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## Performance of intercrops and levels of fertilizers in cotton AKH- 9916 (*Gossypium hirsutum*) under dryland condition

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**Abstract**

The present study was conducted in vertisols during the year 2015-16 to 2017-18 at All India Coordinator Research Project for Dryland Agriculture, Dr. PDKV, Akola (M.S.). The main objectives of the study was to know the suitable row proportions and fertilizer levels in cotton + vegetable intercropping system for higher production and economic returns under dryland conditions of Vidarbha region of Maharashtra. On the basis of pooled data, results revealed that sowing of cotton at 90 x 20 cm spacing recorded significantly higher seed cotton yield (1354 kg ha<sup>-1</sup>) and found being at par with the treatments of intercropping of cotton + cowpea (1329 kg ha<sup>-1</sup>) and cotton + clusterbean (1310 kg ha<sup>-1</sup>) in 1:1 row proportion than rest of the treatments. The lowest seed cotton yield was recorded in the treatments of cotton + okra in 1:1 and 1:2 row proportion *i.e.* 890 and 733 kg ha<sup>-1</sup> respectively. Intercropping of cotton + cowpea and cotton + clusterbean in 1:1 row proportion found being at par in respect of cotton equivalent yield (2373 and 2347 kg ha<sup>-1</sup>), NMR (Rs. 62,622/- and 64,907/- ha<sup>-1</sup>), B:C ratio (2.10 and 2.13) and rainwater use efficiency (3.62 and 3.58 kg ha<sup>-1</sup> mm<sup>-1</sup>). An application of 125 % RDF (75:37.5:37.5 NPK kg ha<sup>-1</sup>) recorded higher seed cotton yield (1156 kg ha<sup>-1</sup>) seed cotton equivalent yield (1992 kg ha<sup>-1</sup>), NMR (Rs. 50317/- ha<sup>-1</sup>) and the higher value of B:C ratio (1.95) and RWUE (3.07 kg ha<sup>-1</sup> mm). The parameters such as crop productivity, system productivity, crop profitability and system profitability were also found being at par in the treatments of cotton + cowpea and cotton + clusterbean in 1:1 row proportion with 125 % RDF.

**Keywords:** row proportion, vegetable intercrops and fertility levels

**Introduction**

Cotton system is ideally suitable for intercropping because of the relatively longer duration and its slow growth in the initial stages. The objective of intercropping is to obtain a maximum yield of cotton along with additional returns from intercrops. The common practice of cotton cultivation is inter or mixed cropping with pulses. However, the monetary advantage of pulses intercropping is meager. In addition to that existing low price situation for cotton is discouraging cotton cultivation. To overcome the above situation, intercropping of high value vegetable crops is one of the viable options. While considering the inconsistency in performance and price fluctuation of vegetable crops, intercropping of vegetables with different growth habits are aimed. The intercropping system experiment was conducted with an objective to find out the suitable cotton based vegetable intercropping system for higher production and economic return.

**Materials and Methods**

The field experiment entitled "Performance of intercrops and levels of fertilizers in *hirsutum* cotton AKH- 9916 under dryland condition" was conducted during *kharif* 2015-16 to 2017-18 at AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS). The soil of experimental plot was clayey in texture, slightly alkaline in reaction (7.95), EC (dSm<sup>-1</sup>) 0.29, medium in organic carbon 5.22 (g kg<sup>-1</sup>) and available nitrogen (235.8 kg ha<sup>-1</sup>), low in available phosphorus (19.2 kg ha<sup>-1</sup>) but having fairly rich status in available potassium (335.8 kg ha<sup>-1</sup>). The depth of the soil was 132.5 cm, FC 33.2%, PWP 14.5 % and BD (1.37 Mg m<sup>-3</sup>).

