

Methods of Fertilizers Application & Recommendations Under Rainfed & Irrigated Conditions

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To obtain the maximum benefit from fertilizers, it is most essential that fertilizers are applied at the proper time and proper place. The fertilizers to be applied possess different qualities with regard to solubility in water and movement into the soil solution. Similarly soils are of different nature, sandy to clayey. The nature of soil governs the movement of applied fertilizer. The requirement of different plant nutrients varies in relation to their growth stages. Thus, the time and method of application will vary in relation to the nature of the fertilizer, soil type and difference in nutrient requirement and nature of field crops.

Time of application

The correct time of application is aimed at providing nutrients in sufficient quantities to meet the crop demand and at the same time avoiding excess availability and leaching losses. The time of application mainly depends on crop uptake pattern, soil properties and nature of the fertilizer material etc.

- 1. Crop uptake :** Nitrogen, phosphorus and potassium are taken in large quantities in early stages of crop growth. For example: 95, 86 and 68 per cent of N, P, K uptake is completed by panicle initiation stage in finger millet. Nitrogen is necessary for the synthesis of proteins which are essential for the development of tissues. After flowering, most of the crops, especially cereals, contain lesser percentage of nitrogen due to greater accumulation of carbohydrates. The uptake of nitrogen is slow at the later stages, which is generally met from the soil by mineralization. Legumes require nitrogen until root nodules are formed. Potassium is taken gradually throughout the growth and development of the crop.
- 2. Soil properties and nature of fertilizers :** Nitrogenous fertilizers are soluble and highly mobile in soil. Nitrogenous fertilizers are lost into deeper layers beyond root zone if the entire quantity of fertilizer is applied especially in light textured soils. However, phosphatic fertilizers which are highly reactive are fixed in the soil and become immobile. Potassium fertilizers are less mobile since they are adsorbed on the clay complex. The entire quantity of phosphatic and potassium fertilizers are, therefore, applied in one dose at the time of sowing.

Basal application

Application of fertilizers before or at the time of sowing is known as basal application. A portion of a recommended dose of nitrogen and entire quantity of phosphatic and potassic fertilizers are applied as basal. Modified forms of urea like urea super granules, sulphur-coated urea, neem-coated urea etc. are used for basal application.

Split application

Application of recommended dose of fertilizers in two or three splits during crop period is known as split application of fertilizers. Application of fertilizers in the standing crop is known as top dressing. In general, the nitrogenous fertilizers are applied in more split doses for cereal crops or long duration crops. The number of split applications has to be more in light soils and less in heavy soils. The stage of application is also important. In cereals, nitrogen is applied at tillering and panicle initiation stages in addition to basal application. Basal application is sufficient in pulses.

Optimum time of application of nitrogen for different crops :-

Crops	Time of Application
Rice	Basel, at tillering and PI – Panicle Initiation (1/3 at each stage or $1/2 + 1/4 + 1/4$)
Sorghum	Basel, PI
Pearl millet	Basel, PI
Finger millet	Basel, tillering and PI
Wheat	Basel, Crown Root Initiation and PI
Groundnut and pulses	Basel
Sugarcane	60, 90 ad 120 days after planting

Factors influencing methods of application

Suitable method for a particular situation depends on the nature of the soil, crop and fertilizer material.

- 1. Nature of the Soil :** Soil properties like texture, pH, CEC, nutrient and moisture status are important factors to be considered for selecting suitable method of application. Soil texture influences the mobility of the fertilizer material. Soil pH increases volatilization of ammoniacal fertilizers when it is more than pH. The soils with high CEC retain the cations present in the fertilizer material and thus reduce leaching losses. In soils low in phosphorus status, band placement of phosphatic fertilizer reduces fixation, while in soils of medium phosphorus status, incorporation of phosphorus fertilizer after broadcasting is better for higher availability. For crops

