

Chapter 9

Effects of Split Mineral Fertilizer Applications on the Growth and Productivity of Three Tomato Varieties (*Lycopersicon esculentum* Mill.) in Rainy Season Cropping



Ouango Koala and Jérôme Bélem

Abstract The objective of this study was to evaluate the effects of three frequencies of mineral fertilizer applications (NPK and Urea) on the growth and productivity of tomato produced in the rainy season. Three varieties of tomato: Padma, Thorgal and Tomy were used for a trial set up at the Kamboinsé Research Station under shelter “insect proof” to evaluate their response to three types of mineral fertilizer applications (NPK and Urea). The experimental design used was a split-plot with 4 replicates. Fertilizer use frequency (F1: splitting in 6 applications with an application frequency of 2 weeks; F2: splitting in 4 applications with an application frequency of 3 weeks; and F3: a single application for NPK and two applications for urea) was the main factor while the variety was the secondary factor. Observations and measures focused, among others, on seedling raising date, flowering date, plant height, height of insertion of the first floral bouquet, fruit setting date, harvest date, number of floral bouquets per plant, number of clustered fruits per plant, number of fruits per plant, total weight of fruit per plant, average weight of a fruit, output, firmness and soluble dry matter content of the fruits.

The results achieved highlighted the positive effect of the application every 3 weeks of NPK and urea (F2) on plant height. Results also showed that the application of NPK and urea every other week (F1) increased yields by 51% and soluble dry matter content by 19% compared to conventional application (F3). On the other hand, regarding fruit firmness, the single application of NPK and urea (F3) gave the best results in comparison with split applications (F1 and F2). Results also showed that the Thorgal variety was the best in terms of growth under the F2 application type. The Padma and Tomy varieties gave higher yields and higher

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soluble dry matter content with F1 fertilizer application. The Tomy variety produced the firmest fruits with the single fertilizer application F3.

Thus results achieved indicate that high frequency of fertilizer applications (F1) improves the rain-fed tomato productivity in terms of quantity and quality. This method can be exploited not only to reduce tomato shortages during the rainy season but also to improve diet quality for the Burkinabè population.

Keywords Split application · Single application · Mineral fertilizer · Tomato · Variety · Rainy season crop

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9.1 Introduction

In sub-Saharan Africa, soils have low inherent fertility due to natural constraints that are specific to each agro-ecological zone (Nyembo et al. 2013). According to Bado et al. (1991), agriculture in these countries is characterized by low productivity. In Burkina Faso, low crop yields are largely due to low rainfall (Bado et al. 1991; Sedego et al. 1997) and poor soils (Bado 1994; Sedego et al. 1997). Moreover, nutrients exported by harvests on already poor soils are not adequately replenished.

The low inherent soil nutrient content explains the efficiency of mineral fertilizers in raising crop yields (Kabrahy et al. 1996; Sedego et al. 1997). Improving soil fertility through the use of nutrients in mineral or organic forms, increases water efficiency and crop yields (Sedego et al. 1997). Under these conditions, mineral fertilizer becomes a determining production factor.

However, the use of mineral fertilizers on food crops in rural areas remains insignificant due to farmers' low purchasing power (Nyembo et al. 2013). Nevertheless, Burkinabè farmers strive to increase the use of mineral fertilizers on vegetable crops given the financial contribution of these crops to the improvement of their incomes. Indeed, since the 1990s, the fruit and vegetable sector has emerged as an important source of agricultural growth and poverty reduction (Mahrh 2008).

Tomato is the most important vegetable crop in Burkina Faso. It ranks first in terms of quantity produced (INERA/CREAF 2010) and monetary incomes (Masa 2012). However, for decades, tomato crops have been grown mainly during the dry season due to the lack of or inaccessibility of varieties adapted to the rainy season. The amounts of fertilizers applied to this dry season crop are 450 kg/ha of NPK and

200 kg/ha of urea. These amounts are brought in a single application for NPK and in two applications for urea.

In recent years, scientific research has focused on evaluating new imported varieties of tomato under our rain-fed based agro-ecological conditions and breeding new varieties (FBT1, FBT2 and FBT3, etc.) in order to increase the availability of this vegetable during the rainy period. At farmers' level, the mineral fertilization of this rainy season production is done in the same way as for the dry season production. However, if during the dry season water supplies are controlled, which limits mineral nutrient losses through leaching; this is not the case in the rainy season. Indeed, the use of the single application of mineral fertilizers to the crop in the rainy season, as is the case in dry season, increases nutrient losses. Rainfall, which is heavier and not controlled like irrigation in the dry season, accelerates nitrogen nitrification and increases losses through leaching. According to Pieri (1982), the amount of nitrogen lost during the rainy season in sandy soils varies between 10 kg/ha and 50 kg/ha. The leaching process is all the more accentuated as the water height at the ground surface is high (Ganry 1990). In leached ferruginous tropical soils, 1 mm of rain causes nitrates to leach to the lower layers of the soil, which can be as low as 70 mm (Ganry 1990). These high leaching levels are combined with losses through runoff. Gigou and Chabalier (1987) observed nitrogen losses through water erosion of about 11 kg/ha under maize crop. The nitrate ion is the main lost nutrient. These ions carry with them calcium and magnesium (Gigou and Chabalier 1987). These losses may also be due to wind erosion (Falisse et al. 1994).

