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Discussion:

Foliar application of fertilizer materials provides a quick method of supplying nutrients to plants. The results of this study demonstrated the response of banana suckers grown under nursery conditions to the foliar application of different combinations of NPK. This response is a good indication of the importance of fertilization at the nursery level to banana suckers. The beneficial effect of spraying different combinations of NPK on improvement of growth was clear from the findings of this study. The results showed that all treated suckers resulted in significantly greater values in growth parameters evaluated in terms of pseudostem height and girth, number of leaves, leaf area, relative growth rate, fresh and dry weights of different plant parts than control. These results are in general agreement with the findings of other investigators who applied different NPK combinations to the banana plants grown under plantation conditions (Tingwa, 1970; Shaikh and Rana, 1985).

Among the different treatments used in this experiment, however, slightly greater values of all measured growth parameters were associated with 19-19-19 and 19-6-20 sprayed suckers than the other two NPK combinations. These greater values might be due to the presence of higher content of nitrogen in their composition than the other two NPK combinations. These findings were in agreement with those reported by Tingwa (1970) who found greater increase in growth parameters of banana plants in NPK treatment containing the highest level of nitrogen than the other treatments.

It could be concluded from this study that 19-19-19 and 19-6-20 treatments were superior in almost all parameters studied in this experiment. Further research to study the effect root promoting and shoot enhancement substances such as organic acids, amino acids,.....etc on banana suckers should be carried out.

Table 4 shows the nutrient element contents of banana leaves as influenced by foliar application of various combinations of NPK. Significantly greater leaf-N, P, K, Mg and Cu contents were associated with all treated suckers than the control. There were no significant differences in Leaf-P, K, and Cu contents among the treated suckers. Significantly, greater leaf- N content was detected in 19-19-19 and 19-6-20 sprayed suckers than the other two treatments. Leaf-Mg content was significantly greater in 12-12-36 sprayed suckers than the other treatments which, on the other hand, showed no significant differences among them. Foliar application of 19-19-19 resulted in significantly greater leaf- Ca content than the other treatments which, on the other Hand , showed no significant differences among them. Leaf-Fe content was significantly greater in 12-12-36 sprayed suckers than the other treatments.

Table 4 Effect of foliar application of NPK fertilizers on nutrient contents of leaves of banana suckers grown under nursery conditions.

Treatment	Dry weight %					Dry weight (ppm)			
	N	P	K	Ca	Mg	Mn	Fe	Zn	Cu
N ₀ P ₀ K ₀	1.8 c	0.16 b	3.8 b	1.0 b	0.17 c	220 b	238 c	23.3 c	4.5 b
N ₁₉ P ₁₉ K ₁₉	2.5 a	0.18 a	4.2 a	1.2 a	0.21 b	265 a	238 c	35.7 a	7.5 a
N ₁₂ P ₁₂ K ₃₆	2.3 b	0.18 a	4.2 a	1.0 b	0.22 a	225 b	384 b	25.2 b	7.5 a
N ₁₅ P ₅ K ₃₀	2.1 b	0.19 a	4.2 a	1.0 b	0.19 b	255 a	326 a	28.0 b	7.5 a
N ₁₉ P ₆ K ₂₀	2.5 a	0.18 a	4.2 a	1.0 b	0.19 b	225 b	244 b	25.0 b	7.5 a
CV%	4.5	10.9	12.5	8.9	5.2	5.27	4.96	12.7	12.9

*The same letters in column indicate no significant difference between means separated by Duncan,s Multiple Range Test, at 5% level.

Foliar application of 15-5-30 was associated with significantly greater leaf-Fe content than 19-19-19, 19-6-20 and control which, on the other hand, showed no significant differences among them. Significantly greater Leaf- Zn content was found in suckers sprayed with 19-19-19 than the other treatments which were not significantly different from each other.

dry weights of leaves, pseudostem, corms and roots among all treatments; however, the greatest values were associated with 19-19-19 and 19-6-20 treatments. No significant differences were noted in total fresh weights and that of leaves and pseudostems and total dry weights between 19-19-19 and 19-6-20 sprayed suckers or between 12-12-36 and 15-5-30 sprayed suckers; however, the former two treatments resulted in significantly greater values than the latter two treatments.

