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The Influence Of Lablab (*Lablab purpureus*) On Grain And Fodder Yield Of Maize (*Zea mays*) In A Humid Forest Region Of Nigeria.

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ABSTRACT: The influence of lablab on maize grain and fodder (stover) yield was investigated during the early and late cropping seasons of 1998 and 1999, at Onne, in the humid forest zone of Nigeria. Lablab was simultaneously planted in maize the same day and also undersown in maize at 2, 4, 6 and 8 weeks after maize planting (WAP) while sole maize and sole lablab were used as control. Simultaneous planting reduced maize grain yield by 40-63% relative to the sole maize crop while higher grain yield was obtained when undersowing of lablab was delayed beyond 2 WAP. Unlike maize grain yield, highest lablab DM fodder yield was obtained when maize and lablab were simultaneously planted, and declined progressively with delayed undersowing of lablab while maize fodder yield was not affected by time of lablab undersowing. Time of lablab undersowing positively influence total fodder (maize + lablab) yield. When fed to livestock, rate of digestibility was higher in lablab fodder than the maize fodder, indicating that lablab fodder enhanced the digestibility of lablab-maize forage. Undersowing of lablab in maize not latter than 4 WAP, effectively controlled weed infestation in the intercrops than undersowing later. @JASEM

Increasing demand for animal protein is leading to integration of crop and livestock production in sub-Saharan Africa. Although the process of integration is well developed in smallholder farming systems in the sub-humid and semi-arid zones, some level of integration is also occurring in the humid forest zone. Farmers in the zone are predominantly crop farmers while most of them also keep some livestock especially the trypanotolerant dwarf sheep and goats. Although feed is not a major constraint of small ruminant keeping in the zone because of the presence of browse from plant foliage, they are usually of very low quality (Wahua and Oji, 1987; McIntire *et al.*, 1982). The use of forage legumes in the traditional farming system is a new innovation in the humid forest zone. Results from the sub-humid zones show that both the quantity and feeding value of biomass (grain and fodder) could be increased (Mohamed-Saleem, 1985; Kouame *et al.*, 1993). Other advantages of this practice include the improvement of soil physical and chemical properties (Tarawali and Ikwuegbu, 1993), soil erosion control and weed control (Sistachs *et al.*, 1992) and better performance of animals fed on such crop residues (Powell and Williams, 1995).

The effective performance of animals fed on forages such as maize stover supplemented with lablab forage depends greatly on the digestibility of such fodder materials. Digestibility is said to be positively correlated with crude protein (CP) of fodder materials (Capper *et al.*, 1989). Similarly, Buxton (1996) estimated the CP concentration of maize stover to be less than 100g kg^{-1} while the CP concentration of lablab was estimated to be 135-280 g kg^{-1} (Addy and Thomas, 1976). Digestibility and CP characteristic of forages and crop residues are important determinants of forage quality and form better predictors of animal performance (Orskov, 1990). There is therefore the need to investigate and evaluate the positive effects of incorporating forage legumes into cereal-based farming systems of the humid forest zone. This study was initiated to investigate the appropriate time to introduce lablab into a maize crop in the humid forest zone to optimise grain and fodder yield.

MATERIALS AND METHODS

Site Description:The experiment was conducted at the Research Farm of the International Institute of Tropical Agricultural (IITA), High Rainfall Station, Onne, Long. 4^{o} 46 N, Lat. 7^{o}10 E, near Port Harcourt, South Eastern Nigeria during the 1997 cropping seasons. Onne, at an altitude of 10 m above sea level, is in the humid forest zone with an annual rainfall of 2400 mm usually in a monomodal distribution lasting from February to November. Mean total rainfall during the experimental period was 1269 and 925 mm for the early (April-August) and late (September-December) cropping seasons, respectively. The soil of the study site is an Ultisol with the general properties at the 0-15 cm top soil level as follows: pH 4.9 (1:2.5 soil:water ratio), %OM 1.16, %Total N 0.12, Bray-1 P 58.4, K 0.2 Cmol kg^{-1}, Mg 0.70 Cmol kg^{-1}, Ca 2.75 Cmol kg^{-1} and CEC 4.5 Cmol kg^{-1}.

Experimental Details: A complete randomised block design with four replications was used. There were seven treatments consisting of maize and lablab as sole crops, lablab in maize on the same day and lablab undersown in maize at 2, 4, 6 and 8 weeks after maize planting (WAP). The plot size was 4.5 by 4.5 m. Soil samples were collected between land preparations and

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planting of maize in each cropping season, using an auger.