Furthermore, even in dry season, the availability of the nutrients applied at the beginning of the growing season does not always coincide with the periods when the needs of the tomato are greatest. In the soil, nitrogen, which plays a pivotal role in the fertilization process, is extremely mobile, its efficiency and loss depend on the composition of the fertilizers used and their application periods (Nyembo et al. 2013). In general, ammonia from urea is fixed as NH_4^+ on clay fractions and on soil organic matter (MO) (FAO 2003). This also applies to phosphorus and potassium. However, as soils in Burkina Faso are very poor in organic matter (Sedogo 1981), irrigation and / or rainfall lead to clay dispersing, causing nutrient losses through leaching. In addition, low soil organic matter content greatly reduces cation exchange capacity (CEC). This limits the capacity for the sequestration of K^+ , Ca^{2+} and Mg^{2+} . According to Charbeau (2013) CEC characterizes the size of soil "pantry" and indicates whether it can be emptied and filled up rapidly or over a long period of time. Phosphorus fixation is also limited by the weak captions, particularly Ca^{2+} , on the absorbing complex. These result in low tomato yields in Burkina Faso compared to world data. In 2005, tomato yields were estimated at 24 tons/ha and 26.2 tons/ha in 2012 (Masa 2012), while international yields reached 40–80 tons per ha (Marques and Moreau 2007).

These conditions pose technical problems especially to small-scale, low-income farmers as they must manage with efficiency small fertilizer amounts to achieve higher profits. **Split fertilizer applications could be a key to this efficient management.**

The aim of this study is to evaluate the effect of split applications of mineral fertilizers on the growth and productivity of the tomato produced in the rainy season in Burkina Faso.

9.2 Study Objectives and Assumptions

The overall objective of this study is to improve tomato production in the rainy season.

Specifically, it aims to determine the effect of the correct frequency of mineral fertilizer applications on the growth and productivity of three tomato varieties as rainy season crops;

The study was based on the following assumptions:

- Split mineral fertilizer applications increase yields compared to conventional application;
- Tomato response to split mineral fertilizer applications varies according to the variety.

Three improved tomato varieties were used in the study. These are the varieties Padma (V1), Thorgal (V2) and Tomy (V3).

The trial was conducted in pots under shelter “insect proof”. The pots used were 6 liter plastic buckets. On average, 4.5 kg of soil was put into each pot for carrying out the trial.

The mineral fertilizers used in this study were NPK (14-23-14-6S) and Urea (46% N).

9.2.1 Experimental Design

The trial used a split-plot design with four replicates. The treatments (fertilizer input frequencies) were placed in main plots and the varieties (three) in secondary plots.

The applied rates of NPK and urea were 450 kg/ha and 200 kg/ha, respectively:

- F1: Application of 3 grams of NPK and 1.33 grams of urea per pot every two (02) weeks from 14 days after plant emergence.
- F2: Application of 4.5 grams of NPK and 2 grams of urea per pot every three (03) weeks from 14 days after plant emergence.
- F3: Single application of 18 grams of NPK per pot 14 days after emergence and 8 grams of urea per pot in two applications (three weeks after emergence and six weeks after emergence).

In each replicate, interactions between factors gave 9 elementary plots; resulting in 36 elementary plots for the 4 replicates which constitute the trial. Each

elementary plot consists of 8 pots, leading to 72 pots for each replicate and 288 pots for the whole trial. In each replicate, the main treatments (application frequencies) were randomized and within each main treatment, the secondary treatments (varieties) were also randomized giving the final layout below.

The trial was carried out from May to August 2014

9.2.2 Mineral Fertilizers Application (NPK and Urea)

Fertilizers were applied on the basis of the rates disseminated in farming areas, that is 450 kg of NPK/ha and 200 kg of urea/ha. One hectare carries 25,000 tomato plants; this assumes that each plant receives 18 grams of NPK and 8 grams of urea. The tomato crop requires mineral fertilization until fruit production. It requires more nitrogen during this period (Pip and Coleacp 2011). To achieve this, we phased out the different application frequencies up to 90 days after plant emergence. The Table 9.1 indicates the number of fertilizer applications and the amounts supplied per treatment.

9.3 Results and Discussions

9.3.1 Effect of Fertilizer Application Frequency on Growth

9.3.1.1 Effect of Fertilizer Application Frequency on Plant Height

Figure 9.1 shows the developments of the height of tomato plants according to the frequency of fertilizer applications. It shows that plants under NPK and urea applications every three weeks (F2) grew faster than those under F1 and F3. This difference in plant height under F2 was more visible from 40 Days After Emergence (DAE). Plant heights under F1 (application every two weeks) and F3 (single application) were almost similar all along from plant emergence to the end of crop growth.

Figures 9.2a, b and c show the evolution of plant height for each variety depending on application frequencies.

For the Padma variety (Fig. 9.2a), plants that received fertilizers every three weeks (F2) achieved faster growth. They are followed by plants that received a single application (F3). Under F1, the plant height limit was reached at 50 DAEs whereas under F2 and F3, the height limit was reached approximately 10 days later.

