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Mobility, Distribution and Persistence of Metalaxyl Residues in Pearl Millet (*Pennisetum americanum* (L.) Leeke.)

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Metalaxyl (Ridomil) chemically known as methyl N-(2-methoxyacetyl)-N-(2,6-xylyl)-DL-alaninate is a systemic fungicide known to control diseases caused by Oomycetes fungi (Schwinn et al. 1977 and HouseWorth, 1987). The fungicide is available in different formulations such as Apron 35 WS (for seed treatment, Ridomil 5G (for soil treatment), Ridomil 25 WP (for foliar sprays) and in mixtures as (metalaxyl +) mancozeb; captan; folpet and copper oxychloride. Several reports stated its systemic property in different crops and showed the relation between fungicide accumulation in plants during growth and disease control (Kotwaletet al., 1981; Tonini and Avigliano, 1981). However a crop like pearl millet (Pennisetum americanum (L) Leeke) in India is repeatedly attacked by downymildew disease caused by the fungus; Sclerospora graminicola Sacc. Schroet, resulting in total crop failures in northern states of the country. Singh et al.,(1986) demonstrated the uptake and translocation of 14c-metalaxyl in pearl millet following seed application only. It is showed that metalaxyl persisted in maize for 29 days following seed treatment (Cho, 1981), for four weeks in lettuce (Curte 1980) and entire crop season in pea and sunflower (Brokenshire, 1980; Niklov, 1981). The present study aims at discovering the possible accumulation and persistence of fungicide residues in the vegetative parts of the plant and harvested seeds as it is used as a food and fodder crop in semi-arid tropics.

MATERIALS AND METHODS

Freshly harvested seeds of NHB-3 a downy mildew susceptible pearl millet cultivar obtained from a

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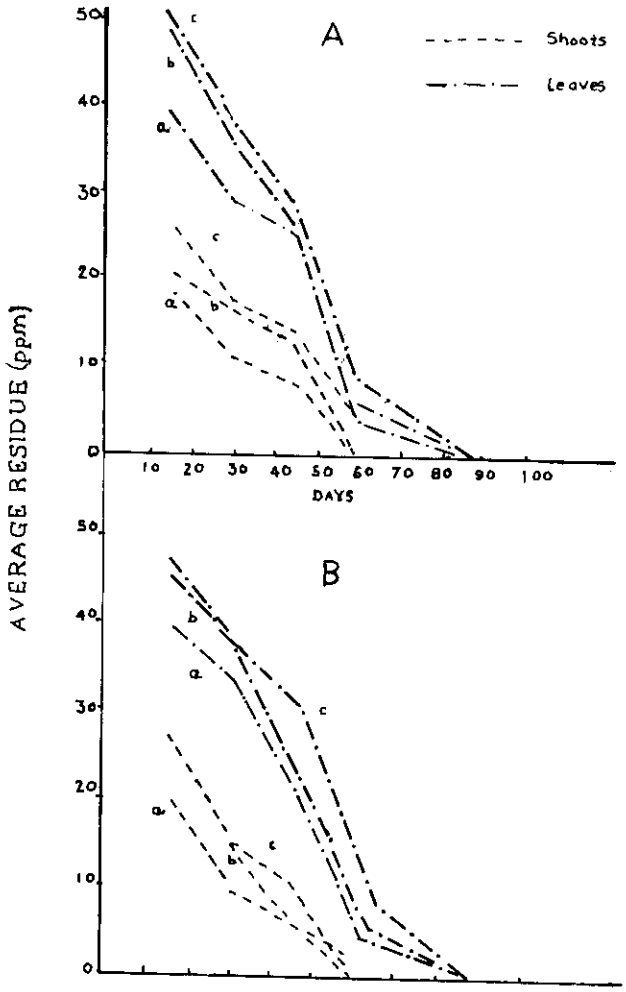

Figure 1. Uptake and persistence of Metalaxyl in pearl millet when applied to seed (Apron 35WS) A-2.10; B-2.62 g a.i./kg.

qualified plant pathologist of an agricultural university were used. Formulations of metalaxyl such as Apron 35 WS, Ridomil 25 WP and Ridomil 5G obtained as gift from Prof. F.J. Schwinn, Ciba-Geigy agrochemical division, Basel, Switzerland.

The formulations of metalaxyl were utilised as per the recommended mode of treatment. Field experiments were carried out in plots measuring 5 m^2 for seed treatments and 1 m^2. for soil applications. Four replicates of each treatment were maintained in a randomized block design.