The land was slashed, stumped manually and soil surface leveled with spades. Two maize crops were planted yearly using the white-seeded maize variety (DMR-SR-W) obtained from IITA, Ibadan. Lablab was a white-seeded variety obtained from National Animal Production and Research Institute (NAPRI), Zaria. The early season maize was planted in April, while the late season crop was planted in September in the years 1998 and 1999, respectively. A planting spacing of 75 and 25 cm intra- and inter-row respectively, was adopted in each season. For each crop, two seeds were planted per stand but thinned to one seedling per stand, 3 WAP, giving a population of 53333 plants ha^{-1} for sole maize and sole lablab, respectively. The intercrop had the same planting spacing but, with a row of maize alternating with every row of lablab, giving a population of 26667 plants ha^{-1} for each crop. Plots were hoe weeded at 3 and 6 WAP in each cropping season. A compound fertilizer (NPK-15:15:15) was applied at a rate of 300 kg ha^{-1}, three days after the first weeding.

Observations were made on ten maize plants randomly selected from the two middle rows for forage and grain yields. For weed yield, four quadrants measuring 0.5 x 0.5m each, randomly selected per plot, were taken at maize harvest, while forage lablab yield was based on whole plot basis because lablab entanglement in the plots. At harvest, cobs were picked from the standing maize plants, dehusk and air-dried for one week under a shade before it was shelled and weighed. Maize fodder (stover) was latter harvested and separated into leaf (blade and sheath) and stem (stem, husk and tassel) and weighed. The leaves were taken as fodder while the stems were left on the plots.

Lablab above ground dry matter was also harvested as fodder and weighed. Edible fodder composed of maize forage (leaf and sheath) and lablab forage (leaf and vine). Grain yield was adjusted to 13% moisture content. Ten cobs were randomly selected from each treatment for the determination of 1000 grains weight, number of grains per cob and shelling percentage. Samples of maize stover and lablab forage were oven-dried at a temperature of 60^{o}C for 48 hours for dry matter (DM) determination. Sub-samples of oven-dried maize stover and lablab fodder samples were ground to pass through a 2 mm sieve for degradation (digestibility) studies.

In sacco DM degradation characteristics of maize and lablab forages was done using three rumen fistulated N' Dama steers (*Bos indicus*). The degradation was determine using the nylon bag technique (Orskov *et al*., 1980), while potential degradability of DM was estimated using the equation reported by Orskov and McDonald (1979):

$$P = a + b\,(1 - e^{-ct})$$

where: p = potential degradability at time t, a the water soluble fraction (or rapidly degradable fraction at time zero), b the slowly degradable fraction i.e. insoluble but fermentable fraction in time t, c the degradable constant of b fraction i.e. fraction rate constant at which the fraction described by b will be degraded per hour while t is time of incubation.

Weeds were assessed at harvest by the use of a quadrat measuring 0.5 x 0.5m. Four quadrats were taken per plot for the determination of weed density and type (broad leaf and grass) after which all weeds within the quadrat were cut to ground level to determine yield.

Statistical analysis: Analysis of variance was carried out on all data collected, using the General Linear Model (GLM) procedure (SAS, 1998). Initial analysis did not show any yearly effects; therefore year was pooled in the final analysis. When the analysis of variance was significant (F-test), the standard error of means (SE) (SAS, 1998) was used to compare treatment means at 0.05 significant level of probability.

RESULTS AND DISCUSSION

Grain Yield: Generally, grain yields ranged from 1.70 to 2.88 t/ha and 1.30 to 1.84 t/ha in the early and late seasons, respectively (Fig. 1). Simultaneous intercrop (planting maize and lablab on same day) produced the least grain yields in both seasons. Yields rise from the simultaneous intercrop to a peak when undersowing was delayed to 4 WAP and thereafter tend to be sustained with further delayance of time of undersowing. Differences in the intercrop yields were not significant ($P \leq 0.05$) in both seasons except with simultaneous planting which significantly reduced grain yield by 35 - 58% in relation to other intercrop yields.