For the Thorgal variety (Fig. 9.2b), plants that received fertilizers every three weeks (F2) also achieved faster growth. They are followed by plants fertilized every two weeks (F1). Under F1 and F3, the height limit was nearly reached at

Table 9.1 Number of fertilizer applications and amounts per application

Treatment	Type of fertilizers	Number of applications	Amounts per application
F1 (Application every two weeks)	NPK	90/14 = 6 times	18/6 = 3 g
	Urea	90/14 = 6 times	8/6 = 1,33 g
F2 (Application every three weeks)	NPK	90/21 = 4 times	18/4 = 4,5 g
	Urea	90/21 = 4 times	8/4 = 2 g
F3 Single application	NPK	1 time	18 g
	Urea	2 times	8/2 = 4 g

The measurement of the amounts applied was done with an electronic scale. The application started two weeks after plant emergence i.e. on June 04, 2014

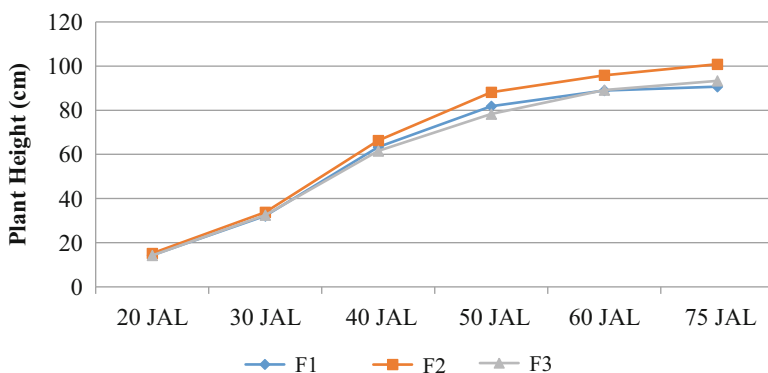


Fig. 9.1 Effect of fertilizer application frequencies on plant height

50 DAEs while under F2, growth continued up to 75 DAEs. Regarding the Tomy variety (Fig. 9.2c), plants under F1 and F2 showed similar growth. Their growth was faster than for plants under single application (F3) up to 60 DAEs.

9.3.2 Effect of Fertilizer Application Frequencies on Main Stem Diameters

Figure 9.3a shows the developments of the main stem diameters according to the frequency of mineral fertilization. The results indicate a similarity for all three frequencies of fertilizer applications from plant emergence up to 75 DAE. The maximum average diameters were 9.3 mm for the application frequency F1, 9.2 mm for the application frequency F2 and 9.1 mm for the application frequency F3. The maximum diameter of the stem was reached from the 60th DAE.

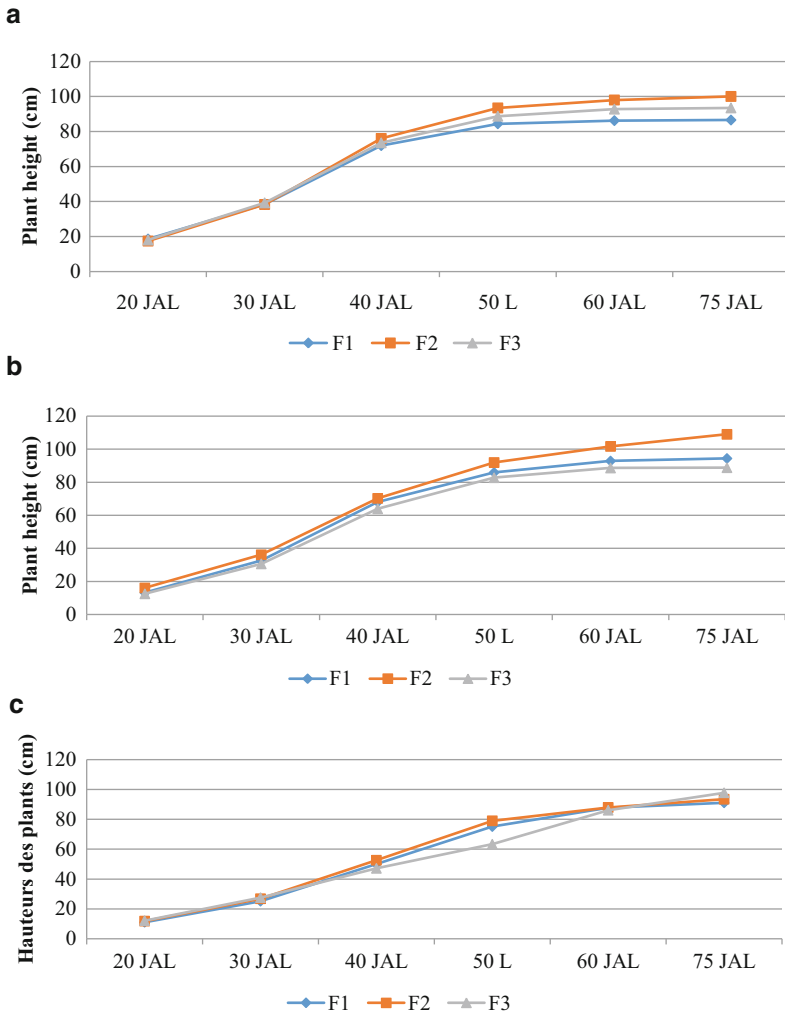


Fig. 9.2 (a) Effect of application frequencies on plant height for the Padma variety (b) Effect of application frequencies on plant height for the Thorgal variety (c) Effect of Application Frequencies on Plant Height for the Tomy Variety

Figures 9.3b, c and d show the developments of main stem diameters, per variety, under the three fertilization frequencies. They show a similarity of main stem diameters under the three application frequencies for each variety. For the Padma and Thorgal varieties, the maximum diameter was reached approximately at 50 DAEs whereas for the Tomy variety, growth continued up to 75 DAEs.

