Results

ISOLATION AND IDENTIFICATION

The Nutrient agar plates were observed after 2 days incubation for bacterial enumeration and the Sabouraud agar plates were observed after 3 days incubation for fungal enumeration. It was found that more number of bacterial and fungal colonies in $10^3$ and $10^4$ dilution, 255 colony forming units of bacteria and 25 colony forming units of fungi in $10^5$ dilution, 29 colony forming units of bacteria and 3 colony forming units of fungi in $10^5$ dilution and in $10^7$ dilution, it was 3 colony forming units of bacteria and less than 1 colony forming units fungi after incubation. Finally, it was calculated the initial mother suspension contains $3 \times 10^7$ colony forming units of bacteria per mL and $3 \times 10^6$ colony forming units of fungi per mL. The results were presented in Table 1.

The same serial diluted suspension ($10^3$ to $10^7$ dilutions) were inoculated into Pikovskaya agar the plates were observed after 3 days of incubation for phosphate solubilizing microorganisms (PSB). The plates were inoculated with the suspensions such as $10^3$ and $10^4$ dilution, showed more colonies and were too numerous to count for both bacteria and fungi. In $10^5$ dilution, 16 bacterial and 7 fungal colonies and in $10^6$ dilution, 2 bacterial and 1 fungal colonies were found to be phosphate solubilizers. Based on the results, the between rhizosphere microbes and phosphate solubilizers were calculated which was 15:1 for bacteria and 3.5:1 for fungi. The results were presented in Table 2.

The Phosphate solubilizing bacterial cultures were found to be single type based on colony morphology in Kings B agar and cetrimide agar and gram reaction by gram staining. Pale white, translucent colonies Circular, convex, and smooth colonies and Green mucoid colonies were observed in Kings B agar and...
Cetrimide agar respectively. The gram staining showed gram negative reaction. Further, it was observed as Indole, Urease, Methyl Red, Vogus Proskauer and Hydrogen sulphide production were negative and Citrate, Gelatin hydrolysis, Nitrate reduction, Starch hydrolysis, Catalase and Oxisdase were positive. The isolated bacteria was motile, produced green color pigment in Cetrimide agar and Asparagine –proline broth which fluoresects in UV Trans illuminator. Carbohydrate fermentation tubes showed no gas production and acid production found on top of the tube.

The isolated bacterial cultures were identified as Pseudomonas sp. by cultural, morphological and biochemical characteristics. The results were presented in Table 3.

Plate-1 showes the colonies of Pseudomonas sp. on Nutrient and Cetrimide agar Asparagine –Proline broth tube in UV Trans illuminator and Oxidase test.

Among the fungal cultures isolated, three fungal colonies were shown clear zone around them in Pikovskaya agar medium were selected for further studies. The fungal cultures were identified as Aspergillus niger, Aspergillus fumigatus and Penicillium sp. based on the below observations in macroscopic and microscopic methods.

Aspergillus niger showed black surface pigmentation with a dense felt of conidiophores. Conidiophores are long, smooth walled and have round shaped terminal vesicle which support a biseriate of phialides on the vesicle. Over the phialides are the round conidia forming radial chains.
*Aspergillus fumigatus* showed green surface pigmentation with a dense felt of conidiophores. Conidiophores are colorless, rough walled and have round shaped terminal vesicle which support a biseriate of phialides on the vesicle. Over the phialides are the round conidia forming radial chains.

*Penicillium* sp. showed green color colonies consisting of a dense felt of conidiophores. Microscopically, conidiophores show branching, and phialides produced in groups from branched metulae, giving brush-like appearance. Conidia are globuse, greenish and smooth.

Plate-2 shows the growth of fungal colonies on Sabouraud agar plates and Plate-3 shows the Phosphate solubilization of fungal colonies in Pikovskaya agar.

**Random UV Mutagenesis**

The bacterial colonies gradually decreased with increasing exposure time. There was no growth on plates which were exposed to UV light more than 8 minutes. Four bacterial strains resistant for 7 min UV exposure were selected, designated as PSUV 1, PSUV 2, PSUV 3 and PSUV 4 and transferred to nutrient broth and agar slants for further study.

The fungal cultures were selected from the plates exposed to 30, 40, 50 and 60 min UV exposure time and they were given the code numbers as ANuv30, ANuv40, ANuv50 and ANuv60 for *Aspergillus niger*, *Aspergillus fumigatus* mutants were AFuv30, AFuv40, AFuv50 and AFuv60 whereas the *Penicillium* species mutants were given the code numbers PEuv30, PEuv40, PEuv50 and PEuv60. There was no growth observed the plates inoculated with fungal cultures at 70 and 80 minutes UV exposure time.
Random Chemical Mutagenesis

The *Aspergillus niger*, *Aspergillus fumigatus* mutants cultures were selected from the plates exposed to 30, 60, 90 and 120 min exposure time where as *Penicillium* species mutants cultures from 60, 90, 120 and 150 min exposure time of Sodium azide.

The Sodium Azide treated *Aspergillus niger* mutants were given the code numbers ANsa30, ANsa60, ANsa90 and ANsa120, *Aspergillus fumigatus* mutants were AFsa30, AFsa60, AFsa90 and AFsa120 whereas the *Penicillium* species mutants were given the code numbers PEsa60, PEsa90, PEsa120 and PEsa150.

The *Aspergillus niger*, *Aspergillus fumigatus* mutants cultures were selected from the plates exposed to 30, 60, 90 and 120 min exposure time where as *Penicillium* species mutants cultures from 60, 90, 120 and 150 min exposure time of Ethyl Methane Sulphonate.

The Ethyl Methane Sulphonate treated *Aspergillus niger* mutants were given the code numbers ANems30, ANems60, ANems90 and ANems120, *Aspergillus fumigatus* mutants were AFems30, AFems60, AFems90 and AFems120 whereas the *Penicillium* species mutants were given the code numbers PEems60, PEems90, PEems120 and PEems150.

Then the cultures were tested for Phosphate estimation, Acid Phosphatase, Lipase and Indole Acetic acid production.
Phosphate Solubilization

Phosphate Solubilization Capacity of UV Treated *Aspergillus niger*

The results of Phosphate Solubilization capacity of UV treated *Aspergillus niger* were presented in Table 4.

The phosphate solubilization capacity of UV treated *Aspergillus niger* (ANuv60) on day three recorded maximum efficacy in solubilization (3.05 ppm of Phosphate) followed by ANuv50 strain (2.85 ppm of Phosphate), ANuv30 (2.65 ppm of Phosphate) and ANuv40 (2.50 ppm of Phosphate). The wild *Aspergillus niger* which was used as a standard control solubilized 2.20ppm of Phosphate in the third day of incubation.

The phosphate solubilization capacity of UV treated *Aspergillus niger* (ANuv60) on day six recorded maximum efficacy in solubilization (4.65 ppm of Phosphate) followed by ANuv50 strain (4.35 ppm of Phosphate), ANuv30 (4.05 ppm of Phosphate) and ANuv40 (3.85 ppm of Phosphate). The wild *Aspergillus niger* which was used as a standard control solubilized 3.65 ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization capacity of UV treated *Aspergillus niger* (ANuv60) on day nine recorded maximum efficacy in solubilization (5.85 ppm of Phosphate) followed by ANuv50 strain (5.50 ppm of Phosphate), ANuv30 (5.00 ppm of Phosphate) and ANuv40 (4.75 ppm of Phosphate). The wild *Aspergillus niger* which was used as a standard control solubilized 4.60 ppm of Phosphate in the ninth day of incubation.

The phosphate solubilization efficacy of ANuv60 strain increased 38.64% on third day, 27.40% phosphate solubilization on sixth day and 27.17%
phosphate solubilization on ninth day of incubation using wild type as a standard (100%)..

**Phosphate Solubilization Capacity of UV Treated *Aspergillus fumigatus***

The results of Phosphate Solubilization capacity of UV treated *Aspergillus fumigatus* were presented in Table 5.

The phosphate solubilization capacity of UV treated *Aspergillus fumigatus* (AFuv50) on day three recorded maximum efficacy in solubilization (3.55ppm of Phosphate) followed by AFuv60 strain (3.35 ppm of Phosphate), AFuv30 (3.25 ppm of Phosphate) and AFsa40 (3.15 ppm of Phosphate). The wild *Aspergillus fumigatus* which was used as a standard control solubilized 2.95 ppm of Phosphate in the third day of incubation.

The phosphate solubilization capacity of UV treated *Aspergillus fumigatus* (AFuv50) on day six recorded maximum efficacy in solubilization (3.95ppm of Phosphate) followed by AFuv60 strain (3.85 ppm of Phosphate), AFuv30 (3.65 ppm of Phosphate) and AFsa40 (3.65 ppm of Phosphate). The wild *Aspergillus fumigatus* which was used as a standard control solubilized 3.25 ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization capacity of UV treated *Aspergillus fumigatus* (AFuv50) on day nine recorded maximum efficacy in solubilization (4.55ppm of Phosphate) followed by AFuv60 strain (4.45 ppm of Phosphate), AFuv40 (4.15 ppm of Phosphate) and AFsa30 (3.85 ppm of Phosphate). The wild *Aspergillus fumigatus* which was used as a standard control solubilized 3.65 ppm of Phosphate in the ninth day of incubation.
The phosphate solubilization efficacy of AFuv50 strain increased 20.34% on third day, 21.54% phosphate solubilization on sixth day and 24.66% phosphate solubilization on ninth day of incubation using wild type as a standard (100%).

**Phosphate Solubilization Capacity of UV Treated *Penicillium* sp**

The results of Phosphate Solubilization capacity of UV treated *Penicillium* sp were presented in Table 6.

The phosphate solubilization capacity of UV treated *Penicillium* sp (PEuv50) on day three recorded maximum efficacy in solubilization (3.75 ppm of Phosphate) followed by PEuv40 strain (3.65 ppm of Phosphate), PEuv30 (3.45 ppm of Phosphate) and PEuv60 (3.40 ppm of Phosphate). The wild *Penicillium* sp which was used as a standard control solubilized 3.30 ppm of Phosphate in the third day of incubation.

The phosphate solubilization capacity of UV treated *Penicillium* sp (PEuv50) on day six recorded maximum efficacy in solubilization (4.40 ppm of Phosphate) followed by PEuv40 strain (4.25 ppm of Phosphate), PEuv60 (4.20 ppm of Phosphate) and PEuv30 (4.10 ppm of Phosphate). The wild *Penicillium* sp which was used as a standard control solubilized 3.85 ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization capacity of UV treated *Penicillium* sp (PEuv50) on day nine recorded maximum efficacy in solubilization (4.75 ppm of Phosphate) followed by PEuv40 strain (4.45 ppm of Phosphate), PEuv60 (4.35 ppm of Phosphate) and PEuv30 (4.25 ppm of Phosphate). The wild *Penicillium*
sp which was used as a standard control solubilized 4.00 ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization efficacy of PEuv50 strain increased 13.64% on third day, 14.29% phosphate solubilization on sixth day and 18.75% phosphate solubilization on ninth day of incubation using wild type as a standard (100%).

**Phosphate Solubilization Capacity of UV Treated *Pseudomonas* sp.**

The results of Phosphate Solubilization capacity of UV treated *Pseudomonas* sp were presented in Table 7.

