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# RESIDUES OF ENDOSULFAN AND MONOCROTOPHOS SPRAYS IN MUNG BEAN [*VIGNA RADIATA* (L.) WILCZEK]

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**ABSTRACT**

Residues and their dissipation patterns, following the sprays of endosulfan (0.035% and 0.07%) and monocrotophos (0.02% and 0.04%) in the leaves, green pods and grains of mung bean were studied by spectrophotometry. Endosulfan gave initial deposits (ID) of 4.66 to 12.94 ppm on leaves and 1.92 to 2.29 ppm on pods, with half life ($RL_{50}$) values ranging from 2.67 to 4.64 days on leaves and 1.18 to 1.81 days on pods. Monocrotophos residues on leaves (ID 24.26 to 37.54 ppm) had $RL_{50}$ of 2.81 to 7.88 days, and on pods (ID 2.34 to 4.91 ppm) $RL_{50}$ ranged from 4.61 to 6.63 days. Initial deposits were generally high and dissipated faster in summer than in the rainy season but the persistence of endosulfan 0.07% spray was better in summer crop. The dissipation of the insecticides was also faster in green pods. At or after flowering, endosulfan is recommended to be used in the mung bean crop raised for vegetable purposes, the waiting period being only 1 day. Monocrotophos required a waiting period of 15.22 days. No harvest time residues of endosulfan were detected in ripe mung bean grains but monocrotophos residues could be detected, though below MRL, upto 16 days after spray.

## INTRODUCTION

Endosulfan and monocrotophos are effective and recommended insecticides for pest management in mung bean, *Vigna radiata* (L.) Wilczek (Verma, 1986). No reports are, however, available on the residue dissipation pattern of these insecticides in Rajasthan. This paper reports residues of these two commonly used insecticides in both summer as well as rainy season (kharif) crops of mung bean.

## MATERIAL AND METHODS

Mung bean crops were raised at the research farm of the College of Agriculture, Udaipur during 1985 in Randomized Block Design with three replications. A basal dose of 18 kg N and 46 kg $P_2O_5$/ha was applied in the form of DAP and the plants were uniformly spaced (P x P 10 cm, R x R 30 cm) in summer as well as kharif crop. The summer crop (cv 'Pusa Baisakhi') was sown in 3 m x 3 m plots on 20 April; green pods were available from 10 June, pickings started on 18 June and the crop was finally harvested on 29 June. The kharif crop (cv 'K 851') was sown on 27 July; green

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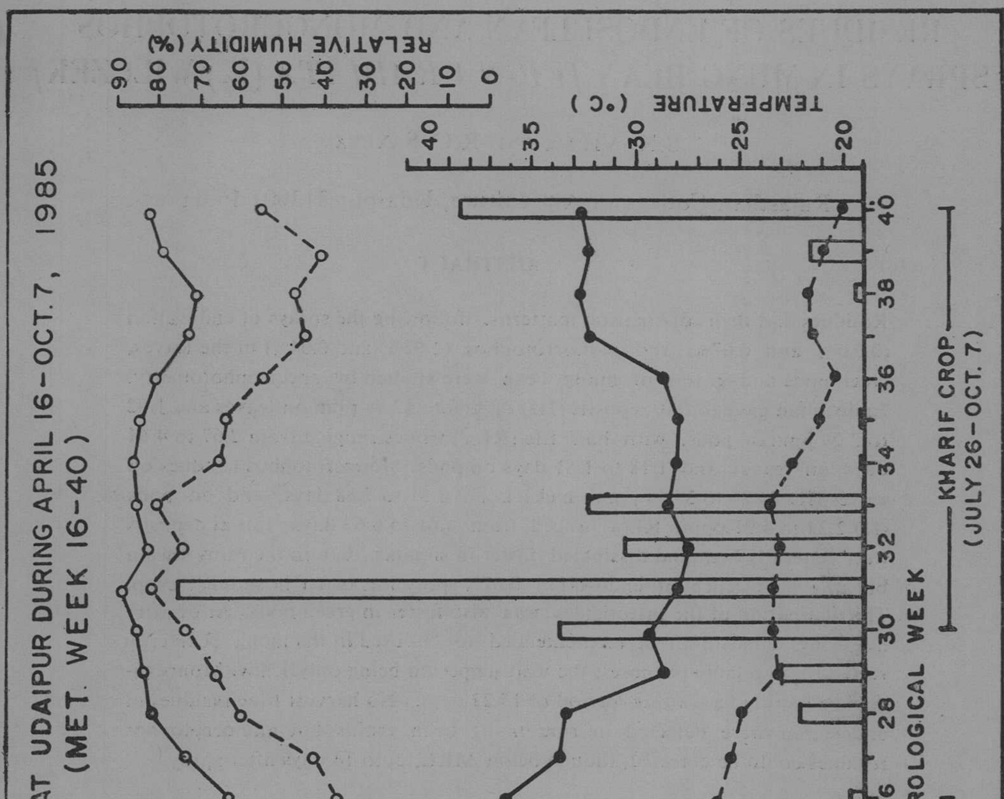