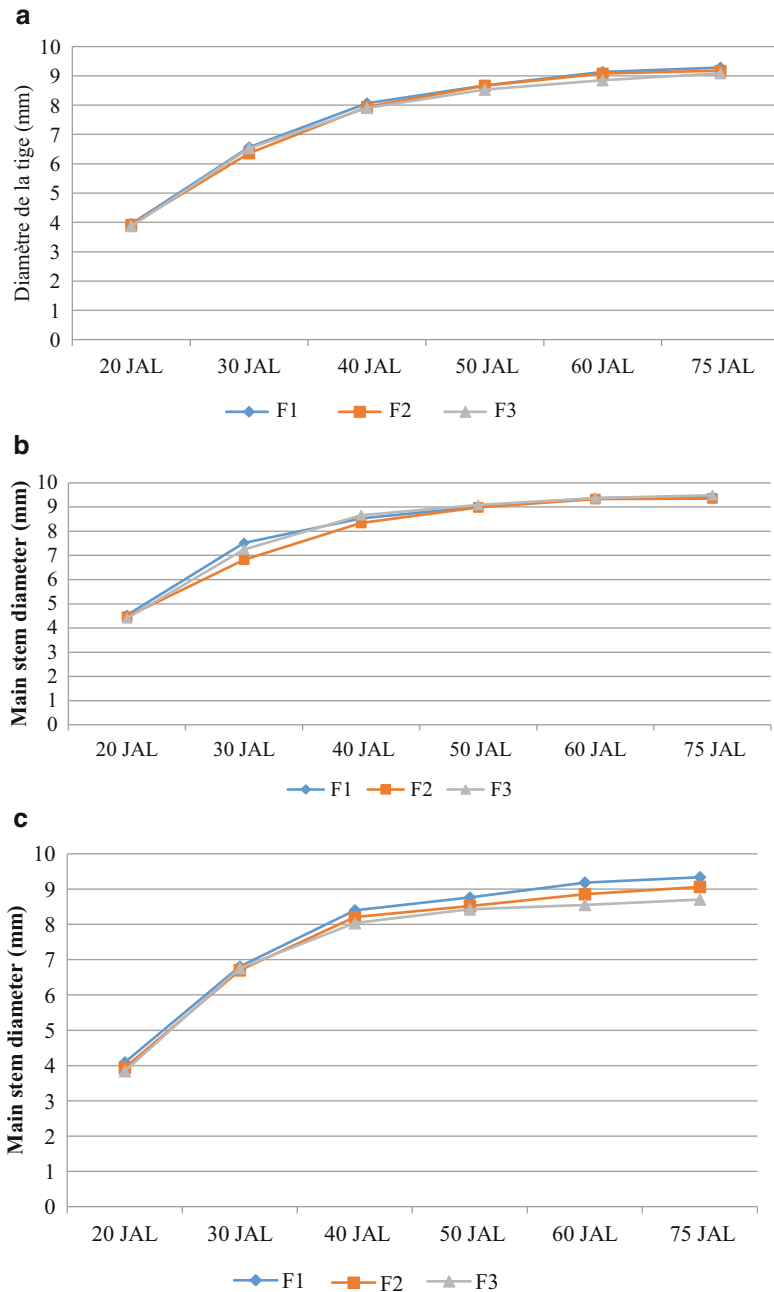


Fig. 9.3 (a) Effect of fertilizer application frequencies on tomato stem diameters (b) Effect of application frequencies on Padma stem diameter (c) Effect of application frequencies on Thorgal stem diameter (d) Effect of application frequencies on Tomy stem diameter

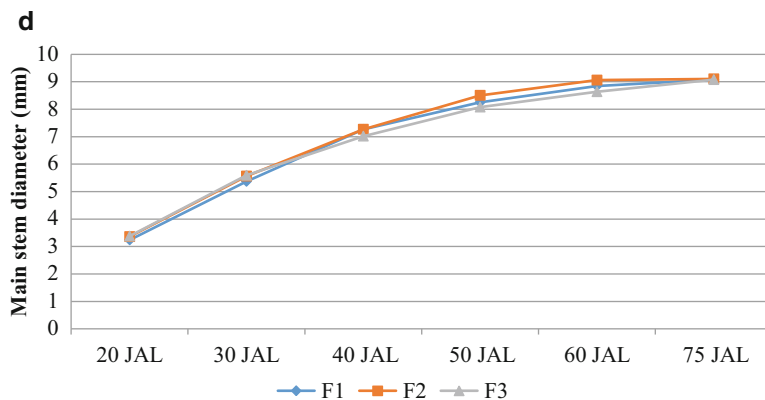


Fig. 9.3 (continued)

9.3.3 *Effect of Fertilizer Application Frequencies on Development Variables for Tomato*

9.3.3.1 **Effect of Application Frequencies on Flowering**

Table 9.2 shows tomato plant flowering (beginning and 50%) under the three fertilization frequencies. With treatment F3 (conventional fertilizer application), the beginning of the flowering phase was delayed by 1 day compared to plants under F1 and F2. But all treatments had the same number of days for flowering at 50%.

The Padma and Thorgal varieties flowered sooner than the Tomy variety with all application frequencies (Table 9.2). They also reached 50% flowering for all fertilizer application frequencies before the Tomy variety.

9.3.3.2 **Effect of Fertilizer Application Frequencies on the Height of Insertion of 1st Floral Bouquet**

Figure 9.4 shows the height of insertion of the first floral bouquet on tomato plants under the three fertilizer application frequencies. The height of insertion of the first floral bouquet was lower on the plants under conventional application (F3) compared to the other application frequencies F1 and F2 (Fig. 9.4). The 1st floral bouquet under F1 was also lower than that appearing under F2.

Figure 9.5 shows that irrespective of the application frequencies, the height of insertion of the first floral bouquet was higher in the Padma variety than in the other two varieties. For all varieties, a fertilizer application every three weeks resulted in a higher insertion height (Fig. 9.5).

