College, Jaunpur. The results demonstrate significant improvements in students' understanding, with a notable increase in the proportion of students achieving high levels of comprehension post-classroom intervention. The positive correlation between pre-classroom and post-classroom understanding underscores the importance of leveraging prior knowledge to maximize learning outcomes.

Entrepreneurial education in agricultural studies is vital for preparing students to address modern challenges in agribusiness, such as market inefficiencies, resource optimization and sustainability. By equipping students with essential entrepreneurial skills, institutions can contribute to transforming agriculture from a subsistence activity into a dynamic, innovative sector. The findings call for continued emphasis on experiential learning, tailored curriculum design and periodic assessments to bridge knowledge gaps and enhance the readiness of agricultural graduates to embrace entrepreneurial ventures. Future research can focus on longitudinal studies to evaluate the long-term impact of such interventions on students' career trajectories and contributions to rural development.

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EFFECT OF DIFFERENT TREATMENTS ON GROWTH AND YIELD OF TORIA (*BRASSICA RAPA VAR. TORIA*)

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ABSTRACT

The present investigation entitled *"Effect of Different Treatments on Growth and Yield of Toria (Brassica rapa var. toria)"* was conducted during the rabi season 2022–23 at the research farm of Tilak Dhari Postgraduate College, Jaunpur, Uttar Pradesh. The experiment was laid out in a Randomized Block Design (RBD) with ten treatments and three replications, evaluating different weed management practices including hand weeding, pre-emergence and post-emergence herbicides, along with weedy and weed-free checks. Observations were recorded on growth parameters, yield attributes, yield, weed population and economics. Results revealed that weed-free treatment (T10) produced significantly higher values of plant height (151.27 cm), dry matter accumulation (42.50 g plant^{-1}), number of siliquae per plant (268), siliqua length (5.87 cm), seeds per siliqua (11.0) and test weight (5.87 g). It also recorded the highest seed yield (10.83 q ha^{-1}) and stover yield (21.83 q ha^{-1}). Among herbicidal treatments, pendimethalin @ 1.25 kg ha^{-1} as pre-emergence (T4) and pendimethalin @ 1.0 kg ha^{-1} followed by one hand weeding (T5) were found at par with the weed-free treatment in improving crop performance. Economic analysis showed that the weed-free treatment gave the maximum net return (₹18,505 ha^{-1}) and B:C ratio (1.51), while pendimethalin-based treatments also provided higher profitability compared to weedy plots.

Keywords: *Toria, brassica rapa, weed management, pendimethalin, isoproturon, growth attributes, yield, economics*

INTRODUCTION

Toria (*Brassica rapa* var. *toria*), also known as *Sarson Lahi*, is one of the important oilseed crops cultivated during the rabi season in India. Belonging to the Brassicaceae family, it holds a significant place in the agricultural economy due to its multipurpose uses in human consumption, animal feed and organic farming. Oilseeds are the second largest agricultural commodity in India after cereals, accounting for nearly 14 percent of the gross cropped area and contributing about 10 percent of the total value of agricultural output. Among the nine major oilseed crops grown in the country, rapeseed-mustard occupies a premier position and ranks second after groundnut in both area and production. Within this group, Indian mustard (*Brassica juncea*) dominates, but toria remains a crucial short-duration crop, particularly suited for double cropping systems.

The crop plays a vital role in enhancing farm income by utilizing the rabi season efficiently after the harvest of early kharif crops such as maize and rice. Toria is well adapted to the agro-ecological conditions of India and requires relatively low water (80–240 mm) compared to other rabi crops. Its short growing season, cool temperature requirement and dry harvest conditions make it an ideal crop for diverse regions. The seeds contain 35–40 percent oil and 20–25 percent protein, making them valuable not only for edible purposes but also for industrial applications. The oil is widely used for cooking, pickling and as fuel for lamps, while the oilcake serves as nutritious cattle feed and organic manure, contributing to sustainable agriculture.

Globally, the significance of rapeseed-mustard can be gauged from the fact that world production of rapeseed in 2022–23 was estimated at 88.56 million metric tons (USDA). In India, the rapeseed-mustard group includes Indian mustard, toria, yellow sarson, brown sarson, black mustard, taramira, gobhi sarson and Ethiopian mustard, cultivated across both tropical and temperate zones. Historical evidence suggests that these crops have been grown since around 3500 BC, reflecting their deep cultural and economic roots. Given the importance of toria in India's oilseed economy, research on improving its growth and yield through different agronomic treatments becomes essential. Enhancing productivity not only addresses the edible oil demand but also contributes to farmers' livelihoods and national self-reliance in oilseed production.

MATERIALS AND METHODS

The present investigation was carried out during the rabi season 2022–23 at the research farm of Tilak Dhari Postgraduate College, Jaunpur, Uttar Pradesh, to study the effect of different treatments on growth and yield of toria (*Brassica rapa* var. *toria*). The experimental site is situated in the Indo-Gangetic plains with sandy loam soil, neutral to slightly alkaline in reaction, low in nitrogen, medium in phosphorus and potassium. The crop variety selected for the study was Type-9 Toria, a short-duration and high-yielding variety suited for double-cropping systems.

The experiment was laid out in a Randomized Block Design (RBD) with ten treatments and three replications, comprising a total of thirty plots. Treatments included a combination of hand weeding, pre-emergence and post-emergence herbicides such as pendimethalin, isoproturon and quizalofop at different doses, along with weedy and weed-free checks. The crop was sown at a spacing of 30 cm × 10 cm using a seed rate of 5 kg ha^{-1} and standard agronomic practices were followed for land preparation, fertilizer application, irrigation and plant protection. Herbicides were applied using a knapsack sprayer at recommended dosages and timings, while cultural practices like thinning and weeding were also performed as per requirement.

Plant material and experimental treatments

The crop variety used was Type-9 Toria (maturity 90–95 days; semi-spreading habit; seed oil 38–40%; yield potential 12–14 q ha^{-1}) sown on 10 September 2022 and harvested on 11 December 2022. The experiment evaluated different weed management and herbicidal treatments (ten treatments) — including hand weeding, pre-emergence and post-emergence herbicides at specified doses, weedy and weed-free checks. Treatments (symbols T1–T10) and their details are as follows:

T1 — Hand weeding (25 DAS)
T2 — Isoproturon @ 0.55 kg ha^{-1} (30 DAS)
T3 — Isoproturon @ 0.60 kg ha^{-1} (30 DAS)
T4 — Pendimethalin @ 1.0 kg ai ha^{-1} (pre-emergence)
T5 — Pendimethalin @ 1.0 kg ai ha^{-1} (PE) followed by one hand weeding
T6 — Pendimethalin @ 1.25 kg ai ha^{-1} (PE)
T7 — Propaquizafop (Quizalofop) 10% EC @ 60 g ha^{-1} (30 DAS)
T8 — Propaquizafop 10% EC @ 80 g ha^{-1} (30 DAS)
T9 — Weedy check
T10 — Weed free check.

Data collection focused on growth, yield and weed parameters. Growth observations included plant height and number of branches per plant recorded at different crop growth stages. Yield attributes such as siliquae per plant, siliqua length, seeds per siliqua and 1000-seed weight were assessed at harvest. Final seed yield and stover yield were computed on a per hectare basis. Weed population and dry weight were measured using quadrat sampling and weed control efficiency (WCE) and weed index (WI) were calculated. Economic analysis was carried out by computing cost of cultivation, gross return, net return and benefit:cost ratio. Statistical analysis of the data was done using analysis of variance (ANOVA) appropriate for RBD and treatment means were compared at a 5% level of significance.

RESULTS AND DISCUSSION

Crop Growth Studies

Plant population (m^{-2})

The data on plant population at different growth stages are presented in Table 1. A significant influence of weed management practices was observed. At 30 DAS, weed-free treatment (T10) recorded the highest plant population (29.33 m ^{2}), which was statistically at par with pendimethalin @ 1.25 kg ha ^{1} (T4). At 60 DAS and harvest stages also, the weed-free treatment maintained significantly higher populations (43.67 and 46.00 m ^{2}, respectively). The lowest values were noted under pendimethalin @ 1.0 kg ha ^{1} + one hand weeding (T5). These findings are in agreement with Yadav et al. (1995), who reported better plant establishment under effective weed control.

Table 1. Effect of weed management practices on plant population of toria (m^{-2})

Treatments	30 DAS	60 DAS	At Harvest
T1 – Hand Weeding (25 DAS)	25.00	37.67	43.33
T2 – Isoproturon @ 0.55 kg ha ^{1} (30 DAS)	26.00	39.00	41.33
T3 – Isoproturon @ 0.60 kg ha^{-1} (30 DAS)	28.33	39.33	41.00
T4 – Pendimethalin @ 1.25 kg ha^{-1} (PE)	29.00	41.33	45.00
T5 – Pendimethalin @ 1.0 kg ha^{-1} (PE) + H .	23.00	40.33	38.00
T6 – Pendimethalin @ 1.0 kg ha^{-1} (PE)	25.33	39.33	42.00
T7 – Propaquizafop @ 60 g ha^{-1} (30 DAS)	26.33	34.67	41.00
T8 – Propaquizafop @ 80 g ha^{-1} (30 DAS)	22.33	39.33	42.00
T9 – Weedy check	25.67	39.00	42.33
T10 – Weed Free	**29.33**	**43.67**	**46.00**
SEm±	1.07	1.18	1.39
CD (P=0.05)	3.18	3.50	4.12

Plant height (cm)

Plant height increased progressively with crop age under all treatments At 30 DAS, weed-free plots (35.57 cm) produced significantly taller plants than all other treatments, followed by pendimethalin @ 1.25 kg ha ^{1} (31.27 cm). At 60 DAS and harvest, similar trends were observed with T10 producing maximum height (67.57 and 151.27 cm, respectively). These results corroborate the findings of Bhoyar and Yaduraju (2000) and Sarkar et al. (2005), who reported significant plant height advantage under weed-free environments.

Dry matter accumulation (g plant-^{1})

Dry matter accumulation was significantly influenced by. At all stages, weed-free plots (T10) recorded maximum dry matter (2.33, 19.35 and 42.50 g plant ^{1} at 30 DAS, 60 DAS and harvest, respectively), followed closely by pendimethalin @ 1.25 kg ha ^{1} (T4) and pendimethalin @ 1.0 kg ha ^{1} + hand weeding (T5). Weedy check (T9) had the lowest dry matter (27.10 g at harvest). Similar results were earlier reported by Yadav et al. (1997).

Yield Attributes and Yield

Yield attributes like siliquae plant ^{1}, siliqua length, seeds siliqua ^{1} and test weight are presented in Weed-free treatment (T10) produced maximum siliquae (268 plant ^{1}), siliqua length (5.87 cm), seeds siliqua ^{1} (11.0) and test weight (5.87 g). Among herbicidal treatments, pendimethalin @ 1.25 kg ha ^{1} (T4) was the most effective, performing at par with T10 in siliqua length and test weight. Superior yield attributes under weed-free treatment may be due to reduced crop-weed competition, ensuring better nutrient and light availability. Nirala and Dinkar (2012) reported similar findings.

Effect of weed management practices on yield attributes of toria

Seed and stover yields were significantly affected Weed-free treatment recorded the highest seed yield (10.83 q ha ^{1}) and stover yield (21.83 q ha ^{1}). Among herbicidal options, pendimethalin @ 1.0 kg ha ^{1} + HW (T5) and pendimethalin @ 1.25 kg ha ^{1} (T4) also produced higher yields compared to other treatments. Weedy check recorded the lowest seed yield (9.67 q ha ^{1}). Harvest index ranged between 0.44–0.51, with weed-free treatment maintaining favorable values. These findings indicate that unchecked weed growth reduces yield potential drastically, confirming Singh et al. (2001).

CONCLUSION

The results of the present investigation indicated that different weed management practices had a marked effect on the growth, yield attributes and productivity of toria (*Brassica rapa* var. *toria*). The weed-free treatment (T10) consistently recorded superior values for plant population, plant height, dry matter accumulation, siliquae per plant, siliqua length, seeds per siliqua, test weight and ultimately seed and stover yield. Among the herbicidal treatments, pendimethalin @ 1.25 kg ha ^{1} as pre-emergence (T4) and pendimethalin @ 1.0 kg ha ^{1} followed by hand weeding at 25 DAS (T5) were found to be highly effective in suppressing weeds and improving crop performance. In contrast, the weedy check (T9) significantly reduced growth and yield, highlighting the adverse impact of crop–weed competition on toria.

Economic evaluation revealed that the weed-free treatment, despite higher cultivation costs, produced the maximum gross return, net return and benefit:cost ratio. Among herbicidal options, pendimethalin-based treatments proved to be the most profitable, showing results statistically at par with the weed-free situation and thus offering practical and cost-effective alternatives to resource-limited farmers. It can therefore be concluded that adoption of efficient weed management practices, particularly pendimethalin @ 1.25 kg ha ^{1} or pendimethalin @ 1.0 kg ha ^{1} followed by hand weeding, is essential for achieving higher growth, yield and profitability of toria under eastern Uttar Pradesh conditions. Effective weed control not only enhances productivity but also contributes to sustainable oilseed production and improved farm income.

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EFFECTS OF PRETREATMENT OF POLLUTED WATER OF SAI RIVER ON GERMINATION AND SEEDLING GROWTH OF *CICER ARIETINUM L. (DESI)*

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ABSTRACT

River Sai is the main river in Pratapgarh district. The discharge of effluents without proper treatment has polluted the river water. Inadequate irrigation facilities has forced the farmers to use polluted water for irrigation. This research was conducted to investigate the impact of polluted Sai River water on germination and seedling growth of *Cicerarietinum L.* (desi). The result reveals that the river water was inhibitory to seed germination and seeding growth. There was reduction in seed germination (-30%), Radicle length (-61%), Epicotyl length (-59%) Fresh weight of radicle (-58%) and Fresh weight of epicotyls (-50%)

Keywords : *Cicer arietinum l. (desi), pollution, germination.*

INTRODUCTION

Rapid progress in science and technology has given many products to mankind; however, environmental pollution has also been its byproduct.

