PLANTING INFORMATION

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Establishing the planting

a) Soil preparation -
A good supply of organic matter in the soil improves aeration and drainage, and increases water-holding capacity. You can apply organic matter the summer or fall of the year before you plant; under no circumstances should you use animal manures. You can also use compost, leaves, chopped hay or straw, peat moss, etc. Take care to use only materials that you think are free of insects and weed seeds.

Pre-planting soil amendments such as lime, gypsum or sulfur, should be thoroughly disked into the soil after leveling to prevent pockets of salt concentration.

To assure good production, the soil should be well worked, free of clods, and reasonably dry when fumigated. The subsoil should be cross-ripped before fumigation to insure adequate internal drainage. To minimize soil compaction, work the soil when completely dry. Adequate soil aeration is essential to healthy root growth, plant vigor, and satisfactory yields. Crowns from the previous strawberry crop should be completely decomposed or removed as they interfere with proper soil fumigation. Old plant materials harbor organisms that cause poor root growth and low yields. We strongly recommend a 2 to 3 years rotation between strawberry planting on the same ground.

b) Fumigation -
Apply the fumigants after the soil is leveled and properly prepared. For best results, the soil should be very moist but not saturated. Fumigants are dispersed more efficiently in light, moist soils. A mixture of methyl bromide and chloropicrin applied under a sealed plastic tarp is the standard fumigation practice in California. In other regions, growers use Basamid, Vapam and other formulations of Metham Sodium.

Both the continuous tarp method and bed treatment are currently used. In the case of flat field or continuous tarp application, the plastic sheet should remain in place at least 48 hours after fumigation. After it is removed, the land is ready for aeration. To avoid any phytotoxic residual damage, strawberries should not be planted for at least 10 days after removal of the tarp. Low soil moisture, low soil temperature, high clay content, soil compaction, and/or lack of soil aeration may extent the waiting period.

If bed fumigation is used, the plastic tarp is left on the beds and utilized as the bed mulch after planting. In this case, the grower plants through the plastic cover after the fumigant has dissipated through the soil profile. The grower should allowed 21 days from the time of fumigation to the time of planting.

c) Pre-plant fertilization -
Experimental results indicate that fertilizer placement is of paramount importance.

All nutrients, including part of the nitrogen, can be broadcast, then thoroughly incorporated into the soil. For most nutrients, other than nitrogen and boron, a pre-planting application should carry the crop through harvest if a sufficient amount is applied and the roots remain healthy. Direct or close root contact with the fertilizer will severely stunt or kill strawberry plants. To provide adequate calcium, lime or gypsum is broadcast and then triple disked into the soil several months before planting. A soil pH test should be taken before making a decision between lime and gypsum. Lime will help raise the soil pH if needed. Strawberries will grow over a range of pH; however, soil pH of 6.8 to 7.2 provides the best environment for root health.

Setting up the beds

a) How to form the beds -

To provide a good drainage, especially in high rainfall areas or where irrigation water has a high level of salts, we recommend raising the beds of culture 30 to 40 cm. above the furrow level. To form a good bed, the soil should have enough moisture to hold its shape with a minimum of crumbling, sloughing or deterioration of the sides of the beds.

Dig the planting slot deep enough for the full length of the roots. We recommend the use of a planting slot opener. This simple machine opens a uniform planting furrow in the bed surface into which the plants are placed at time of transplanting. The device carries a marking wheel that pre-sets the spacing within the row. It reduces variation in planting depth and plant spacing, giving uniformity to the field at time of planting.

Planting

a) Transplanting methods -
Plants are usually set by hand. The grower should bath the plants in a solution of fungicide (Benlate or Rovral) and should keep the plants very moist prior to planting. Neither before or during transplant, should you allow the plants to dry out. Keep them sheltered under wet burlap or paper during the entire transplanting procedure.

Plants must be set so that only the top of the crown bud is exposed. Plants die when the crowns are completely covered with soil. Poor plant growth results from setting plants too high, exposing the crown area where new roots initiate. Cover roots with soil and gently press it in place. Eliminate air pockets from around the roots and create a uniform soil density throughout the bed.

