## Virulence of entomopathogenic fungi (spore suspension) against 2nd instar larvae of *Spodoptera littoralis* :-

For studying the toxicity of entomopathogenic fungi on the cotton leaf worm, leaf dipping technique was used. Aqueous suspension of entomopathogenic fungi were tested.

Data in table (1, 2, 3, 4, 5) show that the mortality percentage in the 2nd instar larvae of *S. littoralis* increased with increasing the time elapsed after treatment.

For *Metarhizium anisopliae*, data in table(1) and fig(1) show that the mortality percentage after two days of treatment was 2.60, 1.05, 4.16, 12.64, 19.38 % at the concentrations $2.8x10^5$, $2.8x\ 10^6$, $2.8x\ 10^7$, $2.8x\ 10^8$, $2.8x\ 10^9$ spore / ml respectively. After four days post treatment it was 7.46, 6.60, 12.83, 26.35, 33.43 %, as well as after six days it was 12.52, 14.98, 21.64, 36.92, 43.14 % for the same concentrations, respectively. After eight days mortality percentages were 17.32, 24.06, 29.59, 45.15, 50.32 %, while after ten days it was 21.76, 32.77, 36.56, 51.70, 55.90 % at concentrations $2.8x10^5$, $2.8x\ 10^6$, $2.8x\ 10^7$, $2.8x\ 10^8$, $2.8x\ 10^9$ spore / ml respectively. After twelve days mortality percentage increased to be 25.83, 40.70, 42.61, 57.02, 60.38 % for the same concentrations mentioned above respectively.

**Table (1): Cummulative corrected mortality percentage of *S. littoralis* 2nd instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *M. anisopliae* at different periods.**

| Conc (Spore/ml) | Cummulative mortality % indicated days after treatment | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 |
| $2.8 \times 10^9$ | 19.38 | 33.43 | 43.14 | 50.32 | 55.90 | 60.38 |
| $2.8 \times 10^8$ | 12.64 | 26.35 | 36.92 | 45.15 | 51.70 | 57.02 |
| $2.8 \times 10^7$ | 4.16 | 12.83 | 21.64 | 29.59 | 36.56 | 42.61 |
| $2.8 \times 10^6$ | 1.05 | 6.60 | 14.98 | 24.06 | 32.77 | 40.70 |
| $2.8 \times 10^5$ | 2.60 | 7.46 | 12.52 | 17.32 | 21.76 | 25.83 |

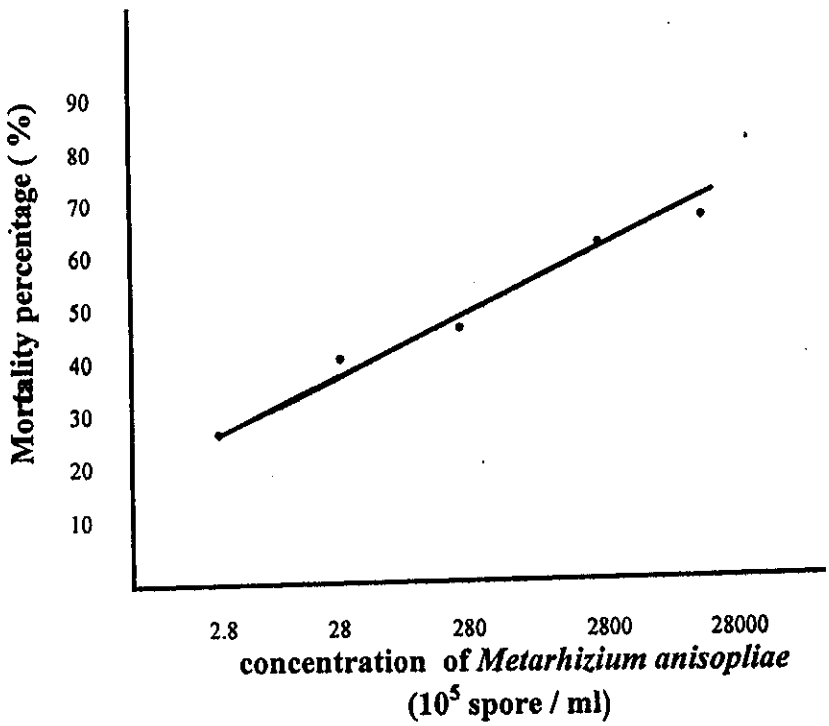



Fig. (1) : Toxicity regression line of *M. anisopliae* against 2nd instar larvae of *S. Littoralis* after 12 day of inoculation

Regarding *Metarhizium flavovrdiae*, data in table (2) and fig (2) show that the mortality percentage after two days of treatment was 10.46, 9.91, 4.31, 15.73, 12.58 % for the concentrations $2.7x10^5$, $2.7x\ 10^6$ , $2.7x\ 10^7$ , $2.7x\ 10^8$ , $2.7x\ 10^9$ spore / ml respectively. Through the period from the $4^{th}$ to the $12^{th}$ day, the mortality percentage increased with increasing the time elapsed post treatment. For example, mortality percentage was ranged between 20.20 - 26.10 % after 4 days post treatment, while it ranged between 27.83 - 36.54 %, 33.99 - 44.67 %, 39.09 - 51.16 % and 43.40-56.44 % after 6, 8, 10 and 12 days post treatment, respectively.

**Table (2): Cummulative corrected mortality percentage of *S. littoralis* 2nd instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *M. flavovrdiae* at different periods.**

| Conc (Spore/ml) | Cummulative mortality % indicated days after treatment | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 |
| $2.7 \times 10^9$ | 12.58 | 26.10 | 36.54 | 44.67 | 51.16 | 56.44 |
| $2.7 \times 10^8$ | 15.73 | 26.58 | 34.33 | 40.29 | 45.08 | 49.06 |
| $2.7 \times 10^7$ | 4.31 | 14.22 | 24.42 | 33.54 | 41.41 | 48.11 |
| $2.7 \times 10^6$ | 9.91 | 20.63 | 29.26 | 36.26 | 42.03 | 46.89 |
| $2.7 \times 10^5$ | 10.46 | 20.20 | 27.83 | 33.99 | 39.99 | 43.40 |

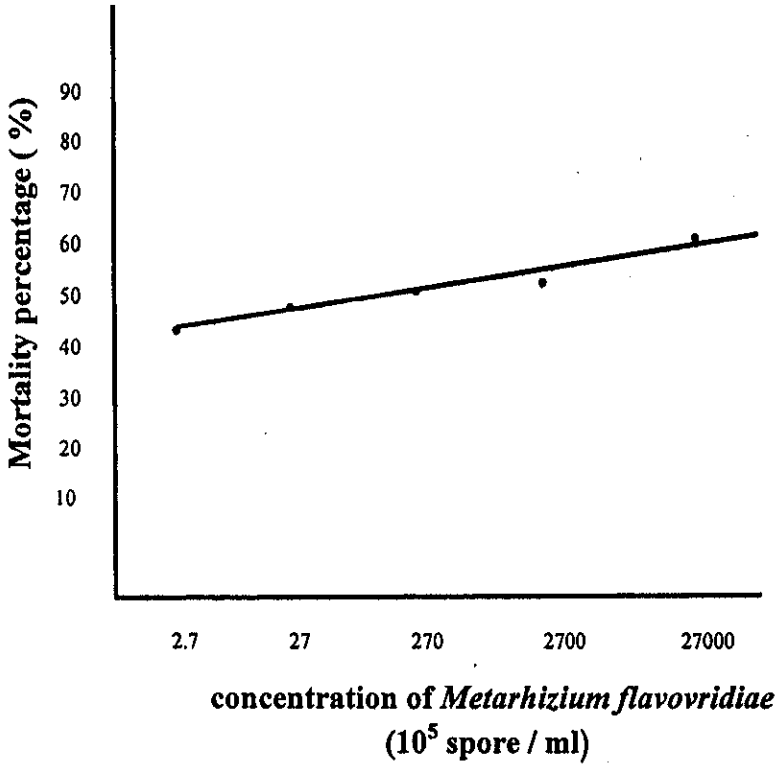



Fig. (2) : Toxicity regression line of *M. flavovridiae* against 2nd instar larvae of *S. Littoralis* after 12 day of inoculation

Taking into account the mortality percentage of *Pacilomyces farinosus* (Table: 3 and Fig: 3) after two days of treatment was 14.09, 13.60, 15.21, 5.75, 3.07 % for the concentrations $0.3x10^5$, $0.3x\ 10^6$, $0.3x\ 10^7$, $0.3x\ 10^8$, $0.3x\ 10^9$ spore / ml respectively.

After four days post treatment it was 21.46, 21.31, 23.85, 15.76, 13.12 %, while it was 26.66, 26.81, 29.94, 25.16, 24.75 % after six days post treatment at the same concentrations respectively. There were slight difference in mortality percentage was pronounced between the three highest tested concentrations after 8, 10 and 12 days of treatment. Also, at two lower concentrations, mortality percentage was almost the same after 8, 10 and 12 days.

**Table (3): Cummulative corrected mortality percentage of *S. littoralis* 2nd instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *P. farinosus* at different periods.**

| Conc (Spore/ml) | Cummulative mortality % indicated days after treatment | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 |
| $0.3 \times 10^9$ | 3.07 | 13.12 | 24.75 | 35.53 | 44.84 | 52.69 |
| $0.3 \times 10^8$ | 5.75 | 15.76 | 25.16 | 33.29 | 40.21 | 46.13 |
| $0.3 \times 10^7$ | 15.21 | 23.85 | 29.94 | 34.65 | 38.47 | 41.69 |
| $0.3 \times 10^6$ | 13.60 | 21.31 | 26.81 | 31.10 | 34.62 | 37.60 |
| $0.3 \times 10^5$ | 14.09 | 21.46 | 26.66 | 30.70 | 34.00 | 36.80 |

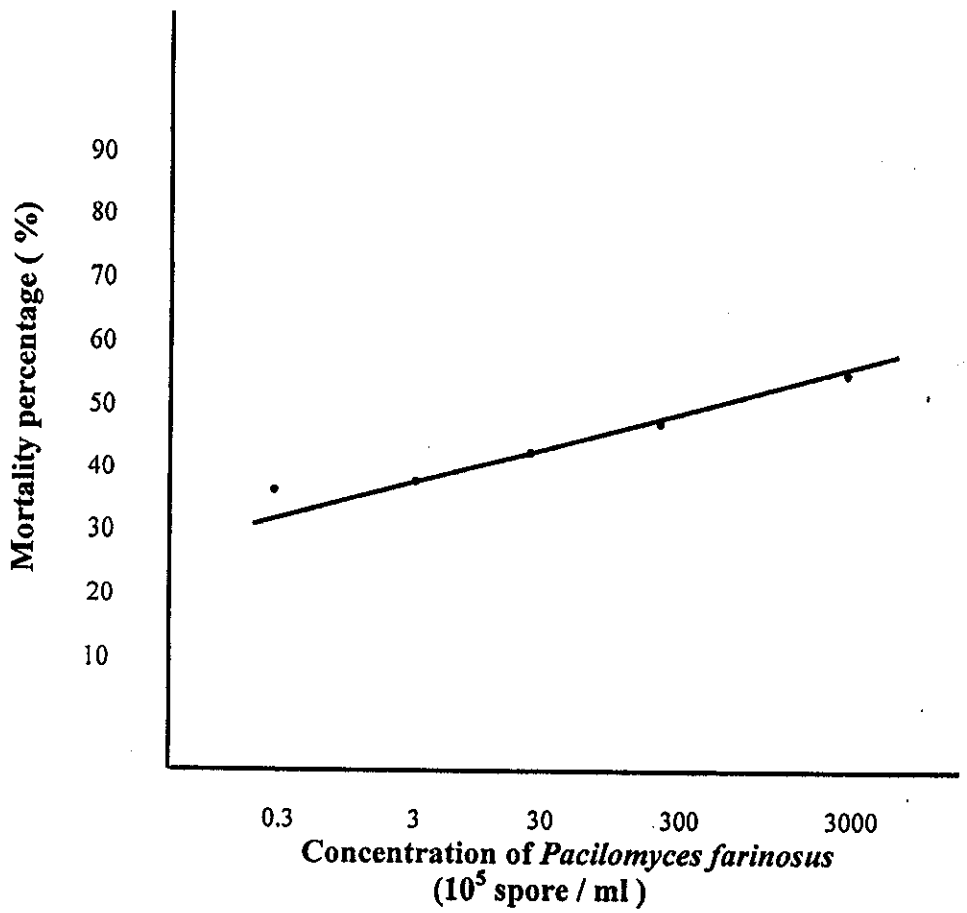



Fig. (3): Toxicity regression line of *P. farinosus* against 2nd instar larvae of *S. littoralis* after 12 day of inoculation

As for *Beauveria bassiana* (Table: 4 and Fig: 4) the mortality percentage increased with increasing the time elapsed after treatment at different concentrations. After two days, mortality percentages were almost lower than 10 %, then gradual increase in mortality percentage appeared at different time intervals. Mortality percentage ranged between 23.57-51.37 % after 12 days post treatment.

Generally, positive correlation was obtained between mortality percentage and tested concentrations.

**Table(4): Cummulative corrected mortality percentage of S. *littoralis* 2nd instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *B. Bassiana* at different periods.**

| Conc (Spore/ml) | Cummulative mortality % indicated days after treatment | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 |
| $1.6 \times 10^9$ | 10.54 | 22.54 | 32.17 | 39.88 | 46.16 | 51.37 |
| $1.6 \times 10^8$ | 8.15 | 18.70 | 27.65 | 35.07 | 41.27 | 46.51 |
| $1.6 \times 10^7$ | 5.75 | 13.22 | 19.85 | 25.59 | 30.57 | 34.94 |
| $1.6 \times 10^6$ | 6.23 | 12.01 | 16.78 | 20.81 | 24.29 | 27.36 |
| $1.6 \times 10^5$ | 3.51 | 8.25 | 12.68 | 16.68 | 20.30 | 23.57 |

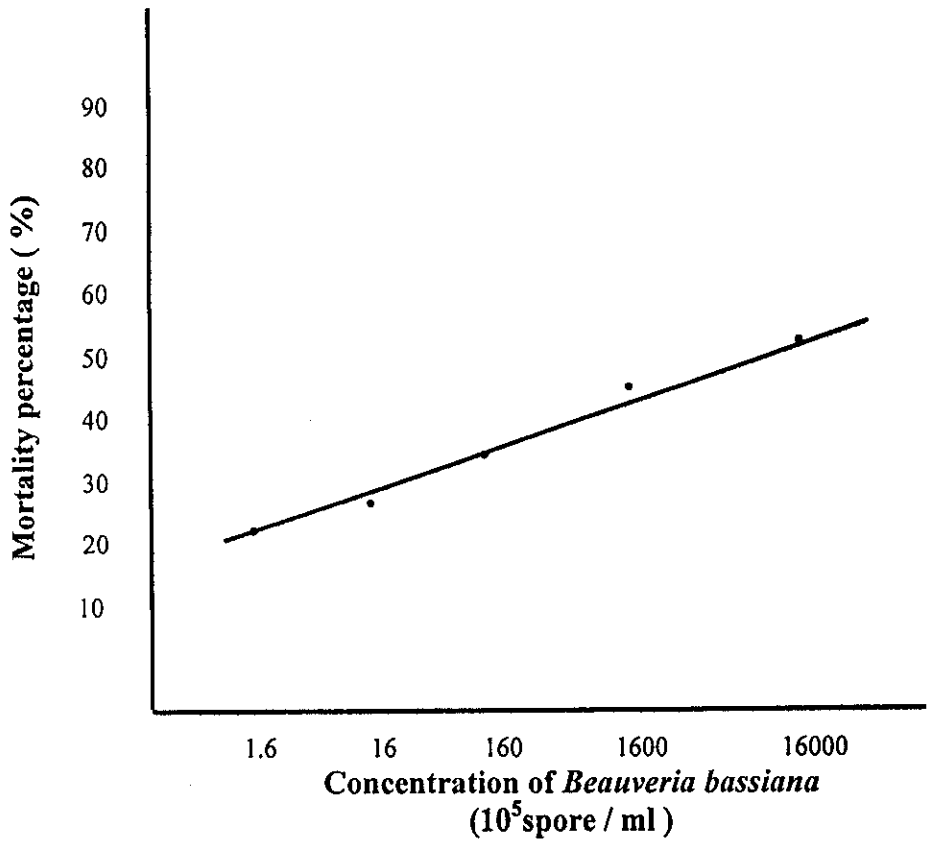



Fig. (4): Toxicity regression line of *B.bassiana* against 2nd instar larvae of *S. littoralis* after 12 day of inoculation

In addition to the mortality percentage of *Beauveria brongniartti* (Table: 5 and Fig: 5) after tow days post treatment was 5.98, 10.70, 9.36, 9.35, 11.69 % for the concentrations $0.9x10^5$, $0.9x\ 10^6$ , $0.9x\ 10^7$ , $0.9x\ 10^8$ , $0.9x\ 10^9$ spore / ml respectively.