Pratapgarh also called Belha is a city and municipality in the state of U.P. in India. It is an administrative head quarter of Pratapgarh district, part of Allahabad division. There are two main rivers in this district viz. Sai and Ganga, but main river is Sai because Ganga touches only border of Pratapgarh. At Present both the rivers are adversely polluted by agricultural, domestic, sewage disposal and industrial effluents. (Fig.1) River Sai is an important river of U.P., originate from a pond in village Bijgwan near Pihani in district Hardoi and travel about 600 Km to form district boundary between Lucknow and Unnao. After passing through Hardoi, Raebareli and Jaunpur district where it finally join the Gomati River at Rajapur in Jaunpur district. In Hardoi local call the stretch as "Jhabar" from where a river called Bhainsta take shape. The river flows for a good 10 Km before getting its more popular name Sai. The total course of the river in Raebareli is about 100 Kms in length. The length of the Gomti river is 940 Km and it drains a total area of 30,437 sqkm. The Sai catchment is

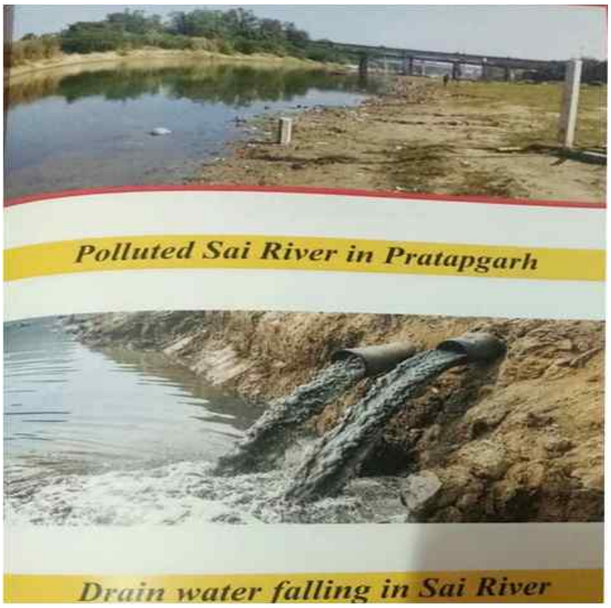

Fig.1- Polluted Sai River in Pratapgarh

bounded in north by Ghaghara catchment While in south by Ganga Catchment. Throughout its journey Sai river travel in the alluvial terrain and transports the sediment derived from Himalayan terrain. In its long Journey the river receives water from other streams also namely Bhainsta, Loni, Sakarni and Bakulahi rivers. Few industries in Raebareli and Pratapgarh discharge their effluents in Sai river without proper treatment which has polluted the river water.

In India 106.6 million hectares of land is under crop cultivation. Only 37 million hectare is being irrigated. More than 66% of the cultivated land is still dependent on rain waters. This dependence and the inadequate irrigation facilities forced the farmers to use sewage as constant device for irrigation.

The effluents contain acids, alkalies, heavy metals, toxic inorganic and organic compounds in dissolved and suspended forms. Agro-soil receiving these industrial effluents by irrigation have adversely affected the agroecosystem. The effluent may affect the soil pH, salinity, soil ionic balance and the availability of essential minerals to plants and many more physico-chemical properties of soil which are vital for growth. These elements are absorbed, metabolized, retained by plant and trapped into food chains, which are used by animals including human being as consumers.

Cereals and legumes cultivated adjacent to Sai river are often irrigated with polluted river water. It was of interest to investigate the impact of polluted Sai River water on germination and seeding growth of *Cicer arietinum L*. (desi).

Gram (Chickpea) is an important winter legume and is mostly consumed in the form of processed whole seed, dal, besan or even fresh green seeds. It is good source of protein, carbohydrate, fat, minerals (calcium, phosphorus, iron) and vitamins. It is an excellent animal feed. Its straw also has good forage value. Green leaves are used as sag.

MATERIALS AND METHODS

Three water samples were collected in 1 litre polyethylene bottle from Sai river (Belha Devi) in the month of January. The collected water samples were subjected to Physico-Chemical analysis to determine pH, DO, BOD, Sodium, Fluoride, Potassium, Chlorine, Total Alkaninity, Total Hardness, Phosphate, Sulphate, Nitrate, Magnesium and Calcium. (Table.1)

Table - 1 : Physico-chemical analysis of water sample of Sai River in Pratapgarh

Parameter	Unit	Standard	Sai River
pH	-	6.5-8.5 (BIS)	8.49
DO	(mg/l)	6.0 (BIS)	7.2
BOD	(mg/l)	5.0 (ICMR)	11.5
Na	(mg/l)	200 (WHO)	66.1
Fluoride	(mg/l)	1.5 (WHO)	0.91
Potassium	(mg/l)	12 (WHO)	10
Chlorine	(mg/l)	25 (WHO)	58.51
Total Alkalinity	(mg/l)	600 (BIS)	287
Total hardness	(mg/l)	100 (WHO)	204
Phosphate	(mg/l)	6 (BIS)	0.78
Sulphate	(mg/l)	200 (WHO)	47
Nitrate	(mg/l)	45 (WHO)	0.89
Magnesium	(mg/l)	100 (BIS)	30
Calcium	(mg/l)	200 (BIS)	100

Comments : Contaminated water with high DO (Dissolved Oxygen), BOD (Biochemical oxygen demand), Chlorine and Hardness.

Seeds of gram were selected for uniformity of size, shape, colour and weight. Surface of seeds were sterilized with 0.1% mercuric chloride solution. After sterilization they were washed with distilled water.

Seeds were soaked for their full imbibition period in Sai river water. Seeds of control set were imbibed in distilled water. There after seeds were taken out washed with distilled water and transferred to sterilized Petri plates lined with moist filter paper and kept in lab for germination. There were three replicates.

After 72 hours their germination percentage was recorded. The seeds with 2 mm length of radicle were considered as germinated seeds. After 3, 5, 7 days of plating seeding of each sets were taken and their length was mcasured. The seedlings were dissected into the radicle and epicotyls.

RESULTS AND DISCUSSIONS

The Physico-Chemical analysis of water sample of Sai River in Pratapgarh (Table-1) shows that the river water is contaminated with high DO (Dissolved Oxygen), BOD (Biochemical Oxygen demand), Chlorine and hardness, above the max. permissible range as prescribed by BIS and WHO drinking water standards.

The studies on effect of Pre-treatment of polluted Sai river water on seed germination and seedling growth of *Cicer arietinum L.* (Desi), (Table-2) reveals that the river water was inhibitory to seed germination and seedling growth. The results reveal the reduction in seed germination (-30%) Radicle length (-60%), Epicotyl length (-59%), Fresh weight of radicle (-58%) and Fresh weight of epicotyls (-50%).

Our studies indicate that the polluted river water starts to exert its effect from the very beginning of the plant life.

Our finding are in agreement with earlier reports. Amina Kanwal *etal.* (2020) in their work on effect of industrial waste water on wheat germination and growth found that lead severely reduces germination and seedling fresh weight. Similar observations were made by Muhammad Zafar Iqbal *etal.* (2015) on their studies on growth of Mungbean by mercury treatment and Acharya, S and Sharma, D.K. (2014) on their studies on effects of heavy metals on seed germination and plant growth on *Jatropha curcas.*

Table - 2 : Effect of Pre-treatment of Polluted Sai river water on seed germination and seeding growth of *Cicer arietinum. L. (Desi)*

Parameter	Days after Radicle Emergence					
	3		5		7	
	Control	Treated	Control	Treated	Control	Treated
Germination	95%	65%	95%	65%	95%	65%
Length of radicle (Cm)	4.3	2.9	6.2	3.8	9.8	6.4
Length of Epicotyl (Cm)	2.95	1.1	4.2	2.5	6.6	4.0
Fresh weight of radic le (mg)	70.1	45	97.6	57	145.3	129.8
Fresh weight of Epicotyl (mg)	58.3	37.8	106.7	53.5	120	105.5

CONCLUSION

The present investigation reports the toxic effect of polluted Sai river water on seed germination and seeding growth. Due to fresh water scarcity, farmers are using polluted water for irrigation. Our studies and earlier observations clearly indicates the hazardous effect of polluted water. There is a need to formulate techniques for treatment of effluents from factories and other sources for conservation of the small rivers and tributaries.

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STUDY ON CONSUMER BEHAVIOR IN FISH MARKET OF HYDERABAD

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ABSTRACT

This study investigates the distribution channels, pricing mechanisms, and consumer behavior within the Ramnagar Fish Market one of the largest wholesale and retail hubs for fish in Hyderabad, India. Utilizing a mixed-method approach involving primary surveys and secondary data analysis, the research provides a comprehensive assessment of the market's operational structure, and consumer behavior. Two predominant marketing channels were identified: Channel-1, involving Commission Agents, Wholesalers, Retailers, and Consumers; and Channel-2, a more streamlined route excluding commission agents. While Channel-2 offers greater transactional efficiency and improved price realization, both models persist due to varying access, scale of operations, and logistical capabilities. Consumer behavior analysis revealed critical determinants such as freshness indicators (eye clarity, gill color, body firmness), sensitivity to hygiene, origin of fish, and socio-cultural attitudes that confine fish consumption to traditional occasions. Barriers such as high and volatile prices, irregular supply, poor market hygiene, and limited nutritional awareness collectively hinder regular consumption. The findings highlight the importance of improving supply chain efficiency, , and consumer awareness to enhance urban fish marketing systems. Strategic interventions focusing on quality assurance, education, and equitable market access are essential to boosting consumption, supporting livelihoods, and ensuring the long-term sustainability of Hyderabad's fisheries economy.

Keywords : *Consumer behavior, market channel fish market*

INTRODUCTION

Among India's states,Telangana stands out as a major fish-producing and consuming region, whereper capita fish consumption is 1.5 times the national average, i.e. 88.25% of the population in Telangana consumes fish. The demand for fish in Telangana has been rising steadily due todiverse consumer preferences, increasing incomes, and a growing appetite for fish. The demand-supply relationship in the state is influenced by key factors such asavailability, accessibility, and affordability. However, there islimited data on household fish consumption patterns, preferred fish varieties, and key factors driving or restricting fish consumption. To address this gap, a study was conducted to analyzefish consumption trends in Telangana, particularly acrossurban and rural inland areas, while identifying major drivers and barriers to fish consumption.

To support Telangana's growing fish consumption demand, it is essential toensure a stable and affordable fish supply. Additionally,local fishermen should be educated on good handling practicesto maintainquality standards and secure better prices.

The regional tastes and preferences of fish eating population of the country and the frequency of fish consumption also exert substantial influence on the market (Shyam, 2012). Consumption of fish in India is increasing significantly due to lifestyle changes and higher cost of meat. In addition, the perception of fish as a healthy food with high levels of digestible protein, PUFA and cholesterol-lowering capability is also a major for its increased consumption. Sutanuka (2011) stated that this phenomenon is gradually spreading beyond hypermarkets and supermarkets. The present trend is surging towards market driven economy and hence the consumer should be at the centre stage. Past studies provided scanty information on the consumer's meat consumption pattern.

Focus of Present Study

The study analyzed the channel distribution of the main fish market in Hyderabad, providing insights into consumer behavior and their purchasing trends.

2. MATERIALS AND METHODS

2.1 Study Area:

Ramnagar Fish Market, is one of the largest and most significant wholesale and retail fish markets located in the twin cities of Hyderabad and Secunderabad which is the study area of research work .This market plays a crucial role in the local fish supply chain, serving as a primary hub for the distribution of a wide variety of freshwater and marine fish, along with other seafood such as prawns and crabs and follows a traditional fish marketing system where traders procure fish from various sources, including inland fisheries, coastal suppliers, and aquaculture farms. The distribution network involves wholesalers, retailers, and local vendors who supply fish to other small fish markets locally in Hyderabad and Secunderabad, households, restaurants, and commercial establishments. Pricing within the market is influenced by factors such as seasonal availability, demand fluctuations, and supply chain logistics. It supports the livelihoods of numerous fish traders, transporters, and laborers. Additionally, it plays a role in the economic sustainability of the fisheries sector in the region. Understanding the market's operational structure and consumption patterns can provide valuable insights into urban fish demand and its impact on the broader fisheries economy in Hyderabad.

Primary and secondary data were collected throughout the research period. Primary data were gathered from fish market and urban areas of Hyderabad through direct surveys, interaction with the fishermen's, consumers and observations. Secondary data were obtained from credible sources, including books, research journals, periodicals, newspapers, RBI bulletins, Economic Reviews, Census Reports, NSSO reports, publications from Central and State Statistical Organizations, FAO reports, and relevant government and institutional websites.

Throughout the survey period, it was evident that market prices for both fish and crustaceans were subject to seasonal variations. These fluctuations were closely tied to species availability, which depends on environmental conditions such as rainfall, water temperature, and breeding cycles. For instance, certain species were more abundant during the monsoon or post-monsoon months, leading to temporary reductions in price due to increased supply. Conversely, scarcity during off-seasons often led to higher prices. Consumer preferences also shift seasonally, further influencing demand and pricing trends. Thus, the economic dynamics of Hyderabad's fish markets are intricately linked to seasonal cycles, emphasizing the importance of adaptive market strategies and sustainable resource management.

2.2 Market Channel and Consumer behavior

2.2.1 Data Collection approach

2.2.3 Market Channel: A multi-method primary data collection strategy was employed to comprehensively capture fish species availability, and market channel structures with the help of direct interaction with fishermen and consumers.

2.2.4 Consumer behavior: Although, the consumers of fish are spread all over the country due to the limitations of time and resource the present study was based on the formal questionnaire and investigate consumers' attitudes towards fish consumption (Arabatzis and Anagnos, 2002).Consumer Behavior covering according to 3 question keys on 'Quality and Marketing'.

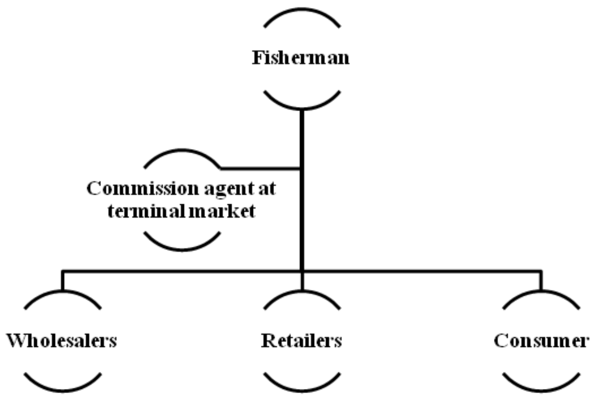

Fig 1: Channel-1 Showing market flow in Hyderabad market

Fig. - 2: Channel-2 Showing market flow in Hyderabad market

The fish consumption survey revealed that Fishes were caught on a daily basis and brought to the market. In the Hyderabad fish market, two predominant marketing channels have been identified, which explained about the flow of fish from producers to consumers.

