*The Asian Journal of Horticulture*, Vol. 3 No. 2 : 297-300 (December-2008)

# Effect of planting systems, spacing and nutrition on dry matter production and distribution in banana cv. ROBUSTA

D. THIPPESHA, V. SRINIVAS, SRIHARSHA, G. JANARDHAN AND B. MAHANTHESH

**Accepted :** *September, 2008*

See end of the article for authors' affiliations

Correspondence to:

**D. THIPPESHA**
Department of Pomology,
College of Horticulture,
Mudigere, CHIKMAGALUR
(KARNATAKA) INDIA

## ABSTRACT

An investigations on the Effect of planting systems, spacing and nutrition on dry matter production and distribution in different plant parts such as corms**,** pseudostem, leaves, stalk and fruits of banana cv. ROBUSTA was studied during 2003-04, with 19 treatments replicated thrice with a Randomized Block Design. The treatments includes, planting 2 and 3 suckers/hill at a spacing of 2.0 m x 2.0 m, 2.5 m x 2.5 m, 3.0 m x 2.0 m with 3 levels of NPK *i.e.*, 180:125:250g/hill; 270:185:375 g/hill and 360:250:500 g/hill and were compared with conventional planting system (single sucker/hill) with recommended practices. The results reveal that, the total dry matter production and distribution in different plant parts was highest in $T_3$ (13.92 kg and 19.60 kg/ plant), where, planting two suckers per hill at 2.0m x 2.0m apart, supplied with 360:250:500 g NPK indicated that there was better uptake and translocation of nutrients at shooting and harvesting stages, respectively.

**Key words :** Banana, Robusta, High density planting, Nutrition, Dry matter production.

The system of High Density Planting (HDP) has been successfully implicated in banana, since HDP results in the optimum utilization of natural resources. In most of the regions, where banana is grown, solar radiation is abundant and thus productivity largely depends upon its efficient utilization. The system and density of planting need to be designed to intercept the solar radiation effectively. Banana plant, mostly feeds at the surface of the soil, subsequently, it is of paramount importance to maintain a high degree of soil fertility, if the production is to be maintained at an economical level over long periods. The crop gives good response to judicious fertilizer programmes. Any excess or deficit application of fertilizers will not exploit the full potential of its yield. Although adequate information on banana dry matter production and distribution is found in the literature, most of it is for low-density situation. The information available on proper system and density of planting, spacing and nutritional requirement for optimum production in banana cv. Robusta under different agro-climatic situations is meagre. This clearly emphasizes the need for research on these aspects, which is expected to provide vital information on practical benefits to the growers.

## MATERIALS AND METHODS

The present investigations were carried out in the farmer's field at Tarikere taluk of Chikmagalur district, Karnataka state from 2001 to 2004. The soil was sandy clay loam having pH: 6.6, electric conductivity: 0.16m mhos/cm: organic carbon: 0.90% available nitrogen: 87.0 kg/ha, available phosphorus: 80.0 kg/ha and available potash: 425.0 kg/ha.

The experiment was laid out with banana cv. Robusta in a randomized block design with 19 treatments and 3 replications. Each treatment was surrounded by 2 guard rows on all sides of the treatment, occupying a net area of 12m x 12m; the treatment details are presented in Table.

The planting systems followed in the trial were, planting 3 suckers / hill, 2 suckers/hill at a spacing of 2.0mx2.0m, 2.5mx2.5m, and 3.0mx2.0m and compared with the recommended practices. The quantity of nutrients (NPK) applied to each treatment *i.e.*, $T_1$, $T_4$, $T_7$, $T_{10}$, $T_{13}$ and $T_{16}$ at 180:125:250 g/hill, $T_2$, $T_5$, $T_8$, $T_{11}$, $T_{14}$ and $T_{17}$ at 270:185:375 g/hill, $T_3$, $T_6$, $T_9$, $T_{12}$, $T_{15}$ and $T_{18}$ at 360:250:500 g/hill and control ($T_{19}$- recommended practices) with 180:108:225 g/hill, in the form of urea, single super phosphate and muriate of potash. The fertilizers were applied in 3 splits, at 2$^{nd}$ 4$^{th}$ and 6$^{th}$ month after planting, while potash was applied in 4 splits; last split was applied at shooting stage. The detailed observations recorded from the bunches of 3 plants (3 suckers planted per hill), 2 plants (2 suckers planted per hill) and from one plant (single sucker planted per hill) as control from each replication, were used for recording observations

