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RESEARCH ARTICLE

COMPATIBILITY OF AGROCHEMICALS

Jyothsna[1].M., Parimal Kumar[2].M and Divya Rani[3].V and Vishwamitra[4].V

[1 & 3] ANGRAU, Hyderabad – 500030
[2]IARI, New Delhi-110012
[4]Department of Entomology, ANGRAU, Hyderabad-500030

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ABSTRACT

The knowledge about compatibility of agrochemicals is very vital in selecting the compatible combination for effective management of insect pests, diseases and weeds. Combined application of pesticides is a labour saving short cut method, but an understanding and knowledge of pesticide compatibility is essential in order to avoid problems which may arise from combinations of some pesticides. Pesticide combinations may show physical, chemical or phytotoxic incompatibility causing undesirable results. Hence, information on compatibility of different agrochemicals is essential for adopting the technology in field. In this paper different kinds of incompatibility and its possible effects, compatibility of different agrochemicals were discuseed.

INTRODUCTION

It is often economical and convenient to apply a mixture of two or more pesticides when a wide range of pests and diseases must be controlled. In most instances pesticide user must add separate products to the spray tank. These products must be compatible with each other. Two or more pesticides, or pesticides and a fertilizer, are compatible if no adverse effects occur as a result of mixing them together. The deactivation of active ingredient often occurs. Applying a tank mix of pesticides, or a pesticide and a liquid fertilizer, can save time, labour, energy and equipment costs. Pesticide combinations usually alter plant absorption and translocation as well as metabolism and toxicity at the site of action of one or more of the mixed products. Not all changes are for the better. Negative effects can occur such as reduced pest control, increased damage to non-target plants (phytotoxicity) and incompatibility problems between materials.

Compatibility

Compatibility is the ability of two or more components of a pesticide mixture to be used in combinations without impairment of toxicity, physical properties or plant safety of either of the component.

Possible effects of mixing incompatible chemicals

- Reduced effectiveness of one or both compounds.
- Precipitate in the tank, clogging screens and nozzles in the sprayer.
- Plant phytotoxicity, stunting or reducing seed germination.
- Excessive residues.
- Excessive runoff.

Types of Interactions

1. Additive effects
2. Synergism
3. Antagonism
4. Enhancement

1. Additive effects

Mixing of two pesticides provides the same response as the combined effects of each material when applied alone. The products neither hurt nor enhance each other. Such mixes save time, labour and equipment use. Dhakshinamoorthy *et al. (*1981) reported that methamidohos and maneb mixture shown additive effect against chilli white aphid. When FMC 35001 0.048% mixed with Maneb 0.2% showed additive effect i.e., % reduction of *Myzus persicae* population by FMC 35001 0.048% + Maneb 0.2% was 78% same as FMC 35001 0.048% alone applied(77% of reduction).

2. Synergism

When pesticides provide a greater response than the added effects of each material when applied separately. Piperonyl butoxide (PBO) has some insecticidal activity on its own but real benefit is adding it to pyrethrum, it suppresses MFO's which the insect uses to detoxify insecticide so insect gets greater wallop than from pyrethrum alone. Field experiments conducted in the wet season of 2005 and 2006 at APRRI, Maruteru revealed that imidacloprid 200SL @ 0.25ml + validamycin 3 L @ 2.5 ml/litre of water reduced the plant hopper build-up and sheath blight incidence effectively and recorded higher grain yields in both the seasons (Bhanu *et al*., 2007).

3. Enhancement

* Corresponding author: **Jyothsna**
Ph. D. Schoalr, ANGRAU, Hyderabad – 500030

It is not between two pesticides and happens with some adjuvants. When pesticide is mixed with an additive to provide a greater response than if pesticide is applied alone.

4. Antagonism

When two pesticides applied together produce less control than if each material is applied separately. Fenobucarb mixed with tridemorph exhibit antagonistic effect against *Spodotera litura (*Prakash and Srivastava, 1992). In addition to reducing control, antagonistic responses also may increase phytotoxicity to plants. When the herbicides Assert® (imazamethabenz-methyl) and Banvel® (dicamba) are mixed together, they negatively affect each other's performance. Lakshminarayana and Subbaratnam (2000) reported that monocrotophos at its LC_{50} (0.52 ppm) in combination with all test concentrations of mancozeb resulted in less than 50% non-germination of *C. gloeosporioides* spores as compared to when mancozeb applied alone. It is evident that the interaction decreased the activity of thiodocarb LC_{50} with all concentrations and exhibiting incompatibility with antagonism.

Types of Incompatibility

1. Chemical
2. Mechanical
3. Phytotoxic
4. Physical

1. *Chemical Incompatibility*

When two or more pesticides are mixed together the resultant loss or reduction of effectiveness of one or all components. Deactivation of active ingredient often occurs. When tank mixing full rates of pesticides, there is not only the full rate of a.i. for both pesticides in the tank, but the full rates of adjuvant for both pesticides (basically a double dose of adjuvant for a given area). Chemical compatibility is Common in insecticides especially organophosphate E.C. formulations. Chemical incompatibility is affected by temperature**,** tank pH and length of time the mixture is held before use. Avoid tank mix combinations for strongly acid and alkaline materials which can result in chemical incompatibility. In areas where pesticides, particularly certain insecticides, are mixed with alkaline water, inactivation has been known to occur, especially when held in suspension overnight or extended periods.