Table 3 Effect of foliar application of NPK fertilizers on total fresh and dry weights and those of different plant parts of banana suckers grown under nursery conditions

Treatment	Fresh weights (gm)					Dry weights (gm)				
	Leaves	Pseudo stems	Corms	Roots	Total	Leaves	Pseudo stems	corms	Roots	Total
$N_0P_0K_0$	148.0c*	200.9 c	113.7 b	347.6 b	810.3 c	20.2 b	14.7 b	16.5 b	26.0 b	77.3 c
$N_{19}P_{19}K_{19}$	22303 a	280.9 a	135.8 a	388.0 a	1027.5 a	27.9 a	17.5 a	19.0 a	29.0 a	93.4 a
$N_{12}P_{12}K_{36}$	193.1 b	232.4 b	132.5 a	373.8 a	931.8 b	25.5 a	16.9 a	18.4 a	28.8 a	89.0 b
$N_{15}P_5K_{30}$	191.5 b	238.3 b	131.8 a	383.5 a	945.0 b	25.2 a	17.3 a	18.5 a	28.9 a	89.5 b
$N_{19}P_6K_{20}$	204.0 a	279.0 a	137.8 a	388.5 a	1009.3 a	26.3 a	17.5 a	18.6 a	29.0 a	90.8 a
CV%	14.26	17.22	8.21	4.84	8.16	12.8	13.96	7.16	4.11	6.50

*The same letters in column indicate no significant difference between means separated by Duncan,s Multiple Range Test, at 5% level.

Treatment	Time from planting (month)								
	Two			Four			Six		
	PH	PG	NL	PH	PG	NL	PH	PG	NL
CV%	7.24	6.55	7.32	9.50	8.61	8.01	9.10	8.86	6.42

*The same letters in column indicate no significant difference between means separated by Duncan,s Multiple Range Test, at 5% level.

There were no significant differences in all tested parameters among the different combination of NPK fertilizer treatments; however, slightly greater values were associated with 19-19-19 and 19-6-20 sprayed suckers than the other treatments. Leaf area values showed the same trend (Table 2). Relative growth rates were significantly greater in the treated suckers than the control (Table 2).

Table 2 Effect of foliar application of NPK fertilizers on relative growth rate (RGR) and leaf area of banana suckers grown under nursery conditions

Treatment	Relative growth rate	Leaf area (cm2)
$N_0P_0K_0$	235.5 c*	531.2 b
$N_{19}P_{19}K_{19}$	354.0 a	558.8 a
$N_{12}P_{12}K_{36}$	291.0 b	547.4 a
$N_{15}P_5K_{30}$	309.0 b	548.4 a
$N_{19}P_6K_{20}$	344.0 a	555.0 a
CV%	13.5	

*The same letters in column indicate no significant difference between means separated by Duncan,s Multiple Range Test, at 5% level.

The differences in relative growth rate between 19-19-19 and 19-6-20 sprayed suckers and also between 12-12-36 and 15-5-30 sprayed suckers were not significant; however, the former two treatments resulted in significantly greater values than the latter two treatments.

All combinations of NPK resulted in significantly greater values of fresh and dry weights of different plant parts than the control (Table 3). There was no significant difference in values of fresh weights of corms and roots and

Where W_1 and W_2 are the initial and final fresh weight at t_1 and t_2 in days; t_1 represents time of commencement of the experiment, whereas t_2 represents time of termination of the experiment

Leaf area, which is the product of length and width multiplied by the factor (0.8), was calculated as reported by Murray (1960). The third leaf from the top of each sucker was taken for leaf sampling. Leaf samples were washed quickly and dried in a forced-air draft oven at 70 °C for 48 hours. After complete drying, the samples were ground in a Willey mill to pass a 40- mesh screen. Total nitrogen was determined using macro- Kjeldahl method. Leaf contents of K, Ca, Mg, Mn, Fe, Zn and Cu were determined using atomic absorption spectrophotometer (model Perkin Elmer 2380).

The treatments were arranged in a randomized complete block design with four replications. Treatment means were separated by Duncan's Multiple Range Test at the 5% level (Ram et al., 1989).