## RESULTS AND DISCUSSION

The total dry matter production (DMP) and its distribution (Table 1) in different parts of plant *viz.*, corms, pseudostem, leaves, stalk and fruits differed significantly among the treatments at shooting. Among all the

**Table : The details of treatments followed for the study**

| Treatments | No. of Suckers/hill | Spacing (mxm) | Nutritional level (N: P: K g/hill) | No. of plants/ha |
|---|---|---|---|---|
| $T_1$- $P_2S_1N_1$ | Two | 2.0 x 2.0 | 180:125:250 | 5000 |
| $T_2$- $P_2S_1N_2$ | Two | 2.0 x 2.0 | 270:185:375 | 5000 |
| $T_3$- $P_2S_1N_3$ | Two | 2.0 x 2.0 | 360:250:500 | 5000 |
| $T_4$ $P_2S_2N_1$ | Two | 2.5 x 2.5 | 180:125:250 | 3300 |
| $T_5$- $P_2S_2N_2$ | Two | 2.5 x 2.5 | 270:185:375 | 3300 |
| $T_6$- $P_2S_2N_3$ | Two | 2.5 x 2.5 | 360:250:500 | 3300 |
| $T_7$- $P_2S_3N_1$ | Two | 3.0 x 2.0 | 180:125:250 | 3250 |
| $T_8$- $P_2S_3N_2$ | Two | 3.0 x 2.0 | 270:185:375 | 3250 |
| $T_9$- $P_2S_3N_3$ | Two | 3.0 x 2.0 | 360:250:500 | 3250 |
| $T_{10}$- $P_3S_1N_1$ | Three | 2.0 x 2.0 | 180:125:250 | 7500 |
| $T_{11}$- $P_3S_1N_2$ | Three | 2.0 x 2.0 | 270:185:375 | 7500 |
| $T_{12}$- $P_3S_1N_3$ | Three | 2.0 x 2.0 | 360:250:500 | 7500 |
| $T_{13}$- $P_3S_2N_1$ | Three | 2.5 x 2.5 | 180:125:250 | 4500 |
| $T_{14}$- $P_3S_2N_2$ | Three | 2.5 x 2.5 | 270:185:375 | 4500 |
| $T_{15}$- $P_3S_2N_3$ | Three | 2.5 x 2.5 | 360:250:500 | 4500 |
| $T_{16}$-$P_3S_3N_1$ | Three | 3.0 x 2.0 | 180:125:250 | 5000 |
| $T_{17}$- $P_3S_3N_2$ | Three | 3.0 x 2.0 | 270:185:375 | 5000 |
| $T_{18}$- $P_3S_3N_3$ | Three | 3.0 x 2.0 | 360:250:500 | 5000 |
| $T_{19}$-CONTROL | One | 1.8 x 1.8 | 180:108:225 | 3086 |

treatments, the dry matter production (DMP) and distribution in all the plant parts was found to be maximum in the treatment ($T_3$) wherein planting two suckers per hill at 2.0m x 2.0m apart with the application of 360:250:500g NPK per hill. The value of DMP in corm was 5.11 kg, which was at par with $T_6$ and $T_2$, while minimum was recorded in $T_{10}$ (4.30 kg). In the pseudostem the maximum DMP was 4.65 kg and it was at par with $T_9$ and $T_6$, while the minimum was recorded in $T_{10}$ and $T_{16}$ (3.37 kg). The production and distribution of dry matter of leaves was more in $T_3$ (3.37 kg), which was at par with $T_6$, $T_{19}$, $T_9$, $T_8$, $T_2$, $T_5$ and $T_4$. The lowest was recorded in $T_{11}$ (2.87 kg). Irrespective of the planting systems and spacing, application of 360:250:500 g NPK per hill resulted in the maximum production of dry matter in the stalk. It ranged from 0.44 kg in $T_{16}$ to 0.79 kg in $T_3$. The $T_3$ was at par with $T_9$ and $T_6$.

