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# Impact of pesticides-mycorrhia interaction on growth and development of wheat

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## ABSTRACT

In the present study impact of five pesticides viz. G- 696, Bavistin, Thiram, Captan and Aldrin on VAM colonization, host growth and nutrient uptake of wheat has been quantified. Most of the test pesticides suppressed the plant height, total dry weight of root-shoot and mycorrhizal density of host plants as compared to VAM alone treated plants. Captan application exhibited most inhibitory effect on all the parameters followed by Thiram and Bavistin. The plant nutrients i.e. nitrogen, phosphorus and potash uptake was also significantly affected by the application of pesticides.

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## INTRODUCTION

Pesticides are designed to react with living cells. Though a wide range of such chemicals is directed to protect plants from pathogenic organisms, many of these toxicants adversely influence the symbiotic relationships between the host plants and the microorganisms. In the present studies, vesicular arbuscular mycorrhiza (VAM) has been taken as a microbial model system, since phosphorus uptake by VAM fungi in symbiotic association with the roots of higher plants is emerging as one of the frontier areas for the improvement of crop productivity. This is of particular significance because VAM occurs on a large range of commercial crops; and the wide use of toxic material in normal farming system may upset this balance. Most of the crop plants benefit from the VAM association because of greater efficacy in nutrient (particularly phosphorus) and water uptake from soil (Zakaria *et al.,* 2010). The VAM fungal colonization of roots has also been shown to increase the drought resistance of wheat (Al-Karaki 1998; Ghazi *et al.,* 2004).

In our preliminary studies, a diverse group of pesticides comprising fungicides, insecticides, nematicides and herbicides were evaluated to quantify their side effects on VA-mycorrhizal growth and development in major commercial crops *viz.,* chickpea, pigeon pea and pearl millet (Jalali *et al.*1989). In the light of information generated during these studies, the present study was under taken with a view to quantifying the impact of some commonly used pesticides on the colonization of VAM endophyte *Glomus fasciculatum*, host growth and nutrient uptake in wheat (*Triticum aestivum* L.) plants.

## MATERIALS AND METHODS

A pot trial was conducted at CCS Haryana Agricultural University, Hisar in a Randomized Block Design. The pots were filled three fourths with nutrient–deficient steam sterilized (15 lb. p.s.i. for 2 h twice on alternate days) soil having pH 7.9; with available N, P, K as 19.8, 9.0 and 25.7 ppm, respectively. Details of the test pesticides included in the present studies are: Metsulfovax (G- 696 20% WP) (2, 4-dimethyl-5-carboxanilido thiazole) @ 1.0 g/ml a.i. seed$^{-1}$; Carbendazim (Bavistin 50% WP) Methyl-2 benzimidazole carbamate @ 2.0 g/ml a.i. seed$^{-1}$; Thiram (Thiram 50%WP ) (Tetramethyl thiuram disulphide) @ 2.0 g/ml a.i. seed$^{-1}$; Captan (Dhanutan 50%WP) (N-trichloromethyl-thio-4-cyclohexene-1,2-dicarboximide) @ 2.0 g/ml a.i. seed$^{-1}$ and Aldrin (Aldrex 30% EC) (1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-dimethanonapthalene) @ 2.0 g/ml a.i. seed$^{-1.}$

The inoculum of mycorrhizal fungus *Glomus fasciculatum* (approx. 450 extramatrical spores/ 100g soil) was placed in mycorrhizal sets at upper 2" soil layer of the pot (50 g/kg soil). Ten seeds of wheat variety WH-147 were planted in each pot and later thinned out to maintain five plants /pot. The plants were maintained under green-house conditions with regular watering. Observations were recorded for plant height (at two plant growth stages i.e. 60 and 100 days), total dry weight of roots and shoots, mycorrhizal density and nutrient content of plants. Mycorrhizal density of the roots was assessed by the method of Jalai and Domsch (1975) after clearing the root segments with 10 percent KOH and stained with trypan blue (Phillips and Hayman, 1970). The nutrient content of roots and shoots were estimated by Jackson’s (1958) methods.

## RESULTS AND DISCUSSION

By and large, most of the pesticides suppressed the plant height, dry weight of root-shoot and mycorrhizal density of host plants as compared to mycorrhiza alone treated plants (Table 1). On the other hand, those mycorrhizal plants having received pesticide application had better plant growth and dry weight than plants with pesticides application alone. Captan application exhibited most inhibitory effect on VAM colonization with 28.93% reduction followed by Thiram, Aldrin , Bavistin and G-696 over mycorrhizal alone inoculated plants. The application of Captan and Thiram with VAM inoculation exhibited maximum reduction of plant height as compared to VAM alone at 60 days and 100 days , respectively. Further, Thiram had also affected the root and shoot dry weight biomass with 54.83% and 40.95% reduction compared to control (VAM alone).

