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Effect of monsoon sowing of cotton genotypes under HDPS with soybean (6:6) - mustard in strip intercropping system

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Abstract
An experiment was conducted during the year 2014-15 to 2016-17 at AICRP for Dryland Agriculture, Dr. PDKV, and Akola (MS). Results on the basis of pooled analysis showed that, sowing of monsoon cotton under HDPS with soybean in row proportion of (6:6) followed by mustard during rabi season in strip intercropping system recorded that treatment of *G. arboreum* cotton (AKA-7) + soybean (6:6)-mustard recorded significantly higher cotton equivalent yield (1914 kg ha^{-1}), NMR (Rs. 49812 ha^{-1}), B:C ratio (2.67), RWUE (3.33 kg $ha^{-1}mm^{-1}$), crop productivity and system productivity (7.81 and 5.24 kg $ha^{-1}day^{-1}$) as well as crop profitability and system profitability (Rs. 203.31 & 136.47 $ha^{-1}day^{-1}$) than rest of the treatments under study.

Keywords: Cotton genotypes, HDPS, strip intercropping, sequence cropping

Introduction
Strip intercropping is the adaptation of system to contemporary, mechanized agriculture practices. The multiple crops are grown in narrow, adjacent strips that allow interaction between the different species, but also allow management with modern equipment. Perusal of the Indian scenario reveals that in variance to the mono-cropping of cotton and concept of cotton belts in the India. Especially for the rain fed area is always is a combination of mixed cropping and intercropping. In the irrigated area and high rainfall zones, cotton is grown in sequential cropping as double or triple cropping sequences and in extreme cases going in for intensive relay cropping. Improvement in cropping intensity is one of the possible ways of enhancing agriculture production through better utilization of available resources. Cropping intensity could be improved by adoption of multiple cropping. However, under rain fed situation often not more than one growing season is available for crop cultivation. Intercropping system which involves raising of more than one crop on the same piece of land more or less simultaneously increases cropping intensity both in space and dimension. Such a varied inter/mixed and relay cropping scenario in the cotton based cropping system gives a mosaic of varied cropping system ensuring stable yield and avoiding crop failures. Such varied cropping system also restricted incidence of pests and diseases.
Planting density is the most active factor and plays pivotal role in crop management practices, hence plant density is the enduring topic for crop production improvement. The rational plant population is an important attribute to high yield of cotton, because it can provide a beneficial micro environment within the canopy for plant growth and development as well as yield formation. Hence increasing plant population could be one of the most effective ways of improving yield. The optimum plant density in this parabolic (density-yield) relationship was a function of the genotype, soil type, climate and management. Before the advent of hybrid cotton, the highest plant density recommended for varieties of *G. hirsutum* were 55000 plants ha^{-1} (Bonde and Raju, 1996) [3]. Keep these points in view the present experiment was conducted with objectives to find out the most suitable cotton genotypes under HDPS, to find out most suitable cotton genotypes with soybean (6:6) row proportion-mustard sequence strip inter-cropping system under HDPS and to find out the economics of experimental treatments.

Materials and Methods
The field experiment was conducted during *kharif* season of 2014-15 to 2016-17 at AICRP for Dry land Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, and Akola (MS) to study the effect of monsoon sowing of cotton genotypes under HDPS with soybean (6:6)-mustard in strip intercropping system. The soil of experimental plot was clayey in texture, slightly alkaline in reaction (7.95), EC (dSm^{-1}) 0.29, medium in organic carbon 5.22 (g kg^{-1}) and

available nitrogen (235.8 kg ha^{-1}), low in available phosphorus (19.2 kg ha^{-1}) but having fairly rich status in available potassium (335.8 kg ha^{-1}). The experiment was laid out in randomised block design with three replications and seven treatments i.e. sole *G. hirsutum cotton* (AKH-081), sole *G. hirsutum hybrid (Bt. Cotton)* (Balwan), sole *G. arboreum cotton* (AKA-7), sole soybean (JS-335)-mustard (ACN-9), *G. hirsutum cotton* (AKH-081) + soybean (6:6) - mustard (ACN-9), *G. hirsutum hybrid (Bt. Cotton)* (Balwan) + soybean (6:6) – mustard (ACN- 9) and *G. arboreum* cotton+soybean (6:6)-mustard (ACN- 9). Rainfall received during the cropping period of experiments was 617.4, 644.6 and 735.7 in 25, 28 and 45 rainy days respectively.