The mortality percentage ranged between 13.42-23.14 % after 4 days post treatment, while it ranged between 19.95-32.02 %, 25.56-39.06 %, 30.43-44.79 % and 34.69-49.57 % after 6, 8, 10 and 12 days, respectively.

**Table (5): Cummulative corrected mortality percentage of *S. littoralis* 2nd instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *B. brongniartti* at different periods.**

| Conc (Spore/ml ) | Cummulative mortality % indicated days after treatment | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 |
| $0.9 \times 10^9$ | 11.69 | 23.14 | 32.02 | 39.06 | 44.79 | 49.57 |
| $0.9 \times 10^8$ | 9.35 | 19.42 | 27.59 | 34.26 | 39.82 | 44.52 |
| $0.9 \times 10^7$ | 9.36 | 20.44 | 29.53 | 36.94 | 43.06 | 48.20 |
| $0.9 \times 10^6$ | 10.70 | 16.88 | 21.40 | 24.99 | 27.98 | 30.55 |
| $0.9 \times 10^5$ | 5.98 | 13.42 | 19.95 | 25.56 | 30.43 | 34.69 |

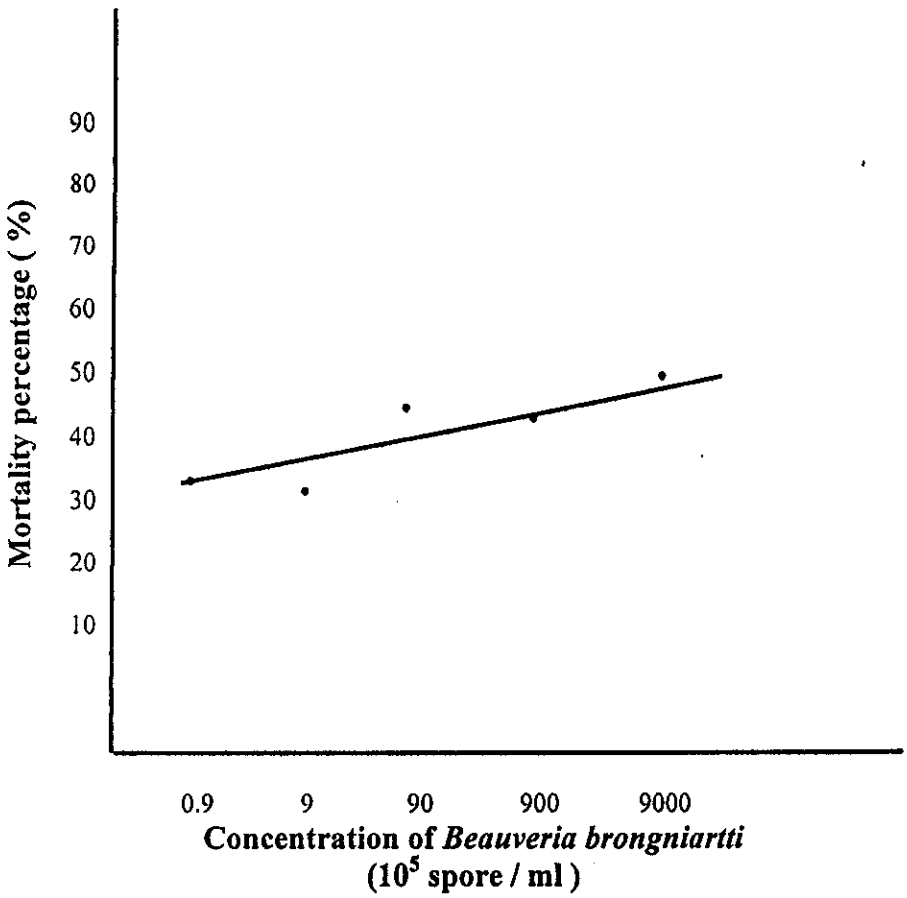



Fig. (5): Toxicity regression line of *B. brongniartti* against 2nd instar larvae of *S. littoralis* after 12 day of inoculation

Generally *M. anisopliae* was found to be the most effective isolate against 2nd instar larvae of *S. littoralis* followed by *M. flavovridae*, *P. farinosus*, *B. bassiana* then *B. brongniartti* respectively.

Probit analysis show that $LT_{50}$ values for *M. anisopliae* (Table: 6 and Fig: 6) were 29.4, 14.7, 14.8, 9.4 and 7.8 days for the concentrations $2.8x10^5$, $2.8x\ 10^6$, $2.8x\ 10^7$, $2.8x\ 10^8$, $2.8x\ 10^9$ spore / ml respectively, as for *M. flavovridae* (Table:7 and Fig: 6) they were 15.7, 13.4, 12.6, 12.5, 9.4 days for the concentrations $2.7x10^5$, $2.7x\ 10^6$, $2.7x\ 10^7$, $2.7x\ 10^8$, $2.7x\ 10^9$ spore / ml respectively.

$LT_{50}$ values for *P. farinosus* (Table:8 and Fig: 6) ranged between 11-27days for the concentrations $0.3x10^5$, $0.3x\ 10^6$, $0.3x\ 10^7$, $0.3x\ 10^8$, $0.3x\ 10^9$ spore / ml respectively, Regarding *B. bassiana* (Table: 9 and Fig: 6) $LT_{50}$ values ranged between 11-39 days for the concentrations $1.6x10^5$, $1.6x\ 10^6$, $1.6x\ 10^7$, $1.6x\ 10^8$, $1.6x\ 10^9$ spore / ml respectively, In addition to $LT_{50}$ values for *B. brongniartti* (Table:10 and Fig: 6 ) ranged between 12-22 days for the concentrations $0.9x10^5$, $0.9x\ 10^6$, $0.9x\ 10^7$, $0.9x\ 10^8$, $0.9x\ 10^9$ spore / ml respectively.

**Table (6): Virulence of *M. anisopliae* against the 2nd instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (Spore/ml) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| $2.8 \times 10^9$ | 7.8979 | 6.5692 | 10.0032 | 3.6998±0.1974 | 1.4487±0.2361 |
| $2.8 \times 10^8$ | 9.4389 | 7.9628 | 11.9671 | 3.3457±0.2128 | 1.6969±0.2504 |
| $2.8 \times 10^7$ | 14.8895 | 12.0226 | 21.2926 | 2.6691±0.2694 | 1.9873±0.3046 |
| $2.8 \times 10^6$ | 14.7035 | 12.3502 | 19.5465 | 1.8889±0.3566 | 2.6649±0.3889 |
| $2.8 \times 10^5$ | 29.4444 | 19.0676 | 79.2048 | 2.5560±0.3111 | 1.6637±0.3475 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (7): Virulence of *M. flavoviridae* against the 2nd instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (Spore/ml) | $LT_{50}$(days) | 95% (fiducial limit ) | | a Intercept | B Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| $2.7 \times 10^9$ | 9.6105 | 8.0827 | 12.2788 | 3.3473±0.2130 | 1.6817±0.2506 |
| $2.7 \times 10^8$ | 12.5292 | 9.6313 | 20.3381 | 3.6146±0.2052 | 1.2618±0.2428 |
| $2.7 \times 10^7$ | 12.6250 | 10.6192 | 16.4557 | 2.6383±0.2651 | 2.1446±0.3004 |
| $2.7 \times 10^6$ | 13.4714 | 10.6444 | 20.2115 | 3.2455±0.2243 | 1.5535±0.2611 |
| $2.7 \times 10^5$ | 15.7700 | 11.8163 | 27.3581 | 3.3225±0.2227 | 1.4005±0.2597 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (8): Virulence of *P. farinosus* against the 2nd instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (Spore/ml) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| $0.3 \times 10^9$ | 11.2745 | 9.8198 | 13.7023 | 2.3796±0.2819 | 2.4906±0.3169 |
| $0.3 \times 10^8$ | 13.5004 | 11.0328 | 18.7181 | 2.8512±0.2508 | 1.9010±0.2864 |
| $0.3 \times 10^7$ | 19.0080 | 12.6708 | 50.6428 | 3.6562±0.2075 | 1.0507±0.2454 |
| $0.3 \times 10^6$ | 24.7545 | 15.0539 | 94.6192 | 3.5991±0.2128 | 1.0052±0.2509 |
| $0.3 \times 10^5$ | 27.1628 | 15.7402 | 132.6001 | 3.6375±0.2116 | 0.9501±0.2499 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (9): Virulence of *B. bassiana* against the 2nd instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (Spore/ml) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| $1.6 \times 10^9$ | 11.4376 | 9.3901 | 15.5778 | 3.2510±0.2208 | 1.6526±0.2578 |
| $1.6 \times 10^8$ | 13.5283 | 10.8311 | 19.6460 | 3.0994±0.2333 | 1.6801±0.2697 |
| $1.6 \times 10^7$ | 21.5037 | 15.1660 | 43.9351 | 2.9643±0.2550 | 1.5277±0.2916 |
| $1.6 \times 10^6$ | 38.0946 | 21.0357 | 190.9748 | 3.1034±0.2547 | 1.1997±0.2931 |
| $1.6 \times 10^5$ | 39.1842 | 22.1402 | 174.8575 | 2.7678±0.2931 | 1.4012±0.3310 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (10): Virulence of *B. brongniartii* against the 2nd instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (Spore/ml) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| $0.9 \times 10^9$ | 12.1999 | 9.7679 | 17.6746 | 3.3530±0.2168 | 1.5161±0.2539 |
| $0.9 \times 10^8$ | 14.7900 | 11.4226 | 23.5566 | 3.2232±0.2274 | 1.5187±0.2642 |
| $0.9 \times 10^7$ | 12.7867 | 10.2948 | 18.2983 | 3.1886±0.2266 | 1.6367±0.2632 |
| $0.9 \times 10^6$ | 41.5471 | 20.6212 | 411.9550 | 3.4732±0.2255 | 0.9433±0.2643 |
| $0.9 \times 10^5$ | 22.0220 | 15.3566 | 46.5762 | 2.9942±0.2530 | 1.4937±0.2897 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

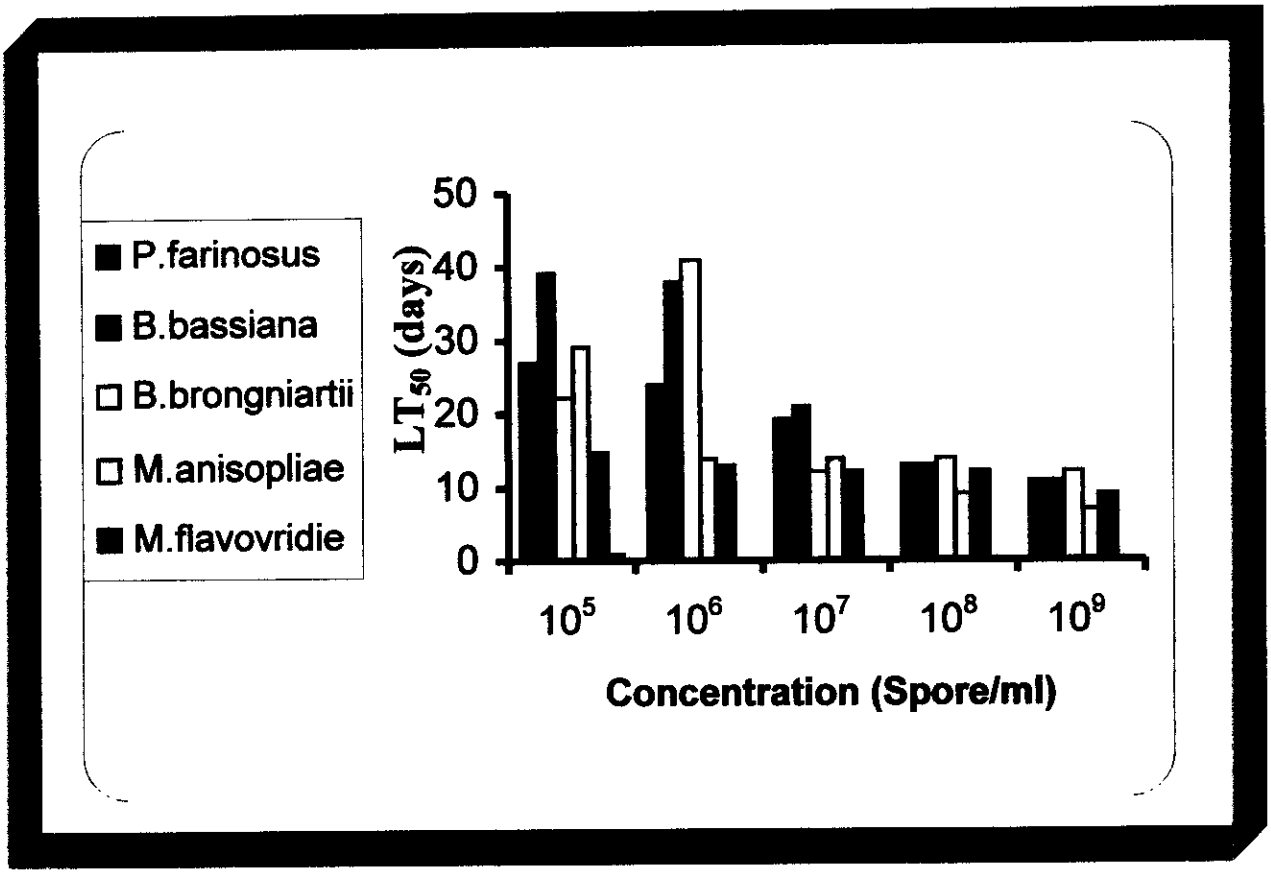



Fig (6): Relationship between different concentrations of the five tested fungi and $LT_{50}$ values (days)

## Virulence of entomopathogenic fungi (spore suspension) against 4th instar larvae of *S. littoralis*:-

Data in table (11, 12, 13, 14, 15) show that the mortality percentage in the 4th instar larvae of *S. littoralis* increased with increasing the time elapsed after treatment.

For *M. anisopliae* data in table (11) and fig (7) show that the mortality percentage after four days of treatment was 4.25, 6.85, 7.33, 7.74, 7.13 % for the concentrations $2.8x10^5$, $2.8x\ 10^6$ , $2.8x\ 10^7$ , $2.8x\ 10^8$ , $2.8x\ 10^9$ spore / ml respectively. At the three highest tested concentrations, the mortality percentage was almost the same after 4 days post treatment but there were slight difference in mortality percentage between the two lower concentrations after 4 days. The mortality percentage ranged between 8.06 – 18.23 %, 12.04 – 30.52 %, 12.04 – 30.52 % and 19.71 – 55.00 % after 6, 8 and 10 days.

**Table(11):Cummulative corrected mortality percentage of S. *littoralis* 4th instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *M. anisopliae* at different periods.**

| Conc (Spore/ml) | Cummulative mortality % indicated days after treatment | | | |
|---|---|---|---|---|
| | 4 | 6 | 8 | 10 |
| $2.8 \times 10^9$ | 7.13 | 18.23 | 30.52 | 55.00 |
| $2.8 \times 10^8$ | 7.74 | 13.89 | 19.88 | 30.57 |
| $2.8 \times 10^7$ | 7.33 | 11.97 | 16.33 | 24.04 |
| $2.8 \times 10^6$ | 6.85 | 11.43 | 15.79 | 23.58 |
| $2.8 \times 10^5$ | 4.25 | 8.06 | 12.04 | 19.71 |

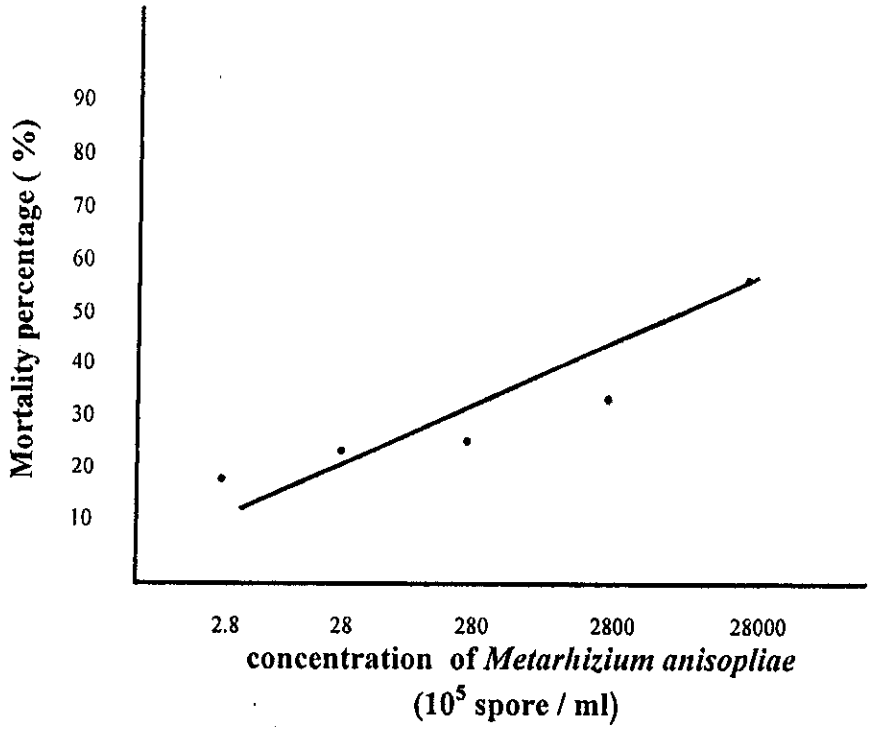



Fig. (7) : Toxicity regression line of *M. anisopliae* against 4th instar larvae of *S. Littoralis* after 10 days of inoculation

As for *M. flavovrdiae* (Table: 12 and Fig: 8) there were positive correlation between mortality percentage and time elapsed post treatment was pronounced through the period from $4^{th}$ to $10^{th}$ days. The mortality percentage ranged between 4.53 - 10.71 %, 10.91 - 23.04 %, 18.30 – 35.22 % and 32.89 – 54.98 % after 4, 6, 8 and 10 days at different concentrations.