The experiment was laid out in factorial randomized block design with three replication with 14 treatment combinations *i.e.* sole cotton, cotton+ cowpea (1:1), cotton+ cowpea (1:2), cotton+ clusterbean (1:1), cotton+ clusterbean (1:2), cotton+ okra (1:1) and cotton+ okra (1:2)

with two fertility levels 100 and 125 % RDF (half N and full P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O applied at the time of sowing to cotton as well as to the vegetables crops and remaining half N applied one month after sowing to cotton crop only). Rainfall received during the cropping period of experiment was 644.6, 735.7 and 492.9 in 28, 45 and 42 rainy days respectively during kharif 2015-16 to 2017-18.

## Results and Discussion

### Seed cotton yield and cotton stalk yield

Seed cotton yield was reduced due to intercropping either in 1:1 and 1:2 row proportions compared to sole cotton. During the years 2015-16, 2016-17, 2017-18 and also in pooled, results indicated that sole cotton sown at 90 x 20 cm spacing recorded significantly higher seed cotton yield and found being at par with the intercropping treatments of cotton + cowpea and cotton + clusterbean in 1:1 row proportions over rest of the treatments.

Among the intercrops, the yield of cowpea and clusterbean were more in row proportion of 1:2 and less in some extent in 1:1 row proportions. Cotton + okra in 1:1 row proportion was recorded higher yield and lowest yield in 1:2 row proportions. Same trend of results were also recorded in stalk yield of cotton and straw yield of vegetables in intercropping system.

The higher yield of sole cotton and the treatments of cotton + cowpea and cotton + clusterbean intercropping system in 1:1 row proportion reflected higher seed cotton yield compared to other treatments. This might be due to favorable effect or no effect of cowpea and clusterbean in 1:1 row proportions on cotton growth as there was no interplant competition for growth as well as the yield attributing characters. However, All the growth yield parameters were reduced in cotton + okra in 1:1 and 1:2 and cotton + cowpea and cotton + clusterbean with 1:2 row proportion due to their profuse growth and

competition for growth resources for longer period in between the intercrops as well as with the cotton. This may be attributed to fast growing habit of okra and clusterbean which smothered the cotton crop in early stage and produced competition for longer period. Similar results were reported by Kubsad *et al.* (2004) [4], Meena *et al.* (2007) [6], Velmurugan *et al.* (2012) [14] on cotton intercropped with clusterbean and Hallikeri *et al.* (2007) [3] on cotton intercropped with vegetables.

During the years 2015-16, 2016-17 and in pooled mean, the results showed that 125 % RDF (75:37.5:37.5 NPK kg ha<sup>-1</sup>) recorded significantly higher seed cotton yield and higher cotton stalk yield. Vegetables as well as the straw yield of vegetables also recorded higher value at 125 % RDF. However, during the year 2017-18, seed cotton yield and cotton stalk yield found to be non-significant.

The various levels of fertility had significant effect on seed cotton yield. On the basis of pooled analysis, results showed that seed cotton yield increased from 1067 kg ha<sup>-1</sup> with 100% RDF to 1156 kg ha<sup>-1</sup> with 125% RDF, which accounted for 3.29 per cent increase. Cotton stalk yield and vegetable straw yield showed the same trend of results with higher fertility levels (125 %) of nutrients. The higher dose of (125%) NPK kg ha<sup>-1</sup> to cotton and vegetable crops, which supply the balanced and favorable nutrients to the cotton crop physically, chemically and biologically resulted in increased plant growth and yield attributes which finally lead to increased seed cotton yield & stalk yield along with vegetable yield & vegetable stalk yield. These results are in line with Sankarnarayan *et al.* (2004) [8], Suresh and Chellamuthu (2004) [13] and Ghongane *et al.* (2009) [2] who reported that application of 150 per cent RDF resulted in significantly higher seed cotton yield and yield attributing characters in cotton due to combined effect of nitrogen, phosphorous and potassium.