Results and Discussion

A. Cotton equivalent yield

During the year 2014-15, treatment of *arboreum* cotton (AKA-7) + soybean (6:6)-mustard cropping system recorded significantly higher cotton equivalent yield than rest of the treatments. However, treatments of *hirsutum* cotton (*AKH-081)* + soybean (6:6)- mustard, *hirsutum* hybrid cotton (Balwan) + soybean (6:6)-mustard and sole soybean – mustard were found to be being at par and significantly higher than the sole cotton genotypes.

During the year 2015-16, all the treatments of sole cotton genotypes and cotton genotypes + soybean (6:6)-mustard were found being at par with each other and significantly superior than the treatments of sole soybean – mustard.

During the year 2016-17, the treatments of *G. hirsutum* cotton (AKH-081), *G. hirsutum hybrid* cotton (Balwan) and *G. arboreum* cotton (AKA-7) + soybean (6:6)-mustard, found to be being at par and recorded significantly higher cotton equivalent yield than rest of the treatments.

However, in pooled results, cotton equivalent yield among the different cotton genotypes + soybean (6:6)-mustard strip intercropping system ranged between 1712 to 1914 q ha^{-1} and were significantly superior over sole crops of cotton genotypes and sole soybean – mustard crop. *G. arboreum* cotton (AKA-7) + soybean (6:6) – mustard strip cropping system recorded significantly higher cotton equivalent yield (1914 kg ha^{-1}) than rest of the treatments. In kharif season, cotton with soybean, might have increased light interception in soybean, reduced evaporation and improved soil moisture conservation compared with sole crop.

Table 1: Cotton equivalent yield as influenced by the various treatments

Treatments	Cotton equivalent yield (kg ha^{-1})			
	2014-15	2015-16	2016-17	Mean
T^{1} - Sole *G. hirsutum cotton* (AKH-081) 45x15cm	891	2070	2176	1712
T^{2} - Sole *G. hirsutum* hybrid *(Bt. Cotton* Balwan) 45x60cm	953	2114	2195	1754
T^{3} - Sole *G. arboreum cotton* (AKA-7) 45x15cm	999	2081	2167	1749
T^{4}- Sole Soybean (JS-335) (45x5cm)(6:6)-mustard (ACN- 9) 45x15cm	1107	1373	2165	1511
T^{5}-*G. hirsutum* cotton (AKH-081) 45x15cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	1161	2018	2315	1813
T^{6}-*G. hirsutum* hybrid *(Bt. Cotton)* (Balwan) 45x60cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	1181	2085	2374	1803
T^{7}- *G. arboreum cotton (AKA-7)* + soybean (6:6)-mustard (ACN- 9) 45x15cm	1343	2148	2367	1914
S.Em. ±	35.7	41.6	32.3	19.2
C.D. at 5%	110.1	128.4	99.4	59.3
C.V. %	9.82	7.30	10.29	

Cotton equivalent yield was higher in the strip cropping systems in medium deep black soils. The appropriate land configuration besides the advantages of agronomic measures like component crops in appropriate row proportions play a vital role both for moisture conservation and removal of excess water during high rainfall events from the cropped fields. In area with low rainfall and post rainy season cropping under residual moisture, the initial establishment and good growth of the component crops is important which would be influenced by the quantum of rainfall and soil moisture status in the initial stages. Maize + soybean - French bean cropping system gave higher equivalent yield compared to other cropping systems. These results are in conformity with the findings of Chittapur (2004) [4], Gill and Ahlawat, (2006) [5] and Sankaranarayanan *et al.*, (2012) [9].

B. Economics

During the year 2014-15, the treatments of *arboreum* cotton (AKA-7) + soybean (6:6)-mustard recorded significantly higher gross monetary returns (Rs.52,509 ha^{-1}) than rest of the treatments studied.

During the year 2015-16, all the treatments of sole cotton genotypes and cotton genotypes + soybean (6:6)-mustard were found being at par with each other and significantly superior than the treatment of sole soybean – mustard.

