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Full Length Research Paper

Response of date palm (*Phoenix dactylifera*) seedlings to organic manure, N and K fertilizers in polybag nursery

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A trial was conducted at NIFOR's sub-station, Dutse, Jigawa State, Nigeria to investigate the influence of soil fertility amendment using inorganic fertilizers and organic manure on date palm seedlings in polybag nursery. Experimental design was a 3 × 4 × 4 factorial with organic manure (dried poultry droppings) at 0, 50 and 100 g per seedling, ammonium sulphate at 0, 2, 4 and 8 g per seedling and muriate of potash at 0, 2, 4 and 8 g per seedling. Seedling dry matter significantly increased with increasing rates of organic manure applied. Application of ammonium sulphate or muriate of potash beyond 2 g per seedling significantly reduced seedling dry matter. Manure × N interaction effect on dry matter was significant. However, manure × muriate of potash or manure × N × muriate of potash or muriate of potash × N interaction were not significant. Leaf nutrient contents were not significantly enhanced by the application of the soil amendment treatments. Supplementation of poultry manure with ammonium sulphate enhanced date palm seedling dry matter. Thus while poultry manure could serve as alternative soil fertility treatment to inorganic N or K, its supplementation with inorganic sources of N may be needed to enhance seedling dry matter.

Key words: Date palm, inorganic fertilizers, organic manure, leaf nutrients.

INTRODUCTION

Date palm (*Phoenix dactylifera*) is an important tree crop of the hot semi and arid regions where it grows in unplanted and cultivated groves with little rains and high evapotranspiration. The crop is cultivated in natural spontaneous groves and as a homestead crop in most of the Sudan-Sahel region of Nigeria. Its importance and cultivation in the country is increasing and farmers rely on seedlings or side suckers to raise new plantings. Date palm is also now being used as shelter belt vegetation for soil conservation and to mitigate desertification in Nigeria. Usually farmers in the date palm belt of Nigeria rely on cow dung for manuring their palms either in the field or in seedling nurseries. As a general rule in date palm fertilization, 2 to 3 kg N per palm per year for fully grown palm is recommended (Arar, 1975). This amount could be applied in two to three applications in sandy soils. In the Middle-east and North Africa, the better date palm gardens are said to use organic manures which are often buried in deep circular trenches around the palms. These manures are usually dung of animals and are used at rates of 1 – 37 t/ha (Arar, 1975). In long term studies, organic manures have been shown to largely improve soil physical conditions such as moisture retention capacity and aggregate soil stability, crop water use efficiency (Hati et al., 2006), improve soil fertility, crop performance and yield (Kaur et al., 2005; Sarkar et al., 2003; Bokhtiar and Sakurai, 2005; Hossain and Ishimine, 2007; Tirol-Padre et al., 2007). In Nigeria, although date palm cultivation is old, there are yet no reported studies on its nutrient requirement under the prevailing soils of its growing region in the country. While organic manure may be beneficial to crops on the long term, their efficiency in enhancing crop growth and yield in the short term have in most cases been enhanced with combination of inorganic fertilizers. Yaduvanshi (2003) for example showed that rice and wheat yields were enhanced when inorganic fertilizer was

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Table 1. Physical and chemical characteristics of soils.

Sand	Clay	Silt	pH	Org. Matter	N	P	Na	K	Ca	Mg	ECEC	Exchange Acidity	Base Saturation
%				gkg^{-1}		$mgkg^{-1}$			C $molekg^{-1}$				%
96	3.1	0.9	6.50	3.50	0.40	23.0	0.21	0.26	2.08	1.04	3.89	0.30	92.0

Table 2. Chemical characteristics of dried poultry manure.

pH	N	P	K	Mg	Ca	Na
	gkg^{-1}					
7.6	1.3	8	11.0	8.9	20.8	0.9

combined with organic manures. In Nigeria, there are yet no reported doses of inorganic fertilizers or their supplementation with organic manures in manuring date palm seedlings where a wide variety of animal manures are used by the farmers. This study investigated the response of nursery date seedlings to manure and inorganic fertilization.

