Effect of Intercropping on Productivity and Profitability of Sesame under Dryland Arid Conditions

MOOLA RAM
Agricultural Research Station, Mandor, Agriculture University, Jodhpur, Rajasthan, India.

Abstract
An experiment on sesame intercropping system was conducted during kharif (rainy) season of 2017 on sandy loam soil (8.72 pH, 0.88 EC dS m⁻¹), with low nitrogen (137 kg N ha⁻¹), medium phosphorus (14.4 kg ha⁻¹) and high potassium content (357 kg ha⁻¹) at Agricultural Research Station, Mandor, Jodhpur in randomized block design with 3 replications. Among 7 treatments (T1 – Sole Sesame, T2 – Sesame + Urdbean in 3:1, T3 – Sesame + Urdbean in 4:2, T4 – Sesame + Mungbean in 3:1, T5 – Sesame + Mungbean in 4:2, T6 – Sesame + Mothbean in 3:1, T7 – Sesame + Mothbean in 4:2 row ratio), it was found that intercropping of sesame with mungbean in ratio 3:1 resulted significantly higher total productivity and net returns (541 kg ha⁻¹ & Rs. 18270 ha⁻¹) over sole sesame crop (344 kg ha⁻¹ & Rs. 6156 ha⁻¹) followed by mungbean in 4:2 (490 kg ha⁻¹ with net return of Rs. 15164 ha⁻¹) being at par with urdbean in 3:1 (473 kg ha⁻¹ with net return of Rs. 14078 ha⁻¹). It was concluded that mungbean can be grown as a beneficial intercrop in sesame under dryland conditions of Rajasthan.

Sesame (Sesamum indicum L.) is one of oldest oilseed crop with excellent nutritional, medicinal, cosmetic and cooking qualities of the oil. The oil has wide applications in culinary, industry, engineering, and pharmaceuticals. India leads in area, production and export of sesame seed in the world. However, productivity of sesame in India (291 kg ha⁻¹) is quite low in comparison to the average yield of the world and major sesame producing countries mainly because of its cultivation under rainfed/dryland conditions on marginal, poor fertility soils. Sesame is arid climate resilient crop and is, therefore, grown on considerable area (1.59 lac ha) in western Rajasthan which comprises about 61% area of Rajasthan and receives very low rainfall. Millets, mothbean, mungbean and clusterbean are other low water requiring crops adapted to the area. Under such conditions, cultivation of sole crop is a risky proposition, whereas different legumes prove more remunerative in the

CONTACT Moola Ram mramresearch@gmail.com Agricultural Research Station, Mandor, Agriculture University, Jodhpur, Rajasthan, India

© 2020 The Author(s). Published by Enviro Research Publishers.
This is an Open Access article licensed under a Creative Commons license: Attribution 4.0 International (CC-BY).
Doi: http://dx.doi.org/10.12944/CARJ.8.2.11
region due to their short duration and good market price. Intercropping is one of the strategies practiced under rainfed and dryland conditions to minimize risk of yield reduction or total crop failure due to inadequate or uncertain moisture availability during crop growth. Intercropping of sesame with legumes may prove more remunerative under such conditions. Therefore, present attempt was made to find out profitable sesame based intercropping system under western Rajasthan conditions.

Materials and Methods
The experiment was conducted at research farm of Agricultural Research Station, Mandor, Jodhpur during kharif (rainy) 2017. The soil of experimental field was sandy loam in texture, slightly alkaline (pH 8.72, EC 0.88 dS m⁻¹) in reaction, low in nitrogen (137 kg N ha⁻¹), medium in phosphorus (14.4 kg ha⁻¹) and rich in potassium content (357 kg ha⁻¹) in the 15 cm soil layer. Experiment was conducted in 7 treatments viz. (T1 – Sole Sesame, T2 – Sesame + Urdbean in 3:1, T3 – Sesame + Urdbean in 4:2, T4 – Sesame + Mungbean in 3:1, T5 – Sesame + Mungbean in 4:2, T6 – Sesame + Mothbean in 3:1, T7 – Sesame + Mothbean in 4:2 row ratio), replicated thrice under randomized block design. The component crops were sown as per treatments on 8th July, using variety RT 351 of sesame, GM 4 of mungbean, RMO 435 of mothbean and Local of urdbean. Application of 20 kg nitrogen and 25 kg phosphorus per ha was made through urea and DAP at the time of sowing.

