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Fertilizer Placement — A Better Farming Procedure

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Introduction

DURING the past few decades much evidence has been obtained to help in fulfilling one of the main aims of agricultural research, namely to tell the farmers, how to put the right manure, in the right place and at the right time. Extensive fertilizer experiments carried out in various parts of the world have given significant information on the manurial requirements of crops in the different soil and climatic regions. These have helped in the more efficient use of the fertilizer materials. Proper selection of the fertilizers, use of adequate and economic amounts of these, for use with particular crops as well as the methods and time of their applications have all now been systematised, and all these have contributed to increased agricultural production. The marketing in recent years of concentrated inorganic and organic fertilizer materials have resulted in exploring new methods of applying them to the soil in order to avoid any possible injurious action to the plant root systems, on account of the salt effects of the fertilizers. Such a procedure

is necessary due to the certain inherent and special characteristics of the fertilizer materials particularly their movement within the soil. Of the fertilizers in common use, only nitrates and chlorides are readily mobile in the soil. These get washed down with the percolating water usually accompanied by an equivalent amount of calcium ions. Potassium is also freely mobile in sandy soils low in organic matter as they contain no base exchange material capable of holding it. This, however, is not so in clayey soils where potassium ions may be held up rather tightly. It is well known that phosphorus compounds are very sluggish movers, except in the more sandy soils. In order to get maximum effectiveness it can be seen that phosphorus has to be placed in the soil in the zone of root development. Surface applications, unless worked into the soil, do not help to supply the deeper roots with this nutrient. In a way, this immobility of phosphorus is helpful in that the total quantity of this element necessary for a given season can be applied at one time without any chance of its loss by leachage. Potassium and to an even greater extent, nitrogen tend to move from their ones of placement mostly vertically down depending upon the direction of the water movement in the soil instead of laterally. Nutrients supplied in fertilizers do not move laterally appreciably in level fields as has been shown by an experiment of over ninety years' duration in the grass fields at Rothamstead. It is thus necessary that the plant nutrients be applied in zones within the reach of plant roots, but not so close, as to cause the plant any injury. There should be also adequate amounts of all the necessary nutrients in an available form, but not excessive supplies to avoid loss by fixation or leaching. In the case of nitrogen and potassium it is also possible to apply them in split doses thus avoiding leaching losses, the second application being done as a top-dressing, the water movement helping these to reach the plant roots. This property of nitrogenous and potassic fertilizers necessitates careful consideration in the matter of their placement with respect to the seed.

In general, inorganic nitrogen fertilizers are mobile in soil moisture, and surface dressings are washed into the root zone by rain. Being fairly mobile, the potassium fertilizers in the light soils also move to the roots when dissolved in soil water, while on heavy soils potassium combines with colloids and may not move very far and are therefore better placed near the roots. Soluble phosphorus fertilizers in all soils combine with clay colloids or calcium compounds. In order to be effective, therefore, phosphorus fertilizers should also always be placed in the root zone deep in the soil.

These considerations are again important from the point of view of root systems of plants. Crops with poor root systems are less well equipped than those with good root systems to take up fertilizers distributed through the soil. Crops with well developed lateral roots use nutrients in the soil placed between rows while tap rooted plants take nutrients from deep soil zones.

Moisture and drought aspects in relation to manuring

Plants can obtain their main supply of nutrients only from damp soil. Hence

it can be seen that if they are to use nutrients added to the soil as a fertilizer during periods of drought, the mobility of these nutrients in the soil is of great importance. The fertilizers are usually put in seed beds and incorporated with all or part of the top few inches of the soil. This position affects root development of a plant, the root system mostly ramifying in the fertilized soil volume. Thus the fertilizer if put in the sub-soil will bring about a greater development of the roots there than if it is all put in the surface soil.

The practice of putting the fertilizer deep, can affect the drought resistance of plants growing in soils where the sub-soil is very poor in the dry years. From a soil, poorly supplied with a particular nutrient, crops are usually found to be able to take up more of this nutrient from a dressing of fertilizer concentrated in the soil near the plant root system than if the same dressing is applied broadcast over the surface soil. This is because of the availability of the fertilizer at the root feeding zone and earlier in the growing season the plants could get their benefit. Indeed, plants have been found to be able to absorb more potassium from a zone containing a high ratio of available potassium to calcium than a low one under calcareous soil conditions. In the case of phosphatic fertilizers this may be due to the slower reversion of available phosphate when concentrated in a restricted zone of the soil than when distributed uniformly throughout the soil. In soils with strong phosphate fixing power it may even be worthwhile to place pellets of phosphate fertilizer under each plant. Now, this way of putting the fertilizer somewhere in the root zone, near to the seed to enhance easier availability, but far enough to prevent injury is known as "placement of fertilizers", and when adopted helps the plant to the best advantage.