The phosphate solubilization capacity of UV treated *Pseudomonas* sp (PSuv3) on day three recorded maximum efficacy in solubilization (4.15 ppm of Phosphate) followed by PSuv4 strain (4.05 ppm of Phosphate), PSuv2 (3.95 ppm of Phosphate) and PSuv1 (3.85 ppm of Phosphate). The wild *Pseudomonas* sp which was used as a standard control solubilized 3.80 ppm of Phosphate in the third day of incubation.

The phosphate solubilization capacity of UV treated *Pseudomonas* sp (PSuv4) on day six recorded maximum efficacy in solubilization (4.35 ppm of Phosphate) followed by PSuv3 strain (4.25 ppm of Phosphate), PSuv2 (4.10 ppm of Phosphate) and PSuv1 (3.95 ppm of Phosphate). The wild *Pseudomonas* sp which was used as a standard control solubilized 4.15 ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization capacity of UV treated *Pseudomonas* sp (PSuv4) on day nine recorded maximum efficacy in solubilization (4.65 ppm of
Phosphate) followed by PSuv3 strain (4.45 ppm of Phosphate), PSuv2 (4.30 ppm of Phosphate) and PSuv1 (4.15 ppm of Phosphate). The wild Pseudomonas sp which was used as a standard control solubilized 4.75 ppm of Phosphate in the ninth day of incubation.

All mutants of Pseudomonas strains treated with UV on day nine showed decreased phosphate solubilization activity when compared to wild type.

**Phosphate Solubilization Capacity of Sodium Azide Treated Aspergillus niger**

The results of Phosphate Solubilization capacity of sodium azide treated Aspergillus niger were presented in Table 8.

The phosphate solubilization capacity of sodium azide treated Aspergillus niger (ANsa120) on day three recorded maximum efficacy in solubilization (3.45 ppm of Phosphate) followed by ANsa90 strain (2.95 ppm of Phosphate), ANsa60 (2.50 ppm of Phosphate) and ANsa30 (2.40 ppm of Phosphate). The wild Aspergillus niger which was used as a standard control solubilized 2.20 ppm of Phosphate in the third day of incubation.

The phosphate solubilization of sodium azide treated Aspergillus niger (ANsa120) on day six recorded maximum efficacy in solubilization (4.95 ppm of Phosphate) followed by ANsa90 strain (4.65 ppm of Phosphate) ANsa60 (4.30 ppm of Phosphate) and ANsa30 (4.10 ppm of Phosphate). The wild Aspergillus niger which was used as a standard control solubilized 3.65 ppm of Phosphate in the sixth day of incubation.
The phosphate solubilization of sodium azide treated *Aspergillus niger* (ANsa120) on day nine recorded maximum efficacy in solubilization (6.15 ppm of Phosphate) followed by ANsa90 strain (5.80 ppm of Phosphate) ANsa60 (5.55 ppm of Phosphate) and ANsa30 (5.05 ppm of Phosphate). The wild *Aspergillus niger* which was used as a standard control solubilized 4.60 ppm of Phosphate in the ninth day of incubation.

The phosphate solubilization efficacy of ANsa120 strain increased 56.8% on third day, 35.6% phosphate solubilization on sixth day and 33.6% phosphate solubilization on ninth day of incubation using wild type as a standard (100%). Here the percentage of phosphate solubilization is decreased with the increasing the day of incubation.

**Phosphate Solubilization Capacity of Sodium Azide Treated *Aspergillus fumigatus***

The results of Phosphate Solubilization capacity of sodium azide treated *Aspergillus fumigatus* were presented in Table 9.

The phosphate solubilization capacity of sodium azide treated *Aspergillus fumigatus* (AFsa120) on day three recorded maximum efficacy in solubilization (4.05 ppm of Phosphate) followed by AFsa90 strain (3.45 ppm of Phosphate), AFsa60 (3.25 ppm of Phosphate) and AFsa30 (3.10 ppm of Phosphate). The wild *Aspergillus fumigatus* which was used as a standard control solubilized 2.95 ppm of Phosphate in the third day of incubation.

The phosphate solubilization capacity of sodium azide treated *Aspergillus fumigatus* (AFsa120) on day six recorded maximum efficacy in solubilization (4.65 ppm of Phosphate) followed by AFsa90 strain (4.00 ppm of Phosphate),
AFsa60 (3.75 ppm of Phosphate) and AFsa30 (3.25 ppm of Phosphate). The wild *Aspergillus fumigatus* which was as a standard control solubilized 3.45 ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization capacity of sodium azide treated *Aspergillus fumigatus* (AFsa120) on day nine recorded maximum efficacy in solubilization (5.50 ppm of Phosphate) followed by AFsa90 strain (5.30 ppm of Phosphate), AFsa60 (4.25 ppm of Phosphate) and AFsa30 (3.95 ppm of Phosphate). The wild *Aspergillus fumigatus* which was used as a standard control solubilized 3.65 ppm of Phosphate in the ninth day of incubation.

The phosphate solubilization efficacy of AFsa120 strain increased 37.0% on third day, 43.0% phosphate solubilization on sixth day and 50.6% phosphate solubilization on ninth day of incubation using wild type as a standard (100%). Here the percentage of phosphate solubilization is increased with the increasing the day of incubation.

**Phosphate Solubilization Capacity of Sodium Azide Treated *Penicillium* sp**

The results of Phosphate Solubilization capacity of sodium azide treated *Penicillium* sp were presented in Table 10.

The phosphate solubilization capacity of sodium azide treated *Penicillium* sp (PEsa150) on day three recorded maximum efficacy in solubilization (3.80 ppm of Phosphate) followed by PEsa120 strain (3.70 ppm of Phosphate), PEsa90 (3.60 ppm of Phosphate) and PEsa60 (3.50 ppm of Phosphate). The wild *Penicillium* sp which was used as a standard control solubilized 3.30 ppm of Phosphate in the third day of incubation.
The phosphate solubilization capacity of sodium azide treated *Penicillium* sp (PEsa150) on day six recorded maximum efficacy in solubilization (4.85 ppm of Phosphate) followed by PEsa120 strain (4.65 ppm of Phosphate), PEsa90 (4.50 ppm of Phosphate) and PEsa60 (4.15 ppm of Phosphate). The wild *Penicillium* sp which was used as a standard control solubilized 3.85 ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization capacity of sodium azide treated *Penicillium* sp (PEsa150) on day nine recorded maximum efficacy in solubilization (5.95 ppm of Phosphate) followed by PEsa120 strain (5.65 ppm of Phosphate), PEsa90 (5.05 ppm of Phosphate) and PEsa60 (4.35 ppm of Phosphate). The wild *Penicillium* sp which was used as a standard control solubilized 4.00 ppm of Phosphate in the ninth day of incubation.

The phosphate solubilization efficacy of PEsa150 strain increased 15.1% on third day, 25.9% phosphate solubilization on sixth day and 48.7% phosphate solubilization on ninth day of incubation using wild type as a standard (100%).

**Phosphate Solubilization Capacity of Sodium Azide Treated *Pseudomonas* sp**

The results of Phosphate Solubilization capacity of sodium azide treated *Pseudomonas* sp were presented in Table 11.

The phosphate solubilization of sodium azide treated *Pseudomonas* sp. (PSsa120) recorded maximum efficacy in solubilization (3.45 ppm of Phosphate) followed by PSsa90 strain (3.35 ppm of Phosphate), PSsa60 strain (3.15 ppm of Phosphate) and PSsa30 strain (2.85 ppm of Phosphate). The wild *Pseudomonas* sp which was used as a standard control solubilized 3.80 ppm of Phosphate in the third day of incubation.
The phosphate solubilization of sodium azide treated *Pseudomonas sp.* (PSsa120) recorded maximum efficacy in solubilization (4.25 ppm of Phosphate) followed by PSsa90 strain (4.05 ppm of Phosphate), PSsa60 strain (3.95 ppm of Phosphate) and PSsa30 strain (3.65 ppm of Phosphate). The wild *Pseudomonas sp.* which was used as a standard control solubilized 4.15 ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization of sodium azide treated *Pseudomonas sp.* (PSsa120) recorded maximum efficacy in solubilization (4.65 ppm of Phosphate) followed by PSsa3 strain (4.50 ppm of Phosphate), PSsa60 strain (4.45 ppm of Phosphate) and PSsa30 strain (4.15 ppm of Phosphate). The wild *Pseudomonas sp.* which was used as a standard control solubilized 4.75 ppm of Phosphate in the ninth day of incubation.

All mutants of *Pseudomonas* strains treated with sodium azide on day three, six and nine showed decreased phosphate solubilization activity when compared to wild type.

**Phosphate Solubilization Capacity of Ethyl Methane Sulphonate Treated *Aspergillus niger***

The results of Phosphate Solubilization capacity of Ethyl Methane Sulphonate treated *Aspergillus niger* were presented in Table 12.

The phosphate solubilization capacity of Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems120) on day three recorded maximum efficacy in solubilization (2.85 ppm of Phosphate) followed by ANems90 strain (2.65 ppm of Phosphate), ANems60 (2.50 ppm of Phosphate) and ANems30 (2.30 ppm of Phosphate).
ppm of Phosphate). The wild *Aspergillus niger* which was used as a standard control solubilized 2.20ppm of Phosphate in the third day of incubation.

The phosphate solubilization capacity of Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems120) on day sixth recorded maximum efficacy in solubilization (4.75ppm of Phosphate) followed by ANems90 strain (4.45 ppm of Phosphate), ANems60 (4.25 ppm of Phosphate) and ANems30 (3.90 ppm of Phosphate). The wild *Aspergillus niger* which was used as a standard control solubilized 3.65ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization capacity of Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems120) on day ninth recorded maximum efficacy in solubilization (6.25ppm of Phosphate) followed by ANems90 strain (5.65 ppm of Phosphate), ANems60 (5.40 ppm of Phosphate) and ANems30 (4.75 ppm of Phosphate). The wild *Aspergillus niger* which was used as a standard control solubilized 4.60 ppm of Phosphate in the ninth day of incubation.

The phosphate solubilization efficacy of ANems120 strain increased 29.5% on third day, 30.1% phosphate solubilization on sixth day and 35.8% phosphate solubilization on ninth day of incubation using wild type as a standard (100%).

**Phosphate Solubilization Capacity of Ethyl Methane Sulphonate Treated* Aspergillus fumigatus***

The results of Phosphate Solubilization capacity of Ethyl Methane Sulphonate treated *Aspergillus fumigatus* were presented in Table 13.
The phosphate solubilization capacity of Ethyl Methane Sulphonate treated *Aspergillus fumigatus* (AFems120) on day three recorded maximum efficacy in solubilization (3.95ppm of Phosphate) followed by AFems90 strain (3.75 ppm of Phosphate), AFems60 (3.55 ppm of Phosphate) and AFems30 (3.25 ppm of Phosphate). The wild *Aspergillus fumigatus* which was used as a standard control solubilized 2.95 ppm of Phosphate in the third day of incubation.

The phosphate solubilization capacity of Ethyl Methane Sulphonate treated *Aspergillus fumigatus* (AFems120) on day six recorded maximum efficacy in solubilization (4.45ppm of Phosphate) followed by AFems90 strain (4.15 ppm of Phosphate), AFems60 (3.80 ppm of Phosphate) and AFems30 (3.45 ppm of Phosphate). The wild *Aspergillus fumigatus* which was used as a standard control solubilized 3.25 ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization capacity of Ethyl Methane Sulphonate treated *Aspergillus fumigatus* (AFems120) on day nine recorded maximum efficacy in solubilization (5.15ppm of Phosphate) followed by AFems90 strain (4.65 ppm of Phosphate), AFems60 (4.15 ppm of Phosphate) and AFems30 (3.85 ppm of Phosphate). The wild *Aspergillus fumigatus* which was used as a standard control solubilized 3.65 ppm of Phosphate in the ninth day of incubation.