Fig. 1 WEATHER CONDITIONS AT UDAIPUR DURING APRIL 16-OCT. 7, 1985 (MET. WEEK 16-40)

pods were available from 18 Sept, pickings started on 22 Sept and finally harvested on 5 October. Two concentrations each of endosulfan 35 ec (0.035%, 0.07%) and monocrotophos 36 sc (0.02%, 0.04%) were sprayed @ 500 l/ha. The single spray in summer crop was given just before the initiation of flowering (on 29 May) whereas in kharif crop, the first spray was given on 3-week crop (21 Aug) and the second spray given after one month when the green pods were formed (20 Sept) so as to get a complete picture of the dissipation pattern of residues on the leaves (from the first spray) and also the residue dissipation pattern on pods and in grains. The weather conditions prevailing during the course of these investigations are presented in Fig. 1.

**a. Samples and their preparations**

Samples of leaves and pods from the crop and of grains after harvest were taken at random from out of each replicate so as to give the final samples of 50 g leaves and 25 g of pods or grains after quartering from each lot. Leaf and pod samples were chopped and then crushed with a glass pestle and mortar by adding 5 g of anhydrous sodium sulphate. Grains taken from pods matured after 12, 16 and 20 days of the II spray were analysed for the residue levels. Grains obtained from ripe pods were prepared for extraction by grinding in a Waring blender for two minutes.

**b. Extraction procedures**

Single solvent extraction of residues was done with redistilled analytical grade reagents : *n*-Hexane for endosulfan, and chloroform for monocrotophos residues. The extraction was carried in two parts, each time using a 1 : 2 w/v sample-to-solvent ratio. The crushed samples were transferred into 500 ml erlenmeyer flasks and shaken over an electric shaker for 15 minutes. The filtrate was carefully decanted and passed through a Whatman filter paper No. 1 over a 1" layer of anhydrous sodium sulphate,

**c. Clean up**

For clean up, 2 g of activated charcoal was added to the filtrate, shaken and passed through Whatman filter paper No. 1 for endosulfan residues (*n*-Hexane medium). However, for monocrotophos residues (chloroform medium), the extract was shaken with 2 g of activated charcoal + 2 g of adsorbent mixture (equal parts of activated charcoal, magnesium oxide and Celite) and then passed through a column containing 4-cm layers each of anhydrous sodium sulphate (in bottom) and adsorbent mixture.

**d. Residue determinations**

The residues were determined by spectrophotometry following the method of Butler et al. (1962) as modified by Maitlen et al. (1963) for endosulfan and that of Getz and Watts (1964) for monocrotophos. Since recovery tests gave a mean recovery of 85%, 85.63% and 84.37% endosulfan and 82%, 84.97% and 85.71% monocrotophos from the leaves, green pods and grains, respectively, the residues calculated were accordingly corrected by multiplication with the corresponding correction factor.

Half life ($RL_{50}$) of the residues was worked out according to Hoskins (1961) by calculating the slope of the regression line(b) for the time (days) elapsed (x) and the corresponding log ppm residues(y). Dissipation curves were drawn to interpret the pattern of dissipation. Maximum residue limits (MRL) were assumed for leaves (fodder residue level). For green pods and grains, the levels prescribed by the Government of India (1976) for vegetables and cotton seed, respectively, in case of endosulfan, and those prescribed by FAO (1976) in case of monocrotophos, were taken.

## RESULTS AND DISCUSSION

### Residues of endosulfan

Residues of endosulfan in mung bean leaves and pods are given in Table 1.

