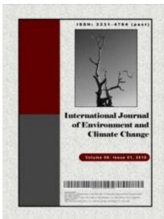

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Response of Cotton and Soybean Intercropping System to Integrated Nutrient Management

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Authors' contributions

This work was carried out in collaboration between all authors. Author AMP designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors VVA and JAH managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Field experiment was conducted to study the integrated nutrient management on yield, all yield components and resource use efficiency of cotton and soybean intercropping system.
Study Design: Randomized complete block design with three replications and twenty treatments.
Place and Duration of Study: Plot number '101' of 'D' block, All India Coordinated Research Project, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka (India) during June 2016.
Methodology: As per the treatments, organic manure (FYM) and green leaf manures (gliricidia and pongamia) were applied 15 days before sowing of the crop. Vermicompost was applied on the spot to soil before dibbling of seeds in cotton and soybean intercropping system in 1:2 row proportions, soybean introduced as intercrop in cotton with row spacing of cotton 120 cm and soybean 30 cm.
Results: Results revealed that all the yield components like number of bolls per plant, boll weight, seed cotton yield and cotton stalk yield in cotton and number of pods per plant, seed weight per plant, seed yield and haulm yield were higher under sole crop. Application of 150 and 125% RDF for cotton and soybean intercropping system found higher yield and yield components of cotton and soybean. However, the land equivalent ratio (LER), area time equivalent ratio (ATER) and cotton equivalent yield (CEY) were higher in intercropping system than sole crops.
Conclusion: Application of 125% RDF for both crops was found to be agronomically feasible, economically viable, environment friendly and in sustainable approach. In addition to this it provides insurance against inter-climatic changes.

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Keywords: Yield; LER; ATER; cotton equivalent yield; RDF; INM.

1. INTRODUCTION

Cotton popularly known as 'white gold', is one of the most important commercial crops in the world. India stands first among all the cotton growing countries of the world with an area of 13.08 m ha, which accounts to one fourth of the world cotton area; and production of 35.48 m bales of seed cotton. In recent years, trends in agricultural production systems have changed towards achieving high productivity and promote sustainability over time. Cotton being long durated, wide spaced, slow growing at early stage offers a great scope for intercropping short duration, fast growing, non-competitive intercrops with dissimilar growth habit. Such system can utilize the available resources very efficiently and effectively. Intercropping enables crop diversification with agro eco-region and ensures better returns to growers.

Short duration and short stature legume like soybean, has greater ability to fix atmospheric nitrogen. It occupies prime position in intercropping system. Growing short duration intercrops like soybean in cotton helps to safe guard the economy of the farmer through extra yields of intercrop and protects from adverse climatic risk and improves soil fertility through biological nitrogen fixation [1]. Intercropping provides insurance against crop failure or against unstable market prices for a given commodity, especially in areas subject to extreme weather conditions such as frost, drought, and flood. Thus, it offers greater financial stability than sole cropping, which makes the system particularly suitable for labor-intensive small farms. Besides, intercropping allows lower inputs through reduced fertilizer and pesticide requirements, thus minimizing environmental impacts of agriculture [2]. Use of organic manures along with inorganic fertilizers helps to rejuvenate the degraded soils and ensures sustainability in crop production. Agronomic management practices like intercropping and judicious combination of organic and inorganic manures are considered ecologically viable, economically feasible and avoid environmental pollution [3] and [4]. Soil can act as a major sink of carbon and can play an important role in reducing level of greenhouse gases (GHGs) in the atmosphere through carbon (C) sequestration. Mitigation of CO2 emission from agriculture can be achieved by increasing C sequestration in soil, which implies storage of C as soil organic matter [5]. Soil management practices such as tillage, fertilizer, irrigation; crop residue management, etc. modify soil C stocks to varying degrees. Reducing the intensity and frequency of ploughing and leaving green manures on the soil surface as mulch and incorporation of manures are important to built strategies for enhancing soil organic carbon (SOC) content. Judicious nutrient management is crucial to SOC sequestration in tropical soils [6] and [7]. Long-term manure application increases the SOC pool [8] and the effects may persist for a century [9]. Successful adaptation to climate change implies strong understanding of processes and properties of soils and the related natural resources, but also the response of the community. Engaging the natural resource management [10] is important to promoting adoption of recommended management practices (RMPs), strengthening science enhancing the awareness. Considering these facts the present investigation was undertaken.