2. *Mechanical Incompatibility*

Reasons for mechanical incompatibility were different pesticides may require different droplet size to be most effective, spray volumes may vary, adjuvant recommendations may vary, over agitation may cause foaming in some older products. In case of soybeans smaller droplet size required for fungicides. But larger droplets to avoid herbicide drift will negatively affect fungicide efficacy.

3. *Phytotoxic Incompatibility*

When two or more pesticides used in combination result in injury to the host plants. Pesticides are perfectly safe when used alone, but injurious in certain combination. Symptoms include chlorotic spots, darkened shallow pits on fruits, scortching and bleaching of foliage and reduced growth. They often not caused by active ingradient but by adjuvants. Seen very frequently in oil-based pesticide mixtures (E.C. formulations) Mixture of sencor (metribuzin) and Tilt (propiconazole) was incompatible and highly phytotoxic resulting in low yield (28.8 q/ha) when sprayed against foliar diseases of wheat i.e, rust, powdery mildew and blight. However yield obtained from control treatment was 67.4q/ha (Tewari *et al.* 2003). Among the sixteen fungicide-insecticide combinations, only three combinations containing thiodocarb viz., carbendazim + thiodocarb, Chlorothalonil + tiodocarb and Hexaconazole + thiodicarb were phytotoxic to chilli plants resulting in scortching of tip of leaves (Manohar 2005).

4. *Physical Incompatibility*

When two or more pesticides are mixed together and the result is an unstable mixture or soapy flocculate. Usually involves inert ingredients of a formulation. Sometimes a problem in EC formulations which don't have a good stabilizing agent. They may Caused due to improper mixing and sometimes avoided with jar test.

Effects of Physical Incompatibility

Unstable mixtures, Crystals, flake or sludge is formed. Clogs spray equipment. For herbicides, incompatibility most often occurs when an E.C. formulation mixed with W.P. Do not mix EC insecticides with fungicides or herbicides. Liquid fertilizers can also cause compatibility problems, mainly due to their strong electrochemical nature. Tank mixing potassium sulphate with calcium nitrate is not generally a recommended practice as this forms insoluble precipitates. Physical imcompatibility was assessed by emulsion stability test, wettability test and jar test.

Tank Mixing Guidelines

- Recommendations, labels and compatibility charts are certainly helpful but the pesticide user should take additional precautions. Check the pesticide label for tank mix recommendations and note any restraints.
- No label recommendations exist, do a jar test prior to spraying. Mix all pesticides properly and according to labels. Make sure all components of your spraying have the correct filters. If you have a spray blockage, try to retrieve the mix, before disposing of your tank mix.
- Test pH. Many incompatibilities result from excessively alkaline (sometimes acidic) pH in the tank. The addition of buffering adjuvants can help.
- Make a test application to expose any phytotoxicity or antagonism before you make a large-scale application. If you overlap a few strips, this also can show you how much of a margin of safety you have. Wait a few days for symptoms to become visible.
- Take care with fertilizers. If you add fertilizers, be aware that they can have substantial effects on the chemistry of a tank mix, especially pH. Read the pesticide label for any fertilizer restrictions.
- Do not mix iron sulfate with phenoxy herbicides. Iron sulfate is incompatible with amine formulations of some phenoxy herbicides and can cause a precipitate to form, clogging spray equipment.
- Mix no more than one soluble or emulsifiable chemical with any insoluble products such as wettable powders or flowables.
- Avoid mixing strongly acid materials with strongly alkaline materials.
- Apply sprays soon after mixing. Mixes that sit for several hours or longer are prone to degrade, especially if the pH is alkaline.

Proper Mixing Procedures

- **Mixing Order:** Pesticide labels usually provide directions for mixing different materials, often describing the sequence of mixing. In general, follow the W-A-L-E-S plan when adding herbicides to a tank mix.

❖ **W**ettable Powders (WP) then Flowables (F, DF)
❖ **A**gitate then add adjuvants such as anti-foaming compounds, buffers
❖ **L**iquid and Soluble products
❖ **E**mulsifiable concentrates (EC)
❖ **S**urfactants

- Prior to mixing you should fill your spray tank with half of the carrier intended to use, usually water. Then start the sprayer and check to make sure that all valves and gauges work and that you have proper tank agitation.
- NOTE: Compatibility agents are adjuvants that reduce the risk of incompatibility in pesticide or pesticide/fertilizer combinations. If you use a compatibility agent, it should be the first thing you put in the tank.
- **Pre-mixing:** Pre-mixing in a smaller, separate container or tank is necessary for many pesticide formulations.
- Wettable powders (WP): Make a slurry in a separate container by adding small increments of water until it forms a gravy-like consistency. Slowly add this slurry to the tank with the spray tank agitator running.
- Dry Flowable (DF) and Water-Dspersing Granules (WDG): Pre-mix with 1 part flowable to 1 part water (start with the water and add the flowable to it) and then pour the mix slowly into the tank.
- Liquid Flowables : Premix liquid flowables by adding 1 part liquid chemical to 2 parts water (or liquid fertilizer) before blending in the tank. Many labels for liquid-flowable products describe the proper mixing procedure.

CONCLUSION

Compatibility of pesticide mixtures thus played a greater role in management of pests, health of plants and economics of crop production. Combined application of pesticides is a labour saving short cut method, but an understanding and knowledge of pesticide compatibility is essential in order to avoid problems which may arise from combinations of some pesticides. pesticide combinations may show physical, chemical or phytotoxic incompatibility causing undesirable results. Hence, information on compatibility of different agrochemicals is essential for adopting the technology in field.

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