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Effect of Integrated Nutrient Management on Yield Attributes, Yield and Production Efficiency of Cotton and Soybean Intercropping System

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ABSTRACT

A field experiment was conducted to study the integrated nutrient management practices on yield components and production efficiency of cotton and soybean intercropping system in 1:2 row proportion during kharif 2015 Dharwad. The field experiment was laid out in randomised complete block design with three replications and twenty treatments. 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 in soybean were higher under sole crop, followed by 150% RDF for cotton and soybean intercropping system. However, the land equivalent ratio (LER), area time equivalent ratio (ATER) and cotton equivalent yield (CEY) were higher in 125% RDF for cotton and soybean intercropping system, which was on par with 100% RDF for cotton and soybean + vermicompost 1.25 t ha^{-1} + gliricidia 2.5 t ha^{-1}. These treatments proved most optimum for better use of growth resources in intercropping system.

Key words: *Yield, LER, ATER, Cotton Equivalent Yield, RDF*

INTRODUCTION

Cotton (*Gossypium* spp.), the king of fibres, is an industrial commodity of worldwide importance. It is one of the most important commercial crop, playing a key role in economic and social affairs of 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. 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.

Soybean is a short duration and short stature legume, with 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].

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Application of organic manures along with inorganic fertilizers helps to rejuvenate the degraded soils and ensures sustainability in crop production. Suitable management practices like intercropping and judicious combination of organic and inorganic manures are considered ecologically viable, economically feasible and avoid environmental pollution[2,3]. Considering these facts the present investigation was undertaken.

MATERIALS AND METHODS

A field experiment was conducted to study the INM practices on yield components and production efficiency of cotton and soybean intercropping system in 1:2 row proportion during *kharif* 2015 at UAS, Dharwad (Karnataka). 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 field experiment was laid 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 40 cm x 10 cm for soybean in intercropping system (1:2) during *kharif* season on 9.7.2015. As per the treatments the organic manure (FYM) and green leaf manures (gliricidia and pongamia) were applied 15 days before sowing of the crop. 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). Statistical analysis was carried out using M – STATC software package and the mean values were subjected to Duncan`s Multiple Range Test.

RESULTS AND DISCUSSION

Yield components and yield of cotton

Integrated nutrient management practices had significant effect on number of bolls per plant, boll weight, seed cotton yield and cotton stalk yield at harvest of cotton crop. Significantly higher number of bolls per plant (62.2) was recorded in sole cotton, followed by 150 % RDF in cotton and soybean intercropping system (58.6), which was at par with 125% RDF in cotton and soybean intercropping system (58.1). Lower number of bolls per plant was recorded in 100% RDF for cotton and soybean (47.1). Significantly higher boll weight was recorded in sole cotton (4.84 g) which was on par with 150 % RDF (4.80 g) in cotton + soybean intercropping system. Lower boll weight (3.32 g) was recorded in 100% RDF for cotton and soybean.

Significantly higher seed cotton yield was recorded in sole cotton (1906 kg ha^{-1}). It was followed by 150% RDF (1535 kg ha^{-1}), 125% RDF (1525 kg ha^{-1}) and 100% RDF + Vermicompost 1.25 t ha^{-1} + Gliricidia 2.5 t ha^{-1} (1503 kg ha^{-1}). Similar trend was followed for cotton stalk yield at harvest. This was because of lack of competition for nutrients, moisture and light in sole cotton compared to intercropped treatments. Higher yield found in vermicompost and gliricidia treatment may be due to faster rate of decomposition of vermicompost and gliricidia, releasing nutrients and creating favorable environment as compared to application of RDF alone. However, harvest index was not significantly influenced by the treatments. The results of present investigation are also in agreement with the findings of Babalad[4]; Hosmath *et al.*[5] and Vidhyavathi *et al.*[6], who also reported integration of organic and inorganic nutrient sources found viable proposition in Bt cotton production.