Table 1. Residues of endosulfan (ppm) in mung bean crop (Figures in parentheses are per cent reduction of initial deposits)

| *Days after spray | Summer Crop | | Rainy season Crop | |
|---|---|---|---|---|
| | 0 035% spray | 0.07% spray | 0 035% spray | 0 07% spray |
| | | **LEAVES** | | |
| 0 | 8.982 | 12.939 | 4.657 | 8.858 |
| 2 | 4.286 (52.28) | 7.993 (38.21) | 1.444 (68.98) | 1.05/ (88.07) |
| 4 | 1.452 (83.83) | 6.493 (49.80) | 0 562 (87.92) | 0.436 (95.07) |
| 8 | 0.537 (94 02) | 3.231 (75.02) | 0·243 (94.78) | 0.243 (97 25) |
| 12 | 0.290 (96.77) | 1.433 (88.92) | 0.182 (96.08) | 0.228 (97 43) |
| 16 | 0.122 (98.64) | 0.351 (97.28) | — | BDL (100) |
| 20 | BDL (100) | 0.259 (98.24) | | |
| 24 | — | 0.122 (99 06) | | |
| 28 | — | BDL (100) | | |
| RE | Y=0.9534-0.1124x | Y=1.118-0.649x | Y=0.6681-0.1124x | Y=0.9473-0.0.33x |
| $RL_{50}$ | 2.678 days | 4 640 days | 2.678 days | 3.226 days |
| $T_{tol}$ | 2.264 days | 6.361 days | (ID<MRL) | 2.662 days |
| | | **PODS** | | |
| 0 | — | — | 1.924 | 2.292 |
| PW | — | — | 5.556 (19.21) | 2 047 (10.70) |
| 2 | — | — | 0.698 (63 74) | 1.188 (48.16) |
| 4 | — | — | 0.182 (71.58) | 0.241 (89.47) |
| 8 | — | — | BDL (100) | 0.121 (94.72) |
| 12 | — | 1.066 | RE. Y=0.2843-0.2558x | Y=0.3602-0.166x |
| 16 | — | 0.345 | $RL_{50}$ 1.176 days | 1.813 days |
| 20 | — | BDL (100) | $T_{tol}$ (ID<MRL) | 0.356 days |

MRL : Leaves—5 ppm; pods—2 ppm

*RE-regression equation, PW-pods washed, $T_{tol}$ - time required for residues to reach MRL

In the summer crop, initial deposits (ID) on leaves were 8.982 ppm from the spray of 0.035% endosulfan. Residues from 0.07% spray (ID 12.936 ppm) dissipated relatively slowly, although 97.28% had dissipated by 16th day of spray, almost at par with 0.035% spray (98.64% dissipation) Residues from the 0.035% and 0.07% spray of endosulfan reached below detectable level (BDL) on 20th and 28th day, respectively. In rainy season crop (knarif), dissipation of endosulfan residues was initially faster for 0.07% spray than for 0.035% spray. Residues dissipated fully on the 16th and 20th day after spray from 0.035% and 0.07% spray, respectively.

Initial deposits of endosulfan (range 4.617 to 12.936 ppm) were higher on summer crop than on kharif crop. The relatively luxuriant crop growth in knarif might have resulted in lesser initial deposits of non-systemic endosulfan than in summer where the crop had relatively poor vegetative growth. The levels of ID reported by earlier workers (Verma and Pant, 1976; Vyas 1977) were 11.58 and 13.07 ppm, respectively. In Chickpea leaves still higher deposits of 22.5 ppm were obtained by Pandey et al. (1977) from similar spray whereas Chandrasekhar (1984) reported ID to be in the range of 8.33 to 12.82 ppm from endosulfan 0.0525% to 0.1% sprays. Verma and Pant (1976) and Vyas (1977) reported the ID of 11.58 ppm and 13.07 ppm, respectively, in mung bean leaves with 0.07% spray of endosulfan.

The half life of residues from endosulfan 0.035% spray was the same (2.678 days) in summer as well as in rainy season but it was longer (4.64 days) in summer than in rainy season (3.226 days) for 0.07% spray. In summer, residues in leaves fell to MRL in 2.264 days for 0.035% spray and in 6.361 days for 0.07% spray. In kharif, ID by 0.035% spray were less than MRL whereas the residues from 0.07% spray reached MRL in 2.662 days only.

In the summer crop, pods were set and became available at 12 days after the spray. Pods from the crop sprayed with endosulfan 0.035% spray had no residues of the insecticide. However, pods from 0.07% spray contained 1.066 ppm endosulfan on 12th day, fairly below the MRL (2 ppm).

In the rainy season crop, dissipation of insecticides on pods was studied for the second spray applied on 20 September, 1985. From 0.035% endosulfan spray, ID (1.924 ppm) were less than the MRL and from 0.07% spray, the ID were 2.292 ppm, a little more than MRL. Washing of pods removed 19.21% ID from 0.035% spray and 10.7% ID from 0.07% spray. Residues reached BDL on 8th and 12th day after 0.035% and 0.07% endosulfan spray, respectively. Obviously, half life of endosulfan was shorter on pods than on leaves.