Channel -1

The first channel follows the sequence: Fisherman → Commission Agent at Terminal Market → Wholesalers → Retailers → Consumers. In this structure, fishermen bring their catch directly to the terminal market, where commission agents act as intermediaries to facilitate transactions between fishermen and wholesalers. These agents earn a commission for their services, often on a per-kilogram basis, and play a significant role in price negotiation and auctioning. Once the fish is procured by wholesalers, it is distributed to various retailers, who then sell it to the consumers. This model, while organized, includes multiple layers, which can reduce the fishermen's profit margins and increase the final cost to consumers. (Figure-1)

Channel-2

The second and more streamlined channel is: Fisherman → Wholesalers → Retailers → Consumers. In this pathway, fishermen directly sell their catch to wholesalers, bypassing the commission agents at the terminal market. This reduces transaction time and intermediary costs. The wholesalers then supply the fish to retailers, who make it available to consumers. This simplified channel is more efficient and can lead to better price realization for both producers and buyers. However, its applicability often depends on the fishermen's access to wholesale buyers and their capacity to handle logistics and bargaining independently. Both these channels coexist in the Hyderabad market, reflecting the diversity in marketing practices based on scale, infrastructure, and trader networks.(Figure-2)

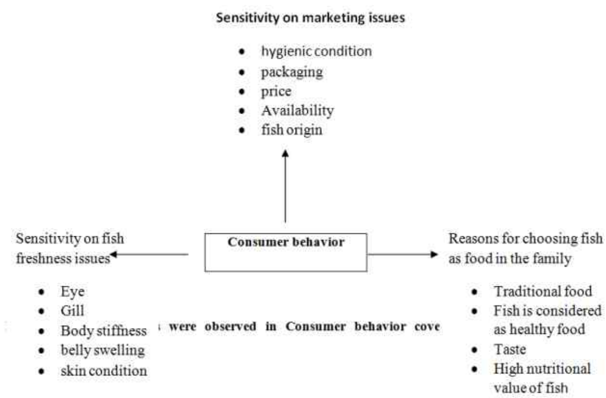

Fig.-3: Three main keys were observed in Consumer behavior covering on quality and marketing

In the Hyderabad fish market, consumer behavior is significantly influenced by three main factors: sensitivity to marketing issues, awareness of fish freshness, and the underlying reasons for fish consumption within households. Consumers show a strong sensitivity toward various marketing aspects such as the hygienic conditions of the selling environment, the quality of packaging, the pricing of fish, its availability, and importantly, the origin of the fish whether it is locally sourced or transported from distant regions. These factors play a crucial role in shaping purchasing decisions. In addition, consumers are highly attentive to indicators of fish freshness, based on visual and physical cues such as the clarity of the eyes, the color and condition of the gills, the firmness or stiffness of the body, any swelling in the belly area, and the overall appearance and texture of the skin. (Figure-3)

Challenges in Fish Consumption and Market Access

A comprehensive analysis of consumer responses and market observations in Hyderabad revealed a broad range of challenges affecting the consumption of fish and seafood. Prominent issues cited by consumers included high market prices, wide fluctuations in pricing, and irregular supply. These price variations were often seasonally driven and influenced by inconsistent availability of preferred fish varieties. Moreover, many buyers expressed dissatisfaction with the lack of freshness and quality of fish available in local markets. Poor access to purchase points due to location, limited market hours, or logistical constraints further contributed to consumer hesitancy. These factors were compounded by concerns over hygiene and cleanliness in fish purchasing environments, which significantly discouraged regular consumption.

Socio-Cultural and Awareness Barriers

In addition to market-related concerns, several socio-cultural and perceptual barriers were identified. A significant number of respondents highlighted a general lack of awareness regarding the nutritional value and health benefits of fish. In many cases, fish consumption was perceived to be restricted to certain social functions or traditional occasions, limiting its integration into regular diets. Cultural attitudes and inherited food preferences further influenced purchasing behavior. The unavailability of preferred fish species was a recurring concern, with consumers often reporting dissatisfaction with substitute options.

CONCLUSION

A structural duality within Hyderabad's fish marketing system, characterized by two predominant distribution channels coexisting in parallel. Channel 1 (Fisherman → Commission Agent → Wholesaler → Retailer → Consumer) incorporates a dedicated intermediary layer at the terminal market, facilitating transactions and price negotiation but incurring higher transaction costs and diminishing fishermen's profit margins through commission fees. In contrast, Channel 2 (Fisherman → Wholesaler → Retailer → Consumer) demonstrates enhanced transactional efficiency by eliminating the commission agent, thereby reducing costs and potentially improving price realization for both producers and consumers. The persistence of both models highlights a supply chain heterogeneity driven by varying scales of operation, fishermen's access to market infrastructure and bargaining power, and the availability of logistical support.

This analysis reveals that consumer behavior in the Hyderabad fish market is shaped by a complex interplay of multifaceted determinants. Consumers exhibit heightened sensitivity to critical marketing aspects, including hygiene, packaging, price, availability, and origin, alongside a sophisticated reliance on sensory cues (e.g., eye clarity, gill color, body firmness) to assess freshness (Figure-8). However, significant barriers impede consumption and market access. These include persistent challenges such as high and volatile pricing, irregular supply of preferred species, dissatisfaction with freshness and quality, and poor physical access to markets compounded by hygiene concerns. Furthermore, socio-cultural factors and a notable lack of awareness regarding the nutritional benefits of fish restrict its integration into regular diets, confining consumption often to specific occasions or traditions. Collectively, these findings underscore that demand stimulation and market development require addressing not only supply chain inefficiencies and price stability but also actively overcoming perceptual barriers through targeted consumer education and improving the overall market experience to meet the sophisticated yet constrained demands of Hyderabad's fish consumers.

Hyderabad's fish market is defined by a dualistic supply chain structure. The presence and role of Commission Agents in Channel-1 introduce significant transactional friction and cost, contrasting sharply with the efficiency gains of the streamlined Channel-2. The choice of channel is contingent upon fishermen's access, capacity, and existing networks, representing a primary factor influencing the distribution of economic value along the supply chain and ultimately impacting producer profitability and consumer prices. This structural duality highlights the interplay between market organization, intermediary roles, and economic outcomes in urban fish distribution systems.

he Hyderabad fish market faces substantial challenges beyond simple supply and demand economics. Consumer participation is critically moderated by sophisticated sensory evaluation of freshness, acute sensitivity to market conditions (hygiene, price, origin, access), and fundamental socio-cultural perceptions. The convergence of economic volatility (high/fluctuating prices), supply chain deficiencies (irregularity, poor quality control, species unavailability), infrastructural limitations (market access), and hygienic shortcomings creates significant structural friction. This friction is compounded by cultural norms that restrict fish to ceremonial consumption and a pervasive lack of nutritional awareness. Consequently, these intertwined factors create a self-reinforcing cycle that significantly discourages regular fish consumption, impacting both public health nutrition goals and market growth potential. Addressing these multifaceted barriers requires integrated strategies targeting market infrastructure, price stabilization, quality assurance, consumer education on nutrition, and efforts to normalize fish within daily diets.

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IMPACT OF ORGANIC MANURES AND BIOFERTILIZERS ON GROWTH, YIELD AND QUALITY OF BEETROOT (*BETA VULGARIS* L.) AT PRAYAGRAJ DISTRICT OF UTTAR PRADESH. CV. ATLAS

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ABSTRACT

The current research was carried out during the Rabi season of 2024–25 at the Research Farm of the Department of Horticulture, Kulbhaskar Ashram P.G. College, Prayagraj, to assess the impact of organic fertilizers and biofertilizers on the growth, yield, and quality of beetroot (Beta vulgaris L.). The experiment was structured in a Randomized Block Design (RBD) with 11 treatments replicated three times, employing the variety 'Atlas.' The treatments consisted of applications of Farmyard Manure (FYM), Vermicompost, Neem Cake, and Phosphate Solubilizing Bacteria (PSB), both individually and in various combinations. The results indicated that the integrated use of Vermicompost (2.5 t/ha) and PSB (1.25 kg/ha) (T_{11}) significantly produced the greatest plant height (31.45 cm), number of leaves (17.49), and leaf area (1053.67 cm²) at the time of harvest. This treatment also yielded the longest root length (18.70 cm), heaviest root weight (165.80 g), and highest root yield (30.80 t/ha), along with enhanced quality features such as TSS (°Brix). The economic evaluation revealed that T_{11} yielded the maximum net return (₹72,000/ha) and a benefit-cost ratio of 2.20. The study concludes that utilizing an integrated nutrient management approach with organic fertilizers and biofertilizers improves crop productivity, soil health, and profitability, positioning it as a sustainable method for beetroot farming.

Keywords: *Beetroot, organic manures, biofertilizers, vermicompost, psb, integrated nutrient management*

INTRODUCTION

Beetroot (Beta vulgaris L.) is a significant root crop grown globally for its nutritional, medicinal, and industrial significance. It is classified under the Amaranthaceae family and is grown as a biennial plant, although it is cultivated annually for its fleshy roots and edible greens. Beetroot is abundant in carbohydrates, fiber, minerals (such as iron, potassium, calcium, and magnesium), and vitamins like folic acid and vitamin C. The distinctive red hue of beetroot arises from betalain pigments that possess antioxidant properties and offer healthbenefits such as lowering oxidative stress, managing blood pressure, and enhancing liver function (Gupta et al., 2019).

In India, beetroot is primarily farmed during the Rabi season in temperate and subtropical climates. The crop flourishes in sandy loam soils that have good drainage and a pH ranging from 6.0 to 7.0. With the increasing demand in fresh produce markets and processing industries, beetroot proves to be a profitable crop for farmers.

Nutrient management presents challenges for beetroot cultivation. Being a nutrient-demanding crop, it requires a balanced and timely supply of nutrients to achieve optimal growth and root development. Farmers often rely on chemical fertilizers for quick and reliable nutrient access. However, the overuse and haphazard application of chemical fertilizers have resulted in:

Soil degradation and imbalance of nutrients.

Decreased diversity of soil microorganisms.

Environmental concerns, including groundwater pollution.

Rising input costs, which impact profitability (Bhattacharjee & Dey, 2014).

Sustainable options exist as alternatives. Organic manures like Farmyard Manure (FYM), vermicompost, and neem cake enhance soil structure, improve water retention, and gradually deliver essential nutrients. Vermicompost is loaded with macro- and micronutrients, humic acids, and substances that promote growth, thus boosting soil fertility and plant development (Rani et al., 2006). Neem cake functions both as organic fertilizer and bio-pesticide, enhancing soil health and minimizing pest problems.

Biofertilizers like Phosphate Solubilizing Bacteria (PSB) improve phosphorus availability in the soil by transforming insoluble phosphates into forms usable by plants. This practice diminishes the reliance on expensive chemical fertilizers and encourages environmentally friendly farming methods (Sunandarani & Mallareddy, 2007).

Justification for the research is needed. Although the independent advantages of organic manures and biofertilizers are well-established, their synergistic application as part of an integrated nutrient management approach for beetroot has been less thoroughly investigated, especially under the agro-climatic conditions of Prayagraj. This study intends to fill that knowledge gap by assessing the combined impacts of organic manures and biofertilizers on the growth, yield, quality, and economic viability of beetroot cultivation.

MATERIALS AND METHODS

Experimental Site and Design

The field experiment was conducted during Rabi season 2024–25 at the Research Farm, Department of Horticulture, Kulbhaskar Ashram P.G. College, Prayagraj. The soil was sandy loam with pH 7.2, low in organic carbon, and medium in NPK content. The experiment was laid out in Randomized Block Design (RBD) with 11 treatments replicated thrice.

Crop Details

- Crop: Beetroot (*Beta vulgaris* L.)
- Variety: Atlas
- Spacing: 30 cm × 10 cm
- Plot size: 2.5 m × 2m

Treatment Details

- T_1: Control
- T_2: RDF (125:50:70 kg NPK/ha)
- T_3: FYM @ 20 t/ha
- T_4: Vermicompost @ 5 t/ha
- T_5: Neem Cake @ 80 kg/ha
- T_6: PSB @ 2.5 kg/ha
- T_7: FYM (10 t/ha) + Vermicompost (2.5 t/ha)
- T_8: FYM (10 t/ha) + Neem Cake (40 kg/ha)
- T_9: FYM (10 t/ha) + PSB (1.25 kg/ha)
- T_{10}: Vermicompost (2.5 t/ha) + Neem Cake (40 kg/ha)
- T_{11}: Vermicompost (2.5 t/ha) + PSB (1.25 kg/ha)

Observations Recorded

- Growth: Plant height, number of leaves, leaf area.

- Yield: Root length, diameter, weight, yield/ha.
- Quality: TSS (°Brix).
- Economics: Cost of cultivation, net returns, B:C ratio.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes

The height of the plants, the count of leaves, and the area of the leaves exhibited notable differences across the treatments. T_{11} displayed the greatest plant height (31.45 cm), the highest number of leaves (17.49), and the largest leaf area (1053.67 cm²). This phenomenon can be linked to the combined effects of vermicompost and PSB, which enhanced soil structure, increased nutrient availability, and boosted microbial activity (Gupta et al., 2019).

Table -1 : Effect of Treatments on Growth Parameters

Treatment	Plant Height (cm)	No. of Leaves	Leaf Area (cm²)
T_1	21.10	12.10	765.12
T_2	27.15	14.50	921.32
T_{11}	31.45	17.49	1053.67

3.2 Yield Attributes

The maximum root length, root weight, and yield were observed in T_{11}. The integration of applications enhanced nutrient uptake and photosynthetic effectiveness, resulting in improved root growth..

Table - 2 : Yield Attributes

Treatment	Root Length (cm)	Root Weight (g)	Yield (t/ha)
T_1	13.20	85.15	19.50
T_2	15.80	125.50	25.40
T_{11}	18.70	165.80	30.80

3.3 Quality Parameters

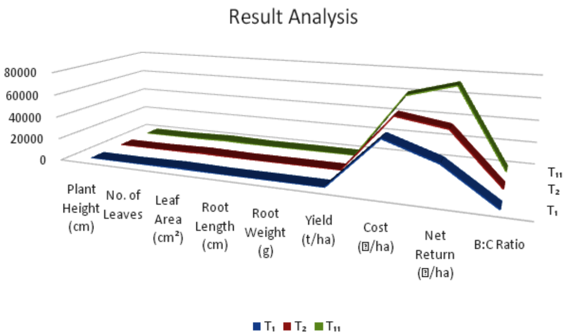
The highest TSS (°Brix) was observed in T_{11}, attributed to improved potassium absorption and a well-rounded nutrient supply that facilitates sugar buildup.

3.4 Economic Analysis

T_{11} achieved the highest net return of ₹72,000 per hectare and a benefit-cost ratio of 2.20, demonstrating its economic viability.

Table - 3 : Economics

Treatment	Cost (/ha)	Net Return (₹ /ha)	B:C Ratio
T_1	45,000	30,000	1.67
T_2	52,000	45,000	1.86
T_{11}	60,000	72,000	2.20



4. CONCLUSION

The current study on the effects of organic fertilizers and biofertilizers on the growth, yield, and quality of beetroot (Beta vulgaris L.) clearly indicated that the combined use of organic nutrient sources significantly improved crop performance compared to applying them individually or using control treatments. Among the different combinations tested, Vermicompost (2.5 t/ha) combined with PSB (1.25 kg/ha) stood out as the most effective treatment (T_{11}), yielding superior results in all assessed parameters—growth, yield, quality, and economic viability.

Summary of Findings

The favorable reaction of beetroot to integrated nutrient management is linked to the combined effects of organic manures and biofertilizers. Vermicompost enhanced soil structure, aeration, and moisture retention while providing essential nutrients in a gradual-release manner, minimizing nutrient losses and ensuring their availability throughout the growing season. Moreover, biofertilizers such as PSB increased phosphorus availability by converting insoluble forms, thereby fostering better root growth and photosynthetic performance. These complementary impacts led to robust vegetative growth, evident from the significantly taller plants, greater leaf count, and augmented leaf area seen in T_{11}.

This improved vegetative growth resulted in enhanced root development and a greater root yield. Treatment T_{11} achieved the longest root length, widest root diameter, and highest average root weight, all of which contributed to a remarkable yield of 30.80 t/ha—an increase of nearly 58% compared to the control and 21% more than the RDF treatment. Additionally, quality indicators such as TSS (°Brix) were also better under the integrated treatment, reflecting superior sugar content and overall root quality, which is essential for consumer appeal and market value.

Economic Viability

Economic analysis indicated that integrated nutrient management not only increased yields but also boosted profitability. Treatment T_{11} produced the highest net return of ₹72,000 per hectare with a benefit-cost ratio (B:C) of 2.20, significantly surpassing the chemical fertilizer-based RDF, which had a ratio of 1.86, as well as sole organic treatments. Although the costs associated with organic inputs were somewhat higher, the additional yield and improvements in quality more than justified the extra expenditure, making this strategy economically viable for farmers.

