Economic evaluation of crop management practices under cotton based intercropping system in Vertisol

Payal Hadke, Dr. RN Katkar, Dr. VV Gabhane, Dr. NM Konde, Dr. AN Pasalawar and RD Walke

DOI: https://doi.org/10.22271/chemi.2020.v8.i6ap.11919

Abstract
Economic evaluation of crop management practices under cotton based intercropping system in Vertisol was investigated during 2015-16 and 2016-17 on Research Farm, Department of Soil Science and Agriculture Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The treatments comprised of control (only cotton), and cotton based intercropping systems viz. cotton + dhaincha (1:1), cotton + sunhemp (1:1), cotton + green gram (1:1), cotton + cow pea (1:1), cotton + black gram (1:1), cotton + pigeon pea (6:2) and cotton + soybean (1:1) which were executed in randomized block design with three replications. The highest seed cotton yield, gross monetary return and B: C ratio was registered with cotton + black gram intercropping system (1:1).

Keywords: Intercropping, dhaincha, black gram, gross monetary return

Introduction
Cotton is one of the most important fiber and cash crop of India. It plays a key role in Indian economy. It is globally known as ‘king of fiber’. Cotton seed contain 15-20% oil and used as vegetable oil in soap industries. The left over cake, a byproduct of cotton mill is very good vegetable fat for livestock. In India cotton is grown on 122.38 lakh ha area, with 361 lakh bales production and 501 kg ha⁻¹ yield. In Maharashtra it is grown on 41.19 lakh ha area with 81.00 lakh bales production and 334 kg ha⁻¹ yield (Anonymous, 2018) [1]. The reasons for low productivity includes erratic distribution of rainfall, imbalanced fertilizer use, poor quality seed, low adoption of improved agro-techniques and decline in soil health. Therefore, adoption of proper crop management strategies is necessary to increase productivity and fertility of soil by increasing soil carbon sequestration under cotton based intercropping system. The amount of SOC declines (Arrouays and Pelisser, 1994) [2] when the land area under agricultural activity is increased to produce more food grains. In Vertisols, of central India, integrated soil management (e.g., conservation tillage for erosion control, water harvesting, soil-fertility management, and legume-based rotations), increased grain yield from 1 Mg ha⁻¹ under traditional systems to 4.7 Mg ha⁻¹ with an attendant increase in the SOC pool and improvement in soil quality Wani et al. (2003) [15]. The decline in SOC leading to poor soil health, it is necessary to adopt proper intercropping in soil health and economic point of view. The impact of different intercropping and their biomass addition to soil on soil physical, chemical and biological properties and different carbon pool needs to be ascertained with economic benefit.

Material and Method
The field experiment was conducted on Research Farm, Department of Soil Science and Agriculture Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. There were eight treatments with three replications in randomised block design. The experimental site was located between 22.42°N latitude and 77.02°E longitude at an altitude of 307.42 m above the mean sea level and has a subtropical climate. The soil of the experimental site was clayey in nature and slightly alkaline having pH 8.02 (Jackson, 1973) [4], non – saline with medium calcareous (Jackson 1973) [4] and moderate in soil organic carbon (Jackson 1973) [4].
Soil fertility status indicated low in available nitrogen (Subbiah and Asija 1956) [33], medium in available phosphorous (Watanabe and Olsen, 1965) [16], high in available potassium (Jackson 1973) [4] and medium in available sulphur (Chesnin and Yien, 1951) [9]. In case of micronutrients sufficient in DTPA – Zinc, iron, manganese and copper (Lindsay and Norvell 1978) [8] at the start of experiment (Table1).

Table 1: Physical and chemical properties of soils at start of experiment (kharif, 2015-16)

| Sr. No. | Particulars | Value |
|--------|-------------|-------|
| 1      | Bulk density (Mg m⁻³) | 1.36  |
| 2      | Mean weight diameter (mm) | 0.60  |
| 3      | hydraulic conductivity (cm hr⁻¹) | 0.68  |