**Table(12):Cummulative corrected mortality percentage of *S. littoralis* $4^{th}$ instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *M. Flavovrdiae* at different periods.**

| Conc (Spore/ml) | Cummulative mortality % indicated days after treatment | | | |
|---|---|---|---|---|
| | 4 | 6 | 8 | 10 |
| $2.7 \times 10^9$ | 10.71 | 23.04 | 35.22 | 54.98 |
| $2.7 \times 10^8$ | 4.27 | 13.79 | 26.04 | 49.54 |
| $2.7 \times 10^7$ | 6.31 | 14.48 | 23.17 | 39.45 |
| $2.7 \times 10^6$ | 1.87 | 7.12 | 15.12 | 33.82 |
| $2.7 \times 10^5$ | 4.53 | 10.91 | 18.30 | 32.89 |

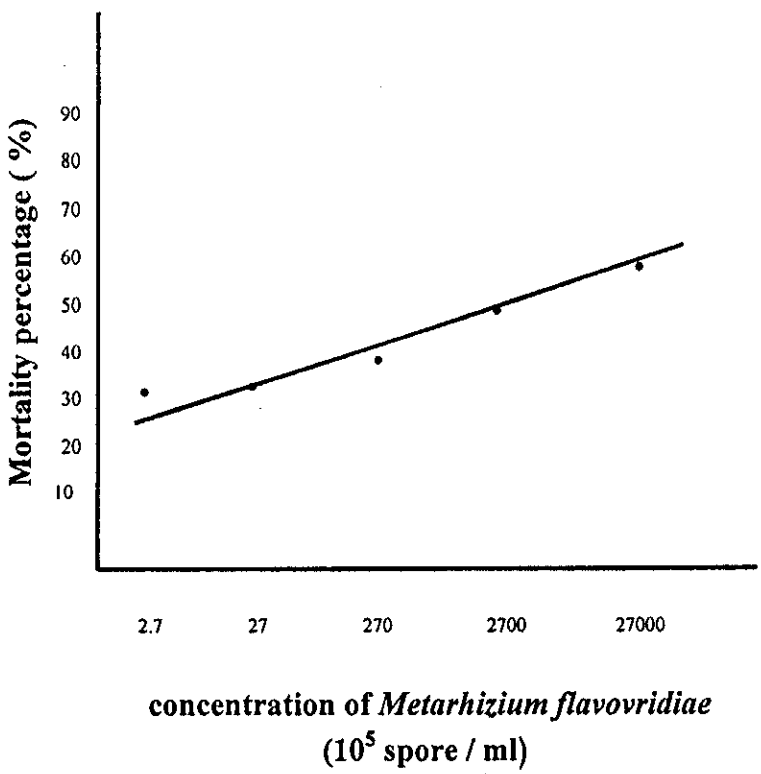



Fig. (8) : Toxicity regression line of *M. flavovridiae* against 4$^{th}$ instar larvae of *S. Littoralis* after 10 days of inoculation

Taking into consideration, the mortality percentage of *P. farinosus* as shown in table (13) and fig (9) after four days post treatment was 20.45, 24.70, 25.96 22.54, 27.36 % for the concentrations $0.3x10^5$, $0.3x\ 10^6$ , $0.3x\ 10^7$ , $0.3x\ 10^8$ , $0.3x\ 10^9$ spore / ml respectively.

The mortality percentage was almost the same at the four lower tested concentrations to be ranged between 25.97 - 28.95 %, 30.31 - 33.96 % and 36.91 - 41.50 % after 6, 8 and 10 days but it was more than 50 % at the higher concentration after 10 days.

**Table(13):Cummulative corrected mortality percentage of *S. littoralis* 4th instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *P. farinosus* at different periods.**

| Conc (Spore/ml) | Cummulative mortality % indicated days after treatment | | | |
|---|---|---|---|---|
| | 4 | 6 | 8 | 10 |
| $0.3 \times 10^9$ | 27.36 | 36.77 | 44.01 | 54.51 |
| $0.3 \times 10^8$ | 22.54 | 28.95 | 33.96 | 41.50 |
| $0.3 \times 10^7$ | 25.96 | 30.98 | 34.79 | 40.41 |
| $0.3 \times 10^6$ | 24.70 | 29.86 | 33.80 | 39.65 |
| $0.3 \times 10^5$ | 20.45 | 25.97 | 30.31 | 36.91 |

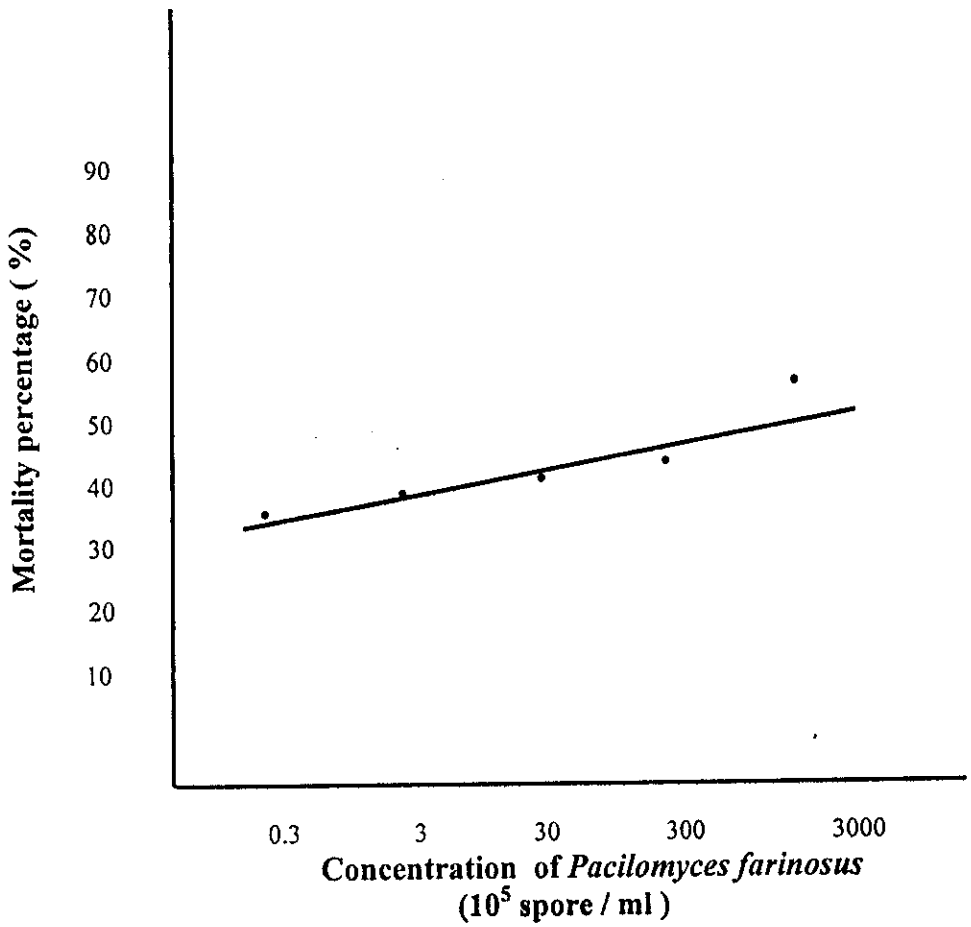



Fig. (9): Toxicity regression line of *P. farinosus* against 4th instar larvae of *S. littoralis* after 10 days of inoculation

Regarding *B. bassiana*, (Table: 14 and Fig: 10) the mortality percentage was lower than 10 % after 4 days then increased with increasing the time elapsed post treatment at different concentrations to be ranged between 5.05 - 18.95 %, 8.66 - 29.67 % and 16.59 - 48.15 % after 6, 8 and 10 days.

**Table(14):Cummulative corrected mortality percentage of *S. littoralis* 4th instar larvae after feeding on treated castor bean leaves immersed in different concentration of *B. bassiana* at different periods.**

| Conc (Spore/ml) | Cummulative mortality % indicated days after treatment | | | |
|---|---|---|---|---|
| | 4 | 6 | 8 | 10 |
| $1.6 \times 10^9$ | 8.58 | 18.95 | 29.67 | 48.15 |
| $1.6 \times 10^8$ | 5.17 | 13.35 | 22.90 | 41.15 |
| $1.6 \times 10^7$ | 3.58 | 9.04 | 15.62 | 29.22 |
| $1.6 \times 10^6$ | 4.35 | 9.36 | 14.91 | 25.85 |
| $1.6 \times 10^5$ | 2.11 | 5.05 | 8.66 | 16.59 |

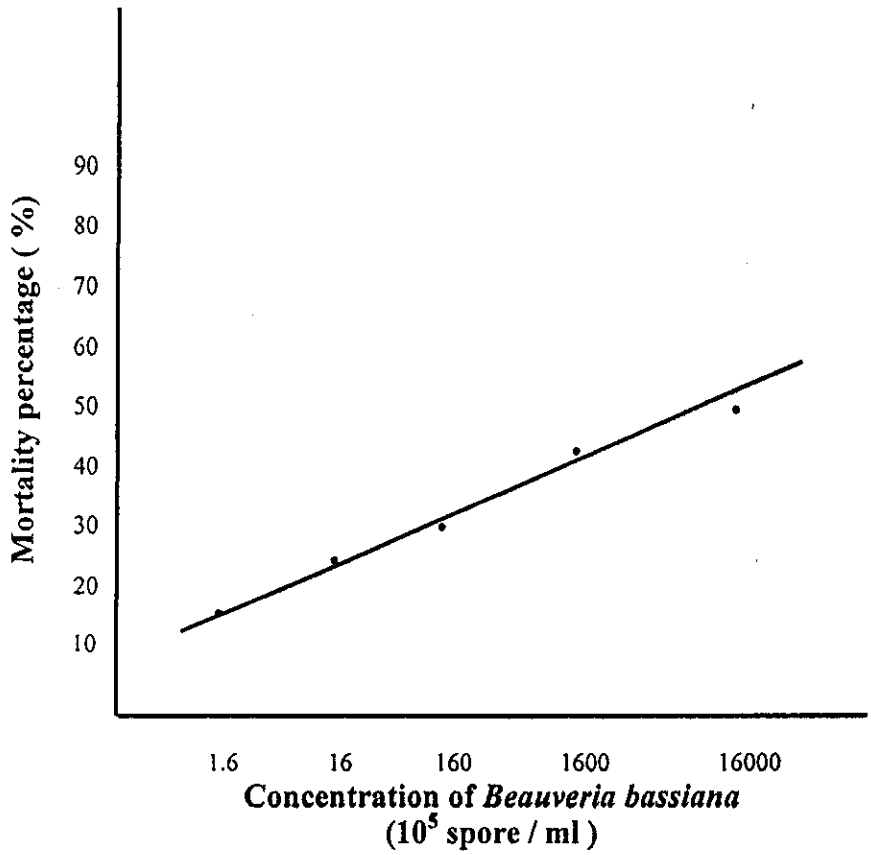



Fig. (10): Toxicity regression line of *B. bassiana* against 4$^{th}$ instar larvae of *S. littoralis* after 10 days of inoculation

In addition to the mortality percentage of *B. brongniartti* (Table: 15 and Fig: 11) ranged between 7.40 - 9.17 %, 12.95 - 20.14 %, 18.33 - 31.33 % and 27.93 - 50.29 % after 4, 6, 8 and 10 days.

There were similarity in the mortality percentage between the two highest tested concentrations was noticed after 4, 6, 8 and 10 days, but there were difference in mortality percentage at the three lower tested concentrations after the same days.

**Table(15):Cummulative corrected mortality percentage of *S. littoralis* 4th instar larvae after feeding on treated castor bean leaves immersed in different concentration of *B. brongniartti* at different periods.**

| Conc (Spore/ml) | Cummulative mortality % indicated days after treatment | | | |
|---|---|---|---|---|
| | 4 | 6 | 8 | 10 |
| $0.9 \times 10^9$ | 9.17 | 20.14 | 31.33 | 50.29 |
| $0.9 \times 10^8$ | 10.14 | 20.82 | 31.35 | 48.99 |
| $0.9 \times 10^7$ | 18.29 | 25.26 | 30.94 | 39.76 |
| $0.9 \times 10^6$ | 7.48 | 14.16 | 20.84 | 32.84 |
| $0.9 \times 10^5$ | 7.40 | 12.95 | 18.33 | 27.93 |

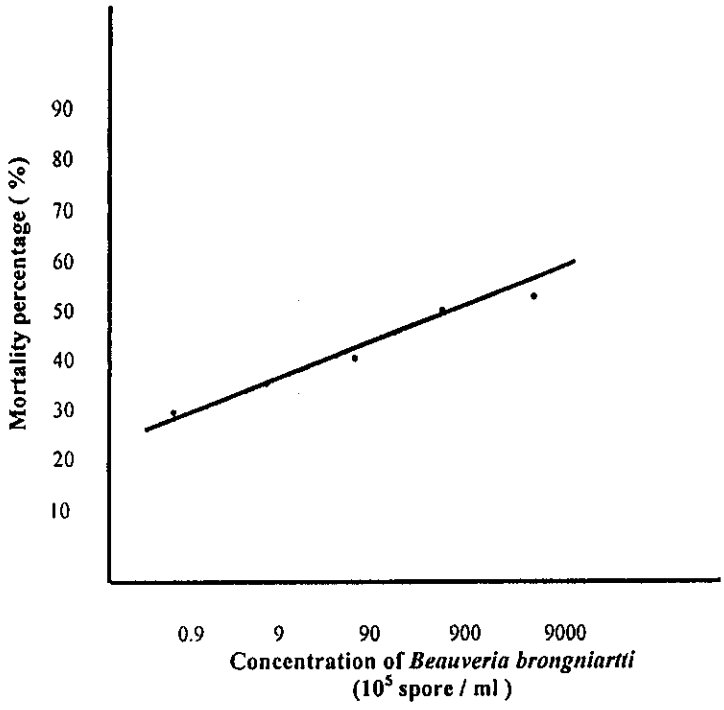



Fig. (11): Toxicity regression line of *B. brongniartti* against 4th instar larvae of *S. littoralis* after 10 days of inoculation

Generally *M. anisopliae* was found to be the most effective isolate against 4th instar larvae of *S. littoralis* followed by *M. flavovridae*, *P. farinosus*, *B. brongniartti* then *B. bassiana* respectively.

Data in table 16,17,18,19&20 and fig 12 show that $LT_{50}$ values for *M. anisopliae* (table: 16 and Fig: 12) were 35.1, 33.8, 33.6, 22.0, 10.5 days for the concentrations $2.8x10^5$, $2.8x\ 10^6$, $2.8x\ 10^7$, $2.8x\ 10^8$, $2.8x\ 10^9$ spore / ml respectively, while $LT_{50}$ values for *M. flavovridae* (Table: 17 and Fig: 12) were 17.7, 15.8, 15.1, 12.0, 10.8 days for the concentrations $2.7x10^5$, $2.7x\ 10^6$, $2.7x\ 10^7$, $2.7x\ 10^8$, $2.7x\ 10^9$ spore / ml respectively.

