



## EVALUATION OF COTTON (*GOSSYPIMUM HIRSUTUM*) - PULSES INTERCROPPING BASED RELAY CROPPING OF RABI SORGHUM (*SORGHUM BICOLOR*) UNDER RAINFED CONDITION

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**Abstract:** A field experiment was conducted during kharif and rabi season of 2015 at Agronomy Farm, College of Agriculture, Dhule (Maharashtra) to study the effect of cotton based intercropping system on yield of succeeding rabi sorghum under relay cropping. Among cotton-pulses intercropping system, the highest land equivalent ratio (1.42) and cotton equivalent yield (3138 kg ha<sup>-1</sup>) were recorded in cotton + green gram (1:2) than rest of the intercropping treatments. Grain (1116 kg ha<sup>-1</sup>) and stover yield (2728 kg ha<sup>-1</sup>) of rabi sorghum were significantly the highest in the sole cropping sown after the harvest of green gram. Among relay cropping, cotton + green gram (1:2) followed by relay rabi sorghum (1:1) produced significantly higher grain (396 kg ha<sup>-1</sup>) and stover yield (1126 kg ha<sup>-1</sup>) of rabi sorghum. As regards to cotton-pulses based relay cropping system, cotton + green gram (1:2) followed by relay rabi sorghum (1:1) recorded the highest land equivalent ratio (1.77), cotton equivalent yield (3289 kg ha<sup>-1</sup>) and higher net monetary return (108586 ha<sup>-1</sup>) than rest of the treatments. Sole green gram followed by rabi sorghum crop sequence recorded the highest B:C ratio (2.83). Cotton + green gram (1:2) row ratio of intercropping system found more profitable than rest of the systems. Evaluation of cotton-pulses based relay cropping system revealed that competitive indices and economics were superior with cotton + green gram (1:2) intercropping based relay cropping of rabi sorghum (1:1), except in respect of B:C ratio. Green gram-rabi sorghum crop sequence found more profitable in respect of income per rupee invested than cotton-pulses based relay cropping of rabi sorghum.

**Keywords:** Cotton, pulses, intercropping, relay cropping, equivalent yields and economics.

### Introduction

Intercropping is a potential system for maximizing the crop production in dry land over space and time in subsistence farming situations. The major objectives of intercropping system are to produce an additional crop to optimize the use of natural resources and stabilize the yield of crops (Willey, 1979). The system aimed at increasing productivity per unit area and guarantee insurance against total crop failure, particularly under aberrant weather conditions. The scope for increasing area under pulses is very limited. Therefore, assigning more area as intercrop of pulses is the need of the day. Relay cropping is another system in which the second crop is amidst the first crop before it has been harvested. By relay cropping, farmers may be able to effectively extend the growing season by several weeks. Hopefully such studies will lead to

maximize the productivity and income of cotton growers with small land holdings.

Cotton being a long duration and widely spaced crop with a row spacing of 90 to 120 cm, offers great scope for intercropping of short to medium duration legume crop without much effect on main crop. The area under cotton in Maharashtra was about 42.07 lakh hectares, total production of 39.14 lakh bales with 158 kg lint ha<sup>-1</sup> productivity during 2015-16. Green gram and black gram matures in 75 to 80 days and cotton is having a long maturity period of 150 to 160 days. If both the pulse crop are intercropped in cotton, there is a period of about 80 to 85 days after harvest of intercrop, in which cotton remain sole crop. So there is scope to sow a relay crop during early rabi season. Green gram (*Vigna radiata* L.) is one of the important food legume crop of Maharashtra and occupies an area of 3.66 lakh

hectares having total production was 0.69 lakh tones with 190 kg ha<sup>-1</sup> productivity. Black gram (*Vigna mungo* L.) occupies an area of 2.86 lakh hectares having total production was 0.61 lakh tones with 214 kg ha<sup>-1</sup> productivity. As regards to *rabi* sorghum (*Sorghum bicolor*) is also important staple food and fodder crop of India as well as Maharashtra state. *Rabi* sorghum covered area was about 25.97 lakh hectares with 8.37 lakh tones total production and 322 kg ha<sup>-1</sup> productivity during 2015-16.