During the year 2016-17, the treatments of *hirsutum* cotton (AKH-081), *hirsutum hybrid* cotton (Balwan) and *arboreum* cotton (AKA-7) + soybean (6:6)-mustard, found to be at par with each other and recorded significantly higher gross monetary returns than rest of the treatments i.e. Rs. 99,607, 1,02,222 and 1,01, 705 ha^{-1} respectively.

Table 2: Gross monetary returns (Rs ha^{-1}) as influenced by the various treatments

Treatments	Gross Monetary Returns (Rs ha^{-1})			
	2014-15	2015-16	2016-17	Mean
T^{1} - Sole *G. hirsutum cotton* (AKH-081) 45x15cm	35551	100085	93037	71388
T^{2} - Sole *G. hirsutum* hybrid *(Bt. Cotton* Balwan) 45x60cm	37941	102318	94903	73488
T^{3} - Sole *G. arboreum cotton* (AKA-7) 45x15cm	39015	100652	93001	72423
T^{4}- Sole Soybean (JS-335) (45x5cm)(6:6)-mustard (ACN- 9) 45x15cm	43601	66439	92963	62914
T^{5}-*G. hirsutum* cotton (AKH-081) 45x15cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	45987	97599	99607	75489
T^{6}-*G. hirsutum* hybrid *(Bt. Cotton)* (Balwan) 45x60cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	46771	100894	102222	79006
T^{7}- *G. arboreum cotton (AKA-7)* + soybean (6:6)-mustard (ACN- 9) 45x15cm	52509	103914	101705	79637
S.Em. ±	1410	3494	1858	739
C.D. at 5%	4345	10766	5725	2277

Market Rates (Rs q^{-1})			
	2014-15	**2015-16**	**2016-17**
Seed Cotton	3800/-	4700/-	4020/- and 4350/-
Cotton Stalk	100/-	125/-	125/-
Soybean Grain	3200/-	3550/-	2750/-
Soybean Straw	125/-	100/-	125/-
Mustard Seed	3500/-	3800/-	3800/-
Mustard Straw	100/-	75/-	75/-

However in pooled results, treatments of *arboreum* cotton (AKA-7) + soybean (6:6)-mustard and *hirsutum* hybrid (Bt. Cotton Balwan) + soybean(6:6)-mustard strip intercropping were found to be at par and significantly higher than rest of the treatments.

In respect of net monetary returns, during the year 2014-15, the treatment of *arboreum* cotton (*AKA-7*) + soybean (6:6) - mustard recorded significantly higher net monetary returns than rest of the treatments.

During the year 2015-16, the treatments of sole *hirsutum* cotton (AKH-081), sole *arboreum* cotton (AKA-7) and *arboreum* cotton (AKA-7) + soybean (6:6) - mustard were found to be at par with each other.

Whereas in year 2016-17, results revealed that, the treatments of *hirsutum* cotton (AKH-081), *hirsutum hybrid* cotton (Balwan) and *arboreum* cotton (AKA-7) + soybean (6:6)-mustard, found to be at par with each other and recorded significantly higher net monetary returns than rest of the treatments.

However, in pooled results, *arboreum* cotton (AKA-7) + soybean–mustard strip intercropping recorded significantly higher net monetary returns (Rs. 49,812/- ha^{-1}) than rest of the treatments.

Table 3: Net monetary returns (Rs ha^{-1}) as influenced by the various treatments

Treatments	**Net Monetary Returns (Rs ha^{-1})**			
	2014-15	**2015-16**	**2016-17**	**Pooled**
T^{1} - Sole *G. hirsutum cotton* (AKH-081) 45x15cm	8671	64655	53851	42138
T^{2} - Sole *G. hirsutum* hybrid *(Bt. Cotton* Balwan) 45x60cm	1528	60628	45778	36768
T^{3} - Sole *G. arboreum cotton* (AKA-7) 45x15cm	14089	67130	52158	44173
T^{4}- Sole Soybean (JS-335) (45x5cm)(6:6)-mustard (ACN- 9) 45x15cm	13910	27223	52247	30304
T^{5}-*G. hirsutum* cotton (AKH-081) 45x15cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	9774	54365	61997	45939
T^{6}-*G. hirsutum* hybrid *(Bt. Cotton)* (Balwan) 45x60cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	7139	54834	59022	43629
T^{7}- *G. arboreum cotton (AKA-7)* + soybean (6:6)-mustard (ACN- 9) 45x15cm	18163	63080	59198	49812
S.Em. ±	1410	3494	1858	739
C.D. at 5%	4345	10766	5725	2277