Do not cut roots. Do not bend roots, dig a planting hole deep enough to accommodate complete root system.

b) Irrigation -

Plants should be sprinkler-irrigated within a few hours after planting. Emerging roots are very sensitive to drying out and to the presence of salts. Any condition that inhabits or slows growth will reduce yields. Daily irrigation may be needed during the first 3 months after planting depending on the rains. Sprinkler-application rates replace water lost through evapo-transpiration but should be low enough to prevent accumulation of free water in the furrows.

c) Plant spacing -
Plant spacing will vary according to the cultivar, planting system, soil type, and the grower's preference. Double-row beds are recommended for summer planting. The double-row beds will vary from 101 to 132 cms, center to center; 122 cms seems to be the most efficient width for maximum yield. Plant density varies from 18,000 plants to 24,000 plants per acre on two-row beds.

d) Bed mulching -
Mulch should be applied 4 to 6 weeks after planting.

Post-planting management

a) Management -
Careful management of a new planting is critical during the first 3 months and, particularly, during the first 4 weeks after planting. Soil should be thoroughly settled around the plant at planting time. High moisture levels should be maintained by sprinkling every day the first few weeks and during hot or prolonged dry weather. Maintain optimum nitrogen fertility levels during the first 3 months.

Properly grown plants usually produce runners during the establishment period and will continue to do so until weather conditions move the plant into a flower cycle. Runners must be removed shortly after they appear to help promote large, multiple-crown growth and to avoid draining the energy of the plant into the vegetative cycle. Insects and disease control is important throughout the life of the plantation.

b) Fertilization -
A basic fertilizer program will vary according to the varieties, the soil types and fertility and the production/market strategy of the grower. Hence the following recommendations are quite generalized and should be modified

according to the experience that you gain over time.

Nitrogen: Commercial varieties from California such as Pajaro, Chandler or Camarosa have a high demand for nitrogen. You should calculate an uptake of about 250 - 275 kgs of elemental N per hectare over the course of a single production season. More important than the total amount of N is the form of application and the timing of the applications. The goal is to maintain a constant amount of N in the plant tissue during the period of flowering and fruiting. Please keep in mind the following recommendations:

> Do not utilize animal manure as a source of nitrogen. Plow down green manure crops or crop residues to add organic matter to the soil but avoid animal manure at all costs.
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> On the basis of soil analysis, calculate the residual amount of N in the soil at time of planting. The difference between this residual and the total uptake is the amount of N that you will have to apply in order to maximize yields. For example, if your analysis shows a residual of 100 kgs of elemental N per hectare in the soil prior to planting, you will have to apply between 150 and 175 kgs of N to reach the goal of the 250 - 275 kgs that the plantation requires during the production season.
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> Apply 20 percent of the additional N between the time of transplant and the formation of the flower buds in the crown of the plant (about 6 weeks prior to flowering). Apply 80 percent of the additional N in bi-weekly applications from the onset of bud formation to the end of the production season. Please note that the Sweet Charlie variety from the University of Florida requires only 50 percent of the nitrogen of the California varieties noted above. See the attached annex for an example of nitrogen management in a hypothetical production case utilizing California varieties.

Phosphorus and Potassium (P and K): Unlike nitrogen, P and K are generally insoluble and do not move with the water through the soil profile. For this reason, the producer can make a single application of P and K to the soil prior to forming the beds. Note the exceptions below. Commercial strawberry varieties will take up between 180 and 220 kgs of elemental P and K per hectare during the course of a single production cycle. An application of 500 kgs of Superphosphate (36%) prior to bed formation supplies sufficient P for strawberry production. The farmer should disk in the fertilizer at least three times to make sure that it is well mixed into the soils.

The key variable in calculating the utilization of P and K is the amount of the nutrients that are actually available to the plant in comparison to the amount that is available in the soil. Some soils have a high fixation rate. The analysis may show a high P content but the fixation may be such that only a very low portion is available to the plants. In this case, the plants will be deficient in P or K even though the elements are in the soil. It is important to utilize the "*available* P/K" analysis rather than the "total P/K" analysis when planning the nutrient program. An analysis that shows a range of 60 - 120 ppm of *available* P and K is an indication of adequate nutrients for sustained production.