There were no residues of endosulfan in the grains of mung bean at 20 days after the spray in summer. In kharif also, grains even from the pods sprayed just 2 days before harvest contained no detectable residues of endosulfan.

**Residues of monocrotophos**

Residues of monocrotophos in different parts of mung bean plants are given in Tables 2 and 3 for the summer and the kharif crops, respectively. There was not much difference in the ID of monocrotophos on leaves.

Initial deposits of 24.456 ppm in the leaves of summer crop with the spray of 0.02% monocrotophos reached BDL on 20th day. In kharif, ID (24.458 ppm) took longer (24 days) to reach BDL, the $RL_{50}$ being 10.72 days. Residues of monocrotophos from 0.04% spray had half life of 2.88 and 7.88 days for summer and kharif, respectively.

In green pods of the summer crop available from 12th day after spray, residues were to the tune of 0.314 ppm and 0.6804 ppm from monocrotophos 0.02 and 0.04% sprays, respectively. Subsequent samples had no detectable residues for the 0.02% treatment. The samples from 0.04% treatment contained monocrotophos residues at 20 and 24 days after spray to the extent of 0.2295 and 0.0796 ppm respectively, and were BDL on 28th day after spray (Table 2). In kharif 1.299 ppm of monocrotophos could be detected in green pods at 28 days after the first spray of 0.04% monocrotophos. ID of 2.328 ppm by the second spray of monocrotphos 0 02% dissipated below the MRL (1 ppm) in 5.618 days. From 0.04% spray (ID 4.912 ppm), residues reached MRL in 15.22 days. Washing removed an almost equal proportion (61.65 and 62.343 per cent) of initial deposits in pods from plants sprayedwith 0.02 and 0 04% monocrotophos, respectively (Table 3). Awasthi et al. (1978) reported removal of 82% of ID of monocrotophos 0.025% spray by washing.

Table 2. Residues (ppm) of monocrotophos in mung bean summer crop (RE-regression equation)

| Days after spray | Leaves | | Pods | |
|---|---|---|---|---|
| | 0.02% spray | 0.04% spray | 0.02% spray | 0.04% spray |
| 0 | 24.456 | 37.544 | | |
| 2 | 12.161 (50.272) | 24 059 (32.718) | | |
| 4 | 4.824 (80.273) | 7.402 (79.299) | | |
| 8 | 1.454 (94 055) | 2.297 (93.577) | | |
| 12 | 1 101 (95.496) | 1.795 (94.979) | 0.314 | 0.6804 |
| 16 | 0.405 (98.345) | 0.801 (97.759) | BDL | 0.3907 |
| 20 | BDL (100) | 0.082 (99.769) | — | 0.2295 |
| 24 | — | BDL (100) | | 0.0796 |
| 28 | — | — | — | BDL |
| RE : | Y=1.3884-0.1071x | Y = 1.5745-0.10437 | | |
| $Rl_{50}$ | 2.810 days | 2 884 days | | |
| $T_{tol}$ | 6 437 days | 8.389 days | | |

MRL : Leaves 5 ppm; Pods 1 ppm

Table 3. Residues (ppm) of monocrotophos in mung bean crop, kharif

| Days after spray | 0.02% spray | 0.04% spray |
|---|---|---|
| | **LEAVES (I SPRAY)** | |
| 0 | 24.258 | 35.759 |
| 2 | 10.178 (58.040) | 14.343 (59.890) |
| 4 | 5.419 (77.659) | 8.195 (77.001) |
| 8 | 2.346 (90.327) | 3.586 (89.973) |
| 12 | 2.078 (91 349) | 3.040 (91.498) |
| 16 | 1.503 (93 802) | 2 792 (92.191) |
| 20 | 0.875 (99.639) | 2.451 (93.945) |
| 24 | BDL (100) | 2.148 (93.993) |
| 28 | — | 1.867 (94.778) |
| **RE :** | Y = 1.38485 - 0.06398 x | Y = 1.5534 - 0.0382 x |
| **RL 50** | 4.70[illegible] days | 7.879 days |
| $T_{tol}$ | 10.72 days | 22.367 days |
| | **PODS I SPRAY)** | |
| 28 | BDL | 1.299 |
| | **PODS (II SPRAY)** | |
| 0 | 2 328 | 4.912 |
| 0-pw | 0.892 (61.65) | 1.849 (62.343) |
| 2 | 0.892 (61.65) | 1.946 (60.394) |
| 4 | 0.797 (65.766) | 1.754 (64.291) |
| 8 | 0 638 (72.607) | 1.451 (70.456) |
| 12 | 0 542 (76.717) | 1.259 (74.353) |
| 16 | 0.104 (98.551) | 0.462 (90.586) |
| **RE :** | Y = 0.3671 - 0.06534 x | Y = 0 6913 - 0.04542 x |
| **RI 50** | 4.[illegible]06 days | 6.627 days |
| **Total** | 5.618 days | 15.22 days |
| | **GRAINS (II SPRAY)** | |
| 12 | 0.395 | 0.5849 |
| 16 | BDL (100) | 0.1501 |
| 20 | — | 0.079 |