### Materials and Methods

A field experiment was conducted during *kharif* and *rabi* season of 2015 at Agronomy Farm, College of Agriculture, Dhule (Maharashtra). The soil of experimental field was clayey with pH 7.5, organic carbon 0.27 per cent, and available N, P and K were 162.24, 14.75 and 352.30 kg ha<sup>-1</sup>, respectively. The field experiment was laid out in randomized block design with seven treatments { sole cotton, sole green gram, sole blackgram, cotton + green gram (1:1), cotton + green gram (1:2), cotton + black gram (1:1), cotton + black gram (1:2) in *kharif* season followed by cotton + relay cropping of *rabi* sorghum (1:1), green gram followed by sole *rabi* sorghum, black gram followed by sole *rabi* sorghum, cotton + green gram (1:1) relay cropping of *rabi* sorghum (1:1), cotton + green gram (1:2) relay cropping of *rabi* sorghum (1:1), cotton + blackgram (1:1) relay cropping of *rabi* sorghum (1:1) and cotton + blackgram (1:2) relay cropping of *rabi* sorghum (1:1) in *rabi* season, respectively} with three replications. The sole cotton crop was sown at 90x90 cm<sup>2</sup>, green gram and black gram were sown at 30x10 cm<sup>2</sup> and *rabi* sorghum was sown at 45x15 cm<sup>2</sup>. The spacing's for intercrops were cotton (90 x 90 cm) + green gram (1:1) (plant to plant 10cm), cotton (90 x 90 cm) + green gram (1:2) (30 x 10 cm), cotton (90 x 90 cm) + black gram (1:1) (plant to plant 10cm), cotton (90 x 90 cm) + black gram (1:2) (30 x 10 cm) and cotton (90 x 90 cm) + *rabi* sorghum (1:1) (plant to plant 15cm). The *kharif* crops i.e., Cotton, green gram and black gram were sown on 15 June 2015 and *rabi* sorghum was sown on 21 September, 2015. The relay crop of *rabi* sorghum was sown in standing crop of

cotton after harvest of intercrops. Application of organic manure was done through farmyard manure (FYM) @ 10 tones ha<sup>-1</sup> before last harrowing before sowing of *kharif* crops. The recommended dose of fertilizer for cotton 125:65:65 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup> was applied. Recommended fertilizer doses for sole crop of green gram (20:40:00 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup>), black gram (20:40:00 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup>) and *rabi* sorghum (40:20:00 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup>) were applied. In case of intercropping treatments, the general recommended dose of fertilizer of base crop was applied.

### Results and Discussion

Sole cropping of cotton produced the highest seed cotton yield (2497 kg ha<sup>-1</sup>) than rest of the treatments. In intercropping systems, cotton + green gram (1:1) produced higher seed cotton yield (2277 kg ha<sup>-1</sup>) than rest of the intercropping treatments, followed by cotton + black gram (1:1). The lowest seed cotton yield was noticed under cotton + black gram (1:2) row ratio (Table 1). The reduction in yield of seed cotton was higher with black gram as compared to green gram in intercropping systems. Solaippan and Dason(1998) and Vekariya *et al.*(2015) reported that sole cotton recorded comparatively higher seed cotton yield than intercropping system.

Higher seed yield of green gram (1063 kg ha<sup>-1</sup>) was recorded in sole cropping as compared to its intercropping treatment. The second best treatment was cotton + green gram 1:2 row ratio (640 kg ha<sup>-1</sup>) and the minimum seed yield of green gram was noted in cotton + green gram 1:1 row ratio (391 kg ha<sup>-1</sup>). Higher seed yield was recorded in sole black gram (935 kg ha<sup>-1</sup>), as compared to their intercropping treatments (Table 1). Higher seed yield in sole cropping was due to higher plant population than its intercropping system. Rao and Sadaphal (1993) also reported reduction in yield of mungbean in intercropping as compared with its sole cropping. Sarkar *et al.* (1995) observed that yields of inter crops decreased by 28-83 per cent in cotton based intercropping systems.