A. Physical properties

B. Chemical properties

The experiment was laid out in a randomized block design (RBD) on the same site with three replications having eight treatments, that is, T1 - control (only cotton), T2 - Cotton + Dhainchana (1:1), T3 - Cotton + Sunhemp (1:1), T4 - Cotton + Green gram (1:1), T5 - Cotton + Cow pea (1:1), T6 - Cotton + Black gram (1:1), T7 - Cotton + pigeon pea (6:2), T8 - Cotton + Soybean (1:1). Sowing of cotton was done at 90 X 45 cm spacing. Intercrops were grown in between two rows of cotton crop. The *in situ* incorporation of dhainchana and sunhemp was done 45 and 30 days after sowing respectively. The incorporation of green gram, cow pea, black gram and soybean was done after pod picking. Shaded leaf litter incorporation of green gram, cow pea, black gram and soybean was done 45 and 30 days after sowing respectively. The results during first year of study revealed that, highest seed cotton yield (10.41 q ha⁻¹) was recorded in the treatment of cotton + dhainchana (1:1) intercropping system which was found at par with cotton+ sunhemp (1:1) (10 q ha⁻¹), cotton + black gram (1:1) (9.75 q ha⁻¹), cotton + cow pea (1:1) (8.96 q ha⁻¹), cotton + green gram (1:1) (8.73 q ha⁻¹) intercropping system. The pooled results revealed that cotton + dhainchana (1:1) intercropping system recorded significantly highest seed cotton yield (13.57 q ha⁻¹) as compared to all treatments and found at par with cotton + sunhemp (1:1) (12.68 q ha⁻¹) and cotton + black gram (1:1) (12.45 q ha⁻¹). This could be attributed to the green manuring effect of dhainchana and sunhemp in cotton.

This may be ascribed to the improvement in the soil physical, chemical and biological properties due to *in situ* incorporation of dhainchana along with recommended dose of fertilizers which might have hastened the nutrient availability as well as better soil condition for root penetration. The results are in close agreement with the findings reported by Singh et al. (2013) [11, 13], Thimma Reddy et al. (2013) [14].

Monetary return

Gross monetary returns (GMR)

The gross monetary returns ranged from Rs. 33210 to 52829 and Rs. 46675 to 84122 per hectare during first and second year respectively. The results during first year and second year of study indicated that, treatment of cotton + black gram (1:1) intercropping system recorded highest gross monetary returns i.e. (Rs. 52829 ha⁻¹) and (Rs. 84122 ha⁻¹) respectively. The highest average gross monetary returns Rs. 68476 ha⁻¹ was also observed with treatment cotton + black gram (1:1) intercropping system.

The findings are in line with the results reported by Katkar et al. (2008) [15, 6] reported that highest GMR in the treatment of cotton crop residue @ 2.5 t ha⁻¹ + vermicompost @ 2.5 t ha⁻¹ + 50% RDF (T9) (Rs. 28,763 ha⁻¹) and at par with 100 per cent recommended dose of fertilizer (Rs. 28,488 ha⁻¹), cotton crop residue @ 2.5 t ha⁻¹ + glycridica green foliage lopping at 30 DAE @ 2.5 t ha⁻¹ + 50% RDF (T10) (Rs. 27,427 ha⁻¹), sunhemp in *in situ* green manuring at 30 DAE + 50% RDF (T11) (Rs. 27,326 ha⁻¹) (Hongal et al, 2004) and greengram intercrop residue incorporation after plucking of pods + 50% RDF (T12) (Rs. 24,656 ha⁻¹).

Cost of cultivation (COC)

The cost of cultivation ranged from Rs.45406 to 47505 and Rs. 35624 to 37691 per hectare during first and second year respectively. The results during first year and second year of study noted that, treatment cotton + soybean (1:1) intercropping system recorded highest cost of cultivation i.e. (Rs. 47505 ha⁻¹) and (Rs. 37691 ha⁻¹) respectively. The highest average cost of cultivation Rs.42598 ha⁻¹ was also recorded with treatment cotton + soybean (1:1) intercropping system.

Net monetary returns (NMR)

The net monetary returns ranged from Rs. -12196 to 6615 and Rs. 11051 to 47376 per hectare during first and second year respectively. The results during first year and second year of study observed that, treatment of cotton + black gram (1:1)
intercropping system recorded highest net monetary returns i.e. (Rs. 6615 ha\(^{-1}\)) and (Rs. 47376 ha\(^{-1}\)) respectively. The highest average net monetary returns Rs. 26996 ha\(^{-1}\) was also recorded with treatment of cotton + black gram (1:1) intercropping system.

**B:C ratio**

The B: C ratio ranged from 0.73 to 1.14 and 1.31 to 2.29 during first and second year respectively. The results during first year and second year of study emanated that, treatment of cotton + black gram (1:1) intercropping system recorded highest B:C ratio i.e. 1.14 and 2.29 respectively. The highest average B:C ratio 1.72 was also resulted with treatment cotton + black gram (1:1) intercropping system.

The Similar results were in line with the results reported by katkar (2008) \(^5\) \(^6\) treatment receiving 100 per cent recommended dose of fertilizer recorded highest BC ratio followed by sunhemp in situ green manuring at 30 DAE + 50% RDF (T\(_6\)) during both the years of investigations and pooled mean also indicated the similar trend. This can be attributed to the higher costs of organic manures.