Average of three years indicated that, in respect of B:C ratio, the treatment of *arboreum* cotton (AKA-7) + soybean (6:6)-mustard, recorded higher B:C ratio (2.67) than rest of the treatments. Increased productivity of cotton with additional yield of mixed crops of soybean and mustard helped in increasing the net monetary returns and cotton equivalent yield. Secondly, more productivity and market rates of the mixed crops and low cost of cultivation also helped in increasing higher value of B:C ratio due to reduction in some cultural operations, use of own seed and involvement of family members as a labour.

Table 4: B:C Ratio as influenced by the various treatments

Treatments	**B:C Ratio**			
	2014-15	**2015-16**	**2016-17**	**Mean**
T^{1} - Sole *G. hirsutum cotton* (AKH-081) 45x15cm	1.22	2.82	2.37	2.44
T^{2} - Sole *G. hirsutum* hybrid *(Bt. Cotton* Balwan) 45x60cm	1.03	2.45	1.93	2.00
T^{3} - Sole *G. arboreum cotton* (AKA-7) 45x15cm	1.39	3.00	2.28	2.56
T^{4}- Sole Soybean (JS-335) (45x5cm)(6:6)-mustard (ACN- 9) 45x15cm	1.31	1.69	2.28	1.93
T^{5}-*G. hirsutum* cotton (AKH-081) 45x15cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	1.24	2.26	2.65	2.55
T^{6}-*G. hirsutum* hybrid *(Bt. Cotton)* (Balwan) 45x60cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	1.17	2.19	2.37	2.23
T^{7}- *G. arboreum cotton (AKA-7)* + soybean (6:6)-mustard (ACN- 9) 45x15cm	1.34	2.45	2.39	2.67

Tanaka *et al.,* (2007) [10] reported that, crop sequence has a significant effect on cropping system net returns. A cropping systems approach may offer opportunities for producers to increase economic returns. Management of dynamic cropping systems will need to be based not only on single-year profit opportunities, but also on subsequent crop sequence effects. Maximum net returns was recorded at *hirsutum* cotton – mustard sequence followed by *hirsutum* cotton-wheat and *arboretum* cotton-wheat sequence than sole cotton cropping system also reported by Venugopal *et al.*,(2000) [14]. Cotton + sorghum-ragi, followed by cotton-sunflower –ragi and cotton-maize –ragi sequences were more profitable and economically viable than sole cotton (Jagvirsingh *et al.,* 2000) [8].

C. Rain water use efficiency

In respect of rain water use efficiency, during the year 2014-15, the treatments of *arboreum* cotton (AKA-7) + soybean (6:6)-mustard recorded significantly higher rain water use efficiency than rest of the treatments.

Table 5: Rain water use efficiency as influenced by the various treatments

Treatments	RWUE (kg ha^{-1}mm^{-1})			
	2014-15	2015-16	2016-17	Mean
T^1 - Sole *G. hirsutum cotton* (AKH-081) 45x15cm	1.88	3.62	3.01	2.88
T^2 - Sole *G. hirsutum* hybrid *(Bt. Cotton* Balwan) 45x60cm	2.01	3.69	3.03	2.96
T^3 - Sole *G. arboreum cotton* (AKA-7) 45x15cm	2.11	3.63	2.99	2.96
T^4- Sole Soybean (JS-335) (45x5cm)(6:6)-mustard (ACN- 9) 45x15cm	2.34	2.40	2.99	2.58
T^5-*G. hirsutum* cotton (AKH-081) 45x15cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	2.45	3.52	3.20	3.09
T^6-*G. hirsutum* hybrid *(Bt. Cotton)* (Balwan) 45x60cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	2.50	3.64	3.28	3.18
T^7- *G. arboreum cotton (AKA-7)* + soybean (6:6)-mustard (ACN- 9) 45x15cm	2.84	3.75	3.27	3.33
S.Em. ±	0.08	0.07	0.04	0.11
C.D. at 5%	0.23	0.22	0.14	0.34

However, during the year 2015-16, the treatments of sole *hirsutum* cotton (AKH-081), sole *arboreum* cotton (AKA-7) and *arboreum* cotton (AKA-7) + soybean (6:6)-mustard were found to be at par with each other and significantly superior to the rest of the treatments.