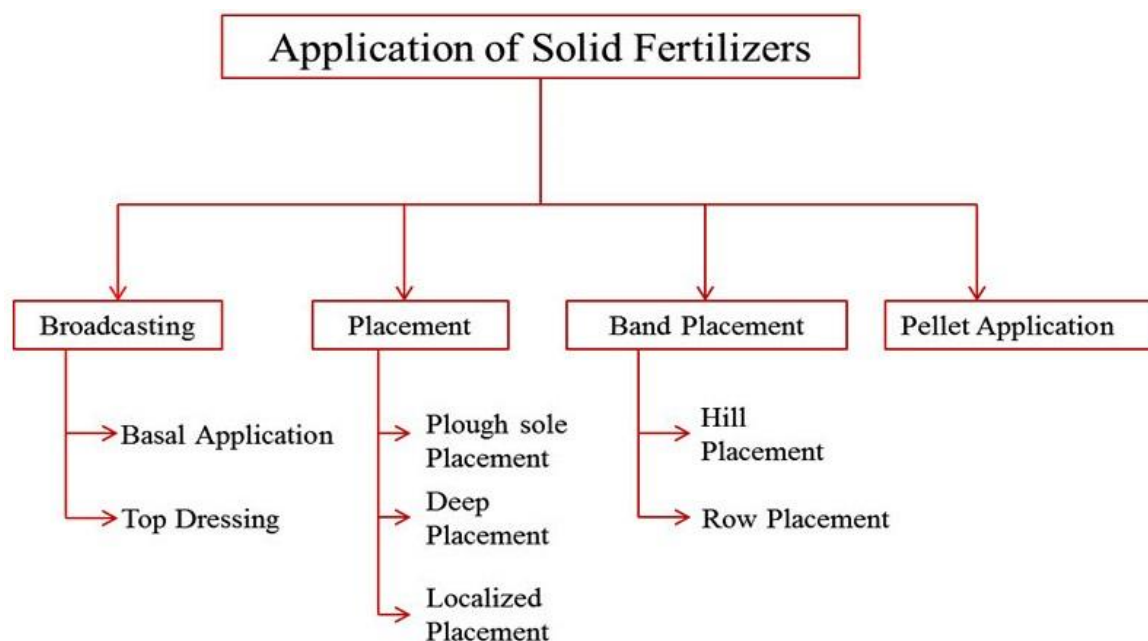
grown on residual moisture, deep placement of fertilizer in the moist zone is essential and when it is not possible foliar application is resorted to.

2. **Nature of the Crop :** Depending on the type of root system and spacing adopted for the crop, different methods of fertilizer application are practiced. In crops with fibrous root system and those grown with closer spacing, most of top layer of the soil is occupied by the root system. In such a situation, broadcasting of fertilizer is resorted to followed by irrigation. In widely spaced crops with initial slow growth, point placement is adopted instead of broadcasting over the entire field.
3. **Nature of the fertilizer :** Suitable method of fertilizer application depends on the properties of fertilizers such as physical form, solubility and mobility. Mud-ball urea, pellets and briquettes of urea are amenable for placement with hand. Granules and prills can be drilled while granules, prills and powders can be broadcasted. Liquid fertilizers are applied with irrigation water alone or mixed with herbicide sprays. Soluble fertilizers can be applied as foliar application. Fertilizers containing plant nutrients which are immobile or less mobile are applied in the root zone. Fertilizers which are subject to volatilization and denitrification losses are incorporated into the soil.

Different methods of fertilizer application :-

A. Application of Fertilizers in Solid Form:-

The different methods of solid fertilizer application are given through the following chart.



1. **Broadcasting** : Application of fertilizer uniformly on the soil surface is known as broadcasting of fertilizer. This is done either before sowing of the crop (as basal application) or in the standing crop (top dressing). Broadcasting is the most widely practiced method in India due to easy in application. Broadcasting is advantageous with solid and soluble fertilizers. Generally, the entire dose of a phosphatic and potassium fertilizer is applied by broadcasting before sowing. Because of their low mobility in soil, these fertilizers are incorporated into the rooting zone.

- **Broadcasting before or at the Time of Sowing** : In this method fertilizers are broadcasted in the field one day before or at the time of sowing and sowing is done. This method is very common in India. Half amount of nitrogen and total amount of phosphorus and potassium are applied by this method. Secondary and micro-nutrient fertilizers are also applied by broadcasting. In hilly area broadcasting is done by aero plane.
- **Top Dressing**: Broadcasting of fertilizers in standing crop is called Top Dressing. Nitrate and sometime ammonical nitrogen is top dressed in standing crop to supply nitrogen at once.
 - Broadcasting of fertilizers, in standing crop sown in lines, in side of plant is called side dressing.
 - Crops, in which there is some distance between two plants, fertilizers are kept around the plant or in a side near the plant. It is called spot dressing.
 - Broadcasting is done on dry leaves in the evening. In natural grass fields and pastures fertilizers are applied by broadcasting.

