*Indian J Hill Farmg 12 (1 & 2) : 65–74 (1999)*

# Bioefficacy and Residues of Insecticides in/on Fodder Cowpea in North Eastern Hills of India

S. K. Gangwar and D. Kumar
Division of Entomology, ICAR Research Complex for NEH Region,
Barapani -793103 Meghalaya, India

## ABSTRACT

Endosulfan @0.05, 0.1 and 0.2% and Furadan 3G @ 1.5, 3.0 and 6.0g per meter length row were most effective against the flea beetles of fodder cowpea. Endosulfan was found to persists for longer period in mixed crop with maize in comparison to cowpea as a sole crop. The waiting periods varied from 2.90 to 23.50 days. Endosulfan was not to excreted in milk of dairy cows and eggs of poultry. The washing for 1-2 minutes removed the residues to the extent of 19.12 - 41.65 percent respectively. Carbofuran was found to be translocated in cowpea plants and was not found safe for use as fodder at intermittent cuttings.

Cowpea *Vigna unguiculata* (L.) Walp is an important vegetable and fodder crop of North Eastern Hill region of India. At medium altitude hills of Meghalaya, it is severely damaged by flea beetles (*Chaetocnema basalis, Monolepta signata*). Besides, minor to medium damage is inflicted by aphids, jassids, white flies and grass hoppers which necessitates the protection of the crop from early vegetative stage. Endosulfan (Sagar and Ramzan, 1983) and Carbofuran (Faleiro *et al.,* 1985) have been used to combat the pest of cowpea. But the information is meagre on the dissipation and translocation of insecticides in high rainfall areas at medium altitude hills. Hence the investigation undertaken on bioefficacy, dissipation and translocation of insecticides in high rainfall area of Meghalaya.

## MATERIAL AND METHODS

The experiments were conducted in Kharif, at ICAR Research Complex farm, Barapani, Meghalaya (980 m, above msl). Cowpea cv. 'Pusa Barsaty' was sown in terraced land of watershed W-1 of Farming System Research Project, which was divided into equal plots of 30m2. The crop was sown for fodder purpose. The cropping system included cowpea as a sole crop and as an inter-crop with maize.

The damage of flea beetles was noticed in the form of holes on leaves. These holes were recorded by counting 3 uppermost tender leaves per plant and 10 plants from each replications were taken. The first foliage spraying of endosulfan 0.05%, 0.1% and 0.2% was done on two and subsequent one month old crop sprayings after 25 and 58 days of 1st spraying. Furadan 3G @ 1.5g, 3.0g and 6.0g per meter length row was applied in the soil on one month old crop in cowpea intercropped with maize. Each treatment was replicated thrice in RBD.

For endosulfan residues the representative samples of 25g were extracted with 75ml of n-hexane by blending in mixer for 2 minutes. The clean-up procedure of Kathpal and Dewan (1975) was followed, while colorimetric method of Maitlen *et al.*, (1963) was used for residue determination. A regression equation (y = 0.0058 x + 0.0047) was also set from standard curve to workout the residues from field samples. To study the effect of washing on removal the samples were washed in running water for 1 and 2 minutes. The endosulfan residues was also assessed in milk and eggs. The milch cows and layers were fed with contaiminated fodder for 3 consecutive days and every following day the milk and egg samples were estimated for endosulfan residues. Carbofuran residues were extracted with acetone and determined by the method of Gupta and Dewan (1973). The regression equation (y=0.006 x + 0.008) was used to calculate the residues. The half life was calculated by Hoskin's formula (1961). T (BDL) by log residues × $10^2$.

## RESULTS AND DISCUSSION

Bioefficacy of insecticides: It is evident from Table 1 that both the insecticides at all concentrations were most effective to reduce the damage of flea beetles in comparison to check. Further, it was seen that the different concentrations of insecticides did not differ significantly among themselves in efficacy suggesting that both the insecticides even at lower concentrations were equally effective. Endosulfan was found less deleterious to coepea seedlings in comparison to other insecticides.