**Table 1:** Seed cotton yield and cotton stalk yield as influenced by the various treatments

Treatments	Yield (Kg ha <sup>-1</sup> )							
	Seed cotton yield				Cotton Stalk Yield			
	2015-16	2016-17	2017-18	Pooled	2015-16	2016-17	2017-18	Pooled
<b>A. Intercrops</b>								
Sole cotton	1445	2062	554	1354	2284	2962	815	2020
Cotton+ Cowpea (1:1)	1401	2036	550	1329	2185	2877	754	1939
Cotton+ Cowpea (1:2)	1228	1540	492	1086	1793	2143	747	1561
Cotton+ Clusterbean (1:1)	1395	2005	529	1310	2162	2856	743	1920
Cotton+ Clusterbean (1:2)	1196	1550	518	1077	1805	2101	727	1409
Cotton+ Okra (1:1)	1144	1103	423	890	1545	1502	644	1230
Cotton+ Okra (1:2)	869	974	358	733	1112	1294	624	1010
S.Em. ±	44.8	20.9	21.6	26.2	62.8	32.4	30.7	44.2
C.D. at 5%	130.3	61.1	62.8	76.2	182.7	94.2	89.5	128.5
<b>B. Fertility levels</b>								
620 100 % RDF	1196	1526	483	1067	1776	2111	703	1483
621 125 % RDF	1283	1694	495	1156	1905	2385	742	1668
S.Em. ±	29.33	6.00	11.5	14.0	41.2	9.26	16.5	23.6
C.D. at 5%	85.29	17.4	NS	40.7	119.6	16.7	NS	68.7
<b>C. Interaction effect</b>								
S.Em. ±	8.85	41.9	30.5	37.1	10.4	64.7	43.5	62.5
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	9.11	8.82	10.8		9.88	11.20	10.44	

**Table 2:** Intercrop vegetable and straw yield as influenced by the various treatments

Treatments	Yield (Kg ha <sup>-1</sup> )							
	Seed cotton yield				Cotton Stalk Yield			
	2015-16	2016-17	2017-18	Pooled	2015-16	2016-17	2017-18	Mean
<b>A. Intercrops</b>								
Sole cotton	-	-	-	-	-	-	-	-
Cotton+ Cowpea (1:1)	2881	3604	1143	2543	3601	3785	1171	2852

Cotton+ Cowpea (1:2)	2912	3733	1221	2622	3757	3919	1400	3025
Cotton+ Clusterbean (1:1)	2868	3597	1119	2528	3756	3669	1117	2847
Cotton+ Clusterbean (1:2)	2934	3618	1133	2561	3843	3690	1441	2991
Cotton+ Okra (1:1)	2051	2348	963	1788	2790	3029	1391	2403
Cotton+ Okra (1:2)	1777	2596	1077	1817	2435	3349	1430	2405
<b>B. Fertility levels</b>								
100 % RDF	2114	3165	1091	1921	2766	3484	1313	2293
125 % RDF	2292	3334	1127	2039	3001	3663	1336	2428

### Cotton equivalent yield

During the year 2015-16, 2016-17 and 2017-18 in pooled data, results showed that the treatments of intercrops of cotton + cowpea and cotton + clusterbean in 1:1 row proportion were being at par and recorded significantly higher cotton equivalent yield than rest of the treatments. Seed cotton equivalent yield increase due to better productivity of cotton and intercrops of cowpea and clusterbean in 1:1 row proportion than 1:2 row proportion and their remunerative market prices than the intercrop of okra. Okra significantly reduces the yield of cotton and increases the infestation of cotton bollworms causing reduction in yield of cotton as well as the okra in 1:1 and 1:2 row proportions. Kumar *et al.* (2017) [5] reported that in intercropping of cotton + cowpea and cotton + clusterbean higher seed cotton equivalent yield is recorded than rest of the treatments. When cotton intercropped with cowpea and clusterbean, higher average seed cotton equivalent yield recorded in intercropping system than sole cotton because of yield of intercrops were higher than their sole treatments. The market price was also higher as

clusterbean and cowpea were used as vegetable purpose. Similar, results were also reported by the workers by Chellaiah and Gopalswamy (2001) [1] at Srivilliputtur (T.N.), Nandini and Chellamuthu (2004) [7] at Dharwad, Venkataraman, (2008) [15] at Kovilpatti (T.N.), Sankarnaryanan *et al.* (2012) [9] at CICR Coimbtour and Velmurgan *et al.* (2012) [14] at Adilabad (Andhra Pradesh).