Advantages of Broadcasting Method:

- Less time is required in applying the fertilizers.
- It is very convenient in our country because most of the farmers are still illiterate.
- It is relatively less costly.

Disadvantage of Broadcasting Method:

- Plant do not get the total advantage of fertilizer because some amount of fertilizer is beyond the reach of plant roots.
 - Some amount of fertilizer is fixed in soil which is not available to plants.
 - Weeds grown in the field take the advantage of fertilizer and thus, weeds flourish and harm the crops. Besides, very less amount of fertilizer becomes available to plants.
2. **Placement** : Keeping of fertilizer at a definite and suitable place in the field is called Placement. Plant roots are active in a definite area. So, it is an essential to place the

fertilizer in that area to increase the efficiency of fertilizer. Placement is done in different ways:

- (i) **Plough Sole Placement** : Making furrow by plough fertilizer is placed in the bottom of furrow where most of the plant roots develop. Thus plant roots absorb the nutrient quickly. This method is also suitable for dry area. Some times instrument are also used for this purpose.
- (ii) **Deep placement** : To control the loss of fertilizers, it is kept in soil at more depth. As nitrogenous fertilizer is in anaerobic horizon, its loss does not occur as ammonia gas and nitrogen is being regularly absorbed by plants. This processes is adopted in Japan and Philippines in paddy crop.
- (iii) **Localized Placement**: Placing of fertilizers near the seed or plant at a special place is called localized placement. Different methods of localized placement is as below-
 - **Dibbing Placement**: Fertilizers are placed by Dibbler instrument. By Dibbler holes are made in field and seeds and fertilizers are added in the holes together. This method is costly and unsuitable because less germination occurs.
 - **Contact or Drilling Placement**: Sowing off seed and fertilizer together in furrow is called contact or drilling placement. It is common for the crops sown in lines. Sometimes drilling of fertilizer and seed is done separately. Application of seed and fertilizer separately is better which is very useful for dry farming.
 - **Side Dressing**: Fertilizers are spread in between the lines of crops or around the tree plants.
 - Placement of nitrogenous fertilizers by hand in between the rows of crops like maize, sugarcane, cotton etc. to apply additional doses of nitrogen to the growing crops.
 - Placement of fertilizers around the trees like mango, apple, grapes, papaya etc.
 - **Ring Placement**: In this method ring is made around the tree plants or crops sown at long distances. The fertilizer is applied in pit of the ring which is readily absorbed by plants.
 - **Sub Soil Placement** : This method is used in acidic soil of moist area. Phosphatic and potassic fertilizers are placed in sub-soil by instruments.

3. Band Placement : Application of fertilizers in narrow bands beneath and by the side of the crop rows is known as band placement of fertilizers. Band placement is done under the following situations:

- When the crop needs initial good start
- When soil fertility is low
- When fertilizer materials react with soil constituents leading to fixation, and
- Where volatilization losses are high.

Depending on the root system, fertilizer band is placed directly beneath the seed or by the side of the row. In cereals and millets, which produce fibrous root system, it is advantageous to place fertilizers 5 cm away from the seed row and 5 cm deeper than the seed placement. Fertilizers are placed in band in the side of plants. Phosphatic and potassic fertilizers are used by this method. Maximum amount of fertilizers is utilized by plants in this method.

(i) Row Placement- This method is used for those crops which are sown in line with less distance in between the lines. Fertilizers are applied in sugarcane, cotton, maize, vegetables, potato and cereal crops.

(ii) Hill Placement- This method is used for those crops which are sown in line with more distance in between the lines(1 meter or more). Fertilizers are applied by this method in fruit plants like guava, grape, apple, pear, lemon, orange, banana etc.

Advantage of Placement:

- Plant nutrients are easily available because fertilizers are placed near plant root zone.
- Fixation of phosphorus and potassic fertilizers is less.
- Plants grow rapidly and weeds do not grow.
- Germination is not affected by fertilizer placement.
- The residual effect of fertilizer remains for longer period.

