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Early growth and dry matter accumulation of *Tephrosia bracteolata* Perr. and Guill. as influenced by Nitrogen and Phosphorus fertilizer

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ABSTRACT
Nutrients requirements for maximum productivity of the Nigerian indigenous fodder plants have not been completely elucidated. Pot experiment was conducted to investigate the influence of nitrogen (N) and phosphorus (P) fertilizer levels on the early growth of Tephrosia bracteolata, a nodulating fodder plant of great economic importance for livestock production in Nigeria. Seedlings of T. bracteolata raised in washed sand were given two levels of nitrogen fertilizer (0 and 50kgN/ha) and five levels of phosphorus fertilizer (0, 25, 50, 75, and 100kgP/ha) in a 2 x 5 factorial experiment fitted into randomized complete block (RCB) design. The fertilizer treatments were given in two splits at 3 and 7 weeks after planting. Harvesting was carried out at 3, 7 and 11 weeks after planting (WAP) for growth assessment. The result of this trial shows that treatment means in plant height, number of leaf, leaf area, and dry matter accumulation were significantly ($P<0.01$) different. However, while application of nitrogen fertilizer alone reduced these growth parameters, application of phosphorus fertilizer alone increased the parameters. The application of nitrogen and low level of phosphorus fertilizer (50kgN/ha + 25kg P/ha) increased dry matter accumulation, and the application of 50kgN/ha and 75kg P/ha enhanced plant height and number of leaf. The result of this experiment suggests that phosphorus fertilizer and at least starter nitrogen are essential for early growth of T. bracteolata.

Keywords: Biomass, fodder, green manure, nitrogen, phosphorus, *Tephrosia*.

Introduction

Crop and livestock production in Africa are constrained by wide fluctuations in the quality and quantity of feed resources during the year and by low availability of nutrients, especially nitrogen and phosphorus. In most African soils, this threatens the sustainability of primary production and consequently, farm productivity (Hague and Tothill, 1988; Peters and Tothill, 1988).

Recently, attention has been focused on the utilization of indigenous legume by the livestock industry, particularly the legume *Tephrosia bracteolata* Perr and Guill (Family, Papilionaceae – Leguminosae–Papilionoideae PPL), which is well accepted by livestock. It is one of the several *Tephrosia spp* reported by De leeuw (1979) to be favoured by livestock in Northern Nigeria. Bunches of the plant are hung to feed goats at homes and in local livestock markets in the dry forest and derived ecozones of the southwest Nigeria. Working on a related species, Babayemi and Bamikole (2006) reported weight gain of 27.38 g/day in grazing West African Dwarf goats fed with unconventional protein source of seeds of *Tephrosia candida*.

T. bracteolata, is an erect under-shrub with height range of 0.6m – 2.0m. It is regarded as weed of roadside and fallow (Akobundu and Agyakwa, 1987). The legume is seen growing widely along roadsides in the Guinea savanna up to the dry forest ecological belts in Nigeria (Isichei and Awodoyin, 1990). *T. bracteolata* regenerates from seeds and has good seeding ability to perpetuate its population in the natural ecosystem. As a legume, it has a high crude protein percentage of 22.28% (Ayoade *et al*, 1998). Isichei and Awodoyin (1990) reported 17.98% crude protein content in the leaves at the early growing season and 12.98% at the late growing season, which are high enough to meet the protein demand requirement of livestock throughout the season. Though the plant is indigenous to Africa and the local populace has ample knowledge of its use in cut-and-carry livestock production and in green manuring, not much has been done on it by the Researchers. There is limited documented information on its production, management and general agronomy.

Although the plant is often encountered on poor soils and in denuded areas, its establishment and growth can be improved by many factors including fertilizer application. Thus, livestock farmers can be assured of better legume pasture and more positive net income in *Tephrosia* growing areas. *T. bracteolata* maintains positive association with some grass species, especially *Andropogon tectorum* (Isichei and Awodoyin, 1992), therefore maintaining a fodder bank of the two species will improve the pasture quality available to livestock.

