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Effects of N fertilization on the vegetative growth of passion fruit (*Passiflora edulis* f. *flavicarpa*) seedlings

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Abstract

The effects of N fertilization on the growth and dry matter production of juvenile-transition phase of yellow passion fruit plants were investigated in pot experiments conducted in 1996 and 2002/2003. The study covered the juvenile and transition stages of growth. In the first trial, the plants received N at rates equivalent to 30-120 kg ha^{-1}. In the second trial, the plants received N at rates equivalent to 60-480 kg ha^{-1}. In both trials, no N pots served as control. In the first trial, application of N 30-120 kg ha^{-1} had no consistent effects on the growth and dry matter accumulation by the passion fruit plants compared with control. In the second trial, the effects of N 0-120 kg ha^{-1} on vine length, number of leaves, leaf area, number of branches and dry matter production were similar to those observed in the earlier trial. However, application of N 240 or 480 kg ha^{-1} consistently significantly enhanced vine length, number of leaves, leaf area, number of branches and total dry matter accumulation of the plants. Except for number of branches, the effects of N 240 kg ha^{-1} on other growth parameters were often not significantly different from those of N 480 kg ha^{-1}. Since, number of branches is positively related to fruit yield, thus N 480 kg ha^{-1} which produced the largest number of branches is considered the optimum N rate for the vegetative growth of yellow passion fruit during the juvenile and transition stages of growth.

Key words: Passion fruit, juvenile, transition stage, vegetative growth.

Introduction

The yellow passion fruit (*Passiflora edulis* f. flavicarpa) is a semi-woody climber in the family Passifloracea [9]. Its origin is unknown, but it is widely grown in the tropical lowland climates to which it is better suited than its purple-fruited relative (*P. edulis*). It produces edible, deep canary-yellow spherical fruits 6-12 months after planting [8]. The fruits can be eaten out of the hand, or processed into single strength fruit juice, fruit juice punches, sherbet and jam for local and export markets [3]. The fruit peel is good silage material for dairy cattle [11]. Whereas the yellow passion fruit is well suited to the ecology of southern Nigeria, it is relatively unknown by farmers and hardly grown. The recent government ban on the importation of fruit juices and fruit concentrates has, however, stimulated a demand for locally produced juice concentrate by the domestic fruit juice and fruit drink industry. This has in turn stimulated an interest in medium and large-scale production of fruits, including the yellow passion fruit. One of the most critical aspects of optimizing crop growth is plant nutrition. There is currently no fertilizer recommendation for the yellow passion fruit in Nigeria [1]. The fertilizer recommendations for passion fruit based on investigations conducted elsewhere vary widely. Nakasone and Paull [8] recommended N 294 kg ha^{-1} sourced from NPK 10-5-10 fertilizer. Menzel et al. [7] recommended N 280 kg ha^{-1} sourced from alternate applications of NPK 15-4-11 fertilizer. Nitrogen is vital for vigorous growth and flowering of passion fruit [6]. Sub-optimal N may stunt the growth of passion fruit. Similarly, excessive application of N may stimulate vegetative growth at the expense of fruit yield [4, 10]. Consequently, this study focused on determination of the nitrogen requirement of yellow passion fruit in southwestern Nigeria.

significantly more branches than plants that received N 0, 30 or 60 kg ha^{-1}. In the 2002/2003 trial in which plants received N 60-480 kg ha^{-1}, control plants had the fewest number of branches while plants that received 480 kg ha^{-1} produced the largest number of branches. At 2 MAN, The effects of N 60-240 kg ha^{-1} did not differ significantly from one another, but control produced significantly fewer branches than plants that received 480 kg ha^{-1} (Fig. 4B). At 3 MAN, the effects of N 60 and 120 kg ha^{-1} on branch production did not differ significantly from one another or control. However, control produced significantly fewer branches than those fertilized with N 240 or 480 kg ha^{-1}. Plants fertilized with N 240 kg ha^{-1} produced significantly fewer branches than those fertilized with 480 kg ha^{-1}. At 4MAN, control produced significantly fewer branches than plants which received N 60-480 kg ha^{-1}. The effects of N 60 and 120 kg ha^{-1} did not differ significantly from one another but plants that received 60 kg ha^{-1} produced significantly fewer branches than those which received 240 or 480 kg ha^{-1}. Plants that received N 480 kg ha^{-1} produced significantly more branches than those that received 240 kg ha^{-1} or lower rates of N.

Stem diameter and root length: In both studies, stem diameter and root length were not significantly influenced by N rate (Table 3).

