Table 2: Effect of Plant Biomass Ashes on Soil pH

Type of plant biomass ash	Quantum of Ash applied			
	No Ash	0.05% Ash	0.1% Ash	0.15% Ash
	Soil pH			
TSA	5.08	5.67	6.15	6.70
CSA	5.08	6.02	7.09	7.72
MWA	5.08	5.82	6.82	7.50

Quality of tobacco leaf interms of nicotine and reducing sugars not statistically affected by source of potassium. It is therefore clear that PBAs can be used as potassium sources as alternative to expensive SOP fertilizer for obtaining same or more yield without affecting the leaf quality (Fig. 4 & 5).

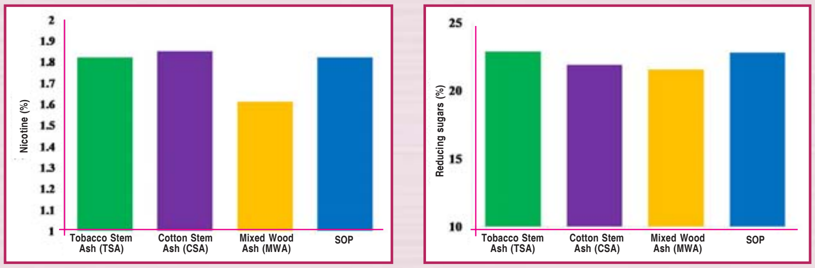

Fig.4 & 5: Effect of plant biomass ashes on nicotine and reducing sugars of FCV tobacco

Ready Reckoner for Potassium Supply through Plant Biomass Ashes

The results clearly suggest that PBAs can be used as alternate source of K in light textured soils. Actual quantity of the ash to be applied depends on K content in the ash and ready reckoner can be worked out as :

$$\text{Plant Biomass Ash (PBA) required (kg ha}^{-1}\text{)} = \frac{\text{K recommendation (kg ha}^{-1}\text{) x 100}}{\text{K Content of PBA (\%)}}$$

Percent K	Amount of Ash (kg ha^{-1}) to be applied to supplement 100 kg K ha^{-1}	Percent K	Amount of Ash (kg ha^{-1}) to be applied to supplement 100 kg K ha^{-1}
3	3333	18	556
6	1667	21	476
9	1111	24	417
12	833	27	370
15	667	30	333

Advantages of Plant Biomass Ashes (PBAs)

- PBAS are Inexpensive alternate K sources for FCV tobacco
- PBAs supply substantial quantity of Ca, Mg, micronutrients and organic carbon.
- Owing to alkaline nature, the PBAs act as liming agents and improve P availability in acid soils.
- PBAs can improve the potassium use efficiency of FCV tobacco

Published by

Dr. D. Damodar Reddy
Director
ICAR-Central Tobacco Research Institute
Rajahmundry - 533 105
directorctri@gmail.com; ddreddy132@gmail.com, ctri.icar.gov.in,
0883-2449871, FAX 0091-0883-2410555

Technical Assistance by
Md. Elias

ICAR-CTRI/2021

PLANT BIOMASS ASHES AS ALTERNATE SOURCES OF POTASSIUM FOR FCV TOBACCO ON LIGHT TEXTURED SOILS

D. Damodar Reddy, J. Poorna Bindu, C. Chandrasekhara Rao, L.K. Prasad and S. Kasturi Krishna

ICAR - CENTRAL TOBACCO RESEARCH INSTITUTE
(An ISO 9001: 2015 Certified Institute)
RAJAHMUNDRY - 533 105, ANDHRA PRADESH, INDIA

FCV Tobacco and Light Textured Soils

Tobacco (*Nicotiana tobaccum L.*) is an important high value commercial crop in India. It is grown in an area of 4.5 lakh ha with annual production of 804 million kg cured leaf. Among the different tobacco types cultivated in the country, the FCV (Flue-cured Virginia) tobacco (used mainly in cigarette making) accounts for 29% of the total production. The FCV type of tobacco is cultivated mainly in Andhra Pradesh and Karnataka. At present, the best quality FCV tobacco is preferentially grown on light textured soils. The FCV tobacco production in the Northern Light Soils (NLS) region of Andhra Pradesh is under irrigated conditions. Irrigated Alfisols in NLS region are low in clay content, organic carbon & CEC and known for their poor potassium (K) fertility and high external K requirement. The K deficiency is an important limiting factor for quality tobacco production on light textured soils.

Potassium Importance in FCV Tobacco

Potassium is a key essential plant nutrient and performs a wide range of vital roles in plant systems including, among others, enzyme activation, photosynthesis, respiration, stomatal control etc. It plays a critical role in enhancing plant tolerance to abiotic and biotic stresses and improving the quality of produce in crops like tobacco. Concentration of K in leaf tissue is the key factor that enhances tobacco quality in terms of improved leaf size, specific leaf weight, leaf colour, pliability and combustibility. Generally, K is absorbed by the FCV tobacco in larger quantity than any other nutrient. On an average, a tobacco crop yielding 2000 kg ha^{-1} takes up 100-120 kg K ha^{-1}. Alfisols supporting FCV tobacco under NLS region have low native K fertility and require liberal input of K. In FCV tobacco production, sulphate of potash (SOP) is preferred over muriate of potash (MOP) due to chloride injury and low combustibility associated with the latter. Prohibitive cost of SOP (about 3 times the cost of MOP) calls for low cost alternate sources and for improving K recycling in production systems.