During the year 2016-17 and also in pooled, results revealed that the treatments of *hirsutum* cotton (AKH-081), *hirsutum Bt. hybrid* cotton (Balwan) and *arboreum* cotton (AKA-7) with + soybean (6:6)-mustard, found to be at par with each other and recorded significantly higher rain water use efficiency than rest of the treatments.

This indicated higher resource use efficiency of both rainfall and soil moisture by the component crops during the crop season. This might be due to higher grain yields of both the crops than the amount of water used for biomass production. Consumptive use and rate of moisture use were higher in the intercropping system than sole crop because both the crops absorbed more moisture during the crop period. Higher water use efficiency has been reported for maize-cowpea (Hulugalle and Lal, 1986) [7], Maize + potato (Bharati *et al.*, 2007) [2], pearlmillet + greengram and pearlmillet + cowpea (Goswami *et al.*, 2002) [6] intercrops in relation to their respective monocrops. Tetarwal and Rana (2006) [11] one row of mothbean in paired row of pearlmillet + and one row of greengram between paired rows of pigeonpea recorded higher water use efficiency over sole crop, respectively.

D. Productivity and profitability of cropping systems

Crop duration was numerically found maximum (245 days) under treatments of different cotton genotypes + soybean (6:6) - mustard strip intercropping system.

The treatment of *G. arboreum cotton (AKA-7)* + soybean (6:6)-mustard recorded significantly higher crop productivity (7.81 kg ha^{-1} mm^{-1}) and system productivity (5.24 kg ha^{-1} mm^{-1}) and found significantly superior than rest of the treatments.

In respect of system profitability, the treatment of *G. arboreum cotton (AKA-7)* + soybean (6:6)-mustard recorded significantly higher crop profitability and system profitability i.e. 203.31 and 136.47 Rs ha^{-1}day^{-1} respectively than rest of the treatments.

Thus, more productivity and market rates of the mixed crops and low cost of cultivation also helped in increasing higher system productivity and profitability. Cotton + sorghum-ragi, followed by cotton-sunflower –ragi and cotton-maize –ragi sequences were more profitable and economically viable than sole cotton (Jagvirsingh *et al.*, 2000) [8]. Soybean-mustard-groundnut, soybean-coriander-wheat, soybean-Isabgol–groundnut recorded higher NMR, B:C ratio and system productivity in Western Vidarbha zone of Maharashtra (Anonymous, 2008).

Table 6: System productivity and system profitability as influenced by various treatments

Treatments	System Productivity (kg ha^{-1}day^{-1})		System Profitability (Rs ha^{-1}day^{-1})	
	Crop Productivity	System Productivity	Crop Profitability	System Profitability
	245 Days	365 Days	245 Days	365 Days
T^1 - Sole *G. hirsutum cotton* (AKH-081) 45x15cm	6.99	4.69	171.99	115.45
T^2 - Sole *G. hirsutum* hybrid *(Bt. Cotton* Balwan) 45x60cm	7.16	4.81	150.08	100.74
T^3 - Sole *G. arboreum cotton* (AKA-7) 45x15cm	7.14	4.79	180.30	121.02
T^4- Sole Soybean (JS-335) (45x5cm)(6:6)-mustard (ACN- 9) 45x15cm	6.17	4.14	123.69	83.03
T^5-*G. hirsutum* cotton (AKH-081) 45x15cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	7.40	4.97	187.50	125.86
T^6-*G. hirsutum* hybrid *(Bt. Cotton)* (Balwan) 45x60cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	7.36	4.94	178.08	119.53
T^7- *G. arboreum cotton (AKA-7)* + soybean (6:6)-mustard (ACN- 9) 45x15cm	7.81	5.24	203.31	136.47
S.Em. ±	0.08	0.05	3.02	2.02
C.D. at 5%	0.24	0.16	9.29	6.24