2. MATERIALS AND METHODS

The field experiment was conducted at plot 101 'D' block, All India Co-ordinated Research Project on Soybean, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka (India) to study the INM practices on yield components and resource use efficiency of cotton and soybean intercropping system in 1:2 row proportion during *kharif* 2016. Soil of the experimental site was *vertisol,* having 0.51% organic carbon, 281 kg ha^{-1} available N, 34 kg ha^{-1} available P_2O_5 and 312 kg ha^{-1} available K_2O, 7.3 pH and 0.35 dsm^{-1} EC. The experiment was carried out in randomised complete block design with three replications and twenty treatments as given in the tables. Sowing was done by adopting 120 cm x 60 cm row spacing for cotton and soybean introduced as intercrop with 40 cm x 10 cm in 1:2 row proportions during *kharif* season on June 12th, 2016. Organic manure (FYM) and green leaf manures (gliricidia and pongamia) were applied 15 days before sowing of the crop according to the treatments. Vermicompost was spot applied to soil before dibbling of seeds. RDF was applied to both crops in intercropping system according to population (100:50:50 and 40:80:25 kg N, P_2O_5 and K_2O_5 ha^{-1} for Cotton and Soybean, respectively).

2.1 Observations on Cotton

2.1.1 Number of bolls per plant

The number of good opened bolls and bad opened bolls per plant were counted separately and added in the five tagged plants at harvest.

2.1.2 Boll weight

Ten fully opened bolls were picked randomly from each net plot and weighed. Mean weight per boll was calculated and recorded as boll weight in grams (g).

2.1.3 Seed cotton yield per hectare

On the basis of seed cotton yield recorded per net plot, the seed cotton yield per hectare was computed and expressed as seed cotton yield in kilogram per hectare (kg ha^{-1}).

2.1.4 Harvest index

Harvest index was calculated by using the formula given by [11] and expressed in percentage (%).

2.2 Observations on Soybean

2.2.1 Number of pods per plant

The pods of individual plants were counted and average of five plants was recorded as number of pods per plant.

2.2.2 Seed weight per plant

The pods from randomly selected five plants were harvested and threshed and weighed separately and the average seed yield per plant was expressed in grams (g).

2.2.3 Seed yield per hectare

Seed yield per plot was recorded after threshing and winnowing the seeds from each net plot area. Weight of the grains and moisture content of the grains at the time of weighing were recorded and the grain weight was adjusted to 9 per cent moisture using the following formula [12] and expressed in kilograms per hectare (kg ha^{-1}).

$$\text{Adjusted grain weight} = \frac{100 - M}{91} \times W$$

Where,

M- Moisture content (%) of the grain
W- Weight of the harvested grains.

2.2.4 Haulm yield per hectare

The total biological yield of above ground portion from net plot at harvest was recorded after complete sun drying and haulm yield per ha was worked out by deducting the seed yield and expressed in kilograms per hectare (kg ha^{-1}).

2.2.5 Harvest index

Harvest index was calculated as per the procedure outlined for the main crop.

2.3 Observations on System Productivity

2.3.1 Land equivalent ratio (LER)

It is defined as relative land area under sole crop that is required to produce yields achieved in intercropping system. LER is worked out by using following formula given by [1].

$$LER = La + Lb = Ya/Sa + Yb/Sb$$

Where,

La and Lb = LER of the crop a and b

Ya and Yb = Individual crop yields under respective intercropping

Sa and Sb = Individual crop yield under respective sole cropping

2.3.2 Area time equivalent ratio (ATER)

The limitation in the use of LER is the emphasis on the land without consideration of the duration for which the field is dedicated to production. To correct this deficiency, the LER was modified by [13] to include the duration of the crop on the land from sowing to harvest. Area time equivalent ratio (ATER) was calculated as under:

$$ATER = \frac{(RY_a \times t_a) + (RY_b \times t_b)}{T}$$

Where,

RY = Relative yield of species a or b

RY = Yield of intercrop ha^{-1} / Yield of sole crop ha^{-1}

t = Duration (days) for species a or b

T = Total duration (days) of the intercropping system

2.3.3 Cotton equivalent yield (CEY)

It was calculated by considering the prices of two crops with the following formula:

$$\text{CEY (kg ha}^{-1}\text{)} = \frac{[\text{SC yield (kg ha}^{-1}\text{)} \times \text{price of SC (Rs. kg}^{-1}\text{)}] + [\text{CS yield (kg ha}^{-1}\text{)} \times \text{price of CS (Rs. kg}^{-1}\text{)}] + [\text{SG yield (kg ha}^{-1}\text{)} \times \text{price of SG (Rs. kg}^{-1}\text{)}] + [\text{SB yield (kg ha}^{-1}\text{)} \times \text{price of SB (Rs. kg}^{-1}\text{)}]}{\text{Price of SC (Rs. ha}^{-1}\text{)}}$$

Where,

SC = Seed cotton
CS = Cotton stalk
SG = Soybean grain
SB = Soybean bhusa

2.4 Statistical Analysis

Statistical analysis was carried out based on mean values obtained. Analysis of variance is carried out and the level of significance used in ‘F’ and ‘T’ test was P= 0.05. The treatment means were compared by Duncan’s Multiple Range Test (DMRT) at 0.05 level of probability [14].

3. RESULTS AND DISCUSSION

3.1 Effect of INM on Cotton Yield and Yield Parameters

The data in Table 1 indicated significantly higher number of bolls per plant was observed in sole cotton than intercropped cotton at harvest. Among intercropping systems, the highest number of bolls per plant (69.1) was observed in T_3 (150% RDF for cotton and soybean). Significantly higher boll weight was observed in sole cotton than intercropped cotton (Table 1). Among intercropping systems, T_3 (150% RDF for cotton and soybean) recorded the highest boll weight (4.83 g boll^{-1}). Significantly higher seed cotton yield was observed in sole cotton than intercropped cotton. Among intercropping systems, T_3 (150% RDF for cotton and soybean) recorded the highest yield (2,025 kg ha^{-1}) and it was on par with T_2 (125% RDF for cotton and soybean) (2,003 kg ha^{-1}). Significantly higher cotton stalk yield was observed in sole cotton than intercropped cotton (Table 1). Among intercropping systems, T_3 (150% RDF for cotton and soybean) recorded higher cotton stalk yield (3,544 kg ha^{-1}) and it was on par with T_2 (125% RDF for cotton and soybean) (3,504 kg ha^{-1}) and T_{17} (T_1 + vermicompost 1.25 t ha^{-1}) (3,487 kg ha^{-1}). This indicated that fertilizer requirement was higher under high density planting in intercropping. The fact that excess application of fertilizers, particularly nitrogen results in increased vegetative growth, but does not help in promoting production of reproductive parts that contribute to yield. This might be the reason for lack of significant response beyond 125 per cent RDF (T_2). Similar results were observed by [15], who reported that for dynamic crops like cotton, excess nitrogen delays maturity, promotes vegetative tendencies and usually results in lower yields. The results are in agreement with the findings of [16], who reported that integration of organic and inorganic sources of nutrients improved the growth and yield parameters of cotton. Harvest index did not differ significantly due to INM treatments (Table 1). Soil carbon sequestration is enhanced through agricultural management practices (such as increased application of organic manures, use of intercrops and green manures, higher shares of perennial grasslands and trees or hedges, etc.), which promote greater soil organic matter (and thus soil organic carbon) content and improve soil structure [17,18] and [19]. Increasing soil organic carbon in agricultural systems has also been pointed out as an important mitigation option by [20].

3.2 Effect of INM on Soybean Yield and Yield Parameters

In the present investigation soybean introduced as intercrop in cotton. The data in Table 2 indicated significantly higher number of pods per plant was recorded in sole soybean than intercropped soybean. Among the intercropping systems, T_3 (150% RDF for cotton and soybean) recorded the highest number of pods per plant (48.4). Significantly higher seed weight per plant was recorded in sole soybean than intercropped soybean (Table 2). Among the intercropping systems, T_2 (125% RDF for cotton and soybean) recorded the highest seed weight per plant (19.4 g plant^{-1}). Significantly higher seed yield was recorded in sole soybean than intercropped soybean (Table 2).