The crops were sown at row spacing of 30 cm. Seed rate of sole sesame was 3.0 kg ha⁻¹ whereas it was 2.25 kg ha⁻¹ in case of 3:1 row ratio and 2.0 kg ha⁻¹ in 4:2 row ratio with intercrops. The seed rate of mothbean was 2.5 and 3.3 kg ha⁻¹ in 3:1 and 4:2 row ratio, respectively. Seed rate of urdbean and mungbean was 3.0 and 4.0 kg ha⁻¹ in 3:1 and 4:2 row ratio, respectively. Mothbean was earliest to mature in 68 days, urdbean and mugbean in 73 days and sesame was last to harvest at 82 days which were harvested on 14th September, 19th September and 28th September, 2017, respectively. Nutrients were
applied as per recommended dose of fertilizers in the package of practices for the region i.e. 20 nitrogen and 25 kg phosphorus per ha for rainfed condition. Rainfall of 303.1 mm was received in 24 rainy days during crop period between 28th to 38th meteorological week (MW) but bulk of total rainfall (155.4 mm) was received in a single week of 23-29 July (30th MW) just after two weeks of sowing (Fig. 1). The crop observations were recorded at harvest stage. Yields of component crops were converted into sesame seed equivalent yield using following formula:

\[
\text{Sesame Seed Equivalent Yield} = \frac{(\text{Intercrop Seed Yield} \times \text{Intercrop Seed Price})}{\text{Sesame Seed Price}} + \text{Sesame Seed Yield}
\]

The cost of cultivation of main crop was taken into account for calculating economics of treatments as yield was converted into equivalent yield and expressed as gross return, net return (Rs. ha\(^{-1}\)) and benefit cost ratio (B:C). Investments on inputs and labour for different field operations etc., were worked out on market prices prevailing at Jodhpur. The gross return was computed by multiplying current price of sesame with sesame equivalent yield. The net return was estimated by deducting cost of cultivation from gross return. The benefit-cost ratio was worked out by dividing gross return by cost of cultivation.

**Result and Discussion**

**Growth and yield**

Plant height, number of branches per plant and capsules per plant of sesame were not influenced significantly by different inter crops viz., urdbean, mungbean and mothbean in 3:1 and 4:2 ratios (Table 1). However marginally higher plant height, number of branches per plant and capsules per plant of sesame were recorded in intercropping with mungbean in 3:1 ratio than other component crops. Grain yield was significantly influenced by different row ratios of intercrops. Though yield of sole sesame was significantly higher than its yield under intercropping with different component crops, sesame seed equivalent yield was significantly higher in intercropping of sesame with mungbean in 3:1 followed by the same intercrop in 4:2 (Table 2). Sesame seed equivalent yield with urdbean was also significantly higher than sole sesame. Similar findings of more productivity due to intercrops were also reported in soybean\(^8\) and sesame.\(^9\)

**Table 1: Plant height, number of branches, capsules per plant and seed yield of component crops**

| Treatments | Plant height (cm) | Number of branches (plant\(^{-1}\)) | Capsules/pods (plant\(^{-1}\)) | Seed yield (kg ha\(^{-1}\)) |
|------------|------------------|------------------------------------|--------------------------------|---------------------------|
|            | Sesame           | Intercrop                           | Sesame                         | Intercrop                 | Sesame                     | Intercrop                 |
| T1         | 135.5            | -                                   | 1.97                           | -                         | 61.6                       | -                         |
| T2         | 129.3            | 70.3                                | 2.09                           | 7.04                      | 59.0                       | 26.6                      | 285                       | 231                      |
| T3         | 128.5            | 67.5                                | 2.07                           | 6.35                      | 56.1                       | 24.1                      | 265                       | 223                      |
| T4         | 136.9            | 74.0                                | 2.17                           | 8.76                      | 61.5                       | 29.8                      | 321                       | 311                      |
| T5         | 131.2            | 73.7                                | 2.11                           | 7.70                      | 60.1                       | 27.3                      | 291                       | 282                      |
| T6         | 132.7            | 36.7                                | 2.00                           | 7.33                      | 53.6                       | 98.1                      | 221                       | 236                      |
| T7         | 130.3            | 36.1                                | 1.93                           | 6.58                      | 51.5                       | 97.4                      | 221                       | 235                      |
| SEm ±      | 8.03             | 4.53                                | 0.13                           | 0.54                      | 4.18                       | 2.64                      | 27.2                      | 29.5                     |
| CD at 5%   | NS               | 13.95                               | NS                             | 1.68                      | NS                         | 8.13                      | 83.8                      | 90.9                     |
| CV (%)     | 10.5             | 11.1                                | 10.6                           | 14.4                      | 12.6                       | 8.8                       | 11.3                      | 12.8                     |

**Economics of Sesame Intercropping**

The maximum returns with B:C ratio of 2.2 was recorded due to intercropping of sesame with mungbean in row ratio of 3:1 followed by same intercrop in 4:2 row ratio (Table 2). The higher price of produce of mungbean as well seed yield of mungbean was responsible factor for higher return as sesame seed equivalent yield is the function of...
yield and price. The intercropping of sesame with urdbean was next profitable system due to higher price of urdbean. Higher benefit cost ratio (2.15) was also achieved in three rows of groundnut within paired rows of sesame compared to other intercropping and sole cropping systems.  

