

Original Research Article

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Economic Evaluation of Finger Millet under different Nutrient Management Practices

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ABSTRACT

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Finger millet was grown under three year old *Melia azedarach* in red sandy loam soil with different management options viz., application of FYM @ 10 t ha⁻¹, 100% RDF (40:20:20 NPK kg ha⁻¹) alone, and in conjunction with 75% RD N with 25% N through FYM, Vermicompost, Poultry manure; also with biofertilizers @ 5 kg ha⁻¹ *Azospirillum* and PSB along with finger millet alone as sole cropping with 100% RDF. The highest grain (2681 kg ha⁻¹) and straw yield (5063 kg ha⁻¹) resulted with sole crop on par with 75% RD N + 25% N poultry manure (2405 and 4733 kg ha⁻¹) and 100% RDF (2393 and 4745 kg ha⁻¹). The lowest grain (1583 kg ha⁻¹) and straw yield (3402 kg ha⁻¹) was found with control FYM @ 10 t ha⁻¹ i.e., farmers practice. Gross monetary returns (₹ 42,747 ha⁻¹), net monetary returns (₹ 26,987 ha⁻¹) and B:C ratio (2.71) were highest with sole crop followed by 100% RDF and 75% RD N + 25% N poultry manure compared to other treatment combinations. Among nutrient management practices tested, 75% RD N + 25% N poultry manure and 100% RDF in agri-silvi culture system was better for realizing higher grain yield, straw yield and economic returns apart from sustaining better soil nutrient status on sandy loam soils of Southern Telangana region of Andhra Pradesh.

Introduction

Finger millet (*Eleusine coracana* L.) is an important small millet crop grown in India and has the pride of place in having highest productivity among millets. It is also known as ragi, African millet and bird's foot millet and an important staple food crop in part of eastern and central Africa and India. Grain is

higher in protein, fat and minerals than rice, corn or sorghum. When consumed as food it provides a sustaining diet, especially for people doing hard work. Straw makes valuable fodder for both working and milking animals. Grain may also be malted and a flour of the malted grain used as cakes

or porridge and a nourishing food for infants and invalids. Finger millet is considered an especially wholesome food for diabetics.

In India, finger millet is cultivated in an area of 1.14m ha with a production of 1.69 m tand an average productivity of 1483 kg ha⁻¹. In Andhra Pradesh, it covers an area of 0.42 lakh ha with a production of 0.50 lakh t at an average productivity of 1179 kg ha⁻¹ (Department of Agriculture and Cooperation, 2014).

Modern management practices rely on chemical fertilizers and pesticides that have led to decline in soil organic matter, increased soil erosion and pollution of surface and ground water (Singh, 2000 and Relyea, 2005). The low productivity and risk are the other problem in the arable cropping system. High production cost and reliance on loans to purchase inputs are the major risks especially in rainfed areas where yields are uncertain (Eyhorn *et al.*, 2007).

Agroforestry is an appropriate and efficient land use system in dry lands, for site improvement and also for optimization of productivity of agricultural crops as well as forest crops. Cultivation of finger millet (*Eleusine coracana* L.) as one of the multipurpose intercrops in the alleys of young plants of *Melia* is desirable to maximize the dry lands and space use efficiency to generate supplemental income during the initial juvenile phase of *Melia* silviculture system. In view of diversity of the problems in rainfed areas, an integrated approach of land management to utilize the natural resources more efficiently in dryland agriculture is essential to meet the requirements of farming community and their deteriorating livestock, both to enhance the land productivity and also to generate continuous and stable income. In order to achieve an intensive production of grain and good quality of finger millet in low fertile

red sandy loam soils, it is necessary to follow simultaneously all management practices through integrated nutrient management to sustain the productivity and to improve the soil fertility. So, under these circumstances it is imperative to study the various nutrient sources like organic manures, biofertilizers along with chemical fertilizer to better understand the resource use efficiencies particularly of economic efficiency.