Table 9.2 Effect of fertilizer application frequencies on early flowering (number of DAEs)

Treatments		Beginning of flowering			50% flowering		
		Padma	Thorgal	Tomy	Padma	Thorgal	Tomy
F1		32 ^b	32 ^b	38 ^a	35 ^b	36 ^b	40 ^a
F2		33 ^b	33 ^b	37 ^a	36 ^b	36 ^b	41 ^a
F3		33 ^b	33 ^b	38 ^a	35 ^b	36 ^b	40 ^a
Source of variation (test F)	Replicate	NS			NS		
	Fertilizer	NS			NS		
	Variety	***			***		
	Fertilizer*Variety	NS			NS		

NB: Values affected by the same letter in the same column are not significantly different at the 5% threshold according to the LSD test

NS: Non Significant; ***significant at $p < 0, 001$; *significant at $p < 0, 05$

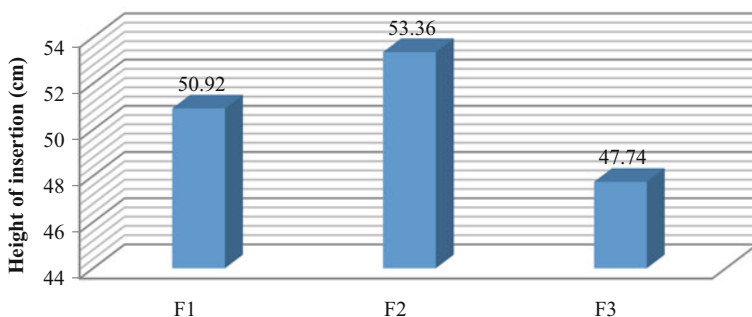


Fig. 9.4 Effect of fertilizer application frequencies on the insertion height of the 1st floral bouquet

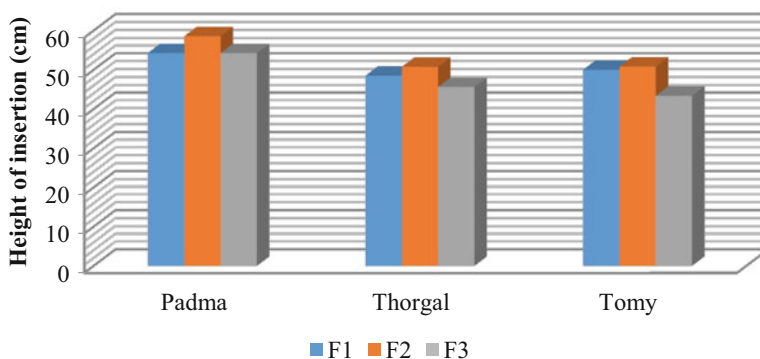


Fig. 9.5 Effect of fertilizer application frequencies on the insertion height of the 1st floral bouquet depending on the variety

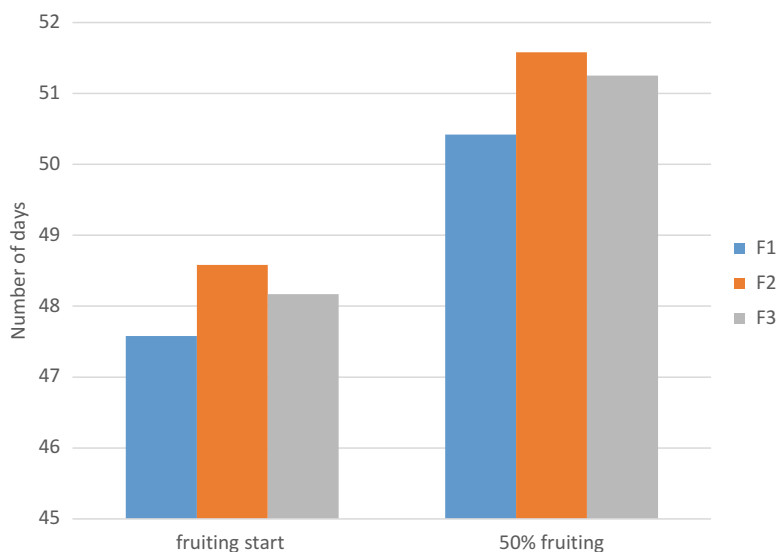


Fig. 9.6 Effect of fertilizer application frequencies on fruit setting

Table 9.3 Effect of fertilizer application frequencies on early fruit setting (Number of DAEs)

Treatments		Beginning of fruit setting			50% of fruit setting		
		Padma	Thorgal	Tomy	Padma	Thorgal	Tomy
F1		39 ^b	39 ^b	50 ^a	41 ^b	43 ^b	53 ^a
F2		40 ^b	40 ^b	52 ^a	42 ^b	43 ^b	55 ^a
F3		39 ^b	40 ^b	51 ^a	41 ^b	43 ^b	55 ^a
Source of variation (test F)	Replic	NS			NS		
	Ferti	NS			NS		
	Variety	***			***		
	Fert*V	NS			NS		

NB: Values affected by the same letter in the same column are not significantly different at the 5% threshold according to the LSD test

NS = Non Significant; ***Significant at $p < 0.001$

9.3.3.3 Effect of Fertilizer Application Frequencies on Fruit Setting

Figure 9.6 shows the effect of fertilizer application frequencies on the beginning and 50% of tomato fruit setting. The results show that under the single application (F3) and application every two weeks (F1) of NPK fertilizers and urea, fruit setting started a little earlier than under application every three weeks.