The various levels of fertility had significant effect on yield of seed cotton equivalent yield. Seed cotton equivalent yield increased from 1855 kg ha<sup>-1</sup> with 100 % RDF to 1992 kg ha<sup>-1</sup> with 125 % RDF, which accounted for 6.14 per cent increase. The higher dose of (125%) NPK kg ha<sup>-1</sup> to cotton and vegetables crops supplied the balanced and favorable nutrients to cotton crop physically, chemically and biologically resulting in increased plant growth and yield attributes which finally led to increased cotton equivalent yield. Similar, results were also reported by the workers viz Suresh and Chellamuthu (2004) [13] and Ghongane *et al.* (2009) [2].

**Table 3:** Seed cotton equivalent yield as influenced by the various treatments

Treatments	Cotton Equivalent Yield (Kg ha <sup>-1</sup> )			
	2015-16	2016-17	2017-18	Pooled
<b>A. Intercrops</b>				
Sole cotton	1445	2062	554	1354
Cotton+ Cowpea (1:1)	2320	3466	1019	2373
Cotton+ Cowpea (1:2)	2157	3020	993	2163
Cotton+ Clusterbean (1:1)	2310	3432	988	2347
Cotton+ Clusterbean (1:2)	2132	2985	983	2128
Cotton+ Okra (1:1)	1799	2034	818	1624
Cotton+ Okra (1:2)	1436	2003	800	1479
S.Em. ±	50.08	27.42	30.4	32.5
C.D. at 5%	145.61	79.72	88.5	94.5
<b>B. Fertility levels</b>				
100 % RDF	1871	2602	867	1855
125 % RDF	2014	2827	892	1992
S.Em. ±	32.78	7.83	16.3	17.4
C.D. at 5%	95.32	22.78	NS	50.5
<b>C. Interaction effect</b>				
S.Em. ±	144.5	54.8	43.0	46.0
C.D. at 5%	NS	159.4	NS	NS
C.V. %	8.12	7.29	8.48	

### Economics

During the year, 2015-16, 2016-17 and 2017-18 and in pooled, the results revealed that, intercropping of cotton + cowpea and cotton + clusterbean in 1:1 row proportion gave significantly higher gross monetary returns and net monetary returns. However, during the year 2017-18, treatments of cotton + cowpea and cotton + clusterbean in 1:1 and 1:2 row

proportion were being at par and recorded significantly higher gross monetary returns than rest of the treatments. Treatments of cotton + okra in 1:1 and 1:2 row proportions recorded lowest gross monetary returns.

An application of 125 per cent RDF recorded significantly higher gross monetary returns (Rs. 87242 ha<sup>-1</sup>) and net monetary returns (Rs.50317 ha<sup>-1</sup>).

**Table 4:** Gross monetary returns as influenced by the various treatments

Treatments	Gross Monetary Returns (Rs. ha <sup>-1</sup> )			Pooled
	2015-16	2016-17	2017-18	
<b>Intercrops</b>				
Sole cotton	70791	89461	23307	61186
Cotton+ Cowpea (1:1)	115377	151565	43089	103343
Cotton+ Cowpea (1:2)	107392	132232	42249	93958
Cotton+ Clusterbean (1:1)	115017	150005	41768	102264
Cotton+ Clusterbean (1:2)	106296	130485	41874	92885
Cotton+ Okra (1:1)	89267	89537	35073	71292
Cotton+ Okra (1:2)	71301	88303	34386	64663
S.Em. ±	2462	1196	1240	1438
C.D. at 5%	7158	3478	3605	4181
<b>Fertility levels</b>				
100 % RDF	92921	113862	36856	81213
125 % RDF	100062	123735	37928	87242
S.Em. ±	1315	342	662	769
C.D. at 5%	3825	994	NS	2235
<b>Interaction effect</b>				
S.Em. ±	3481	2392	1753	2033
C.D. at 5%	NS	6957	NS	NS