Sustainability Perspective

Besides short-term gains in yield and profits, the implementation of integrated nutrient management strategies provides advantages for long-term sustainability. Relying solely on synthetic fertilizers has been linked to soil deterioration, nutrient imbalances, and environmental pollution. Conversely, organic manures enhance the content of organic matter in the soil, boost microbial diversity, and help restore soil fertility. The addition of biofertilizers further lessens the reliance on chemical inputs, thereby reducing the ecological footprint while preserving crop productivity. This is in line with the global movement towards environmentally friendly farming practices that ensure food security without jeopardizing environmental integrity.

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AN ECONOMIC ANALYSIS OF WHEAT CROP CULTIVATION IN PRAYAGRAJ DISTRICT OF UTTAR PRADESH

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ABSTRACT

The attempt has been made in present study to examine the economic aspect of wheat cultivation in Prayagraj district of Uttar Pradesh.The main objective of the study was, to know the economic profitability of wheat cultivation. Is wheat cultivation really profitable or not? For achieving this objective Pratappur block from Prayagraj district has selected on the basis of production criteria and five villages namely Pure Thakurain, Chhatauna, Patel nagar, Nahati and Bharauli selected randomly. The total sample size (n) was 100. The result of study revealed that average cost of cultivation (C_3) in study area was ₹. 38041.16 q/hectare. The production cost was observed ₹. 1279.99 per quintal. The B-C ratio has been calculated 1:2.71 which reflects the return from per rupee investment.

Keywords: *Wheat cultivation, cost of production, cost of cultivation, benefit-cost ratio, cost concepts.*

INTRODUCTION

Indian agriculture is a prelude to economic development and a pre-requisite for generation of income and employment for overall economic development of farme₹. Agriculture is a land-based activity in which production are released with factor and production. Resources are decisive for their level of production. Agricultural production, being biological in nature, shows wide variation across different agro-climatic regions, soil, rainfall, topography, temperature and infrastructure facilities like irrigation, marketing greatly influence the level of production and cropping pattern of a region. Wheat is the world's most widely cultivated food crop, has been grown since pre-historic time and being consumed in various form by more than one thousand million people in the world. Wheat is staple food of our country and is growing 122 countries over an area 217 million hectare and wheat production in world 777 million metric tons (Food and Agriculture Organization figures from FAOSTAT data based older from International Grain Council – 2024). India is second largest producer of wheat after China(2020-2021). The area under wheat in India was reported 29.8 million hectares (2021-22) with the total production of 75.81 million tones (recorded PIB 2023), while productivity was recorded 94.88 quintal per hectare recorded wheat season 2021 (Ministry of Agriculture, 2021). The cost of cultivation is an important economic indicator being taken into consideration by Govt. of India while fixing Minimum Support Price (MSP) crops. MSP for wheat (2024-2025) is ₹.2275 but wide variation has been notice in the cost of cultivation of the crops.

In district Prayagraj wheat was grown in 95,000 hectare and total production is 29450 tonnes with yield 31.9 q/ha. In block Pratappur area wheat is grown in 15150 hectare and production 4,39,350 quintal with productivity of 29 q/ha. To ensure the farme₹ adequate return on their surplus produce, marketing became import with the establishment of regulated market from were provide with various marketing infrastructural facilities. However farm suffered from several inherent weakness particularly, the continuous pressure for urgent cash requirement both for production and consumption.

MATERIALS AND METHODS

Prayagraj District of Uttar Pradesh has been selected purposively to avoid the operational inconvenience. A list of 23 blocks of the Prayagraj District was prepared and out of 23 blocks one block, Pratappur, was selected purposively. From the selected block, a list of all villages was prepared and five villages were randomly selected.In the selected villages, a list of wheat growing farme₹ were prepared and arranged in ascending order according to the size of their operational holdings. Further, the farme₹ were categorized into three categories, i.e., (i) marginal (0–1.00 ha), (ii) small (1.00–2.00 ha), (iii) medium (2.00– 4.00 ha). At final stage 100 numbe₹ of farme₹ were selected propertionally from each categary of farme₹. There are 62 marginal 27 small and 11 medium farme₹ from five selected villages (Purethakurain, Chhatauna, Patel Nagar, Nahati, Bharauli) of one block from Prayagraj District. After the seleation of the respondents a well structured survey schedule was prepared and tested. The primary data at farm level and required information on wheat cultivation farme₹ pertaining to crop year 2024-25 collected by pe₹onal survey method. The collected data were analyzed by using the tabular method. Mainly tabular and simple percentage analysis method has been applied to inference some meaningful conclusion.

Analytical procedure:

Estimation of costs and returns:

The farm management, cost concept approach is widely used in India for evaluating crop profitability in production. The cost concepts in brief are cost **A_1, A_2, B_1, B_2, C_1, C_2 and cost C_3**.

Cost A_1: This cost included actual expenditure incurred in cash and kind.

1. Value of hired human, bullock and machinery labour.

2. Value of seed (both farm production and purchased).

3. Value of manure (owned and purchased).

4. Value of insecticide, pesticide and chemical fertilizer.

5. Depreciation on implements and building.

6. Irrigation charges.

7. Land revenue and other taxes.

8. Interest on working capital.

9. Miscellaneous expenses.

Cost Concepts:

Cost A2 = Cost A_1 + rent paid for leased-in land.

Cost B1 = Cost A_2 + interest on the fixed capital (excluding land).

Cost B2 = Cost B_1 + rent value of owned land (net land revenue).

Cost C1 = Cost B_1 + imputed value of family labour.

Cost C2 = Cost B_2 + imputed value of family labour.

Cost C3 = Cost C_2 + 10% of Cost C_2 (managerial cost).

Income Concepts:

Gross Income: Value of farm output (main product and by-product) whether sold or utilized by the family.

Net income: It is difference between gross income and total cost.

Net income = Gross income - cost C_3

Family business income:

Farm business income = Cost A_1 or cost A_2 in case of leased in land.

Farm investment income:-

Farm investment income=Net income+rental value of owned land+interest on owned fixed capital.

Cost of production: The cost of production was worked by the following formula.

Cost of production/qt= Cost of cultivation ₹ per hectare/Quantity of main product qn per hec.

Benefit Cost Ratio:

Benefit- Cost ration is the determination of the ratio of the benefit of given project, closely related to cost – benefit ratio is cost effectiveness analysis.

Benefit – cost ratio = Gross Income / Total cost

Table 1 indicates that on an average, the cost of cultivation of wheat per hectare came to ₹. 38040.89. The cost of cultivation was maximum on small farms(₹. 37627.84) followed by meduim farms (₹. 38187.27) and marginal farms (₹. 38050.43). Due to the reason in favourite more expenses incurred in curred on human labour (₹. 8574.59) per hectare cost of cultivation was highest (₹.37627.84) on small farms, mainly due to maximum investment on fixed capital compared to marginal and medium farms. On an average the study futher reveals that major components on which maximum cost was incurred being 22.54 percent on human labour followed by machinery charges 12.97 percent manures and fertilizer 8.01 percent, irrigation 6.67 percent, seed 5.18 percent plant protection 1.42 percent and bullock labour 0.85 percent respectively. Similar trend indicated on all catergaries of sample farms too.

The cost incurred on interest on working capital, rental value of owned land interest on fixed capital and 10% managerial cost of subtotal was calculated as 9.09 percent of total costs respectively.

CONCLUSION

The cultivato₹ were classified into three categories viz., below 1.00 ha (marginal), 1–2 ha (small) and 2–4 ha (medium). Finally, hundred farme₹ were selected randomly from five selected villages.

`The primary data were collected by survey method through pe₹onal interview technique with the use of pre-structured and pre-tested schedule while secondary data were collected from journals, reports and records of district and block head quarter. The study cove₹ the agriculture year 2023–24.

Statistical analysis of collected data was carried out to study the costs and returns, input-output relationship and constraints analysis. The sample of 100 farme₹ of selected block were considered to study and resulted average size of holding as 0.69, 1.35 and 2.55 hectares in respect of marginal, small and medium farms, respectively. On all farms per farm investment to total assets on farm building, implements and machineries and livestock accounted for 38.13, 27.28 and 34.58 percent, respectively. Cropping pattern of the sample farm for wheat crop area to gross cultivated area shows increasing trend with increasing size of farms. Per farm area for wheat accounted 0.29, 0.40 and 0.60 hectare. Cropping intensity observed as 269.56, 263.70 and 250.58 percent for marginal, small and medium farms, respectively. Intensity cropping showed decreasing trend with increasing size of farms, except medium farms Per hectare cost of cultivation of wheat was highest under small size of sample farms. Per hectare cost of cultivation of wheat was highest under small size of sample farms which was mainly due to heavy investment towards

Table 1: Per-hectare input cost on different components under different size of farms (₹./ha.):

S.No.	Component of Investment	Size of group Farms (/ha)			
		Marginal	Small	Medium	Average
1.	Human Labour	8427 (22.14)	8745 (22.90)	8982.2 (23.84)	8574.59 (22.54)
a.	Family Labour	5660.4 (14.27)	4595.1 (12.03)	2618.2 (6.94)	5037.88 (13.24)
b.	Hired Labour	2766.6 (7.27)	4149.9 (10.86)	6370.6 (16.90)	3536.53 (9.29)
2.	Bullock Labour	328.00 (0.86)	318.00 (0.83)	312.7 (0.82)	323.6 (0.85)
3.	Machinery Charges	5088.00 (13.37)	4823.00 (12.62)	4356.6 (11.55)	4935.99 (12.97)
4.	Seed	1961.00 (5.15)	1965.24 (5.14)	2054.28 (5.45)	1972.41 (5.18)
5.	Manure and Fertilizer	3010.4 (7.91)	3169.4 (8.29)	2962.7 (7.86)	3048.1 (8.01)
6.	Irrigation Charges	2612.00 (6.86)	1279.34 (6.49)	2279.00 (6.04)	2539.55 (6.67)
7.	Plant Protection	519.0 (1.36)	561.8 (1.47)	636 (1.68)	543.42 (1.42)
8.	Total Working Capital	21945.4 (73.02)	22061.78 (57.77)	21589.48 (57.28)	21937.67 (57.66)
9.	Interest on Working Capital	329.18 (0.86)	330.92 (0.86)	323 (0.85)	328.97 (0.86)
10.	Rental Value of Land	11000 (28.90)	11000 (28.80)	11000 (29.18)	11000 (28.91)
11.	Interest on Fixed Capital	1316.72 (3.37)	1323.70 (3.46)	1295.36 (3.44)	1316.25 (3.46)
12.	Sub Total	3459.13	34715.7	34207.84	34582.71

Table. 2: Measure of per hectare costs and profit of wheat (₹./ha.)

S.No.	Particula₹	Cost and Farm Profit			
		Marginal	Small	Medium	Average
1.	Cost A1/A2	16614.18	17797.6	18745.28	17168.12
2.	Cost B1	17930.9	19121.3	20068.98	18487.49
3.	CostB2	28930.9	30121.3	31068.98	29487.50
4.	CostC1	23591.3	23716.4	22687.18	23525.62
5.	CostC2	34591.3	34716.4	33687.18	34525.62
6.	CostC3	38050.43	38188.27	37627.84	38041.16
7.	Productivity (q.t/hec)				
A.	Main Product (q.t/hec)	30.21	29.00	28.75	29.72
B.	By Product (q.t/hec)	32.56	31.54	30.51	32.06
8.	Gross Income	105064	101140	99510	103393.58
A..	Main Product	72504	69600	69000	71334.48
B..	By Product	32560	31540	30510	32059.1
9..	Net return over cost C3	67013.7	62951.73	61882.16	65352.42
10.	Family Labour	76133.1	71018.7	68441.02	73906.00
11.	Farm Investment Income	73699.17	70680.33	71559.32	72630.10
12.	Farm business income	88449032	83342.4	80764.72	86225.46
13.	Cost of Product(./qt)	1259.53	1316.83	1308.79	1279.99

fixed capital. In this crop maximum cost was incurred on human labour having overall average i.e. 22.54 percent. On an overall average, cost of cultivation of wheat was observed to be ₹.38041.16. Cost A, Cost B_1, and Cost B_2 were worked out to be ₹. 71168.12, ₹.18487.49 and ₹.29487.50 respectively. Gross income per hectare was observed highest under small cost of size of sample farms due to high productivity of these farms. The reason of high productivity was encountered due to adopting better management practices, HYV of seeds and timely sowing & transplanting by the farmers. The net return over Cost C, net return over Cost B_2, family labour income and farm investment income was lower under marginal size of farms. Overall average cost of production per quintal was ₹.1279.99.

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STUDIES ON THE EFFECT OF AM FUNGI ON THE GROWTH AND YIELD OF LYCOPERSICON ESCULENTUM MILL.

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ABSTRACT

Arbuscular mycorrhizal fungi (AMF) play a very important role for the improvement of crops. In the present study we observe that AM fungi when applied singly or in combination with vermicompost increase the growth and yield of tomato plant. Application of AM fungi as organic fertilizer is very effective ecofriendly technology. It is very good substitute of chemical fertilizers and protect the crops from harmful impact of chemical fertilizers.

Keywords: AM, chemical fertilizer, crops, organic fertilizer, tomato, vermicompost

INTRODUCTION

The AM fungi are very helpful to their hosts as they enhance the ability of plants to absorb phosphorus from soil, which is relatively inaccessible to the plants (Mcgonigle and Miller, 1996; Miller, 2000). The AM association may also increase the Phyto availability of micronutrients, e.g., copper and zinc (Smith and Read, 1997). In a study, absorption of trace elements, such as boron and molybdenum, was thought to be enhanced by AM mycorrhizae (Sieverding, 1991). In addition, it has been suggested that some AM associations are able to mobilize organically bound nitrogen, which the plants are unable to absorb (Hodge *et al*., 2001). Phosphorus content in tomato plants was increased when inoculated with the AM fungus *G. etunicatum* (Kim *et al*., 1997).AM technology increase the production of vegetables, including potato, brinjal, tomato, lady's finger, lettuce, onion,tomato, etc.

Arbuscular mycorrhizal symbiosis very effective association for promoting plant health and productivity. Chemical fertilizer not very effective to increase production of agriculture soil because its decreases productivity of soil. Chemical fertilizer also very costly. Therefore, AM fungi very effective as a bio fertilizer, in terms of cost effectiveness and as environment friendly, is a promising perspective. The main objective of this work was to study the effects of AM fungi with other biofertilizers like cow dung and vermicompost on the growth & yield of plants.

MATERIALS AND METHODS

Site description: For the experiments, soil wascollected from Agriculture field of village Rampur, Post Dan (Mungra Badshahpur), District Jaunpur, Uttar Pradesh (Plate 1). Characteristics of agriculture soil used in the experiments are presented in Table-1.

Collection of soil samples: The rhizospheric soil samples were collected from the root region of the plants growing in agriculture soil.