Plant Biomass Ashes as Alternate Potassium Sources

Huge quantity of plant residues from agriculture crops *viz.*, cotton, tobacco, redgram, maize and sunflower are available annually and majority of them have not been utilized fully. Important among them include tobacco stalks and cotton stalks that are available substantial quantities but not beneficially used. In India, these plant residues have traditionally been discarded as solid waste and disposed-off by open burning in heaps. The ashes resulting from open burning of plant residues are rich in plant nutrients particularly K. Combustion of wood as fuel used in flue curing of tobacco also results substantial quantities of biomass ashes. Plant biomass ashes (PBAs) resulting from either burning of crop residues or combustion of wood for bio-energy represent an excellent source of plant nutrients especially K, Ca, Mg and micro nutrients. Amending soils with plant ashes can be an effective strategy to substitute/supplement K in tobacco production and reduce the dependency on costly SOP fertilizer. Details of selected PBAs (Tobacco stem ash - TSA, Cotton stem ash - CSA and Mixed wood ash - MWA) and their utility as alternate K sources are presented in this technology folder.

Nutrient Composition and Other Properties of Plant Biomass Ashes

PBAs contained K, Ca and Mg in high concentration. The K content of crop residue ashes was relatively greater than that of wood ashes. In contrast, the Ca content was greater in wood ashes than in crop residue ashes (Table 1). Hence, the biomass ashes rich in K, Ca and Mg can be potential sources of these nutrients for crops grown on light textured soils. All the biomass ashes were highly alkaline in reaction as indicated by the pH values in excess of 11 (Table 1). These PBAs when applied to soils even at small quantities can serve as potential liming agents improving the soil pH and P fertility in acidic Alfisols. The CCE, an index of lime potential, varied from 27.5% in tobacco stem ash to 58.5% in mixed wood ash. The biomass ashes of cotton and mixed wood with CCE of > 50% can act as potential liming material and influence the pH dependent changes in nutrient availability, particularly of phosphorus. The organic carbon content in PBAs (7.21 – 15.45%) can contribute to improving physical and biological health of the light textured soils (Table 1).

Table 1: Plant Biomass Ashes - Properties

Plant ash	Nutrient composition (%)			Properties		
	K	Ca	Mg	pH	CCE (%)	TOC (%)
TSA	16.0	7.82	2.33	11.16	27.5	7.62
CSA	20.6	10.22	3.42	11.34	57.5	15.45
MWA	3.5	14.35	2.97	11.23	58.5	7.21

CCE: Calcium carbonate equivalence

Plant Biomass Ashes Effect on FCV tobacco Productivity and Quality

Crop residue/wood ashes *viz.*, tobacco stem ash, cotton stem ash and mixed wood ash were evaluated as potassium sources for FCV tobacco grown in light textured Northern Light Soils of Andhra Pradesh under irrigated conditions at CTRI Research Station, Jeelugumilli. Effectiveness of PBAs vis-à-vis fertilizer SOP was assessed by applying them on K equivalent basis at the rate of 100 kg ha^{-1}.

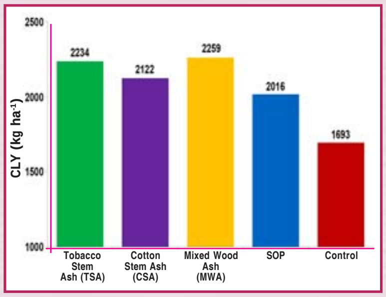

Fig.1: Effect of plant biomass ashes on cured leaf yield of FCV tobacco

Application of K through either PBAs or SOP has increased productivity of FCV tobacco (Fig.1). PBAs *viz.*, TSA, CSA and MWA proved effective than SOP in increasing the FCV tobacco yield as is evident from agronomic efficiency of added potassium. The agronomic efficiency of K added through biomass ashes was ranged from 4.29 to 5.66 kg.kg^{-1} against 3.23 kg.kg^{-1} for SOP (Fig.2). Relative agronomic efficiency of potassium sources has further revealed that PBAs were 105 to 112% as effective as SOP (Fig.3). Relatively greater effectiveness of PBAs as potassium sources *vis-a-vis* SOP could be attributed to the fact (i) Indirect benefits *viz.*, addition of organic carbon and other plant nutrients particularly P, Ca, Mg and Micronutrients (ii) Liming effect in acid soils (Table 2).

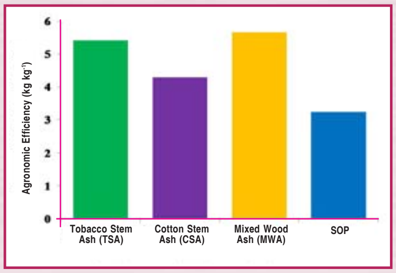

Fig.2: Effect of plant biomass ashes on agronomic efficiency of FCV tobacco

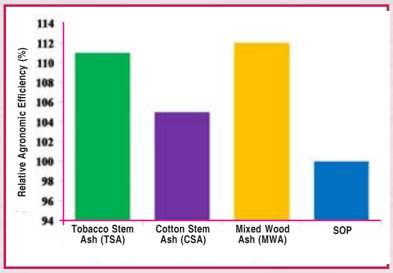

Fig.3: Effect of plant biomass ashes on relative agronomic efficiency of FCV tobacco