MRL : Leaves 5 ppm : Pods = 1 ppm : grains 0.1 ppm

In kharif, grains from the mature pods picked up at 12, 16 and 20 days after 0.04% spray respectively contained 0.585, 0.150 and 0.079 ppm of monocrotophos residues. Residues from monocrotophos 0.02% spray appeared only in the grains harvested at 12 days after spray and not in later pickings.

Levels of initial deposits were very high as compared to other reports. With 0.04% spray of monocrotophos, ID were reported to be 9.42 ppm in chickpea leaves (Singh and Gupta, 1981) and 5.63 ppm (Vyas, 1977) and 7.70 to 8.08 ppm (Vyas et al., 1979) in mung bean. Chandrasekhar (1984) reported ID on leaves by 0.036% monocrotophos spray to be 4.552 ppm in pea and 4.905 to 5.076 ppm in chickpea. ID were 3.69 ppm in cowpea (Dutta, 1977). On the other hand, higher levels of ID have also been reported by many workers. By 0.08% monocrotophos spray in chillies, ID on leaves were 88.79 ppm (Narkhede et al., 1977). Shetgar et al. (1982) also obtained 20.78 to 56.76 ppm ID on okra leaves with monocrotophos 0.03 to 0.07% sprays.

The vast differences in initial deposits reported by different workers in various crops and even in the same crop by similar concentration of sprays might have been due to different properties of the leaf surfaces, different stages of the crops, varied amounts of spray volumes or levels of coverage and differences in the distribution patterns of droplets by different types of nozzles, pressure of spray discharge, position of nozzle during spray etc.

**Dissipation patterns of endosulfan and monocrotophos**

Dissipation pattern of endosulfan residues differed from that of monocrotophos. It was a little slower in summer than in kharif Chandrasekhar (1984) also reported the dissipation of endosulfan in sugarcane leaves to be slower in summer (June) than in winter (January). Longer persistence of 0.07% spray of endosulfan in summer than in kharif could be ascribed only to relative humidity which was low (31-66%) in summer and high (55-86%) in kharif (Fig. 1). Washing effect of rains could also be a reason for reduced persistence of endosulfan in rainy season.

Dissipation of endosulfan from the leaves was substantially more than 50% within two days of application, except that dissipation of 0.07% spray was slower (38.2%) in summer. The dissipation was initially rapid. It was, however, slower beyond 4 days after spray in kharif and 12 days after spray in summer (Fig. 2). Verma and Pant (1976) also reported a similar trend of endosulfan dissipation in mung bean. In the pods, dissipation of endosulfan (Fig. 3) was even faster. On the other hand, Pandey et al. (1977) observed the endosulfan residues in chickpea to be more than 2 ppm even at 25 days after spray.

Unlike endosulfan, dissipation of monocrotophos was faster in summer than in knarif. The course of dissipation of the two concentrations of monocrotophos followed almost a parallel pattern in summer season (Fig. 4) whereas there was a conspicuous difference in the rate of dissipation of the two concentrations in kharif crop.

Initial dissipation of the residues of monocrotophos was very rapid upto first 8 days in leaves (Fig. 4). Thereafter dissipation was very gradual. Maximum dissipation occurred in the first 4 days. In leaves, the residues of monocrotophos reached MRL for fodder (5 ppm) in 6.437 and 8.389 days in summer and in 10.72 and 22.367 days in kharif for 0.02% and 0.04% sprays, respectively.