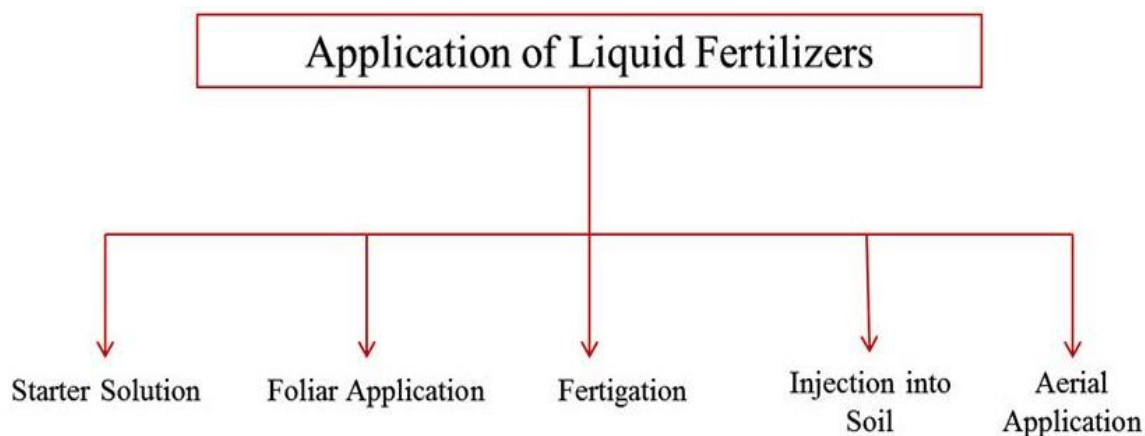
Disadvantage of Placement:

- Salt concentration becomes more in soil solution.
- If anyhow excess amount of fertilizer is collected near the seed, seed germination is badly affected.
- Sometimes plants are destroyed in the beginning stage.

4. Pellet Application : In this method pellets of mixture of fertilizer and moist soil are made which are placed near the plants 3-6 cm below the surface. Sometimes fertilizer is rolled in paper and used as pellet. This is the best method for increasing the utility capacity of urea.

B. Application of Fertilizers in Liquid Forms :-

Liquid fertilizers and water soluble granular fertilizers can be applied in different ways. The classification of these methods is given in following chart.



- 1. Starter solutions :** It refers to the application of solution of N, P_2O_5 and K_2O in the ratio of 1:2:1 and 1:1:2 to young plants at the time of transplanting particularly for vegetables. Starter solution helps in rapid establishment and quick growth of seedlings. Very less amount of fertilizers are mixed and it is used at the place of water to establish plants. Starter solutions supply plant nutrients in the beginning of plant growth. The disadvantages of starter solutions are :
 - Extra labour is required, and
 - The fixation of phosphate is higher.
- 2. Foliar application:** Dilute solution of fertilizer is sprayed on plants in standing crop. One or many nutrients are sprayed together. Plants absorb nutrients very soon. Thus, the effect of foliar application is more than soil application. Foliar spray is done by sprayer. These solutions may be prepared in a low concentration to apply any one of plant nutrient or a combination of nutrients. This method is suitable for application of small quantities of fertilizers, especially micronutrients. Major nutrients can also be applied by this method when there is not adequate moisture in the top layer of soil.

Foliar spray is useful in following Conditions:

- It is useful in dry farming and in crops sown late.
- The effect of fertilizer is necessary at once.
- Plant density is more in crop.
- When broadcasting of fertilizer is not possible.
- For spraying insecticides and fungicides.

Advantages of Foliar Spray:

- Less amount of fertilizer is required.
- Uniform distribution of fertilizers occurs in the whole field.
- Fixation of nutrients does not occur in soil.
- Foliar spray of micronutrients is very useful because soil application causes toxicity.
- It is very useful in dry farming.
- Equal distribution of fertilizers is possible in up and low land and hilly area.
- Plants utilize maximum amount of nutrients.

Disadvantage of Foliar Spray:

- Generally dilute solutions are sprayed from which less amount of nutrients is available to plants.
- On spraying high concentrated solution leaves are scorched.
- Labour charge is more in spraying.
- On spraying urea solution biuret reaches in leaves which causes toxicity.