Seeds were treated with Apron 35 WS at two concentrations viz; 2.10 and 2.62 g a.i./kg as

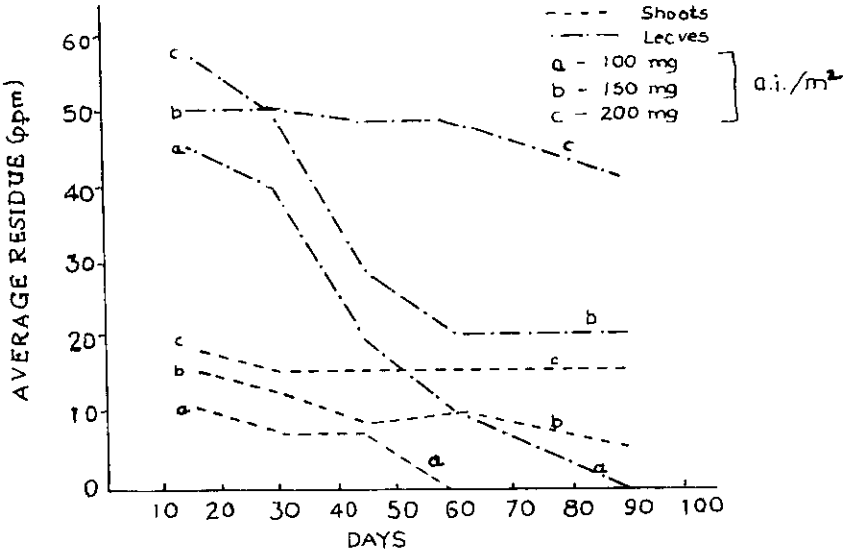

Figure 2. Uptake and persistence ofMetalaxyl in pearl millet when applied to soil (Ridomil 5G).

recommended by government of India and Ciba-Geigy Switzerland respectively as dust, slurry and soak methods. In dust method dry seeds were thoroughly shaken with dry formulation of the fungicide in a plastic bag for 10 minutes. In slurry seeds were stirred in a methyl cellulose + fungicide suspension (required quantity of fungicide + 750 ml 1% methyl cellulose /kg seed). While soaking was carried out for four hours in the fungicidal suspension prepared by dissolving the calculated amount of the fungicide in a litre of water. In the soil treatment method the fungicide was broadcasted at the rate of 100, 150 and 200 mg a.i./m^2 (equivalent to 1,1.5 and 2 kg a.i./ha respectively). Foliar spray suspensions of the fungicide were sprayed at the rate of 125, 250, 500 and 1000 ppm using low volume hand sprayer at the rate of 500 l/ha.

The treated seeds were sown in the field and normal irrigation practices were followed. Plant material (roots, shoots and leaves) was collected at 15,30, 60 and 90 days after sowing (DAS) to asses the fungicidal residues. Similarly untreated seeds were sown in the field treated with the fungicide and the plant material was collected at similar intervals. Foliar sprays of the fungicide were undertaken on 15 days old seedlings and the material was collected at 30, 60 and 90 DAS. In double dose application of the fungicide the plants raised through seed treatment (2.10 g a.i./kg) and soil treatments (100 and 150 mg a.i./m^2) were sprayed at

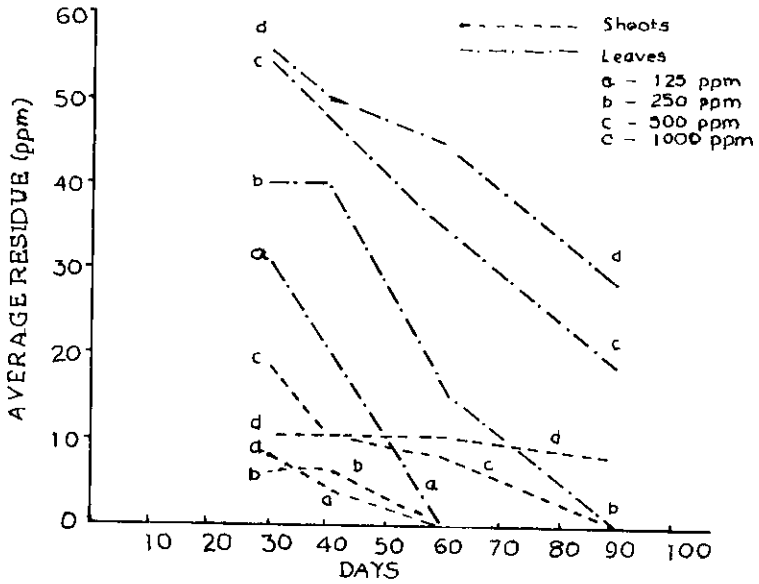

Figure 3. Uptake and persistence of Metalaxyl in pearl millet when sprayed (Ridomil 25WP) after 15 days of seedling growth.