Isolation of AM fungi: AMF spores were isolated by wet sieving and decanting method (Gerdemann and Nicolson 1963). A known amount of soil was dissolved in water. After through shaking, it was left for some time for the soil particles to settle down. The clear solution was passed through sieve of 500, 350, 210, 150, 90 and 60 micro meters in descending order. The AM spores retained on various sieves were transferred on filter papers. Filter papers were examined under binocular microscope. Identification of AM fungi: Different AM spores present in the soil were recovered and AM spores were mounted in PVLG and identified to the species level using the synoptic keys of Trappe (1982), Schenck and Parez (1990) and INVAM species guide (*http//: invam.caf.wvu.edu*).

The most dominant indigenous AM fungi was the species of *Glomusviz. Glomus aggregatum*,*Glomus, Glomus fasiculatum*.

Extraction of chlorophyll: One gram of finely cut fresh leaves were taken and ground with 20 – 40ml of 80% acetone. It was then centrifuged at 5000 –10000rpm for 5mins. The supernatant was transferred and the procedure was repeated till the residue becomes colourless. The absorbance of the solution was red at 645nm and 663nm against the solvent (acetone) (Arnon, 1949).

Estimation of Chlorophyll content: The concentrations of chlorophyll a, chlorophyll b and total chlorophyll were calculated using the following equation:

Total Chlorophyll: 20.2(A645) + 8.02(A663)

Chlorophyll a: 12.7(A663) – 2.69(A645)

Chlorophyll b: 22.9(A645) – 4.68(A663)

Maintenance of Trap culture: Numerous healthy spores of different AMF species collected from the plants growing in the agriculture field of Jaunpur.Shoots were removed at crown and roots were chopped into small fragments. These root segments along with rhizospheric soil were mixed with autoclaved coarse sand soil mixture 1:1 ratio (v/v). These mixtures were then transferred to sterilized earthen pots and seeds of *Trifolium repens* (L.) were sown in each pot. Cultures were grown under greenhouse conditions for three months. After three months spore population was determined in trap cultures. Another set of trap cultures was prepared on *Sorghum bicolor* (L.) using the soil of first set. Mycorrhizal inoculum consisted of soil having 60 AM spores/10 gm. soil, mycelia and infected root fragments (95% root length colonization). This consortium was used as inoculum for the experimental work.

Mycorrhizal colonization: Mycorrhizal colonization was measured by the technique of Phillips and Hayman (Phillips and Hayman, 1970).

Experimental Design: For experiment tomatoplants grown in pots under greenhouse condition to evaluate the performance of tomato (NTH – 1800) crop F1 Hybrid tomato, raisedthe plants in agriculture soil of Jaunpur amended with organic fertilizers like vermicompost, cowdung and inoculated with consortium of AM fungi. The experiment had a complete randomized design in one block, seven treatment / block and three replicates / treatment. The seven treatments were as follows

a) Agriculture soil (Control)

b) AgricultureSoil + VAM

c) Agriculture Soil + Vermicompost (VR)

d) Agriculture Soil + VAM+Vermicompost (VR)

e) Agriculture Soil + Cowdung (CD)

f) Agriculture Soil + VAM+Cowdung (CD)

g) Soil+VAM+Cowdung (CD) +Vermicompost (VR)

h) Agriculture Soil+ Vermicompost (VR) +Cowdung (CD)

After sowing finally emergence and establishment only five seedlings per pot were maintained. Five plants from each treatment series were carefully uprooted at different stages of plant growth *viz*; vegetative, flowering and fruiting. Samples of roots along with adhering soil were collected and processed for determining the mycorrhizal intensity in the roots and population of AM spores. Data on dry weight of roots/shoots, fresh and dry weight of fruits were recorded.

Parameters

Microbiological parameters:

Mycorrhizal Intensity: Mycorrhizal intensity in the roots was processed by the method of Phillips and Hayman (1970).

Mycorrhizal intensity = No. of roots bits infected / Total number of root bits examined × 100

AM Spore population: AM spores were isolated by wet sieving and decanting method of Gerdemann and Nicolson (1963). The population of spores in the soil was calculated and expressed in terms of their number per 60g air dried soil.

Growth Parameters: Five plants per treatment were uprooted at different stages of plant growth to record the data on growth parameters.

Root and Shoot Biomass: Dry weight of roots and shoots of the plants for each treatment was determined fruiting stage. For recording the dry weight of roots and shoots the samples were oven dried at 70°C for 48 hrs.

Yield: Number of pods and dry weight of pods for each treatment was determined separately at the time of harvest. For recording the dry weight of the

Table 1:Soil analysis report

S.no.	Parameters	Results	Unit	Observation
1	pH	7.5		Normal
2	EC	101	mmho/cm	Normal
3	OC (organic carbon)	0.40	%	Low
4	Nitrogen(N)	90.0	Kg. /Hectare	Low
5	Phosphorus(P)	13.5	Kg. /Hectare	Low
6	Potassium (K)	324	Kg. /Hectare	High

Table 2:length of root, shoot & fruit of tomato plant in different series

S. no.	Series	Length of root	Length of shoot	Length of fruit
1.	**Soil (Control)**	13.066 ±0.27 cm.	26 .1 ±0.071cm.	2.033 ±0.023 cm.
2.	**Soil + AM***	6.366 ±0.087 cm.	31.5 ±0.151 cm.	1.333 ±0.022 cm.
3.	**Soil + VR***	6.433 ±0.102 cm.	30 ±0.055 cm.	1.633 ±0.023 cm.
4.	**Soil + AM* + VR**	23.333 ±0.040 cm.	28.9 ±0.027 cm.	2.3 ±0.001 cm.
5.	**Soil + CD**	13.333 ±0.156 cm.	22.933 ±0.09Cm.	1.966 ±0.060 cm
6.	**Soil + AM + CD**	10 ±0.27cm.	16.833 ±0.056Cm.	1.466 ±0.023 cm
7.	**Soil + AM + CD + VR**	14.2 ±0.32 cm.	23.233 ±0.40 cm.	1. 666 ±0.032cm.
8.	**Soil + VR + CD**	9.633 ±0.149 cm.	28.6 ±0.026 cm.	1.5 ±0.01 cm.

***AM: Arbuscular mychorrhiza*VR : Vermicompost , *CD : Cowdung**

Table 3 :Weight of root , shoot and fruit in different series of plant

S. No.	Series	Weight of root		Weight of shoot		Weight of fruit	
		Fresh	Dry	Fresh	Dry	Fresh	Dry
1.	Soil (Control)	0.68 ±0.002	0.20 ±0.006	2.46 ±0.001	0.67 ±0.001	11.66 ±0.008	10.42 ±0.016
2.	Soil + AM	0.39 ±0.009	0.123 ±0.001	1.21 ±0.001	0.32 ±0.002	6.11 ±0.00003	4.80 ±0.02
3.	Soil + VR	1.353 ±0.007	0.33 ±0.001	0.696 ±0.002	1.09 ±0.001	7.19 ±0.002	6.20 ±0.002
4	Soil + AM + VR	0.776 ±0.001	0.25 ±0.011	6.106 ±0.001	1.48 ±0.002	11.71 ±0.009	10.42 ±0.001
5.	Soil + CD	0.67 ±0.001	0.18 ±0.001	3.81 ±0.001	1.02 ±0.005	7.19 ±0.005	5.30 ±0.005
6	Soil + AM + CD	0.88 ±0.01	0.17 ±0.001	3.873 ±0.008	0.70 ±0.0089	11.26 ±0.002	9.20 ±0.01
7.	Soil + AM + CD + VR	0.433 ±0.001	0.12 ±0.012	3.326 ±0.002	0.76 ±0.002	7.60 ±0.002	6.49 ±0.001
8.	Soil + VR + CD	0.46 ±0.001	0.166 ±0.002	3.37 ±0.005	0.86 ±0.002	6.25 ±0.008	3.52 ±0.002

Table 4 :AM spore population in 100gm of soil in different series

S. No.	Series	Total no. of spores in 100 gm. of soil
1.	Soil (Control)	30
2.	Soil + AM	62
3.	Soil + VR	42
4.	Soil + AM + VR	70
5.	Soil + CD	32
6.	Soil + AM + CD	37
7.	Soil + AM + CD + VR	55
8.	Soil + VR + CD	57

Table 5 :Percentage mycorrhization in different series

Series	Percentage of Mycorrhization
Soil (Control)	50%
Soil + VAM	65%
Soil + Vermicompost	50%
Soil + VAM + Vermicompost	75%
Soil + Cowdung	30%
Soil + VAM + Cowdung	40%
Soil + VAM + Cowdung + Vermicompost	60%
Soil + Vermicompost + Cowdung	40%

Table 6: Yields of tomato in different series

Series	No. of fruits / plant
Soil (Control)	1.667 ± 0.19
Soil + AM	1.333 ± 0.15
Soil + VR	1.667 ± 0.15
Soil + AM + VR	2.333 ± 0.15
Soil + CD	1.333 ± 0.15
Soil + AM + CD	1.333 ± 0.15
Soil + AM + CD + VR	1.667 ± 0.15
Soil + VR + CD	2.333 ± 0.15

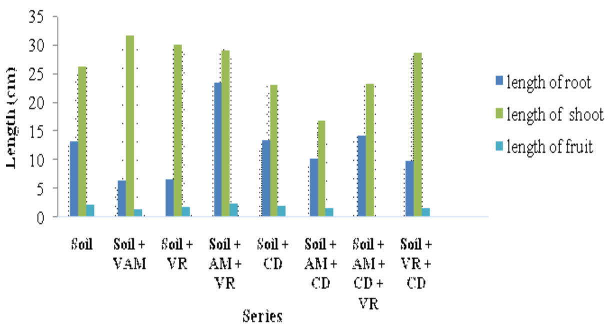
Table 7 :Chlorophyll and carotenoid content in plant

S. no.	eries	Chl. 'a'(mg/g)	Chl . 'b' (mg/g)	Carotenoid (mg/g)	Total chl. (mg/g)
1.	**Soil (Control)**	1.47±0.004	0.32±0.01	1.78±0.001	0.003±0.0002
2.	**Soil + AM**	1.45±0.005	2.60±0.57	2.32±0.006	0.11±0.002
3.	**Soil + VR**	1.56±0.002	0.61±0.004	2.18±0.002	0.12±0.002
4.	**Soil + AM + VR**	1.32±0.002	0.85±0.002	3.89±0.002	0.09±0.002
5.	**Soil + CD**	1.11±0.002	0.46±0.069	1.62±0.005	0.07±0.002
6.	**Soil + AM +CD**	1.05±0.002	0.54±0.004	1.56±0.005	0.06±0.004
7.	**Soil + AM + CD + VR**	1.34±0.002	0.54±0.002	1.84±0.005	0.12±0.002
8.	**Soil + VR + CD**	0.85±0.002	0.45±0.002	1.31±0.002	0.12±0.002

seeds, the samples were oven dried at 70°C for 48 hrs.

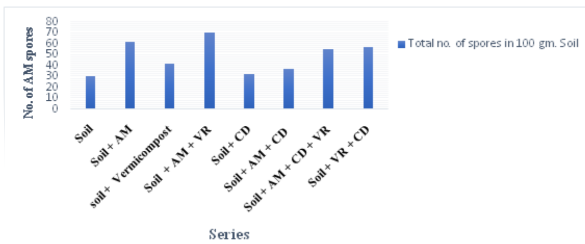
***StatisticalAnalysis*:** Statistical analysis of all the data by using Microsoft Excel.

RESULTS

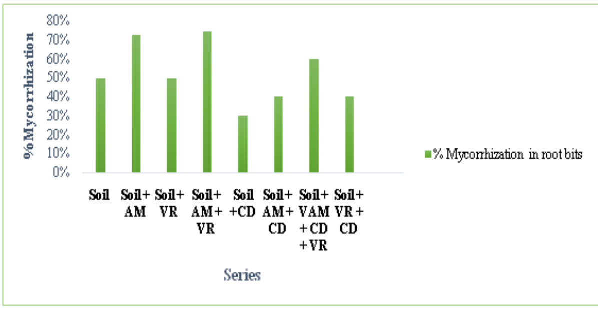


Graph 1 : Length of root , shoot and fruit

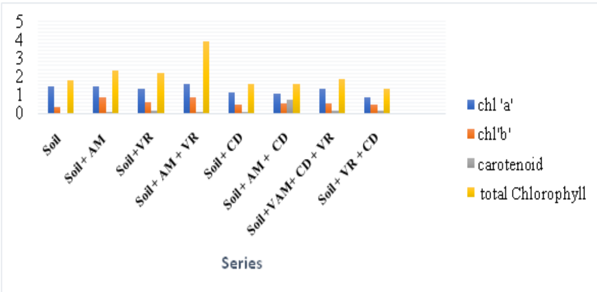
Graph 2 : Weight of shoot & fruit (fresh & dry)



Graph 3 : Total no. of spores in 100 gm. soil



Graph 4 : Percentage mycorrhization



Graph 5 : Chlorophyll 'a', 'b', carotenoid and total chlorophyll

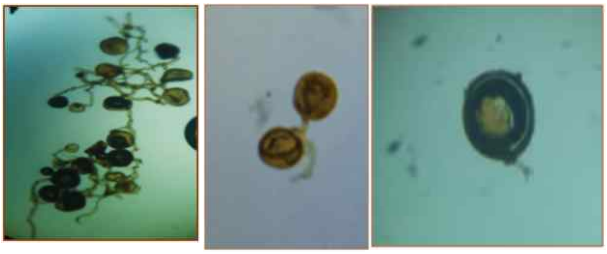
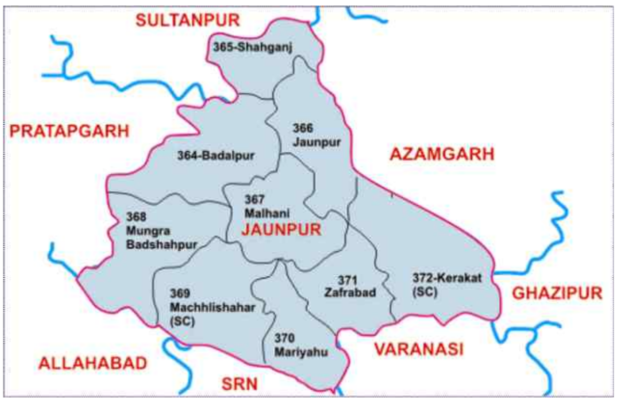


Figure 1 : Diversity of ***Glomus*** sp. in the experimental soil



Map: Collection site of Agriculture soilfor experimental set up(Source Googleimage)Jaunpur district Uttar Pradesh Election 2017 | Jaunpurdistr… | Flickr

Figure 2 : Agriculture soil collection site

Figure 3 : Maintenance of Trap Culture

Figure 4 : Pots set up of different series of *Lycopersicon esculentum* (tomato) (NTH – 1800) crop F1 Hybrid

Figure 5: Fruiting stage of plants in different series (Tomato)

Figure 6 : Tomato plants in VAM + VR series

DISCUSSION

In India, vegetables alone contribute 58.73% of total horticultural production. India produced 162.89 million tonnes of vegetables from an area of 9.39 million ha. (Arora *et al*., 1980).