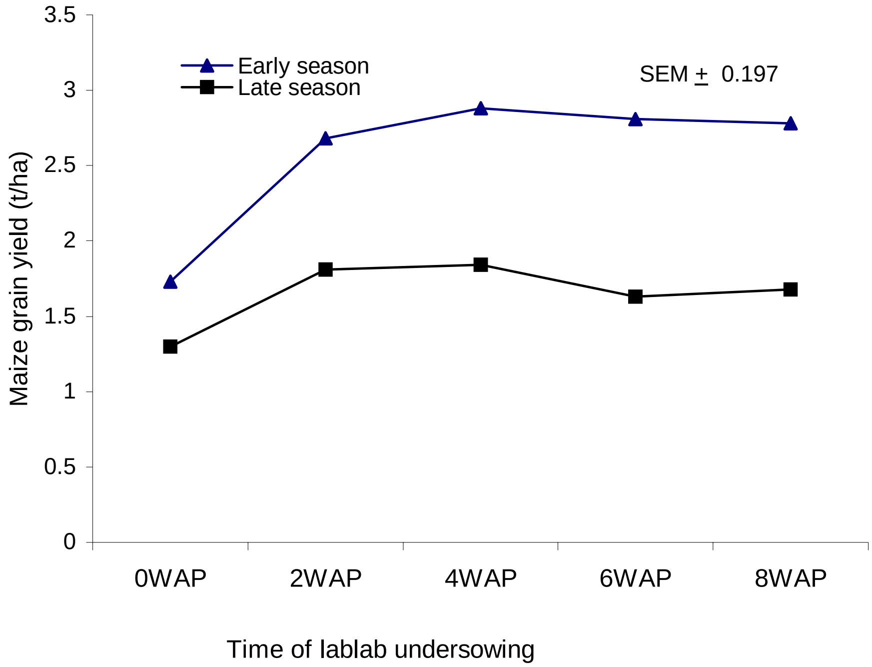


Fig. 1. Effect of time of lablab undersowing in maize on maize grain yield

Delayed undersowing to 4 WAP significantly increased grain yields beyond 66 and 42% in the early and late seasons, respectively, in relation to simultaneous intercrop. This is an indication that delayed undersowing beyond 2 WAP is advantageous in terms of grain yields. A similar result was obtained in the sub-humid zone by Mohammed-Saleem (1985) stating that grain yield loss in simultaneous intercropping of sorghum and stylo could be minimized by delayed planting of stylo by 3-6 weeks after sorghum planting. All intercrop treatments except simultaneous planting, had little effect on grain yield components such as number of grains per cob, 1000 grain weight, shelling percentage and harvest index (Table 1.). The poor performance of simultaneous planting with respect to both grain yield and yield attributes was probably due to the aggressively competitive ability of lablab in the mixture. Lablab completely entangled the entire maize plant from base to tassel, forming a dense forage cover, which might have impeded the physiological development of maize. Similar results have been reported by Mutsaers *et al.*, (1997). It was observed that early intercropping of lablab in maize allowed lablab an excessive entanglement of the maize plant at tasseling and silking. It is evident that any stress at such critical period of maize growth could seriously affect DM accumulation, which eventually results in poor grain formation and subsequently, poor yield (Bidinger *et al.*, 1996; Blade *et al.*, 1997). The yields of the late season planting were consistently low as compared to early season yields. This could be attributed to the low rainfall associated with the late season as compared with early season. Also a high degree of stem borer infestation consistently occurred during late season cropping (data not shown).

Forage yield: Maize forage (leaf) yield was reduced by 57% in the simultaneous intercop as compared to the sole maize crop (Table 2). The intercrop yield then decreased by 40, 41, 35 and 32% when lablab was undersown in maize at 2, 4, 6 and 8 WAP, as compared with the sole crop in the early season. Similarly, it decreased by 40% in the simultaneous intercrop and by 39, 29, 37 and 31% at 2, 4, 6 and 8 WAP in the late season. The high fodder yield of the sole maize crop was attributed to the high initial population associated with the sole crop as compared to the intercrop, which had just half the sole crop population. Although yields of the simultaneous intercrop were the lowest in both seasons, yields did not differ significantly from other intercrops, except in the early season. Generally, time of undersowing lablab in maize did not significantly influence maize forage yield. Sole lablab gave the highest lablab fodder yields which were 53 and 63% higher than the best intercrop yields in both early and late seasons. Planting both maize and lablab on the same day gave the highest lablab intercrop fodder yield. Yields then decreased steadily with delayed undersowing. The higher yield associated with simultaneous planting is an indication of the competitive ability of lablab compared with the sole crop (control).

