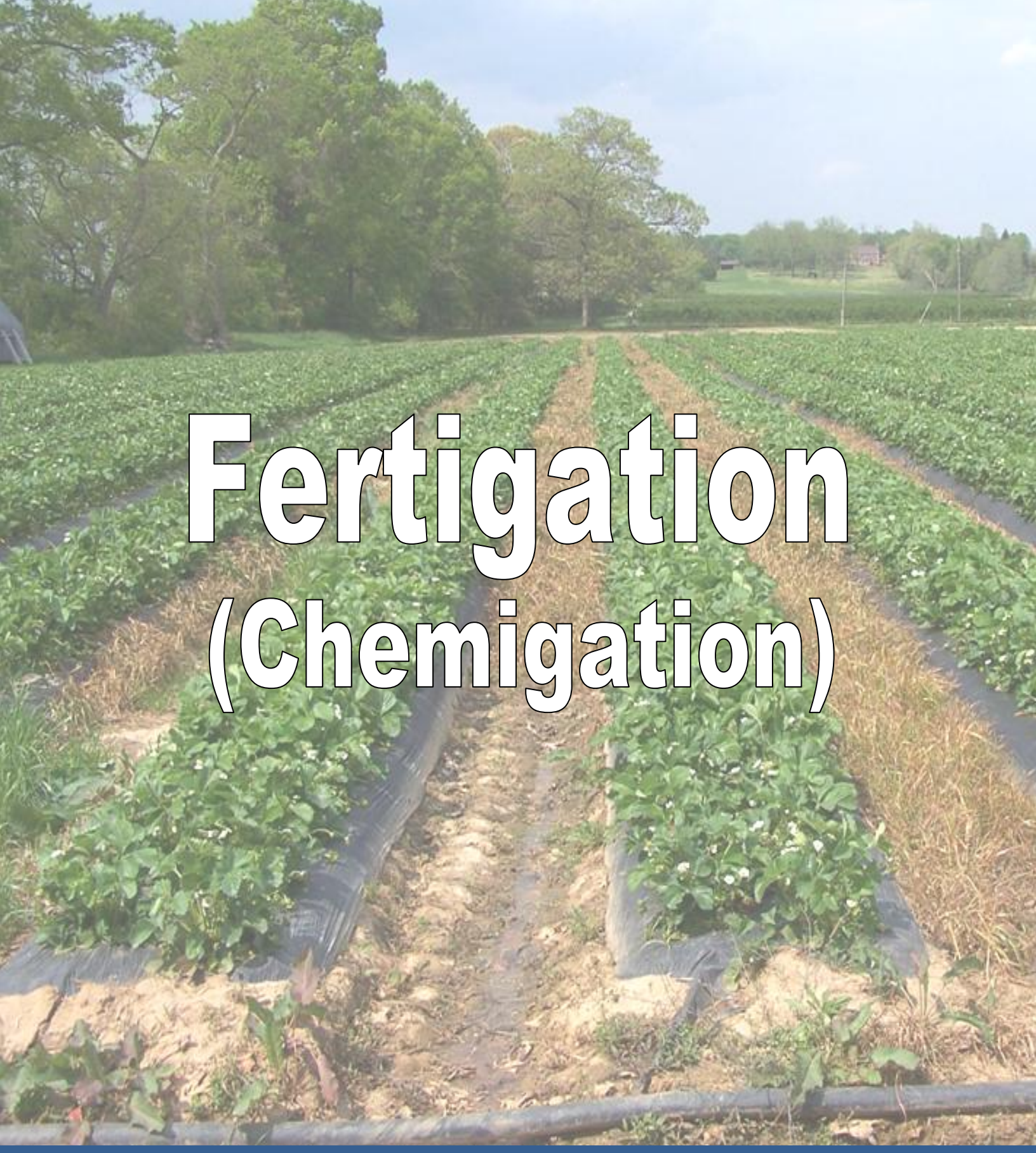

Fertigation
(Chemigation)

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FERTIGATION: Applying fertilizer via Irrigation

An injector takes a fertilizer solution out of a concentrate tank and injects it into irrigation water. To determine the amount of fertilizer being applied, one must know (1) the concentration of fertilizer in the tank (lb of fertilizer per gallon of concentrate) and (2) the rate or ratio at which the concentrate is being injected into the irrigation water (gallon of concentrate per gallon of irrigation water).

For example, if 50 lbs of a 15-10-20 soluble fertilizer is dissolved in water making 30 gallons of concentrate, the concentration of fertilizer is 50 lb/30 gallons in the concentrate. And, the concentration of N in the concentrate is 7.5 lb/30 gallons. Likewise the concentration of phosphate, $P_2 0_5$, is 5 lb/30 gal, and that of potassium oxide or potash, $K_2 0$, is 10 lb/30 gal. The concentration of P is 2.2 lb/30 gal (43.7% of $P_2 0_5$), and that of K is 8.3 lb/30 gal (83.0% of $K_2 0$). [The values 43.7% and 83.0% are explained later under Fertilizer Calculations.]

Further, if the rate that this concentrate is being injected into the irrigation water is 1 gallon of concentrate for each 80 gallons of irrigation water, the injection ratio is 1 to 80, or 1/80. Thus the concentration of the fertilizer in the irrigation water is (50 lb/30 gal) X (1/80) = 50 lb/2400 gal = 1 lb/48 gal. And, the concentration of N in the irrigation water is (7.5 lb/30 gal) X (**1/80**) = 7.5 lb/2400 gal = 1 lb/320 gal. Likewise the concentration of phosphate in the irrigation water is 5 lb/30 gal) X (**1/80**) = 5 lb/2400 gal = 1 lb/480 gal, and that of potash is 10 lb/2400 gal = 1 lb/240 gal. The concentration of P in the irrigation water is 2.2 lb/2400 gal = 1 lb/1100 gal, and that of K is 8.3 lb/2400 gal = 1 lb/289 gal.