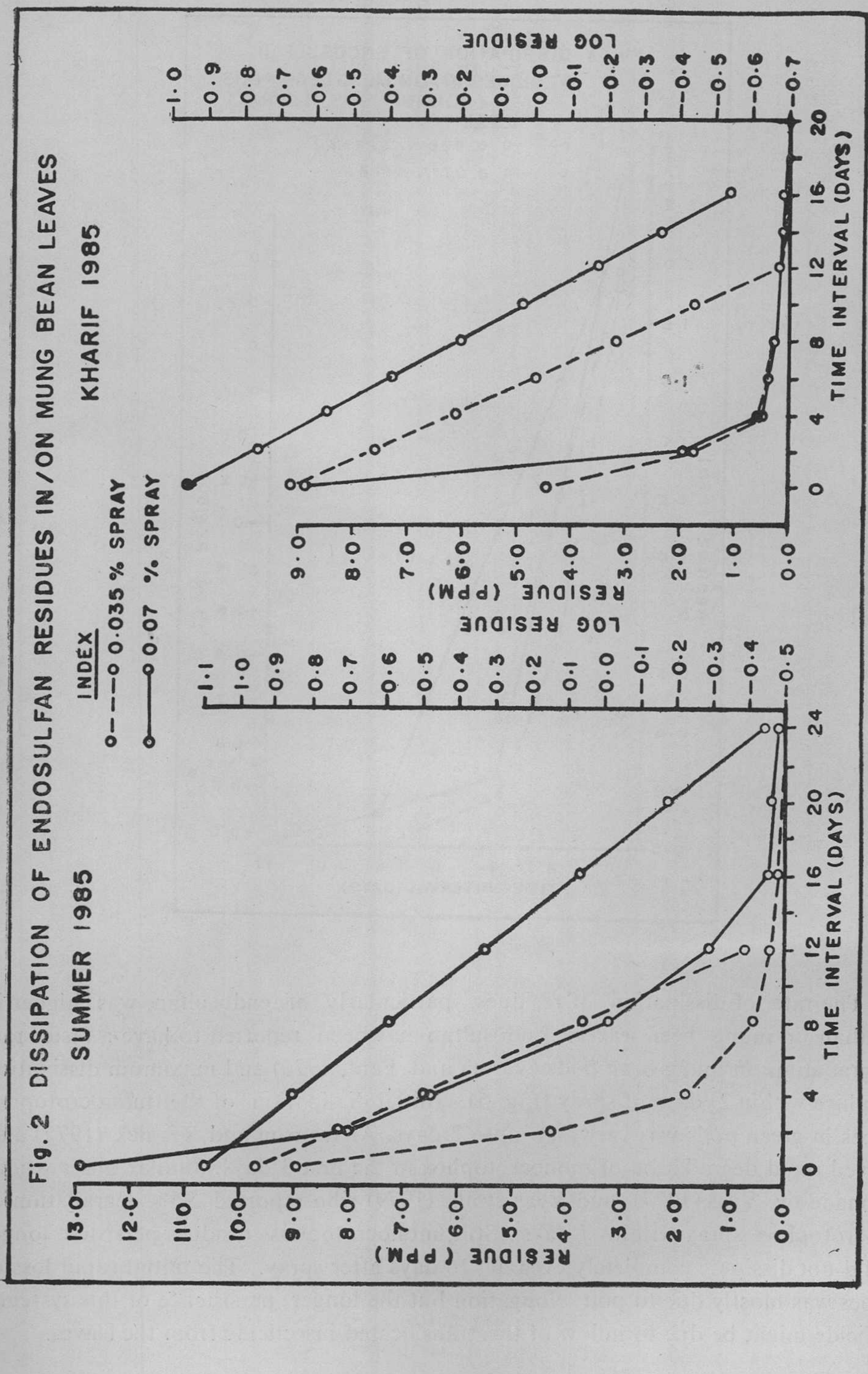
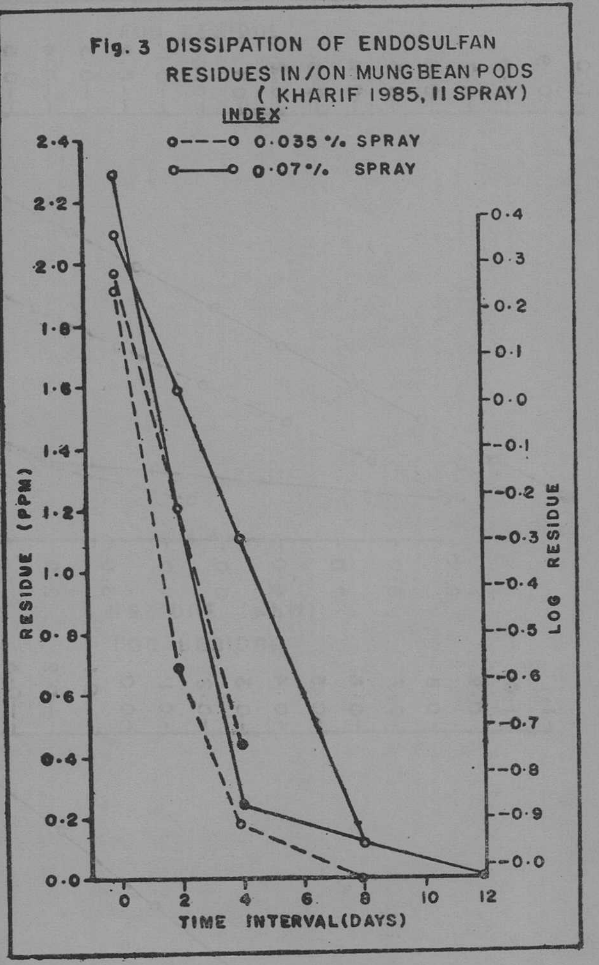