Fruit setting started earlier for the Padma and Thorgal varieties with all application frequencies (Table 9.3). Fruit setting started late for the Tomy variety. Plants

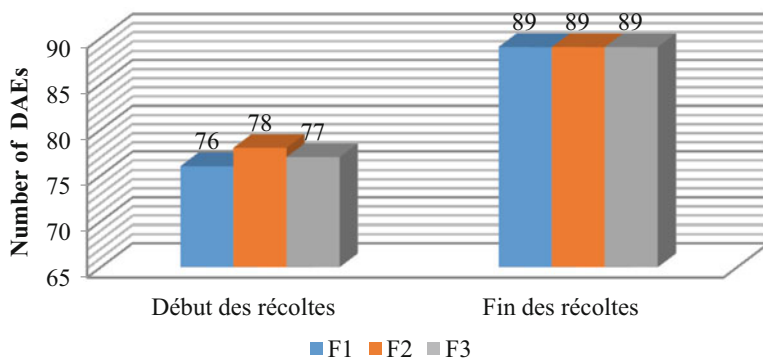


Fig. 9.7 Effect of fertilizer application frequencies on the beginning and end of harvests

Table 9.4 Effect of application frequencies on the beginning and end of harvests (Number of DAEs)

Treatments		Beginning of harvests			End of harvests		
		Padma	Thorgal	Tomy	Padma	Thorgal	Tomy
F1		73 ^b	72 ^b	83 ^a	86 ^b	86 ^b	96 ^a
F2		76 ^b	73 ^b	84 ^a	86 ^b	86 ^b	94 ^a
F3		73 ^b	73 ^b	86 ^a	86 ^b	86 ^b	96 ^a
Source of variation (test F)	Replicate	NS			NS		
	Fertilization	*			NS		
	Variety	***			***		
	Fertilization*Variety	***			NS		

NB: Values affected by the same letter in the same column are not significantly different at the 5% threshold according to the LSD test

NS = Non Significant; ***Significant at $p < 0.001$; * = significant at $p < 0,05$

of the Tomy variety under application frequency F1 started fruit setting earlier than plants under application frequencies F2 and F3.

9.3.3.4 Effect of Fertilizer Application Frequencies on Harvests

Figure 9.7 presents the harvesting dates (start and end) of the tomato plants under the three fertilization frequencies. The results show that plant harvesting under F1 started one to two days earlier than under F3 and F2, respectively. However, at the end of the harvest period, all treatments produced the same result.

The Padma and Thorgal varieties had earlier harvests irrespective of application frequencies. The Tomy variety, on the other hand, had later harvest (Table 9.4). Fertilization did not influence the end of harvests.

Table 9.5 Effect of fertilizer application frequencies on the production of floral bouquets and fruit clusters

Treatment	Number of floral bouquets per plant	Number of fruit clusters per plant
F1	9 ^a	5 ^a
F2	9 ^a	6 ^a
F3	10 ^a	5 ^a

NB: Values affected by the same letter in the same column are not significantly different at the 5% threshold according to the LSD test

Table 9.6 Effect of application frequencies on the production of floral bouquets and fruit clusters

Treatments		Number of floral bouquets per plant			Number of fruit clusters per plant		
		Padma	Thorgal	Tomy	Padma	Thorgal	Tomy
F1		8 ^b	10 ^a	9 ^a	6 ^a	5 ^b	6 ^a
F2		8 ^b	11 ^a	9 ^a	6 ^a	5 ^b	6 ^a
F3		8 ^b	10 ^a	10 ^a	6 ^a	5 ^b	5 ^b
Source of variation (test F)	Replicate	NS			NS		
	Fertilization	NS			NS		
	Variety	**			*		
	Fertilization*Variety	NS			NS		

NB: Values affected by the same letter in the same column are not significantly different at the 5% threshold according to the LSD test

NS: Non Significant; *significant at $p < 0, 0.05$; **significant at $p < 0, 0.01$

9.3.4 Effect of Application Frequencies on Tomato Productivity

9.3.4.1 Effect of Application Frequencies on the Number of Floral Bouquets and Fruit Clusters

There were no significant differences between the three treatments regarding the number of floral bouquets and the number of fruit clusters (Table 9.5).

Table 9.6 shows the number of floral bouquets and fruit clusters per plant. It was found that under all application frequencies, 75% of the floral bouquets of the Padma variety were transformed into fruit clusters. For the Thorgal variety, 46–50% of the floral bouquets have become fruit clusters under all fertilization types. For the Tomy variety 67% of the floral bouquets under F1 and F2 were transformed into fruit clusters, whereas under F3 only 50% of the floral bouquets were transformed into fruit clusters.

Table 9.7 Effect of fertilizer application frequencies on the total number of fruits harvested, marketable fruits and nonmarketable fruits

Treatment		Total number of fruits harvested	Number of marketable fruits	Number of non-marketable fruits
F1		20 ^a	14 ^a	6 ^a
F2		22 ^a	18 ^a	3 ^b
F3		22 ^a	18 ^a	4 ^b
Source of variation (test F)	Replicate	NS	NS	NS
	Fertilization	NS	NS	NS
	Variety	***	**	**
	Fertilization*Variety	NS	NS	NS

NB: Values affected by the same letter in the same column are not significantly different at the 5% threshold according to the LSD test

NS: Non Significant; ** Significant at $p < 0.01$; *** Significant at $p < 0.001$

9.3.4.2 Effect of Application Frequencies on the Total Number of Harvested Fruits, Salable Fruits and Non-salable Fruits

Table 9.7 shows the total number of fruits harvested, the number of salable fruits and the number of non-salable fruits with the three fertilization frequencies. Of the fruits harvested under F1, 30% were non-salable while under F2 and F3, the rate was respectively 14% and 18%.