Materials and Methods

Experimental site

Field experiment was conducted with finger millet variety (PRS-2) at agroforestry research block, Acharya N.G Ranga Agricultural University campus, Rajendranagar, Hyderabad during *kharif*, 2013. The weekly mean maximum temperature during the crop growth period ranged from 27.8 to 33.5°C with an average of 30.5°C, while the weekly mean minimum temperature ranged from 17.7°C to 25.0°C with an average of 21.6°C. The total rainfall received during the crop growth period was 437.1 mm distributed in 30 rainy days. The experimental soil was Alfisol with sandy loam texture with pH (7.57), EC (0.195 dSm⁻¹) and OC (0.75 %). The soil was medium in available nitrogen (259.2 kg ha⁻¹), phosphorus (40.85 kg ha⁻¹) and high in available potassium (352.1 kg ha⁻¹). The experiment was laid out in a Randomized Block Design and replicated thrice with 9 treatments comprised of T₁ FYM 10 t ha⁻¹, T₂ 100% RDF (40:20:20 - N: P₂O₅: K₂O kg ha⁻¹), T₃ 75% RD N + 25% N through FYM, T₄ 75% RD N + 25% N Vermicompost, T₅ 75% RD N + 25% N Poultry manure, T₆ 75% RD N + *Azospirillum* @ 5 kg ha⁻¹, T₇ 75% RD N + PSB @ 5 kg ha⁻¹, T₈ 75% RD N + *Azospirillum* + PSB @ 5 kg ha⁻¹ and T₉ Sole crop without trees. The other package

of practices used recommended for raising the crop.

Biometric and yield observations

Five plants in each plot were selected at random and tagged. These plants were used for recording biometric observation at different stages of crop growth. The harvested produce from each net plot was threshed, sun dried, winnowed separately and the finger millet grain yield was recorded at 14% moisture content and expressed in kg ha⁻¹ (Watson, 1947). Plant height was measured with a wooden scale from the base of the plant to the tip of growing point at harvest. The observations were taken from the ten earmarked plants and mean value was expressed in cm.

Leaf area index (LAI)

Leaf area was estimated on two plants in each plot at 30, 45, 60, 75 DAS and at harvest stages. The area of total leaves was measured with digital leaf area meter (LI-3100) and expressed in cm. Leaf area index was calculated by using the formula as proposed by Watson (1952).

$$\text{LAI} = \frac{\text{Leaf area}}{\text{Unit ground area}}$$

Economics

The cost of cultivation for each treatment was worked out. Similarly, gross returns were calculated based on current market price of the produce. The net returns were obtained after deducting the cost of cultivation from gross returns. Later, the benefit-cost ratio was worked out by using the formula:

$$\text{B:C} = \frac{\text{Gross returns}}{\text{Cost of cultivation}}$$

Statistical Analysis

The data on various characters studied during the course of investigation were statistically analysed for randomized block design. Wherever treatment differences were significant ("F" test), critical differences were worked out at five per cent probability level. Treatment differences that were not significant were denoted as "NS".

Results and Discussion

Plant height

Plant height of finger millet at harvest ranged from 78.6-94.8 cm with a mean 88.7 cm. Different treatments significantly influenced over control i.e. FYM @ 10 t ha⁻¹. The data on plant height revealed that, the plant height increased progressively with different sources of N. However, among the nitrogen sources sole crop without trees has produced the taller plants (94.8 cm) on par with 100% RDF (91.3 cm) and 75% RD N + 25% N poultry manure (91.1 cm) followed by 75% RD N + 25% N vermicompost (90.4 cm).

Among biofertilizers, on par height was obtained over control with shorter plants (78.6 cm) at harvest. The increased availability of nutrients in the soil through mineralization of organic sources could have triggered cell elongation and multiplication resulting in high growth rate of shoots in turn plant height of finger millet over control. Combination of organics and inorganics which ensured ready availability of nutrients at initial stages of crop is due to improved soil properties and long term nutrient availability through organics. Similar results were obtained by Sunitha *et al.*, (2004), Narolia *et al.*, (2009) and Giribabu *et al.*, (2010).

Leaf area index (LAI)

The mean LAI at harvest was 2.82. The LAI was significantly influenced by different treatments over control. Among different nitrogen sources at harvest in agri-silvi culture system, sole crop had shown higher LAI (3.43) at harvest followed by 75% RD N + 25% N vermicompost (3.12), 75% RD N + 25% N poultry manure (3.09), 75% RD N + *Azospirillum* + PSB (2.91) and 100% RDF (2.90). Highest LAI might be due to more light interception and enhanced photosynthetic rate (NAR), which ultimately resulted in higher dry matter production, straw yield, test weight, grain weight earhead⁻¹ and grain yield. These are in conformity with the findings of Patil *et al.* (2003) in sweet sorghum. He also observed relationship with leaf area and distribution of sugars and starch into stem and grain in sweet sorghum cultivars as LAI play crucial role in enhancing the photosynthetic assimilation.