Nitrogen, phosphorus, molybdenum, calcium, iron, sulphur, boron, zinc, manganese, magnesium and cobalt have been identified as mineral nutrient requirements of legumes (Remison, 1980; FAO, 1982; Van Kessel, 1983). Of all the nutrients tested, only phosphorus and nitrogen significantly affected forage legumes, though with controversial reports. Nitrogen is required by plants in comparatively larger amounts than other elements. Nitrogen is an essential component of many compounds of plant, such as chlorophyll, nucleotides, proteins, alkaloids, enzymes, hormones and vitamins (Marschner, 1995). Biological nitrogen fixation has often been reported insufficient in many studies (Ruszkowska *et al*., 1991; Zinkiewicz *et al*., 1992; Vikman and Vessey, 1993). This suggests the need to apply some amount of nitrogen in addition to symbiotic nitrogen fixation by the crop to meet the requirement for good yield. Phosphorus is important for successful establishment and good root development of legumes. It often increases dry matter production, nodulation, nitrogen fixation, nutrients uptake and protein yields of legumes (Haque *et al.*, 1986).

In utilizing *T. bracteolata* to establish fodder bank, it is pertinent to understand the response to fertilizer levels to ensure high yield of forage, enhance nutritive value and reduce cost of production of the forage. Also, high shoot yield facilitated by fertilizer application will ensure production of enough biomass that can be worked into the soil or used as mulch pruning in the green manure farming system.

MATERIALS AND METHODS

The study was conducted at the roof-top garden (latitude $7^{o}27.076^{1}$N; longitude $3^{o}53.824^{1}$E; elevation 218 m asl) of the Department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria. River sand thoroughly washed was used for the study. The river sand was thoroughly mixed and approximately 5 kg sand was weighed into each of the ninety pots (4-litre capacity) whose bases were perforated. Each pot has a depth of 20 cm and a top diameter of 22 cm. The sand–filled plastic pots were arranged on the roof–top garden. Subsequently, sample of experimental sand was taken for routine analysis in the analytical laboratories of International Institute of Tropical Agriculture (IITA) and Department of Agronomy, University of Ibadan, Ibadan.

The viable seeds of *T. bracteolata* were collected from International Livestock Research Institute ILRI (germplasm) IITA, Ibadan, Nigeria. The dormancy of the seeds of *T. bracteolata* was broken by acid treatment as reported by Awodoyin (1987).

The treatments included 2 nitrogen levels (0 and 50kg N/ha) combined with 5 phosphorus levels (0, 25, 50, 75,100kg P/ha), making 10 treatment combinations in a 2 x 5 factorial experiment fitted into randomized complete block (RCB) design.

Nine pots were established for each of the ten (10) treatment combinations to have a total of ninety pots. The pots were arranged into 3 blocks (replicates) of 30 pots each. Each of the ten (10) treatments was randomly allocated to 3 pots in each block.

Acid–scarified seeds of *T. bracteolata* were sown in plastic pots filled with sand and well watered daily. Seven days after planting, when the first foliage leaves had formed, the seedlings were thinned to one plant per pot. The seedlings of *T. bracteolata* were given a basal fertilizer dressing of N.P.K 20-10-10 at 25kg $N.ha^{-1}$ at 7days after sowing (DAS) with each pot taking 0.31g.

When the plants attained the mean of 6-leaf stage, at 3 weeks after planting, the first harvest was done for growth assessment. The application of treatment commenced at this stage. Fertilizers application was split into two and applied at 4-week interval interval.

Nitrogen fertilizer was applied as urea (46%N) at 2 levels N_0 (0) and N_1 (50kgN/ha) while phosphorus fertilizer, supplied as single superphosphate (20%PO_5), was applied at 5 levels P_0 (0), P_1 (25), P_2 (50), P_3 (75), and P_4 (100kg P/ha).

A 2-factor factorial experiment was employed; the design was RCB with three (3) replications. Fertilizer treatments were applied at 3 and 7 weeks after sowing.

At three weeks after sowing and subsequently at 4-week interval, one pot was randomly selected from each treatment combination in each of the 3 blocks, and assessed for the following parameters:

1. Plant height (measured from the surface of sand to the tip of the plant using a meter rule).
2. Number of leaves or leaflets (by simple counting)
3. Leaf area: leaf area per plant was determined approximately as the product of leaflet length along the mid-rib and breadth at the median point, the leaflet being almost linear (Awodoyin, 1987).
4. The root lengths of the seedling were measured using a 30-cm rule.

The plants were then separated into leaf, stem and root components, oven-dried at 75^{o}C to constant weight for 3 days and weighed with a top-loading mettler balance, model P1210.