Precautions During Spraying:

- Spraying should be done at proper plant growth stage.
 - Spraying should be done in the morning after drying dew. Spraying should not be done after 12:00 P.M.
 - Concentration of fertilizer should be made according to the type and stage of crops and type of sprayer.
 - Spraying should not be done on the day of possibility of raining or fast wind blows.
 - For uniform spray, fine nozzle should be used in sprayer.
 - Urea used for spray should not contain biuret more than 1.0%.
- 3. Injection into soil:** Dilute solution of fertilizers is injected into plants and added deep in soil by special instruments. Generally micronutrient solutions are injected into xylem of plants which are translocated in all parts of plant. In soil both macro and micronutrients are injected by special instruments. The method is highly used in United State of America.
- 4. Aerial application :** In areas, where ground application is not practicable, the fertilizer solutions are applied by aircraft particularly in hilly areas, forest lands,

grass lands, sugarcane fields etc. In this method considerable amount of fertilizer is lost. In a very special case this method is adopted.

5. **Fertigation** : Application of fertilizers with irrigation water is known as fertigation. Straight an mixed fertilizers containing N, P and K easily soluble in water, are allowed to dissolve in the irrigation stream. The nutrients are thus carried into the soil in solution. This saves the application cost and allows the utilization of relatively inexpensive water soluble fertilizers. Usually nitrogenous fertilizers are most commonly applied through irrigation water. It is generally followed with drip irrigation.

Difference between soil application and foliar application of fertilizers :-

S. No.	Soil Application	Foliar Application
1.	Generally solid form of fertilizers are used which is required in excess amount	Fertilizers are applied only in solution form which are required in less amount.
2.	Excess of plant nutrients are lost by run off, leaching and fixation.	There is no any loss of nutrients by this method.
2.	The effect of fertilizers occurs relatively after many days of their application.	The effect of fertilizer solution starts at once after spray.
3.	Use of fertilizers increases the concentration of soil solution, hence excess of soil moisture is required to reduce the concentration otherwise it causes harmful effects.	Dilute solution of fertilizers is used. High concentrated solution causes harmful effects.
4.	Micronutrient compounds are not distributed uniformly.	Uniform distribution of micronutrient compounds is possible.
5.	Uniform distribution of fertilizers does not occur in up and low land area. Due to rain or irrigation water nutrients dissolved from up land are collected in low land.	Uniform distribution of fertilizers occurs in up and low land area.
6.	Immobile nutrients like P etccan not be applied in standing crops.	Immobile nutrients can easily be applied in standing crops.
7.	Fertilizers can be applied at flowering stage.	Fertilizers cannot be applied at flowering stage.
8.	This methods is simple.	This method is complicated.
9.	Fertilizers can be applied in all types of crops.	Limited nutrients on a few crops in limited area can be applied.
10.	Continuous applications of some	Use of fertilizers by this method has not

	fertilizers have bad effect on soil structure, chemical and biological conditions of soil.	bad effect on soil.
11.	If fertilizer is applied in dry soil, irrigation is very essential or benefit only occurs on raining.	If rain occurs after foliar application, all the nutrients are washed out.
12.	Soil application is less effective on trees.	Foliar application is more effective on trees.
13.	After top dressing of fertilizers, it has to be mixed in soil or irrigation has to be done, so extra time, labour and more capital is required.	In this method such type of time, labour and capital are not spent.

S. No.	Recommended dose of NPK for kharif crops (kg ha ⁻¹)	
1.	Paddy	Early (50:30:20)
		Medium (100:40:25)
		Late / hybrid (120:60:40)
2.	Maize	Early (90:40:30)
		Medium (120:50:30)
		Late / hybrid (180:60:40)
3.	Sorghum	(80:40:40)
4.	Pearl millet	Variety (60:40:20)
		Hybrid (120:60:50)
5.	Soybean	(20:80:20)
6.	Niger	(20:30:20)
7.	Castor	(20:40:20)
8.	Groundnut	(20:80:20)
9.	Black gram	(20:50:20)
10.	Green gram	(20:50:20)
11.	Pigeon pea	(30:60:40)

S. No.	Recommended dose of NPK for rabi crops(kg ha ⁻¹)	
1.	Linseed	Unirrigated (30:20:10)
		Irrigated (75:50:25)
2.	Mustard	Unirrigated (40:20:10)
		Irrigated (80:40:20)
3.	Safflower	Unirrigated (40:40:20)
		Irrigated (60:40:20)
4.	Wheat	Unirrigated (30:20:10)
		Irrigated (120:60:40)
5.	Lentil	(20:40:20)
6.	Pea	(30:60:40)
7.	Gram	(20:50:20)
8.	Sunflower	Variety (60:30:20)
		Hybrid (120:40:25)
9.	Sugarcane	(300:60:60)
10.	Maize	(180:60:60)
11.	Vegetables	(100:50:30)