Methods of application of fertilizers

An important factor in the more efficient use of fertilizers is the manner of their application to the soil. These must be applied in the correct place in relation to the seed and this is probably as important as applying the right kind and amount of fertilizers. No single fertilizer placement pattern has so far been found that is superior for all crops and under all conditions although it is now well recognised that localized placement in relation to the seed or plant has been most efficient. In this method the fertilizer is placed at the sides of the seed or plant rather than applied broadcast although obviously with hay, orchard and pasture crops, this method of fertilizer application cannot usually be followed.

The two main general methods of applying fertilizers to soils are broadcasting and localised placement. In the former, the fertilizer is spread over the entire soil area to be fertilized. This is usually done immediately before planting the crop, but is also sometimes done before the land is ploughed or while the crop is growing, that is top dressing. With certain commercial fertilizers it has been shown that a given amount may produce a greater effect in increasing crop yields when placed in the soil in narrow bands near the seed than when broadcast. With some other fertilizers and under other conditions however, the

two methods may be equally satisfactory, or broadcasting may be preferable. Quite a number of factors, among them the type of soil, the soil management practices, the crop grown, the method of planting and the kind and amount of fertilizer used, determine the results obtained. In all these matters the cost of labour, the availability of the machinery for applying the fertilizer etc. also orientate the choice of the method.

By broadcasting fertilizers at different stages in the cultivation of arable land, dressings may be incorporated deeply with the soil or may be concentrated in some desired position. Some of these methods have interesting advantages over the common practice of surface broadcasting on a prepared seed bed. These can also be done without any special equipment.

The main objective in broadcasting is to distribute the fertilizer evenly and to mix it with 5–10 cm. of the surface soil by subsequent cultivation. This is usually done by hand or by spreaders and in several countries this is the only method adopted extensively. Broadcasting is a satisfactory method when nitrogenous fertilizers are used and where heavy applications are made to maintain a high fertility level for intensive crop production. Localised placement actually means placing the fertilizer either in bands or local areas along the planted row often in a definite space relationship to the seed or plant. This method was in vogue in China even in the seventeenth century where, farmers placed oilcake meal at the side of each hill of sugarcane and beside each row of cotton and tobacco. Planting seeds mixed with manure in open furrows is said to be a common practice in China. American Indian farmers used to put fish in the hills with seeds of maize. Nitrogenous fertilizer is applied in pinches at the base of each pair of cotton plants in Egypt. French farmers used to inject solutions of fertilizers into the soil in fruit tree orchards at the outer perimeter of the branches. Localised placement has been used to considerable advantage in several countries–Australia, Netherlands, East Indies, New Zeland and in the U. K. Considerable research work has been carried out in the States on localised placement of fertilizers and the National Joint Committee on Fertilizer Application have issued their recommendations covering a great range of crops.

The method of fertilizer application in general may depend on the nature of crops to be fertilized. For this purpose the crops can be divided into row crops, vegetables, small grains, pastures and meadows, and trees. Cultivated crops such as corn, cotton and potatoes are usually fertilized in the hill or the row part, all of the fertilizer being applied at the time of planting. If placed in the hill, the fertilizer may be deposited slightly below and on one side or better on both sides of the seed. When applied to the row fertilizer is usually laid in a narrow band on one or both sides of the row, two or three inches away and a little below the seed level. In general, localised application of fertilizers in narrow bands at moderate rates is most effective for the more widely spaced row crops. Placing the fertilizer directly above the seed or in the furrow or mixing the fertilizer with the soil immediately around the seed is generally hazardous, with large amounts of fertilizer, although crops vary

considerably in their susceptibility to damage from fertilizer salts. In fact the idea behind the band or hill application of fertilizers is that the plants may take up a sufficient amount of a nutrient by having only a part of the root system absorbing the nutrient and also that the concentration of the fertilizer element will reduce its fixation or immobilisation. Uneven distribution may result in salt damage to some plants and insufficient fertilization of others. When large doses of fertilizer have to be used, it is wiser to broadcast part of it and work it thoroughly into the soil prior to the planting. The crops may also be side-dressed with an additional amount of fertilizer later in the season. This practice involves placing the fertilizer along the side of the row at a time most satisfactory to the crop; only this is a practice which requires experience and good judgement. This has been reported to give excellent results with vegetables. When the crop is well started, larger total amounts of fertilizers are added and side-dressing is quite common especially with a nitrogenous fertilizer such as nitrate of soda. When the fertilizer is applied around crops such as melons the treatment is called a "spot application".