Depending on the varieties, Padma produced more fruits harvested than the two other varieties with all application frequencies (Fig. 9.8a). Plants under F2 and F3 produced more salable fruits in the Padma and Thorgal varieties (Fig. 9.8b). Plants under F1 and F3 of the Padma variety produced more non-salable fruits than plants under F2 (Fig. 9.8c). For the Tomy variety, fertilization frequency F1 produced more non-salable fruits (Fig. 9.8c).

9.3.5 Effect of Application Frequencies on the Number of Rotten and Cracked Fruits

Table 9.8 shows the percentage of rotten and cracked fruits according to the types of fertilizer application. The application frequency F3 caused more rotting and cracking of fruits.

Figures 9.8a, b show the percentages of rotting and cracking per variety. The Tomy variety had the highest percentage of rotten fruits under the F1 and F3 application frequencies. Under the frequency F2, the Thorgal variety recorded more rotting (Fig. 9.8a).

Regarding cracking, fruits under F3 fertilization frequency (conventional fertilization) had the highest percentage (%) for all three varieties (Fig. 9.8b).

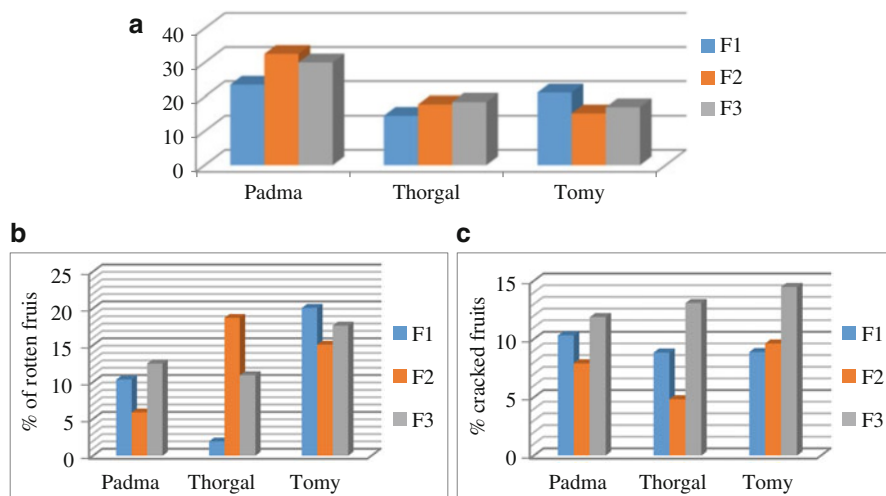


Fig. 9.8 (a) Effect of application frequencies on the number of fruits harvested (b) Effect of application frequencies on the percentage of rotten fruits (c) Effect of application frequencies on the percentage of cracked fruits

Table 9.8 Effect of fertilizer application frequencies on the percentage of rotten and cracked fruits

Treatment	Total number of fruits harvested	Number of marketable fruits	% of rotten fruits	% of cracked fruits
F1	20 ^a	14 ^a	11,72	9,39
F2	22 ^a	18 ^a	11,51	7,48
F3	22 ^a	18 ^a	13,39	12,89

9.3.5.1 Effect of Application Frequencies on Fruit Firmness

Figure 9.9 shows the percentage of fruit firmness according to fertilizer application frequencies. The application frequency F3 gave the firmest fruits compared to the other two forms of fertilization.

Table 9.9 shows the percentage of fruit firmness per variety. All varieties produced firmer fruits with the application frequency F3 compared to the two other frequencies. The variety Thorgal gave the least firm fruits under the application frequency F1 whereas under the application frequency F2, the variety Tomy gave the least firm fruits.

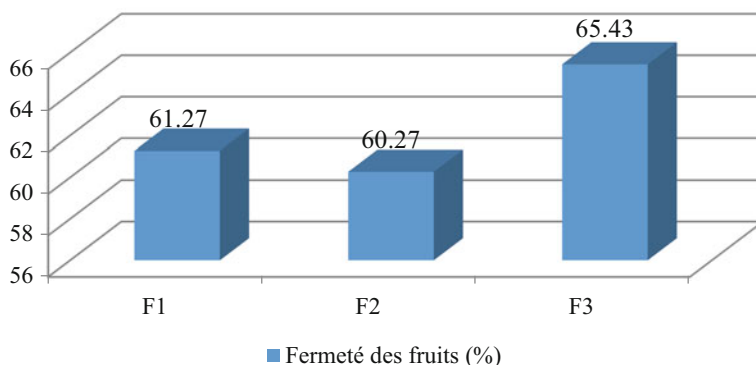


Fig. 9.9 Effect of application frequencies on fruit firmness

Table 9.9 Effect of application frequencies on fruit firmness

Treatment		Padma	Thorgal	Tomy
F1		62,60 ^b	58,00 ^c	63,20 ^b
F2		60,00 ^c	62,40 ^b	58,40 ^c
F3		63,80 ^b	66,00 ^a	66,50 ^a
Source of variation (test F)	Replication	NS	NS	NS
	Fertilization	**	**	**
	Variety	NS	NS	NS
	Fertilization*Variety	*	*	*

NB: Values affected by the same letter in the same column are not significantly different at the 5% threshold according to the LSD test

NS: Non Significant ; * Significant at $p < 0,05$; ** Significant at $p < 0,01$

9.3.5.2 Effect of Application Frequencies on Soluble Dry Matter Content

Figure 9.10 shows the rates of soluble dry matter content depending on the fertilization frequencies. The application of NPK and urea fertilizers every two weeks (F1) yielded fruits with highest soluble dry matter content.