The phosphate solubilization efficacy of AFems120 strain increased 33.8% on third day, 36.9% phosphate solubilization on sixth day and 41.0% phosphate solubilization on ninth day of incubation using wild type as a standard (100%).
Phosphate Solubilization Capacity of Ethyl Methane Sulphonate Treated *Penicillium* sp

The results of Phosphate Solubilization capacity of Ethyl Methane Sulphonate treated *Penicillium* sp were presented in Table 14.

The phosphate solubilization capacity of Ethyl Methane Sulphonate treated *Penicillium* sp (PEems150) on day three recorded maximum efficacy in solubilization (4.80 ppm of Phosphate) followed by PEems120 strain (4.55 ppm of Phosphate), PEems90 (4.05 ppm of Phosphate) and PEems60 (3.65 ppm of Phosphate). The wild *Penicillium* sp which was used as a standard control solubilized 3.30 ppm of Phosphate in the third day of incubation.

The phosphate solubilization capacity of Ethyl Methane Sulphonate treated *Penicillium* sp (PEems150) on day six recorded maximum efficacy in solubilization (5.70 ppm of Phosphate) followed by PEems120 strain (5.10 ppm of Phosphate), PEsa90 (4.90 ppm of Phosphate) and PEems60 (4.70 ppm of Phosphate). The wild *Penicillium* sp which was used as a standard control solubilized 3.85 ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization capacity of Ethyl Methane Sulphonate treated *Penicillium* sp (PEems150) on day six recorded maximum efficacy in solubilization (5.95 ppm of Phosphate) followed by PEems120 strain (5.45 ppm of Phosphate), PEems90 (5.30 ppm of Phosphate) and PEems60 (5.15 ppm of Phosphate). The wild *Penicillium* sp which was used as a standard control solubilized 4.00 ppm of Phosphate in the ninth day of incubation.

The phosphate solubilization efficacy of PEems150 strain increased 45.4% on third day, 48.0% phosphate solubilization on sixth day and 48.7%
phosphate solubilization on ninth day of incubation using wild type as a standard (100%).

**Phosphate Solubilization Capacity of Ethyl Methane Sulphonate Treated *Pseudomonas* sp**

The results of Phosphate Solubilization capacity of Ethyl Methane Sulphonate treated *Pseudomonas* sp were presented in Table 15.

The phosphate solubilization of Ethyl Methane Sulphonate treated *Pseudomonas* sp (PSems150) on day three recorded maximum efficacy in solubilization (2.45 ppm of Phosphate) followed by PSems120 strain (2.40 ppm of Phosphate), PSems90 (2.35 ppm of Phosphate) and PSems60 (2.30 ppm of Phosphate). The wild *Pseudomonas* sp which was used as a standard control solubilized 3.80 ppm of Phosphate in the third day of incubation.

The phosphate solubilization of Ethyl Methane Sulphonate treated *Pseudomonas* sp (PSems150) on day six recorded maximum efficacy in solubilization (3.25ppm of Phosphate) followed by PSems120 strain (3.05 ppm of Phosphate) PSems90 (2.90 ppm of Phosphate) and PSems60 (2.80 ppm of Phosphate). The wild *Pseudomonas* sp which was used as a standard control solubilized 4.15 ppm of Phosphate in the sixth day of incubation.

The phosphate solubilization of Ethyl Methane Sulphonate treated *Pseudomonas* sp (PSems150) on day nine recorded maximum efficacy in solubilization (4.25ppm of Phosphate) followed by PSems120 strain (4.15 ppm of Phosphate) PSems90 (3.55 ppm of Phosphate) and PSems60 (3.30 ppm of Phosphate). The wild *Pseudomonas* sp which was used as a standard control solubilized 4.75 ppm of Phosphate in the ninth day of incubation.
All mutants of *Pseudomonas* strains treated with Ethyl Methane Sulphonate on day three, six and nine showed decreased phosphate solubilization activity when compared to wild type.

**Effect of Different Carbon and Nitrogen Sources on the Efficacy of Phosphate Solubilization**

The superior mutated cultures of Phosphate solubilization in Pikovskaya broth were identified as Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems120), Sodium Azide Treated *Aspergillus niger* (ANsa120) and Sodium Azide Treated *Penicillium* sp (PEsa150) and their efficacy of Phosphate solubilization on different Carbon and Nitrogen Sources were studied.

**Effect of Different Carbon Sources on the Efficacy of Phosphate Solubilization of Ethyl Methane Sulphonate Treated *Aspergillus niger* (ANems120)**

The results of different carbon sources on the efficacy of phosphate solubilization of Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems120) were presented in Table 16.

The efficacy of phosphate solubilization of ANems120 was maximum in the medium containing Glucose (2.85 ppm of Phosphate) followed by Sucrose (2.40 ppm of Phosphate), Lactose (2.20 ppm of Phosphate) and Mannitol (2.05 ppm of Phosphate) in the third day of incubation.

The efficacy of phosphate solubilization of ANems120 was maximum in the medium containing Glucose (4.75 ppm of Phosphate) followed by Sucrose.
(3.75 ppm of Phosphate), Lactose (3.60 ppm of Phosphate) and Mannitol (3.05 ppm of Phosphate) in the sixth day of incubation.

The efficacy of phosphate solubilization of ANems120 was maximum in the medium containing Glucose (6.25 ppm of Phosphate) followed by Sucrose (4.85 ppm of Phosphate), Lactose (4.60 ppm of Phosphate) and Mannitol (4.35 ppm of Phosphate) in the ninth day of incubation.

Effect of Different Nitrogen Sources on the Efficacy of Phosphate Solubilization of Ethyl Methane Sulphonate Treated Aspergillus niger (ANems120)

The results of different nitrogen sources on the efficacy of phosphate solubilization of Ethyl Methane Sulphonate treated Aspergillus niger (ANems120) were presented in Table 17.

The efficacy of phosphate solubilization of ANems120 was maximum in the medium containing Ammonium sulphate (2.85 ppm of Phosphate) followed by Urea (2.40 ppm of Phosphate), Potassium nitrate (2.35 ppm of Phosphate) and Sodium nitrate (1.90 ppm of Phosphate) in the third day of incubation.

The efficacy of phosphate solubilization of ANems120 was maximum in the medium containing Ammonium sulphate (4.75 ppm of Phosphate) followed by Urea (3.70 ppm of Phosphate), Potassium nitrate (3.70 ppm of Phosphate) and Sodium nitrate (2.65 ppm of Phosphate) in the sixth day of incubation.

The efficacy of phosphate solubilization of ANems120 was maximum in the medium containing Ammonium sulphate (6.25 ppm of Phosphate) followed by Urea (4.75 ppm of Phosphate), Potassium nitrate (4.70 ppm of Phosphate)
Phosphate) and Sodium nitrate (3.20 ppm of Phosphate) in the ninth day of incubation.

**Effect of Different Carbon Sources on the Efficacy of Phosphate Solubilization of Sodium Azide Treated Aspergillus niger (ANsa120).**

The results of different carbon sources on the efficacy of phosphate solubilization of sodium azide treated *Aspergillus niger* (ANsa120) were presented in Table 18.

The efficacy of phosphate solubilization of ANsa120 was maximum in the medium containing Sucrose (3.55 ppm of Phosphate) followed by Glucose (3.45 ppm of Phosphate), Lactose (3.05 ppm of Phosphate) and Mannitol (1.85 ppm of Phosphate) in the third day of incubation.

The efficacy of phosphate solubilization of ANsa120 was maximum in the medium containing Glucose (4.95 ppm of Phosphate) followed by Sucrose (4.53 ppm of Phosphate), Lactose (3.55 ppm of Phosphate) and Mannitol (2.15 ppm of Phosphate) in the sixth day of incubation.

The efficacy of phosphate solubilization of ANsa120 was maximum in the medium containing Glucose (6.15 ppm of Phosphate) followed by Sucrose (4.95 ppm of Phosphate), Lactose (3.95 ppm of Phosphate) and Mannitol (2.90 ppm of Phosphate) in the ninth day of incubation.
Effect of Different Nitrogen Sources on the Efficacy of Phosphate Solubilization of Sodium Azide Treated *Aspergillus niger* (ANsa120).

The results of different nitrogen sources on the efficacy of phosphate solubilization of sodium azide treated *Aspergillus niger* (ANsa120) were presented in Table 19.

The efficacy of phosphate solubilization of ANsa120 was maximum in the medium containing Ammonium sulphate (3.45 ppm of Phosphate) followed by Urea (2.45 ppm of Phosphate), Potassium nitrate (2.40 ppm of Phosphate) and Sodium nitrate (1.75 ppm of Phosphate) in the third day of incubation.

The efficacy of phosphate solubilization of ANsa120 was maximum in the medium containing Ammonium sulphate (4.95 ppm of Phosphate) followed by Urea (3.85 ppm of Phosphate), Potassium nitrate (3.70 ppm of Phosphate) and Sodium nitrate (2.30 ppm of Phosphate) in the sixth day of incubation.

The efficacy of phosphate solubilization of ANsa120 was maximum in the medium containing Ammonium sulphate (6.15 ppm of Phosphate) followed by Urea (4.70 ppm of Phosphate), Potassium nitrate (4.65 ppm of Phosphate) and Sodium nitrate (2.75 ppm of Phosphate) in the ninth day of incubation.

Effect of Different Carbon Sources on the Efficacy of Phosphate Solubilization of Sodium Azide Treated *Penicillium* sp (PEsa150).

The results of different carbon sources on the efficacy of phosphate solubilization of sodium azide treated *Penicillium* sp (PEsa150) were presented in Table 20.
The efficacy of phosphate solubilization of PEsa150 was maximum in the medium containing Glucose (3.80 ppm of Phosphate) followed by Sucrose (3.35 ppm of Phosphate), Lactose (3.15 ppm of Phosphate) and Mannitol (3.05 ppm of Phosphate) in the third day of incubation.

The efficacy of phosphate solubilization of PEsa150 was maximum in the medium containing Glucose (4.85 ppm of Phosphate) followed by Sucrose (3.90 ppm of Phosphate), Lactose (3.80 ppm of Phosphate) and Mannitol (3.75 ppm of Phosphate) in the sixth day of incubation.

The efficacy of phosphate solubilization of PEsa150 was maximum in the medium containing Glucose (5.95 ppm of Phosphate) followed by Sucrose (4.60 ppm of Phosphate), Lactose (4.35 ppm of Phosphate) and Mannitol (4.25 ppm of Phosphate) in the ninth day of incubation.

**Effect of Different Nitrogen Sources on the Efficacy of Phosphate Solubilization of Sodium Azide Treated Penicillium sp (PEsa150)**

The results of different nitrogen sources on the efficacy of phosphate solubilization of sodium azide treated *Penicillium* sp (PEsa150) were presented in Table 21.

The efficacy of phosphate solubilization of PEsa150 was maximum in the medium containing Ammonium sulphate (3.80 ppm of Phosphate) followed by Urea (3.70 ppm of Phosphate), Potassium nitrate (3.35 ppm of Phosphate) and Sodium nitrate (3.30 ppm of Phosphate) in the third day of incubation.