The Similar trend was observed in case of DMP at harvesting also, wherein the treatment $T_3$ resulted in maximum DMP of corms (4.06 kg) and it was at par with $T_6$. The minimum was in $T_{10}$ (3.03 kg). The DMP of stalk was also high in $T_3$ (1.21 kg) , which was at par with $T_{18}$, $T_9$, $T_{19}$, $T_2$, $T_{12}$ and $T_6$. While, lowest DMP (1.05 kg) of stalk was recorded in $T_{10}$. Similarly, the DMP of pseudostem was also maximum in $T_3$ (4.18 kg), followed by $T_6$, $T_9$ and $T_2$. The minimum was recorded in $T_{10}$ (3.13 kg). The DMP of leaves was highest $T_3$ (1.82 kg), which was at par with $T_9$ and $T_6$. The lowest was recorded in $T_{10}$ (1.38 kg). The maximum DMP of fruit was recorded in $T_3$ (8.33 kg), followed by $T_2$, $T_9$ and $T_5$, while the minimum was in $T_{10}$ (5.11 kg). In general, irrespective of planting systems and spacing, an increased trend in dry matter production and distribution in different plant parts was observed due to increased application of nutrients.

The accumulation and distribution of biomass in various parts of the plant plays a vital role in determining the growth and production in banana. The total dry matter production and distribution in different plant parts was highest in $T_3$ (13.92 kg and 19.60 kg/plant) at shooting and harvesting stages, respectively. While, minimum total DMP was noticed in $T_{10}$ (11.06 and 13.70 kg) both at shooting and harvesting stages, respectively. The control recorded 12.82 and 16.74 kg total DMP at shooting and harvesting stages, respectively. The biomass accumulation and distribution was higher with higher levels of nutrients. Higher accumulation of dry matter in the treatments supplied with 360:250:500 g NPK and two suckers per hill, indicated that there was better uptake and translocation of nutrients, which can be clearly seen in better weight of bunch obtained (Table 2). Higher dry matter production in these treatments might be due to better plant growth, more number of leaves per plant, more leaf area per plant and better uptake of nutrients from the soil. These findings confirm the reports of Thippesha *et al.* (2005), Turner and Barkus (1981) and Kohli *et al.* (1985).

Low level of nitrogen and potassium restricted the growth of leaves resulting in smaller leaves, thus affecting the leaf area and photosynthetic efficiency, thereby reducing the total dry matter production in the treatment

**Table 1 : Effect of planting systems, spacing and nutrition on dry matter production and distribution at shooting in banana cv. ROBUSTA**

| Treatments | Dry matter production and distribution at shooting (kg) | | | | |
|---|---|---|---|---|---|
| | Corm | Pseudostem | Leaf | Stalk | Total |
| $T_{1-}$ $P_2S_1N_1$ | 4.70 | 3.61 | 3.18 | 0.53 | 12.02 |
| $T_{2-}$ $P_2S_1N_2$ | 4.92 | 4.13 | 3.22 | 0.66 | 12.93 |
| $T_{3-}$ $P_2S_1N_3$ | 5.11 | 4.65 | 3.37 | 0.79 | 13.92 |
| $T_4$ $P_2S_2N_1$ | 4.71 | 3.52 | 3.21 | 0.61 | 12.05 |
| $T_{5-}$ $P_2S_2N_2$ | 4.77 | 4.06 | 3.22 | 0.64 | 12.69 |
| $T_{6-}$ $P_2S_2N_3$ | 4.96 | 4.56 | 3.36 | 0.70 | 13.58 |
| $T_{7-}$ $P_2S_3N_1$ | 4.42 | 4.25 | 3.11 | 0.64 | 12.48 |
| $T_{8-}$ $P_2S_3N_2$ | 4.49 | 4.36 | 3.24 | 0.67 | 12.76 |
| $T_{9-}$ $P_2S_3N_3$ | 4.74 | 4.57 | 3.29 | 0.74 | 13.34 |
| $T_{10}$- $P_3S_1N_1$ | 4.30 | 3.37 | 2.88 | 0.53 | 11.06 |
| $T_{11-}$ $P_3S_1N_2$ | 4.31 | 3.38 | 2.87 | 0.54 | 11.10 |
| $T_{12-}$ $P_3S_1N_3$ | 4.45 | 3.47 | 3.05 | 0.55 | 11.52 |
| $T_{13-}$ $P_3S_2N_1$ | 4.44 | 3.43 | 2.90 | 0.51 | 11.28 |
| $T_{14-}$ $P_3S_2N_2$ | 4.44 | 3.44 | 2.99 | 0.52 | 11.39 |
| $T_{15-}$ $P_3S_2N_3$ | 4.47 | 3.49 | 3.10 | 0.55 | 11.61 |
| $T_{16-}P_3S_3N_1$ | 4.46 | 3.37 | 2.89 | 0.44 | 11.16 |
| $T_{17}$- $P_3S_3N_2$ | 4.42 | 3.39 | 3.07 | 0.51 | 11.39 |
| $T_{18}$- $P_3S_3N_3$ | 4.54 | 3.49 | 3.11 | 0.53 | 11.67 |
| $T_{19-}$CONTROL | 4.79 | 4.08 | 3.34 | 0.61 | 12.82 |
| S.E ± | 0.09 | 0.07 | 0.07 | 0.04 | 0.06 |
| C.D. (P=0.05) | 0.27 | 0.19 | 0.23 | 0.12 | 0.20 |