Table 1. Characteristics of soil used.

	Sand (%)	Silt (%)	Clay (%)	pH	OM (%)	Total N (%)	AvP * (mg/kg)	K** (mg/kg)	Ca** (mg/kg)
1996	85.8	8.0	6.2	5.7	0.74	0.04	14.20	0.13	0.8
2002/2003	88.5	11.0	3.5	6.5	3.99	0.20	0.04	0.84	14.1

* Bray I extracts
** Ammonium acetate extracts

Table 2. Monthly rainfall (mm) during the period of study.

	J	F	M	A	M	J	J	A	S	O	N	D
1996	0.0	54.2	128.4	126.6	115.0	169.1	124.9	228.4	204.4	131.5	0.0	0.0
2002	0.0	2.7	38.1	136.9	131.9	133.7	325.5	110.1	148.3	297.0	84.0	0.0
2003	12.3	25.7	6.5	161.5	40.6	293.1	191.7	76.5	286.7	91.6	27.0	0.0

Dry matter production: Compared with control, application of N 30-120 kg ha^{-1} did not significantly influence dry matter accumulation into lamina, petiole, stem and whole plant. However, control plants had the least root dry weight which was significantly smaller than root dry weight of plants which received N 30-120 kg ha^{-1}. Root dry weight of plants that received N 30-120 kg ha^{-1} did not differ significantly (Table 4). Similarly, application of N 60-480 kg ha^{-1} did not significantly affect root dry weight compared with control. Conversely, application of N 60-480 kg ha^{-1} significantly influenced dry weight of leaves, stem and whole plant when compared with control (Table 3). The effects of N 60 or 120 kg ha^{-1} did not significantly influence dry matter content of leaves, stem and whole plants when compared with the effects of no N (control). However, dry matter content of leaves and stem in plants that received N 0, 60 or 120 kg ha^{-1} was significantly lower than those of plants which received 240 or 480 kg ha^{-1}. The effects of N 240 and 480 kg ha^{-1} on these parameters did not differ significantly. Total dry matter content of the plants followed a similar response, however, the effect of N 120 kg ha^{-1} did not differ significantly from that of 240 kg ha^{-1} (Table 3).

Table 3. Stem girth and root length of yellow passion fruit in response to N fertilization.

N rate (kg ha^{-1})	Stem girth (mm plant-^{1})		Root length (cm plant^{-1})	
	1996	2002/2003	1996	2002/2003
0	13.5 a	31.4 a	21.6 a	18.0a
30	16.3 a		34.3 a	
60	17.3 a	38.5 a	25.4 a	23.0 a
90	18.2 a		21.4 a	
120	17.3 a	39.3 a	18.6 a	28.0 a
240		42.4 a		27.0 a
480		44.7 a		32.0 a

Values in the same column followed by the same letter are not significantly different by DMRT at P<0.05

Discussion

The growth response of passion fruit to N fertilization depended on growth parameter, rate of N and time after N application. Whereas stem diameter and root length were not sensitive to N fertilization, leaf and branch production were more sensitive to N fertilization. The absence of response by roots could be because they are naturally stubby [2]. Alternatively, it could be because the plants were pot-bound. The changing N sensitivity of the parameters as the study progressed could be because these reflected different stages of the asymptotic pathway of vegetative growth in which the rapid growth phase was more sensitive to N than the slow growth phase.

In both trials, N rates less than 90 kg ha^{-1} were generally too low to produce significant growth increases compared with no N application. This indicates that yellow passion fruit has a high N requirement. The trials conducted in 2002/2003 showed that 120 kg ha^{-1} which was the highest N rate applied in the 1996 trial was sub-optimal for growth of yellow passion fruit and that growth could be further increased by the application of N 240 or 480 kg ha^{-1}. Except with respect to number of branches, further increase of N rate above 240 kg ha^{-1} did not produce significant increase in growth. This suggests that higher N rates may amount to luxurious consumption. It also suggests that 240 kg ha^{-1} is the optimum N requirement for passion fruit. This tends to support the findings of Menzel et al. [7]. However, the branches being the bearing surfaces have a more direct influence on fruit yield than other parameters. Since passion fruit is grown primarily for its fruit and since branch production was optimized at N 480 kg ha^{-1}, it is considered the optimum of N rate for yellow passion fruit.

Conclusions

480 kg N ha^{-1} is considered the optimum rate for vegetative growth of the yellow passion fruit in southwestern Nigeria.