The efficacy of phosphate solubilization of PEsa150 was maximum in the medium containing Ammonium sulphate (4.85 ppm of Phosphate) followed by
Urea (3.95 ppm of Phosphate), Potassium nitrate (3.90 ppm of Phosphate) and Sodium nitrate (3.75 ppm of Phosphate) in the sixth day of incubation.

The efficacy of phosphate solubilization of PEsa150 was maximum in the medium containing Ammonium sulphate (5.95 ppm of Phosphate) followed by Urea (4.70 ppm of Phosphate), Potassium nitrate (4.60 ppm of Phosphate) and Sodium nitrate (4.05 ppm of Phosphate) in the ninth day of incubation.

Figure-1 showes the comparsion of efficacy of Phosphatate solublization by wild strains and Figure-2 showes the comparsion of efficacy of Phosphatate solublization by chemical treated fungal strains.

**Phosphatase Activity**

**Efficacy of UV Treated Aspergillus niger on Phosphatase Activity**

The results of Phosphatase activity of UV treated *Aspergillus niger* were presented in Table 22.

The maximum efficacy of Phosphatase activity of UV treated *Aspergillus niger* (ANuv60) on day three recorded (0.165 µmol min⁻¹) followed by ANuv50 strain (0.134 µmol min⁻¹), ANuv30 (0.121 µmol min⁻¹) and ANuv40 (0.103 µmol min⁻¹). The Phosphatase activity of Wild *Aspergillus niger* which was used as a standard control produced 0.097µmol min⁻¹ in the third day of incubation.

The maximum efficacy of Phosphatase activity of UV treated *Aspergillus niger* (ANuv60) on day six recorded (0.275µmol min⁻¹) followed by ANuv50 strain (0.260 µmol min⁻¹), ANuv30 (0.223 µmol min⁻¹) and ANuv40 (0.218 µmol min⁻¹). The Phosphatase activity of Wild *Aspergillus niger* which was used as a standard control produced 0.192 µmol min⁻¹ in the sixth day of incubation.
The maximum efficacy of Phosphatase activity of UV treated *Aspergillus niger* (ANuv60) on day nine recorded (0.424 µmol min⁻¹) followed by ANuv50 strain (0.399 µmol min⁻¹), ANuv30 (0.345 µmol min⁻¹) and ANuv40 (0.341 µmol min⁻¹). The Phosphatase activity of Wild *Aspergillus niger* which was used as a standard control produced 0.303 µmol min⁻¹ in the ninth day of incubation.

The Phosphatase activity of ANuv60 strain increased 70.10% on third day, 43.23% Phosphatase activity on sixth day and 39.93% Phosphatase activity on ninth day of incubation using wild type as a standard (100%).

**Efficacy of UV Treated *Aspergillus fumigatus* on Phosphatase Activity**

The results of Phosphatase activity of UV treated *Aspergillus fumigatus* were presented in Table 23.

The maximum efficacy of Phosphatase activity of UV treated *Aspergillus fumigatus* (AFuv50) on day three recorded (0.195 µmol min⁻¹) followed by ANuv60 strain (0.173 µmol min⁻¹), ANuv30 (0.171 µmol min⁻¹) and ANuv40 (0.160 µmol min⁻¹). The Phosphatase activity of Wild *Aspergillus fumigatus* which was used as a standard control produced 0.156 µmol min⁻¹ in the third day of incubation.

The maximum efficacy of Phosphatase activity of UV treated *Aspergillus fumigatus* (AFuv50) on day six recorded (0.227 µmol min⁻¹) followed by AFuv60 strain (0.224 µmol min⁻¹), AFuv40 (0.205 µmol min⁻¹) and AFuv30 (0.203 µmol min⁻¹). The Phosphatase activity of Wild *Aspergillus fumigatus* which was used as a standard control produced 0.178 µmol min⁻¹ in the sixth day of incubation.
The maximum efficacy of Phosphatase activity of UV treated *Aspergillus fumigatus* (AFuv50) on day nine recorded (0.269 µmol min\(^{-1}\)) followed by ANuv60 strain (0.265 µmol min\(^{-1}\)), AFuv40 (0.232 µmol min\(^{-1}\)) and AFuv30 (0.221 µmol min\(^{-1}\)). The Phosphatase activity of Wild *Aspergillus fumigatus* which was used as a standard control produced 0.197 µmol min\(^{-1}\) in the ninth day of incubation.

The Phosphatase activity of AFuv50 strain increased 25.00% on third day, 27.53% Phosphatase activity on sixth day and 36.55% Phosphatase activity on ninth day of incubation using wild type as a standard (100%).

**Efficacy of UV Treated Penicillium sp on Phosphatase Activity**

The results of Phosphatase activity of UV treated *Penicillium* sp were presented in Table 24.

The maximum efficacy of Phosphatase activity of UV treated *Penicillium* sp (PEuv50) on day three recorded (0.209 µmol min\(^{-1}\)) followed by PEuv40 strain (0.195 µmol min\(^{-1}\)), PEuv30 (0.180 µmol min\(^{-1}\)) and PEuv60 (0.178 µmol min\(^{-1}\)). The Phosphatase activity of Wild *Penicillium* sp which was used as a standard control produced 0.169 µmol min\(^{-1}\) in the third day of incubation.

The maximum efficacy of Phosphatase activity of UV treated *Penicillium* sp (PEuv40) on day six recorded (0.245 µmol min\(^{-1}\)) followed by PEuv50 strain (0.237 µmol min\(^{-1}\)), PEuv60 (0.234 µmol min\(^{-1}\)) and PEuv30 (0.228 µmol min\(^{-1}\)). The Phosphatase activity of Wild *Penicillium* sp which was used as a standard control produced 0.213 µmol min\(^{-1}\) in the sixth day of incubation.
The maximum efficacy of Phosphatase activity of UV treated \textit{Penicillium} sp (PEuv50) on day nine recorded (0.267 µmol min\(^{-1}\)) followed by PEuv40 strain (0.264 µmol min\(^{-1}\), PEuv60 (0.257 µmol min\(^{-1}\)) and PEuv30 (0.239 µmol min\(^{-1}\)). The Phosphatase activity of Wild \textit{Penicillium} sp which was used as a standard control produced 0.236 µmol min\(^{-1}\) in the ninth day of incubation.

The Phosphatase activity of PEuv50 strain increased 23.67\% on third day, 11.27\% Phosphatase activity on sixth day and 13.14\% Phosphatase activity on ninth day of incubation using wild type as a standard (100\%).

\textbf{Efficacy of UV Treated \textit{Pseudomonas} sp on Phosphatase Activity}

The results of Phosphatase activity of UV treated \textit{Pseudomonas} sp were presented in Table 25.

The maximum efficacy of Phosphatase activity of UV treated \textit{Pseudomonas} sp (PSuv3) on day three recorded (0.227 µmol min\(^{-1}\)) followed by PSuv2 strain (0.215 µmol min\(^{-1}\), PSuv4 (0.210 µmol min\(^{-1}\)) and PSuv1 (0.205 µmol min\(^{-1}\)). The Phosphatase activity of Wild \textit{Pseudomonas} sp which was used as a standard control produced 0.200 µmol min\(^{-1}\) in the third day of incubation.

The maximum efficacy of Phosphatase activity of UV treated \textit{Pseudomonas} sp (PSuv3) on day six recorded (0.233 µmol min\(^{-1}\)) followed by PSuv2 strain (0.227 µmol min\(^{-1}\), PSuv4 (0.226 µmol min\(^{-1}\)) and PSuv1 (0.225 µmol min\(^{-1}\)). The Phosphatase activity of Wild \textit{Pseudomonas} sp which was used as a standard control produced 0.234 µmol min\(^{-1}\) in the six day of incubation.
The maximum efficacy of Phosphatase activity of UV treated *Pseudomonas* sp (PSuv4) on day nine recorded (0.286 µmol min\(^{-1}\)) followed by PSuv3 strain (0.275 µmol min\(^{-1}\)), PSuv2 (0.236 µmol min\(^{-1}\)) and PSuv1 (0.231 µmol min\(^{-1}\)). The Phosphatase activity of Wild *Pseudomonas* sp which was used as a standard control produced 0.287 µmol min\(^{-1}\) in the ninth day of incubation.

All mutants of *Pseudomonas* strains treated with UV on day six and nine showed decreased Phosphatase activity when compared to wild type.

**Efficacy of Sodium Azide Treated *Aspergillus niger* on Phosphatase Activity**

The results of Phosphatase activity of sodium azide treated *Aspergillus niger* were presented in Table 26.

The maximum efficacy of Phosphatase activity of sodium azide treated *Aspergillus niger* (ANsa120) on day three recorded (0.184 µmol min\(^{-1}\)) followed by ANsa90 strain (0.152 µmol min\(^{-1}\)), ANsa60 (0.110 µmol min\(^{-1}\)) and ANsa30 (0.107 µmol min\(^{-1}\)). The Phosphatase activity of Wild *Aspergillus niger* which was used as a standard control produced 0.097 µmol min\(^{-1}\) in the third day of incubation.

The maximum efficacy of Phosphatase activity of sodium azide treated *Aspergillus niger* (ANsa120) on day six recorded (0.340 µmol min\(^{-1}\)) followed by ANsa90 strain (0.268 µmol min\(^{-1}\)), ANsa60 (0.234 µmol min\(^{-1}\)) and ANsa30 (0.218 µmol min\(^{-1}\)). The Phosphatase activity of Wild *Aspergillus niger* which was used as a standard control produced 0.192 µmol min\(^{-1}\) in the sixth day of incubation.
The maximum efficacy of Phosphatase activity of sodium azide treated \textit{Aspergillus niger} (ANsa120) on day nine recorded (0.474 \mu mol \text{ min}^{-1}) followed by ANsa90 strain (0.421 \mu mol \text{ min}^{-1}), ANsa60 (0.401 \mu mol \text{ min}^{-1}) and ANsa30 (0.335 \mu mol \text{ min}^{-1}). The Phosphatase activity of Wild \textit{Aspergillus niger} which was used as a standard control produced 0.303\mu mol \text{ min}^{-1} in the ninth day of incubation.

The Phosphatase activity of ANsa120 strain increased 89.69\% on third day, 77.08\% Phosphatase activity on sixth day and 56.43\% Phosphatase activity on ninth day of incubation using wild type as a standard (100\%).

\textbf{Efficacy of Sodium Azide Treated \textit{Aspergillus fumigatus} on Phosphatase Activity}

The results of Phosphatase activity of sodium azide treated \textit{Aspergillus niger} were presented in Table 27.

The maximum efficacy of Phosphatase activity of sodium azide treated \textit{Aspergillus fumigatus} (AFsa120) on day three recorded (0.232 \mu mol \text{ min}^{-1}) followed by AFsa90 strain (0.185 \mu mol \text{ min}^{-1}), AFsa60 (0.174 \mu mol \text{ min}^{-1}) and AFsa30 (0.165 \mu mol \text{ min}^{-1}). The Phosphatase activity of Wild \textit{Aspergillus fumigatus} which was used as a standard control produced 0.156\mu mol \text{ min}^{-1} in the third day of incubation.

The maximum efficacy of Phosphatase activity of sodium azide treated \textit{Aspergillus fumigatus} (AFsa120) on day six recorded (0.274 \mu mol \text{ min}^{-1}) followed by AFsa90 strain (0.229 \mu mol \text{ min}^{-1}), AFsa60 (0.203 \mu mol \text{ min}^{-1}) and AFsa30 (0.189 \mu mol \text{ min}^{-1}). The Phosphatase activity of Wild \textit{Aspergillus
*fumigatus* which was used as a standard control produced 0.178 µmol min\(^{-1}\) in the sixth day of incubation.