$P_2$ - Two suckers/hill; $P_3$ -Three suckers/hill; Control- single sucker with recommended practices
$S_1$ - 2.0m x 2.0m; $S_2$ -2.5m x 2.5m; $S_3$ - 3.0m x2.0m
$N_1$ - 180:125:250 g NPK/hill; N2 -270:185:375 g NPK/hill; $N_3$ - 360:250:500 g NPK/hill

**Table 2 : Effect of planting systems, spacing and nutrition on dry matter production and distribution at harvesting in banana cv. ROBUSTA**

| Treatments | Dry matter production and distribution at harvesting | | | | | | Bunch wt. (kg) |
|---|---|---|---|---|---|---|---|
| | Corm | Pseudo-stem | Leaf | Stalk | Fruit | Total | |
| $T_{1-}$ $P_2S_1N_1$ | 3.68 | 3.48 | 1.63 | 1.13 | 6.85 | 16.77 | 16.22 |
| $T_{2-}$ $P_2S_1N_2$ | 3.75 | 3.96 | 1.70 | 1.17 | 7.47 | 18.05 | 16.75 |
| $T_{3-}$ $P_2S_1N_3$ | 4 .06 | 4.18 | 1.82 | 1.21 | 8.33 | 19.60 | 22.64 |
| $T_4$ $P_2S_2N_1$ | 3.28 | 3.75 | 1.57 | 1.14 | 6.68 | 16.57 | 16.91 |
| $T_{5-}$ $P_2S_2N_2$ | 3.49 | 3.77 | 1.62 | 1.15 | 6.99 | 17.03 | 18.64 |
| $T_{6-}$ $P_2S_2N_3$ | 3.97 | 4.04 | 1.75 | 1.16 | 6.91 | 18.16 | 21.12 |
| $T_{7-}$ $P_2S_3N_1$ | 3.20 | 3.68 | 1.62 | 1.11 | 6.66 | 16.28 | 18.68 |
| $T_{8-}$ $P_2S_3N_2$ | 3.26 | 3.75 | 1.70 | 1.12 | 6.78 | 16.62 | 20.82 |
| $T_{9-}$ $P_2S_3N_3$ | 3.88 | 4.00 | 1.76 | 1.17 | 7.34 | 18.16 | 19.55 |
| $T_{10}$- $P_3S_1N_1$ | 3.03 | 3.13 | 1.38 | 1.05 | 5.11 | 13.70 | 13.27 |
| $T_{11-}$ $P_3S_1N_2$ | 3.10 | 3.21 | 1.43 | 1.07 | 5.13 | 13.95 | 12.01 |
| $T_{12-}$ $P_3S_1N_3$ | 3.16 | 3.26 | 1.56 | 1.16 | 5.76 | 14.90 | 12.42 |
| $T_{13-}$ $P_3S_2N_1$ | 3.11 | 3.24 | 1.39 | 1.11 | 5.25 | 14.10 | 15.12 |
| $T_{14-}$ $P_3S_2N_2$ | 3.20 | 3.31 | 1.41 | 1.11 | 5.34 | 14.37 | 16.37 |
| $T_{15-}$ $P_3S_2N_3$ | 3.43 | 3.36 | 1.55 | 1.13 | 5.55 | 15.03 | 15.84 |
| $T_{16-}P_3S_3N_1$ | 3.11 | 3.22 | 1.42 | 1.12 | 5.24 | 14.09 | 13.15 |
| $T_{17}$- $P_3S_3N_2$ | 3.13 | 3.35 | 1.46 | 1.14 | 5.42 | 14.50 | 15.77 |
| $T_{18}$- $P_3S_3N_3$ | 3.43 | 3.51 | 1.53 | 1.18 | 5.95 | 15.61 | 14.35 |
| $T_{19-}$ONTROL | 3.55 | 3.73 | 1.63 | 1.17 | 6.63 | 16.74 | 19.11 |
| S.E. ± | 0.06 | 0.04 | 0.03 | 0.01 | 0.11 | 0.11 | 0.42 |
| C.D. (P=0.05) | 0.19 | 0.12 | 0.09 | 0.05 | 0.34 | 0.32 | 1.22 |