125 and 250 ppm at 25 DAS and plant material was collected at 45, 60 and 90 days. Seeds harvested from plants in all the treatments were analysed for the fungicidal residues.

The residues were extracted following the procedure of Ciba-Geigy Ltd., (Anon, 1976). At each time 50 g of leaves, 50 g of shoots, 25 g of roots and 50 g of harvested seeds at the end were collected and macerated in methanol (1:3 W/V). The slurry was filtered and transferred to a separating funnel of 500 mL capacity containing 200 mL of water and 20 mL of saturated sodium chloride solution. The aqueous solution was extracted three times, each time with 75 mL of dichloromethane. The dichloromethane fraction was collected, filtered and evaporated to dryness. The residues were dissolved in 5mL of hexane and subjected to column chromatography. The detection and estimation was done by gas liquid chromatography (GLC).

A Varian Aerograph series 1400 GLC equipped with a 6 feet 1/8" internal diameter (1.d.) stainless steel column packed with 5% carbowax in chromosorb p of 60-80 mesh was employed. Nitrogen gas flow was maintained at 50 ml/min as a carrier. The flow of hydrogen (45 mL/min) and air (240 L/min) were adjusted. The injector, column and detector were operated at 210, 170 and 200° C respectively at $4x10^{-2}$ range. Alkali flame ionisation detector with rubidium sulphate was

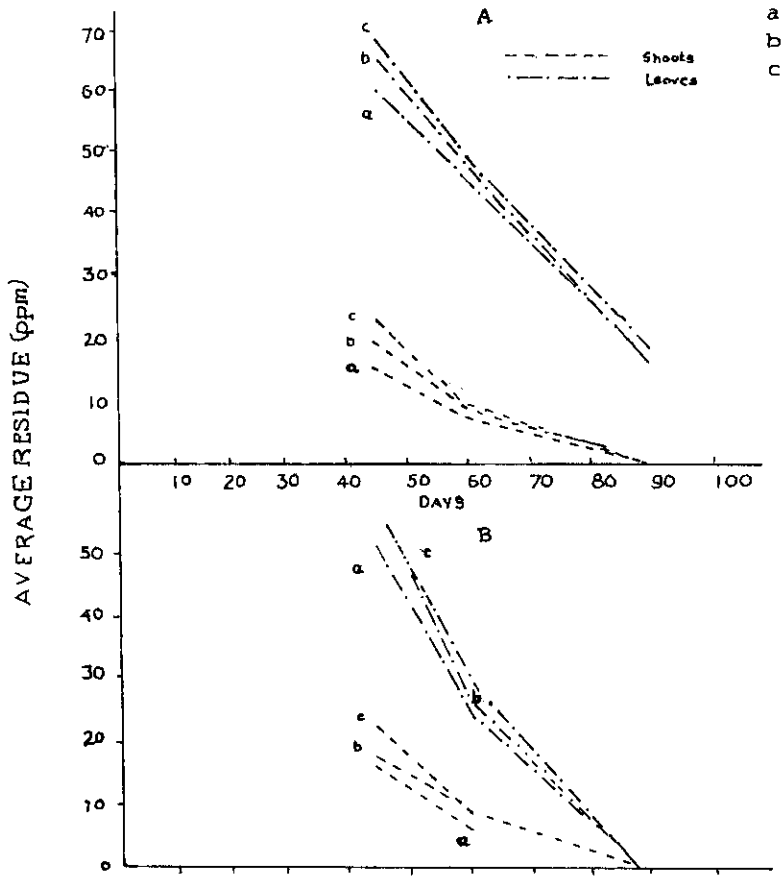

Figure 4. Uptake and persistence of Metalaxyl in pearl millet when applied to seed (Apron 35WS) at the rate of 2.1 g/kg by three methods and followed by foliar sprays (Ridomil 25WP) at A-125 ppm and B-250 after 25 days of plant growth.

employed. The aliquots of extracted fungicide were injected to GLC and the residues were quantified by comparing with the standard peaks obtained.