The maximum efficacy of Phosphatase activity of sodium azide treated *Aspergillus fumigatus* (AFsa120) on day nine recorded (0.365 µmol min\(^{-1}\)) followed by AFsa90 strain (0.351 µmol min\(^{-1}\)), AFsa60 (0.241 µmol min\(^{-1}\)) and AFsa30 (0.213 µmol min\(^{-1}\)). The Phosphatase activity of Wild *Aspergillus fumigatus* which was used as a standard control produced 0.197 µmol min\(^{-1}\) in the ninth day of incubation.

The Phosphatase activity of AFsa120 strain increased 48.71% on third day, 53.93% Phosphatase activity on sixth day and 85.27% Phosphatase activity on ninth day of incubation using wild type as a standard (100%).

**Efficacy of Sodium Azide Treated Penicillium sp on Phosphatase Activity**

The results of Phosphatase activity of sodium azide treated *Penicillium* sp were presented in Table 28.

The maximum efficacy of Phosphatase activity of sodium azide treated *Penicillium* sp (PEsa150) on day three recorded (0.210 µmol min\(^{-1}\)) followed by PEsa120 strain (0.200 µmol min\(^{-1}\)), PEsa90 (0.191 µmol min\(^{-1}\)) and PEsa60 (0.181 µmol min\(^{-1}\)). The Phosphatase activity of Wild *Penicillium* sp which was used as a standard control produced 0.169 µmol min\(^{-1}\) in the third day of incubation.

The maximum efficacy of Phosphatase activity of sodium azide treated *Penicillium* sp (PEsa150) on day six recorded (0.276 µmol min\(^{-1}\)) followed by PEsa120 strain (0.261 µmol min\(^{-1}\)), PEsa90 (0.249 µmol min\(^{-1}\)) and PEsa60
The Phosphatase activity of Wild *Penicillium* sp used as a standard control produced 0.213 µmol min\(^{-1}\) in the sixth day of incubation.

The maximum efficacy of Phosphatase activity of sodium azide treated *Penicillium* sp (PEsa150) on day nine recorded (0.420 µmol min\(^{-1}\)) followed by PEsa120 strain (0.400 µmol min\(^{-1}\)), PEsa90 (0.349 µmol min\(^{-1}\)) and PEsa60 (0.261 µmol min\(^{-1}\)). The Phosphatase activity of Wild *Penicillium* sp which was used as a standard control produced 0.236 µmol min\(^{-1}\) in the ninth day of incubation.

The Phosphatase activity of PEsa150 strain increased 24.26% on third day, 29.57% Phosphatase activity on sixth day and 77.96% Phosphatase activity on ninth day of incubation using wild type as a standard (100%).

**Efficacy of Sodium Azide Treated *Pseudomonas* sp on Phosphatase Activity**

The results of Phosphatase activity of sodium azide treated *Pseudomonas* sp were presented in Table 29.

The maximum efficacy of Phosphatase activity of sodium azide treated *Pseudomonas* sp (PSsa120) on day three recorded (0.185 µmol min\(^{-1}\)) followed by PSsa90 strain (0.180 µmol min\(^{-1}\)), PSsa60 (0.171 µmol min\(^{-1}\)) and PSsa30 (0.169 µmol min\(^{-1}\)). The Phosphatase activity of Wild *Pseudomonas* sp which was used as a standard control produced 0.200 µmol min\(^{-1}\) in the third day of incubation.

The maximum efficacy of Phosphatase activity of sodium azide treated *Pseudomonas* sp (PSsa120) on day six recorded (0.241 µmol min\(^{-1}\)) followed by PSsa90 strain (0.232 µmol min\(^{-1}\)), PSsa60 (0.220 µmol min\(^{-1}\)) and PSsa30
The Phosphatase activity of Wild \textit{Pseudomonas} sp which was used as a standard control produced 0.234µmol min\(^{-1}\) in the six day of incubation.

The maximum efficacy of Phosphatase activity of sodium azide treated \textit{Pseudomonas} sp (PSsa120) on day nine recorded (0.275 µmol min\(^{-1}\)) followed by PSsa90 strain (0.260 µmol min\(^{-1}\)), PSsa60 (0.256 µmol min\(^{-1}\)) and PSsa30 (0.224 µmol min\(^{-1}\)). The Phosphatase activity of Wild \textit{Pseudomonas} sp which was used as a standard control produced 0.287µmol min\(^{-1}\) in the ninth day of incubation.

All mutants of \textit{Pseudomonas} strains treated with sodium azide on day three, six and nine showed decreased Phosphatase activity activity when compared to wild type.

**Efficacy of Ethyl Methane Sulphonate Treated \textit{Aspergillus niger} on Phosphatase Activity**

The results of Phosphatase activity of Ethyl Methane Sulphonate treated \textit{Aspergillus niger} were presented in Table 30.

The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated \textit{Aspergillus niger} (ANems120) on day three recorded (0.131 µmol min\(^{-1}\)) followed by ANems90 strain (0.125 µmol min\(^{-1}\)), ANems60 (0.104 µmol min\(^{-1}\)) and ANems30 (0.099 µmol min\(^{-1}\)). The Phosphatase activity of Wild \textit{Aspergillus niger} which was used as a standard control produced 0.097µmol min\(^{-1}\) in the third day of incubation.

The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated \textit{Aspergillus niger} (ANems120) on day six recorded (0.273
μmol min⁻¹) followed by ANems90 strain (0.253 μmol min⁻¹), ANems60 (0.222 μmol min⁻¹) and ANems30 (0.210 μmol min⁻¹). The Phosphatase activity of Wild Aspergillus niger which was used as a standard control produced 0.192μmol min⁻¹ in the sixth day of incubation.

The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated Aspergillus niger (ANems120) on day nine recorded (0.452 μmol min⁻¹) followed by ANems90 strain (0.412 μmol min⁻¹), ANems60 (0.365 μmol min⁻¹) and ANems30 (0.316 μmol min⁻¹). The Phosphatase activity of Wild Aspergillus niger which was used as a standard control produced 0.303 μmol min⁻¹ in the ninth day of incubation.

The Phosphatase activity of ANems120 strain increased 35.05% on third day, 42.18% Phosphatase activity on sixth day and 49.17% Phosphatase activity on ninth day of incubation using wild type as a standard (100%).

**Efficacy of Ethyl Methane Sulphonate Treated Aspergillus fumigatus on Phosphatase Activity**

The results of Phosphatase activity of Ethyl Methane Sulphonate treated Aspergillus fumigatus were presented in Table 31.

The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated Aspergillus fumigatus (AFems120) on day three recorded (0.219 μmol min⁻¹) followed by AFems90 strain (0.206 μmol min⁻¹), AFems60 (0.189 μmol min⁻¹) and AFems30 (0.175 μmol min⁻¹). The Phosphatase activity of Wild Aspergillus fumigatus which was used as a standard control produced 0.156 μmol min⁻¹ in the third day of incubation.
The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated *Aspergillus fumigatus* (AFems120) on day six recorded (0.258 µmol min⁻¹) followed by AFems90 strain (0.236 µmol min⁻¹), AFems60 (0.212 µmol min⁻¹) and AFems30 (0.197 µmol min⁻¹). The Phosphatase activity of Wild *Aspergillus fumigatus* which was used as a standard control produced 0.178 µmol min⁻¹ in the sixth day of incubation.

The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated *Aspergillus fumigatus* (AFems120) on day nine recorded (0.318 µmol min⁻¹) followed by AFems90 strain (0.261 µmol min⁻¹), AFems60 (0.231 µmol min⁻¹) and AFems30 (0.214 µmol min⁻¹). The Phosphatase activity of Wild *Aspergillus fumigatus* which was used as a standard control produced 0.197 µmol min⁻¹ in the ninth day of incubation.

The Phosphatase activity of AFems120 strain increased 40.38% on third day, 44.94% Phosphatase activity on sixth day and 61.42% Phosphatase activity on ninth day of incubation using wild type as a standard (100%).

**Efficacy of Ethyl Methane Sulphonate Treated Penicillium sp on Phosphatase Activity**

The results of Phosphatase activity of Ethyl Methane Sulphonate treated *Penicillium* sp were presented in Table 32.

The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated *Penicillium* sp (PEems150) on day three recorded (0.278 µmol min⁻¹) followed by PEems120 strain (0.245 µmol min⁻¹), PEems90 (0.227 µmol min⁻¹) and PEems60 (0.197 µmol min⁻¹). The Phosphatase activity of Wild
Penicillium sp which was used as a standard control produced 0.169 µmol min⁻¹ in the third day of incubation.

The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated Penicillium sp (PEems150) on day six recorded (0.381 µmol min⁻¹) followed by PEems120 strain (0.324 µmol min⁻¹), PEems90 (0.325 µmol min⁻¹) and PEems60 (0.275 µmol min⁻¹). The Phosphatase activity of Wild Penicillium sp which was used as a standard control produced 0.213 µmol min⁻¹ in the sixth day of incubation.

The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated Penicillium sp (PEems150) on day nine recorded (0.425 µmol min⁻¹) followed by PEems120 strain (0.371 µmol min⁻¹), PEems60 (0.370 µmol min⁻¹) and PEems90 (0.369 µmol min⁻¹). The Phosphatase activity of Wild Penicillium sp which was used as a standard control produced 0.236 µmol min⁻¹ in the ninth day of incubation.

The Phosphatase activity of PEems150 strain increased 64.49% on third day, 78.87% Phosphatase activity on sixth day and 80.00% Phosphatase activity on ninth day of incubation using wild type as a standard (100%).

Efficacy of Ethyl Methane Sulphonate Treated Pseudomonas sp on Phosphatase Activity

The results of Phosphatase activity of Ethyl Methane Sulphonate treated Pseudomonas sp were presented in Table 33.

The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated Pseudomonas sp (PSsa150) on day three recorded (0.113 µmol min⁻¹) followed by PSsa120 strain (0.100 µmol min⁻¹), PSsa90 (0.095
µmol min$^{-1}$) and PSsa60 (0.091 µmol min$^{-1}$). The Phosphatase activity of Wild *Pseudomonas* sp which was used as a standard control produced 0.200µmol min$^{-1}$ in the third day of incubation.

The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated *Pseudomonas* sp (PSsa150) on day six recorded (0.175 µmol min$^{-1}$) followed by PSsa120 strain (0.167 µmol min$^{-1}$), PSsa90 (0.161 µmol min$^{-1}$) and PSsa60 (0.150 µmol min$^{-1}$). The Phosphatase activity of Wild *Pseudomonas* sp which was used as a standard control produced 0.234µmol min$^{-1}$ in the six day of incubation.

The maximum efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated *Pseudomonas* sp (PSsa150) on day nine recorded (0.229 µmol min$^{-1}$) followed by PSsa120 strain (0.220 µmol min$^{-1}$), PSsa90 (0.191 µmol min$^{-1}$) and PSsa60 (0.180 µmol min$^{-1}$). The Phosphatase activity of Wild *Pseudomonas* sp which was used as a standard control produced 0.287µmol min$^{-1}$ in the nine day of incubation.

All mutants of *Pseudomonas* strains treated with Ethyl Methane Sulphonate on day three, six and nine showed decreased Phosphatase activity when compared to wild type.