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Table 4. Dry matter distribution in yellow passion fruit in response to N fertilization.

N rate (kg ha^{-1})	Leaf (g plant^{-1})		Vine (g plant^{-1})		Root (g plant^{-1})		Whole plant (g plant^{-1})	
	1996	2002/2003	1996	2002/2003	1996	2002/2003	1996	2002/2003
0	2.6 a	6.0 b	3.7 a	12.3 b	1.5 c	8.3 a	7.8 a	26.5 b
30	5.3 a		8.7 a		3.2 b		17.3 a	
60	5.5 a	10.0 b	8.8 a	18.4 b	3.3 b	8.2 a	17.7 a	37.5 b
90	7.1 a		11.9 a		4.1 a		23.0 a	
120	7.3 a	11.2 b	12.1 a	19.2ab	3.9 a	11.0 a	23.2 a	42.1 b
240		20.5 a		31.3 a		13.8 a		67.8 a
480		24.1 a		39.2 a		14.6 a		78.0 a

Values in the same column followed by the same letter are not significantly different by DMRT at P<0.05

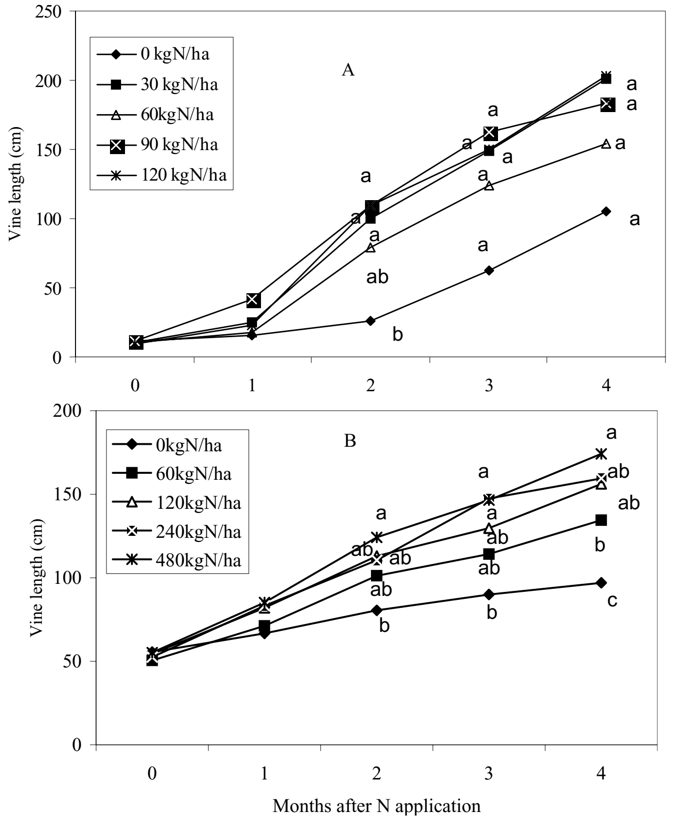

Figure 1. Vine growth of passion fruit in response to N fertilization.

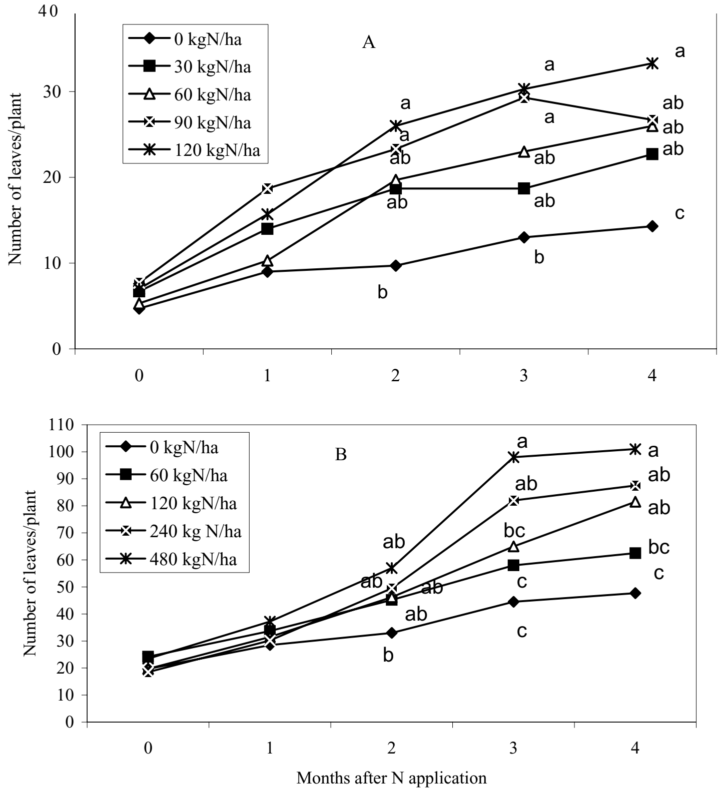

Figure 2. Leaf production in yellow passionfruit in response to N fertilization.