The differences in cotton equivalent yield of intercropping systems due to different treatments were found significant. Cotton + green gram 1:2 row

ratio (3138 kg ha<sup>-1</sup>) recorded the highest cotton equivalent yield as compared to rest of the treatments, however it was at par with cotton + green gram 1:1 row ratio (2949 kg ha<sup>-1</sup>). Cotton + green gram (1:1) and cotton + black gram (1:2) were at par with each other. Tabib *et al.* (2014) reported that the highest seed cotton (2951 kg ha<sup>-1</sup>) and mungbean (3373 kg ha<sup>-1</sup>) equivalent yield was recorded from the paired row cotton + 4 rows of mungbean.

Sole green gram followed by *rabi* sorghum treatment produced significantly the highest grain yield of sorghum (1116 kg ha<sup>-1</sup>). Whereas, sole black gram followed by *rabi* sorghum (1008 kg ha<sup>-1</sup>) recorded second best treatment than rest of the treatments. In intercropping systems, cotton + green gram (1:2) followed by relay *rabi* sorghum (1:1) produced significantly higher grain yield (396 kg ha<sup>-1</sup>) than rest of the relay cropping treatments. The lowest grain yield of *rabi* sorghum was noticed under Sole cotton + relay *rabi* sorghum (1:1) (Table 2). As there was deficit of rainfall during *kharif* season, the residual moisture was limiting for *rabi* sorghum. Due to soil moisture limitations and shedding effect of cotton, the initial growth and development of *rabi* sorghum was stunted in relay cropped treatments. Khan and Khaliq (2005) observed that under irrigated condition, relaying wheat by surface seeding produced 69.37 per cent higher grain yield than sowing after harvest of cotton and by this technique increase in barley yield was 22.84 per cent over conventional planting. Sole green gram followed by *rabi* sorghum treatment produced significantly the highest stover yield of *rabi* sorghum (2728 kg ha<sup>-1</sup>)

than rest of the treatments. Among intercropping systems, cotton + green gram (1:2), cotton + green gram (1:1) and cotton + black gram (1:2) were at par with each other (Table 2) in respect of yield of *rabi* sorghum. Khan and Khaliq (2005) reported that significantly greater biological yield (4924 kg ha<sup>-1</sup>) was recorded for barley relayed into cotton as compared to that sown after the harvest of cotton (4016 kg ha<sup>-1</sup>).

The cotton + green gram (1:2) relayed by *rabi* sorghum 1:1 row ratio recorded the highest land equivalent ratio (1.77), cotton equivalent yield (3289 kg ha<sup>-1</sup>) and net monetary returns (₹ 108586 ha<sup>-1</sup>) than rest of the treatments (Table 3). Jabbar *et al.* (2005) observed that among relay cropping systems, the highest total rice grain yield equivalent of 7.97 t ha<sup>-1</sup> and 9.27 t ha<sup>-1</sup> was recorded for rice/fenugreek relay cropping system both under zero and conventional tillage, respectively. Saeed *et al.* (1999) reported that maximum net income of ₹ 48052 ha<sup>-1</sup> was obtained from cotton + mashbean / lentil inter-relay cropping system followed by cotton + mungbean/ lentil (₹ 47415 ha<sup>-1</sup>) and cotton + mungbean/ wheat (₹ 46732 ha<sup>-1</sup>). The highest B:C ratio (2.83) was recorded in the sole green gram followed by *rabi* sorghum crop sequence. Among the inter and relay cropping systems, cotton + green gram (1:2) followed by *rabi* sorghum 1:1 row ratio (2.79) recorded higher B:C ratio. Higher B:C ratio was obtained in sole cropping of green gram followed by *rabi* sorghum may be attributed to the good market price of green gram with lower cost of cultivation.