Grain and Straw yield

Grain and straw yield significantly affected by the judicious use of inorganic fertilizer with organic manures, Poultry manure, Vermicompost, FYM and biofertilizers i.e., *Azospirillum* and PSB (Table1). The highest grain yield (2681 kg ha⁻¹) was recorded with sole crop on par with 75% RD N (2405 kg ha⁻¹) + 25% N through poultry manure (2394 kg ha⁻¹) and 100% RDF significantly superior over 75% RD N + 25% N through vermicompost and 75% RD N + *Azospirillum* + PSB. The percentage increase in grain yield with sole crop, 75% RD N + 25% N poultry manure and 100% RDF over control was 65.39%, 48.37% and 47.69% respectively. Among the nutrient biofertilizers combination treatments also performed better than control where only FYM @ 10 t ha⁻¹ was applied. Among them 75% RD N + *Azospirillum* + PSB (2126 kg ha⁻¹) was significantly superior to control

(1621 kg ha⁻¹). In terms of percentage, the increase of 34.30, 24.89 and 23.44% with 75% RD N + *Azospirillum* + PSB, 75% RD N + *Azospirillum* and 75% RD N + PSB respectively (Figure 1 and 2).

Finger millet as sole crop (5063 kg ha⁻¹) resulted on par yields with 100% RDF (4745 kg ha⁻¹) and 75% RD N + 25% N through poultry manure (4733 kg ha⁻¹) significantly superior over 75% RD N + 25% N through vermicompost (4377 kg ha⁻¹) and 75% RD N + *Azospirillum* + PSB (4241 kg ha⁻¹). The percentage increase in grain yield with sole crop, 75% RD N + 25% N through poultry manure and 100% RDF over control was 48.82%, 39.12% and 39.12% respectively.

The conjunctive use of organic and inorganic sources has beneficial effect on physiological process of plant metabolism and growth, there by leading to higher grain yield. The easy availability of nitrogen due to mineralization of organics there by influence the shoot and root growth favouring absorption of other nutrients. Similar results were obtained by Varalakshmi *et al.*, (2005), Yakadri and Reddy (2009), Umesh *et al.*, (2006), Basavaraju and Purushotham (2009). Reduced yield in finger millet compared to sole crop may be ascribed due to competition for light, moisture and nutrients with suppressing effect on crops, reduced solar radiation on crop canopy. Similar results were reported by Deswal and Nandal (2008), Prasad *et al.*, (2011) and Kumar *et al.*, (2013).

Economics

The conjoint use of organic and inorganic sources of nitrogen progressively increased the net returns and B:C ratio of finger millet crop. The gross returns, net returns and B:C ratio ranged ₹ 42,747 to ₹ 25,446 ha⁻¹, ₹ 26,987 to ₹ 5,846 ha⁻¹ and 2.71 to 1.30 respectively (Table 2).

Table.1 Plant height, LAI and yield of finger millet as influenced by nutrient management in *Melia azedarach* based agri-silvi system

Treatments	Plant height(cm)	LAI	Grain yield (kg ha ⁻¹)	Straw yield (kg ha ⁻¹)
T ₁ FYM @ 10 t ha ⁻¹	78.6	1.82	1583	3402
T ₂ 100% RDF	91.3	2.90	2393	4745
T ₃ 75%N + 25% N FYM	84.0	2.57	1828	3745
T ₄ 75% RD N + 25% N Vermicompost	90.4	3.12	2216	4377
T ₅ 75% RD N + 25% N Poultry manure	91.1	3.09	2405	4733
T ₆ 75% RD N + <i>Azospirillum</i>	89.7	2.81	1977	4014
T ₇ 75% RD N + PSB	87.6	2.73	1954	4006
T ₈ 75% RD N + <i>Azospirillum</i> + PSB	90.8	2.91	2126	4241
T ₉ Sole crop without trees	94.8	3.43	2681	5063
Mean	88.7	2.82	2129	4258
S.Em ±	1.24	0.12	102	205
CD (P=0.05)	3.74	0.36	310	619