Where fixation is a problem, the farmer may have to make applications of P and K in the bed. In this case, the fertilizers are placed in bands that are 2 cm. below the root level and 2 cm. to the side of the line of plants. Precision application shoes or injecting knives are important for this type of application. Concentrating the fertilizers in bands partially overcomes the tendency of the soils to fix and immobilize the elements.

Calcium: Strawberry plants utilize as much calcium as phosphorus and potassium. Where soil pH is 7.2 or higher, I recommend yearly applications of 1,000 - 1,500 kgs of gypsum (calcium magnesium sulfate) per hectare as part of the regular soil preparation practice. If the soils are acidic, then similar quantities of agricultural lime will raise the pH and supply the needed Ca to the plants. Calcium deficiencies will show up in a deterioration of fruit quality and reduced yields.

Annex A: Example of a Fertilization Scheme for **California Strawberry Varieties:**

1) A soil sample taken prior to land preparation indicates that the soil is sandy and has the following characteristics:

Extension ---------- 1,0 Hectares
pH ---------- 7,8 (slightly alcaline)
Residual Nitrogen -------- low content, equivalent to 75 kgs of N per hectare
Phosphorus---------- medium content, equivalent to 35 ppm
Potassium ---------- medium content, equivalent to 55 ppm
Calcium ---------- low content, equivalent to 450 kgs per hectare
Phosphorus Fixation ------ low fixation rate

ELEMENTS	PREPLANT 1 MAY - 30 AUGUST	ESTABLISH 1 SEPT 31JANUARY	BEGINNING OF HARVEST 1 FEB - 1 MARCH	FULL HARVEST 1 MARCH - 15 ABRIL	END OF CROP CYCLE	TOTAL
NITROGEN N	100 KGS DE AMMONIUM SULFATE @ 23% (TOTAL OF 23 KGS OF N) INCORPORATED PRIOR TO BED FORMATION	75 KGS DE AMMONIUM SULFATE@ 23% IN 4 APPLICATIONS VIA THE DRIP LINE (TOTAL-17.25 KGS OF N)	100 KGS OF AMMONIUM SULFATE @ 23% IN 8 APPLICATIONS VIA THE DRIP LINE (TOTAL- 23 KGS OF N)	400 KGS OF AMMONIUM SULFATE @ 23 % IN 18 APPLICATIONS VIA THE DRIP LINE (TOTAL - 92 KGS OF N)	85 KGS DE AMMONIUM SULFATE @ 23% IN 12 APPLICATIONS VIA THE DRIP LINE (TOTAL - 19.5 KGS DE N)	760 KGS OF AMMONIUM SULFATE TO SUPPLY 175 KGS OF N (IN ADDITION TO THE 75 KGS OF RESIDUAL N)
P	300 KGS DE SUPERPHOSFATE @ 36% P (TOTAL OF 108 KGS OF P) INCORPORATED PRIOR TO BED FORMATION			WEEKLY APPLICATIONS PHOSPHORIC ACID @ 1 LTR PER HECTARE	WEEKLY APPLICATIONS PHOSPHORIC ACID @ 1 LTR PER HECTARE	300 KGS OF SUPER-PHOSPHATE + 10 LTRS OF PHOSPHORIC ACID
POTASSIUM K	210 KGS OF POTASSIUM SULFATE @ 52% K (TOTAL OF 109 KGS. OF K) INCORPORATED PRIOR TO BED FORMATION					210 KGS OF POTASSIUM SULFATE @ 52% (TOTAL - 109 KGS OF K)
CALCIUM	1000 KGS OF GYPSUM @ 23% Ca (TOTAL OF 230 KGS OF Ca) INCORPORATED PRIOR TO BED FORMATION	2 APPLICATIONS OF 1.2 LTS OF 6% FOLIAR CALCIUM	6 APPLICATIONS OF 1.2 LTS OF 6% FOLIAR CALCIUM	4APPLICATIONS OF 1.2 LTS OF 6% FOLIAR CALCIUM	2 APPLICATIONS OF 1.2 LTS OF 6% FOLIAR CALCIUM	1,000 KGS OF GYPSUM + 16.8 LTRS OF 6% FOLIAR CALCIUM