**Table 5:** Market rates for Cotton and vegetable intercrops

Market Rates (Rs q <sup>-1</sup> )	2015-16	2016-17	2016-17
Seed Cotton	4700/-	4150/-	4020/-
Cowpea(Vegetable)	1500/-	1650/-	1650/-
Clusterbean (Vegetable)	1500/-	1650/-	1650/-
Okra (Vegetable)	1500/-	1650/-	1650/-
Cotton Stalk	125/-	125/-	125/-
Clusterbean straw	100/-	100/-	100/-
Cowpea straw	100/-	100/-	100/-
Okra	75/-	75/-	100/-

**Table 6:** Net monetary returns as influenced by the various treatments

Treatments	Net Monetary Returns (Rs ha <sup>-1</sup> )			
	2015-16	2016-17	2017-18	Pooled
<b>Intercrops</b>				
Sole cotton	39559	48184	-4365	33514
Cotton+ Cowpea (1:1)	65865	87915	2967	62622
Cotton+ Cowpea (1:2)	54967	64321	-3067	48646
Cotton+ Clusterbean (1:1)	66582	86453	4412	64907
Cotton+ Clusterbean (1:2)	56124	65417	4592	55604
Cotton+ Okra (1:1)	45484	40750	5189	41409
Cotton+ Okra (1:2)	27188	37604	2869	30560
S.Em. ±	2462	1196	1240	1438
C.D. at 5%	7158	3479	3605	4182
<b>Fertility levels</b>				
100 % RDF	48349	56977	1648	46043
125 % RDF	53299	66064	1743	50317
S.Em. ±	1315	342	662	769
C.D. at 5%	3825	994	NS	2235
<b>Interaction effect</b>				
S.Em. ±	3481	2392	1753	2033
C.D. at 5%	NS	NS	NS	NS

**B:C ratio**

During the year 2015-16 to 2017-18 and also in pooled analysis results revealed that cotton + cowpea (2.10) and cotton + clusterbean (2.13) in 1:1 row proportions recorded

higher values of B:C ratio than rest of the intercropping treatments. Fertility levels showed difference in respect of economics. An application of 125 per cent RDF recorded higher value of B:C ratio (1.95) than 100 % RDF (1.90).

**Table 7:** B:C Ratio and cost of cultivation as influenced by the various treatments

Treatments	B:C Ratio				COC			
	2015-16	2016-17	2017-18	Mean	2015-16	2016-17	2017-18	Mean
<b>Intercrops</b>								
Sole cotton	2.27	2.17	0.84	1.93	31232	41278	27672	31669
Cotton+ Cowpea (1:1)	2.33	2.38	1.06	2.10	49513	63649	40722	51300
Cotton+ Cowpea (1:2)	2.05	1.95	0.93	1.70	52426	67911	45312	55102
Cotton+ Clusterbean (1:1)	2.37	2.36	1.12	2.13	48435	63552	37357	48027
Cotton+ Clusterbean (1:2)	2.12	2.01	1.12	1.99	50171	65068	37281	46752
Cotton+ Okra (1:1)	2.04	1.84	1.17	1.96	43783	48788	29884	36343
Cotton+ Okra (1:2)	1.62	1.74	1.09	1.76	44113	50700	31517	36757
<b>Fertility levels</b>								
100 % RDF	2.08	1.99	1.05	1.90	44572	56884	35170	42794
125 % RDF	2.14	2.13	1.06	1.95	46763	57671	36186	44620