Growth Analysis

Using the mean plant dry weight, mean leaf area and mean leaf dry weight at the harvests as primary data, the following indices of growth were determined for each treatment combination, according to Wareign (1970) and Evans (1972).

(a) Dry Matter Production (DMP): change in total plant dry weight
$DMP = W = W_2 – W_1$ (g)
(b) Leaf Weight Ratio (LWR): Average fraction of the total dry weight invested in leaf production.
LWR = LW/TDW.
(c) Relative Growth Rate (RGR): Efficiency of the plants at producing dry matter over time.
$RGR = (lnW_2 – lnW_1/t_1 – t_2$ g/g .day
(d) Leaf Area Ratio (LAR): Average amount of leaf area per unit plant dry weight.
(LAR = LA/TDW).

The different growth parameters measured and calculated variables were subjected to analysis of variance and the means separated by least significant difference at 5% probability level.

RESULTS

Soil Characteristics

Physical and Chemical characteristics (pH value, organic matter, total nitrogen, total phosphorus and textural classification) of the soil used for growth trial are shown in Table 1. Using the soil textural triangle, the soil is classified as sand (Bouyoucos, 1962).

Influence on growth plant height

There were variations in the height of plants and it increased with age (Table 2). The plants given phosphorus only (N_0P_3) were tallest, while the shortest plants were the ones given nitrogen fertilizer only (N_1P_0). The differences among the treatments were highly significant (P< 0.01) at 3WAP, 7 WAP and 11 WAP. The highest mean height was observed at 11 WAP when *T. bracteolata* was given nitrogen and high level of phosphorus fertilizer (N_1P_3).

Table 1. Some physical and chemical properties of soil used in the experiment

Parameters	pH	Organic matter (%)	Total N (%)	Phosphorus (µg/g)	Textural Classification (%)		
					Sand	Silt	Clay
Values	7.30	0.590	0.010	5.883	93.00	7.00	0.00

Table 2: Influence of n and p fertilization on height of *T. bracteolata.* Values are means of 3 replicates

TREATMENTS	MEAN PLANT HEIGHT (cm/plant)		
	3 WAP	7 WAP	11 WAP
N_0P_0 (Control)	3.53	10.60	21.87
N_OP_1	2.66	11.30	25.83
N_OP_2	2.60	13.50	31.56
N_OP_3	4.20	14.50	30.27
N_OP_4	3.77	15.07	30.73
N_1P_O	2.60	13.10	18.97
N_1P_1	3.00	18.17	37.90
N_1P_2	3.23	13.13	26.27
N_1P_3	2.73	14.27	45.13
N_1P_4	3.00	15.67	31.77
LSD (p=0.05)	0.39	2.09	6.19
C.V. (%)	7.30	8.76	12.01

Number of Leaflets

Again, the variation among the treatments in number of leaflets increased with age of the plants. At 3 WAP, all treated plants, except N_1P_1 showed no significant variation (P>0.05). The highest number of leaflets (6.66) was recorded in plants given lowest levels of nitrogen and phosphorus fertilizer (N_1P_1) while the lowest number of leaflets (5.33) was recorded in plants given nitrogen fertilizer alone (N_1P_0) and combined nitrogen and high level of phosphorus fertilizer (N_1P_3) (Table 3). Plants given combined nitrogen and high level of phosphorus fertilizers (N_1P_3) treatment had the highest number of leaflets at 7 WAP, while the control (N_0P_0) plants had the lowest number of leaflets. Similarly, all treated plants, irrespective of the level of fertilizer application produced more number of leaflets as compared to the control. The differences among the treatments were highly significant (P< 0.01) with regards to number of leaflets (7WAP). However, at 11WAP, plants given combined application of nitrogen and high phosphorus fertilizer (N_1P_3) treatment produced highest number of leaflets (376.67) which was significantly (P< 0.01) higher than all other treatments. Application of nitrogen fertilizer alone (N_1P_0) produced the lowest number of leaflets at 11 WAP. The differences among the treatments were highly significant (P< 0.01).