Injection ratios vary even for similar injectors due to variations in manufacturing, wear, and operating conditions. Thus, injectors should be tested (at least once per year) to determine their true injection ratio. Additionally, non-proportional type injectors like canister injectors (e.g., EZ-Flo and Rainbow) and siphon injectors (e.g., Hozon and Mazzei) should be tested using the same operating conditions that they will experience in use.

US Liquid Equivalents

1 lb = 16 oz

1 oz = 2 tbsp

1 cup = 8 oz = 16 tbsp = ½ lb

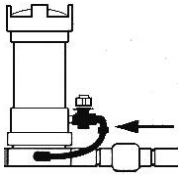
1 pint = 2 cups = 1 lb

1 quart = 2 pints = 2 lb

1 gal = 4 quarts = 8 pints = 128 oz = 4 lb

1 gal = 3.785411784 liter

1 liter = 0.2641721 gal = 1.056688209 qt = 2.113376418 pt = 33.8140227 oz = 2.1133764188 lb



Fertilizer Calculations

Plant fertilizer nutrients/elements are present in various compounds (e.g., urea, ammonium nitrate, phosphoric acid, calcium phosphate, potassium chloride). The composition as a percentage by weight of each of the 'big 3' elements present in a fertilizer must be stated on the bag/container. This is referred to as the fertilizer guarantee, which expresses each of elemental N, phosphate, and potash as a percent by weight of the fertilizer.

For example, suppose a fertilizer (guarantee) has the numbers 10-5-8. This fertilizer contains 10% (1st number) elemental nitrogen, 5% (2nd number) available phosphate (P_2O_5) and 8% (3rd number) water soluble potash (K_2O). The remainder of the fertilizer material is comprised of other elements and filler. The filler helps to assure accurate/uniform application/spreading of the small amounts of the nutrients to relatively large crop areas. The filler often includes ground limestone, to offset the acid potential of the fertilizer.

In order to make sure that these values are understood, let's calculate the amount of elemental N, P and K in a 100 pound bag of 10-5-8 fertilizer.

Begin with N, the easier calculation. The 10-5-8 fertilizer is 10% N by weight. Convert 10% to a decimal (0.1) and compute the weight of N in the 100 lb bag of 10-5-8 fertilizer:

100 lb X 0.1 = 10 lb N

Likewise there is 5 lb of N in a 50 lb bag of 10-5-8, and 20 lb of N in a 50 lb bag of 40-5-8.

Elemental P is more difficult, requiring another step. The guarantee (5%) is expressed as percent by weight of phosphate (P_2O_5). We need to find out how much P is in P_2O_5.

Atomic weights are: P = 31 and O = 16

P_2O_5 has two atoms of P, so 2 X 31 = 62

P_2O_5 has five atoms of O, so 5 X 16 = 80

Atomic weight for P_2O_5 is [62 + 80] = 142

Therefore, the proportion of P in P_2O_5 is [62 / 142] = 0.437 = 43.7%

Thus the 100 pound bag of 10-5-8 fertilizer contains 5 lb of P_2O_5 of which P is 5 lb X 0.437 = 2.18 lb.

Elemental K requires a step similar to P. The guarantee (8%) is expressed as percent by weight of potash (K_2O). We need to find out how much K is in K_2O.

Atomic weights are: K = 39 and O = 16

K_2O has two atoms of K, so 2 X 39 = 78

K_2O has one atom of O, so 1 X 16 = 16

Atomic weight for K_2O is [78 + 16] = 94

Therefore, the proportion of K in K_2O is [78 / 94] = 0.830 = 83.0%

Thus the 100 pound bag of 10-5-8 fertilizer contains 8 lb of K_2O of which K is 8 lb X 0.830 = 6.64 lb.

Fertilizer Application Rates for Individual Plants/Trees

How many ounces of a 33-15-15 fertilizer should be applied to a tree/area to supply 2 oz of elemental N? Algebraically this can be written as:

0.33 X F = 2 oz, where F is the amount of fertilizer needed. Thus,

F = 2 oz / 0.33 = 6.06 oz

About 6 oz or 12 tablespoons of 33-15-15 fertilizer provides 2 oz N.

Now, if 6.06 oz of 33-15-15 fertilizer is added to a tree, how much elemental P and K are also added? First, 6.06 oz of 33-15-15 fertilizer contains 15% P_2O_5 or 0.15 X 6.06 oz = 0.909 oz, and P_2O_5 contains 43.7% P. Thus 0.437 X 0.909 oz = 0.397 oz of elemental P is applied when 2 oz of elemental N is applied. Likewise, the 6.06 oz of 33-15-15 fertilizer contains 15% K_2O or 0.15 X 6.06 oz = 0.909 oz, and K_2O contains 83.0% K. Thus 0.830 X 0.909 oz = 0.754 oz of elemental K is applied when 2 oz of elemental N is applied.

How much of 46-0-0 fertilizer would need to be applied to a plant/area to provide 5 oz of N?

Answer: F = 5 oz / 0.46 = 10.87 oz or 22 tablespoons = 0.7 lb = 0.7 pint = 1.4 cups = 1/3 L

Note: the amount of P and K applied would be none

Availability of Plant Nutrients vs. Soil pH

Note how available plant nutrients are at 6.5 pH. This is why most plants/crops like a pH near 6.5.