In the case of small grains and similar crops a drill is used which is equipped with a fertilizer distributor so that the fertilizer enters the soils more or less in contact with the seed. Germination injuries which may be caused by the fertilizer are not serious in concentrations less than 300–400 lb. per acre. Indeed under this condition more seeds than necessary get planted so that the badly coming up seedlings could be sacrificed, without any bad effect on the final yields. It is to be borne in mind that improper placement of a fertilizer can adversely affect the plant stand resulting in plant populations which are too low to adequately utilise the applied fertilizer. In several places, the fertilizer applied to row crops is not properly placed to get the maximum effect. Improperly placed fertilizers may again injure seed or young plants resulting in reduced stands delayed emergence, stunted growth, and delayed maturity. Uniform distribution of the fertilizer is important with both the broadcast and the localised methods of application particularly with the latter. Broadcasting which secures a uniform distribution of the fertilizer in the soil and working it thoroughly into the seed bed is often better particularly when the fertilization is heavy with meadows, pastures and lawns, although usually it is advisable to fertilize the soil well at the time of seeding. Top dressing these crops with suitable fertilizer mixtures in the succeeding years would be necessary but care has to be taken to regulate the amount and time of treatment to avoid injury to the foliage and root crowns of the plants.

Fertilizing orchard trees is usually done individually, the fertilizer being applied around each tree within the spread of the branches, but beginning from several feet away from the trunk. The fertilizer is worked into the soil as much as possible. Ornamental trees are fertilized by the perforation method, that is by sinking numerous small holes around each tree within the outer half of the branch spread zone, and extending well into the upper subsoil. Suitable amounts of the fertilizer is placed in

these holes and filled up. This places the nutrient in the root zone, also avoiding undesirable stimulation of grass that may be growing around the ornamental trees. A method used to supply extra fertilizer when large quantities are required than can be safely applied in bands at planting time is that of ploughing the fertilizer under, placing part of the application on the plough-sole before planting. This is known as "plough-sole-fertilization" and is widely used as a supplementary manure, rather than to replace the customary methods although adverse weather conditions may seriously reduce the effectiveness of this procedure.

Water solubility and particle size of the fertilizer

There is some correlation between water solubility and particle size of the fertilizer from point of view of band placement. Experiments conducted with tagged phosphorus (P. 32) on the migration of phosphorus from granules into the soil have shown a strong interaction between degree of phosphorus solubility, particle size and the method of placement. For maximum efficiency band applied fertilizer should contain not less than 40 per cent of its phosphorus in water soluble form and those fertilizers without any water soluble phosphorus should be thoroughly mixed with the soil and should be powdered rather than be granular. In fact granulation and banding avoids extreme fixation of soluble phosphorus in the fertilizers, since both these reduce the area of soil-fertilizer contact. It is also better to band apply solid fertilizers high in degree of water solubility as also liquid fertilizers. The former should better be granular or pelleted if these are to be bulk spread.

Different kinds of fertilizer placement

There are three phases which arise when we take a comprehensive look at the process of fertilizer placement. These are placement under row crops, placement under forage crops, both for establishment and maintenance and the deep placement of fertilizers. It is well known that the rooting zone of all plants must have adequate quantities of plant nutrients in the proper balance to produce maximum yields. Usually in the case of crops seeded annually preplant application of phosphate, potash and lime broadcast in quantities sufficient to bring the entire plough layer of the soil up to a maximum growth level is enough. But leachage losses bring about a deficiency of nitrogen. In many low fertile acidic soils, phosphate fixation chances make it economically unsatisfactory for broadcast application before planting. In such cases planting the fertilizer in bands near the seed is profitable. On soils of high fertility yield differences between broadcast and banded application would be diminished on account of the less tendency of the added phosphate and potash to get fixed, since banding the fertilizer reduces the contact between soil and fertilizer. In low fertility soils band placement would cause greater use of the applied fertilizer resulting in higher yields. Here the root systems of plants also have only reduced contact with the fertilizer elements. The lower the phosphate and potash content of a soil, the less is the likelihood of a given phosphate or potassium, ion being

absorbed by the root system. When fertilizer is banded, root proliferation in the zone of banding might increase the total absorptive capacity of the root system in the early stages of growth. When absorption is greater — a fact borne out by studies employing tagged phosphorus—the reduced efficiency of broadcast versus band placement of fertilizer may be traced again to the growth habit of the plant. With row crops considerable time may elapse before the soil between the row is penetrated by the plant root system.