Fig. 2 DISSIPATION OF ENDOSULFAN RESIDUES IN/ON MUNG BEAN LEAVES




The rate of dissipation of residues, particularly of endosulfan, was higher in pods than in mung been leaves. Endosulfan has been reported to have a faster rate of degradation on mung bean pods (Verma and Pant, 1976) and maximum dissipation took place within 2 days of spray (Fig. 5). Initial dissipation of the monocrotophos residues in green pods was very fast upto 2 days. Aharonson and Resnick (1972) also observed rapid degradation of monocrotophos in the first 3 days. Similar observations were made by Vyas (1977) and Vyas et al. (1979) who reported 95% degradation of monocrotophos spray within 7 days. Still, monocrotophos residues persisted longer and did not dissipate completely even at 16 days after spray. The initial rapid loss of residues was mostly due to pod elongation but the longer persistence of this systemic insecticide might be due to inflow of the translocated insecticide from the leaves.

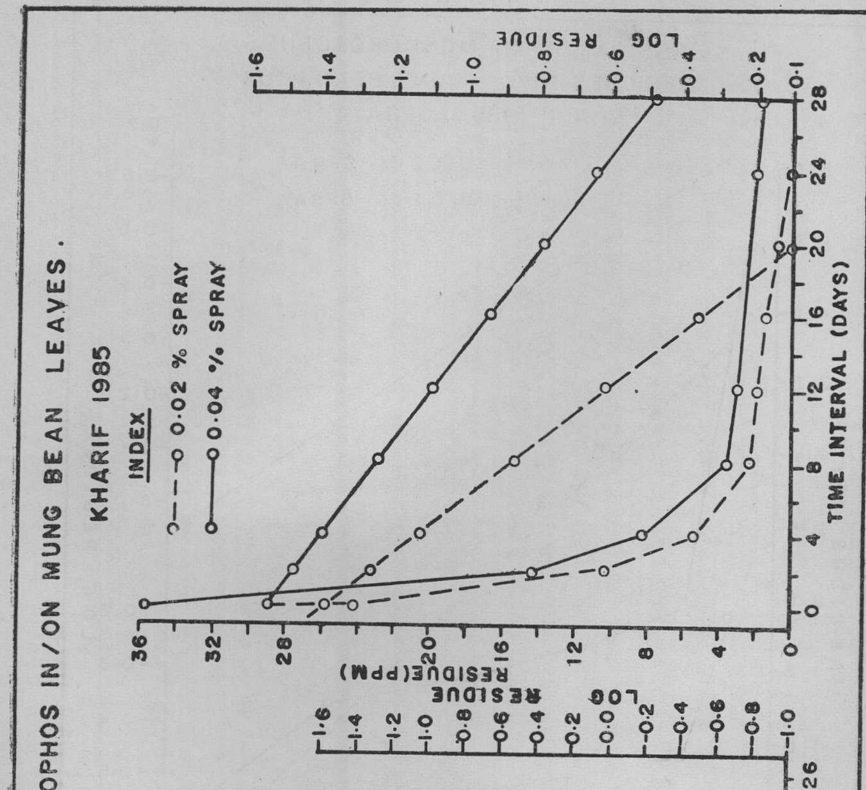
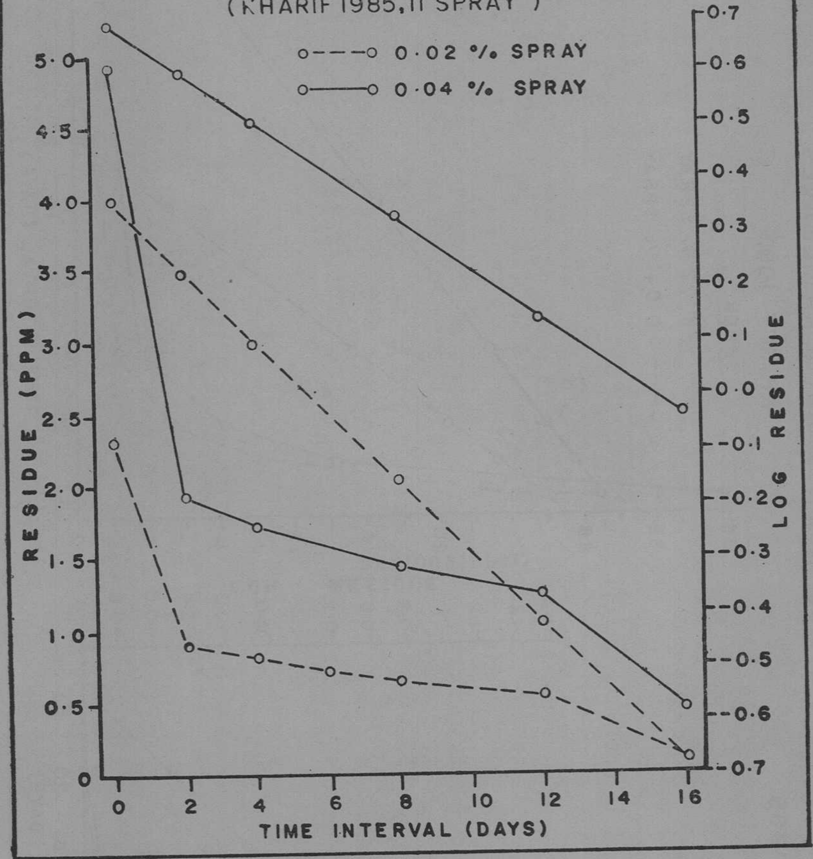