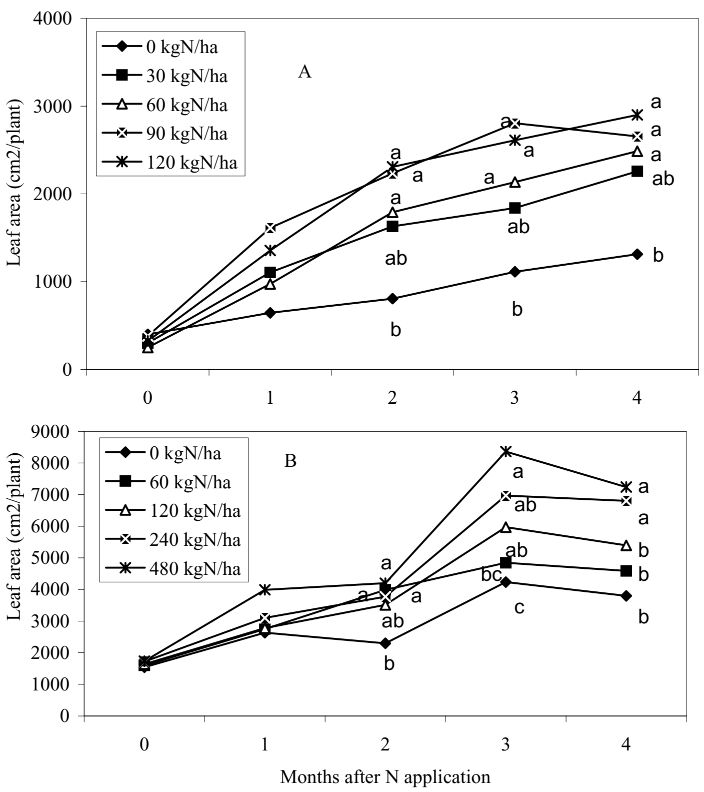

Figure 3. Leaf area of yellow passion fruit in response to N fertilization.

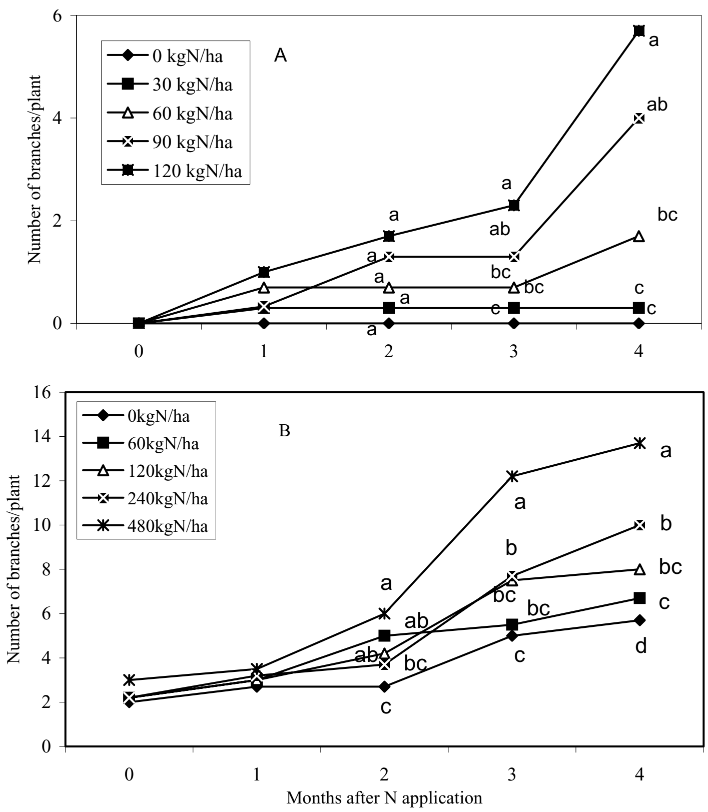

Figure 4. Branch production by yellow passion fruit in response to N fertilization.