### Extent of Residues

### Endosulfan

Recovery: Endosulfan was recovered to the extent of 90.5 from cowpea which is fairly high and comparable to those reported by Awasthi *et al.*, (1974) on cauliflower and Prasad and Awasthi (1982) on various crops.

## PERSISTENCE OF ENDOSULFAN IN MIXED CROP (COWPEA + MAIZE)

**First spraying** : The average deposits of 4.655, 6.724 and 8.793 ppm were obtained from endosulfan 0.05, 0.10 and 0.20% respectively (Table II). The deposits were reduced to the extent of 36.77 - 41.65% in one day, which further reduced to 98.83 - 99.27% in 15 - 23 days and after that the residues became below detectable level (BDL). The statistical treatment of data led to half life (T 0.5) value which varied from 2.47 to 4.78 days and time to reach tolerance level (T, toil) varied from 2.90 to 9.28 days and time to reach below detectable level (T, BDL) varied from 20.07 to 45.80 days.

**Second spraying** : The second spraying done after 25 days of first spraying resulted into deposits of 10.086, 14.741 and 19.397 ppm from the respective dosages which were reduced to the extent of 64.67 - 70.51% in 5 days and 98.76 - 99.15% in 18 - 30 days. The (T. 0.5) varied from 2.84 to 5.68 days. (T tol) 6.83 - 16.24 days and T (BDL) 28.54 to 59.65 days (Table 12)

**Third spraying** : The third spraying done after 58 days of first spraying gave the cumu-

lative deposits of 18.879, 24.569 and 39.052 ppm on the day of spraying (Table 3). The reduction in residues after 3 days was found to be 43.71 - 49.31% which subsequently reduced to 98.69 - 99.66% in 25 - 35 days. The residues on 27 - 37 days were below detectable level. T (0.5) varied from 3.46 to 5.47 days, (T, tol) 11.29 - 23.50 days and T (BDL) 37.73 - 65.33 days.

**Persistence of endosulfan in sole crop** : The crop grown as sole crop was sprayed with endosulfan which resulted into residues of 15.259, 21.466, 36.466 ppm from the above same dosages. The reduction on third day was found to be 51.06 - 57.63% which further brought down to the level of 99.28 - 99.57% in 18 - 27 days and on the following day, the residues became BDL. The (T, 0.5) varied from 2.39 to 4.31 days, T (Tol) 7.18 - 16.92 days and T (BDL) 24.45 - 49.79 days.

It was observed that the sole crop got less deposits in comparison to mixed crop which could be attributed to less chances of drift being surrounded by a tall crop like maize while in sole crop there was no such barrier to check the drift. The persistence of insecticides was governed by the deposits, hence the higher deposits obtained in mixed crop persisted for longer duration. It was also noticed that with the increase in crop volume, the deposits also increased tremendously which also helped plants to receive higher amount of spray fluid. Pandey *et al.,* (1977 a & b) also obtained higher deposits of endosulfan in second spraying in comparison to first spraying on pea and Bengal gram. Hence, higher deposits persisted for longer duration than lower deposits. The amount of spray fluid required to full coverage point also varied from first spraying to third spraying. The first spraying required 800 1 while second 1200 1 and the third spraying required 1400 l/ha spray fluid. Endosulfan has been reported to persist almost to the same period on moong (Verma and Pant, 1976a), soybean (Dixit *et al.*, 1977) and pea (Pandey *et al.*, 1977a)

It is interesting to note that although the average maximum temperature, minimum temperature and relative humidity were almost the same, there was marked variation in T (0.5) and T (BDL) in different sprayings. However, there was marked difference in rain fall. During the dissipation period of first spraying the total rainfall was 217.5mm, 347.6mm in second and 837.5mm in third spraying, T (0.5) and T (BDL) were higher in third spraying, suggesting retarded dissipation of endosulfan from repeat applications. Dewan *et al.,* (1971) reported that oxidative reductive and hydrolytic biodegradation factors could become weakly operative in dissipating the residues from repeat application, which is in agreement with the present findings.

