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## Assessment of planting pattern and land configuration on productivity of groundnut + sesame intercropping system under rainfed condition

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### Abstract

A field experiment was conducted during *khariif* season of 2010-2015 for five years at Oilseeds Research Station, Jalgaon, to find out the suitable planting pattern and land configuration in groundnut + sesame intercropping system. The experiment was conducted on clay textured soil low in available nitrogen (196 kg ha<sup>-1</sup>), medium in phosphorus (17.6 kg ha<sup>-1</sup>) and high in potash (604 kg ha<sup>-1</sup>) with slightly alkaline in reaction having pH 8.20. The experiment conducted in randomized block design having fourteen treatment combinations replicated thrice. The treatment consists of sole groundnut and sesame at recommended spacing, sole crops with skip row in 2:1, 3:1 and 4:1 row proportions, intercropping of groundnut + sesame in 2:1, 3:1 and 4:1 row proportions and intercropping of groundnut + sesame in 2:1, 3:1 and 4:1 row proportions with skip row after each intercrop combination. The openings of furrow in every skip row were done after 30 days after sowing. Among different intercropping of groundnut + sesame in 4:1 row proportions gave significantly higher groundnut equivalent yield (1986 kg ha<sup>-1</sup>), land equivalent ratio (1.30), net returns (Rs.54768 ha<sup>-1</sup>) and B: C ratio 2.54 followed by groundnut + sesame in 3:1 row proportion recorded groundnut equivalent yield (1950 kg ha<sup>-1</sup>), land equivalent ratio (1.28), net returns (Rs.53560 ha<sup>-1</sup>) and B: C ratio 2.52. Also the moisture conservation technique of furrow opening shows significant results in intercropping combinations as well as in sole cropping of groundnut and Sesame.

**Keywords:** Intercropping, groundnut, sesame, groundnut equivalent yield, land equivalent ratio

### Introduction

Intercropping is an advanced agro-technique and is considered to be an effective and potential means of increasing crop productivity, particularly in marginal and small holdings under rainfed situation. It provides an efficient utilization of natural resources, decreases the cost of production, provide financial stability, decreases the pest and disease incidence, intercropping system smothers weeds growth, improves soil fertility and increase crop yield along with improves quality of produce (Willy, 1979) [10]. Intercropping can achieve much larger yield than sole crops by using environmental resources more fully over time or more efficiently in space (Willey *et al.*, 1983) [9]. Groundnut and sesame crops differing in height, canopy, adaptations and growth habit grow simultaneously with least competition and hence prove more beneficial in intercropping than sole cropping.

Groundnut (*Arachis hypogaea* L.) is also known as a 'King' of oilseed (Priya *et al.*, 2013) [6] belongs to family fabaceae. Groundnut is one of the principal economic crop of the world that ranks 13<sup>th</sup> among the food crops (Kabir *et al.*, 2012) [5]. It is an important oilseed crop of India, cultivated in various parts of the country. The area (5.86 m ha), production (8.26 m tonnes) and productivity (1411 kg ha<sup>-1</sup>) of groundnut in 2010-11 declines to 4.68 m ha, 6.56 m tonnes and 1400 kg ha<sup>-1</sup> respectively in 2014-15 (Agriculture statistics at a glance 2015). The efforts to arrest the decline area, production and productivity did not succeed due to biotic and abiotic stresses. The biotic, abiotic and economic reasons drastically interrupted the area of groundnut (Singh *et al.*, 2012) [8].

Sesame (*Sesamum indicum* L.) is the most important oilseed crop belongs to the family pedaliaceae.

It is the oldest oilseed crop grown for its high quality edible oil which is often referred as the “queen” of vegetable oil. The oil content of groundnut and sesame is higher than soybean and mustard. To make the country self sufficient in edible oil, it is imperative to increase the production of oilseeds including groundnut either by increasing productivity or by acreage or by combination of them.