Table.2 Yield and economics of finger millet as influenced by nutrient management in *Melia azedarach* based agri-silvi system

Treatments	Cost of cultivation (₹ ha ⁻¹)	Gross return (₹ ha ⁻¹)	Net return (₹ ha ⁻¹)	B:C ratio
T ₁ FYM @ 10 t ha ⁻¹	19600	25446	5846	1.30
T ₂ 100% RDF	14359	36268	21909	2.53
T ₃ 75%N + 25% N FYM	16531	29293	12762	1.77
T ₄ 75% RD N + 25% N Vermicompost	17421	35427	18006	2.03
T ₅ 75% RD N + 25% N Poultry manure	17121	38442	21321	2.25
T ₆ 75% RD N + <i>Azospirillum</i>	14621	31662	17041	2.17
T ₇ 75% RD N + PSB	14621	31313	16692	2.14
T ₈ 75% RD N + <i>Azospirillum</i> + PSB	15021	34011	18990	2.26
T ₉ Sole crop without trees	15760	42747	26987	2.71

*Price of finger millet: ₹ 15 kg⁻¹ grain

*Gross returns were calculated by multiplying grain yield with price of finger millet

Fig.1 Grain yield of finger millet as influenced by nutrient management in *Melia azedarach* based agri-silvi system

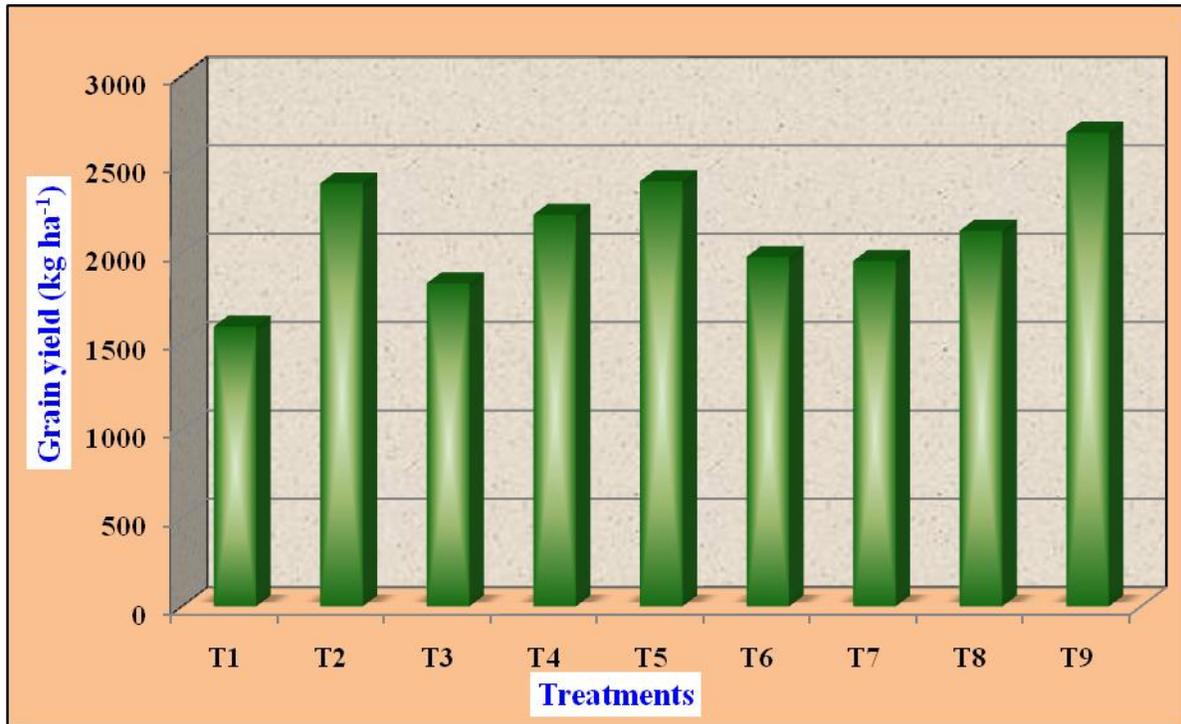


Fig.2 Straw yield of finger millet as influenced by nutrient management in *Melia azedarach* based agri-silvi system