**Effect of washing on removal** : In first spraying the one minute washing removed residues to the extent of 19.12 - 30.55%, in second spraying 18.67 - 25.64% and in third spraying 19.87 - 24.66% while two minutes washing removed the residues to the tune of 27.94 - 41.65, 24.00 - 35.89 and 26.51 - 32.88% in the corresponding dosages. It is obvious from the Table 4 that the removal due to washing was more in first spraying in comparison to subsequent sprayings, indicating that some of the insecticide might have penetrated deep into the tissues which was not affected by extraneous washings. While washing reduced the residues 20–80% in moong and 53 - 71% in arhar (Verma and Pant 1976a). The difference could be due to different crops used in their experiments.

**Excretion of insecticides in milk and egg** : The milch cows were fed consecutively for 3 days with cowpea having the residues of 0.643 ppm after 30 days of third spraying. The next day milk was assessed for endosulfan which indicated the residues were below detectable level (BDL). The layer of "White Leg Horn" were fed with treated cowpea having residues of 0.643 ppm for 3 days consecutively. The next day eggs were analyzed for residues which indicated BDL. Beck *et al.*, (1966) also reported that the endosulfan residues were not detected (BDL) in milk from dairy cows when fed for 21 days on silage containing average residues of 0.41 - 2.35 ppm on forage.

**Carbofuran : (Cowpea + Maize)**

**Recovery** : Carbofuran was recovered to the extent of 90% from soil and 84% from plants. similar recoveries from soil and cowpea plants were also reported by Faleiro *et al.* (1985).

**Persistence in soil** : The initial deposits of 9.640, 22.04 and 28.04 ppm were obtained from soil incorporation of Furadan 3G @ 1.5g, 3.0g and 6.0g per meter row length respectively. The deposits became BDL in 63 - 100 days (Table 6). The T (0.5) ranged from 8.6 - 11.58 days and T (BDL) 69.09 - 105.00 days, similarly Faleiro *et al.,* (1985) reported T (0.5) 7 - 8 days in soil, (Table 5) . Naitam and Sukhani (1984) reported the loss of carbofuran 72 - 83% while in present study 97% reduction was obtained in 35 days exhibiting proximity in results.

**Uptake and translocation in cowpea** : Carbofuran was found to translocate from root to other plant parts also. Plants grown in treated soil were unsafe for cattle consumption as fodder at intermittent cuttings. (Table 6).


## ACKNOWLEDGEMENTS

The authors are thankful to Dr. R.N. Prasad, Director, for providing facilities to carry out the investigation.


## REFERENCES


Awasthi, M.D., Dixit, A.K., Verma, S., Handa, S.K. and Dewan R.S., (1974). Dissipation of endosulfan (Thiodan) residues from cauliflower (*Brassica oleracea* L. Var. Capitata) crop. *Indian J. Pl. Prot.,* 2: 24 - 29.

Beck, E.W., Johnson, J.R., Woodham, D.W., Leuck, D.B., Dawsey, L.H.Robbins, J.E. and Bowman, M.C. (1966). Residues of endosulfan in meat and milk of cattle fed treated forage. *J.Econ. Ent.,* 59: 1440 - 1450.

Dewan, R.S., Dixit, A.K., Handa, S.K. and Verma, S., (1971). Dissipation of carbaryl (Sevin) residues from cauliflower (Brassica oleracea var. Capitata) crop. Proceedings, First All India Symposium on 'Progress and Problems in Pesticide Residue Analysis'. Ludhiana (18-19 Nov., 1971), pp 118-23 (Eds. O.S.Bindra and R.L. Kalra).

