
EFFECT OF PLANT DENSITY AND NUTRIENT MANAGEMENT ON PLANTAIN YIELD

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INTRODUCTION

Plantain (*Musa paradisiaca* L.) is a staple and inexpensive food in the tropical and subtropical areas of Latin America. Its consumption has been increasing steadily in recent years. Colombia has the highest consumption rate in the region. This country cultivates more than 400000 has obtaining a total annual plantain production of around 1.7 million tons with an average yield of 6 t/ha. These poor yields are common in Latin American countries due to inadequate inputs and low technology management practices.

Population growth and the consequent demand for more food has encouraged the search for innovative methods of production which can obtain higher sustainable yields. It has been proven that the use of high plant density can significantly increase yield per unit area. Successful cases are coffee and cocoa high density production systems. Research work conducted in last 7 years has documented yield increments up to 300% when plantain plant population was increased from the traditional 1000 plants per hectare to 3000. An added benefit of high density plantain cultivation is a lower incidence of yellow sigatoka (*Micosphaerella musicola*) and blank sigatoka (*Micosphaerella fijiensis*) which are two of the most important diseases that affect plantain.

High plant population increases the length of the production cycle and reduces bunch weight, but these factors are by far compensated by the higher number of bunches per unit area. These results have attracted the attention of plantain growers, extensionists and researchers in different

countries of the region. Starting in 1992, the National Agricultural Research Institute of Colombia (CORPOICA) initiated an ample research program to investigate high density plantain cultivation. Some of the results obtained by this program will be discussed in this paper.

HIGH DENSITY PLANTAIN, A NEW OPTION

Traditionally, plantain has been treated as a semi perennial crop with different plant arrangements in the field, according to the different agro-ecological zones and grower objective. Plant population varies from 1400 to 1600 plants per hectare and the plantation is kept in the field for several ratoons using the suckers coming from the mother plant. Plant population and plant vigor decrease rapidly after the first harvesting cycle. At this point, plantain growers pay little attention to the crop, harvesting every time bunches are ready. This small but continuous cash income has prevented, in many cases, changes in the approach to plantain cultivation.

High population approach treats the plantation as an annual crop (one harvest only). All plants are eliminated after harvest and a new stand is planted using new corms. It has been demonstrated that keeping this type of plantation for more than one cycle is not economical.

Normally, this is the part of the new technology most difficult to introduce because growers resist elimination of an apparent good stand to establish a new one. This is an unorthodox way of handling plantain which differs radically from the traditional way of cultivating this crop.

Results from work conducted in several experimental sites indicate that the increment in the number of plants per hectare reduces yield per plant and increases the total time to harvest. However, the data also indicate that these negative effects are totally upset by the higher yields obtained per unit area. These significant increment in yields compensate for the 3 to 5 more months the grower has to wait for harvesting when using densities of 3300 to 5000 plants, in comparison with the normal density of 1400 - 1600 plants per hectare (Table 1). Semi commercial plots have confirmed the results obtained in the experimental plots and growers are adopting of this new technology faster than expected.

Data in Table 1 also indicates that as plant population increases, the number of harvested plants decreases. This is a direct effect of plant competition. In high population systems, it is important to eliminate all plants that have not developed normally during the first 2-3 month after planting. Plants that have fallen behind never recuperate and only compete with the plants growing at normal rate.

High population can be obtained by planting 2 or 3 corms in the same planting hole. Normally the plant arrangement in the field

is laid in patterns of 2 x 3 m (distance of planting holes and rows, respectively). This will give populations of 3332 and 4998 plants per hectare. A planting density of 3332 plants per hectare can also be obtained planting 1 corm per hole at spacings of 1.5 x 2 m.

MANAGEMENT OF HIGH DENSITY PLANTAIN CROPS

In order to be efficient and profitable with a crop of plantain at high plant population it is necessary to take in account the following management recommendations.

Seed size

This factor is of particular importance since the success of the new plantation depends on the correct selection of the corms to be planted. It is very important that selected corms are uniform in size and weight. A practical way of selecting corms is to organize them in homogeneous groups of the same size and weight. This selection of the seed allows a uniform growth and development of the plantation. At the same time, a gradient of maturity develops in the field which allows harvesting first the plants developed from big corms, then the next size and so on. Lack of uniformity in the plantation reduces yields significantly.

Table 1. Plant population effect on growth factors and yield of plantain in an Andisol from Quindio, Colombia (1993).

Plants/site	Plants/ha	----- Growth factors -----			----- Yield factors -----		
		Plant height	Pseudostem circumferen.	Cycle length	Mean bunch weight	Total yield	Number harvested plants
		m	cm*	months	Kg	t/ha	%
1	1666	3.5	49	15.5	15.0	23.1	92.6
2	3332	4.2	50	18.0	14.3	40.4	85.0
3	4998	4.3	51	20.0	13.3	51.9	78.0

* One meter from soil surface

Table 2. Effect of plant density and fertilizer application on plantain yield in two Colombian soils.

Treatments	Plants/ha	Quindio (Andisol)	Magdalena (Inceptisol)
-----	-----	-----	-----
		----- t/ha -----	
Check	1666	19.3	7.3
Check	3332	28.5	15.6
NPK*	3332	32.7	31.3

* N = 100; P₂O₅ = 20; K₂O = 210 kg/ha, respectively

Plant uniformity

Even with the use of uniform corms it is possible to find differences in size in the plants growing in the same planting hole. In occasions, one plant has a marked difference in size over the other(s). This is due to different physiological age of the planted corms. In this case it is necessary to level the plants by trimming the tall plant by elimination of leaves or cutting the pseudostem. The best time for trimming is when the 5th leaf appears, which is between 30 to 45 days after the first leaf, depending on the altitude.

Disease control

Control of the two main plantain diseases, yellow sigatoka (*Micosphaerella musicola*) and black sigatoka (*Micosphaerella fijiensis*), is indispensable. Good control has been obtained by trimming once a month all dead leaves, all broken green leaves hanging from the pseudostem, and leaves with necrotic spots over more than one third the lamina. High population plantations have a lower incidence of these two diseases. This could be related to the increase in the length of the pathogen growth cycle induced by the modifications in light and temperature inside the high density plantations.

Nutrient management

Fertilizer requirements for plantain in high density arrangements are higher compared with conventional planting. The higher yields obtained take up more nutrients which have to be replaced to sustain high yields even in soils with high natural fertility. Table 2 shows the effect of plant density and fertilizer application on plantain yield in two soils from Colombia with different natural fertility.

CONCLUSION

The advantages of plantain at the high population density include the potential to increase yields significantly, better crop cycle planning to harvest during the best market conditions, optimum use of the land because one hectare of high density can produce as 3-5 hectares of conventional planting, high production of good quality corms which are used as seed for the next cycle, and intensive management which presents a lower incidence of pests, diseases and weeds. Farmers in the plantain producing areas of Ecuador, Colombia and Venezuela are benefiting from this technology.

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