The productivity of *kharif* groundnut was very low and amongst the various reasons crop exposed to the abiotic stress like moisture stress at critical growth stages leads to reduction in yield. Under such circumstances moisture conservation technique like furrow opening and intercropping combinations will overcome the moisture stress and helps in increasing crop yield. Amongst the various agronomic practices, intercropping combination prove to be very suitable option for increasing yield and productivity of the system over sole cropping. The climate change and unpredictable monsoon hampered the yield of sole crops. Hence the present investigation on assessment of planting pattern and land configuration in groundnut + sesame intercropping system was felt necessary.

### Materials and Methods

A field experiment was conducted on intercropping of groundnut (cv. JL-501) and sesame (cv. JLT-408) at Oilseeds Research Station, MPKV, Jalgaon (21°03'N, 75°34'E, 201.2 m above mean sea level), during five consecutive *kharif* seasons from 2010-11 to 2014-15 under rainfed condition. The experimental area belongs to assured rainfall zone of Maharashtra with annual average rainfall of 750 mm. The maximum rainfall received during July and September, mostly dry spells were observed in the month of August. The total rainfall received during growing season was mm in 2010-11, mm in 2011-12, mm in 2012-13, mm in 2013-14 and mm in 2014-15. The experiment was conducted on clay textured soil low in available nitrogen (196 kg ha<sup>-1</sup>), medium in phosphorus (17.6 kg ha<sup>-1</sup>) and high in potash (604 kg ha<sup>-1</sup>) with slightly alkaline in reaction having pH 8.20. The experiment laid out in randomized block design having fourteen treatment combinations replicated thrice. The treatments consisted of sole groundnut and sesame at recommended spacing, sole crops with skip row in 2:1, 3:1 and 4:1 row proportions, intercropping of groundnut + sesame in 2:1, 3:1 and 4:1 row proportions and intercropping of groundnut + sesame in 2:1, 3:1 and 4:1 row proportions with skip row after each intercrop combination. Groundnut was sown with 100 kg seed ha<sup>-1</sup> in rows 30 cm apart and 10 cm plant to plant spacing. Recommended dose of fertilizer (25:50:00 NPK) were applied as basal dose through urea and single super phosphate. While sesame was sown with 2.5 kg seed ha<sup>-1</sup> in 30 cm apart and 15 cm plant to plant by thinning twice at 7<sup>th</sup> and 21<sup>th</sup> days after sowing. The groundnut and sesame were sown on 13 July, 9 July, 16 July, 10 July and 24 June during 2010-11, 2011-12, 2012-13, 2013-14 and 201-15. The recommended dose of nitrogen 50 kg ha<sup>-1</sup> were applied through urea half at the time of sowing and remaining half at 30 DAS top dressed to sesame. The openings of furrow in every skip row were done after 30 days after sowing. Two hand weeding at 20 and 40 DAS were given to make the crop weed free. All the possible plant protection measures were undertaken to control the pest and diseases of groundnut and sesame crop. The sesame crop was harvested on 28 Sept., 26 Sept., 4 Oct., 1 Oct. and 21 Sept. and groundnut was

harvested on 23 Oct., 17 Oct., 3 Nov., 4 Nov. and 10 Oct. during 2010-11, 2011-12, 2012-13, 2013-14 and 201-15.

Groundnut equivalent yields (GEY kg ha<sup>-1</sup>) were calculated by converting the yield equivalent of other crop by using the ratio of prices of two crops. The values of LER were calculated by using the data of recommended sole planting of both crops.

It is calculated as follows:

$$LER = Y_{ab}/Y_{aa} + Y_{ba}/Y_{bb}$$

Where, Y<sub>aa</sub> = pure stand yield of crop 'a' (groundnut), Y<sub>bb</sub> = pure stand yield of crop 'b' (Sesame), Y<sub>ab</sub> = intercrop yield of crop 'a' (groundnut) and Y<sub>ba</sub> = intercrop yield of crop 'b' (Sesame).