Dixit, A.K. Bhattacharjee, N.S., Handa, S.K., Awasthi, M.D. and Dewan, R.S.(1977). Dissipa-

tion of phorate, disulfoton and endosulfan in/on soybean crop. *Indian. J.Pl. Prot.*, 5: 70-74.

Faleiro, J.R., Singh, K.M. and Singh, R.N. (1985). Dissipation of carbofuran and carbaryl in cowpea. *Indian J.Ent.*, 47 : 393 - 400.

Gupta, R.C. and Dewan, R.S. (1973). A rapid colorimetric method for the estimation of carbofuran residues. Proceedings, First All India Symposium on 'Progress and Porblems in Pesticide Residue Analysis'. Ludhiana (18 -19 Nov., 1971), pp 208 - 214. (Eds. O.S. Bindra and R.L. Kalra).

Hoskin, W.M., (1961). Mathematical treatment of loss of pesticide residues. *Plant Prot. Bull.*, FAO. 9:163 - 168.

Kathpal, T.S. and Dewan, R.S., (1975). Improved cleanup technique for the estimation of endosulfan and endrin residues. *J. Ass. Off. Agri. Chem.*, 58: 1076 - 1080.

Maitlen, J.C., Walker, K.C. and Westlake, W.E., 1963. An improved colorimetric method for determining endosulfan in vegetables and beef fat. *J. Agric. Fd. Chem.* 11:416 - 418.

Naitam, N.R. and Sukhani, T.R., (1984) Effect of ecological conditions on the persistence of carbofuran and isofenphos in soil and sorghum seedlings. *Indian J. Ent.* 46 : 452 -459.

Pandey, S.Y., Dixit, A.K., Jain, H.K and Agnihotri, N.P., (1977a) Residues of lindane and endosulfan in/on pea plant. (*Pisum sativum). Indian J. Ent.* 39: 85-87.

Pandey, S.Y., Jain, H.K., Agnihotri, N.P., Dewan, R.S. and Saxena, H.P.(1977 b). Residues from foliar application of carbophenothion, tetrachlorvinphos , dicrotophos, trichlorfon and endosulfan on bengal gram *(Cicer arietinum). Indian, J.Pl. Prot*. 5: 47 - 40.

Prasad, V.G., and Awasthi, M.D. (1982). Final report of project on Analysis of insecticide residues on fruit and vegetables, IIHR, Bangalore, 103p.

Sagar, P. and Ramzan, M., 1983. Laboratory evaluation of some insecticides against Diacrisia obliqua Walker damaging cowpea at Ludhiana. *Indian J.Pt. Prot.* 11: 87 -89.

Verma, S. and Pant, N.C. (1976). Dissipation of endosulfan on moong and arhar crops. *Indian. J. Pl. Prot.* 4 : 24 - 31.

