Forage yield and quality in pigeonpea germplasm lines

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Pigeonpea (*Cajanus cajan*) is an important grain legume of the semi-arid tropics (SAT) that is well adapted to drought periods and that can also be grown on marginal land and requires generally few inputs. Particularly this last aspect made pigeonpea a key crop for large-scale land reclamation in China. Fodder scarcity is prevalent in many areas of the SAT and pigeonpea could well contribute to improved feed resources when used for such natural resource management purposes. Since information available on pigeonpea as forage crop was poor, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and International Livestock Research Institute (ILRI) started collaborative work to systematically investigate its forage potential. This collaboration combined livestock productivity trials with the agronomic testing of a wide range of pigeonpea lines over two years in India, Ethiopia and China. From the livestock productivity trials, it was concluded that widely used conventional laboratory forage quality traits such as protein content and in vitro digestibility did not adequately describe pigeonpea forage quality (Alexander et al. 2006a, 2006c, Ki et al. 2006). These authors suggested that secondary plant component analysis was needed and reported that condensed tannin content in the pigeonpea forage was highly positively correlated with livestock productivity measurements in sheep exclusively fed on pigeonpea forage. Our report deals with observations on forage yield and quality traits and their heritability estimates over the years 2003 and 2004 in India.

Two hundred pigeonpea germplasm lines were planted at ICRISAT, Patancheru, India during *kharif* (rainy) season of 2003 and 2004, with 157 lines grown in both years. The lines were evaluated in a randomized block design with three replications, and harvested at 50% flowering by cutting the plants about 2 feet above ground. The samples were dried and analyzed for nitrogen content (protein content is commonly calculated from nitrogen content by multiplication with 6.25), in vitro organic matter digestibility and condensed tannins

Table 1. Variations in forage yield and quality traits among 200 lines of pigeonpea evaluated during rainy season in 2003 and 2004 at ICRISAT, Patancheru, India.

Trait/Year	Range	Mean	LSD	*P*
Forage dry matter yield (t ha^{-1})				
2003	1.4–10.5	5.0	1.9	<0.0001
2004	0.76–7.8	4.4	1.7	<0.0001
Nitrogen content of forage (%)				
2003	2.8–4.0	3.4	0.46	<0.0001
2004	2.6–4.3	3.6	0.61	<0.0001
In vitro organic matter digestibility (%)				
2003	52.0–58.2	55.2	1.7	<0.0001
2004	43.4–58.1	54.1	4.0	<0.0001
Condensed tannins content of forage (%)				
2003	0.4–3.8	1.8	0.66	<0.0001
2004	0.5–4.3	2.2	0.87	<0.0001

Table 2. Forage yield and quality in five most promising germplasm lines of pigeonpea on the basis of high forage yield in rainy season of 2003 and 2004 at ICRISAT, Patancheru, India.

Germplasm	Forage yield (t ha^{-1})	Nitrogen (%)	In vitro organic matter digestibility (%)	Condensed tannins (%)
2003 rainy season				
ICP 7412	10.5	3.2	54.8	1.4
ICP 9817	10.5	3.6	55.7	2.0
ICP 7063	9.6	3.4	55.5	2.5
ICP 10502	9.2	3.2	56.0	1.3
ICP 2098	8.8	3.5	56.4	1.5
2004 rainy season				
ICP 2098	7.8	3.5	56.7	2.8
ICP 369	7.1	4.3	51.9	1.4
ICP 6958	7.0	2.7	53.5	2.1
ICP 5370	7.0	3.6	54.0	1.7
ICP 13337	7.0	3.8	56.7	2.4

content using a combination of conventional laboratory analysis and Near Infrared Spectroscopy (Alexander et al. 2006b). The data were subjected to analysis of variance (GLM procedure) and simple correlations (CORR procedure) using SAS (2005).

The tested pigeonpea lines showed large genetic variability for forage dry matter yield, nitrogen content, in vitro organic matter digestibility and condensed tannins content in 2003 and 2004 (Table 1). This indicated substantial scope of selection for forage yield and quality traits in this material. Feedstuffs in the SAT are often too deficient in nitrogen to allow efficient feed digestion in the rumen, which requires a minimum of 1 to 1.2% of feed nitrogen (Van Soest 1994). Mean nitrogen content in the pigeonpea forage was 3.4 and 3.6% in 2003 and 2004, respectively, suggesting that pigeonpea forage can serve as an effective supplement to nitrogen deficient feedstuffs. In vitro digestibility is an estimate of the proportion of the forage that can be digested by the livestock. Highly significant differences in in vitro digestibility were observed for both years with a range of about 6 and 15 units in 2003 and 2004, respectively. Generally 5 units difference in digestibility of feedstuff is considered to have noticeable effect on livestock productivity (Van Soest 1994).

The positive effects of condensed tannins in ruminant feeding arise from their inhibition of excessive dietary protein degradation as for example shown in the case of *Lotus* species forages in Australia (Barry and McNabb 1999) and their reducing effect on methane production (Puchala et al. 2005). The positive effects of condensed tannins on forage quality have been observed usually at 2 to 4% concentration, with an optimal content being variable and depending on the basal diet and structure of the condensed tannins. However, condensed tannins can also affect the forage quality negatively if present at higher concentration.

Five best lines for forage yield in rainy season 2003 (8.8–10.5 t ha^{-1}) and 2004 (7.0 to 7.8 t ha^{-1}) with forage nitrogen content, in vitro organic matter digestibility and condensed tannins content are presented in Table 2. ICP 2098 was most promising for forage yield with relatively superior quality in both the years.

Forage dry matter yield and forage quality traits were unrelated in the 2003 rainy season. However, in the 2004 rainy season, forage yield was positively associated with forage nitrogen content ($r = 0.32$) and negatively with condensed tannins content ($r = -0.18$). Estimates of broad sense heritability (h^2) for forage yield, nitrogen, condensed tannins and in vitro digestibility were 0.27, 0.51, 0.70 and 0.34, respectively. The significant variations for forage yield and the three forage quality parameters and high estimates of broad sense heritability for condensed tannins and moderate heritability for nitrogen indicated relative reliability of selection for these traits in this material. The lines detected in this study could provide useful material to initiate forage quality breeding program in pigeonpea.

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