Economics of the treatment applied was calculated as per the prevailing market rates and net returns and B/C ratio was calculated. All the data were subjected to the analysis of variance (ANOVA) as per the standard procedure (Gomez and Gomez, 1984)<sup>[4]</sup>.

### Results and Discussion

**Effect on growth and yield:** Different combinations of groundnut + sesame intercropping in 2:1, 3:1 and 4:1 row proportions shows significant yield advantage over sole cropping of groundnut and sesame (Table 1). Among different intercropping of groundnut + sesame in 4:1 row ratios gave significantly higher groundnut equivalent yield (1986 kg ha<sup>-1</sup>), land equivalent ratio (1.30), net returns (Rs.54768 ha<sup>-1</sup>) and B/C ratio 2.54 followed by groundnut + sesame in 3:1 row proportion recorded groundnut equivalent yield (1950 kg ha<sup>-1</sup>), land equivalent ratio (1.28), net returns (Rs.53560 ha<sup>-1</sup>) and B/C ratio 2.52 over the sole cropping of groundnut and sesame which were at par with each other in all said parameters. The intercropping combination of groundnut + sesame in 4:1 row proportion also shows significant increase in growth and yield attributes of groundnut and sesame (Table 2 and 3). Among the different treatments groundnut + sesame in 4:1 row proportion recorded significantly higher plant height (31 cm), number of branches (6), number of pods (17) and dry pod weight (13 g plant<sup>-1</sup>) in groundnut and in sesame number of capsules (135), number of branches (6), plant height (124 cm) and plant spread (41 cm) in sesame was recorded by the intercropping of groundnut + sesame in 4:1 row proportion. Also the shelling (65 per cent), sound mature kernels (93 per cent) and hundred kernel weight (31 g) were recorded by the same intercropping combination.

The advantage of intercropping was played important role by accommodating appropriate number of plants per unit area and their by increasing the yield. Groundnut and sesame crops differing in height, canopy, adaptation, growth habit and duration grow simultaneously with least competition and hence prove more beneficial in intercropping than sole cropping. This might be due to higher competition offered by intercrops for natural resources like space, nutrient, moisture and solar radiation. The results are also in conformity with the findings of Bhuva *et al.* (2017)<sup>[3]</sup>. As the moisture conservation technique of furrow opening shows significant results in intercropping combinations as well as in sole cropping of groundnut and sesame. The reason might be the furrow opening helps to mitigate the moisture stress during the critical growth stage.

**Table 1:** Groundnut equivalent yield ( $\text{kg ha}^{-1}$ ), Land equivalent ratio (LER) and economics as influenced by different treatments (Pooled means)