**Table 1. Field efficacy of insecticides against the flea beetles on cowpea**

| Treatment | Pre-treatment | I Spraying | | | II Spraying | | |
|---|---|---|---|---|---|---|---|
| | | Days after treatment | | | | | |
| | | 5 | 12 | 20 | 28 | 35 | 43 |
| | | Mean holes/30 leaves | | | | | |
| Endosulfan (%) | 26.0 (6.0) | 5.7 (2.5) | 3.7 (2.0) | 1.7 (1.4) | 3.0 (1.9) | 2.7 (1.7) | 1.0 (1.2) |
| 0.05 | | | | | | | |
| 0.10 | 19.0 (7.7) | 2.3 (1.7) | 3.3 (2.0) | 1.3 (1.3) | 3.0 (1.8) | 3.0 (1.6) | 0.7 (1.0) |
| 0.20 | 21.7 (8.5) | 2.3 (1.5) | 3.0 (1.9) | 0.7 (1.0) | 2.0 (1.6) | 1.3 (1.3) | 1.3 (1.3) |
| Carbofuran (g) | | | | | | | |
| 1.5 | 24.0 (8.4) | 5.0 (2.3) | 4.3 (2.2) | 2.7 (1.7) | 2.0 (1.5) | 2.3 (1.6) | 2.0 (1.6) |
| 3.0 | 19.3 (8.1) | 4.0 (2.1) | 3.0 (1.8) | 2.3 (1.7) | 2.0 (1.6) | 2.3 (1.7) | 2.0 (1.6) |
| 6.0 | 27.3 (8.6) | 2.7 (1.7) | 1.7 (1.7) | 1.7 (1.4) | 2.0 (1.5) | 2.0 (1.5) | 1.7 (1.4) |
| Control | 18.0 (8.3) | 68.0 (8.2) | 73.3 (8.6) | 83.3 (9.1) | 93.3 (9.7) | 94.7 (9.8) | 99.3 (10.0) |
| SE (m) ± | | ± 0,.46 | ± 0.36 | ± 0.40 | ± 0.28 | ± 0.37 | ± 0.27 |
| C.D. (P=0.05) | | 1.0 | 0.77 | 0.88 | 0.60 | 0.80 | 0.58 |

*Mean of 3 replications*
*Figures in parenthesis are /x+0.05 values.*

**Table 2. Extent of residues of endoslfan on cowpea**

Days after treatment

| | I Spraying | | | | | | II Spraying | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.05% | | 0.10% | | 0.20% | | 0.05% | | 0.10% | | 0.20% | |
| | Av. Res. (ppm) | Red (%) | Av. Res (ppm) | Red. (%) | Av. Res (ppm) | Red (%) | Av. Res. (ppm) | Red (%) | Av. Res (ppm) | Red (%) | Av Res. (ppm) | Red (%) |
| | 04.66 | | 6.72 | | 8.79 | | 10.09 | | 14.741 | | 19.397 | |
| 1 | 2.72 | 41.7 | 4.01 | 40.4 | 5.56 | 36.8 | * | * | * | * | * | * |
| 3 | 1.98 | 57.4 | 3.02 | 55.1 | 4.40 | 50.0 | * | * | * | * | * | * |
| 5 | 1.29 | 72.2 | 2.15 | 68.0 | 3.36 | 61.7 | 2.97 | 70.5 | 4.78 | 67.6 | 6.85 | 64.7 |
| 7 | 0.60 | 87.1 | 1.29 | 80.8 | 2.33 | 73.5 | 1.68 | 83.3 | 2.97 | 79.8 | 4.53 | 76.7 |
| 10 | 0.32 | 93.1 | 0.97 | 85.6 | 1.88 | 78.7 | 1.12 | 88.9 | 2.16 | 85.4 | 3.36 | 82.7 |
| 15 | 0.03 | 99.3 | 0.59 | 91.3 | 1.41 | 83.9 | 0.43 | 95.7 | 1.29 | 91.2 | 2.15 | 88.9 |
| 18 | BDL | 100.0 | 0.24 | 96.4 | 0.98 | 88.8 | 0.09 | 99.2 | 0.95 | 93.6 | 1.81 | 90.7 |
| 21 | - | - | BDL | 100.0 | 0.52 | 94.1 | BDL | 100.0 | 0.71 | 95.2 | 1.48 | 92.3 |
| 23 | - | - | - | - | 0.10 | 98.8 | - | - | 0.32 | 97.8 | 1.10 | 94.3 |
| 25 | - | - | - | - | BDL | 100.0 | - | - | 0.07 | 99.6 | 0.84 | 95.7 |
| 27 | - | - | - | - | - | - | - | - | BDL | 100.0 | 0.59 | 96.98 |
| 30 | - | - | - | - | - | - | - | - | - | - | 0.24 | 98.8 |
| 32 | - | - | - | - | - | - | - | - | - | - | BDL | 100.0 |
| T (0.5) days | 2.47 | | 4.24 | | 4.78 | | 2.84 | | 4.01 | | 5.68 | |
| T (tol) days | 2.90 | | 5.76 | | 9.28 | | 6.83 | | 11.13 | | 16.24 | |
| T (BDL) days | 20.07 | | 38.17 | | 45.80 | | 28.54 | | 41.81 | | 59.65 | |