**Effect of Different Carbon and Nitrogen Sources on the Efficacy of Acid Phosphatase Production.**

The superior mutated cultures of Phosphatase in Pikovskaya broth were identified as Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems120), Sodium Azide Treated *Aspergillus niger* (ANsa120) and Sodium Azide Treated
*Penicillium* sp (PEsa150) and their efficacy of Phosphatase on different Carbon and Nitrogen Sources were studied.

**Effect of Different Carbon Sources on the Efficacy of Phosphatase Activity of Ethyl Methane Sulphonate Treated (ANems120).**

The results of different carbon sources on the efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems120) were presented in Table 34.

The efficacy of Phosphatase activity of ANems120 was maximum in the medium containing Glucose (0.131 µmol min⁻¹) followed by Sucrose (0.107 µmol min⁻¹), Lactose (0.094 µmol min⁻¹) and Mannitol (0.083 µmol min⁻¹) in the third day of incubation.

The efficacy of Phosphatase activity of ANems120 was maximum in the medium containing Glucose (0.273 µmol min⁻¹) followed by Sucrose (0.206 µmol min⁻¹), Lactose (0.182 µmol min⁻¹) and Mannitol (0.167 µmol min⁻¹) in the sixth day of incubation.

The efficacy of Phosphatase activity of ANems120 was maximum in the medium containing Glucose (0.452 µmol min⁻¹) followed by Sucrose (0.279 µmol min⁻¹), Lactose (0.257 µmol min⁻¹) and Mannitol (0.229 µmol min⁻¹) in the ninth day of incubation.
Effect of Different Nitrogen Sources on the Efficacy of Phosphatase Activity of Ethyl Methane Sulphonate Treated *Aspergillus niger* (ANems120).

The results of different nitrogen sources on the efficacy of Phosphatase activity of Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems120) were presented in Table 35.

The efficacy of Phosphatase activity of ANems120 was maximum in the medium containing Ammonium sulphate (0.131 µmol min\(^{-1}\)) followed by Urea (0.109 µmol min\(^{-1}\)), Potassium nitrate (0.102 µmol min\(^{-1}\)) and Sodium nitrate (0.074 µmol min\(^{-1}\)) in the third day of incubation.

The efficacy of Phosphatase activity of ANems120 was maximum in the medium containing Ammonium sulphate (0.273 µmol min\(^{-1}\)) followed by Urea (0.203 µmol min\(^{-1}\)), Potassium nitrate (0.200 µmol min\(^{-1}\)) and Sodium nitrate (0.122 µmol min\(^{-1}\)) in the sixth day of incubation.

The efficacy of Phosphatase activity of ANems120 was maximum in the medium containing Ammonium sulphate (0.452 µmol min\(^{-1}\)) followed by Urea (0.275 µmol min\(^{-1}\)), Potassium nitrate (0.271 µmol min\(^{-1}\)) and Sodium nitrate (0.173 µmol min\(^{-1}\)) in the ninth day of incubation.

Effect of Different Carbon Sources on the Efficacy of Phosphatase Activity of Sodium Azide Treated *Aspergillus niger* (ANsa120).

The results of different carbon sources on the efficacy of Phosphatase activity of sodium azide treated *Aspergillus niger* (ANsa120) were presented in Table 36.
The efficacy of Phosphatase activity of ANsa120 was maximum in the medium containing Sucrose (0.186 µmol min⁻¹) followed by Glucose (0.184 µmol min⁻¹), Lactose (0.165 µmol min⁻¹) and Mannitol (0.076 µmol min⁻¹) in the third day of incubation.

The efficacy of Phosphatase activity of ANsa120 was maximum in the medium containing Glucose (0.340 µmol min⁻¹) followed by Sucrose (0.248 µmol min⁻¹), Lactose (0.187 µmol min⁻¹) and Mannitol (0.094 µmol min⁻¹) in the sixth day of incubation.

The efficacy of Phosphatase activity of ANsa120 was maximum in the medium containing Glucose (0.474 µmol min⁻¹) followed by Sucrose (0.330 µmol min⁻¹), Lactose (0.213 µmol min⁻¹) and Mannitol (0.134 µmol min⁻¹) in the ninth day of incubation.

**Effect of Different Nitrogen Sources on the Efficacy of Phosphatase Activity of Sodium Azide Treated Aspergillus niger (ANsa120).**

The results of different nitrogen sources on the efficacy of Phosphatase activity of sodium azide treated *Aspergillus niger* (ANsa120) were presented in Table 37.

The efficacy of Phosphatase activity of ANsa120 was maximum in the medium containing Ammonium sulphate (0.184 µmol min⁻¹) followed by Urea (0.112 µmol min⁻¹), Potassium nitrate (0.108 µmol min⁻¹) and Sodium nitrate (0.008 µmol min⁻¹) in the third day of incubation.

The efficacy of Phosphatase activity of ANsa120 was maximum in the medium containing Ammonium sulphate (0.340 µmol min⁻¹) followed by Urea
(0.216 µmol min⁻¹), Potassium nitrate (0.203 µmol min⁻¹) and Sodium nitrate (0.103 µmol min⁻¹) in the sixth day of incubation.

The efficacy of Phosphatase activity of ANsa120 was maximum in the medium containing Ammonium sulphate (0.474 µmol min⁻¹) followed by Urea (0.273 µmol min⁻¹), Potassium nitrate (0.254 µmol min⁻¹) and Sodium nitrate (0.125 µmol min⁻¹) in the ninth day of incubation.

**Effect of Different Carbon Sources on the Efficacy of Phosphatase Activity of Sodium Azide Treated *Penicillium* sp (PEsa150).**

The results of different carbon sources on the efficacy of Phosphatase activity of sodium azide treated *Penicillium* sp (PEsa150) were presented in Table 38.

The efficacy of Phosphatase activity of PEsa150 was maximum in the medium containing Glucose (0.210 µmol min⁻¹) followed by Sucrose (0.171 µmol min⁻¹), Lactose (0.168 µmol min⁻¹) and Mannitol (0.162 µmol min⁻¹) in the third day of incubation.

The efficacy of Phosphatase activity of PEsa150 was maximum in the medium containing Sucrose (0.288 µmol min⁻¹) followed by Glucose (0.276 µmol min⁻¹), Lactose (0.214 µmol min⁻¹) and Mannitol (0.204 µmol min⁻¹) in the sixth day of incubation.

The efficacy of Phosphatase activity of PEsa150 was maximum in the medium containing Glucose (0.420 µmol min⁻¹) followed by Sucrose (0.342 µmol min⁻¹), Mannitol (0.261 µmol min⁻¹) and Lactose (0.253 µmol min⁻¹) in the ninth day of incubation.
Effect of Different Nitrogen Sources on the Efficacy of Phosphatase Activity of Sodium Azide Treated *Penicillium* sp (PEsa150).

The results of different nitrogen sources on the efficacy of Phosphatase activity of sodium azide treated *Penicillium* sp (PEsa150) were presented in Table 39.

The efficacy of Phosphatase activity of PEsa150 was maximum in the medium containing Ammonium sulphate (0.210 µmol min\(^{-1}\)) followed by Urea (0.205 µmol min\(^{-1}\)), Potassium nitrate (0.165 µmol min\(^{-1}\)) and Sodium nitrate (0.163 µmol min\(^{-1}\)) in the third day of incubation.

The efficacy of Phosphatase activity of PEsa150 was maximum in the medium containing Ammonium sulphate (0.276 µmol min\(^{-1}\)) followed by Urea (0.223 µmol min\(^{-1}\)), Potassium nitrate (0.218 µmol min\(^{-1}\)) and Sodium nitrate (0.209 µmol min\(^{-1}\)) in the sixth day of incubation.

The efficacy of Phosphatase activity of PEsa150 was maximum in the medium containing Ammonium sulphate (0.420 µmol min\(^{-1}\)) followed by Urea (0.270 µmol min\(^{-1}\)), Potassium nitrate (0.261 µmol min\(^{-1}\)) and Sodium nitrate (0.229 µmol min\(^{-1}\)) in the ninth day of incubation.

Plate-4 shows the Phosphate solubilization and Phosphatase production by fungal cultures in Pikovskaya broth.

Figure-3 showes the comparsion of efficacy of Phosphatase activity by wild strains and Figure-4 showes the comparsion of efficacy of Phosphatase activity by chemical treated fungal strains.


**Lipase Activity**

**Efficacy of UV Treated Aspergillus niger on Lipase Activity**

The results of Lipase activity of UV treated *Aspergillus niger* were presented in Table 40.

The maximum efficacy of Lipase activity of UV treated *Aspergillus niger* (ANuv50) grown in Sucrose medium recorded (2.15 unit g\(^{-1}\) of substrate) followed by ANuv40 strain (1.95 unit g\(^{-1}\) of substrate), ANuv60 (1.89 unit g\(^{-1}\) of substrate) and ANuv30 (1.86 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Aspergillus niger* which was used as a standard control produced 1.62 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The maximum efficacy of Lipase activity of UV treated *Aspergillus niger* (ANuv50) grown in olive oil medium recorded (0.90 unit g\(^{-1}\) of substrate) followed by ANuv40 strain (0.62 unit g\(^{-1}\) of substrate), ANuv60 (0.60 unit g\(^{-1}\) of substrate) and ANuv30 (0.49 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Aspergillus niger* which was used as a standard control produced 0.47 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The Lipase activity of ANuv50 strain increased 32.72% followed by ANuv40 (20.37%), ANuv60 (16.66%) and ANuv30 (14.81%) after 96 hrs incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of ANuv50 strain increased 91.49% followed by ANuv40 (31.91%), ANuv60 (27.66%) and ANuv30 (4.26%) after 96 hrs incubation in olive medium using wild type as a standard (100%).
Efficacy of UV Treated *Aspergillus fumigatus* on Lipase Activity

The results of Lipase activity of UV treated *Aspergillus fumigatus* were presented in Table 41.

The maximum efficacy of Lipase activity of UV treated *Aspergillus fumigatus* (AFuv50) grown in Sucrose medium recorded (2.09 unit g\(^{-1}\) of substrate) followed by AFuv60 strain (1.75 unit g\(^{-1}\) of substrate), AFuv40 (1.39 unit g\(^{-1}\) of substrate) and AFuv30 (1.22 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Aspergillus fumigatus* which was used as a standard control produced 1.01 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The maximum efficacy of Lipase activity of UV treated *Aspergillus fumigatus* (AFuv50) grown in olive oil medium recorded (0.60 unit g\(^{-1}\) of substrate) followed by AFuv60 strain (0.56 unit g\(^{-1}\) of substrate), AFuv40 (0.38 unit g\(^{-1}\) of substrate) and AFuv30 (0.33 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Aspergillus fumigatus* which was used as a standard control produced 0.27 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The Lipase activity of AFuv50 strain increased 106.93% followed by AFuv60 (73.26%), AFuv40 (37.62%) and AFuv30 (20.79%) after 96 hrs incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of AFuv50 strain increased 122.22% followed by AFuv60 (107.40%), AFuv40 (40.74%) and AFuv30 (22.22%) after 96 hrs incubation in olive medium using wild type as a standard (100%).