Yield components and yield of soybean

Integrated nutrient management practices had significant effect on number of pods per plant, seed weight per plant, seed and haulm yield of soybean at harvest. Significantly higher number of pods per plant (50.1) was found in sole soybean, followed by 125% RDF for

cotton and soybean. Lower number of pods per plant (41.4) was observed in 100% RDF for cotton and soybean intercropping system. Higher seed weight per plant (18.2 g) was recorded in sole soybean and it was on par with125, 150% RDF and recommended check for cotton and soybean intercropping system. Lower seed weight per plant (15.1 g) was recorded in 100% RDF for cotton and soybean intercropping system.

Variations in seed yield of soybean were observed between sole and intercropped soybean. Sole soybean recorded significantly higher seed yield (2463 kg ha^{-1}), followed by 150% RDF for cotton and soybean intercropping system. Lower seed yield was obtained in 100% RDF for cotton and soybean intercropping system. Similar trend was followed for haulm yield of soybean. Higher yield in sole soybean is due to lack of competition for available resources such as nutrients, soil moisture between soybean and cotton and higher plant population of soybean in sole compared to intercrop. Higher yield observed in vermicompost and gliricidia treatment could be ascribed to continuous supply of N, P and K throughout the crop growth period. However, harvest index of soybean did not vary significantly due to integrated nutrient management practices. Results are in line with the findings of Gabhane *et al.*[7] and Choulwar *et al.*[8], who also reported that supplying nutrients through integration of inorganic sources with organic sources responded better in terms of growth and yield parameters of soybean.

Production efficiency of cotton and soybean intercropping system

Land equivalent ratio (LER) varied significantly due to intercropping of cotton and soybean in different nutrient management practices, with intercropping being significantly superior to either of sole crops. Application of 150% RDF for cotton and soybean intercropping system recorded significantly higher LER (1.52) and it was on par with 125% RDF for cotton and soybean intercropping system (1.51) and T_{17} and T_{18}. Lower LER (1.00) was recorded in cotton and soybean sole crops. The effective use of growth resources in an intercropping system could be indirectly measured through land equivalent ratio (LER). The LER with 150% RDF for cotton and soybean intercropping system was higher than sole crop due to better use of growth resources in the intercropping system as reported by Muyayabantu *et al*[9].

Growing soybean + cotton with different nutrient management practices varied the area time equivalent ratio (ATER) significantly compared to either of sole crops. Significantly higher ATER (1.22) was observed in 150% RDF for cotton and soybean intercropping system and it was on par with 125% RDF for cotton and soybean intercropping system (1.21). Lower ATER (1.00) was observed in cotton and soybean sole crop. Higher ATER indicated higher per day productivity of the system. This was possibly due to greater temporal and spatial complementarity as observed also by Sepat *et al*[10].

Cotton equivalent yield (CEY) differed significantly due to intercropping of soybean in cotton in different nutrient management practices. Application of 150 and 125% RDF for cotton and soybean intercropping system recorded higher CEY (2833 kg ha^{-1}) for cotton + soybean intercropping system (2821 kg ha^{-1}) and it was on par with 100% RDF for cotton and soybean + vermicompost 1.25 t ha^{-1} and gliricidia 2.5 t ha^{-1} (2790 kg ha^{-1}). Lower CEY (1796 kg ha^{-1}) was observed in soybean sole crop. The higher CEY in intercropping might be due to higher yield from intercropped soybean and higher prices of soybean. Similar results were also reported by Zerihun *et al*[11].

Table 1: Effect of integrated nutrient management 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