Regression equations Y=2.6892-0.134X Y=2.7102-0.071X Y=2.8857-0.063X Y=3.0252-0.106X Y=3.1354-0.075X Y=3.1615-0.053X

Av. Res. = Average Residue; Red.=reduction; BDL=Below detectable Level; * = Smaple not drawn

Meteorological data : Av. max. Temp. = 27.19°C; Av. Min. Temp. 21.53°C; Av. relative humidity=79.58%; Total rainfall=1402.6 m; (17.5.87 - 21.8.87)

No. of rainy day 76 days.

**Table 3. Effect of sole and mixed cropping on the persistence of endosulfan**

| Days after treatment | III Spraying (Sole crop) | | | | | | III Spraying (Mixed with maize) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.05% | | 0.10% | | 0.20% | | 0.05% | | 0.10% | | 0.20% | |
| | Av. Res. (ppm) | Red (%) | Av. Res (ppm) | Red. (%) | Av. Res (ppm) | Red (%) | Res. (ppm) | Red (%) | Res (ppm) | Red (%) | Av Res. (ppm) | Red (%) |
| 0 | 15.259 | | 21.466 | | 36.466 | | 18.879 | | 24.569 | | 39.052 | |
| 3 | 6.466 | 57.6 | 10.086 | 53.0 | 17.845 | 51.1 | 9.569 | 49.3 | 13.190 | 46.3 | 21.983 | 43.7 |
| 7 | 1.940 | 87.3 | 3.750 | 82.5 | 7.112 | 80.5 | 3.879 | 79.5 | 5.948 | 75.8 | 11.121 | 71.5 |
| 10 | 1.121 | 92.7 | 2.500 | 88.4 | 5.086 | 86.1 | 2.457 | 87.0 | 4.257 | 82.7 | 8.405 | 78.5 |
| 15 | 0.259 | 98.3 | 1.121 | 94.8 | 3.190 | 91.3 | 1.164 | 93.8 | 2.716 | 89.0 | 6.078 | 84.4 |
| 18 | 0.065 | 99.6 | 0.711 | 96.7 | 1.875 | 94.7 | 0.776 | 95.9 | 2.004 | 91.8 | 5.086 | 87.0 |
| 21 | BDL | 100.0 | 0.323 | 98.5 | 0.358 | 96.3 | 0.431 | 97.7 | 1.638 | 93.3 | 4.224 | 89.2 |
| 23 | - | - | 0.155 | 99.3 | 0.983 | 97.3 | 0.194 | 99.0 | 1.358 | 94.5 | 3.427 | 91.2 |
| 25 | - | - | BDL | 100.0 | 0.586 | 98.4 | 0.065 | 99.7 | 1.099 | 95.5 | 2.651 | 93.2 |
| 27 | - | - | - | - | 0.241 | 99.3 | BDL | 100.0 | 0.711 | 97.1 | 1.875 | 95.2 |
| 30 | - | - | - | - | BDL | 100.0 | - | - | 0.323 | 98.7 | 0.970 | 97.5 |
| 32 | - | - | - | - | - | - | - | - | BDL | 100.0 | 0.453 | 98.8 |
| 35 | - | - | - | - | - | - | - | - | - | - | 0.194 | 99.5 |
| 37 | - | - | - | - | - | - | - | - | - | - | BDL | 100.0 |
| T (0.05) days | 2.39 | | 3.5 | | 4.31 | | 3.46 | | 5.57 | | 5.47 | |
| T (tol) days | 7.18 | | 11.4 | | 16.92 | | 11.29 | | 18.10 | | 23.50 | |
| T (BDL) days | 25.45 | | 38.16 | | 49.79 | | 37.73 | | 60.71 | | 65.33 | |