The 'Green Revolution' in the 1960s and 1970s ushered in by the heavy use of agro-chemicals, increased food productivity but also created several socio-economic and environmental problems like decreased nutritional quality of food produced, decreased soil fertility, higher demand for water for irrigation, soil and water pollution and pesticide poisoning (Sinha, 1998, 2004; Sinha *et al*., 2009). The pesticide remaining in vegetables can cause neurological and blood disorders and lung ailments, and affect the reproductive system of women (Mandal, 2009). Sharma (2009) reported that indiscriminate use of chemical fertilisers in the wake of the Green Revolution in Punjab has pushed the state to the brink of health hazards. To preserve the global agro-ecosystems and protect human health from the harmful agro-chemicals “Ecological Agriculture and Organic Farming” has to be promoted (Gomiero, 2008). Ecological agriculture is relatively more sustainable, and it could be an economically and environmentally viable alternative to the destructive chemical agriculture (Rasul and Thapa, 2003; Sinha, 2004). The effective utilization of 'biological fertilizers' for vegetable crops will not only provide economic benefits to the farmers but also improve and maintain soil fertility and sustainability in natural soil eco-systems (Kannaiyan, 2002). Manure is an important input for maintaining and enhancing soil fertility. As per Fulhage (2000) manure contains the three major plant nutrients, nitrogen, phosphorus and potassium (NPK), as well as many essential nutrients suchas Ca, Mg, S, Zn, B, Cu, Mn etc. That, in addition to supplying plant nutrients, manure generally improves soil health, aeration, and water holding capacity of the soil and promotes growth of beneficial soil organisms.

Cowdung manure plays a significant role in maintaining the nutrient status of the plant. Vermicomposting of cow manure using earthworm species *E. andrei* (Atiyeh *et al*., 2000b) and *E. foetida* (Hand *et al*., 1988) favored nitrification, resulting in the rapid conversion of ammonium-nitrogen to nitrate-nitrogen. Therefore, it improves the nutrient cycling and helping to convert unavailable nitrogen in available forms to plants. It is widely acknowledged that using composts and vermicompost as amendments, rather than industrialized fertilizer and raw manure, could improve soil nutrients and promote soil health (Jack and Thies, 2006).Manure compost has been widely applied as it is highly accessible at low price (Hepperly*et al*, 2009; Ramirez- Guerreo and Meza – Figueroa,2014), and greatly improved most of the characteristics of crop plants compared with mineral fertilizer (Da Silva *et al*, 2011).AMF were shown to confer numerous benefits to their host plants including the enhancement of plant growth and mineral nutrition and the improvement of soil properties (Bousselmane and Achouri, 2002; Diouf *et al*., 2013; Mrabet *et al*., 2014), we also observed that when AMF and vermicompost used in combine, itpromotes the growth and yield of tomato plant as compare to alone (Table 2,3,4,5,6,7).A significant effect of compost and AMF complex on tomato growth in greenhouse experiment, where the root colonization and root dry weight have been improved (Akhter et al., 2015). We also observed, AMF and vermicompost mixture also promote the biomass and mycorrhization in tomato plants (Table

4,5). Indigenous or commercial arbuscular mycorrhizal fungi (AMF) and compost were recently involved to improve plant growth and mineral nutrition of many species such as *Argania spinosa* (Mrabet *et al*., 2014), *Triticum aestivum* and *Trifolium alexandrium*. where a full and half dose of compost inoculated with commercial or indigenous AMF increased significantly root and shoot biomass (Jan, 2014; Jan *et al*., 2014) (Table 3). Also, the use of compost and mycorrhizal fungi have increased growth of *Medicago polymorpha* and a positive correlation was found between biomass production and compost rate(Akhzari *et al*., 2015). The efficiency of vermicompost and AMF on nutrient acquisition, e.g. total nitrogen, potassium as well as pH (from 3.05 to 7.96) and conductivity increasing in contrast with application of vermicompost alone (Akhzari *et al*., 2015). We observed that after experiment, AMF and vermicompost combination very beneficial for the tomato plant. It promotes the biomass and yield of plants. When vermicompost or cowdung apply as single combination it is not much effective for the growth and yield of tomato plant. AMF always beneficial for the growth and yield of plant when combine with vermicompost its give best result. So, after observation we conclude that AMF and vermicompost is best combination for the growth and yield of tomato plant.

CONCLUSIONS

In this study, we observed that when plants grown in AMF and Vermicompost treated soil give best performance. Both growth and yield of tomato plant increases in AMF and vermicompost treated soil in combination as compare to singly. This experiment proves AM technology is eco-friendly technology which promote the quality of tomato plants.

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A COMPREHENSIVE ROLE OF FUNGAL ENDOPHYTES AS MEDICINE IN VARIOUS ASPECTS OF LIFE FORMS

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ABSTRACT

Endophytic fungus generally found as important source of natural bioactive substrates, which may be enhanced by changing in growth condition. Many of bioactive as well as novel molecule obtained by these microorganism are fascinating the attention of various researcher. Endophytic fungi which colonize in the intracellular Parts of plant tissues of healthy plants and establishes symbiosis with host. Such endophytic microorganism yields several secondary metabolite, antibiotic, many enzymes as well as other bioactive products, and these compounds helpful them for the survival in fully aggressive habitat with diverse microorganism. The plant secondary metabolite acquired from endophytic fungus also plays a crucial role for the protection of host plants alongside many fungal and bacterial microbes which are pathogenic in nature and enhance the growth of plant also. Natural products isolated from fungal endophytes shows its application in industry, agriculture, medicine, and the environment due to their chemical and functional diversity. Furthermore, endophytic fungus can boost host plant ability by producing photo chemicals and provide photoprotection. Thus, endophytic fungus research can aid in the identification of new biomolecules as well as in biotechnological fields.

Keywords : *Bioactive compound, endophyte, pathogens, photoprotection, plant growth, symbiotic relationship.*

INTRODUCTION

Because many microorganisms form mutualistic relationships with plants, their interactions are beneficial to both partners. These microbes inhabit both above-ground and below-ground (edaphic) environments. Epiphytes are organisms which resides in the exterior surfaces of any plant, whereas endophytes reside as well as establish themselves within plant tissues, including leaves, roots, fruits, flowers, and seeds. The rhizosphere hosts numerous active microorganisms that enhance plant nutrition, growth, and development. This rhizospheric zone refers to the soil region is that which is spread around the root system of the plants and it is also affected by many microrganisms, compounds secreted by roots of plants and exudates of root (Meena S.K. et al., 2017). This area is characterized by complex relation of plant and microbes, which may be called mutualistic, symbiotic, or parasitic associations.

These interactions often stimulate microbial cells to produce secondary metabolites that can greatly benefit plants by enhancing their resistance to biotic and abiotic stresses and improving their overall fitness (Praveen A. et al., 2023). The term "endosymbiotic microorganisms" refers to common fungi or bacteria that establish mutualistic relationships with their host plants, contributing to improved host fitness. Because these organisms can complete their life cycle without making any harm to host that's why they are considered non-pathogenic (Nair D.N. and Padmavathy S.J.T.S.W.J., 2014).

The fungal endophyte community can be further divided into two subgroups named first one as facultative form endophytes which survive outside the host and maintains the relation with associated soil and second one as obligative type endophytes retaining characteristic of complete dependence on plant derived metabolites for their survival. (Gouda, Sushanto et al., 2016).

MATERIAL AND METHODS

Method for separation and Culture of fungal endophyte

The phylogenetic studies, investigations of diversity, microbe relation with plant and the uses of endophytic fungi in the form of biological fertilizer to enhance nutrition level of plant and exploring biologically active compounds of industrial and pharmaceutical importance, the isolation of endophytic fungi represents a crucial initial step. After surface sterilization, fragments of plant tissue are placed onto culture media, and the fungi emerging from these tissues are subsequently purified (Figure 1).

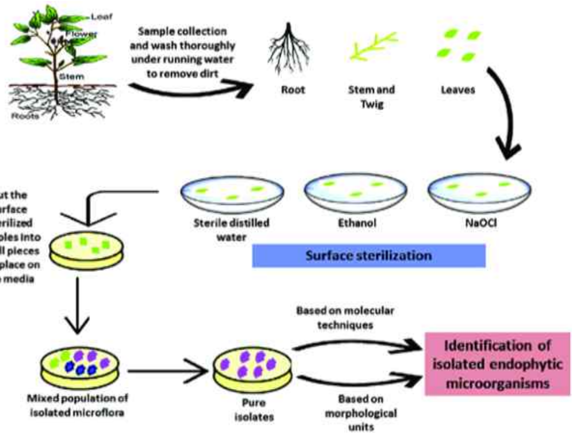

Fig1. Method of isolation of fungal endophytes

Anti-fungal activity as fungal endophytes

According to Nilsson et al., 2008, Based on its internal transcribed spacer (ITS) and morphological features, the region of rDNA, the fungal endophyte isolated from *Torreya mairei* was *Aspergillus clavatonanicus*. The surface culture condition some chemicals obtained named as clavatol (2′,4′-dihydroxy-3′,5′-dimethylacetophenone) and patulin (2-hydroxy-3,7-dioxabicyclo-nona-5,9-dien-8-one) by the help of spectroscopic analysis by EI-MS, X-rayand MS. These compounds exhibited inhibition activity against*Botrytis cinerea, Didymella bryoniae, cucumerinum*, *Fusarium oxysporum, Pythiumultimum, Rhizoctonia solani*. Organic extracts of pestaphthalides A and B strain demonstrated antifungal activity against *Candida albicans* (ATCC 10231), *Geotrichum candidum* (AS2.498), *Aspergillus fumigatus* (ATCC 10894). (Kharwar et al., 2011).

The fungal endophyte of *Xylaria* sp. exhibiting huge antibacterial phenomenon. It was separated from Gymnosperm *Ginkgo biloba* considered as living fossil (Liu et al., 2008). Through bioactivity-guided fractionation, a bioactive compound designated as P3 was obtained from the fungal extract and noted as 7-amino-4-methylcoumarin. This chemical compound shows antimicrobial activity with *Candida albicans* (16 µg mL^{-1}), *Vibrio anguillarum* (25 µg mL^{-1}),*Yersinia* sp. (12.5 µg mL^{-1}), *Aeromonas hydrophila* (4 µg mL^{-1}), *Salmonella enteritidis* (8.5 µg mL^{-1}),*Salmonella typhimurium* (15 µg mL^{-1}),*Salmonella typhi* (20 µg mL^{-1}), *Escherichia coli* (10 µg mL^{-1}), and *Staphylococcus aureus* (16 µg mL^{-1}), by minimum inhibitory concentrations (MICs).

In addition to two previously known compounds the glucoside derivatives xylarosides A and B-2,3-dihydro-5-hydroxy-2-methyl-4H-1-benzopyran-4-one and Sordaricin were separated from fungal endophyte *Xylaria* sp. PSU-D14 (Espada et al., 1997). Among the characterized metabolites, sordaricin displayed average antifungal activity with *Candida albicans* ATCC 90028, relating (MIC) of 32 µg mL^{-1} (Vincent et al., 1998). Similarly, , an endophytic fungus isolated from *Fagonia cretica* known was *Microdochium bolleyi* (strain no. 8880), also producing sordaricin, and it was also showing average antifungal effect with *Candida albicans* ATCC 90028, with the MIC of 32 µg mL^{-1} (Vincent et al., 1998).

Microdochium bolleyi (strain no. 8880), An endophytic fungus isolated from *Fagonia cretica* which is a plant like herb and native to the Gomera region. It was semiarid coastal region and known for producing physiologically active metabolite. Another huge antifungal activity against *Microbotryum violaceum and* average algicidal activity with *Chlorella fusca* obtained from crude extract of ethyl acetate (Vicente et al., 2009).

Preliminary studies indicated that these compounds exhibiting inhibitory effects with *Escherichia coli* and the alga *Chlorella fusca* and antifungal against *Microbotryum violaceum* and antibacterial activity with *Bacillus megaterium* respectively. In vitro bioassays revealed significant activity of these metabolites against three human pathogenic fungi *Aspergillus niger*, *Trichophyton rubrum*, and *Candida albicans* as well as marked cytotoxicity against the cellular carcinoma HepG2 cell line and the human nasopharyngeal epidermoid carcinoma KB cell line (Azam et al., 2012).

Anti-Bacterial activity of endophytes

A highly functionalized naphthoquinone produced by the fungal endophyte *Chloridium* sp. was Javanicin, produced by culturing in both liquid and solid condition, showing massive antibacterial activity with many pathogens affecting both humans and plants (Micropoulou et al., 2023). Its molecular confirmation was done by X-ray crystallography following preliminary identification using conventional spectroscopic techniques. One new dihydrobenzofuran derivative, botryomaman from the fungal endophyte *Botryosphaeria mamane* PSU-M76, isolated from the broth extract along with six known compounds named as 4,5-dihydroxy-2-hexenoic acid, *trans*-4-hydroxymellein,*cis*-4-hydroxymellein, mullein, primin, and 2,4-dimethoxy-6-pentylphenol (Pongcharoen et al., 2007). The diacetate equivalent of phomoenamide with the same minimum inhibitory concentration (MIC) is phomoxanthone B.

Table 1 lists a few substances derived from endophyte fungi that have antioxidant, antibacterial,

Table - 1. Compounds with different Biological activities isolated from Fungal endophyte

Host plant	Endophytic fungus	Compounds	Biological activity
Camptotheca acuminata	*Neurospora crassa*	Camptothecin	Anticancer
Ephedra fasciculata	*Fusarium oxysporium*	Beauvericin	Anticancer
Podophyllum hexandrum	*Trametes hirsute*	Podophyllotoxin	Anticancer
Piper aduncum	*Xylaria* sp.	Phomenone	Antifungal
Fagus sylvatica	*Pezicula livida*	Mullein	Antifungal
Ilex cornuta	*Trichoderma harzianum*	Trichodermin	Antifungal
Ginkgo biloba	*Chaetomium globosum*	Flavipin	Antioxidant
Eucommia ulmoides	*Sordariomycete* sp.	Chlorogenic acid	Antioxidant
Lindenbergia philippensis	*Corynespora cassiicola*	Corynesidones	Antioxidant
Polysiphonia urceolata	*Chaetomium globosum*	Chaetopyranin	Antioxidant
Quercus sp.	*Cytonaema* sp.	Cytonic acids	Antiviral
Paris polyphylla	*Pichia guilliermondii*	Helvolic acid	Antibacterial
Azadirachta indica	*Chloridium* sp.	Pestalone	Antibacterial
Laurencia sp.	*Penicillium chrysogenum*	Conidiogenone B	Antibacterial
Vernonia amygdalina	*Curvularia papendorfii*	Khair acid	Antibacterial
Artemisia mongolica	*Colletotrichum gloeosporioides*	Colletotric acid	Antibacterial
Azadirachta indica	*Chloridium* sp.	Javanicin	Antibacterial
Torreya grandis	*Paecilomyces* sp.	Brefeldin A	Anticancer
Platyclocarpus granatum	*Phyllosticta spinarum*	Tauranin	Anticancer

antifungal, antiviral, and anticancerous properties.

Antiviral Property of Fungal endophytes

The four novel cyclohexadepsipeptides, isolated from fungal endophyte *Pullularia* sp. BCC 8613, they all referred to as pullularins. Pullularins A shows notable activity against the herpes simplex virus type 1 (HSV-1; IC_{50} 3.3 µg mL^{-1}), and malaria parasite *Plasmodium falciparum* K1 (IC_{50} 3.6 µg mL^{-1}). The fungal endophyte *Cytonaema* sp. also performs the cytonic acids A and B discovery which is a product of solid-state fermentation and it acts as new inhibitors of the human cyto megalovirus protease (Sivakumar et al., 2022).