MATERIALS AND METHODS

Poly bags (500 gauge) measuring 22.5 × 25 × 12.5 cm were filled with top soil (0 – 15 cm) obtained in Dutse, Jigawa State from date groves and gene pools of the Date Palm Substation of the Nigerian Institute for Oil Palm Research. The soil used was near neutral pH but slightly acidic, with a high base saturation (> 50%) and low total N (Table 1). The soil was bulked, thoroughly mixed and subsamples taken for physico-chemical analysis before filling into the polybags. Soil organic carbon and total N were determined by the methods of Walkley and Black (1934) and Bremner (1960) respectively. Exchangeable bases were extracted by equilibration in neutral normal ammonium acetate solution followed by the determination of Ca and Mg in the extract by EDTA titration technique and Na and K by flame photometry. Available P was extracted using the method of Bray and Kurtz (1945) and determined by colorimetry. Particle size analysis was determined by the hydrometer method of Bouyoucous (1951).

The polybags were planted to sprouted date palm seeds and watered in the nursery for 6 months until the seedlings attained 2 - 3 leaves. Soil fertility treatments were applied to the palms in a 3 × 4 × 4 factorial replicated three times in a completely randomised design when the seedlings were 6 months old. The treatments were dried poultry droppings as organic manure (Table 2) at 0, 50 and 100 g per bag, N as ammonium sulphate at 0, 2, 4 and 8 g per bag and K as muriate of potash at 0, 2, 4 and 8 g per bag. Seedlings were watered until they were 12 months old. Number of leaves and height of seedlings were measured before they were harvested when 12 months old. Harvested seedlings were separated into shoots, leaves and roots and oven dried to constant weight. Plant tissues were ashed in a muffle furnace and analysed for N by the micro-Kedjhal method and K by flame photometer, P by colorimetry and Ca and Mg by EDTA titration.

RESULTS AND DISCUSSION

All soil fertility amendments applied significantly ($P>0.01$) enhanced seedling dry matter. Leaf nutrient contents of date seedlings were however not significantly enhanced by application of the fertility treatments over those planted in control soils (Table 3). Increasing the rate of manure applied up to 100 g per seedling significantly increased dry matter. Seedling dry matter was enhanced by rates of inorganic N and K fertilizers only up to 2 g per seedling beyond which dry matter was significantly reduced. The interactions of the different fertilizer combinations did not exhibit clear trends (Tables 3, 4, 5 and 6). Manure × N interaction effect on seedling dry matter was significant. The combination of 100 g manure with 2 g ammonium sulphate gave the highest seedling dry matter. The effect of manure on seedling dry matter was independent of K levels applied as manure × K or manure × N × K interactions was not significant. N × K interaction effect on seedling dry matter or leaf nutrient content was also not significant. Leaf nutrient content was not influenced by the fertility treatments (Table 7).

These results suggest that poultry droppings as manure enhances date palm seedling growth in the nursery and could serve as alternative soil fertility treatment to inorganic N or K. However, N supplementation of the poultry manure (< 2 g per seedling) used with inorganic fertilizer may be needed to enhance seedling dry matter. Usually, the effect due to nitrogen from farmyard manure could be slower than that from inorganic sources as only part of the farmyard manure is available following application (Prasad and Singh, 1980). However, beneficial effects of farmyard manure have been demonstrated to be enhanced with mineral fertilizers as shown by Mokwunye (1980) in savanna soils of Nigeria and Tirol-Padre et al. (2007) in long term experiments spanning 15 to 20 years. Goyal et al. (1999) and Tirol-Padre et al. (2007) have reported increased soil mineralizable N and carbon due to combined application of organic manure and inorganic fertilizers. Charreau (1975) showed that higher yields of crops are achieved with the same amount of inorganic fertilizers when they are combined with farmyard manure than when they are applied alone. Satyanarayana et al. (2002) reported significant interactions between farmyard manure and inorganic fertilizer in grain yield of rice.

Although the effects of soil amendments using organic manure are usually positive, the effects could be very

Table 3. Main effects of organic manure, N and K fertilization on dry matter and leaf nutrient content of nursery date seedlings.