Efficacy of UV Treated *Penicillium sp* on Lipase Activity

The results of Lipase activity of UV treated *Penicillium sp* were presented in Table 42.
The maximum efficacy of Lipase activity of UV treated *Penicillium* sp (PEuv60) grown in Sucrose medium recorded (1.69 unit g⁻¹ of substrate) followed by PEuv50 strain (1.62 unit g⁻¹ of substrate), PEuv40 (1.43 unit g⁻¹ of substrate) and PEuv30 (1.28 unit g⁻¹ of substrate). The Lipase activity of wild *Penicillium* sp which was used as a standard control produced 1.20 unit g⁻¹ of substrate after 96 hrs incubation.

The maximum efficacy of Lipase activity of UV treated *Penicillium* sp (PEuv60) grown in olive oil medium recorded (0.85 unit g⁻¹ of substrate) followed by PEuv40 strain (0.73 unit g⁻¹ of substrate), PEuv50 (0.69 unit g⁻¹ of substrate) and PEuv30 (0.48 unit g⁻¹ of substrate). The Lipase activity of wild *Penicillium* sp which was used as a standard control produced 0.46 unit g⁻¹ of substrate after 96 hrs incubation.

The Lipase activity of PEuv60 strain increased 40.83% followed by PEuv50 (35.00%), PEuv40 (19.17%) and PEuv30 (6.67%) after 96 hrs incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of PEuv60 strain increased 84.78% followed by PEuv40 (50.00%), PEuv50 (58.7%) and PEuv30 (4.35%) after 96 hrs incubation in olive medium using wild type as a standard (100%).

**Efficacy of UV Treated *Pseudomonas* sp on Lipase Activity**

The results of Lipase activity of UV treated *Pseudomonas* sp were presented in Table 43.

The maximum efficacy of Lipase activity of UV treated *Pseudomonas* sp (PSuv3) grown in Sucrose medium recorded (2.49 unit g⁻¹ of substrate) followed
by PSuv4 strain (2.29 unit g\textsuperscript{-1} of substrate), PSuv1 (2.22 unit g\textsuperscript{-1} of substrate) and PSuv2 (2.19 unit g\textsuperscript{-1} of substrate). The Lipase activity of wild Pseudomonas sp which was used as a standard control produced 2.10 unit g\textsuperscript{-1} of substrate after 96 hrs incubation.

The maximum efficacy of Lipase activity of UV treated Pseudomonas sp (PSuv3) grown in olive oil medium recorded (0.38 unit g\textsuperscript{-1} of substrate) followed by PSuv4 strain (0.34 unit g\textsuperscript{-1} of substrate), PSuv2 (0.33 unit g\textsuperscript{-1} of substrate) and PSuv1 (0.23 unit g\textsuperscript{-1} of substrate). The Lipase activity of wild Pseudomonas sp which was used as a standard control produced 0.17 unit g\textsuperscript{-1} of substrate after 96 hrs incubation.

The Lipase activity of PSuv3 strain increased 18.57% followed by PSuv4 (9.04%), PSuv1 (5.71%) and PSuv2 (4.28%) after 96 hrs incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of PSuv3 strain increased 123.53% followed by PSuv4 (100.00%), PSuv2 (94.12%) and PSuv1 (35.29%) after 96 hrs incubation in olive medium using wild type as a standard (100%).

**Efficacy of Sodium Azide Treated Aspergillus niger on Lipase Activity**

The results of Lipase activity of sodium azide treated Aspergillus niger were presented in Table 44.

The maximum efficacy of Lipase activity of sodium azide treated Aspergillus niger (ANsa90) grown in Sucrose medium recorded (2.61 unit g\textsuperscript{-1} of substrate) followed by ANsa60 strain (2.09 unit g\textsuperscript{-1} of substrate), ANsa30 (1.90 unit g\textsuperscript{-1} of substrate) and ANsa120 (1.85 unit g\textsuperscript{-1} of substrate). The Lipase activity
of wild *Aspergillus niger* which was used as a standard control produced 1.62 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The maximum efficacy of Lipase activity of sodium azide treated *Aspergillus niger* (ANsa90) grown in olive oil medium recorded (0.98 unit g\(^{-1}\) of substrate) followed by ANsa60 strain (0.68 unit g\(^{-1}\) of substrate), ANsa120 (0.63 unit g\(^{-1}\) of substrate) and ANsa30 (0.51 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Aspergillus niger* which was used as a standard control produced 0.47 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The Lipase activity of ANsa90 strain increased 61.11% followed by ANsa60 (29.01%), ANsa30 (17.28%) and ANsa120 (14.19%) after 96 hrs incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of ANsa90 strain increased 108.61% followed by ANsa60 (44.68%), ANsa120 (34.04%) and ANsa30 (8.51%) after 96 hrs incubation in olive medium using wild type as a standard (100%).

**Efficacy of Sodium Azide Treated *Aspergillus fumigatus* on Lipase Activity**

The results of Lipase activity of sodium azide treated *Aspergillus fumigatus* were presented in Table 45.

The maximum efficacy of Lipase activity of sodium azide treated *Aspergillus fumigatus* (AFsa120) grown in Sucrose medium recorded (1.60 unit g\(^{-1}\) of substrate) followed by AFsa30 strain (1.45 unit g\(^{-1}\) of substrate), AFsa60 (1.25 unit g\(^{-1}\) of substrate) and AFsa90 (1.22 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Aspergillus fumigatus* which was used as a standard control produced 1.01 unit g\(^{-1}\) of substrate after 96 hrs incubation.
The maximum efficacy of Lipase activity of sodium azide treated *Aspergillus fumigatus* (AFsa120) grown in olive oil medium recorded (0.44 unit g$^{-1}$ of substrate) followed by AFsa30 strain (0.41 unit g$^{-1}$ of substrate), AFsa60 (0.38 unit g$^{-1}$ of substrate) and AFsa90 (0.30 unit g$^{-1}$ of substrate). The Lipase activity of wild *Aspergillus fumigatus* which was used as a standard control produced 0.27 unit g$^{-1}$ of substrate after 96 hrs incubation.

The Lipase activity of AFsa120 strain increased 58.42% followed by AFsa30 (43.56%), AFsa60 (23.76%) and AFsa90 (20.79%) after 96 hrs incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of AFsa120 strain increased 62.96% followed by AFsa30 (51.85%), AFsa60 (40.74%) and AFsa90 (11.11%) after 96 hrs incubation in olive medium using wild type as a standard (100%).

**Efficacy of Sodium Azide Treated *Penicillium sp* on Lipase Activity**

The results of Lipase activity of sodium azide treated *Penicillium sp* were presented in Table 46.

The maximum efficacy of Lipase activity of sodium azide treated *Penicillium sp* (PEsa120) grown in Sucrose medium recorded (2.01 unit g$^{-1}$ of substrate) followed by PEsa90 strain (1.76 unit g$^{-1}$ of substrate), PEsa30 (1.56 unit g$^{-1}$ of substrate) and PEsa60 (1.43 unit g$^{-1}$ of substrate). The Lipase activity of wild *Penicillium sp* which was used as a standard control produced 1.20 unit g$^{-1}$ of substrate after 96 hrs incubation.

The maximum efficacy of Lipase activity of sodium azide treated *Penicillium sp* (PEsa120) grown in olive oil medium recorded (0.99 unit g$^{-1}$ of substrate) followed by PEsa90 strain (0.73 unit g$^{-1}$ of substrate), PEsa60 (0.69
unit g\(^{-1}\) of substrate) and PEsa30 (0.48 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Penicillium* sp which was used as a standard control produced 0.46 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The Lipase activity of PEsa120 strain increased 67.50% followed by PEsa90 (46.67%), PEsa30 (30.00%) and PEsa60 (19.17%) after 96 hrs incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of PEsa120 strain increased 115.22% followed by PEsa90 (58.70%), PEsa60 (50.00%) and PEsa30 (4.35%) after 96 hrs incubation in olive medium using wild type as a standard (100%).

**Efficacy of Sodium Azide Treated *Pseudomonas* sp on Lipase Activity**

The results of Lipase activity of sodium azide treated *Pseudomonas* sp were presented in Table 47.

The maximum efficacy of Lipase activity of sodium azide treated *Pseudomonas* sp (PSsa90) grown in Sucrose medium recorded (3.23 unit g\(^{-1}\) of substrate) followed by PSsa120 strain (3.04 unit g\(^{-1}\) of substrate), PSsa60 (2.93 unit g\(^{-1}\) of substrate) and PSsa30 (2.28 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Pseudomonas* sp which was used as a standard control produced 2.10 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The maximum efficacy of Lipase activity of sodium azide treated *Pseudomonas* sp (PSsa90) grown in olive oil medium recorded (0.39 unit g\(^{-1}\) of substrate) followed by PSsa120 strain (0.39 unit g\(^{-1}\) of substrate), PSsa60 (0.35 unit g\(^{-1}\) of substrate) and PSsa30 (0.28 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Pseudomonas* sp which was used as a standard control produced 0.17 unit g\(^{-1}\) of substrate after 96 hrs incubation.
The Lipase activity of PSsa90 strain increased 53.80% followed by PSsa120 (44.76%), PSsa60 (39.52%) and PSsa30 (8.57%) after 96 hrs incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of PSsa90 strain increased 129.41% followed by PSsa120 (129.41%), PSsa60 (105.88%) and PSsa30 (64.71%) after 96 hrs incubation in olive medium using wild type as a standard (100%).

**Efficacy of Ethyl Methane Sulphonate Treated *Aspergillus niger* on Lipase Activity**

The results of Lipase activity of Ethyl Methane Sulphonate treated *Aspergillus niger* were presented in Table 48.

The maximum efficacy of Lipase activity of Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems150) grown in Sucrose medium recorded (3.85 unit g\(^{-1}\) of substrate) followed by ANems120 strain (3.10 unit g\(^{-1}\) of substrate), ANems90 (2.09 unit g\(^{-1}\) of substrate) and ANems60 (1.90 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Aspergillus niger* which was used as a standard control produced 1.62 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The maximum efficacy of Lipase activity of Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems150) grown in olive oil medium recorded (0.94 unit g\(^{-1}\) of substrate) followed by ANems120 strain (0.87 unit g\(^{-1}\) of substrate), ANems90 (0.77 unit g\(^{-1}\) of substrate) and ANems60 (0.62 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Aspergillus niger* which was used as a standard control produced 0.47 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The Lipase activity of ANems150 strain increased 137.65% followed by ANems120 (91.35%), ANems90 (29.01%) and ANems60 (17.28%) after 96 hrs
incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of ANems150 strain increased (100.00%) followed by ANems120 (85.11%), ANems90 (63.83%) and ANems60 (31.91%) after 96 hrs incubation in olive medium using wild type as a standard (100%).

**Efficacy of Ethyl Methane Sulphonate Treated *Aspergillus fumigatus* on Lipase Activity**

The results of Lipase activity of Ethyl Methane Sulphonate treated *Aspergillus fumigatus* were presented in Table 49.

The maximum efficacy of Lipase activity of Ethyl Methane Sulphonate treated *Aspergillus fumigatus* (AFems120) grown in Sucrose medium recorded (2.76 unit g\(^{-1}\) of substrate) followed by AFems150 strain (2.60 unit g\(^{-1}\) of substrate), AFems90 (2.26 unit g\(^{-1}\) of substrate) and AFems60 (1.85 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Aspergillus fumigatus* which was used as a standard control produced 1.01 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The maximum efficacy of Lipase activity of Ethyl Methane Sulphonate treated *Aspergillus fumigatus* (AFems120) grown in olive oil medium recorded (0.45 unit g\(^{-1}\) of substrate) followed by AFems150 strain (0.41 unit g\(^{-1}\) of substrate), AFems90 (0.40 unit g\(^{-1}\) of substrate) and AFems60 (0.33 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Aspergillus fumigatus* which was used as a standard control produced 0.27 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The Lipase activity of AFems120 strain increased 173.26% followed by AFems150 (157.43%), AFems90 (123.76%) and AFems60 (83.17%) after 96 hrs incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of AFems120 strain increased 66.67% followed by AFems150
(51.85%), AFems90 (48.15%) and AFems60 (22.22%) after 96 hrs incubation in olive medium using wild type as a standard (100%).