Table 1. Effect of INM on number of bolls per plant, boll weight, seed cotton yield (SCY), cotton stalk yield (CSY) and harvest index (HI) of cotton at harvest in cotton + soybean intercropping system during 2016—17

Treatments	Number of bolls per plant	Boll weight (g boll^{-1})	SCY (kg ha^{-1})	CSY (kg ha^{-1})	HI (%)
T1: 100% RDF for cotton and soybean	64.3d	3.96i	1,878h	3,284h	36.4b
T2: 125% RDF for cotton and soybean	68.2b	4.81ab	2,003bc	3,504bc	36.3b
T3: 150% RDF for cotton and soybean	69.1b	4.83ab	2,025b	3,544b	36.3b
T4: 100% FYM and RDF for cotton and soybean (Recommended check-RC))	68.4b	4.52de	1,944d-g	3,441c-f	36.1b
T5: T1 + FYM 2.5 t ha^{-1}	68.1b	4.14hi	1,904gh	3,336gh	36.3b
T6: T1 + FYM 5 t ha^{-1}	68.2b	4.17gh	1,908f-h	3,338gh	36.3b
T7: T1+ Gliricidia 2.5 t ha^{-1}	67.6bc	4.36ef	1,934d-g	3,384e-g	36.3b
T8: T1+ Gliricidia 5 t ha^{-1}	67.7bc	4.46de	1,943d-g	3,406d-g	36.3b
T9: T1+ Pongamia 2.5 t ha^{-1}	66.2c	4.24gh	1,914e-h	3,345gh	36.3b
T10: T1+ Pongamia 5 t ha^{-1}	67.5bc	4.33fg	1,922e-g	3,363f-h	36.3b
T11: T1+ Vermicompost 1.25 t ha^{-1}	66.1c	4.27fg	1,909e-h	3,346gh	36.3b
T12: T1+ Vermicompost 2.5 t ha^{-1}	66.2c	4.29fg	1,916e-h	3,354gh	36.3b
T13: T1+ FYM 2.5 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	68.5b	4.66bc	1,950de	3,421c-g	36.3b
T14: T1+ FYM 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	68.5b	4.62cd	1,948d-f	3,411d-g	36.3b
T15: T1 + FYM 2.5 t ha^{-1} + Vermicompost 1.25 t ha^{-1}	68.3b	4.5 de	1,947d-f	3,404d-g	36.3b
T16: T1+ Gliricidia 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	68.7b	4.71bc	1,974cd	3,454c-e	36.3b
T17: T1+ Vermicompost 1.25 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	68.9b	4.80ab	1,993bc	3,487b-d	36.3b
T18: T1+ Vermicompost 1.25 t ha^{-1} + Pongamia 2.5 t ha^{-1}	68.9b	4.74bc	1,975cd	3,457c-e	36.3b
T19: Cotton sole crop (100% RDF and FYM)	72.8a	4.91a	2,728a	4,654a	36.9a
T20: Soybean sole crop (100% RDF and FYM)	**68.0**	**4.50**	**1,985a**	**3,470a**	**36.4**
Mean	**0.50**	**0.03**	**12.4**	**26.1**	**0.15**
S.Em±	**6.84**	**8.22**	**9.45**	**8.41**	**5.90**

Note: Means followed by the same letters do not differ significantly by DMRT at 5%

Table 2. Effect of INM on number of pods plant^{-1}, seed weight plant^{-1}, seed yield, haulm yield and harvest index of soybean at harvest in cotton + soybean intercropping system during 2016-17

