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Study on fungicide formulation and preparation of Bordeaux mixture

History:

Sulfur, in elemental form, appears to have been the first fungicide applied to foliage, primarily for the control of powdery mildew, as early as 1821-1824. Limesulfur was probably the first manufactured fungicide, used on fruit trees as early as in 1803, for insect control and for peach leaf curl in the early 1830's. Copper Sulphate was first used in the mid 1800's in grape vine yards to discourage theft of the grapes, in the bordeaux region of France. Prof. Pierre Marie Alexis Millardet, a French scientist observed that this antitheft treatment was effective in reducing a disease called downy mildew on grapes. He formulated a safe, effective compound in 1885, known as 'Bordeaux Mixture', was the first fungicide to receive large scale use over the world.

Fungicides:

The word „fungicide" originated from two latin words, viz., "fungus" and "caedo". The word "caedo" means „to kill." Thus the fungicide is any chemical substance which has the ability to kill the fungus.

Fungistat:

Some chemicals do not kill the fungal pathogens. But they simply arrest the growth of the fungus temporarily. These chemicals are called fungistat and the phenomenon of temporarily inhibiting the fungal growth is termed as fungistatis.

Antisporulant

Some other chemicals may inhibit the spore production without affecting the growth of vegetative hyphae and are called as Antisporulant.

Fungicides have at least three names all of which can be found on the label:
Trade name: the patented name under which a product is commercially available (e.g., Bavistin® DF).

Common name: a less technical term for the active ingredient (e.g. Carbendazim).

Active ingredient (a.i)/ Chemical name: the active component of a fungicide which denotes by (active ingredient) a.i in a fungicide (e.g., Carbendazim 50% DF).

Characters of an ideal fungicide

- It should have low phytotoxicity and long shelf life
- Stability during dilution
- It should be less toxic to human being, cattle, earth worms, microorganisms etc.
- It should be a broad spectrum in its action
- Fungicide preparation should be ready for use and must be cheaper one
- It should have compatibility with other agrochemicals
- It should be available in different formulations and easily transportable

Classification of Fungicides

Fungicides can be broadly grouped based on their

(i) mode of action
(ii) general use and
(iii) chemical composition.

I. Based on mode of action

Contact fungicide: A fungicide that remains on the surface where it is applied but does not go deeper; these fungicides have no after-infection activity. Repeated applications are needed to protect new growth of the plant and to replace material that has been washed off by rain or irrigation, or degraded by environmental factors such as sunlight.

Systemic fungicide: A fungicide that is absorbed into plant tissue and may offer some after-infection activity. Very few fungicides are truly systemic (i.e., move freely throughout the plant); however, some are upwardly systemic (i.e., move only upward in the plant through xylem tissue) and some are locally systemic (i.e., move into treated leaves and redistribute to some degree within the treated portion of the plant). Meso systemic –strongly attracted to plant surface and are absorbed by waxy layers

II. Based on general uses

The fungicides can also be classified based on the nature of their use in managing the diseases.
Seed protectants: E.g. Captan, thiram, organomercuries carbendazim, carboxin etc.
Soil fungicides (preplant): E.g. Bordeaux mixture, copper oxy chloride, Chloropicrin, Formaldehyde Vapam, etc,
Foliage and blossom: E.g. Captan, ferbam, zineb, protectants mancozeb, chlorothalonil etc.
Fruit protectants: E.g. Captan, maneb, carbendazim, mancozeb etc.
Eradicants: E.g. Organomercurials, lime sulphur, etc.
Tree wound dressers: E.g. Boreaux paste, chaubattia paste, etc.
Antibiotics: E.g. Actidione, Griseofulvin, Streptomycin, Streptocycline, etc.

III. Based on Chemical Composition

The fungicides can be broadly grouped as follows.

- Copper Fungicide E.g. Bordeaux mixture, Burgundy mixture etc.
- Sulphur Fungicide E.g. Thiram, Zineb etc.
- Mercury Fungicide E.g. Mercury bromide, thiomersal etc.
- Quinone Fungicide E.g. Chloranil, Dichlone etc.
- Benzene Fungicide E.g. Chlorothalonil Biphenyl etc.
- Heterocyclic nitrogen compound E.g. Captan, Iprodione etc
- Organo tin compound E.g. Du-ter, Brestanol etc.