E. Chemical properties

The data in respect of the pH, EC, organic carbon, available nitrogen, phosphorus and potassium of the soil found to be non-significant. Timsina *et al.* (2001) [12] reported a slight decrease in pH after three years of rice-wheat cropping system in Bangladesh. The above literature indicates differential response of cropping systems on soil pH. Soil environment and type of crops grown under different cropping systems play a significant role in relation to soil pH. In the strip of the cotton crop, treatment of sole *G. hirsutum* cotton (AKH-081) and *G. hirsutum* hybrid (Balwan) and *G. hirsutum* cotton (AKH-081) + soybean-mustard and *G. hirsutum* hybrid (Balwan) + soybean-mustard crop showed the higher value of available N, P and K than rest of the treatments. But differences did not reached to the levels of significancy. Available P and K status of the surface soil did not shown the significant differences in cropping patterns and also in nutrients management treatments. The value of available phosphorus and potassium increased than initial value with application of RDF as well as by INM. Vertisols are generally rich in K content, and application of potassic fertilizers is not recommended in some pockets to these soils.

Nevertheless, the importance of K in regulating and improving water functions in plant system and enabling the crop to withstand drought under rainfed conditions where intermittent dry spells are usual, cannot be undermined. Similar, observation was made by Bharadwaj *et al.*, (1994).

Table 7: Chemical properties of soil pH, EC and OC as influenced by the various treatments

Treatments	pH (1:2.5)		EC (dS m^{-1})		OC (g kg^{-1})	
	Cotton	Soybean	Cotton	Soybean	Cotton	Soybean
T^1 - Sole *G. hirsutum cotton* (AKH-081) 45x15cm	7.96	-	0.30	-	5.24	-
T^2 - Sole *G. hirsutum* hybrid *(Bt. Cotton* Balwan) 45x60cm	7.95	-	0.31	-	5.24	-
T^3 - Sole *G. arboreum cotton* (AKA-7) 45x15cm	7.96	-	0.30	-	5.23	-
T^4- Sole Soybean (JS-335) (45x5cm)(6:6)-mustard (ACN- 9) 45x15cm	-	7.92	-	0.29	-	5.28
T^5- *G. hirsutum* cotton (AKH-081) 45x15cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	7.95	7.93	0.29	0.30	5.25	5.27
T^6- *G. hirsutum* hybrid *(Bt. Cotton)* (Balwan) 45x60cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	7.94	7.94	0.29	0.29	5.24	5.26
T^7- *G. arboreum cotton (AKA-7)* + soybean (6:6)-mustard (ACN- 9) 45x15cm	7.94	7.92	0.29	0.30	5.23	5.24
S.Em.	0.005		0.003		0.004	
C.D. at 5 %	NS		NS		NS	
Initial Value	7.95		0.29		5.22	

Table 8: Available Nutrients (Kg ha^{-1}) of soil as influenced by the various treatments

Treatments	Available Nutrients (Kg ha^{-1})					
	N		P		K	
	Cotton	Soybean	Cotton	Soybean	Cotton	Soybean
T^1 - Sole *G. hirsutum cotton* (AKH-081) 45x15cm	237.64	-	18.73	-	338.34	-
T^2 - Sole *G. hirsutum* hybrid *(Bt. Cotton* Balwan) 45x60cm	238.42	-	18.95	-	341.50	-
T^3 - Sole *G. arboreum cotton* (AKA-7) 45x15cm	236.46	-	18.64	-	337.36	-
T^4- Sole Soybean (JS-335) (45x5cm)(6:6)-mustard (ACN- 9) 45x15cm	-	240.07	-	19.74	-	344.68
T^5 - *G. hirsutum* cotton (AKH-081) 45x15cm + soybean (6:6)-mustard (ACN- 9) 45x15cm	236.83	238.93	18.67	19.32	342.46	342.65
T^6- *G. hirsutum* hybrid *(Bt. Cotton)* (Balwan) 45x60cm + soybean (6:6)-mustard (ACN-9) 45x15cm	238.52	238.30	18.57	18.26	343.45	344.14
T^7- *G. arboreum cotton (AKA-7)* + soybean (6:6)-mustard (ACN- 9) 45x15cm	235.17	238.22	18.71	18.57	340.49	343.69
S.Em.	0.49		0.19		0.95	
C.D. at 5 %	NS		NS		NS	
Initial Value	235.8		19.2		335.8	