$LT_{50}$ values for *P. farinosus* (Table: 18 and Fig: 12) ranged between 10 – 25 days for the concentrations $0.3x10^5$, $0.3x\ 10^6$, $0.3x\ 10^7$, $0.3x\ 10^8$, $0.3x\ 10^9$ spore / ml respectively, while they ranged between 12 – 32 days for *B. bassiana* (Table: 19 and Fig: 12) at the concentrations $1.6x10^5$, $1.6x\ 10^6$, $1.6x\ 10^7$, $1.6x\ 10^8$, $1.6x\ 10^9$ spore / ml respectively, in addition to *B. brongniartti* (Table: 20 and Fig: 12) they ranged between 11 - 25 days for the concentrations $0.9x10^5$, $0.9x\ 10^6$, $0.9x\ 10^7$, $0.9x\ 10^8$, $0.9x\ 10^9$ spore / ml respectively .

**Table (16): Virulence of *M. anisopliae* against the 4th instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (Spore/ml) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| $2.8 \times 10^9$ | 10.5713 | 9.8782 | 15.5046 | 1.6204±0.6086 | 3.1782±0.6567 |
| $2.8 \times 10^8$ | 22.0846 | 14.0949 | 198.5495 | 2.4223±0.6164 | 1.9178±0.6680 |
| $2.8 \times 10^7$ | 33.6309 | 16.8230 | 1.13197E+05 | 2.5443±0.6434 | 1.6085±0.6978 |
| $2.8 \times 10^6$ | 33.8808 | 16.7658 | 2.80580E+05 | 2.6060±0.6337 | 1.5648±0.6884 |
| $2.8 \times 10^5$ | 35.1764 | 17.6372 | 46649.8689 | 2.1794±0.7220 | 1.8242±0.7745 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (17): Virulence of *M. flavovridae* against the 4th instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (Spore/ml) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| $2.7 \times 10^9$ | 10.8517 | 9.2310 | 14.5449 | 2.0327±0.5643 | 2.8556±0.6156 |
| $2.7 \times 10^8$ | 12.0883 | 10.3918 | 15.9992 | 1.1227±0.6727 | 3.5822±0.7165 |
| $2.7 \times 10^7$ | 15.1504 | 11.8061 | 29.2944 | 1.8791±0.6314 | 2.6439±0.6788 |
| $2.7 \times 10^6$ | 15.8098 | 12.6345 | 27.9566 | 0.8198±0.8171 | 3.4866±0.8537 |
| $2.7 \times 10^5$ | 17.7112 | 13.0834 | 45.0068 | 1.7303±0.6834 | 2.6195±0.7292 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (18): Virulence *P. farinosus* of against the 4th instar larvae of *S. littoralis* expressed as $LT_{50}$ values(days).**

| Conc (Spore/ml) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| $0.3 \times 10^9$ | 10.9828 | 7.6834 | 23.8274 | 3.4952±0.4884 | 1.4995±0.5454 |
| $0.3 \times 10^8$ | 18.5796 | 11.0913 | 1.26083E+14 | 3.5655±0.5033 | 1.1304±0.5599 |
| $0.3 \times 10^7$ | 23.2870 | N.D* | N.D* | 3.8479±0.4942 | 0.8427±0.5517 |
| $0.3 \times 10^6$ | 23.7761 | N.D* | N.D* | 3.7843±0.4978 | 0.8834± |
| $0.3 \times 10^5$ | 25.3296 | N.D* | N.D* | 3.5542±0.5129 | 1.0300±0.5698 |

* Not detected

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (19): Virulence *B. bassiana* of against the 4th instar larvae of *S. littoralis* expressed as $LT_{50}$ values(days).**

| Conc (Spore/ml) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| $1.6 \times 10^9$ | 12.4734 | 10.2962 | 18.8368 | 1.9668±0.5895 | 2.7676±0.6388 |
| $1.6 \times 10^8$ | 14.2940 | 11.5154 | 23.8658 | 1.5985±0.6551 | 2.9446±0.7006 |
| $1.6 \times 10^7$ | 19.3750 | 13.8363 | 60.5636 | 1.6154±0.7243 | 2.6294±0.7689 |
| $1.6 \times 10^6$ | 23.4380 | 15.0097 | 178.6775 | 1.9466±0.7023 | 2.2289±0.7505 |
| $1.6 \times 10^5$ | 32.7771 | 17.5840 | 6240.8546 | 1.6300±0.8566 | 2.2236±0.9037 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (20): Virulence *B. brongniartii* of against the 4th instar larvae of *S. littoralis* expressed as $LT_{50}$ values(days).**

| Conc (Spore/ml) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| $0.9 \times 10^9$ | 11.9296 | 9.9565 | 17.2461 | 1.9816±0.5815 | 2.8036±0.6314 |
| $0.9 \times 10^8$ | 12.2710 | 10.0789 | 18.8841 | 2.1517±0.5713 | 2.6158±0.6219 |
| $0.9 \times 10^7$ | 18.6705 | 11.7030 | 1716.1181 | 3.2816±0.5203 | 1.3518±0.5758 |
| $0.9 \times 10^6$ | 19.5847 | 13.3698 | 89.2160 | 2.3017±0.6176 | 2.0886±0.6681 |
| $0.9 \times 10^5$ | 25.2992 | 14.9925 | 627.0007 | 2.4662±0.6256 | 1.8058±0.6781 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

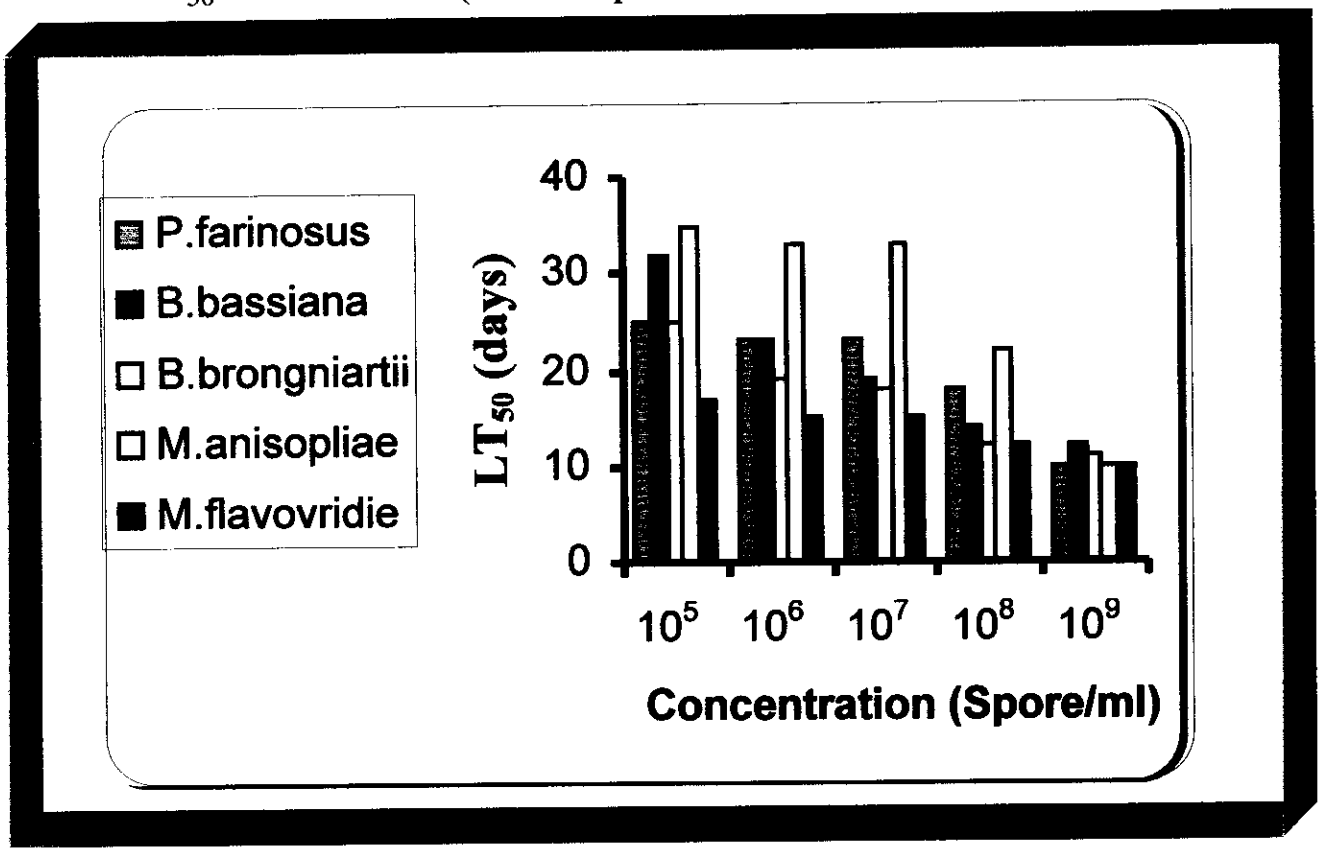



Fig (12): Relationship between different concentrations of the five tested fungi and $Lt_{50}$ values (days)

## Virulence of entomopathogenic fungi (Metabolites) against 2nd instar larvae of *S. littoralis*:-

For *M. anisopliae* (Table: 21 and Fig: 13) the mortality percentage after two days of treatment was 8.81, 8.07, 7.87, 6.81, 6.28 % for the concentrations 100, 75, 50, 25, 10 % respectively.

After four days post treatment it was 18.47, 16.07, 14.49, 13.09, 12.23 %, then ranged between 17.16 – 26.38 %, 21.33 – 32.88 %, 24.94 – 45.33 % and 28.12 – 58.97 % after 6, 8, 10 and 12 days for the same concentration mentioned above respectively. There were similarity in the mortality percentage between the two lower tested concentrations after 2, 4, 6, 8, 10 and 12 days.

**Table(21):Cummulative corrected mortality percentage of *S. littoralis* 2nd instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *M. anisopliae* at different periods.**

| Conc (%) | Cummulative mortality % indicated days after treatment | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 |
| 100 | 8.81 | 18.47 | 26.38 | 32.88 | 45.33 | 58.97 |
| 75 | 8.07 | 16.07 | 22.60 | 28.02 | 32.61 | 36.58 |
| 50 | 7.87 | 14.49 | 19.76 | 24.11 | 27.82 | 31.04 |
| 25 | 6.81 | 13.09 | 18.21 | 22.52 | 26.23 | 29.47 |
| 10 | 6.28 | 12.23 | 17.16 | 21.33 | 24.94 | 28.12 |

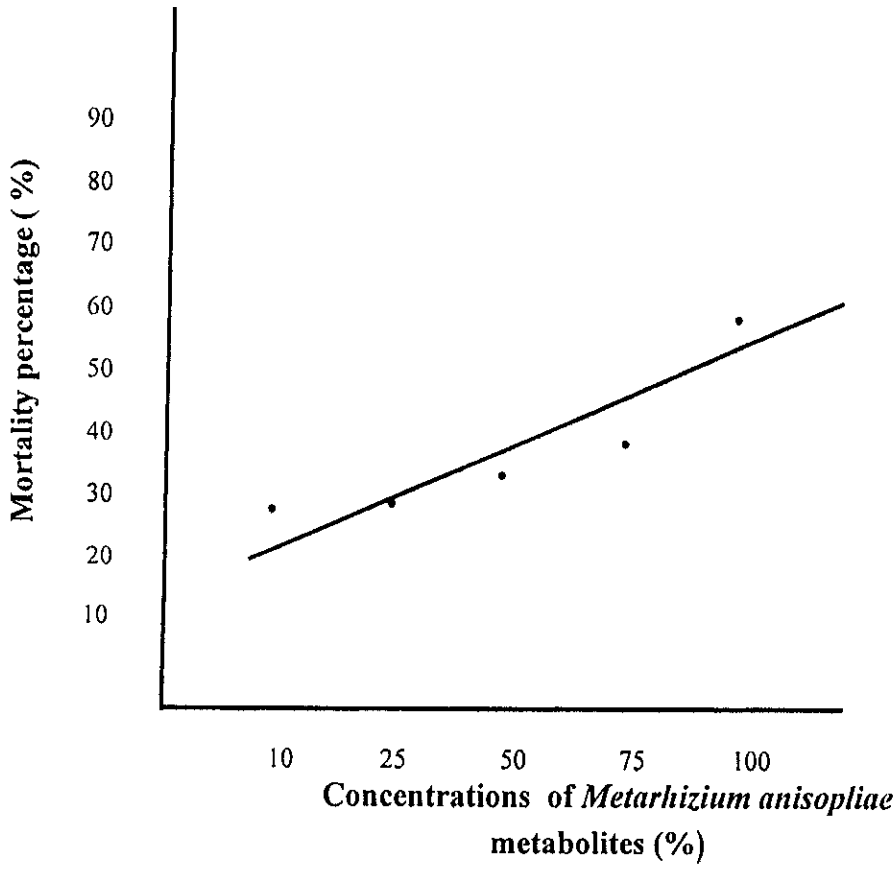



Fig. (13): Toxicity regression line of *M. anisopliae* against 2nd instar larvae of *S. littoralis* after 12 day of inoculation

Regarding *M. flavovrdiae* (Table: 22 and Fig: 14) the mortality percentage after two days of treatment was 23.18, 19.06, 16.73, 15.29, 14.84 % for the concentrations 100, 75, 50, 25, 10 % respectively, then gradual increase in mortality percentage appeared with increasing time elapsed post treatment. The mortality percentage ranged between 39.83 – 60.21 % after 12 days.

**Table(22):Cummulative corrected mortality percentage of *S. littoralis* 2nd instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *M. flavovrdiae* at different periods.**

| Conc (%) | Cummulative mortality % indicated days after treatment | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 |
| 100 | 23.18 | 34.86 | 42.55 | 48.21 | 52.62 | 60.21 |
| 75 | 19.06 | 31.10 | 39.38 | 45.59 | 50.50 | 54.50 |
| 50 | 16.73 | 26.13 | 32.68 | 37.69 | 41.73 | 45.10 |
| 25 | 15.29 | 24.39 | 30.74 | 35.65 | 39.63 | 42.97 |
| 10 | 14.84 | 22.98 | 28.72 | 33.16 | 36.78 | 39.83 |

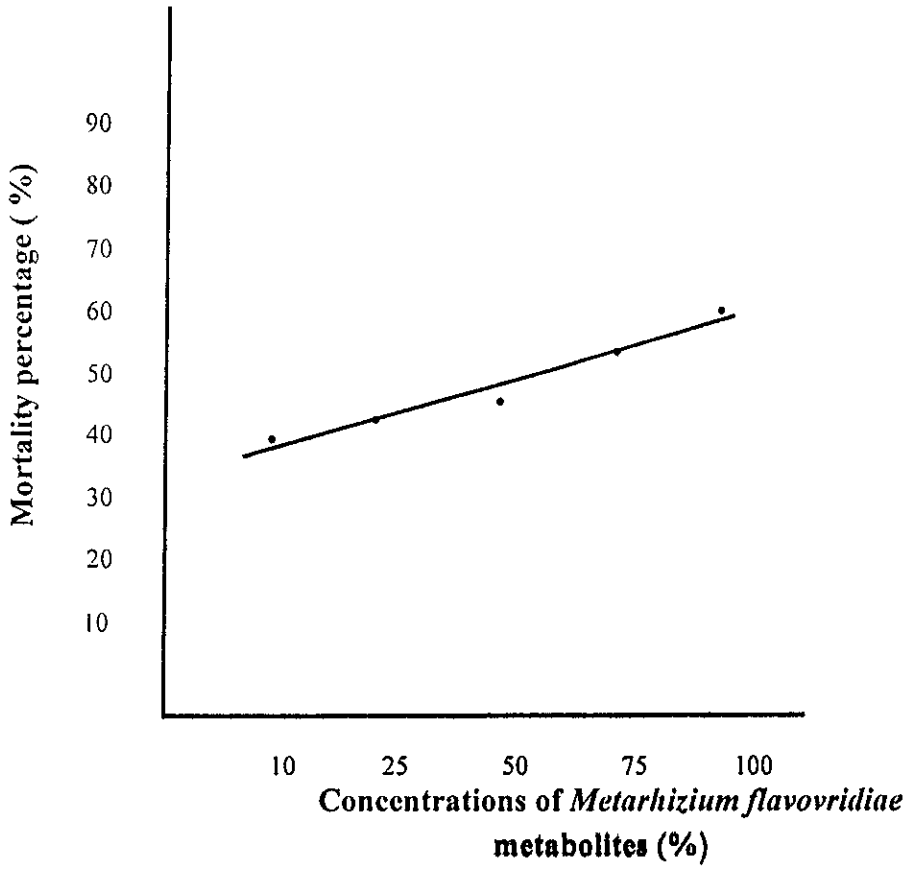



Fig. (14): Toxicity regression line of *M. flavovridiae* against 2nd instar larvae of *S. littoralis* after 12 day of inoculation

As for *P. farinosus* (Table: 23 and Fig: 15 ) the mortality percentage after two days post treatment was 22.70, 16.45, 12.23, 9.73, 6.73 % for the concentrations 100, 75, 50, 25, 10 % respectively. There were increasing in mortality percentage from $4^{th}$ to $12^{th}$ days ranged between 14.39 – 36.88 %, 20.91 – 46.30 %, 26.44 – 53.14 %, 31.20 – 58.39 and 35.33 – 59.58 % for the same concentration mentioned above respectively.