Similar results were also recorded by Kulandaivel et al. (2001) \(^7\) revealed that dry matter production of cotton at boll maturity was significantly higher in cotton + black gram intercropping system than sole cropping of cotton. Due to slow growing nature of cotton much of vacant interspaces remains unutilized during initial stages of crop growth this situation offers ample scope for raising intercrops Nehra et al (1990) \(^10\).

Similar results were also emanated by Muruganandam (1984) \(^9\) reported that intercropping with short, early maturing pulses like black gram, green gram and cluster bean can be advantageously improves the fertility status of soil. Sivakumar (2003) \(^12\) observed increased productivity with higher market value and enhanced profitability when pulses were intercropped with cotton.

| **Table 2**: Effect of crop management strategies on seed cotton yield (q ha\(^{-1}\)), gross monetary returns (GMR), cost of cultivation (COC), net monetary returns (NMR) and B:C ratio under cotton based intercropping system (Rs. ha\(^{-1}\)) |
| **Treatments** | Seed cotton yield | Gross monetary returns | Cost of cultivation | Net monetary returns | B:C ratio |
|---------------|-------------------|------------------------|--------------------|---------------------|----------|
|               | 2015-16 | 2016-17 | Pooled mean | 2015-16 | 2016-17 | Mean | 2015-16 | 2016-17 | Mean | 2015-16 | 2016-17 | Mean | 2015-16 | 2016-17 | Mean | 2015-16 | 2016-17 | Mean |
| T\(_1\) Control (only cotton) | 8.10 | 11.22 | 9.66 | 33210 | 46675 | 39942 | 45406 | 35624 | 40515 | -1296 | 11051 | -572 | 0.73 | 1.31 | 1.02 |
| T\(_2\) Cotton + Sunhemp (1:1) | 10.41 | 16.72 | 13.57 | 42681 | 69555 | 56118 | 45756 | 5974 | 40665 | -3975 | 33561 | 15253 | 0.93 | 1.93 | 1.43 |
| T\(_3\) Cotton + Green gram (1:1) | 7.83 | 12.18 | 10.46 | 47862 | 68690 | 58276 | 4176 | 3606 | 41341 | 1686 | 32184 | 10935 | 1.04 | 1.88 | 1.46 |
| T\(_4\) Cotton + Cow pea (1:1) | 8.96 | 12.28 | 10.62 | 51676 | 78348 | 65012 | 47486 | 37624 | 42555 | 4190 | 40724 | 22457 | 1.09 | 2.08 | 1.59 |
| T\(_5\) Cotton + Black gram (1:1) | 9.75 | 15.15 | 12.45 | 52829 | 84122 | 68476 | 4214 | 36746 | 41480 | 6615 | 47376 | 26996 | 1.14 | 2.29 | 1.72 |
| T\(_6\) Cotton + Pigeon pea (6:2) | 7.71 | 10.28 | 9.00 | 46575 | 60888 | 55832 | 46173 | 36489 | 43189 | 402 | 28599 | 14501 | 1.01 | 1.78 | 1.40 |
| T\(_7\) Cotton + Soybean (1:1) | 8.36 | 11.98 | 10.17 | 46888 | 67819 | 57803 | 47505 | 37691 | 42598 | -616 | 31028 | 15205 | 0.99 | 1.82 | 1.41 |
| *Significance:* | 0.35 | 0.91 | 0.58 | - | - | - | - | - | - | - | - | - | - | - | - |
| *CD at 5%:* | 1.68 | 2.26 | 1.80 | - | - | - | - | - | - | - | - | - | - | - | - |

**Conclusion**

Research evidences revealed that as black gram is an economically cash crop had enhanced the growth and yield of cotton. Black gram being a leguminous crop with a characteristic of atmospheric nitrogen fixation had complemented the base crop through supply of nutrients tends to highest gross monetary returns in cotton + black gram (1:1) intercropping system.

**Acknowledgment**

Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola

**References**

1. Anonymous. Cotton advisory board as per meeting 16.6.18(P)-Provisional 2018.
2. Arrouays D, Pelisser D. Changes in carbon storage in temperate humic loamy soils after forest clearing and continuous corn cropping in France. Plant and Soil 1994;160:215-233.
3. Chesnin L, Yen CH. Turbidimetric determination of available sulphur. Soil Sci. Soc. Am. Proc 1950;15:149-151.
4. Jackson ML, Soil Chemical Analysis (Edn. 2) Prentice Hall of India Pvt. Ltd., New Delhi 1973, P69-182.
5. Katkar RN, Ph.D. thesis submitted to department of soil science and agricultural chemistry, Dr. PDKV Akola 2008.
6. Katkar RN, Turkhede AB, Solanke VM, Wankhede ST. Effect of integrated nutrient management of organic manures and fertilizers on soil properties and yield of cotton. J Cotton Res. Dev 2002;16:89-92.