Results:

Foliar application of various combinations of NPK resulted in significantly greater increases in pseudostem height, girth and number of leaves as compared to the control throughout the experimental period (Table 1)

Table 1 Effect of foliar application of various NPK fertilizers on pseudostem height (PH), pseudostem girth (PG) in cm and number of leaves (NL) of banana suckers grown under nursery conditions.

Treatment	Time from planting (month)								
	Two			Four			Six		
	PH	PG	NL	PH	PG	NL	PH	PG	NL
$N_0P_0K_0$	17.0 b*	8.0 b	7.0 b	24.0 b	11.0 b	13.0 b	29.0 b	13.0 b	17.0 b
$N_{19}P_{19}K_{19}$	19.0 a	10.0 a	8.5 a	30.0 a	14.5 a	14.5 a	37.0 a	17.0 a	18.5 a
$N_{12}P_{12}K_{36}$	18.0 a	9.0 a	8.0 a	27.0 a	13.5 a	14.0 a	35.5 a	15.0 a	18.0 a
$N_{15}P_5K_{30}$	18.0 a	9.0 a	8.0 a	28.0 a	13.0 a	14.0 a	35.0 a	15.0 a	18.0 a
$N_{19}P_6K_{20}$	18.5 a	9.5 a	8.5 a	29.5 a	14.0 a	15.0 a	37.0 a	16.0 a	19.0 a

selected suckers were planted in nursery beds containing sand for the purpose of rooting and depletion of the stored-food materials. After one month from planting, the selected suckers were removed from the rooting medium and weighed for determination of the initial total fresh weight. The suckers were then planted in 45.7 cm clay pots containing 22 kg of river silt and sand mixed in 1:1 ratio. The suckers were allowed to grow for one month in a nursery before the initiation of the different treatments. This study was conducted in Jericho 400 meter below sea level. The low average of rainfall in the Jericho which (160mm-200mm) and the temperature range from (10-40 0C). For that to grow bananas we need about 3000 m3 of water every year for each Donum (Banana 2007).

The treatments consisted of foliar application of four fertilizers containing various combinations of NPK, namely, 19-19-19, 12-12-36, 15-05-30, 19-6-20 and a control (without treatment). All these fertilizers were sprayed at concentration of 20 g/l. The suckers were sprayed five times at monthly intervals through the experimental period of six months. Both upper and lower surfaces of the leaf blades were thoroughly sprayed with very fine droplets until the point of run-off.

The growth parameters evaluated were pseudostem height, pseudostem girth, number of leaves, relative growth rate (RGR), leaf area and fresh and dry weights of leaves, corms and roots. In addition to the element content of the leaves.

The distance from 2 cm above the base of the pseudostem to the point of the intersection of petioles of the two youngest leaves was measured to determine pseudostem height. Pseudostem girth was measured at 2 cm above the soil surface. Measurement of pseudostem height and diameter and number of leaves were recorded after two, four and six months from planting. At the termination of the experiment, the suckers were washed and weighed to determine the total fresh weight. The suckers were, then, divided into leaves pseudostem, corms and roots. The fresh and dry weights of all these parts were recorded.

The relative growth rate (RGR) of suckers was estimated using the equation of Loneragen et al. (1968) as follows:

$$\text{RGR} = \frac{W_2 - W_1}{t_2 - t_1} \times 100$$

Introduction:

Banana (*Musa* sp.) is considered as one of the most important fruit crops grown in Palestine (in Jericho and Al-Aghwar area). The total area planted with banana in Jericho and Al-Aghwar is about 3,500 donums and the production is about 10,000 metric tons (Agricultural Statistics, 2009). Production of well-established banana suckers for permanent planting in a plantation of utmost importance. It is well known that fertilizer application, is one of the essential cultural practices. Nitrogen (N), phosphorus (P) and potassium (K) are essential macronutrients for plants. Adequate and balanced use of these nutrient elements is important for growth and development of plants.

The response of banana plants grown under plantation conditions to soil application of different combinations of NPK was reported by several investigators (Shaikh and Rana, 1985; Dagade, 1986 and Ram et al., 1989).