**Table(23):Cummulative corrected mortality percentage of *S. littoralis* 2nd instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *P. farinosus* at different periods.**

| Conc (%) | Cummulative mortality % indicated days after treatment | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 |
| 100 | 22.70 | 36.88 | 46.30 | 53.14 | 58.39 | 59.58 |
| 75 | 16.45 | 26.21 | 33.05 | 38.29 | 42.51 | 46.03 |
| 50 | 12.23 | 22.20 | 29.72 | 35.67 | 40.55 | 44.66 |
| 25 | 9.73 | 18.51 | 25.41 | 31.01 | 35.70 | 39.70 |
| 10 | 6.73 | 14.39 | 20.91 | 26.44 | 31.20 | 35.33 |

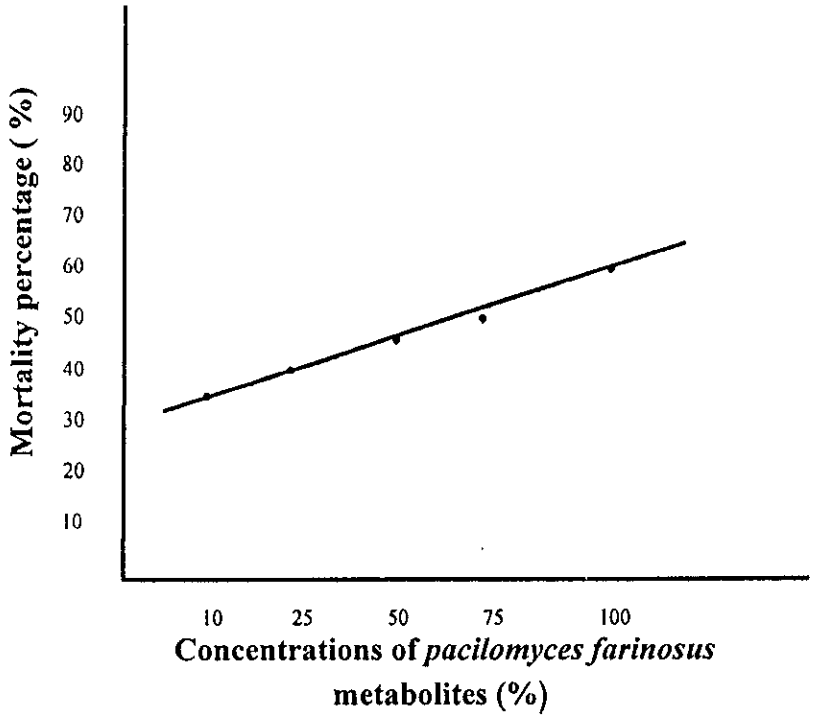



Fig. (15): Toxicity regression line of *P. farinosus* against 2nd instar larvae of *S. littoralis* after 12 day of inoculation

Taking into account the mortality percentage of *B. bassiana* as shown in table (24) and fig (16) after two days of treatment was 12.48, 9.64, 10.01, 7.53, 5.48 % for the concentrations 100, 75, 50, 25, 10 % respectively. The mortality percentage reached 50 % after 12 days at the four highest tested concentrations, generally it ranged between 15.05 – 26.73 %, 24.09 – 37.79 %, 31.97 – 46.38 %, 38.73 – 53.18 % and 44.53 – 55.68 % after 4, 6, 8, 10 and 12 days.

**Table(24):Cummulative corrected mortality percentage of *S. littoralis* 2nd instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *B. bassiana* at different periods.**

| Conc(%) | Cummulative mortality % indicated days after treatment | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 |
| 100 | 12.48 | 26.73 | 37.79 | 46.38 | 53.18 | 55.68 |
| 75 | 9.64 | 22.07 | 32.33 | 40.62 | 47.37 | 52.95 |
| 50 | 10.01 | 21.73 | 31.23 | 38.90 | 45.18 | 50.41 |
| 25 | 7.53 | 19.15 | 29.40 | 37.93 | 45.01 | 50.93 |
| 10 | 5.48 | 15.05 | 24.09 | 31.97 | 38.73 | 44.53 |

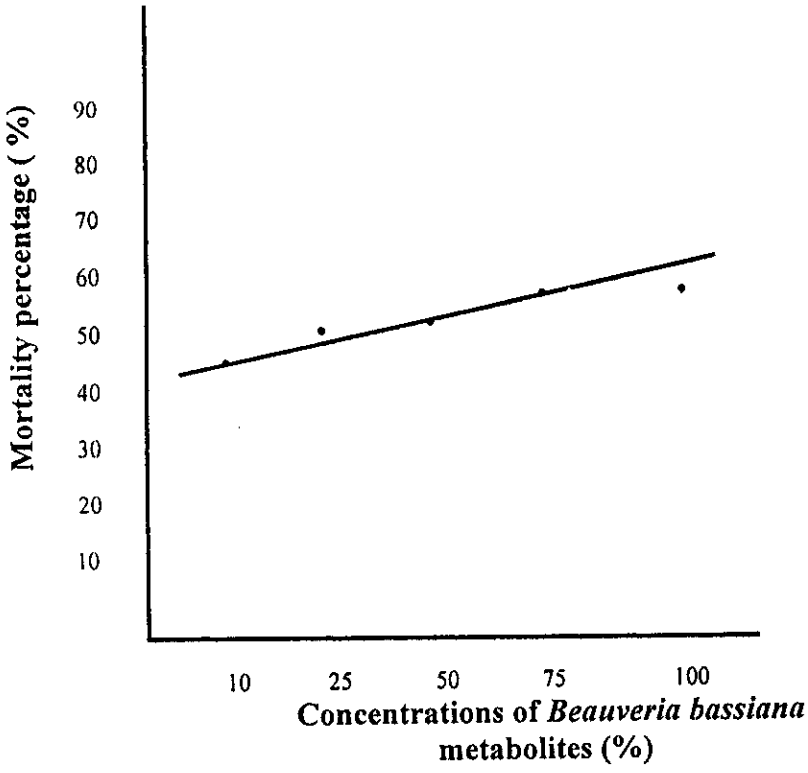



Fig. (16): Toxicity regression line of *B. bassiana* against 2nd instar larvae of *S littoralis* after 12 day of inoculation.

In addition to the mortality percentage of *B. brongniartti* (Table: 25 and Fig: 17) was lower than 10 % at the three lower tested concentrations after 2 days, also it was almost the same at the two highest tested concentrations after 12 days. The mortality percentage ranged between 36.22 – 57.77 % after 12 days.

**Table(25):Cummulative corrected mortality percentage of *S. littoralis* 2nd instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *B. brongniartti* at different periods.**

| Conc (%) | Cummulative mortality % indicated days after treatment | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 |
| 100 | 17.10 | 30.96 | 40.84 | 48.26 | 54.08 | 57.77 |
| 75 | 10.06 | 23.66 | 34.85 | 43.78 | 50.96 | 56.81 |
| 50 | 7.59 | 17.86 | 26.73 | 34.15 | 40.38 | 45.68 |
| 25 | 5.54 | 14.42 | 22.66 | 29.83 | 36.02 | 41.38 |
| 10 | 3.70 | 10.90 | 18.21 | 24.92 | 30.91 | 36.22 |

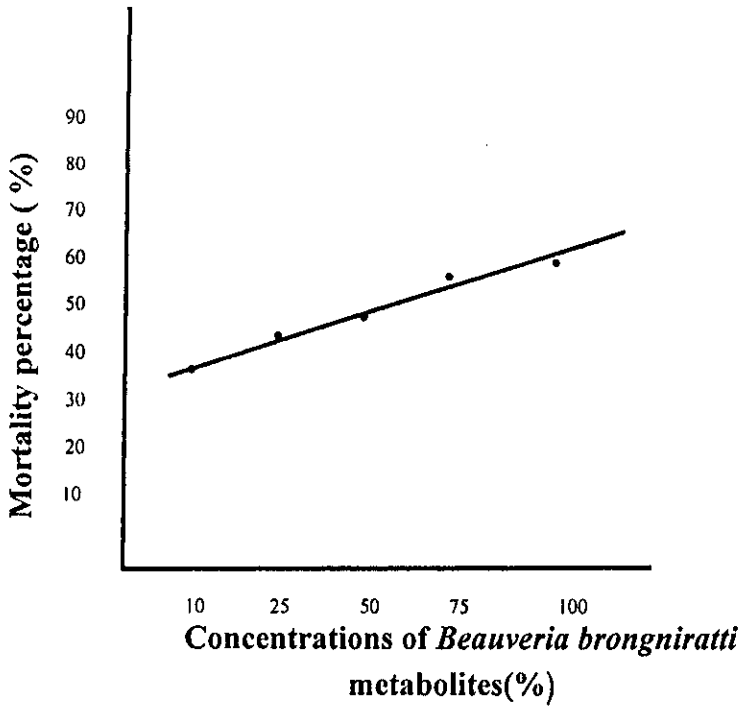



Fig. (17): Toxicity regression line of *B. brongniratti* against 2nd instar larvae of *S. littoralis* after 12 day of inoculation

Generally *M. flavovridae* was found to be the most effective isolate against 2nd instar larvae of *S. littoralis* followed by *P. farinosus*, *M. anisopliae*, *B. brongniartti* then *B. bassiana* respectively .

Data in table 26,27,28,29&30 and fig 18 show that $LT_{50}$ values for *M. anisopliae* (Table: 26 and Fig: 18) were 8.55, 21.45, 31.47, 33.20, 35.69 days for the concentrations 100, 75, 50, 25, 10 % respectively, regarding *M. flavovridae* (Table: 27 and Fig: 18) $LT_{50}$ values were 7.75, 9.77, 15.59, 17.48, 21.59 days for the same concentrations respectively.

As for *P. farinosus* (Table: 28 and Fig: 18) $LT_{50}$ values ranged between 8 - 21 days for the concentrations 100, 75, 50, 25, 10 % respectively, in case of *B. bassiana* (Table: 29 and Fig: 18) they ranged between 9 - 14 days, while *B. brongniartti* (Table: 30 and Fig: 18) they ranged between 9 - 18 days for the same concentrations mentioned above respectively.

**Table (26): Virulence of *M. anisopliae* against the 2nd instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (%) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a | b |
|---|---|---|---|---|---|
| | | Lower | Upper | Intercept | Slope |
| 100 | 8.5507 | 7.9704 | 26.0047 | 3.1931±0.2305 | 1.5102±0.2672 |
| 75 | 21.4539 | 14.7664 | 47.6672 | 3.1902±0.2368 | 1.3592±0.2738 |
| 50 | 31.4725 | 18.5420 | 122.8217 | 3.2304±0.2403 | 1.1814±0.2783 |
| 25 | 33.2024 | 19.3671 | 132.9200 | 3.1426±0.2486 | 1.2211±0.2866 |
| 10 | 35.6917 | 20.2955 | 157.7143 | 3.0997±0.2539 | 1.2240±0.2920 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (27): Virulence of *M. flavovridae* against the 2nd instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (%) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a | b |
|---|---|---|---|---|---|
| | | Lower | Upper | Intercept | Slope |
| 100 | 7.7531 | 6.9250 | 12.5802 | 3.9229±0.1920 | 1.1429±0.2306 |
| 75 | 9.7775 | 7.8178 | 13.9799 | 3.7420±0.1981 | 1.2704±0.2362 |
| 50 | 15.5994 | 11.0347 | 33.6236 | 3.7095±0.2035 | 1.0817±0.2413 |
| 25 | 17.4876 | 12.0216 | 41.4331 | 3.6541±0.2069 | 1.0830±0.2447 |
| 10 | 21.5993 | 13.7183 | 69.9488 | 3.6525±0.2089 | 1.0098±0.2469 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (28): Virulence of *P. farinosus* against the 2nd instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (%) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a | b |
|---|---|---|---|---|---|
| | | Lower | Upper | Intercept | Slope |
| 100 | 8.0113 | 5.7761 | 8.7763 | 3.8374±0.1926 | 1.3745±0.2319 |
| 75 | 14.7096 | 10.6575 | 29.0324 | 3.6850±0.2039 | 1.1262±0.2417 |
| 50 | 15.1604 | 11.3217 | 26.6799 | 3.4379±0.2157 | 1.3230±0.2530 |
| 25 | 18.8480 | 13.3725 | 38.3966 | 3.3024±0.2268 | 1.3312±0.2639 |
| 10 | 21.9149 | 15.1839 | 47.3900 | 3.0708±0.2465 | 1.4389±0.2833 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (29): Virulence of *B. bassiana* against the 2nd instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (%) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| 100 | 9.5097 | 7.6721 | 11.1732 | 3.3186±0.2132 | 1.7611±0.2510 |
| 75 | 10.8973 | 9.1046 | 14.2567 | 3.1654±0.2244 | 1.7686±0.2613 |
| 50 | 11.8317 | 9.6705 | 16.3043 | 3.2199±0.2232 | 1.6596±0.2600 |
| 25 | 11.6621 | 9.7412 | 15.3312 | 2.9972±0.2360 | 1.8774±0.2724 |
| 10 | 14.2017 | 11.4767 | 20.2205 | 2.8342±0.2536 | 1.8795±0.2893 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (30): Virulence of *B. brongniartti* against the 2nd instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (%) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| 100 | 9.1516 | 7.1336 | 10.9303 | 3.5965±0.2016 | 1.5058±0.2399 |
| 75 | 9.7077 | 8.2804 | 12.0920 | 3.1610±0.2221 | 1.8630±0.2594 |
| 50 | 13.8989 | 11.0965 | 20.3319 | 3.0543±0.2369 | 1.7023±0.2732 |
| 25 | 15.9318 | 12.4496 | 24.6064 | 2.8732±0.2542 | 1.7690±0.2900 |
| 10 | 18.6407 | 14.1271 | 31.2047 | 2.6585±0.2796 | 1.8430±0.3150 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

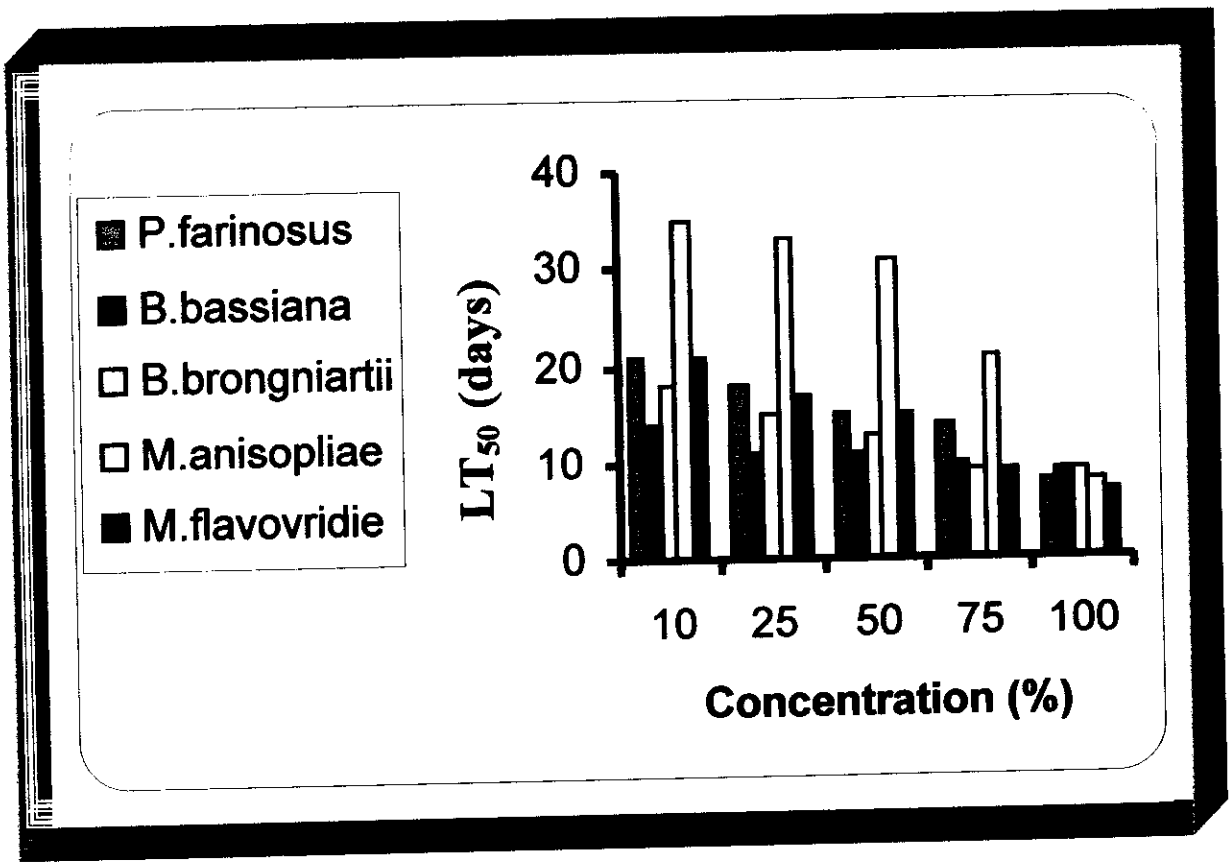



Fig (18) Relationship between different concentrations of the five tested fungi and $LT_{50}$values (days).