Again, according to the manner in which the fertilizer is applied, the placements are known as hill and row placement, drill placement, plough-sole placement and so on. For maize, tobacco, tomatoes and certain other vegetable crops planted in rows one or more meters apart, hill placement has been practised advantageously. The fertilizer is distributed in bands about 15 to 20 cm in length and 2.5 cm in width on one or both sides of the hill. When the seed is drilled close together or the plants placed rather closely in the row the fertilizer is put in continuous uniform bands on one or both sides of the row in the same relative position to the seed and the method becomes known as row placement, and is widely practised for maize, cotton, tobacco, sugar beets, potatoes and many vegetable crops. Somewhat higher rates of application are possible with row placement than with hill placement. Both these methods although efficient for applying small amounts of fertilizers are less so, for higher rates of application except on many of the red soils of the tropics which possess high phosphate fixing power. When higher rates of fertilizers have to be applied, for example 700–750 kgm. of grade containing a total of 20 to 30 per cent of N, P_2O_5 and K_2O per hectare, the additional quantity should be applied prior to seeding during the preparation of seedbeds and the balance after planting time. Often, the fertilizer is applied together with the seed in narrow rows with a combination seed and fertilizer drill. Such application is known as drill placement, a method which has been proved to be excellent for wheat and other small grains as well as some other close growing crops, the seeds of which could stand contact with the fertilizer. Salt sensitive crops such as peas or beans may have to be given split doses at different times. A method of placing the fertilizer in a continuous band at the bottom of the furrow in the process of ploughing, each band being covered as the next furrow is turned, is called plough-sole-placement. This is advocated in localities where there is a tendency for the surface soil to get dried up during the growing season, soils such as having a heavy clay pan a little below the plough-sole. The possible deeper placement of the fertilizer in most regions helps the roots to gather nutrients in the dry seasons. Here also there are less chances of the phosphate and potash fixation than when the fertilizer is broadcasted. This is also an efficient way to apply quantities of fertilizer too large for safe row or hill applications.

The localized placement of fertilizers is often done at the time of seeding the crop with the use of a combination seeder and fertilizer distributor. This economises labour and also serves to increase fertilizer efficiency. Placement is also done by the hand, using a dibble

horticultural crops it has provided a profit under certain conditions where broadcast manuring would not be justified. For crops like potatoes, smaller quantities of placed than of broadcast fertilizers are needed and give full yields. In the case of sugar beet placed fertilizers give good start but not higher yields than broadcast fertilizer but there would be economy in this case in the application of the fertilizer.

There is now sufficient experimental evidence to prove that coconut palms do respond to manuring under average conditions of soil and climate. Not much work has been carried out on coconuts from point of view of the recent trends in the application of manures although a start has already been made in this direction at the Central Coconut Research Station at Kasaragod. The vast amount of information reported from work on annual plants should certainly help us in our approach to the problem of placement of fertilizers in coconut gardens despite the considerations of the peculiar growth features of the palm particularly its expansive spreading root system, its perennial nature, its capacity for continued yields right during every month for sixty to eighty years etc.

It seems appropriate to conclude this paper by quoting the famous Rothamsted authority on fertilizer matters, G. W. Cooke (to whose results among others, the present article is indebted) and who from extensive work has concluded that "Placement is only one aspect of the wider subject of manuring, which, in turn, is only one of the factors that has to be considered in crop production. Methods of applying fertilizers must always be considered at the same time as manures are being chosen for particular crops; correct placement, whether achieved by a special machine or a particular way of broadcasting is an integral part of crop manuring". Placement is relatively inexpensive since ingeneous mechanical equipments are now available to band place fertilizers properly. There is no reason why Indian farmers should feel embarassed by the rather short supply of fertilizers in this country. They only need a new outlook and work with sound knowledge on the various aspects set forth above when a short supply of fertilizers must have to be used to obtain maximum increase in crop yields.