Fig. 4 DISSIPATION OF MONOCROTOPHOS IN/ON MUNG BEAN LEAVES.

Fig. 5 DISSIPATION OF MONOCROTOPHOS RESIDUES IN/ON MUNG BEAN PODS (KHARIF 1985, II SPRAY)




The shortest interval between the spray and the harvesting was of 2 days with no harvest time residues in grain in the case of endosulfan. Absence of harvest time residues of endosulfan in mung bean grains has been reported also by Verma (1975) and Vyas (1977). Residues of monocrotophos were detectable in grains upto 20 days after 0.04% spray, although below MRL at 16 days after spray. Manohar and Balasubramanian (1980) also detected 0.2 ppm monocrotophos residues in blackgram grains harvested 20 days after spray but Awasthi et al. (1977, 1978) however, found no harvest time residues of monocrotophos in cowpea and soybean grains.

**Half life ($RL_{50}$) values and waiting periods ($T_{tol}$)**

These studies revealed that with maximum $RL_{50}$ of 4.64 days in summer and 3.23 days in rainy season, endosulfan residues in leaves reached tolerance level (maximum residue limit) in amarimum of 6.4 days. In case of monocrotophos (maximum $RL_{50}$ 7.9 days), the maximum residue limit was reached latest in 8.4 days in summer (Table 2) and in 22.4 days in rainy season (Table 3). Obviously, mung bean straw at harvest would contain little or no residues of monocrotophos if the insecticide is applied not later than 3 weeks before harvesting of the crop. In case of endosulfan, mung bean straw can be used as fodder just a week after spray.

On green pods, maximum $RL_{50}$ was 1.8 days for endosulfan and 6.3 days for monocrotophos. The maximum time required for residues to reach tolerance level ($T_{tol}$) was $<1$ day for endosulfan and 15.2 days for monocrotophos. Dikshit (1986) reported a waiting period of 25 days for monocrotophos in green pods. Thus, when green mung bean pods are to be used as a vegetable, only endosulfan can be recommended as a safe insecticide requiring no more than 1 day of waiting period.

Since the grains are not consumed raw and a considerable time lapse is always there between harvest of the grain pulse and its consumption, prescription of a waiting period based upon harvest time residues is not warranted. For the control of a pest like *Cydia ptychora* which attacks ripening pods only, late application of monocrotophos after the pod formation may sometimes be required. Under such conditions, a 2-week interval between the last spray and the harvest may be sufficient for a grain crop.

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