Leaf Area

At 3, 7 and 11 WAP, all treated plants produced larger leaf area than the control plants (Table 3). Though the differences were not significant among the treatments at 3 WAP, they were significant at 7 and 11 WAP (P<0.01). The application of phosphorus fertilizers at all levels without nitrogen fertilizer and application of nitrogen fertilizer alone (N_1P_0) did not differ significantly.
The highest leaflet area production at 11 WAP was observed from plants given combined nitrogen and high level of phosphorus fertilizer (N_1P_3) while the lowest

leaflet area production was obtained from the application of nitrogen uncombined with phosphorus fertilizer (N_1P_0).

Tabble 3: Influence of N and P Fertilizer levels and combinations on the production of leaflets and leaf area in T. bracteolata. Values are means of 3 replicates.

Treatments	Mean number of leaflet			leaf area (cm^2/plant)		
	3 WAP*	7 WAP	11 WAP	3 WAP	7 WAP	11 WAP
N_0P_0 (Control)	5.67	27.00	268.70	7.37	82.33	904.80
N_OP_1	6.33	46.00	316.33	8.53	132.97	1051.70
N_OP_2	6.33	43.67	368.33	8.73	137.87	1277.03
N_OP_3	6.33	38.67	300.00	10.57	120.67	1052.77
N_OP_4	6.00	47.33	303.00	8.23	136.73	1053.20
N_1P_O	5.33	44.67	227.67	9.30	132.80	743.80
N_1P_1	6.66	58.00	372.67	8.53	179.60	1284.83
N_1P_2	6.00	59.00	298.67	10.73	185.53	1029.07
N_1P_3	5.33	68.67	376.67	8.33	230.87	1338.13
N_1P_4	5.67	68.00	325.00	10.27	217.73	1097.20
LSD (p=0.05)	1.03	7.82	68.46	3.01	33.91	304.02
C.V. (%)	10.05	9.10	12.64	19.37	12.70	16.36

***WAP**: Weeks after planting.

Root Length

The root length increased with age of the plants (Table 4). At 3 WAP, plants given high phosphorus without nitrogen fertilizer (N_0P_3) produced the longest root length while the plants given low phosphorus without nitrogen fertilizer (N_0P_1) produced the shortest root length. The difference between the treatments was highly significant ($P<0.01$). Plants given nitrogen alone (N_1P_0) had the longest root length at 7 WAP while the shortest root length was recorded in plants given highest phosphorus alone (N_0P_4). The differences among the treatments with regards to the root length were also highly significant ($P< 0.01$). However, at 11 WAP, the differences recorded in the root length between plants treated and the control were not statistically significant, although all treated plants produced longer root than the control.

Dry Matter Yield

At 3WAP the differences among the treatments were not significant ($p>0.05$), although plants given phosphorus fertilizer alone at the lowest level (N_0P_1) produced the least leaf dry weight (Table 5). The plants given nitrogen and phosphorus fertilizer at the lowest level (N_1P_1) produced the highest leaf dry weight at 7 and 11 WAP. Leaf dry weight of treated plants were significantly greater than that of the control.

At 3 WAP, the control (N_0P_0) plants had the lowest root dry weight that was not significantly different from the other treatments (Table 5). At 7 weeks after planting, the plants given combined nitrogen and phosphorus fertilizers at all levels (N_1P_1, N_1P_2, N_1P_3 and N_1P_4) had significantly ($p< 0.01$) higher root dry weight than the treatments given phosphorus without nitrogen fertilizer (N_0P_1, N_0P_2, N_0P_3, N_0P_4), nitrogen fertilizer alone (N_1P_0) and the control (N_0P_0). The control (N_0P_0) plants had the lowest root dry weight.

Table 4: Influence of n and p fertilization on root length of (*T. bracteolata*) *Values are means of 3 replicates.*

Treatments	Mean root length (cm/plant)		
	3 WAP*	7 WAP	11 WAP
N_0P_0 (Control)	5.53	22.37	32.23
N_OP_1	3.20	22.37	35.20
N_OP_2	3.30	25.00	35.33
N_OP_3	6.13	25.63	34.97
N_OP_4	5.13	21.30	32.63
N_1P_O	4.00	30.67	33.73
N_1P_1	4.03	28.03	38.07
N_1P_2	4.90	24.07	34.50
N_1P_3	3.97	25.43	34.20
N_1P_4	4.53	23.93	35.13
LSD (p=0.05)	0.88	1.96	7.38
C.V. (%)	11.41	4.60	12.43

***WAP**: Weeks after planting.

However, at 11 weeks after planting, plants given nitrogen without phosphorus fertilizer (N_1P_0) produced the lowest root dry weight. There were highly significant ($P< 0.01$) differences among the treatments with regards to the root dry weight at both 7 and 11 weeks after planting.