Fungal endophytesas Anticancerous agent

The fungal endophyte two new benzoquinone metabolites isolated 2-chloro-5-methoxy-3-methylcyclohexa-2,5-diene-1,4-dione and xylariaquinone A from *Xylaria* sp. Additionally, the fungal endophyte concerned with *Aegiceras corniculatum* (strain GQ-7) gives off dihydrocitrinin, phenol A, citrinin, along with six novel tetramic acid products, named as penicillenols A1, penicillenols A2, penicillenols B1, penicillenols B2, penicillenols C1, and penicillenols C2, were isolated from *Penicillium* sp. The application of MTT assay these compounds were evaluated in four cell lines as cytotoxic activities (Mondal et al., 2010). Penicillenols A1 and Penicillenols B1 also shows cytotoxic activity against the HL-60 cell line with IC_{50} values of 0.76 mM and 3.20 mM. From an endophytic fungus obtained from *Aegiceras corniculatum* four polyketides named as 9-demethyl FR-901235, arugosin I, penicillenone, and leptosphaerone Cshows cytotoxicity toward P388 cells, with an IC_{50} value of 1.38 µM. Whereas the leptosphaerone C compound also showed cytotoxicity against A-549 cells with an IC_{50} of 1.45 µM.

Antioxidant activity of endophytes

The search for novel and health-promoting antioxidants from natural sources has always been of great importance in preventing and treating disease. Antioxidants are compounds that effectively neutralizes the effects of reactive oxygen species (ROS) by inhibiting oxidative processes. The promising source of natural antioxidants are salidroside, fluoroglusinol, coumarin, lapacol, borineol, isopestacin, pestacin, cornicidin A and B,rutin,5-(hydroxymethyl)-2-furanocarboxylic acid,2,3,6,8-tetrahydroxy-1-methylxanthone are produced by fungal endophyte in the form of secondary metabolites. Many of these compounds also display additional biological activities, including anticancer effects, antimutagenic, antitumor, and anti-inflammatory. Antioxidant compounds belongs strong effective and preventive agents against a wide range of human malignancies. Thus, antioxidant compounds derived from fungal endophyte retains the capacity of reducing the risk of oxidative damage.

Osmotic regulation

Certain endophytic fungi enhance the regulation of osmosis in various tissues of plant, thereby increasing plants resistant to abnormal condition like drought. These fungal strains commonly utilized in grassland ecosystems to improve stress tolerance.

Heavy metals toxicity

The endophytic community plays a vital role in managing heavy metals that are harmful to plants. Fungal endophytes contribute to phytoremediation and help alleviate metal-induced toxicity in soil. By chelating toxic metals and enhancing plant tolerance mechanisms, endophytes effectively reduce environmental stress. Many endophytic fungi are capable of thriving even in environments contaminated with hazardous metals.

Nematicidal or insecticidal activity of endophytes

The fungal endophytic strain *Geotrichum* sp. AL4T gives off two novel chlorinated epimeric 1,3-oxazinane derivative from the ethyl acetate extract of isolated from the leaf of the neem tree (*Azadirachta indica*). The nematicidal activities of these compounds were assessed oppose to nematodes *Panagrellus redivivus* and *Bursaphelenchus xylophilus* all exhibited distinct and measurable bioactivities. Additionally, the first reported nematicidal alkaloid, peniprequinolone, was identified from *penicilliu. Janczewskii*. It is a endophytic fungus associated with gymnosperm named was *Prumnopitys andina*, and was originally separated by soil fungi *Penicillium cf. simplicissimum*.

Anti-Inflammation activity

Endophytic *Streptomyces aureofaciens* CMUAc130 produced two novel anti-inflammation compounds, such as5,7-dimethoxy-4-phenylcoumarin and 5,7-dimethoxy-4-p-methoxyl phenylcoumarin. Their effects were evaluated oncyclooxygenase-2 (COX-2) in lipopolysaccharide (LPS)-stimulated murine macrophage RAW 264.7 cells, inducible nitric oxide synthase (iNOS) and also the production of IL-1β, IL-6, TNF-α, PGE2, and nitric oxide (NO). Both compounds significantly reduced TNF-α production.

Fungal endophytes as Immunosuppressant

The immunomodulatory effects of compounds belonging A to C, received by fungal endophyte separated from *Tripterygium wilfordii* sometimes called thunder god wine, were evaluated (D Shiva Sundara Kumar et al., 2005). The compound B minimises the production of Cytokine by peripheral blood mononuclear cells (PBMNCs) and IL-2 receptor in soluble form, including tumor necrosis factor (TNF)-α, interferon (IFN)-γ, IL-2, and interleukin (IL)-1β. In proliferation assays, compound A showed IC_{50} of 0.35, 1.6, and 0.8 μM in opposite of various stimulants, including pokeweed mitogen (PWM), indicating that it acts as a T-cell-specific immunosuppressant by inhibitings IL-2R, IL-2 and PHA-provoked PBMNC addition. Compound C displayed a dual effect, both inhibiting and stimulating PBMNC proliferation depending on the stimulant used.

RESULT AND DISCUSSION

Teles et al., (2006), and Wiyakrutta et al., (2004), disclosed studies assessing the inhibition of endophyte extracts. The screening of the endophytic extracts' antimicrobial activity in recent study showed similar level of activity against the tested bacteria and yeasts. The majority of the extracts prevented *Pseudomonas* ATCC 27853 and *Staphylococcus* 1564 from growing. The activity that prevented the growth of every pathogen examined was the most notable. Future research should identify the secondary metabolites causing this activity, investigate alternative solvents for its extraction, and determine the MIC (minimum inhibitory concentration).

The results indicate that the microorganisms can use starch and lipids as energy sources. There are currently few references that describe the screening of enzymes from endophytic microorganisms in Petri dishes, the earlier research employed these strains to break down xylan and mannan, according to Tomita (2003). Enzymes like amylases, Xylanan, and Manase are thought to have been secreted by the studied bacteria and fungi during the incubation period, actively breaking down elements of the culture medium. Variability among isolates was found through a comparative investigation of extracellular enzyme synthesis, which can be highly helpful information for the isolation and identification.

Table:MIC values of crude extract of endophytic fungus *Lasiodiplodia sp.*

S. No.	Bacterial Strain	Control	50%	40%	30%
		Stock	500 ml	250 ml	125 ml
1	*Pseudomonas*	-	+	-	+
2	*E. Coli.*	-	+	-	+
3	*Klebsiella*	-	+	-	+
4	*Staphylococcus*	-	+	-	+

Table : Sensitivity of crude extract of fungal endophyte of *Lasiodiplodia sp.*

S. No.	Bacterial Strain	Control	50%	40%	30%
		Stock	500 ml	250 ml	125 ml
1	***Pseudomonas* ATCC27853**	0.6 cm.	0.2 cm.	0.5 cm.	0.5 cm.
2	***E. Coli.* ATCC 25922**	0.00 cm.	0.5 cm.	0.8 cm.	0.4 cm.
3	***Klebsiella* 4151**	0.2 cm.	0.3 cm.	0.5 cm.	0.2 cm.
4	***Staphylococcus* 1564**	0.7 cm.	0.3 cm.	0.6 cm.	0.7 cm.

Conclusions and Future Outlook

The quest of biologically active metabolite isolated from plant and its associated fungal endophyte has expanded due to current research based on medicinal compounds and the enormous need for medications with no side effects. Even so, sunflower was traditionally using as medicine to investigate bioactive chemicals as well as utilise some therapeutic plants. Regarding the bioactivity of related fungal endophytes, some information is available. The pharmacological effects of several endophyte-related bioactive substances are still being studied.

In the fields of agriculture, pharmacology, medicine and research on the microbiological world of plants is currently facing significant challenges. Scientists are becoming more aware of the importance of medicinal plants and the endophytes that are connected with them because of their pharmacological potential, which is utilised in the manufacture of bioactive substances that are found in them naturally. Each medicinal plant has different phytochemical components that could be investigated as treatments for human illnesses.

Therefore, the screening of fungal endophytes using bioactive metabolite extraction may be useful for determining the pharmacological roles for performing research and acquiring knowledge about fungal endophytes as biological organisms which may be in support in long-term beneficial drugs for of human races and to combat from antibiotic resistance.

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ECONOMICS OF BANANA CULTIVATION IN FATEHPUR DISTRICT OF UTTAR PRADESH

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ABSTRACT

The attempt has been made in present study to examine the economic aspect of banana cultivation in Fathepur district of Uttar Pradesh. And the main objective of the study was, to know the economic profitability of banana cultivation. Is banana cultivation really profitable or not? For achieving this objective Hathgaon block from fatehpur district has selected on the basis of production criteria and five villages namely Visui, Kaithola, Achakapur, Ladlepur and Kodarpur selected randomly. The total sample size (n) was 120. The result of study revealed that average cost of cultivation (C_3) in study area was Rs. 323334.44/hectare. The production cost was observed Rs 331.79 per quintal. The B-C ratio has been calculated 1.307 which reflects the return from per rupee investment.

Keywords: *Banana cultivation, cost of production, cost of cultivation, benefit-cost ratio, cost concepts.*

INTRODUCTION

Banana is one of the most popular fruit crop in India after mango. Its importance is increasing due to variety, sweetness, and nutrition content. Banana which are members of the Musa family, are known by their botanical name Musa spp. Banana have been cultivated for thousand years and are believed to have originated in South East Asia. Banana is also one of the favourite fruit among all classes of people as it has round the year availability, affordability, taste and nutritive value. The top five banana producing states in India are Andhra Pradesh, Maharashtra, Tamil Nadu, Uttar Pradesh and Karnataka. All these are contributing approximate 67 per cent in total banana production. In Uttar Pradesh the area covered under banana production is 55342 hectare through which it produces approximate 26 lakh metric tonnes banana. Fatehpur district has secured third place after Kushinagar and Gorakhpur in terms of banana production. Keeping in view the importance of banana crop an attempt has been made in the present study to work out profitability in relation to its production in Fatehpur district of Uttar Pradesh during the agricultural year 2024-25.

MATERIALS AND METHODS

Fatehpur District of Uttar Pradesh has selected purposively to avoid the operational inconvenience. A list of all the 13 blocks of the fatehpur district was prepared and out of 13 blocks one block hathgam was selected purposively. From the selected block, a list of all villages was prepared and five villages were randomly selected on the basis of maximum coverage of the area under banana cultivation. From the selected villages a list of banana growing farmers were prepared and arranged in ascending order according to the size of their operational holdings, Further the farmer was categorized into two categories, i.e. (i) small (1 to 2 ha) and (ii) medium (2 ha and above). At final stage 120 numbers of farmers were selected proportionally from each category of farmers. There are 78 small, and 42 medium farmers from five selected villages (Visui, Kaithola, Achakapur, Ladlepur and Kodarpur) of one block from Fatehpur district. After the selection of the respondents a well structured survey schedule was prepared and tested. The primary data at farm level and required information on banana cultivation farmers pertaining to crop year 2024-25, collected by personal survey method. The collected data were analyzed by using the tabular method. Mainly tabular and simple percentage analysis method has been applied to inference some meaningful conclusions.

Analytical Procedure

Estimation of Costs and Returns

The farm management, cost concept approach is widely used in India for evaluating crop profitability in production. The cost concepts in brief, are Cost A1, A2, B1, B2, C1, C2, and cost C3.

COST A1: This gives the total cash expenses incurred by the owner or operator. It includes the following terms of costs.

1. Value of hired human labour.
2. Value of bullock labour.
3. Value of machinery charges
4. Value of fertilizers and manures.

Table -1 : Cost of cultivation of banana on sample farms (Rs/ha)

S.No	Particular	Small	Medium	Overall
1	Total Human labour	43261.12	40119.12	42161.34
a	Family labour	20100.92	15108.13	18353.44
b	Haird labour	23151.20	25010.10	18801.81
2	Machine charge	17193.25	19118.20	17866.98
3	Planting material	47049.22	51182.25	48495.78
4	Manures and fertilizer	40238.66	43183.65	41269.40
5	Plant protection	13123.26	15233.20	13861.73
6	Irrigation	22125.34	25210.18	23345.04
7	Propping	22010.23	25210.68	23130.00
8	Total working capital	205001.08	259775.04	224171.96
9	Intrest on owned capital	12300.06	15586.50	13450.31
10	Total variable cost	217301.14	275586.50	237701.01
11	Revenue of land	32	32	32
12	Depreciation of implement	7025.33	11695.20	8659.78
13	Rental value of land	40000.14	42000.72	40700.34
14	Interest on fixed capital	7122.90	7117.73	7121.09
15	Total fixed cost	54148.29	60813.65	56481.16
16	Managerial cost	26448.29	34399.43	29231.18
	Grand total (a+b)	297897.43	370574.62	323334.44

5. Value of suckers.
6. Value of insecticides, pesticides and weedicide
7. Irrigation charges.
8. Depreciation on farm implements
9. Interest on working capital.
10. Land revenue paid to government.

COST A2 = Cost A1+ Rent paid for leased in land, if any

COST B1 = Cost A1 + Interest on value of owned fixed capital assets.

COST B2 = Cost B1 + Rental value of owned land less land revenue

COST C1 = Cost B1 + Imputed value of family labour.

COST C2 = Cost B2 + Imputed value of family labour.

COST C3 = Cost C2 + 10% of Cost C2 on account of managerial functions performed by the farmer.

Rates of Returns over Different Cost Concepts

Gross Income:

Yield of main product (in qt./kg) x their prices (Rs.)

Net Income:

Gross Income – Cost C.

Farm Business Income:

Gross Income – Cost A2

Farm Investment Income:

Farm business income- Imputed value of family labour

Family Labour Income:

Gross Income – Cost B

Cost of production:

The cost of production was worked by the following formula:

Benefit-Cost ratio:

It is the ratio between input and output, and computed by dividing value of total output by value of total input cost.

B-C Ratio = O/I

Where,

I = Total input cost

O = Gross Income

Table-2: Cost concept of banana on sample farm.(Rs /ha)

S.NO	Cost	Small	Medium	Overall
1	CostA1	204248.55	231861.49	213913.07
2	costA2	204248.55	231861.49	213913.07
3	CostB1	211371.45	231861.22	221034.09
4	CostB2	251371.59	280979.94	261734.51
5	CostC1	231472.37	254087.35	239387.61
6	Cost C2	271472.14	296088.07	280087.95
7	CostC3	297897.43	370574.62	323334.44

Table-3 Income measures on sample farms

S.NO	Particular	Small	Medium	Overall
1	Average yield(qt)	965	989	973.40
2	Average of price	1020	1020	1020
3	Cost of cultivation	297897.43	370574.62	323334.44
4	Cost of production	308.70	374.69	331.79
5	Gross income	984300	1008780	992868
6	Net income	686402.57	638205.38	669533.55
7	Family labour income	732928.41	727800.15	771133.49
8	Farm business income	780051.45	776918.15	778954.93
9	Farm investment income	733525.61	687323.45	760601.49
10	B.C Ratio	1:3.30	1:3.72	1:307

RESULT AND DISCUSSION

Table 1 indicated that input used pattern for banana cultivation. The overall total working capital on sample farms were found to be Rs. 224171.96/hectare while the interest on working capital was Rs 13450.31 and fixed cost Rs. 56481.16/hectare. The total cost was observed on sample farms Rs 323334.44 / hectare. The highest expenditure incurred on planting materials i.e. Rs.