*Regression equations* $Y=2.2062-0.126X$ $Y=3.2814-0.086X$ $Y=3.4855-0.070X$

$Y=3.2824-0.087X$ $Y=3.2785-0.054X$ $Y=3.5933-0.055X$

**Table 4. Effect of washing on zero day**

| Time | Endosulfan 0.05% | | Endosulfan 0.10% | | Endosulfan 0.20% | |
|---|---|---|---|---|---|---|
| | Av Res. (ppm) | Red (%) | Av. Res. (ppm) | Red (%) | Av. Res. (ppm) | Red (%) |
| **I Spraying** | | | | | | |
| Deposit | 4.655 | | 6.724 | | 8.793 | |
| 1 mt. | 3.233 | 30.5 | 5.043 | 25.0 | 7.112 | 19.1 |
| 2 mt. | 2.716 | 41.7 | 4.526 | 32.6 | 6.336 | 27.9 |
| **II Spraying** | | | | | | |
| Deposit | 10.086 | | 14.741 | | 19.397 | |
| 1 mt. | 7.500 | 25.6 | 11.638 | 21.1 | 15.776 | 18.7 |
| 2 mt. | 6.466 | 35.9 | 10.603 | 28.1 | 14.741 | 24.0 |
| **III Spraying (Mixed with Maize)** | | | | | | |
| Deposit | 18.879 | | 24.569 | | 39.052 | |
| 1 mt. | 14.224 | 24.7 | 19.397 | 21.1 | 31.293 | 19.9 |
| 2 mt. | 12.672 | 32.9 | 17.328 | 29.5 | 28.701 | 26.5 |
| **III Spraying (Sole crop)** | | | | | | |
| Deposit | 15.259 | | 21.466 | | 36.466 | |
| 1 mt. | 11.638 | 23.7 | 16.810 | 21.7 | 28.701 | 21.3 |
| 2 mt. | 10.086 | 33.9 | 15.259 | 28.9 | 26.638 | 27.0 |

**Table 5. Degradation of carbofuran under the cover of cowpea + maize**

| Days after treatment | Doses | | | | | |
|---|---|---|---|---|---|---|
| | 1.5 g/m | | 3.0 g/m | | 6.00/m | |
| | Residue (ppm) | Reduction (%) | Residue (pm) | Reduction (%) | Residue (ppm) | Reduction (%) |
| 0 | 9.640 | - | 22.040 | - | 28.040 | - |
| 10 | 1.839 | 80.9 | 5.240 | 76.2 | 9.040 | 67.8 |
| 17 | 0.819 | 91.5 | 2.820 | 87.2 | 3.420 | 87.8 |
| 35 | 0.350 | 96.4 | 0.517 | 97.7 | 0.767 | 97.3 |
| 63 | BDL | 100.0 | 0.480 | 97.8 | 0.491 | 98.3 |
| 92 | BDL | 100.0 | BDL | 100.0 | BDL | 100.0 |
| T (0.5) days | 8.6 | | 11.58 | | 10.75 | |
| T (BDL) | 69.09 | | 105.00 | | 103.64 | |

*Regression Equation Y=2.719-0.035X  Y=3.0312-0.026X  Y=3.2028-0.028X*

**Table 6. Uptake and translocation of carbofuran in cowpea plant**

| Days | Plant parts | Doses | | |
|---|---|---|---|---|
| | | 1.5 g/m | 3.0 g/m | 6.0 g/m |
| 17 | Leaves and branches | BDL | 1.279 | 2.879 |
| 35 | Whole plant excluding roots | 0.079 | 0.480 | 0.881 |
| 63 | Leaves only | 0.480 | 0.980 | 2.481 |
| 74 | Whole plant | BDL | 0.279 | 0.880 |