RESULTS AND DISCUSSION

Figure 1 depicts the distribution of residues in plant parts raised through seed treatment. In general a time dependent decrease of fungicidal residues were observed in different plant parts. The risidues persisted in all the plant parts upto 45 days of plant growth at both the seed treatment levels. Only the leaves showed residues upto 60 days. In all the treatments roots and shoots showed same amount of residues. Since the amount of fungicidal residues recorded in roots and

= Dust
= Slurry
= Soak

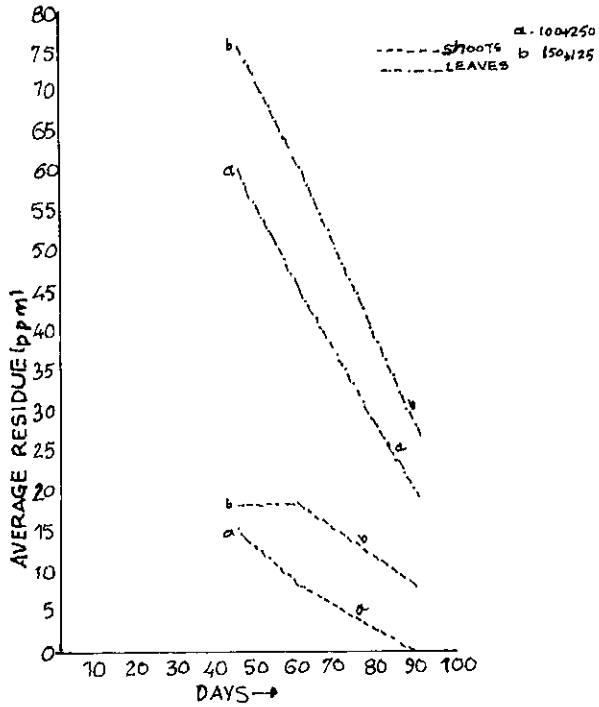

Figure 5. Uptake and persistence of metalaxyl in pearl millet when applied to soil (Ridomil 5G) at two concentrations (100 and 150 mg a.i./m^2) and followed by foliar sprays (Ridomil 25WP) at two concentrations (250 ppm and 125 ppm in water) after 25 days of plant growth.

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shoots were almost similar we have presented residues in shoots and leaves in all the figures. The uptake of the fungicide was initially more in soak method followed by slurry and dust. The increased recovery of the fungicide in soak method of treatment could be due to enhanced mobility of the fungicide when seeds were soaked in the fungicidal suspension. It is said that the absorption, mobility and translocation of any compound into the plant system depends upon the lipophilicity, which is measured as octanol- water partition coefficient (Edgington, 1981). The octanol water partition coefficient of metalaxyl lies in the intermediate range (1.59; as determined by Singh and Tripathi, 1982) which suggests that the fungicide should be absorbed and translocated readily. A major portion of metalaxyl is lost either through diffusion from seed into the soil during germination or remain in seed parts which are shed to ground after some time (Singh etal. 1986). It is yet to be confirmed whether the fungicide lost into the soil gets circulated back to the plants through roots.

Figure 2 shows the distribution of residues in plants raised in treated soil. The residues persisted upto 45 days at 100 mg a.i./m^2 treatment, but the leaves showed the fungicide (5 ppm) upto 60 days. The residues persisted for 90 days in all the plant parts from 150 and 200 mg a.i./m^2 treatments. A dose dependent increased uptake of fungicide was noticed.

Foliar sprays of the fungicide at the concentration of 125, 250, 500 and 1000 ppm revealed the residues in all the plant parts upto 40 days. At 250 ppm spray leaves showed up 60 days and at 500 ppm it was up to 90 days (Figure 3). At all the treatments leaves maintained high amount of residues. This could be due to direct relation between the fungicide accumulation and transpiration water loss as demonstrated by Peterson and Edgington (1971).

When seed treatment followed by foliar spray, the residues were detectable upto 60 days in roots and shoots and 90 days in leaves at higher concentation (Figure 4). Figure 5 shows distribution of residues in plants raised through soil treatment and foliar spray. Similar pattern of persistence of residues as in seed treatment + Foliar sprays was observed.

Seeds harvested from the plants raised through all the above treatments of the fungicide were free from the residues. Residue analysis could not be carried out from seeds of the crop raised through the highest soil treatment concentration of 200 mg a.i./m^2 due to poor seed setting. This concentration is phytotoxic.

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