Formulation: The fungicide formulation is a mixture of the active and inert ingredients in the fungicide. The most commonly used formulations are as under:

a) Solid

- Dusts are free flowing powders containing technical material in the range of 2 to 10 per cent and inert carrier.
- Granule products contain technical material in the range of 3 to 10 per cent and granule base.
- Water dispersible powders or Wettable Powders (WP) are free flowing powders containing technical material mostly in the range of 25 to 75 per cent, and contain wetting and dispersing agents and carriers.

b) Liquid

- Water soluble liquids (SL) are liquid formulations based on technical material which are insoluble in water and contain 36 to 85 per cent technical material and solvent.
- Emulsifiable concentrates (EC) are liquid formulations based on technical material which are not soluble in water and contain 25 to 80 per cent technical material, solvent and emulsifier.
- Fumigant formulations used for indoor application for storage of grains.

c) Other formulations

- Water soluble powders are similar to water dispersible powders but active ingredient is insoluble in water.
- Flowable concentrates are slurry like formulations mixable in water.
- ULV formulations are liquid formulations suitable for ultra-low volume applications.

Significance of symbols on the pesticide label

Toxicity levels of different pesticides are based on their LD_{50} values and are evident from the warning (triangle) symbols present on the package as below:

Toxicity category	**Acute oral toxicity LD_{50}(mg/Kg)**	**Color of the triangle**	**Signal word required on the label**
Extremely toxic	0-50	Red	POISON (With skull & bone mark above it)
Moderately toxic	501-5000	Blue	DANGER
Slightly toxic	More than 5000	Green	CAUTION

Formulation Abbreviations:

C = Concentrate CM = Concentrate Mixture CG = Concentrate Granules D = Dust DF = Dry Flowable DS = Soluble Dust EC = Emulsifiable Concentrate F = Flowable G = Granules LC = Liquid Concentrate or Low Concentrate LV = Low Volatile M = Microencapsulated. MTF = Multiple Temperature Formulation P = Pellets PS = Pellets RTU = Ready To Use S = Solution SD = Soluble Dust SG = Soluble Granule SP = Soluble Powder ULV = Ultra Low Volume ULW = Ultra Low W eight or Ultra Low W ettable W S = Water Soluble W SG = W ater-Soluble Granules W SL = W ater-Soluble Liquid WP = Wettable Powder WSP = Soluble Powder.

Some examples are given below-
DF = Dry Flowable E.g. Bavistin DF
EC = Emulsifiable Concentrate E.g. Tilt 250 EC
G = Granules E.g. Furadan 5G
M = Microencapsulated E.g. Galben M
WP = Wettable Powder E.g. Provax 200 WP
P= Paste E.g. Bordeaux mixture

Preparation of Bordeaux mixture:

Bordeaux mixture—a combination of copper sulfate, lime, and water—is an effective fungicide and bactericide that has been used for decades to control diseases of fruit and nut trees, vine fruits, and ornamental plants. These natural minerals, when mixed in the correct order, provide long-lasting protection to plants against diseases.

The Bordeaux Formula

Although there are many formulas for preparing Bordeaux mixture, generally a ratio of 10-10-100 works well for many disease-causing pathogens. The three hyphenated numbers represent the amount of each material to add.

The first number refers to pounds of copper sulfate, the second to pounds of dry hydrated lime, and the third to the total gallons of water. Thus a 10-10-100 Bordeaux mixture would be comprised of 10 pounds of copper sulfate, 10 pounds of lime, and 100 gallons of water (1 gallon= 4.54 L, 1 pound= 0.45 Kg).

Materials:

Copper Sulfate	Balance	P^H meter
Slaked Lime	Beaker	Measuring cylinder
Water	Stirrer	etc.

Procedure:

- Take 10 pounds Copper Sulfate and 50 gallons Water in one container and 10 pounds Slaked Lime and 50 gallons Water in another container.
- To ensure proper mixing and keep over night
- At early morning pour into 3rd container and mix
- Adjust pH label of the mixture, ~ 9 to 10 for getting maximum efficiency.

Test Bordeaux mixture before use:

- Litmus test: The Bordeaux Mixture is alkaline in reaction if it contains more proportion of lime. It should, therefore, turn red litmus paper blue. An excess of copper compound in the mixture may be dangerous to foliage of many plants and is indicated by solution turning blue litmus paper red.
- Copper deposition test: To test the neutrality of the mixture, dip a brightened iron knife for a minute in the mixture. If the knife remains bright, the mixture is correctly prepared. If the knife turns rusty brown or if its brightness is lost, add more lime solution and the test repeated till no such deposit appears on the clean metallic surface.
- Color test:

  Greenish blue = Excess copper

  Whitish blue = Excess Lime

Precautions:

- The metallic container should be avoided
- Do not use the Bordeaux mixture in combination with any other chemicals or pesticides.
- The application of the mixture should be done on time with adequate coverage underneath the leaf surface for the effective control on the spread of the fungus to newly generated young shoots.
- Avoid spraying in exceptionally hot days, when the plants are showing signs of temporary wilting or in case of continuous and heavy rains.
- The left-over Bordeaux mixture should not be dumped in the field, as this may prove toxic to the subsequent sowings.