At 3 WAP, the differences among the treatments in total plant dry weights were not significant but were highly significant ($P< 0.01$) at 7 WAP and 11 WAP. Meanwhile, plants given combined application of nitrogen and high phosphorus fertilizer (N_1P_3) and plants given low phosphorus without nitrogen fertilizer (N_0P_2) produced the highest total plants dry weight at 7 and 11 weeks after planting (Table 5).

Table 5: Influence of N and P fertilization on leaf, root and total plants dry matter accumulation of *T. bracteolata*. *Values are means of 3 replicates*

	Leaf dry weight (g/plant)			Root dry weight (g/plant)			Mean total plant dry weight (g/plant)		
Treatments	3 WAP*	7WAP	11WAP	3 WAP	7WAP	11WAP	3 WAP	7WAP	11WAP
N_0P_0 (Control)	0.04	0.47	3.58	0.02	0.13	1.28	0.10	0.78	7.48
N_OP_1	0.03	1.03	5.14	0.04	0.22	1.36	0.09	1.64	10.29
N_OP_2	0.04	0.74	7.32	0.03	0.22	1.68	0.11	1.27	15.43
N_OP_3	0.04	0.74	4.25	0.03	0.21	0.93	0.11	1.21	9.53
N_OP_4	0.04	0.79	4.80	0.05	0.18	1.04	0.11	1.27	8.93
N_1P_O	0.04	0.63	4.82	0.04	0.17	0.90	0.10	1.00	7.89
N_1P_1	0.04	1.42	7.71	0.04	0.36	1.67	0.12	2.33	15.38
N_1P_2	0.04	1.25	5.82	0.04	0.33	1.15	0.11	2.37	12.13
N_1P_3	0.04	1.32	7.39	0.04	0.35	1.98	0.11	2.52	15.13
N_1P_4	0.05	1.21	5.19	0.03	0.28	1.73	0.12	2.06	11.75
LSD (0.05)	0.01	0.15	1.60	0.01	0.04	0.56	0.03	0.15	3.09
C.V. (%)	16.19	9.22	16.65	18.97	10.20	24.00	15.88	5.32	15.78

*WAP: Weeks after planting.

Table 6: Influence of n and p fertilization on the relative growth rate, leaf weight ratio and leaf area ratio of *t. bracteolata*. values are means of 3 replicates

	Relative Growth Rate g/g. day		Leaf Weight Ratio			Leaf Area Ratio		
Treatments	1 (week 3/7)	2(week 7/11)	3 WAP*	7WAP	11WAP	3 WAP	7WAP	11WAP
N_0P_0 (Control)	0.07	0.08	0.40	0.59	0.45	73.60	105.55	114.68
N_OP_1	0.10	0.07	0.33	0.63	0.50	94.78	81.07	102.21
N_OP_2	0.09	0.08	0.36	0.58	0.47	79.36	108.55	82.76
N_OP_3	0.09	0.07	0.45	0.63	0.45	96.36	100.58	110.47
N_OP_4	0.09	0.07	0.36	0.62	0.54	74.55	107.66	117.94
N_1P_O	0.09	0.07	0.44	0.60	0.64	103.33	130.00	99.44
N_1P_1	0.11	0.07	0.42	0.61	0.50	70.83	77.08	85.54
N_1P_2	0.11	0.06	0.36	0.53	0.48	97.55	78.28	84.84
N_1P_3	0.11	0.06	0.36	0.52	0.49	75.73	91.62	88.55
N_1P_4	0.10	0.06	0.42	0.59	0.44	85.58	105.69	93.38
Mean	0.10	0.07	0.39	0.59	0.50	95.17	98.61	97.98
SE	0.00	0.00	0.01	0.01	0.02	3.77	5.27	4.11

*WAP: Weeks after planting.

Growth Analysis

The results revealed a decline in the Relative Growth Rate (RGR) in all the treatments, except the control (N_0P_0) (Table 6).