## Virulence of entomopathogenic fungi (Metabolites) against 4th instar larvae of *S. littoralis*:-

For *M. anisopliae* (Table: 31 and Fig: 19) the mortality percentage after four days of treatment was 11.19, 9.54, 7.93, 5.71, 5.04 % for the concentrations 100, 75, 50, 25, 10 % respectively. There were difference in mortality percentage at the three lower tested concentrations after 4, 6, 8 and 10 days. Although the mortality percentage was different at the two highest tested concentrations after 4, 6 and 8 days but it was almost the same after 10 days.

**Table(31):Cummulative corrected mortality percentage of *S. littoralis* 4th instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *M. anisopliae* at different periods.**

| Conc (%) | Cummulative mortality % indicated days after treatment | | | |
|---|---|---|---|---|
| | 4 | 6 | 8 | 10 |
| 100 | 11.19 | 22.09 | 32.57 | 42.81 |
| 75 | 9.54 | 18.45 | 27.19 | 42.19 |
| 50 | 7.93 | 15.41 | 22.91 | 36.29 |
| 25 | 5.71 | 12.58 | 20.06 | 34.22 |
| 10 | 5.04 | 10.97 | 17.48 | 30.06 |

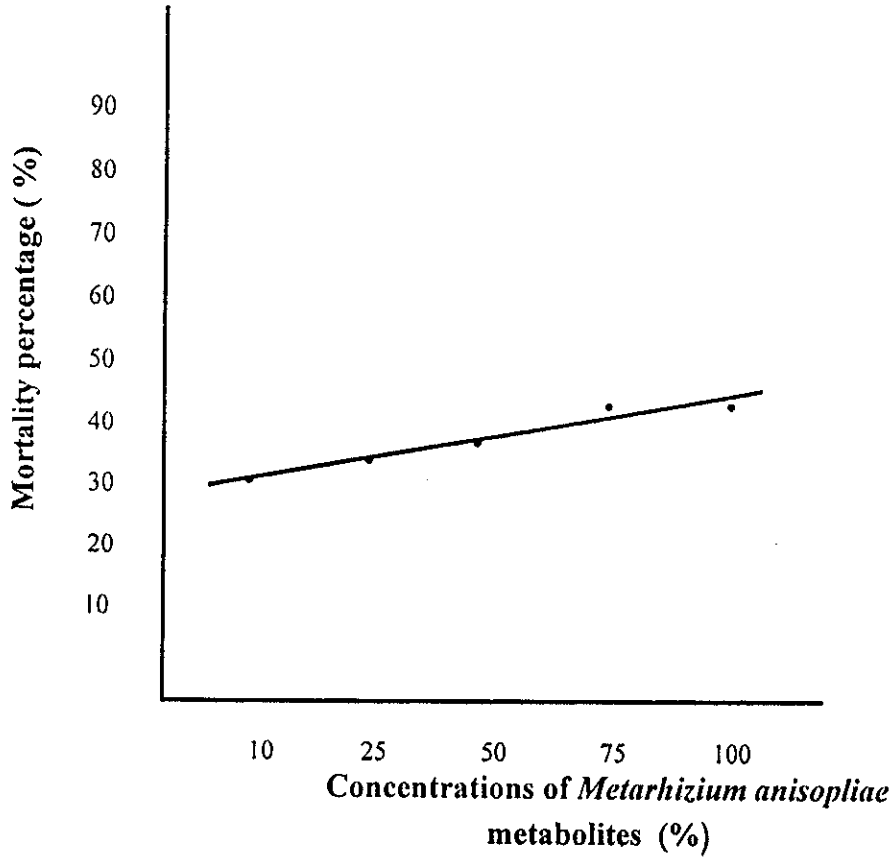



Fig. (19): Toxicity regression line of *M. anisopliae* against 4$^{th}$ instar larvae of *S. littoralis* after 10 days of inoculation.

Regarding *M. flavovrdiae* data in Table (32) and Fig (20) show that the mortality percentage after four days of treatment was 21.59, 17.63, 12.67, 10.15, 4.26 % for the concentrations 100, 75, 50, 25, 10 % respectively, then increased to ranged between 10.86 – 32.37 %, 18.72 – 41.14 % and 34.42 – 54.17 % after 6, 8 and 10 days.

**Table(32):Cummulative corrected mortality percentage of *S. littoralis* 4th instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *M. flavovrdiae* at different periods.**

| Conc (%) | Cummulative mortality % indicated days after treatment | | | |
|---|---|---|---|---|
| | 4 | 6 | 8 | 10 |
| 100 | 21.59 | 32.37 | 41.14 | 54.17 |
| 75 | 17.63 | 28.07 | 36.94 | 50.60 |
| 50 | 12.67 | 20.95 | 28.38 | 40.60 |
| 25 | 10.15 | 17.39 | 24.13 | 35.64 |
| 10 | 4.26 | 10.86 | 18.72 | 34.42 |

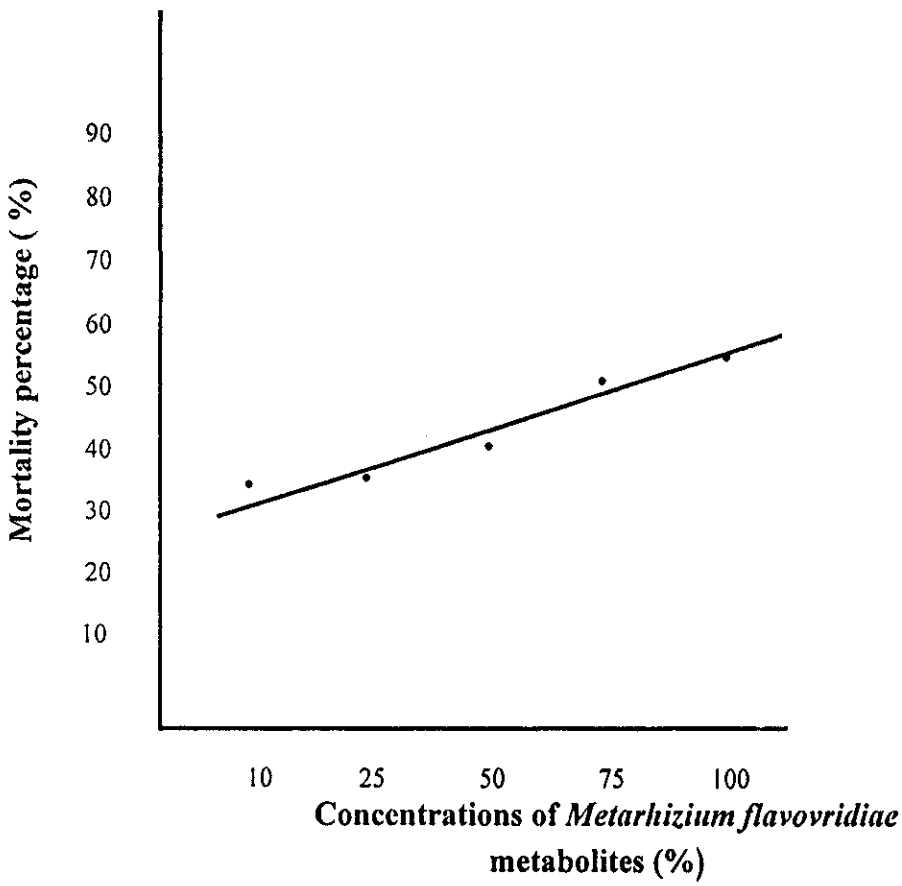



Fig. (20): Toxicity regression line of *M. flavovridiae* against 4th instar larvae of *S. littoralis* after 10 days of inoculation

As well as *P. farinosus* (Table: 33 and Fig: 21 ) the mortality percentage increased from the 4th to the 10th day to be ranged between 2.64 – 14.68 %, 5.92 – 22.34 %, 9.76 – 35.92 % and 17.86 – 45.00 % after 4, 6, 8 and 10 days.

**Table(33):Cummulative corrected mortality percentage of *S. littoralis* 4th instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *P. farinosus* at different periods.**

| Conc (%) | Cummulative mortality % indicated days after treatment | | | |
|---|---|---|---|---|
| | 4 | 6 | 8 | 10 |
| 100 | 14.68 | 22.34 | 35.92 | 45.00 |
| 75 | 7.29 | 12.65 | 17.83 | 27.09 |
| 50 | 4.73 | 9.48 | 14.52 | 24.27 |
| 25 | 5.02 | 9.27 | 13.61 | 21.79 |
| 10 | 2.64 | 5.92 | 9.76 | 17.86 |

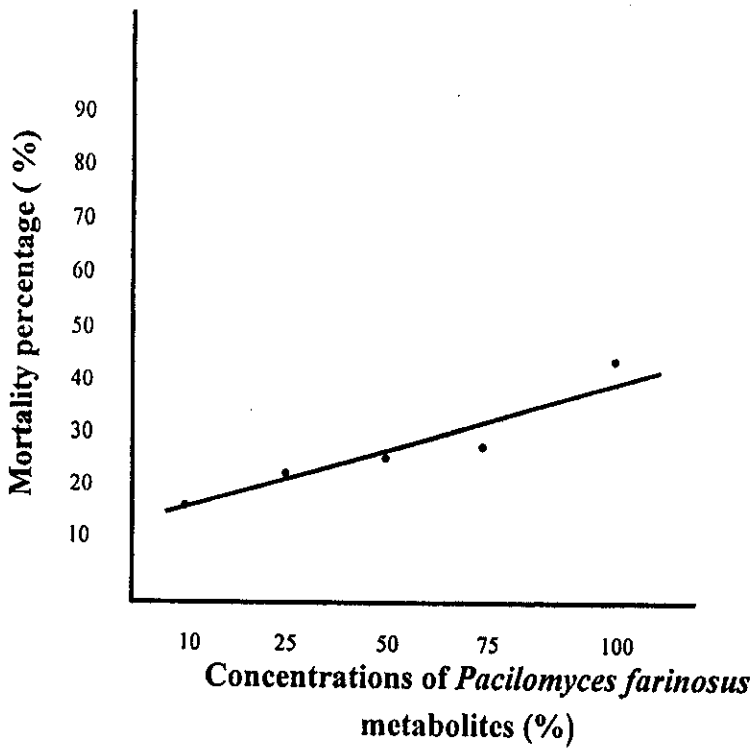



Fig. (21): Toxicity regression line of *P. farinosus* against 4th instar larvae of *S. littoralis* after 10 days of inoculation

Taking into account *B. bassiana* as shown in table: 34 and fig: 22 the mortality percentage was lower than 10 % at the two lower tested concentrations after 4 and 6 days but it ranged between 10.40 – 12.46 % and 17.96 – 21.12 % after 8 and 10 days for the same concentrations. The mortality percentage ranged between 26.45 – 38.78 % after 10 days at the three highest tested concentrations.

**Table(34):Cummulative corrected mortality percentage of *S. littoralis* 4th instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *B. bassiana* at different periods.**

| Conc (%) | Cummulative mortality % indicated days after treatment | | | |
|---|---|---|---|---|
| | 4 | 6 | 8 | 10 |
| 100 | 10.83 | 18.81 | 26.24 | 38.78 |
| 75 | 8.81 | 14.59 | 19.96 | 29.29 |
| 50 | 6.99 | 12.22 | 17.30 | 26.45 |
| 25 | 4 | 8.07 | 12.46 | 21.12 |
| 10 | 3.26 | 6.66 | 10.40 | 17.96 |

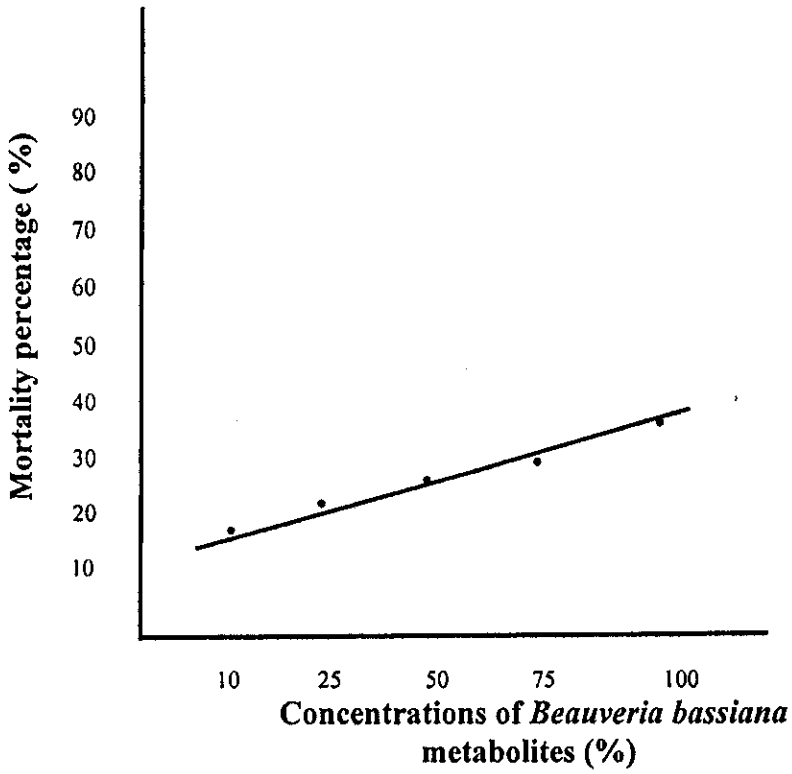



Fig. (22):Toxicity regression line of *B. bassiana* against 4th instar larvae of *S. littoralis* after 10 days of inoculation

In addition to the mortality percentage of *B. brongniartti* (Table: 35 and Fig: 23 ) after four days post treatment was 15.82, 12.56, 7.85, 5.58, 4.57 % for the concentrations 100, 75, 50, 25, 10 % respectively. Through the period between the 6$^{th}$ and the 10$^{th}$ day post treatment there were gradual increase in mortality percentage ranged between 8.30 – 22.37 %, 12.09 – 27.83 % and 19.28 – 36.48 % after 6, 8 and 10 days.

**Table(35):Cummulative corrected mortality percentage of *S. littoralis* 4$^{th}$ instar larvae after feeding on treated castor bean leaves immersed in different concentrations of *B. brongniartti* at different periods.**

| Conc (%) | Cummulative mortality % indicated days after treatment | | | |
|---|---|---|---|---|
| | 4 | 6 | 8 | 10 |
| 100 | 15.82 | 22.37 | 27.83 | 36.48 |
| 75 | 12.56 | 19.05 | 24.71 | 34.00 |
| 50 | 7.85 | 13.72 | 19.38 | 29.41 |
| 25 | 5.58 | 10.33 | 15.15 | 24.14 |
| 10 | 4.57 | 8.30 | 12.09 | 19.28 |

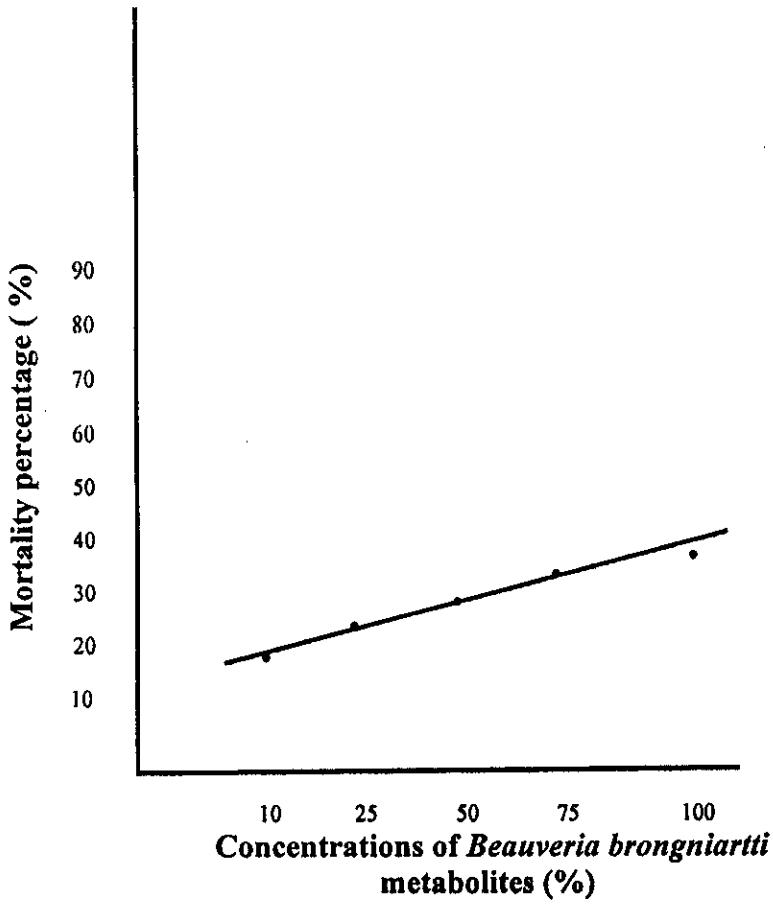



Fig. (23)Toxicity regression line of *B. brongniartti* against 4th instar larvae of *S. littoralis* after 10 days of inoculation

Generally *M. flavovridae* was found to be the most effective isolate against 4th instar larvae of *S. littoralis* followed by *p. farinosus*, *M. anisopliae*, *B. bassiana* then *B. brongniartti* respectively .