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**Table 1: Yields of cotton-pulses intercropping systems as influenced by different treatments (kharif 2015)**

Treatment		Seed cotton yield (kg ha <sup>-1</sup> )	Intercrop Seed yield (kg ha <sup>-1</sup> )	Cotton equivalent yield (kg ha <sup>-1</sup> ) (Cotton + Intercrop)
T <sub>1</sub>	Sole Cotton	2497	-	2497
T <sub>2</sub>	Sole Green gram	-	1063	1829
T <sub>3</sub>	Sole Black gram	-	935	1823
T <sub>4</sub>	Cotton + Green gram (1:1)	2277	391	2949
T <sub>5</sub>	Cotton + Green gram (1:2)	2037	640	3138
T <sub>6</sub>	Cotton + Black gram (1:1)	2160	304	2754
T <sub>7</sub>	Cotton + Black gram (1:2)	2003	473	2925
<b>S.Em. ±</b>				<b>67.26</b>
<b>CD at 5 %</b>				<b>207.27</b>
<b>General Mean</b>		<b>2195</b>	<b>-</b>	<b>2559</b>

**Table 2: Grain and stover yield of relay crop of sorghum as influenced by different treatments (rabi 2015)**

Treatment		Grain yield (kg ha <sup>-1</sup> )	Stover yield (kg ha <sup>-1</sup> )
T <sub>1</sub>	Sole Cotton + Relay <i>Rabi</i> sorghum (1:1)	239	796
T <sub>2</sub>	Sole Green gram followed by <i>Rabi</i> sorghum	1116	2728
T <sub>3</sub>	Sole Black gram followed by <i>Rabi</i> sorghum	1008	2321
T <sub>4</sub>	Cotton + Green gram (1:1) followed by Relay <i>Rabi</i> sorghum (1:1)	302	1018
T <sub>5</sub>	Cotton + Green gram (1:2) followed by Relay <i>Rabi</i> sorghum(1:1)	396	1126
T <sub>6</sub>	Cotton + Black gram (1:1) followed by Relay <i>Rabi</i> sorghum(1:1)	277	918
T <sub>7</sub>	Cotton + Black gram (1:2) followed by Relay <i>Rabi</i> sorghum(1:1)	345	1049
<b>S.Em. ±</b>		16.55	43.65
<b>CD at 5 %</b>		51.00	134.50
<b>General Mean (Sole)</b>		<b>1062</b>	<b>2525</b>
<b>General Mean (Relay Crop)</b>		<b>292</b>	<b>981</b>

Table 3: Competitive indices and economics of *kharif* and *rabi* crops as influenced by different treatments (2015)

Treatment		Competitive indices		Economics			
		LER (C+ I+R)	Cotton equivalen t yield (kg ha <sup>-1</sup> ) (C+ I+R)	Total Gross monetary returns (` ha <sup>-1</sup> ) (C+ I+R)	Total Cost of cultivation (` ha <sup>-1</sup> ) (C+ I+R)	Total Net monetary returns (` ha <sup>-1</sup> ) (C+ I+R)	B:C Ratio (C+ I+R)
T <sub>1</sub>	Sole Cotton + Relay <i>Rabi</i> sorghum (1:1)	1.22	2588	132834	52762	80072	2.51
T <sub>2</sub>	Sole Green gram followed by <i>Rabi</i> sorghum	1.00	2253	120353	42511	77842	2.83
T <sub>3</sub>	Sole Black gram followed by <i>Rabi</i> sorghum	1.00	2206	116853	42988	73865	2.71
T <sub>4</sub>	Cotton + Green gram (1:1) followed by Relay <i>Rabi</i> sorghum (1:1)	1.55	3064	157445	57866	99579	2.72
T <sub>5</sub>	Cotton + Green gram (1:2) followed by Relay <i>Rabi</i> sorghum(1:1)	1.77	3289	169154	60569	108586	2.79
T <sub>6</sub>	Cotton + Black gram (1:1) followed by Relay <i>Rabi</i> sorghum(1:1)	1.45	2859	146874	58005	88868	2.53
T <sub>7</sub>	Cotton + Black gram (1:2) followed by Relay <i>Rabi</i> sorghum(1:1)	1.65	3056	157113	60887	96226	2.58
<b>S.Em. ±</b>		0.02	65.25	-	-	-	-
<b>CD at 5 %</b>		0.08	201.05	-	-	-	-
<b>General Mean</b>		<b>1.37</b>	<b>2759</b>	<b>142947</b>	<b>53665</b>	<b>89291</b>	<b>2.67</b>

Note: C+I+R = Cotton + Intercrop + Relay crop