Generally, intercropping was found to be more remunerative than the cultivation of sole crops only. Increase in net monetary returns with intercropping of clusterbean and cowpea are due to the increased value of cotton equivalent yield. This was fully compensated due to higher yield of intercropping. Secondly, higher productivity of vegetable intercropping viz. cowpea and clusterbean and higher market rates also recorded higher value of B:C ratio. Hallikari *et al.* (2007) [3] reported that cotton with potato (1:1), tomato (1:1), coriander (1:2) and beans (1:1) found profitable over sole cotton under assured rainfall conditions at Karnataka. Kumar *et al.* (2017) [5] recorded higher economics returns than sole cotton. On the similar lines, cropping system did not influence seed cotton yield but additional yield of intercropping make system more remunerative over the sole cotton which are in confirmation with the results of Seema Sepat and Ahlawat (2010) [10]. Intercropping practice stabilizes the productivity besides enhancing the total returns (Singh *et al.* 2009 and Singh and

Ahlawat 2011) [12, 11].

### Productivity and profitability of cropping systems

Crop duration was numerically found maximum (181 days) under treatments of sole cotton and cotton + vegetables intercropping.

Crop productivity and system productivity of cotton + vegetables intercropping system on the basis of cotton equivalent yield was found being at par with the treatments of cotton + cowpea and cotton + clusterbean in 1:1 row proportion (12.53 and 6.50 kg ha<sup>-1</sup>day<sup>-1</sup>) and (12.39 and 6.43 kg ha<sup>-1</sup>day<sup>-1</sup>) than rest of the treatments.

Crop & System productivity as compared to Crop & System profitability of cotton + vegetables intercropping system on the basis of net monetary returns were being at par with the treatments of cotton + cowpea and cotton + clusterbean in 1:1 row proportion (345.98 and 358.60 Rs ha<sup>-1</sup>day<sup>-1</sup>) and (171.57 and 177.83 kg ha<sup>-1</sup>day<sup>-1</sup>) than rest of the treatments.

**Table 8:** System productivity and system profitability on the basis of cotton equivalent yield and net monetary returns as influenced by various treatments

Treatments	System Productivity (Kg ha <sup>-1</sup> day <sup>-1</sup> )		System Profitability (Rs. ha <sup>-1</sup> day <sup>-1</sup> )	
	Crop Productivity	System Productivity	Crop Profitability	System Profitability
Intercrops	181 Days	365 Days	181 ys	365 Days
Sole cotton	7.48	3.71	185.16	91.82
Cotton+ Cowpea (1:1)	12.53	6.50	345.98	171.57
Cotton+ Cowpea (1:2)	11.36	5.92	268.76	133.28
Cotton+ Clusterbean (1:1)	12.39	6.43	358.60	177.83
Cotton+ Clusterbean (1:2)	11.23	5.83	307.20	152.34
Cotton+ Okra (1:1)	8.57	4.45	228.78	113.45
Cotton+ Okra (1:2)	7.81	4.05	168.84	83.73
S.Em. ±	0.18	0.09	7.95	3.94
C.D. at 5%	0.51	0.26	23.10	11.46
<b>Fertility levels</b>				
100 % RDF	9.83	5.08	254.38	126.15
125 % RDF	10.56	5.46	278.00	137.86
S.Em. ±	0.09	0.05	4.25	2.11
C.D. at 5%	0.27	0.14	12.35	6.12
<b>Interaction effect</b>				
S.Em. ±	0.25	0.13	11.2	5.57
C.D. at 5%	NS	NS	NS	NS

### Conclusion

On the basis of three years of analyzed data it is concluded that the cotton + cowpea and cotton + clusterbean in 1:1 row proportion along with 125 % RDF (75:37.5:37.5 NPK kg ha<sup>-1</sup>) resulted in higher cotton equivalent yield, NMR, B:C ratio, system productivity and system profitability under rainfed conditions.

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