| Sr. No. | Treatment                            | Dry pod yield ( $\text{kg ha}^{-1}$ ) | Sesame grain yield ( $\text{kg ha}^{-1}$ ) | Groundnut equivalent yield ( $\text{kg ha}^{-1}$ ) | Land equivalent ratio (LER) | Gross returns ( $\text{Rs ha}^{-1}$ ) | Net returns ( $\text{Rs ha}^{-1}$ ) | B: C ratio |
|---------|--------------------------------------|---------------------------------------|--|--|-----------------------------|---------------------------------------|-------------------------------------|------------|
| T1      | Sole groundnut                       | 1689                                  | -  | 1689   | 1.00                        | 76351                                 | 34706                               | 1.84       |
| T2      | Sole sesame                          | -                                     | 771  | 1385   | 1.00                        | 63370                                 | 42179                               | 2.88       |
| T3      | Sole groundnut with skip row (2:1N)  | 1318                                  | -  | 1318   | 0.80                        | 59703                                 | 25681                               | 1.75       |
| T4      | Sole groundnut with skip row (3:1N)  | 1489                                  | -  | 1489   | 0.91                        | 67562                                 | 32495                               | 1.91       |
| T5      | Sole groundnut with skip row (4:1 N) | 1600                                  | -  | 1600   | 0.96                        | 71064                                 | 34172                               | 1.95       |
| T6      | Sole sesame with skip row (2:1N)     | -                                     | 567  | 1012   | 0.76                        | 44310                                 | 19030                               | 1.76       |
| T7      | Sole sesame with skip row (3:1N)     | -                                     | 628  | 1133   | 0.84                        | 49627                                 | 23993                               | 1.92       |
| T8      | Sole sesame with skip row (4:1N)     | -                                     | 767  | 1401   | 1.03                        | 63221                                 | 38244                               | 2.44       |
| T9      | Groundnut + sesame in (2:1)          | 994                                   | 536  | 1759   | 1.29                        | 84726                                 | 51069                               | 2.47       |
| T10     | Groundnut + sesame in (3:1)          | 1284                                  | 368  | 1950   | 1.28                        | 87895                                 | 53560                               | 2.52       |
| T11     | Groundnut + sesame in (4:1)          | 1460                                  | 305  | 1986   | 1.30                        | 89671                                 | 54768                               | 2.54       |
| T12     | Groundnut + sesame in (2:1N)         | 1032                                  | 324  | 1593   | 1.05                        | 72172                                 | 41100                               | 2.27       |
| T13     | Groundnut + sesame in (3:1 N)        | 1137                                  | 311  | 1657   | 1.07                        | 74727                                 | 42577                               | 2.27       |
| T14     | Groundnut + sesame in (4:1N)         | 1293                                  | 314  | 1786   | 1.13                        | 80495                                 | 47552                               | 2.40       |
|         | S.Em $\pm$                           | 104                                   | 110  | 105  | 0.06                        | -                                     | -                                   | -          |
|         | CD at 5%                             | 294                                   | 313  | 318  | 0.16                        | -                                     | -                                   | -          |

Note: N = Opening of furrow in skip row at 25-30 DAS

**Table 2:** Growth and yield attributes of groundnut at harvest as influenced by different treatments of intercropping under rain fed conditions (Pooled means)

| Sr. No. | Treatment                         | Plant height (cm) | Number of branches plant <sup>-1</sup> at harvest | Total number of pods plant <sup>-1</sup> at harvest | Dry pod weight ( $\text{g plant}^{-1}$ ) | Shelling per cent | Sound mature Kernels (%) | 100-Kernel weight (g) |
|---------|-----------------------------------|-------------------|---|---|--|-------------------|--------------------------|-----------------------|
| T1      | Sole groundnut                    | 30.59             | 6.25  | 18.39   | 13.38                                    | 65.25             | 92.92                    | 29.75                 |
| T3      | Sole Gr.nut with skip row (2:1 N) | 31.82             | 6.33  | 19.55   | 13.04                                    | 62.13             | 93.33                    | 29.50                 |
| T4      | Sole Gr.nut with skip row (3:1N)  | 29.40             | 6.27  | 16.50   | 13.35                                    | 65.54             | 92.50                    | 28.00                 |
| T5      | Sole Gr.nut with skip row (4:1N)  | 30.98             | 6.30  | 17.94   | 12.07                                    | 66.58             | 93.83                    | 29.08                 |
| T9      | Gr. nut + sesame in (2:1)         | 34.32             | 7.85  | 15.23   | 10.53                                    | 63.71             | 92.08                    | 29.67                 |
| T10     | Gr. nut + sesame in (3:1)         | 34.74             | 6.14  | 17.17   | 12.44                                    | 64.71             | 92.58                    | 29.75                 |
| T11     | Gr. nut + sesame in (4:1)         | 35.20             | 6.55  | 17.04   | 13.10                                    | 65.33             | 93.92                    | 31.00                 |
| T12     | Gr. nut + sesame in (2:1N)        | 31.99             | 5.97  | 14.57   | 10.67                                    | 64.21             | 93.00                    | 30.50                 |
| T13     | Gr. nut + sesame in (3:1 N)       | 31.45             | 6.30  | 15.90   | 10.79                                    | 65.04             | 92.33                    | 28.58                 |
| T14     | Gr. nut + sesame in (4:1N)        | 32.92             | 6.15  | 16.45   | 12.01                                    | 65.00             | 92.42                    | 29.50                 |
|         | S.Em $\pm$                        | 1.42              | 0.36  | 1.24  | 0.54                                     | 1.50              | 0.53                     | 1.10                  |
|         | CD at 5%                          | 4.03              | 1.01  | 3.51  | 1.52                                     | NS                | 1.51                     | NS                    |