Data in table 36,37,38,39&40 and fig 24 show that $LT_{50}$ values for *M. anisopliae* (Table: 36 and Fig: 24) were 14.02, 14.57, 17.26, 17.56, 20.04 days for the concentrations 100, 75, 50, 25, 10 % respectively, while $LT_{50}$ values for *M. flavovridae* (Table: 37 and Fig: 24) were 10.54, 11.79, 16.02, 18.75, 16.75 days for the same concentrations respectively. Regarding *P. farinosus* (Table: 38 and Fig: 24) $LT_{50}$ values ranged between 14 - 32 days for the concentrations 100, 75, 50, 25, 10 % respectively, as for *B. bassiana* (Table: 39 and Fig: 24) they ranged between 16 – 35 days, in addition *B. brongniartti*(Table: 40 and Fig: 24) they ranged between 21 - 38 days for the same concentrations mentioned above respectively.

**Table (36): Virulence of *M. anisopliae* against the 4th instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (%) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a | b |
|---|---|---|---|---|---|
| | | Lower | Upper | Intercept | Slope |
| 100 | 14.0217 | 9.8903 | 18.5930 | 2.2547±0.5611 | 2.5395±0.6124 |
| 75 | 14.5785 | 11.2469 | 30.1046 | 2.2890±0.5813 | 2.3296±0.6317 |
| 50 | 17.2684 | 12.5032 | 51.1030 | 2.2539±0.6068 | 2.2195±0.6568 |
| 25 | 17.5623 | 12.8766 | 46.8345 | 1.9406±0.6500 | 2.4582±0.6976 |
| 10 | 20.0477 | 13.8588 | 78.7476 | 1.9473±0.6731 | 2.3445±0.7208 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (37): Virulence of *M. flavoviridae* against the 4th instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (%) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a | b |
|---|---|---|---|---|---|
| | | Lower | Upper | Intercept | Slope |
| 100 | 10.5456 | 8.4026 | 18.4858 | 3.0899±0.5038 | 1.8670±0.5596 |
| 75 | 11.7909 | 9.3193 | 22.1959 | 2.8786±0.5196 | 1.9797±0.5740 |
| 50 | 16.0211 | 11.5293 | 55.3513 | 2.7171±0.5529 | 1.8950±0.6058 |
| 25 | 18.7566 | 12.7585 | 97.5002 | 2.5848±0.5795 | 1.8970±0.6317 |
| 10 | 16.7536 | 12.7300 | 36.5896 | 1.6133±0.6895 | 2.7667±0.7343 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (38): Virulence of *P. farinosus* against the 4th instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (%) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a | b |
|---|---|---|---|---|---|
| | | Lower | Upper | Intercept | Slope |
| 100 | 14.4374 | 11.7939 | 129.2273 | 2.9612±0.5396 | 1.6423±0.5937 |
| 75 | 26.5380 | 15.3064 | 1059.8214 | 2.4794±0.6289 | 1.7702±0.6817 |
| 50 | 26.3749 | 15.7186 | 488.9356 | 2.1005±0.6934 | 2.0402±0.7435 |
| 25 | 32.3587 | 16.9621 | 9533.1600 | 2.2682±0.6907 | 1.8092±0.7433 |
| 10 | 32.4982 | 17.4438 | 5057.3194 | 1.7831±0.8087 | 2.1278±0.8573 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (39): Virulence of *B. bassiana* against the 4th instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (%) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| 100 | 16.6792 | 11.9646 | 56.0766 | 2.5646±0.5701 | 1.9927±0.6221 |
| 75 | 25.1902 | 14.7280 | 973.9752 | 2.6291±0.6024 | 1.6920±0.6558 |
| 50 | 27.1486 | 15.4995 | 1273.3758 | 2.4542±0.6354 | 1.7757±0.6881 |
| 25 | 30.3917 | 16.7661 | 2188.2806 | 2.0527±0.7272 | 1.9877±0.7778 |
| 10 | 35.5735 | 17.9018 | 41565.9137 | 1.9869±0.7714 | 1.9425±0.8226 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

**Table (40): Virulence of *B. brongniartti* against the 4th instar larvae of *S. littoralis* expressed as $LT_{50}$ values (days).**

| Conc (%) | $LT_{50}$ (days) | 95% (fiducial limit ) | | a Intercept | b Slope |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| 100 | 21.3991 | 12.7297 | 4704.9391 | 3.1698±0.5347 | 1.3757±0.5901 |
| 75 | 22.2276 | 13.4151 | 922.2418 | 2.9253±0.5586 | 1.5403±0.6130 |
| 50 | 23.7037 | 14.5174 | 367.2847 | 2.4818±0.6162 | 1.8317±0.6685 |
| 25 | 28.5660 | 16.0741 | 1507.9118 | 2.2871±0.6700 | 1.8634±0.7220 |
| 10 | 38.3324 | 18.0985 | 1.47888E+06 | 2.2759±0.7121 | 1.7202±0.7660 |

$LT_{50}$ : Lethal time ( time required to kill 50% of larvae).

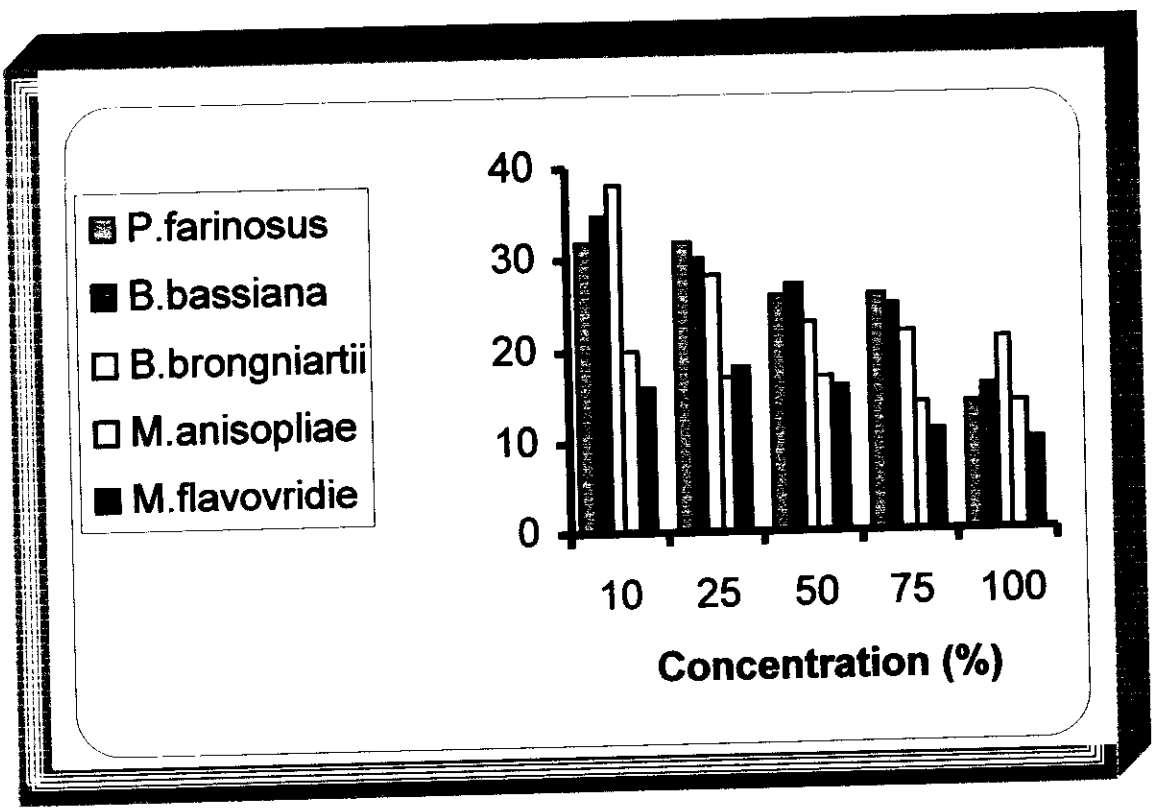



Fig (24) Relationship between different concentrations of the five tested fungi and $LT_{50}$ values (days).

**Fig (25): Malformations induced by M. anisopliae in several stages of cotton leaf worm S. littoralis.**

**Normal larvae**

**Malformation showing intermediate stage between 5th and 6th larval instars showing old and dark exuvium**

**Normal pupae**

**Pupal-moth intermediate stage (pupae failed to be moth ), malformed pupae with small fragment of moth**

**Normal adult**

**Malformation of moth included crumpled wings and frizzled abdomen**

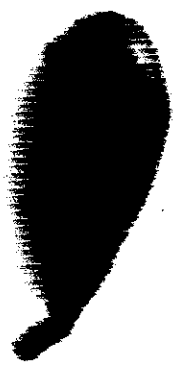
**Fig (26): Malformations induced by *M. flavovridae* in several stages of cotton leaf worm *S. littoralis*.**

**Normal larvae**

**Malformation showing small crumpled and frizzled larvae**

**Normal pupae**

**Malformation showing abnormal pupae attached with moth**



**Malformed pupae showed body shrankage**

**Normal adult**

**Malformation showing small size moth without wings**

**Fig (27): Malformations induced by B. brongniartii in several stages of cotton leaf worm S. littoralis.**

**Normal larvae**

**Malformation showing small and frizzled larvae**

**Normal pupae**

**Malformation showing moth failed in emerging from pupal case**

**Normal adult**

**Malformation showing small moth with twisted wings**

**Fig (28): Malformations induced by B.bassiana in several stages of cotton leaf worm S. littoralis.**

**Normal larvae**

**Malformation showing frizzled and dark larvae**

**Normal pupae**

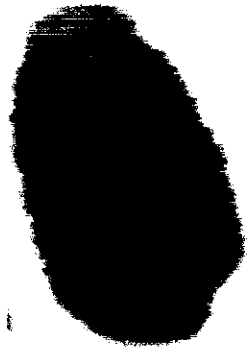
**Malformed pupae showed the growth of the fungus on the surface of pupae**

**Normal adult**

**Malformation show frizzled moth**

**Fig (29): Malformations induced by P. farinosus in several stages of cotton leaf worm S. littoralis.**

**Normal larvae**



**Malformation showing dwarfism larvae**

**Normal pupae**

**Malformation showing intermediate stage between pupae and moth (Pupal-moth**

## Molecular characterization

### a- Random Amplified Polymorphic DNA-Polymerase Chain Reaction (RAPD – PCR) profiles

The five primers amplified 227 DNA fragments including 45 non polymorphic fragments, thus 182 fragments (80%) were polymorphic in one or the other of the 5 genotypes (table: 41).

The different primers revealed different levels of polymorphism among the 5 entomopathogenic fungi genotypes (Fig 30, 31, 32, 33 and 34).

The highest number of amplified fragments was 59 with the primer **OPE 20**, while the lowest was 25 with the primer **OPA 20** (Table 41).

The number of polymorphic amplicons per primer ranged from 30 (Primer **OPA 13**) to 49 (Primer **OPE 20**).

The average number of amplified fragment per primer across the 5 genotypes was 45 and the average of polymorphic amplified fragment was 36. If the primer producing the highest number of reproducible polymorphic amplicons (high level of polymorphism) were considered the best, then this will apply to **OPE 20, OPD 08, OPD 07, OPA 13** and **OPA 20** since they produced 49, 44, 44, 30 and 15 polymorphic amplicons from total of 59, 54, 44, 45 and 25 fragments respectively (table : 41).

***1- OPA 13 primer***

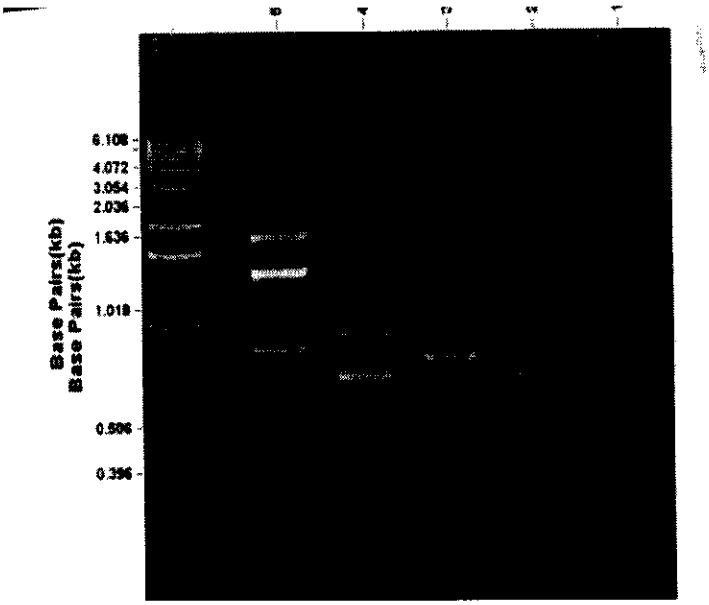



**Fig (30)**

***2-OPA 20* primer**

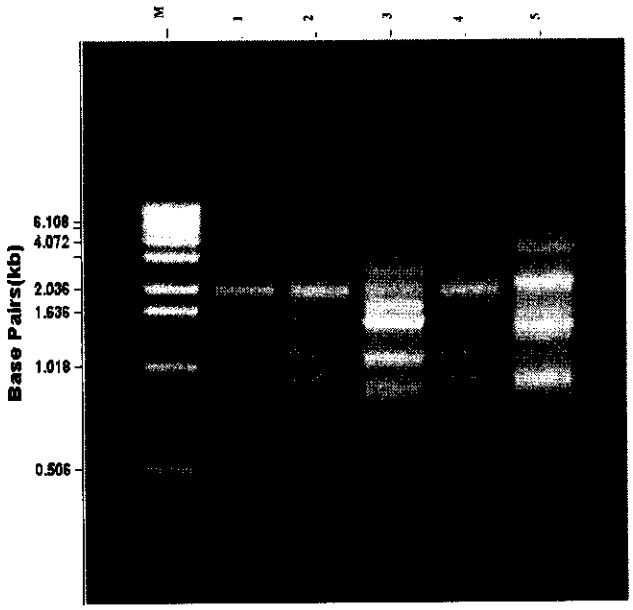



**Fig (31)**

***3-OPD 07 Primer***

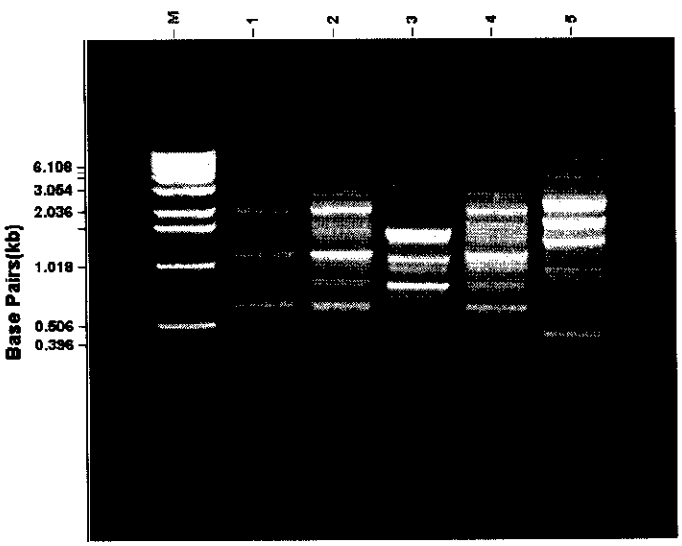



**Fig (32)**

**RAPD profiles of different isolates of entomopathogenic fungi using the primer OPA 13, OPA 20 and OPD 07.Lane 1, *Beauveria bassiana*; Lane 2, *Beauveria brongniartti;* Lane 3, *Pacilomyces farinosus*; Lane 4, *Metarhizium flavovrdiae*; Lane 5, *Metarhizium anisopliae*; Lane M, DNA marker.**