Table 1. Effect of time of undersowing lablab in maize on components of maize grain yield

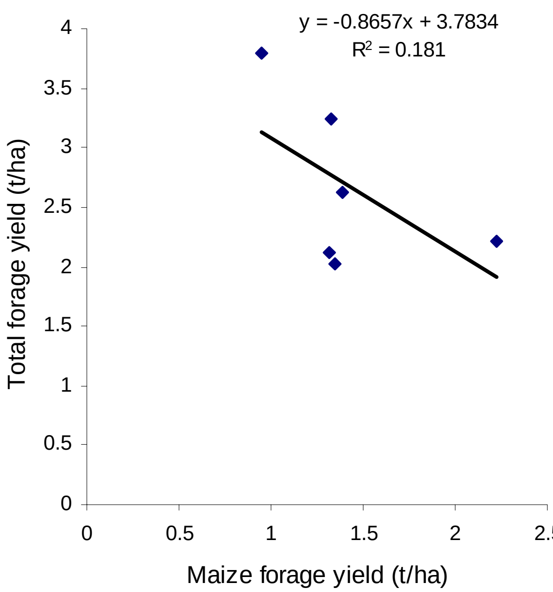
[1]Time of undersowing	Number of grains per cob	1000 grain weight (g)	Shelling percentage (%)	Harvest index	Number of grains per cob	1000 grain weight (g)	Shelling percentage (%)	Harvest index
	Early Season				Late Season			
Sole maize	385	290.2	56.8	0.50	301	247.7	74.0	0.50
Sole lablab	361	306.5	44.0	0.37	318	267.7	71.3	0.38
Simultaneous	420	329.4	59.8	0.45	368	284.2	78.1	0.46
2 WAP	446	323.8	61.3	0.47	381	291.0	78.5	0.53
4 WAP	446	323.3	62.0	0.50	374	288.3	76.2	0.48
6 WAP	438	323.5	61.4	0.48	366	278.3	77.5	0.52
8 WAP	12.1	7.99	3.23	0.06	13.1	8.98	4.2	0.037
SE ±	12.1	7.99	3.23	0.06	13.1	8.98	4.2	0.037

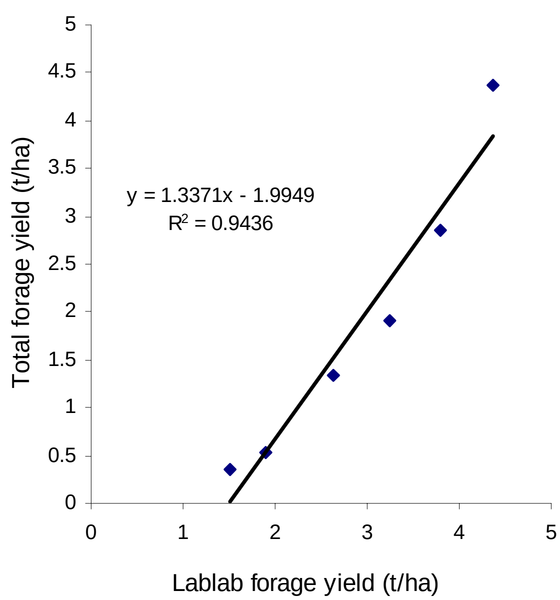
[1] = Weeks after maize planting.

Table 2. Effect of time of undersowing lablab in maize on maize, lablab and total forage yields ($t\ ha^{-1}$).

[1]Time of undersowing	Maize forage ($t\ ha^{-1}$)	Lablab forage ($t\ ha^{-1}$)	Total forage ($t\ ha^{-1}$)	Maize forage ($t\ ha^{-1}$)	Lablab forage ($t\ ha^{-1}$)	Total forage ($t\ ha^{-1}$)
	Early Season			Late Season		
Sole maize	2.22(39)†	-	2.22	0.75(40)	-	0.75
Sole lablab	-	4.37(60)	4.37	-	3.13(69)	3.13
Simultaneous	0.95(38)	2.85(66)	3.80	0.45(38)	1.92(71)	2.36
2 WAP	1.33(37)	1.91(62)	3.23	0.46(42)	1.30(69)	1.76
4 WAP	1.30(38)	1.33(67)	2.63	0.53(39)	0.77(69)	1.29
6 WAP	1.48(40)	0.54(65)	2.01	0.47(40)	0.39(73)	0.86
8 WAP	1.40(40)	0.19(69)	1.59	0.5(41)	0.19(73)	0.76
SE ±	0.162	0.283	0.305	0.094	0.086	0.160

†Figures in parentheses represent percentage digestibility of maize and lablab forage, respectively. WAP = Weeks after maize planting.