The RGR between 3 and 7 weeks after planting for all the treatments, except for the control (N_0P_0), was highest compared to RGR determined between 7 and 11 weeks after planting. Consequently, the rate at which the determined RGR declined was more in plants given combined nitrogen and phosphorus fertilizer treatments at all the levels than in the other treatments, although, the differences among the treatments was not significant. The average leaf weight ratio (LWR) at the different stages of growth (3, 7 and 11 weeks after planting) revealed fluctuation in all the treatments except plants given nitrogen without phosphorus fertilizer (N_1P_0) that increased with age of plants (Table 6). Leaf weight ratio (LWR) increased irrespective of treatments in the second harvest (7 WAP) and then declined in the third harvest (11 WAP) except plants given nitrogen without phosphorus fertilizer (N_1P_0). The differences among the treatments irrespective of stages of growth with regards to LWR are highly significant ($P < 0.01$).

At 3 and 7 weeks after planting, plants given nitrogen without phosphorus fertilizer (N_1P_0) had the highest leaf area ratio (LAR), while at 11 weeks after planting, plants given highest phosphorus without nitrogen fertilizer (N_0P_4) produced the highest (Table 6). The control (N_0P_0) plants given nitrogen and lowest level of phosphorus fertilizers (N_1P_1) and plants given low phosphorus without nitrogen fertilizer (N_0P_2) had the lowest LAR at 3, 7 and 11 WAP. The differences among the treatments were highly significant (P< 0.01) with regards to LAR at different stages of growth.

DISCUSSION

The result obtained from the analysis of soil used in establishing *Tephrosia bracteolata* in this study indicated that the soil is very low in organic matter content and in the reserves of nitrogen and phosphorus. The generally increasing mean height observed in plants given phosphorus with nitrogen fertilizers at all stages of growth could indicate that the combination of nitrogen and phosphorus fertilizers has positive effect on plant height. The relative slow shoot growth of the plants given nitrogen fertilizer alone is indicative of the peculiar growth habit of the plants with imbalance soil nutrient. The increasing dry matter yield recorded for plants given phosphorus with or without nitrogen fertilizers at all stages of growth assessed suggests that phosphorus fertilizer was effective in enhancing dry matter accumulation. This agrees with the report of Bonetti *et al.* (1984) in a green house that plant weight increased under increasing rates of phosphorus when water tension is low. The multiple productions of leaflets observed in *T. bracteolata* is similar to some reports for tropical legumes (Addlestone *et al.*, 1999; Tarawali *et al.,* 1999). The reduced number of leaflets recorded for the control plants in the final stage of growth of this experiment could possibly be ascribed to low nutrient status in the soil in which the plants were grown. On the other hand, plants given combined nitrogen and phosphorus produced more leaves than other treatment. The higher leaf area recorded in plants given combined nitrogen and phosphorus fertilizers could partly account for their high total dry matter accumulation. The RGR of plants at any time is an expression of efficiency of the plants in producing dry matter over time. Thus, the decline observed in RGR of the treated plants in this study could possibly be ascribed to ineffectiveness of the leaves in producing assimilate enough to meet both biomass accumulation and plant respiration. The declining RGR agreed with the report of Brigg *et al.* (1920) that the assimilatory power of the young leaves for some time after their appearance is negligibly small and that the period of early growth of any plant is characterized by negative relative growth rate. Leaf weight ratio (LWR) has been described as the average fraction of the total dry weight invested in leaf production (Evans, 1972). The trend of change in the ratio obtained shows that dry matter allocation in *Tephrosia bracteolata* irrespective of the treatments in this study favours the leaves more than other parts of the plant.

CONCLUSION AND RECOMMENDATION

Tephrosia bracteolata is an indigenous legume growing wild along roadsides in the dry forest to guinea savanna ecological belt. The species is early maturing and posseses high nutritive values. The implication of this is that the use of *T. bracteolata* will not only improve the performance of livestock when fed with it but will also improve the soil by fixing atmospheric nitrogen. In order to improve on the establishment and growth of this tropical legume under poor soil conditions, field management practices such as fertilizer application may be necessary. However, this study has shown that application of phosphorus fertilizer and, at least, starter nitrogen fertilizer are required for good establishment of *T. bracteolata.* In spite of the diverse potentials of *T. bracteolata*, as a fodder, manure and soil conditioner, it has not attracted much attention. Therefore, effort must be geared towards researching into its production management and general agronomy, just like other exotic forage legume species and green manure plants.

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