Table 9.10 shows the effect of application frequencies on soluble dry matter content per variety. Under F1, the Tomy and Padma varieties produced fruits that had the highest soluble dry matter content. Under F2, the fruits of the Tomy variety had the highest soluble dry matter content. Under the F3 application frequency, the Padma variety produced fruits with highest soluble dry matter content.

9.3.5.3 Effect of Application Frequencies on Yields

Production yield under application frequency F1 was 44% and 51% higher than under F2 and F3, respectively (Fig. 9.11).

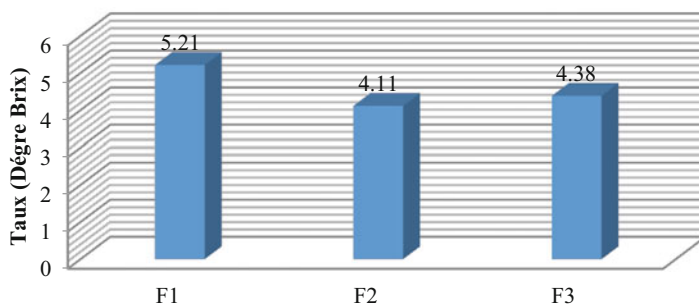


Fig. 9.10 Effect of application frequencies on soluble dry matter content

Table 9.10 Effect of application frequencies on soluble dry matter content

Treatment		Padma	Thorgal	Tomy
F1		570 ^a	407 ^b	588 ^a
F2		364 ^b	332 ^b	538 ^a
F3		529 ^a	441 ^b	344 ^b
Source of variation (test F)	Replicate	NS		
	Fertilization	*		
	Variety	*		
	Fertilization ^a Variety	**		

NB: Values affected by the same letter in the same column are not significantly different at the 5% threshold according to the LSD test

NS: Non Significant ; * Significant at $p < 0,05$; ** Significant at $p < 0,01$

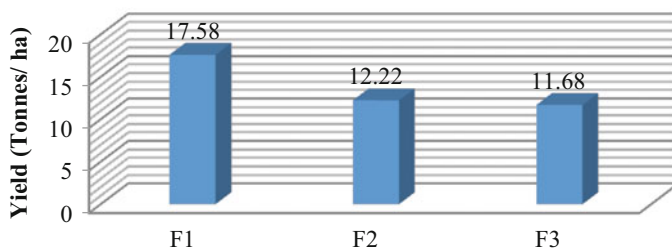


Fig. 9.11 Effect of application frequencies on yields

Yields of the Padma variety under F1 were 26% and 16% higher than yield under F2 and F3, respectively. For the Thorgal variety, yields under F1 were higher than under F2 and F3 respectively by 15% and 48%. For the Tomy variety, yields under F1 exceeded that of F2 and F3 by 103% and 102%, respectively.

9.4 Conclusion– Recommendations and Prospects

This study consisted of verifying the effects of split mineral fertilizer applications on the growth and productivity of tomatoes in rainy season cultivation. In order to achieve this objective, a confined field trial was carried out. The results achieved led to draw the following conclusions:

- The application of NPK and urea every 2 weeks (F1) gave a greater total weight of fruits per plant (422 g) compared to F2 (293 g) and F3 (280 g). It also produced fruits with the highest soluble dry matter content (5.21%) compared to F2 (4.11%) and F3 (4.38%). The greater number of splits inducing high frequency applications increases the agronomic efficiency of fertilizers in production in terms of quantity and quality.
- Splitting NPK and urea in 4 equal fractions with an application frequency of every 3 weeks (F2) fostered growth in tomato plants.
- A single application of NPK (450 kg / ha) and urea in two fractions (100 kg/ha/ application) produced firmer fruits (65.43%) compared to F1 (61.27%) and F2 (60.27%). Fertilizer splitting reduced the firmness of tomato fruits.
- The Padma variety responded better to the F1 application frequency in terms of fruit production (416 g of fruit / plant), and soluble dry matter production (5.21%). The Tomy variety also responded well to the F1 application frequency in terms of fruit production (496 g of fruit / plant), and soluble dry matter production (5.88%). These two varieties responded better to the every two weeks application in terms of production quantity and quality. The Thorgal variety responded better to the F2 application frequency in terms of plant height. The Thorgal and Tomy varieties responded better to the F3 application frequency in terms of fruit firmness with respectively 66% and 66.5% of firmness.

In view of these findings, we recommend raising farmers' awareness on the importance of splitting fertilizers in 6 applications with a frequency of every 2 weeks in order to take full advantage of the contribution of these fertilizers to productivity. Also we suggest the dissemination of the Padma variety in the northern part of the country where the rainy season is short with low rainfall. The Tomy variety can be recommended to farmers in the center and the western part of the country. Moreover, this study is a contribution to reasoned fertilization in tomato production in a context where efficient fertilizer use is required given the high costs of mineral fertilizers.

However, it would be necessary to further this study by setting up a trial in farmers' fields to better take into account the effect of application frequencies on the phytosanitary evolution (fungal, bacterial, viral diseases), cracking and especially fruit blossom-end rot. Blossom-end rot results from calcium deficiency, whereas splitting, which allows the presence of mineral salts around the roots at the time of fruiting and reduces the flow of water to the fruit for a better concentration of soluble dry matter, also may limit the transport of calcium to the fruit. In addition, a study should be carried out to evaluate the economic profitability of

fertilizer application frequencies because splitting requires additional expenditures in crop management, which should normally be compensated for by the crop surplus resulting from the splitting.

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