Treatments	Number of pods plant^{-1}	Seed weight (g plant^{-1})	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	HI (%)
T1: 100% RDF for cotton and soybean	43.4d	17.2d	17.2d	3,034h	47.2a
T2: 125% RDF for cotton and soybean	48.2bc	19.4b	19.4b	3,266b	47.1a
T3: 150% RDF for cotton and soybean	48.4b	19.1bc	19.1bc	3,275b	47.2a
T4: 100% FYM and RDF for cotton and soybean (Recommended check-RC))	47.6bc	18.1cd	18.1cd	3,174de	47.2a
T5: T1 + FYM 2.5 t ha^{-1}	45.5b-d	18.2cd	18.2cd	3,093g	47.2a
T6: T1 + FYM 5 t ha^{-1}	45.3b-d	18.1cd	18.1cd	3,105fg	47.2a
T7: T1+ Gliricidia 2.5 t ha^{-1}	46.0b-d	18.2cd	18.2cd	3,252bc	46.4a
T8: T1+ Gliricidia 5 t ha^{-1}	46.1b-d	18.2cd	18.2cd	3,164ef	47.2a
T9: T1+ Pongamia 2.5 t ha^{-1}	45.2cd	18.2cd	18.2cd	3,137e-g	47.1a
T10: T1+ Pongamia 5 t ha^{-1}	46.4b-d	18.2cd	18.2cd	3,133e-g	47.3a
T11: T1+ Vermicompost 1.25 t ha^{-1}	45.6b-d	18.1cd	18.1cd	3,104fg	47.2a
T12: T1+ Vermicompost 2.5 t ha^{-1}	45.8b-d	18.1cd	18.1cd	3,137e-g	47.0a
T13: T1+ FYM 2.5 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	47.9bc	18.4b-d	18.4b-d	3,193c-e	47.2a
T14: T1+ FYM 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	47.9bc	18.3b-d	18.3b-d	3,193c-e	47.2a
T15: T1 + FYM 2.5 t ha^{-1} + Vermicompost 1.25 t ha^{-1}	47.2bc	18.2cd	18.2cd	3,193c-e	47.2a
T16: T1+ Gliricidia 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	47.6bc	18.4b-d	18.4b-d	3,227b-d	47.1a
T17: T1+ Vermicompost 1.25 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	48.3bc	18.6bc	18.6bc	3,250bc	47.2a
T18: T1+ Vermicompost 1.25 t ha^{-1} + Pongamia 2.5 t ha^{-1}	48.2bc	18.4b-d	18.4b-d	3,233b-d	47.2a
T19: Cotton sole crop (100% RDF and FYM)	53.6a	21.0a	21.0a	3,975a	46.9a
T20: Soybean sole crop (100% RDF and FYM)	**47.1**	**18.4**	**18.4**	**3,217a**	**47.1**
Mean	**0.91**	**0.36**	**0.36**	**18.8**	**0.17**
S.Em±	**6.40**	**5.12**	**5.12**	**9.75**	**5.34**

Note: Means followed by the same letters do not differ significantly by DMRT at 5%

Table 3. Effect of INM on land equivalent ratio (LER), area time equivalent ratio (ATER) and cotton equivalent yield (CEY) in cotton + soybean intercropping system during 2016-17

Treatments	LER	ATER	CEY (kg ha^{-1})
T1: 100% RDF for cotton and soybean	1.46h	1.14h	3,546j
T2: 125% RDF for cotton and soybean	1.56ab	1.22ab	3,796a
T3: 150% RDF for cotton and soybean	1.58a	1.23a	3,824a
T4: 100% FYM and RDF for cotton and soybean (Recommended check-RC)	1.52d-f	1.18ef	3,688ef
T5: T1 + FYM 2.5 t ha^{-1}	1.49g	1.16g	3,605i
T6: T1 + FYM 5 t ha^{-1}	1.49g	1.16g	3,613hi
T7: T1+ Gliricidia 2.5 t ha^{-1}	1.51e-g	1.18ef	3,669e-g
T8: T1+ Gliricidia 5 t ha^{-1}	1.52d-f	1.18ef	3,682ef
T9: T1+ Pongamia 2.5 t ha^{-1}	1.50fg	1.16g	3,633g-i
T10: T1+ Pongamia 5 t ha^{-1}	1.51e-g	1.17fg	3,650f-h
T11: T1+ Vermicompost 1.25 t ha^{-1}	1.49g	1.16g	3,618hi
T12: T1+ Vermicompost 2.5 t ha^{-1}	1.50fg	1.16g	3,630g-i
T13: T1+ FYM 2.5 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	1.53c-e	1.19de	3,706de
T14: T1+ FYM 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	1.53c-e	1.19de	3,704de
T15: T1 + FYM 2.5 t ha^{-1} + Vermicompost 1.25 t ha^{-1}	1.53c-e	1.19de	3,702de
T16: T1+ Gliricidia 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	1.54b-d	1.20cd	3,743cd
T17: T1+ Vermicompost 1.25 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	1.56ab	1.21bc	3,784ab
T18: T1+ Vermicompost 1.25 t ha^{-1} + Pongamia 2.5 t ha^{-1}	1.55bc	1.20cd	3,751bc
T19: Cotton sole crop (100% RDF and FYM)	1.00 i	1.00i	2,734k
T20: Soybean sole crop (100% RDF and FYM)	1.00i	1.00i	2,156l
Mean	**1.50**	**1.20**	**3,561**
S.Em±	**0.007**	**0.006**	**13.4**
	11.2	**5.95**	**11.0**