Treatment	polybag g^{-1}	Dry matter (g)	Leaf nutrient content (%)				
			N	P	K	Ca	Mg
Org. manure	0	15.2	2.08	0.20	0.96	0.73	0.21
	50	21.3	2.20	0.20	1.20	0.67	0.18
	100	25.5	2.23	0.30	1.07	0.63	0.14
SEM ±		0.616***	NS	NS	NS	NS	NS
Sulphate of ammonia	0	20.9	2.23	0.20	1.28	0.83	0.21
	2	22.6	2.23	0.20	1.40	0.97	0.27
	4	21.8	2.27	0.20	1.28	0.87	0.17
	8	17.3	2.13	0.20	1.07	0.90	0.26
SEM ±		0.711***	NS	NS	NS	NS	NS
Potassium chloride	0	18.7	2.22	0.20	1.14	0.8	0.22
	2	24.1	2.31	0.20	1.24	0.90	0.22
	4	22.2	2.33	0.20	1.24	0.90	0.22
	8	17.7	2.07	0.30	1.23	0.77	0.20
SEM ±		0.711***	NS	NS	NS	NS	NS

*** (P = 0.01); NS = not significant (P = 0.05).

Table 4. Influence of inorganic N and organic manure on dry matter of nursery date palm seedlings.

Organic manure (g $seedling^{-1}$)	Sulphate of ammonia (g $seedling^{-1}$)			
	0	2	4	8
	Seedling dry weight (g)			
0	13.2	16.3	17.3	14.1
50	23.1	22.6	21.2	18.2
100	26.5	29.1	26.8	19.5

SEM (manure × N) ± 1.233 * (P = 0.014).

Table 5. Influence of inorganic K fertilization and organic manure on dry matter of nursery date palm seedlings.

Organic manure (g $seedling^{-1}$)	Potassium chloride (g $seedling^{-1}$)			
	0	2	4	5
0	14.6	17.7	16.3	12.3
50	19.7	24.6	22.6	18.1
100	21.8	29.8	27.6	22.8

SEM (organic manure × K interaction) ± 0.123 NS.

Table 6. Inorganic N × Inorganic K fertilization effect of dry matter of nursery date palm seedlings.

Sulphate of ammonia (g $seedling^{-1}$)	Potassium chloride (g $seedling^{-1}$)			
	0	2	4	8
	Seedling dry weight (g)			
0	17.9	24.4	24.5	16.9
2	20.1	27.4	22.8	20.3
4	20.5	24.2	23.3	19.1
8	16.2	20.2	18.1	14.6

SEM (N × K) ± 0.123 NS.

variable as demonstrated by Tirol-Padre et al. (2007). The slow process of mineralization of poultry manure may ultimately necessitate its initial supplementation with inorganic fertilizer to provide adequate nitrogen supply in the short term as shown in this study. The beneficial effects of organic manure on nitrogen content of the soil have only largely been demonstrated under prolong use as shown by Tirol-Padre et al. (2007). In this study, the effectiveness of poultry manure was not enhanced by inorganic K. Agboola et al. (1975) reported that in tropical acid soils, inorganic K fertilizers are usually more effective when combined with organic fertilizers. Further study could elucidate the implication of supplementation of organic manure with inorganic fertilizer in the efficiency of the use of various major nutrient elements such as nitrogen which appear to be the most critical in vegetative

Table 7. Organic manure × N ×K fertilization interaction on dry matter of nursery date seedling (g/seedling).

Manure	N as sulphate of ammonia	K as potassium chloride (g seedling^{-1})				
	g seedling^{-1}	0	2	4	8	Mean
		Seedling dry weight (g)				
0	0	11.0	16.1	14.2	11.6	13.2
0	2	15.7	18.9	16.6	13.9	16.3
0	4	15.6	20.5	18.9	14.0	17.3
0	8	15.9	15.5	15.4	9.6	14.1
50	0	21.1	28.4	25.3	17.5	23.1.
50	2	21.8	26.6	23.2	18.8	22.6
50	4	21.4	20.9	24.1	18.4	21.2
50	8	14.5	22.7	17.7	17.9	18.2
100	0	21.7	28.9	34.0.	21.6	26.5
100	2	22.8	36.6	28.5	28.3	29.1
100	4	24.4	31.3	26.8	25.0	26.8
100	8	18.2	22.4	21.3	16.3	19.5

SEM (manure × N × K interaction) ± 2.46NS.

development and ultimately seedling dry matter of date palm seedlings.

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