## *4-OPD 08 Primer*

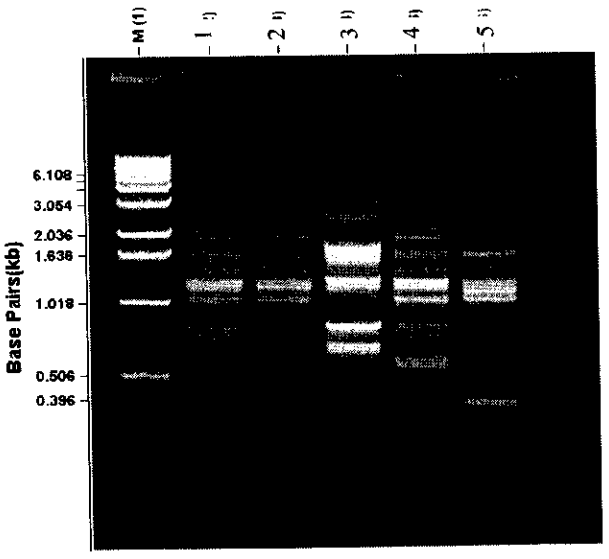



Fig (33)

## *5-OPE 20 Primer*

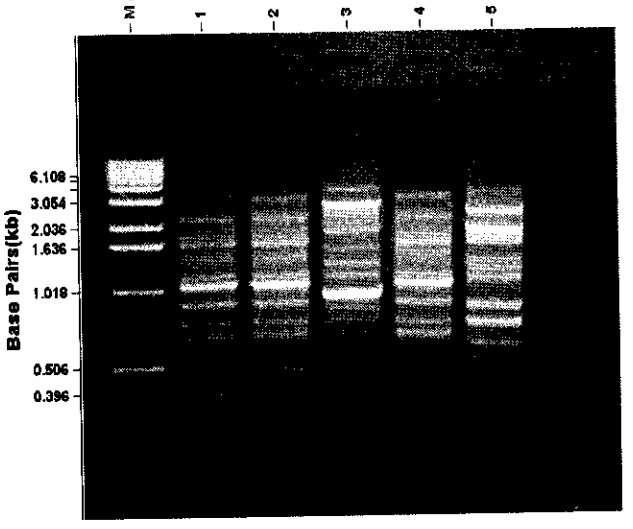



Fig (34)

**RAPD profiles of different isolates of entomopathogenic fungi using the primer OPD08 and OPE 20.Lane 1, *Beauveria bassiana*; Lane 2, *Beauveria brogniartti;* Lane 3, *Pacilomyces farinosus*; Lane 4, *Metarhizium flavovrdiae*; Lane 5, *Metarhizium anisopliae*; Lane M, DNA marker.**

**Table (41) Number of amplicons and the number of polymorphic bands releaved by each RAPD – primer for the five tested fungi.**

| Primers | Number of amplicons | Polymorphic amplicons | Percentage of polymorphism % |
|---|---|---|---|
| **OPA 13** | 45 | 30 | 66 |
| **OPA 20** | 25 | 15 | 60 |
| **OPD 07** | 44 | 44 | 1 |
| **OPD08** | 54 | 44 | 81 |
| **OPE 20** | 59 | 49 | 83 |

## b- Sodium Dodecyle Sulfate Polyacrylamide Gel Electrophoresis (SDS – PAGE) analysis of total cellular proteins

Total cellular proteins of entomopathogenic fungi isolates *B. brongniartti, B. bassiana, M. anisopliae, M. flavovrdiae* and *P. farinosus* were fractionated on denaturing gels by electrophoresis ( Sodium - Dodecyl Sulfate Polyacrylamide Gel Electrophoresis, SDS – PAGE (Fig 35) ) **(Laemmli, 1970).** Comparison of protein patterns from *B. brongniartti* and *B. bassiana* revealed that 10 common bands { No. 1, 5, 6, 8, 9, 11, 12, 13, 15, 19 with Rf (0.037, 0.278, 0.324, 0.377, 0.412, 0.486, 0.53, 0.561, 0.652, 0.921), ( 0.036, 0.283, 0.327, 0.375, 0.408, 0.49, 0.535, 0.561, 0.648, 0.917) and MW ( 183.617, 102.972, 92.79, 78.009, 69.487, 56.425, 49.972, 45.819, 35.524, 17.44 KDa), ( 184.437, 101.773, 91.103, 77.837, 69.676, 57.15, 49.979, 46.332, 36.911, 17.3 KDa)} and band No 2 with M.W (136.21 KDa) and Rf (0.16) was characteristic band for *B. bassiana*, while bands No 3, 4 and 10 with M.W (123.908, 111.657,62.98 KDa) and Rf (0.198, 0.238, 0.447) were characteristic bands for B. *brogniartti* (Table 42,43 and 44).

In case of *M. anisopliae* and *M. flavovrdiae* there were 3 common bands { No. 1, 15, 19 with Rf ( 0.039, 0.65, 0.915), ( 0.036, 0.652, 0.915) and MW ( 184.092, 36.808, 17.245 KDa), ( 182.15, 37.095, 17.085 KDa)} respectively, and bands No 5, 9, 10, 11, 12, 16, 17 and 18 with M.W (100.511, 72.096, 64.538, 58.109, 52.017, 32.065, 27.395, 24.667 KDa) and Rf (0.278, 0.406, 0.448, 0.488, 0.527, 0.702, 0.755, 0.791) were characteristic bands for *M. flavovrdiae*, while bands No 7 and 8 with M.W (87.261, 79.024 KDa) and Rf (0.336, 0.369) were characteristic bands for *M. anisopliae* (Table 42,43 and 44).

In addition to, bands No. 1, 15, 19 were detected in *B. brogniartti, B. bassiana, M.anisopliae* and *M. flavovrdiae* with Rf {(0.037, 0.652, 0.921), (0.036, 0.648, 0.917), (0.039, 0.65, 0.915), ( 0.036, 0.652, 0.915 ) and MW ( 183.617, 35.524, 17.44 KDa), (184.437, 36.911, 17.3 KDa), (184.092, 36.808, 17.245 KDa), ( 182.15, 37.095, 17.085 KDa)} respectively. Band No. 8 with Rf { (0.377), (0.375), (0.369), (0.381) and MW (78.009 KDa), (77.837 KDa), (79.024 KDa), (77.927 KDa) } was detected in *B. brongniartti, B. bassiana, M.anisopliae* and *P. farinosus* respectively, while band No. 4 with Rf { (0.238), (0.24) and MW (111.657 KDa), (110.088 KDa) } was only found in *B. brongniartti* and *P. farinosus*. Bands No. 5, 9, 11, 12 were found in *B. brogniartti, B. bassiana* and *M. flavovrdiae* with Rf { (0.278, 0.412, 0.486, 0.53), (0.283, 0.408,

0.49, 0.535), (0.278, 0.406, 0.488, 0.527) and MW (102.972, 69.487, 56.425, 49.972 KDa), (101.773, 69.676, 57.15, 49.979 KDa), (100.511, 72.096, 58.109, 52.017 KDa) } respectively. Band No. 6 was found in *B. brongniartti, B. bassiana* and *P. farinosus* with Rf { (0.324), (0.327), (0.329) and MW (92.79 KDa), (91.103 KDa), (88.124 KDa) } for the same isolates respectively, but band No. 10 with Rf {(0.447), (0.448) and MW (62.98 KDa), (64.538 KDa) } was detected in *B. brongniartti* and *M. flavovrdiae* (Table 42,43 and 44) .

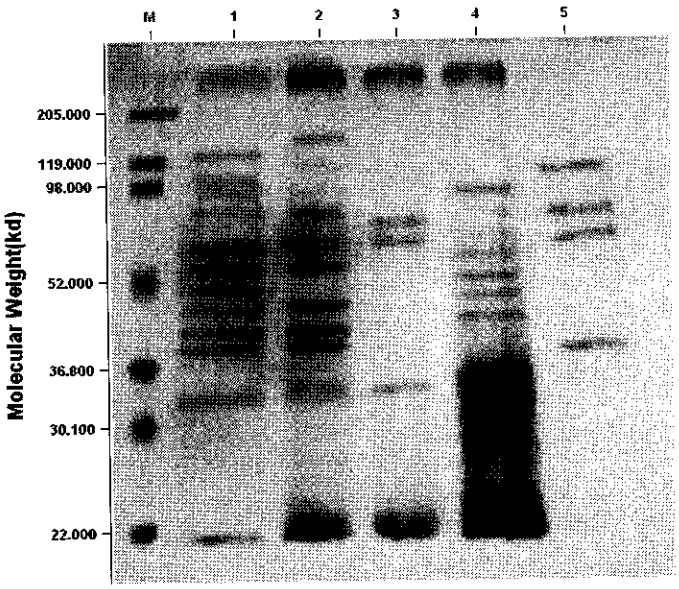



**Fig (35) Electrophoretic patterns of total cellular protein of different isolates of entomopathogenic fungi. The number beside the gel indicate molecular masses of standard marker proteins. Lane 1, *Beauveria brongniartti*; Lane 2, *Beauveria bassiana;* Lane 3, *Metarhizium anisopliae*; Lane 4, *Metarhizium flavovrdiae*; Lane 5, *Pacilomyces farinosus* ; Lane M, Standard molecular masses.**

**Table ( 42 ) Scored bands of the five tested entomopathogenic fungi *B .brongniartti* (1), *B. bassiana* (2), *M. anisopliae* (3), *M. flavovrdiae* (4) *and P. farinosus* (5)**

| | *Marker(KDa)* | *Lane 1* | *Lane 2* | *Lane 3* | *Lane 4* | *Lane 5* |
|---|---|---|---|---|---|---|
| 1 | 183.574 | 1 | 1 | 1 | 1 | 0 |
| 2 | 136.21 | 0 | 1 | 0 | 0 | 0 |
| 3 | 123.908 | 1 | 0 | 0 | 0 | 0 |
| 4 | 110.872 | 1 | 0 | 0 | 0 | 1 |
| 5 | 101.752 | 1 | 1 | 0 | 1 | 0 |
| 6 | 90.673 | 1 | 1 | 0 | 0 | 1 |
| 7 | 87.261 | 0 | 0 | 1 | 0 | 0 |
| 8 | 78.199 | 1 | 1 | 1 | 0 | 1 |
| 9 | 70.42 | 1 | 1 | 0 | 1 | 0 |
| 10 | 63.759 | 1 | 0 | 0 | 1 | 0 |
| 11 | 57.228 | 1 | 1 | 0 | 1 | 0 |
| 12 | 50.656 | 1 | 1 | 0 | 1 | 0 |
| 13 | 46.075 | 1 | 1 | 0 | 0 | 0 |
| 14 | 43.642 | 0 | 0 | 0 | 0 | 1 |
| 15 | 36.584 | 1 | 1 | 1 | 1 | 0 |
| 16 | 32.065 | 0 | 0 | 0 | 1 | 0 |
| 17 | 27.395 | 0 | 0 | 0 | 1 | 0 |
| 18 | 24.667 | 0 | 0 | 0 | 1 | 0 |
| 19 | 17.268 | 1 | 1 | 1 | 1 | 0 |

**Table (43 ) Molecular weight of SDS protein bands detected in the five tested entomopathogenic fungi *B. brongniartti* (1), *B. bassiana* (2), *M. anisopliae* (3), *M. flavovrdiae* (4) *and P. farinosus* (5)**

| *Marker* | *Lane 1* | *Lane 2* | *Lane 3* | *Lane 4* | *Lane 5* |
|---|---|---|---|---|---|
| *(M. W)* | *(M. W)* | *(M. W)* | *(M. W)* | *(M. W)* | *(M. W)* |
| 205 | 183.617 | 184.437 | 184.092 | 182.15 | 110.088 |
| 119 | 123.908 | 136.21 | 87.261 | 100.511 | 88.124 |
| 98 | 111.657 | 101.773 | 79.024 | 72.096 | 77.927 |
| 52 | 102.972 | 91.103 | 36.808 | 64.538 | 43.642 |
| 36.8 | 92.79 | 77.837 | 17.245 | 58.109 | |
| 30.1 | 78.009 | 69.676 | | 52.017 | |
| 22 | 69.487 | 57.15 | | 37.095 | |
| | 62.98 | 49.979 | | 32.065 | |
| | 56.425 | 46.332 | | 27.395 | |
| | 49.972 | 36.911 | | 24.667 | |
| | 45.819 | 17.3 | | 17.085 | |
| | 35.524 | | | | |
| | 17.44 | | | | |

**Table (44) Relative fragmentation (Rf) values of SDS protein bands detected in the five tested entomopathogenic fungi *B. brongniartti* (1), *B. bassiana* (2), *M. anisopliae* (3), *M. flavovrdiae*(4) and *P. farinosus*(5)**

| *Lane 1* | *Lane 2* | *Lane 3* | *Lane 4* | *Lane 5* |
|---|---|---|---|---|
| *Rf* | *Rf* | *Rf* | *Rf* | *Rf* |
| 0.037 | 0.036 | 0.039 | 0.036 | 0.24 |
| 0.198 | 0.16 | 0.336 | 0.278 | 0.329 |
| 0.238 | 0.283 | 0.369 | 0.406 | 0.381 |
| 0.278 | 0.327 | 0.65 | 0.448 | 0.595 |
| 0.324 | 0.375 | 0.915 | 0.488 | |
| 0.377 | 0.408 | | 0.527 | |
| 0.412 | 0.49 | | 0.652 | |
| 0.447 | 0.535 | | 0.702 | |
| 0.486 | 0.561 | | 0.755 | |
| 0.53 | 0.648 | | 0.791 | |
| 0.561 | 0.917 | | 0.915 | |
| 0.652 | | | | |
| 0.921 | | | | |

Densitometric scanning of SDS PAGE protein (Table 45) revealed that:-

Band No. 9 (MW 69.487 KDa with Rf 0.412) for *B. brongniartti* had higher concentration which represented 158.95, while band No. 19 {MW (17.3 KDa), (17.245 KDa), (17.085 KDa) with Rf (0.917), (0.915), (0.915) }for *B. bassiana*, *M.anisopliae* and *M. flavovrdiae* had higher concentration which represented 171.38, 145.94, 228.68 respectively. In addition to, band No. 4 (MW 110.088 KDa with Rf 0.24) for *P. farinosus* had higher concentration which represented 120.13.

**Table (45) Amount of SDS PAGE protein bands (%) of the five tested entomopathogenic fungi *B. brongniartti* (1), *B. bassiana* (2), *M. anisopliae* (3), *M. flavovrdiae* (4) and *P. farinosus* (5)**

| *Marker* | *Lane 1* | *Lane 2* | *Lane 3* | *Lane 4* | *Lane 5* |
|---|---|---|---|---|---|
| *(amount%)* | *(amount%)* | *(amount%)* | *(amount%)* | *(amount%)* | *(amount%)* |
| 166.75 | 128.24 | 150.95 | 133.59 | 132.12 | 120.13 |
| 149.45 | 119.03 | 104.42 | 103.15 | 107.76 | 116.94 |
| 151.93 | 110.36 | 97.05 | 102.94 | 100.41 | 112.02 |
| 130.22 | 118.02 | 126.47 | 87.12 | 112.23 | 113.3 |
| 145.7 | 123.15 | 140.27 | 145.94 | 109.35 | |
| 147.2 | 156.88 | 141.33 | | 114.79 | |
| 140.38 | 158.95 | 151.77 | | 180.39 | |
| | 157.76 | 150.83 | | 171.94 | |
| | 149.59 | 142.53 | | 157.36 | |
| | 148.92 | 119 | | 152.35 | |
| | 147.7 | 171.38 | | 228.68 | |
| | 130.08 | | | | |
| | 117.59 | | | | |

**Table (46) Similarity matrix calculated by DICE Computer Package between the five tested entomopathogenic fungi *B. brongniartti* (1), *B. bassiana* (2), *M. anisopliae* (3), *M. flavovrdiae* (4) and *P. farinosus* (5)**

| Lane | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1 | 1 | | | | |
| 2 | 83 | 1 | | | |
| 3 | 44 | 5 | 1 | | |
| 4 | 67 | 64 | 38 | 1 | |
| 5 | 35 | 27 | 22 | 0 | 1 |

Table (46) show that the mean values of the similarity index of the five different isolates ranged from 83% - 22%. Data in this table demonstrated that similarity value between *M. flavovrdiae* and *P. farinosus* was zero this means that there was no similarity between them but similarity value between *M.anisopliae* and *P. farinosus* was 22% this means that there was small similarity between them, on the other hand similarity value between *M.anisopliae* and *M. flavovrdiae* was 38%, while it was 83% between *B. brongniartti* and *B. bassiana* and this indicated that the higher similarity was found between *B. brongniartti* and *B. bassiana.*