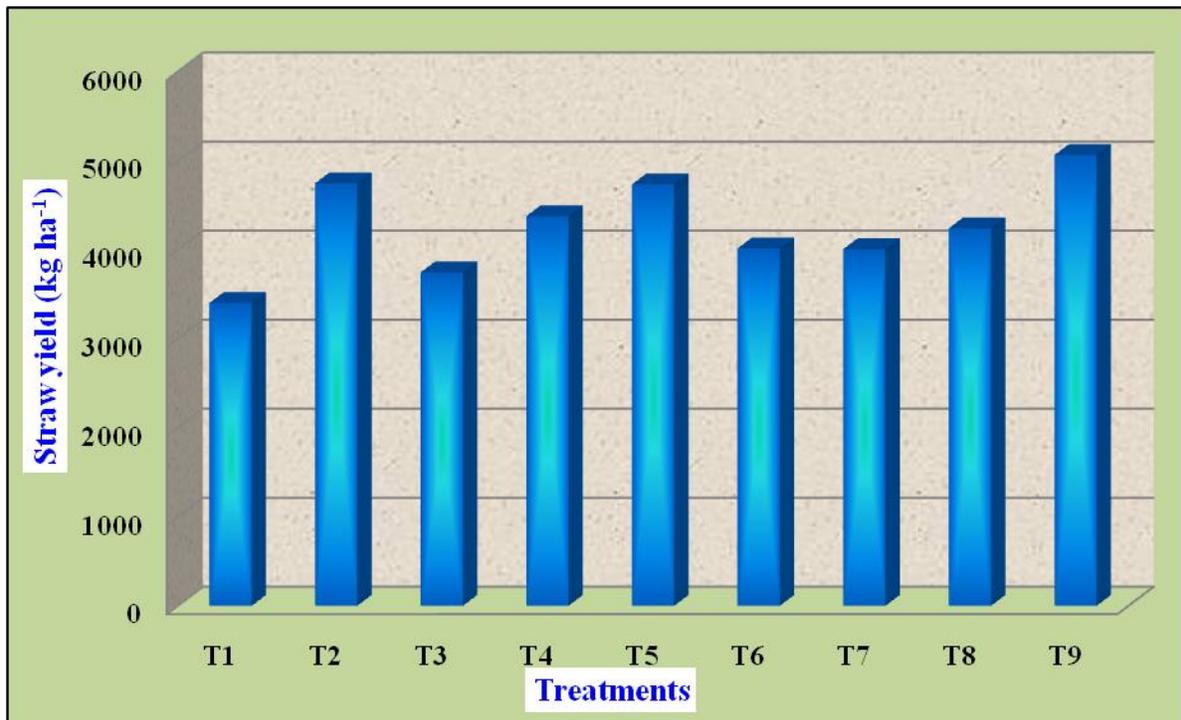
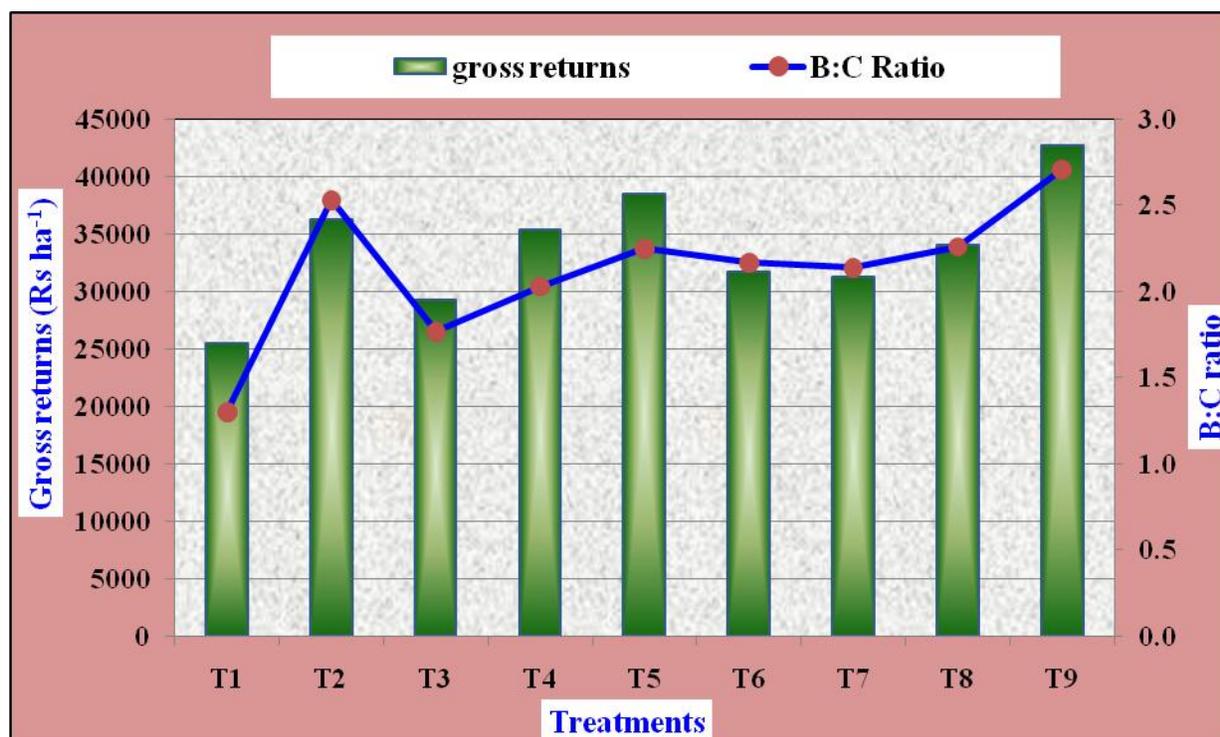