The data computed in Table 2 indicate that application of pesticides significantly affected the uptake of major plant nutrients *viz.*, nitrogen, phosphorus and potash. All the pesticides treated plants had less nitrogen content of root and shoot than control (+VAM). However, the most potent

**Table 1.** Effect of seed treated Pesticides - VAM inoculation on plant growth parameters of wheat

| Treatment | Plant height (cm) | | Dry weight (g/plant) | | Mycorrhizal density (0-4 scale) |
|---|---|---|---|---|---|
| | 60 DAS | 100 DAS | Root | Shoot | |
| G- 696 | 29.18 | 56.40 | 0.501 | 1.00 | 0.00 |
| G- 696 + VAM | 31.16 | 59.00 | 0.576 | 1.26 | 2.90 |
| Bavistin | 29.48 | 52.41 | 0.444 | 0.93 | 0.00 |
| Bavistin + VAM | 32.08 | 62.38 | 0.700 | 1.27 | 2.60 |
| Thiram | 27.30 | 44.75 | 0.397 | 0.83 | 0.00 |
| Thiram + VAM | 27.64 | 54.13 | 0.496 | 1.05 | 2.40 |
| Captan | 20.54 | 46.70 | 0.390 | 0.78 | 0.00 |
| Captan + VAM | 28.70 | 50.46 | 0.506 | 1.15 | 2.35 |
| Aldrin | 27.70 | 51.45 | 0.556 | 0.91 | 0.00 |
| Aldrin + VAM | 33.96 | 60.13 | 0.669 | 1.12 | 2.43 |
| Control- I- (+VAM) | 35.89 | 65.33 | 0.768 | 1.48 | 3.03 |
| Control- II (-VAM) | 29.22 | 53.76 | 0.507 | 1.02 | 0.00 |
| **C.D. (P= 0.05)** | **0.96** | **2.36** | **0.049** | **0.09** | **-** |

**Table 2.** Effect of different Pesticides and mycorrhizal inoculation on N, P, K content of wheat

| Treatment | N (%) | | P (%) | | K (%) | |
|---|---|---|---|---|---|---|
| | Root | Shoot | Root | Shoot | Root | Shoot |
| G- 696 | 0.251 | 0.321 | 0.071 | 0.024 | 0.661 | 0.261 |
| G- 696 + VAM | 0.336 | 0.401 | 0.162 | 0.073 | 0.712 | 0.317 |
| Bavistin | 0.250 | 0.308 | 0.083 | 0.025 | 0.665 | 0.259 |
| Bavistin + VAM | 0.311 | 0.413 | 0.170 | 0.049 | 0.703 | 0.301 |
| Thiram | 0.251 | 0.311 | 0.082 | 0.024 | 0.591 | 0.260 |
| Thiram + VAM | 0.309 | 0.421 | 0.166 | 0.069 | 0.595 | 0.307 |
| Captan | 0.261 | 0.316 | 0.079 | 0.022 | 0.610 | 0.262 |
| Captan + VAM | 0.310 | 0.431 | 0.146 | 0.065 | 0.701 | 0.316 |
| Aldrin | 0.253 | 0.314 | 0.088 | 0.023 | 0.580 | 0.263 |
| Aldrin + VAM | 0.331 | 0.442 | 0.164 | 0.067 | 0.592 | 0.312 |
| Control- I- (+VAM) | 0.344 | 0.462 | 0.178 | 0.077 | 0.720 | 0.323 |
| Control- II (-VAM) | 0.261 | 0.321 | 0.092 | 0.025 | 0.669 | 0.266 |
| **C.D. (P= 0.05)** | **0.040** | **0.056** | **0.039** | **0.016** | **0.018** | **0.021** |

effect was observed on Captan and Bavistin treatments where the P uptake was reduced more in root and shoot respectively than other pesticides application. It is very interesting to note that the plants inoculated with mycorrhiza alone doubled the phosphorus uptake than control (-VAM). Similarly, the K uptake in root and shoot was also observed lesser in Captan and Bavistin treatments than VAM alone plants. Perusal of data further confirmed the ability of VAM colonization significantly enhancing the transport of N, P and K in mycorrhizal than non-mycorrhizal plants.

Mycorrhizal fungi play an important role in the soil ecosystem, acting as a link between the autotrophic host plants and the saprophytic decomposes (Jeffries and Barea, 1994). Any pesticide that affects the host plant or the soil microflora, such as herbicides, fungicides and broad spectrum biocides are bound to affect the mycorrhizal fungi (Fontanet *et al.*, 1998). These toxicants usually decrease mycorrhizal infection and spore population. Systemic fungicides applied to soil around plants can be absorbed by roots and translocation to other parts of the plant (Isaac, 1992). These kinds of fungicides are persistent in the plant and their action on Mycorrhizal fungi can either be against their vegetative or their reproduction structures (Kurle and Pfleger, 1994).

Benomyl, which decomposes in soil to yield carbendazim and butyl isocyanate, has been shown to reduce the percentage of mycorrhizal infection in root samples (Tommerup and Briggs, 1981). Earlier, Jalali and Chhabra (1991) also observed that seed and soil application with conventional and systemic fungitoxicants restricted the development of VAM of host roots and also changed the pattern of amino acid exudation from such roots. The other fungicide Benomyl is among the most frequently used systemic fungicides against pathogenic fungi of cereals and oil seed plants (INTA 1997). In fact, this fungicide inhibits mitosis by blocking the formation of microtubules when chromosomes are separated (Howard and Aist 1980; Hammersachlag and Sisler, 1973; Isaac, 1992). Nevertheless, we should not overlook the ecological significance of the deleterious influence of pesticides on symbiotic relationship that exists in mycorrhizal plants; instead efforts should be focused to strike a balance in the quantum of pesticide application without adversely affecting normal mycorrhizal colonization. Therefore, for strong mycorrhizal development and growth, avoid applying insecticides and fungicides to seed or the soil around plants, and avoid systemic fungicides. However *if required*, choose the fungicide and/or insecticide carefully; and apply at recommended label rates, taking into account factors such as climatic conditions, soil moisture etc.

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