Conclusion

Hence, it is concluded that under HDPS, *G. arboreum cotton AKA-7* + soybean (6:6)-mustard (ACN-9) with 38:40:25 NPK kg ha^{-1} for kharif season and 20:10:10 NPK kg ha^{-1} for rabi season recorded significantly higher monetary returns, rainwater use efficiency, system productivity and system profitability than rest of the treatments in strip intercropping system under dryland conditions.

Refernces

1. Bharadwaj RBL, Tandon HLS. Fertilizer use research in some wheat based cropping system. Fertilizer News. 1981; 26(9):23-32.
2. Bhartati V, Nandan R, Kumar V, Pandey IB. Effect of irrigation levels on yield, water use efficiency and economics of winter maize (*Zea mays*) - based intercropping systems. Indian Journal of Agronomy. 2007; 52(1):27-30.
3. Bonde WC, Raju AR. Effect of varying plant densities and fertilizer levels on rainfed cotton yields in vertisols. J Indian Soc. Cotton Improvement. 1996; 21:50-55.
4. Chittapur BM. Cotton based cropping systems for sustained productivity. International Symposium on "Strategies for Sustainable Cotton Production: A Global Vision". Crop Production, 23-25 November, University of Agriculture Science, Dharwad, Karnataka (India), 2004.
5. Gill MS, Ahlawat IPS. Crop diversification and its role towards sustainability and profitability. Indian Journal of fertilizers. 2006; 2(9):125-138, 150.
6. Goswami VK, Kaushik SK, Gautam RC. Effect of intercropping and weed control on nutrient uptake and water use efficiency of pearlmillet (*Pennisetum glaucum*) under rainfed conditions. Indian Journal of Agronomy. 2002; 47(4):504-508.
7. Hulugalle NR, Lal R. Soil-water balance of intercropped maize and cowpea grown in a tropical hydromorphic soil in western Nigeria. Agron. J. 1986; 77:86-90.
8. Jagvirsingh, Venugopal MV, Kairon MS. Effect of cotton based cropping system and nutrient management in the productivity and soil fertility of rainfed vertisols. Extended summaries. International conference on managing natural resources, February 14-18, New Delhi, India. 2000; 3:945-946.
9. Sankaranarayanan K, Nalayini P, Praharaj. Multitier cropping system to enhance resource utilization, profitability and sustainability of Bt. cotton (*Gossypium hirsutum*) production system. Indian Journal of Agricultural Science. 2012; 82(12):1044-1050.
10. Tanaka DL, Krupinsky JM, Merrill SD, Liebig MA, Hanson JD. Dynamic cropping systems, 2007.
11. Tetarwal JP, Rana KS. Impact of cropping system, fertility levels and moisture conservation practices the sustainability of long-term intensive cropping systems in India. Journal of Sustainable Agriculture. 2006; 24(4):39-56.
12. Timsina J, Singh U, Badaruddin M, Meisner C, Amin MR. Cultivar, nitrogen, and water effects on productivity, and nitrogen-use efficiency and balance for rice-wheat sequences of Bangladesh. Field Crops Res. 2001; 72:143-161.

13. Turkhede AB, Nagdeve MB, Karunakar AP, Gabhane VV, Mohod VD, Mali RS. Diversification in Cotton Based Cropping System under Mechanization in Rainfed Condition of Vidarbha of Maharashtra, India. Int. J. Curr. Microbiol. App. Sci. 2017; 6(9):2189-2206.
14. Venugopal K, Gopalkrishnan N, Guruanajan KN. Sustainability of production potential of cotton and cotton based cropping system. Extended summaries. International conference on managing natural resources, February 14-18, New Delhi, India. 2000; 3:947-949.