Note: Means followed by the same letters do not differ significantly by DMRT at 5%

The reduction in yield with intercropped soybean was mainly attributed to the area covered by the intercrop which was 67 per cent of the sole crop. Similar results were observed by [21], who reported that higher yield was observed in sole soybean than in intercropped soybean. Among the intercropping systems, T_2 and T_3 (125, 150% RDF for cotton and soybean, respectively), T_{17} (T_1 + Vermicompost 1.25 t ha^{-1} + Gliricidia 2.5 t ha^{-1}) and T_{18} (T_1 + Vermicompost 1.25 t ha^{-1} + Pongamia 2.5 t ha^{-1}) recorded higher yield. Significantly higher haulm yield was recorded in sole soybean than intercropped soybean. Among the intercropping systems, T_3 and T_2 (150, 125% RDF for cotton and soybean) recorded higher haulm yield compared to rest of the intercropping systems. This could be ascribed to use of FYM, vermicompost and green leaf manure in combinations, which might have resulted in better mineralization of nutrients and higher enzyme activities in the soil leading to increased transformation of nutrients to available form. The results are in agreement with the findings of [22] and [23], who also reported that combined application of organic and inorganic nutrients was superior over inorganic alone. However, harvest index did not differ significantly due to INM treatments (Table 2).

3.3 Effect of INM on Resource Use Efficiency of Intercropping System

All intercropping systems recorded significantly higher LER compared to either of the sole crops indicating better land utilization (Table 3). Among the different treatments, T_2 and T_3 (125, 150% RDF for cotton and soybean) recorded higher LER and it was on par with T_2 (125% RDF for cotton and soybean). The higher LER with T_3 and T_2 was due to the least competition for all growth resources in general and light in particular by greater complementary soybean and also due to higher yield under T_3 and T_2. Such increase in LER in intercropping system was also observed by earlier workers with cotton + soybean [24]. ATER differed significantly due to INM treatments. Among the different treatments, T_3 (150% RDF for cotton and soybean) recorded significantly higher ATER and it was in par with T_2 (125% RDF for cotton and soybean) compared to rest of the intercropping systems (Table 3). This was probably due to greater temporal and spatial complementarity. The results are in agreement with the findings of [25], who observed that combined application of 100% recommended dose of NPK and bio-inoculants recorded the maximum CEY of 2,460 and 2,190 kg per hectare in 2007 and 2008, respectively. CEY differed significantly due to INM treatments (Table 3). Among the different treatments, T_3 (150% RDF for cotton and soybean) recorded significantly higher CEY and it was on par with T_2 (125% RDF for cotton and soybean) and T_{17} (T_1 + Vermicompost 1.25 t ha^{-1} + Gliricidia 2.5 t ha^{-1}). This was due to higher yield from the intercrop soybean component and higher prices of soybean in the market. Similar results were also reported by [26] in cotton + peanut intercropping system, who reported that FYM maintained the highest cotton equivalent yield.

4. CONCLUSION

It could be concluded that farmers can adopt a fertilizer dose of 125 : 62.5 : 62.5 N, P_2O_5 and K_2O kg ha^{-1} in cotton and soybean intercropping system or 100 : 50 : 50 N, P_2O_5 and K_2O kg ha^{-1} along with Gliricidia + Pongamia 2.5 t ha^{-1} each for cotton and soybean intercropping for profitable yields and provides insurance against crop failure, when aberrant changes in weather conditions occurred.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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