Thus, delayed undersowing gave maize a better establishment ahead of the later introduced lablab thereby suppressing the growth of the later introduced lablab lower down the canopy. The low yield of maize fodder as compared to that of the aggressively grown lablab component could be linked to the observation of Bidinger *et al.*, (1996). They noted that if a component crop in association with other crops absorb or intercepts less than its share of a factor of production, it is likely to acquire a correspondingly small share of all other factors of production. This will eventually affect DM accumulation and subsequently poor yield.

Total intercrop (maize and lablab) fodder yield maintained the same trend as lablab yield in all seasons with the highest intercrop total fodder yield obtained in the simultaneous planting and decreased steadily as lablab yield decreased with delayed undersowing in all the seasons. Maize and lablab fodder yields were negatively (r^2 = 0.181) and positively (r^2 = 0.944) correlated with total fodder yield (Fig. 2), indicating that lablab was the principal contributor to total fodder production from the intercrops. Powell and Unger (1997) noted that high amount of fodder could be obtained with improved crop management in which case sufficient amount of fodder could be removed for livestock feeding without adversely affecting the soil organic matter (SOM) and nutrient levels. Maize forage digestibility ranged between 38 and 42.% while that of lablab ranged between 60 and 75%. Generally, lablab showed higher digestibility rate than maize forage, indicating that inclusion of lablab fodder in the traditional maize stover could accelerate the rate of digestibility in the rumen of small ruminants.

Weed yield: Results obtained at harvest indicated lowest weed yield of 0.21 and 0.13 t ha^{-1} in the sole plot of lablab in the early and late seasons, respectively, followed by simultaneous planting (Fig. 3). Generally, early undersowing of lablab in maize (not later than 4 WAP) significantly ($P<0.05$) reduced weed yield at harvest than in treatments in which lablab undersowing was delayed beyond 4 WAP. This agrees with the finding of Sistachs et al., (1992). Yield steadily increased with delayed undersowing with 6 WAP and 8 WAP having the highest weed yield at harvest. The weed control effect of sole maize (1.5 and 0.7 t ha^{-1}) was not as effective as that of sole lablab. Delayed lablab undersowing up to 8 WAP significantly increased weed yields by 204 and 221%, in the early and late seasons, respectively, relative to simultaneous intercrop yields. The effective weed control associated with early undersowing of lablab could be attributed to the smothering effect of lablab forage cover in the plots with early establishment of lablab. Since the sole maize crop could not effectively control weeds as compared to the sole lablab, it could then be argued that the reduced weed yields in early intercropped treatments was mainly a result of effective ground cover, and smothering effects produced by the lablab component.

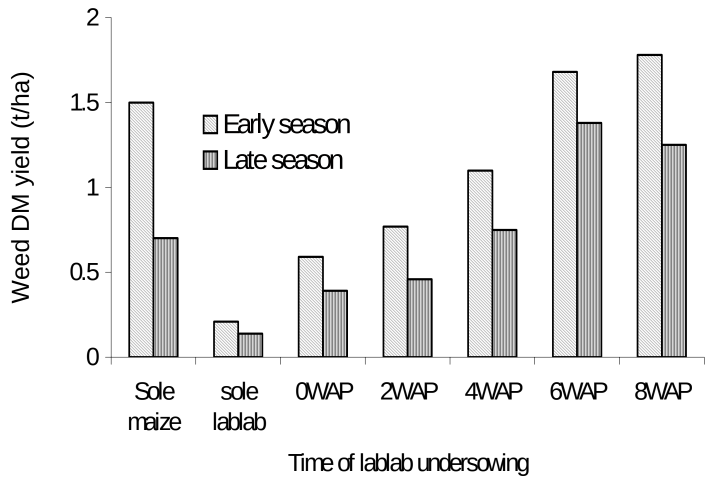


Fig. 3. Effect of time of lablab undersowing in maize on weed DM yield

Conclusion: The study shows that undersowing of lablab into maize between 2 and 4 weeks after maize planting gives appreciable yield of high quality fodder and optimum grain yield. In addition this practice mitigates declining soil fertility, low grain yield, poor fodder quality and weed competition with crops

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