Fig.3 Gross returns and B:C of finger millet as influenced by nutrient management in *Melia azedarach* based agri-silvi system



The highest gross returns (₹ 42,747 ha⁻¹) was recorded with sole crop followed by 75% RD N + 25% N poultry manure (₹ 38,442) > 100% RDF (₹ 36,268) > 75% RD N + 25% N vermicompost (₹ 35,427) > 75% RD N + *Azospirillum* + PSB (₹ 34,011) > 75% RD N + *Azospirillum* > 75% RD N + PSB > 75% RD N + 25% N FYM. The highest net returns (₹ 26,987 ha⁻¹) was recorded with sole crop followed by 100% RDF (₹ 21,909 ha⁻¹) 75% RD N + 25% N poultry manure (₹ 21,321 ha⁻¹) > 75% RD N + *Azospirillum* + PSB (₹ 18,990 ha⁻¹) > 75% RD N + 25% N vermicompost > 75% RD N + *Azospirillum* > 75% RD N + PSB > 75% RD N + 25% N FYM (Figure 3). The highest B:C ratio (2.71) was recorded with sole crop followed by 100% RDF (2.53), 75% RD N + *Azospirillum* + PSB (2.26), 75% RD N + 25% N poultry manure (2.25) > 75% RD N + 25% N vermicompost > 75% RD N + *Azospirillum* > 75% RD N + PSB > 75% RD

N + 25% N FYM. The control treatment registered the lowest gross returns (₹ 25,446 ha⁻¹), net returns (₹ 5,846 ha⁻¹) and B:C ratio (1.30).

Higher level of biomass accumulation and efficient translocation to the reproductive parts due to supply of adequate nutrients might be responsible for the production of elevated yield attributes, which resulted in higher monetary returns and B:C ratio. The lower income obtained in agri-silvi system compared to sole cropping system could be compensated by income from *Melia* trees at maturity in terms of fuel, timber, fodder and other ecological services, besides soil enrichment. Similar results were also reported by Prabhu *et al.*, (2002), Rajesh (2012) and Kumar *et al.*, (2013).

In conclusion, from the study, it was inferred that integrated use of 75% RD N +

25% N through poultry manure and 100% RDF is the best nutrient management practice that can be adopted for agri-silvi system on par with sole crop, which was significantly superior over 75% RD N + 25% N through FYM, 75% RD N + 25% N through Vermicompost, 75% RD N + *Azospirillum* @ 5 kg ha⁻¹, 75% RD N + PSB, 75% RD N + *Azospirillum* + PSB and control in red sandy loam soils to obtain better yields with high benefit cost ratio.

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