**Efficacy of Ethyl Methane Sulphonate Treated *Penicillium* sp on Lipase Activity**

The results of Lipase activity of Ethyl Methane Sulphonate treated *Penicillium* sp were presented in Table 50.

The maximum efficacy of Lipase activity of Ethyl Methane Sulphonate treated *Penicillium* sp (PEems150) grown in Sucrose medium recorded (1.97 unit g⁻¹ of substrate) followed by PEems120 strain (1.89 unit g⁻¹ of substrate), PEems90 (1.79 unit g⁻¹ of substrate) and PEems60 (1.65 unit g⁻¹ of substrate). The Lipase activity of wild *Penicillium* sp which was used as a standard control produced 1.20 unit g⁻¹ of substrate after 96 hrs incubation.

The maximum efficacy of Lipase activity of Ethyl Methane Sulphonate treated *Penicillium* sp (PEems150) grown in olive oil medium recorded (0.77 unit g⁻¹ of substrate) followed by PEems120 strain (0.63 unit g⁻¹ of substrate), PEems90 (0.58 unit g⁻¹ of substrate) and PEems60 (0.50 unit g⁻¹ of substrate). The Lipase activity of wild *Penicillium* sp used as a standard control produced 0.46 unit g⁻¹ of substrate after 96 hrs incubation.

The Lipase activity of PEems150 strain increased 64.17% followed by PEems120 (57.50%), PEems90 (49.17%) and PEems60 (36.67%) after 96 hrs incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of PEems150 strain increased 67.39% followed by PEems120 (36.96%), PEems90 (26.09%) and PEems60 (8.70%) after 96 hrs incubation in olive medium using wild type as a standard (100%).
Efficacy of Ethyl Methane Sulphonate Treated *Pseudomonas* sp on Lipase Activity

The results of Lipase activity of Ethyl Methane Sulphonate treated *Pseudomonas* sp were presented in Table 51.

The maximum efficacy of Lipase activity of Ethyl Methane Sulphonate treated *Pseudomonas* sp (PSems120) grown in Sucrose medium recorded (4.45 unit g\(^{-1}\) of substrate) followed by PSems150 strain (4.12 unit g\(^{-1}\) of substrate), PSems90 (3.53 unit g\(^{-1}\) of substrate) and PSems60 (2.42 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Pseudomonas* sp which was used as a standard control produced 2.21 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The maximum efficacy of Lipase activity of Ethyl Methane Sulphonate treated *Pseudomonas* sp (PSems120) grown in olive oil medium recorded (0.61 unit g\(^{-1}\) of substrate) followed by PSems150 strain (0.52 unit g\(^{-1}\) of substrate), PSems90 (0.47 unit g\(^{-1}\) of substrate) and PSems60 (0.34 unit g\(^{-1}\) of substrate). The Lipase activity of wild *Pseudomonas* sp which was used as a standard control produced 0.22 unit g\(^{-1}\) of substrate after 96 hrs incubation.

The Lipase activity of PSems120 strain increased 101.36% followed by PSems150 (86.43%), PSems90 (59.72%) and PSems60 (9.50%) after 96 hrs incubation in Sucrose medium using wild type as a standard (100%). The Lipase activity of PSems120 strain increased 177.27% followed by PSems150 (136.36%), PSems90 (113.64%) and PSems60 (54.55%) after 96 hrs incubation in olive medium using wild type as a standard (100%).
Effect of Different Carbon and Nitrogen Sources on the Efficacy of Lipase Activity.

The superior mutated cultures of Lipase in Czapek’s dox broth were identified as Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems120) and *Aspergillus fumigatus* (AFems120), *Aspergillus niger* (ANems150), *Pseudomonas* sp. (PSems150) and (PSems120) and their efficacy of lipase activity were studied by using different Carbon and Nitrogen sources.

Effect of Different Carbon Sources on the Efficacy of Lipase Activity.

The results of different carbon sources on the efficacy of lipase activity of Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems120) and *Aspergillus fumigatus* (AFems120), *Aspergillus niger* (ANems150), *Pseudomonas* sp. (PSems150) and (PSems120) were presented in Tables 52 & 53.

The efficacy of lipase activity of *Aspergillus niger* (ANems120) was maximum in the medium containing Sucrose (3.10 Unit/g of substrate) followed by Glucose (2.94 Unit/g of substrate), Mannitol (1.85 Unit/g of substrate) and Lactose (1.65 Unit/g of substrate) after 96 hrs incubation.

The efficacy of lipase activity of *Aspergillus fumigatus* (AFems120) was maximum in the medium containing Sucrose (2.76 Unit/g of substrate) followed by Glucose (2.54 Unit/g of substrate), Mannitol (1.69 Unit/g of substrate) and Lactose (1.25 Unit/g of substrate) after 96 hrs incubation.

The efficacy of lipase activity of *Aspergillus niger* (ANems150) was maximum in the medium containing Sucrose (3.85 Unit/g of substrate) followed
by Glucose (2.44 Unit/g of substrate), Mannitol (1.98 Unit/g of substrate) and Lactose (1.34 Unit/g of substrate) after 96 hrs incubation.

The efficacy of lipase activity of *Pseudomonas sp.* (PSems120) was maximum in the medium containing Sucrose (4.45 Unit/g of substrate) followed by Glucose (2.95 Unit/g of substrate), Mannitol (2.74 Unit/g of substrate) and Lactose (1.80 Unit/g of substrate) after 96 hrs incubation.

The efficacy of lipase activity of *Pseudomonas sp.* (PSems150) was maximum in the medium containing Sucrose (4.12 Unit/g of substrate) followed by Glucose (2.45 Unit/g of substrate), Mannitol (2.05 Unit/g of substrate) and Lactose (1.65 Unit/g of substrate) after 96 hrs incubation.

**Effect of Different Nitrogen Sources on the Efficacy of Lipase Activity**

The results of different nitrogen sources on the efficacy of lipase activity of Ethyl Methane Sulphonate treated *Aspergillus niger* (ANems120) and *Aspergillus fumigatus* (AFems120) *Aspergillus niger* (ANems150) *Pseudomonas* sp. (PSems150) and (PSems120)were presented in Tables 54 & 55.

The efficacy of lipase activity of *Aspergillus niger* (ANems120) was maximum in the medium containing Sodium nitrate (3.10 Unit/g of substrate) followed by Potassium nitrate (2.85 Unit/g of substrate), Ammonium sulphate (2.01 Unit/g of substrate) and urea (1.55 Unit/g of substrate) after 96 hrs incubation.

The efficacy of lipase activity of *Aspergillus fumigatus* (AFems120) was maximum in the medium containing Sodium nitrate (2.76 Unit/g of substrate) followed by Potassium nitrate (2.67 Unit/g of substrate), Ammonium sulphate...
(2.13 Unit/g of substrate) and urea (1.54 Unit/g of substrate) after 96 hrs incubation.

The efficacy of lipase activity of *Aspergillus niger* (ANems150) was maximum in the medium containing Sodium nitrate (3.85 Unit/g of substrate) followed by Potassium nitrate (2.24 Unit/g of substrate), Ammonium sulphate (1.98 Unit/g of substrate) and urea (1.27 Unit/g of substrate) after 96 hrs incubation.

The efficacy of lipase activity of *Pseudomonas* sp. (PSems120) was maximum in the medium containing Sodium nitrate (4.45 Unit/g of substrate) followed by Potassium nitrate (2.94 Unit/g of substrate), Ammonium sulphate (2.71 Unit/g of substrate) and urea (1.45 Unit/g of substrate) after 96 hrs incubation.

The efficacy of lipase activity of *Pseudomonas* sp. (PSems150) was maximum in the medium containing Sodium nitrate (4.12 Unit/g of substrate) followed by Potassium nitrate (2.99 Unit/g of substrate), Ammonium sulphate (2.64 Unit/g of substrate) and urea (1.40 Unit/g of substrate) after 96 hrs incubation.

Figure- 5 showes the comparsion of efficacy of lipase activity by wild strains and Figure-6 showes the comparsion of efficacy of lipase activity by chemical treated fungal strains.
Indole Acetic Acid (IAA)

Screening Of IAA Production by Wild And Mutated Strains of *Aspergillus niger*, *Aspergillus fumigatus* and *Penicillium sp*.

The results of IAA activity in wild and mutated strains of *Aspergillus niger*, *Aspergillus fumigatus* and *Penicillium sp* were presented in Table 56 and Plate-5 shows the IAA production by bacterial and fungal cultures in Czapek’s dox broth and Thinlayer chromatogram for IAA.

The wild and mutated cultures were analysed for IAA production qualitatively by Thin layer chromatography method. All the wild strains except *Aspergillus fumigatus* were positive for IAA production. Among the mutated strains EMS treated *Aspergillus niger* and UV, sodium azide and Ethyl Methane Sulphonate treated *Aspergillus fumigatus* were negative for IAA production where as rest of all mutated strains were positive for IAA production.

Quantitative Estimation of IAA Production by Wild And Mutated Strains of *Aspergillus niger*, *Penicillium sp* and *Pseudomonas sp*.

The wild and mutated cultures were analysed for IAA production quantitatively by Spectrophotometric method. The results were presented in Table 57.

The efficacy of Indole Acetic Acid production of *Aspergillus niger* was maximum in ANsa120 (17.53µg/L) followed by ANsa90 (16.73µg/L), ANsa60 (15.65µg/L), ANuv30 (13.01µg/L), ANsa30 (12.75µg/L), ANuv40 (12.47µg/L) and ANuv60 (11.85µg/L).

The wild *Aspergillus niger* produced 12.33 µg/L of Indole Acetic Acid.
The efficacy of Indole Acetic Acid production of *Pencillium* sp. was maximum in PEsa120 (10.64µg/L) followed by PEsa90 (9.75µg/L), PEsa60 (8.88µg/L), PEsa150 (8.83µg/L), PEuv30 (8.67µg/L), PEems60 (8.35µg/L), PEuv40 (7.55µg/L), PEems90 (7.45µg/L), PEuv50 (7.07µg/L), PEems120 (6.97µg/L), PEuv60 (6.83µg/L) and PEems150 (6.35µg/L).

The wild *Pencillium* sp. produced 7.68 µg/L of Indole Acetic Acid.

The efficacy of Indole Acetic Acid production of *Pseudomonas* sp. was maximum in PSuv3 (8.60µg/L) followed by PEms150 (8.45µg/L), PEms120 (8.35µg/L), PSsa60 (8.23µg/L), PSsa30 (8.08µg/L), PSuv4 (8.08µg/L), PSsa90 (8.00µg/L), PEms90 (8.00µg/L), PSuv2 (7.55µg/L), PEms60 (7.07µg/L), PSsa120 (6.75µg/L) and PEems150 (6.35µg/L).

The wild *Pseudomonas* sp. produced 7.50 µg/L of Indole Acetic Acid.