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	47.1 j	3.32 m	1300 k	2209 j	37.06 a
T2: 125% RDF for cotton and soybean	58.1 bc	4.75 b	1525 bc	2568 bc	37.26 a
T3: 150% RDF for cotton and soybean	58.6 b	4.80 ab	1535 b	2591 b	37.21 a
T4: 100% FYM and RDF for cotton and soybean (Recommended check-RC))	58.0 bc	4.62 c	1499 d	2536 cd	37.16 a
T5: T1 + FYM 2.5 t ha^{-1}	50.1 i	3.71 ij	1345 hi	2270 g-i	37.22 a
T6: T1 + FYM 5 t ha^{-1}	52.2 h	3.76 i	1352 hi	2285 gh	37.18 a
T7: T1+ Gliricidia 2.5 t ha^{-1}	50.1 i	3.66 jk	1333 ij	2257 g-j	37.13 a
T8: T1+ Gliricidia 5 t ha^{-1}	50.1 i	3.68 jk	1345 hi	2272 g-i	37.18 a
T9: T1+ Pongamia 2.5 t ha^{-1}	48.1 j	3.58 l	1315 jk	2226 ij	37.14 a
T10: T1+ Pongamia 5 t ha^{-1}	49.9 i	3.62 kl	1331 ij	2246 h-j	37.21 a
T11: T1+ Vermicompost 1.25 t ha^{-1}	53.2 gh	3.98 h	1365 h	2308 g	37.19 a
T12: T1+ Vermicompost 2.5 t ha^{-1}	55.2 ef	4.06 g	1402 g	2377 f	37.11 a
T13: T1+ FYM 2.5 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	56.2 de	4.23 f	1453 f	2457 e	37.15 a
T14: T1+ FYM 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	56.1 de	4.20 f	1448 f	2449 e	37.15 a
T15: T1 + FYM 2.5 t ha^{-1} + Vermicompost 1.25 t ha^{-1}	56.3 de	4.33 e	1479 de	2492 de	37.24 a
T16: T1+ Gliricidia 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	54.2 fg	4.17 f	1464 ef	2473 e	37.19 a
T17: T1+ Vermicompost 1.25 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	58.1 bc	4.56 c	1503 cd	2547 bc	37.12 a
T18: T1+ Vermicompost 1.25 t ha^{-1} + Pongamia 2.5 t ha^{-1}	57.1 cd	4.44 d	1493 d	2527 cd	37.14 a
T19: Cotton sole crop (100% RDF and FYM)	62.2 a	4.84 a	1906 a	3220 a	37.18 a
T20: Soybean sole crop (100% RDF and FYM)	-	-	-	-	-
Mean	**54.2**	**4.12**	**1441**	**2437**	**37.17**
S.Em±	**0.40**	**0.02**	**7.9**	**16.9**	**0.20**

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

Table 2: Effect of integrated nutrient management on number of pods plant^{-1}, seed weight plant^{-1}, seed yield at 9% moisture, haulm yield and harvest index of soybean at harvest in cotton + soybean intercropping system

Treatments	Number of pods plant^{-1}	Seed weight (g plant^{-1})	Seed yield at 9% moisture (kg ha^{-1})	Haulm yield (kg ha^{-1})	HI (%)
T1: 100% RDF for cotton and soybean	41.4 e	15.1 f	1540 g	2420 l	37.1 a
T2: 125% RDF for cotton and soybean	48.2 b	17.1 a-c	1755 b	2656 b	37.3 a
T3: 150% RDF for cotton and soybean	48.0 b	17.3 ab	1758 b	2661 b	37.2 a
T4: 100% FYM and RDF for cotton and soybean (Recommended check-RC))	48.0 b	17.2 a-c	1747 b	2546 c	37.2 a
T5: T1 + FYM 2.5 t ha^{-1}	45.1 cd	15.8 d-f	1636 d-f	2472 hi	37.2 a
T6: T1 + FYM 5 t ha^{-1}	45.3 cd	16.0 c-f	1654 c-f	2476 g-i	37.2 a
T7: T1+ Gliricidia 2.5 t ha^{-1}	44.8 d	15.8 d-f	1636 d-f	2464 ij	37.1 a
T8: T1+ Gliricidia 5 t ha^{-1}	44.8 d	15.8 d-f	1646 d-f	2464 ij	37.2 a
T9: T1+ Pongamia 2.5 t ha^{-1}	44.7 d	15.6 d-f	1609 fg	2443 k	37.1 a
T10: T1+ Pongamia 5 t ha^{-1}	44.8 d	15.4 ef	1628 ef	2455 jk	37.2 a
T11: T1+ Vermicompost 1.25 t ha^{-1}	46.1 c	16.0 c-f	1683 b-f	2482 gh	37.2 a
T12: T1+ Vermicompost 2.5 t ha^{-1}	46.2 c	16.1 b-f	1701 b-e	2492 fg	37.1 a
T13: T1+ FYM 2.5 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	47.6 b	16.3 b-f	1717 b-d	2513 de	37.2 a
T14: T1+ FYM 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	47.5 b	16.2 b-f	1715 b-d	2514 de	37.2 a
T15: T1 + FYM 2.5 t ha^{-1} + Vermicompost 1.25 t ha^{-1}	47.9 b	16.4 b-e	1729 bc	2510 de	37.2 a
T16: T1+ Gliricidia 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	47.7 b	16.3 b-f	1717 b-d	2503 ef	37.1 a
T17: T1+ Vermicompost 1.25 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	47.9 b	16.7 b-d	1747 b	2537 c	37.1 a
T18: T1+ Vermicompost 1.25 t ha^{-1} + Pongamia 2.5 t ha^{-1}	47.8 b	15.7 d-f	1741 b	2522 d	37.1 a
T19: Cotton sole crop (100% RDF and FYM)	-	-	-	-	-
T20: Soybean sole crop (100% RDF and FYM)	50.1a	18.2 a	2463a	2996 a	37.2 a
Mean	**46.5**	**16.2**	**1727**	**2533**	**37.1**
S.Em±	**0.39**	**0.36**	**24.63**	**5.22**	**0.20**