Tingwa (1970) found an increase in pseudostem height and girth and number of leaves in NPK treatment containing the highest level of nitrogen as compared to the other treatments. Chattopadhyay and Bose (1986) observed significant increased in pseudostem height and girth and number of leaves of banana plants as a result of application of different combinations of NPK than the control. The greatest response was associated with the highest rates of NPK. Ram et al. (1989) examined the nutrient concentration in leaf tissues of "Robusta" banana as influenced by application of different levels of NPK. They reported an increase in content of leaf elements.

In Palestine very little work was carried to determine the response of banana suckers to foliar application of NPK. This study was, therefore, initiated to evaluate the effect of foliar application of various fertilizer materials containing various combination of NPK on growth characteristics and nutrient contents of leaves of banana suckers grown under nursery conditions.

Materials and methods:

One-month-old sword suckers of banana (*Musa*, AAA- Group, Cavendish Subgroup 'Dwarf Cavendish') were selected from banana plantation. The

Abstract:

The effect of foliar application of four different combinations of NPK fertilizers, namely, 19-19-19, 12-12-36, 15-5-30 and 19-6-20 on growth and nutrient element contents of leaves of banana suckers grown under nursery condition was studied. These suckers were sprayed five times at monthly intervals at a concentration of 20 g/l.

Application of all fertilizers resulted in greater pseudostem height, number of leaves, leaf area, relative growth rate and fresh and dry weights of different plant parts as compared to the control. The greatest values of all these parameters were associated, with 19-19-19 and 19-6-20 fertilizers. The contents of nutrient elements in the leaves tended to vary depending on the treatment. Significantly greater values of leaf- N, P, K, Mg, Zn and Cu contents were found in banana suckers sprayed with various NPK fertilizer materials as compared to the control. Foliar application of 19-19-19 resulted in significantly greater leaf-Ca and Zn contents than the other treatments. Significantly, greater leaf-Fe content was detected in 12-12-36 sprayed banana suckers than the other treatments.

Key words: Banana suckers, foliar spray, combinations of NPK fertilizers.

تأثير استخدام تركيبات مختلفة من الأسمدة المركبة من النيتروجين والفسفور والبوتاسيوم بالرش الورقي على فسائل الموز

ملخص:

تمت دراسة تأثير استخدام أربعة تركيبات مختلفة من السماد المركب المحتوية على نسب مختلفة من النيتروجين والفسفور والبوتاسيوم (NPK) وهي 19-19-19، 19-36-12-12، 15-5-30 و 19-6-20 بالرش الورقي على النمو والمحتوى من العناصر الذائبة المختلفة لفسائل الموز تحت ظروف المشتل. رشت الفسائل خمس مرات بتركيز 20 جرام / لتر. وأسفرت النتائج عن رش الفسائل باستخدام التركيبات المختلفة من (NPK) إلى زيادة في طول الساق الكاذبة ومحيطها، وعدد الأوراق، ومساحة الورقة، ومعدل النمو الخضري والأوزان الرطبة والجافة لأجزاء الفسائل المختلفة مقارنة بالشاهد. ولوحظ أن أعلى قيم لهذه المعايير كلها، وجدت في الفسائل التي رُسَّت باستخدام 19-19-19 و 19-6-20. كذلك وجد أن محتوى العناصر الغذائية في الأوراق يختلف باختلاف المعاملة التي استخدمت. أدى رش الفسائل باستخدام التركيبات المختلفة من (NPK) إلى زيادة معنوية في المحتوى الورقي للنيتروجين، والفسفور، والمغنسيوم والنحاس مقارنة بالشاهد. نتج عن الرش الورقي باستخدام 19-19-19 زيادة معنوية في المحتوى الورقي لعنصري الكالسيوم والزنك مقارنة بالمعاملات الأخرى. كذلك وجد أن الفسائل التي رشت باستخدام 12-12-36 تحتوي على أعلى زيادة معنوية من عنصر الحديد مقارنة بالمعاملات الأخرى.

الكلمات المفتاحية: فسائل الموز، الرش الورقي، الأسمدة المركبة NPK.

Effect of Foliar Application of Various Combinations of NPK Fertilizers on Banana Suckers *

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