### Table 2: Sesame seed equivalent yield, gross returns, net returns and benefit : cost ratio of sesame intercropping treatments

| Treatments | Sesame seed equivalent yield (kg ha⁻¹) | Gross income (Rs. ha⁻¹) | Net returns (Rs. ha⁻¹) | B:C ratio |
|------------|-----------------------------------|------------------------|------------------------|-----------|
| T1         | 344                               | 21156                  | 6156                   | 1.41      |
| T2         | 473                               | 29078                  | 14078                  | 1.94      |
| T3         | 446                               | 27448                  | 12448                  | 1.83      |
| T4         | 541                               | 33270                  | 18270                  | 2.22      |
| T5         | 490                               | 30164                  | 15164                  | 2.01      |
| T6         | 346                               | 21262                  | 6262                   | 1.42      |
| T7         | 345                               | 21229                  | 6229                   | 1.42      |
| SEm ±     | 32.1                              |                        |                        |           |
| CD at 5%   | 98.8                              |                        |                        |           |
| CV (%)     | 8.7                               |                        |                        |           |

(Seed price: sesame Rs. 61.5 kg⁻¹, mungbean Rs. 43.5 kg⁻¹, mothbean Rs. 32.5 kg⁻¹, urdbean Rs. 50 kg⁻¹)

**Conclusion**
The variable rainfall condition is quite common in arid and semi arid regions; the sesame productivity under sole crop cannot be assured. In such condition, mungbean can be grown and recommended as intercrop with sesame in row ratio of 3:1 and 4:2 for higher productivity and profitability in western Rajasthan.

**Acknowledgement**
The author is grateful to Dr. S. R. Kumhar, Zonal Director Research, Agricultural Research Station, Mandor, Jodhpur for providing all the necessary facilities for conducting the research.

**Funding**
All India Coordinated Research Project on Sesame, Indian Council of Agricultural Research, New Delhi, Grant Year: 1983

**Conflict of Interest**
Author has no conflict of interest of any type.

**References**
1. Nayar, N. M. and Mehra, K. L.. Sesame: its uses, botany, cytogenetics and origin. *Econ. Bot.*, 1970: 24: 20–31.
2. Kumar, A.K.R, Pal, A., Khanum, F. and Bawa, A.S. Nutritional, medicinal and industrial uses of sesame (*Sesamum indicum* L.) seeds—An overview. *Agri ConspsectusScientificus*, 2010: 75(4): 159–68.
3. IOPEPC. *Kharif*-2019, Survey of Sesame Crop, Indian Oilseeds and Produce Export Promotion Council, Ministry of Commerce, Govt. of India, pp.1-20. (Accessed online at http://www.iopepc.org/misc/2019_20/Kharif%202019%20Sesame%20crop%20survey.pdf).
4. Bhatt, B.K., Dixit, S.K. and Darji, V.B. Monetary evaluation of sesame based intercropping systems. *Indian. J. Agric. Res.*, 2010: 44 (2):
5. Galil, A.M.A. and Ghany, R.E.A.A. Effect of groundnut – sesame intercropping and nitrogen fertilizer on yield, yield components and infection of root – rot and wilt diseases. *Inter. J. Pl. & Soil. Sci.*, 2014: 3(6): 623-43.

6. Islam, M.R., Molla, M.S.H. and Main, M.A.K. Productivity and profitability of intercropping sesame with turmeric at marginal farmers level of Bangladesh. *SAARC J. Agri.*, 2016: 14(1): 47-58.

7. Dossa, K., Konteye, M., Niang, M., Doumbia, Y. and Cissé, N. Enhancing sesame production in West Africa’s Sahel: a comprehensive insight into the cultivation of this untapped crop in Senegal and Mali. *Agri. Food. Sec.*, 2017: 6: 68, 15p. (Accessed online at https://agricultureandfoodsecurity.biomedcentral.com/track/pdf/10.1186/s40066-017-0143-3)

8. Asewar, B.V. Pendke, M.S., Gore, A.K., Samindre, Ravindra Chary M.S.G. and Rao, C.S. Performance of prominent inter cropping systems under various tillage practices in vertisols of Marathwada region. *Indian J. Dryland. Agric. Res. Dev.*, 2017: 32(1): 78-82.

9. Khan, M., Sultana, N., Akhtar, S., Akter, N., and Zaman, M. Performance of Intercropping Groundnut with Sesame. *Bangladesh Agronomy Journal*, 2017: 20(1): 99-105. https://doi.org/10.3329/baj.v20i1.34888 (Accessed online at https://www.banglajol.info/index.php/BAJ/article/view/34888)

10. Rao, A.S. and Poonia Surendra. Climate change impact on crop water requirements in arid Rajasthan. *Journal of Agrometeorology*, 2011: 13(1): 17-24.