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

Table 3: Effect of integrated nutrient management on land equivalent ratio (LER), area time equivalent ratio (ATER) and cotton equivalent yield (CEY) in cotton + soybean intercropping system

Treatments	LER	ATER	CEY (kg ha^{-1})
T1: 100% RDF for cotton and soybean	1.31 j	1.04 l	2438 j
T2: 125% RDF for cotton and soybean	1.51 ab	1.21 ab	2821 a
T3: 150% RDF for cotton and soybean	1.52 a	1.22 a	2833 a
T4: 100% FYM and RDF for cotton and soybean (Recommended check-RC))	1.50 a-c	1.20 bc	2787 a-c
T5: T1 + FYM 2.5 t ha^{-1}	1.37 g-i	1.09 ij	2553 g-i
T6: T1 + FYM 5 t ha^{-1}	1.38 gh	1.10 hi	2572 gh
T7: T1+ Gliricidia 2.5 t ha^{-1}	1.36 hi	1.08 jk	2540 hi
T8: T1+ Gliricidia 5 t ha^{-1}	1.37 g-i	1.09 ij	2559 g-i
T9: T1+ Pongamia 2.5 t ha^{-1}	1.34 ij	1.07 k	2503 i
T10: T1+ Pongamia 5 t ha^{-1}	1.36 hi	1.08 jk	2532 hi
T11: T1+ Vermicompost 1.25 t ha^{-1}	1.40 fg	1.11 h	2606 fg
T12: T1+ Vermicompost 2.5 t ha^{-1}	1.43 ef	1.14 g	2656 f
T13: T1+ FYM 2.5 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	1.46 de	1.17 ef	2718 de
T14: T1+ FYM 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	1.46 de	1.16 f	2718 e
T15: T1 + FYM 2.5 t ha^{-1} + Vermicompost 1.25 t ha^{-1}	1.48 b-d	1.18 de	2753 b-e
T16: T1+ Gliricidia 2.5 t ha^{-1} + Pongamia 2.5 t ha^{-1}	1.47 cd	1.17 ef	2729 c-e
T17: T1+ Vermicompost 1.25 t ha^{-1} + Gliricidia 2.5 t ha^{-1}	1.50 a-c	1.20 bc	2790 ab
T18: T1+ Vermicompost 1.25 t ha^{-1} + Pongamia 2.5 t ha^{-1}	1.49 a-d	1.19 cd	2775 a-d
T19: Cotton sole crop (100% RDF and FYM)	1.00 k	1.00 m	1910 k
T20: Soybean sole crop (100% RDF and FYM)	1.00 k	1.00 m	1796 l
Mean	**1.38**	**1.13**	**2579**
S.Em+	**0.01**	**0.007**	**19.07**

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

CONCLUSION

Cotton + soybean intercropping system ensures sustainability in crop production, with efficient utilization of available resources and higher productivity.

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