48495.78/ hectare followed by human labour Rs 42161.34 per hectare. Per hectare costs and returns for banana crop on different size groups of farms are presented in Table – 2 and Table-3, per hectare cost C_2 worked out to be Rs. 271472.14 on small and Rs. 296088.07 on medium farms with on an average of Rs. 280087.95. The table reveals that positive relation of cost A_1 and cost B_2 with farms size. This was because of the fact that use of variable inputs and investment cost increased with the increase in farms size. The average yield was observed 973.40 quintal per hectare. It was 965 quintal on small farms while 989 quintal on medium farms respectively. On an average farm net income, family labour income, farm investment income and farm business income worked out to be Rs. 669533.55, Rs. 771133.49, Rs., 760601.49 and Rs. 778954.93, respectively. Cost of production per quintal of banana was computed to Rs. 331.79 and varied in the range of Rs. 308.70 and Rs. 374.69.

CONCLUSION

The study revealed the increasing trend of cost of cultivation from small to medium farms. It is due to the fact that large size of holding farmer incurred more expenditure on modern farm inputs. It may be concluded that banana production in the study area is highly profitable than other crops. It provides a net income of Rs. 669533.55 per hectare with a total expenditure of Rs. 323334.44 and gross income of Rs. 992868 per hectare. Fatehpur district is the potential production area of banana which is indicated by profitable and lucrative farming due to high Benefit cost ratio.

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AN ACCOUNT OF SUPER FAMILY FULGOROIDEA *(INSECTA: HEMIPTERA: AUCHENORHYNNCHA)* FROM DALMA WIS, JHARKHAND, INDIA

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ABSTRACT

This study focuses on the diversity of bugs from the superfamily Fulgoroidea (Insecta: Hemiptera: Auchenorrhyncha) found in Dalma Wildlife Sanctuary, Jharkhand, India. The faunistic investigation identified 14 species across 14 genera and 6 families, all documented for the first time in this sanctuary.

Keywords: *Dalma wildlife sanctuary, hemiptera, fulgoroidea, distribution.*

INTRODUCTION

Hemiptera is the fifth largest insect order class Insects generally called True Bugs. Most diversified group of insects comprises about 1053881 species World wide of which about 6771 species are known occur in India. 456 species found from Madhya Pradesh. Dalma wildlife Sanctuary is situated on the Chota Nagpur plateau in the Dalma Hill range of East Singhbhum District of Jharkhand. It lies between 22° 46′ and 22° 57′ North latitude and 86° 7′ and 86° 26′ East longitude with an area of 193.22 square kilometer. This study deals with faunistic diversity of 14 species of superfamily Fulgoroidea belonging to 14 genera under 6 families from the Dalma Wildlife Sanctuary. All of the species are reported first time from the study area.

MATERIALS AND METHODS

The specimens were collected from shrubs with the help of an insect net, handpicking, light tarp methods from Dalma Wildlife sanctuary. The collected bugs were put in the glass vials, containing 70% ethyl alcohol in the field. Identification of the species was made following the keys and characters as given by Distant [10,11,13,16].

RESULTS AND DISCUSSIONS

Order: **HEMIPTERA Linnaeus, 1758**

Suborder: **AUCHENORRHYNCHA**

Infraorder **FULGOROMORPHA EVANS,1946**

Superfamily **FULGOROIDEA**

Family **FULGORIDAE LATREILLE,1807**

1.***Pyrops viridirostris*** (Westwood, 1848)

1848. *Pyrops viridirostris* Westwood, *List of the specimens of Homopterous insects in the collection of the British Museum.* **2**: 261-636.

2018. *Pyrops viridirostris Pyrops*

candelaria: Chandra et al, *Faunal Diversity of Biogeographic Zone. Islands Of India.Arthropoda. Hexapoda*: 264 -270.

Material examined: 1ex, Makulakocha village, Chandil subdivision, Dalma Wildlife Sanctuary, Saraikela Kharsawan District, Jharkhand, 22.91187 N, 86.1491E, 10.vii.2021, J. Chitra & Party coll.

Distribution**:** India: Jharkhand (Dalma Wildlife Sanctuary); TamilNadu, Western Ghats of Southern India.

2.***Kalidasa nigromaculata*** (Gray, 1832)

1832. *Kalidasa nigromaculata* Gray, *Griff.An.Kingd.Ins*., **2**: 260.

1906. *Kalidasa nigromaculata*: Distant, *Fauna.Brit.India.Rhynchota*., **3**: 213.

2018. *Kalidasa nigromaculata*: Chandra et al, *Faunal Diversity of Biogeographic Zone. Islands Of India.Arthropoda. Hexapoda*: 264 -270.

Material examined: 1ex, Dharnigora Rugri village, Chandil subdivision, Dalma Wildlife Sanctuary, Saraikela Kharsawan District, Jharkhand, 22.856N, 86.1621E, 10.vii.2021, J. Chitra & Party coll.

Distribution**:** India: Jharkhand (Dalma Wildlife Sanctuary); Andaman Islands, Kerala.

Elsewhere: China

3.***Penthicodes atomaria*** (Weber, 1801)

1801. *Penthicodes atomaria* Weber*, Handbuch der Entomologie*., **2**: 400.

2018. *Penthicodes atomaria*: Chandra et al, *Faunal Diversity of Biogeographic Zone. Islands Of India.Arthropoda. Hexapoda*: 264 -270.

Material examined: 1ex, Forest Guest House,Dalma Wls, Dist- West Singbhum, Jharkhand, 22.912579 N, 86.143106E, 8.vii.2021, Chitra. J & Party Coll;

Distribution: India: Jharkhand (Dalma Wildlife Sanctuary); Assam, Sikkim, Tamilnadu.

Elsewhere: China,Cambodia,Indonesia,Java, Mayanmar,Sumatra, Taiwan,Thailan,Vietnam.

4. ***Dictyophara dixoni,*** (Distant,1906)

1906. *Dictyophara dixoni,* Distant, *Ann.Mag.Nat.Hist*., **18**: 351.

1918. *Dictyophara dixoni,* Distant, *Fauna.Brit.India.Rhynchota*., **6**: 24.

Material examined: 2exs, Forest Guest House,Dalma Wls, Dist- West Singbhum, Jharkhand, 22.912579 N, 86.143106E, 8.vii.2021, Chitra. J & Party Coll;

Distribution: India: Jharkhand (Dalma Wildlife Sanctuary); Maharashtra, Uttar Pradesh, WestBengal.

5. ***Dichoptera hyalinata*** (Fabricius,1781)

1781. *Dichoptera hyalinata* Fabricius, *Spec.Ins*., **2**: 315.

1916. *Dichoptera hyalinata* : Distant, *Fauna.Brit.India.Rhynchota*., **3**: 238.

Material examined: 1ex, Makulakocha village, Chandil subdivision, Dalma Wildlife Sanctuary, Saraikela Kharsawan District, Jharkhand, 22.91187 N, 86.1491E, 10.vii.2021, J. Chitra & Party Coll. 1ex, Kamdeyong Nussery, Porchat, West Singbhum, Jharkhand, 15.vii.2021, Chitra. J & Party Coll.

Distribution: India: Jharkhand (Dalma Wildlife Sanctuary); Andaman Islands, Karnataka, Maharashtra,West Bengal.

Elsewhere: Sri Lanka.

6. ***Dictyopharina viridissima*** Melichar,1903

1903. *Dictyopharina viridissima* Melichar, *Hom.Faun.Ceylon*.: 26.

1916. *Dictyopharina viridissima*: Distant, *Fauna.Brit.India.Rhynchota*., **3**: 253.

Material examined**:** 1ex, Makulakocha village, Chandil subdivision, Dalma Wildlife Sanctuary, Saraikela Kharsawan District, Jharkhand, 22.91187 N, 86.1491E, 10.vii.2021, J. Chitra & Party coll. 1ex, Chitingdah West Singbhum, Jharkhand, 17.vii.2021, J. Chitra & Party Coll; 2exs, Forest Guest House,Dalma Wls, Dist- West Singbhum, Jharkhand, 22.912579 N, 86.143106E, 8.vii.2021, Chitra. J & Party Coll.

Distribution: India: Jharkhand (Dalma Wildlife Sanctuary); Central India, Madhya Pradesh, West

Bengal.

Elsewhere: Sri Lanka.

7.***Avephora brachycephala*** (Distant,1906)

1906. *Putala brachycephala* Distant: 354.

1912.*Putala brachycephala*: Melichar: 103.

2011. *Avephora brachycephala*: Zhi-Shun Song and Ai-Ping Liang, *Annals of the Entomological Society of America*, **104**(2):154-170.

Material examined: 7exs, Dharnigora Rugri village, Chandil subdivision, Dalma Wildlife Sanctuary, Saraikela Kharsawan District, Jharkhand, 22.856N, 86.1621E, 10.vii.2021, J. Chitra & Party coll; 2exs, Forest Guest House,Dalma Wls, Dist- West Singbhum, Jharkhand, 22.912579 N, 86.143106E, 8.vii.2021, Chitra. J & Party Coll.

Distribution: India: Jharkhand (Dalma Wildlife Sanctuary);

Elsewhere: Maiaysia,Pakistan,Singapore, Sri Lanka.

8.***Orthopagus splendens*** (Germer,1830)

1830.*Flata splendens* Germer.: 48.

1908. *Orthopagus splendens*: Oshanin, 444.

2018.*Orthopagus splendens* Song et al., *Zoosystematics and Evolution*.,94 (2): 369-391.

Material examined: 7exs, Dharnigora Rugri village, Chandil subdivision, Dalma Wildlife Sanctuary, Saraikela Kharsawan District, Jharkhand, 22.856N, 86.1621E, 10.vii.2021, J. Chitra & Party coll. 1ex, Chintingdha, West Singbhum, Jharkhand, 17.vii.2021, Chitra. J & Party Coll; 4exs, Kamdeyung Nursery, Porahat, North Singbhum, Jharkhand, 15.vii.2021, Chitra. J. & Party Coll.

Distribution: India:Jharkhand (Dalma Wildlife Sanctuary);

9.***Raivuna pallida*** (Donovan,1800)

1800.*Fulgora pallida* Donovan, 1800: 1.

2011.*Raivuna pallida*Mozaffarian and Emeljanov, *ZooKeys*.,**145**: 1–57.

Material examined: 1ex, Makulakocha village, Chandil subdivision, Dalma Wildlife sanctuary, Saraikela Kharsawan district, Jharkhand, 22.91187 N, 86.1491E, 10.vii.2021, J. Chitra & Party coll. 1ex, Kamdeyung Nursery Porahat, West Singbhum, Jharkhand, 15.vii.2021, Chitra. J & Party Coll

Distribution: India:Jharkhand (Dalma Wildlife Sanctuary);

Elsewhere: Central and Eastern Asia, North Africa, Southern parts of Western Asia, Transcaucasia.

Family LOPHOPIDAE STAL,1866

10.***Pyrila purpusila*** (Walker,1851)

1889.*Zamila purpusila* Walker, *List.Hom*., **2**; 269.

1916. *Pyrila purpusila*: Distant, *Fauna. Brit. India. Rhynchota*., **6**: 85.

***Material examined*:** 1ex, Makulakocha village, Chandil subdivision, Dalma Wildlife sanctuary, Saraikela Kharsawan district, Jharkhand, 22.91187 N, 86.1491E, 10.vii.2021, J. Chitra & Party Coll; 1ex, Forest Guest House, Dalma Wls, Dist- West Singbhum, Jharkhand, 22.912579 N, 86.143106E, 8.vii.2021, Chitra. J & Party Coll.

Distribution: Bihar, Delhi, Haryana, Uttar Pradesh, Punjab, and Madhya Pradesh

Elsewhere: Afghanistan, Bangladesh, Cambodia, China, India, Indonesia, Laos, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand and Vietnam.

Family FLATIDAE Spinola,1839

11.***Flatida marginella*** (Olivier,1791)

1791. *Flatida marginella* Olivier, *List.Hom*., **3**; 345.

Material examined: 1ex, Makulakocha village, Chandil subdivision, Dalma Wildlife sanctuary, Saraikela Kharsawan district, Jharkhand, 22.91187 N, 86.1491E, 10.vii.2021, J. Chitra & Party Coll.; 1ex, Chitingdah , West Singbhum, Jharkhand, 17.vii.2021, J. Chitra & Party Coll; 2exs, Krighatta Srinivas Temple, Mysore, Karnataka, 12.42335N, 76.71921E, 752.3m, 11.x.2023, P.C.Saha Coll.

Distribution: India: Jharkhand (Dalma Wildlife Sanctuary); Karnataka.

Elsewhere: Srilanka.

Family EURYBRACHIDAE Stål, 1862

12.***Eurybrachys tomentosa*** (Fabricius, 1775)

1775. *Eurybrachys tomentosa* Fabricius, *Syst. Ent*., **2**: 324.

1906. *Eurybrachys tomentosa*: Distant, *Fauna. Brit. India.Rhynchota*., **3**: 222 – 223.

2018. *Eurybrachys tomentosa*: Chandra et al, *Faunal Diversity of Biogeographic Zone. Islands Of India.Arthropoda. Hexapoda*: 264 -270.

Material examined: 1ex, Makulakocha village, Chandil subdivision, Dalma Wildlife sanctuary, Saraikela Kharsawan district, Jharkhand, 22.91187 N, 86.1491E, 10.vii.2021, J. Chitra & Party Coll.

Distribution: India: Jharkhand (Dalma Wildlife Sanctuary); Andaman Islands, Tamilnadu, Karnataka.

13. ***Messena sinuate*** Atkinsoni,1889

1889. *Messena sinuate* Atkinsoni, *J.A.S.Beng*., **17**: 339.

1916. *Messena sinuate*: Distant, *Fauna.Brit.India.Rhynchota*., **3**: 229.

***Material examined*:** 1ex, Kamdeyung Nursery, Porahat, West Singbhum, Jharkhand, 15.vii.2021, Chitra. J. & Party Coll.

Distribution: India: Jharkhand (Dalma Wildlife Sanctuary); Kerala,Tamilnadu.

Remarks:

Family RICANIDAE Amyot and Serville, 1843

14. ***Ricania fenestrate*** (Fabricius,1775)

1775. *Ricania fenestrate* Fabricius, *Syst. Ent*., 688.

1906. *Ricania fenestrate*: Distant, *Fauna.Brit.India.Rhynchota*., **3**: 376.

Material examined: 1ex, Makulakocha village, Chandil subdivision, Dalma Wildlife sanctuary, Saraikela Kharsawan district, Jharkhand, 22.91187 N, 86.1491E, 10.vii.2021, J. Chitra & Party Coll.

Distribution: India: Jharkhand (Dalma Wls); TamilNadu.

Elsewhere: Sri Lanka.

DISCUSSION

The study is based on the mapping survey to Dalma Wls,Jharkhand Zone by the different survey parties in recent years including the Superfamily Fulgoroidea collection housed in the National Zoological Collection. Superfamily. This paper deals with 14 species under 14 genera belonging to 6 families of Superfamily Fulgoroidea from the Dalma Wls, Jharkhand. The distributions of each species in India and elsewhere have been provided.

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