$P_2$ - Two suckers/hill; $P_3$ -Three suckers/hill; Control- single sucker with recommended practices
$S_1$ - 2.0m x 2.0m; $S_2$ -2.5m x 2.5m; $S_3$ - 3.0m x2.0m
$N_1$ - 180:125:250 g NPK/hill; $N_2$ -270:185:375 g NPK/hill; $N_3$ - 360:250:500 g NPK/hill

receiving lesser nutrients (Raju, 1996) with higher population. Similarly, in the present experiment, the treatments with reduced levels of nutrients recorded smaller size of leaves, delayed flowering, reduced fruit number per bunch, number of hands per bunch and fruit size. The increased trend in dry matter at harvest may be due to application of nutrients especially potassium during shooting which might have contributed substantially for higher average weight of fingers, resulting in increased yield. These findings confirm the reports of Garita and Jaramillo (1984), Pandit *et al.* (1992) Natesh *et al.* (1993) and Gietema (1970).

In closer spacing, mutual shading, the light intensity available at the middle and lower strata of the plant will be less than in wider spacing. However, even with low light intensity certain amount of photosynthesis takes place, hence, the dry matter production per plant did not decreased considerably in closer plantings.

Authors' affiliations:
**V. SRINIVAS, SRIHARSHA, G. JANARDHAN AND B. MAHANTHESH,** Department of Pomology, College of Horticulture, Mudigere, CHIKMAGALUR (KARNATAKA) INDIA

## REFERENCES

**Garita, C.R.** and Jarmillo, C.R., (1984). Response of cultivar Giant Cavendish (*Musa* AAA) to increasing rates of potassium in soils on the Caribbean east of Costa Rica. *Informe Menseral, UPEB*, **8** (66) : 50-55

**Gietema, Groenendizk, K.** (1970). Fotosynthese metingen bij banana, *Internal. report*. Vol. **70** (7). Dept. Trop. Crops, Agric. Univ. Wageningen

**Kohli, R.R.,** Reddy, Y.T.N. and Iyengar, B.R.V. (1985). Effect of nitrogen on biomass distribution in Robusta banana. *Gartenbau Wissen sehatt.,* **50** (3) : 117-20.

**Natesh, B.B.,** Aravindakshan, N. and Vatsalakumari, P.K. (1993). Effect of split application of fertilizers in banana. *Musa* AAB 'Nendran'. *South Indian Hort*., **41**(2) : 67-73.

**Pandit, S.N.,** Singh, C., Ray, R.N., Jha, K.K. and Jain, B.P. (1992). Fertilizer scheduling for dwarf Cavendish banana in Bihar. *J.Res.Birsa Agric.Univ*., **4**(1) :25-29.

**Raju, Besagarahalli** (1996). Micropropagation and nutritional studies of tissue cultured banana var. Grand Naine. Ph.D. (Hort.) Thesis UAS, Bangalore.

**Thippesha, D., Raju, B., Jagannath, S. and Jemla Naik, D. (2005).** Studies on planting systems and spacing on growth characters of Banana (*Musa* AAA) under transitional Zone of Karnataka. *The Karnataka J. Hort.*, **1**(3) : 63-69.

**Turner, D.W.** and Barkus, B. (1981). Nutrient concentrations in a range of banana varieties grown in the sub-tropics. *Fruits,* **36** : 217-222.

***********