Note: N = Opening of furrow in skip row at 30 DAS

**Table 3:** Growth and yield attributes of sesame at harvest as influenced by different treatments of intercropping under rainfed conditions (pooled means)

| Sr. No. | Treatment                        | Plant height (cm) | Plant spread (cm) | Number of branches plant <sup>-1</sup> at harvest | Total number of capsules plant <sup>-1</sup> at harvest |
|---------|----------------------------------|-------------------|-------------------|---|---|
| T2      | Sole sesame                      | 126.70            | 29.68             | 5.04  | 99.07   |
| T6      | Sole sesame with skip row (2:1N) | 134.53            | 38.52             | 5.85  | 141.08  |
| T7      | Sole sesame with skip row (3:1N) | 132.17            | 37.60             | 5.88  | 133.53  |
| T8      | Sole sesame with skip row (4:1N) | 132.27            | 37.55             | 5.94  | 144.20  |
| T9      | Gr. nut + sesame in (2:1)        | 132.95            | 36.08             | 5.77  | 133.80  |
| T10     | Gr. nut + sesame in (3:1)        | 127.88            | 37.98             | 5.97  | 135.02  |
| T11     | Gr. nut + sesame in (4:1)        | 123.99            | 40.98             | 5.85  | 153.20  |
| T12     | Gr. nut + sesame in (2:1N)       | 120.44            | 36.19             | 5.47  | 120.92  |
| T13     | Gr. nut + sesame in (3:1 N)      | 123.97            | 42.95             | 5.90  | 148.23  |
| T14     | Gr. nut + sesame in (4:1N)       | 122.04            | 43.05             | 6.13  | 136.52  |
|         | S.Em $\pm$                       | 12.98             | 4.41              | 0.59  | 18.75   |
|         | CD at 5%                         | NS                | 12.52             | NS  | 53.22   |

**Effect on land equivalent ratio:** Land equivalent ratio (LER) calculated from combined intercrop yield was higher with 4:1 row proportion than 3:1 and 2:1 over sole cropping of individual crops (Table 1). This clearly indicates the greater biological efficiency of intercropping. The significantly higher LER (1.30) was recorded by groundnut + sesame in 4:1 row proportions which was at par with groundnut + sesame in 2:1 row proportions (1.29) and 3:1 row proportions (1.28). Similar results are also obtained by Bhuvu *et al.*

(2017) [3]. This was due to the extra yield obtained from intercrop and makes the combination higher advantageous over sole cropping. This might be due to development of better complementary relationship between groundnut and sesame. Growing groundnut with sesame endowed with varying growth patterns as sesame grows taller than groundnut and it provide tolerance to strong light and high evaporative demand, while groundnut favours the shade and high relative humidity and also acts as wind barrier and

protects the shorter crop, thus one component crop helps other. Similarly, varying rooting depths exploits nutrients from different soil profile, thus utilizing the resources more efficiently. It is known to intercept more solar energy and give comparatively higher yield stability and insurance during aberrant weather condition than sole crop. The duration of both the component crop is varying and matures at different times, thus reducing the competition. When early maturing crop is harvested the conditions become favourable for the late maturing crop. Also, intercropping involving legume and non legume, the part of nitrogen fixed by legume may become available to non-legume (Reddy and Reddy, 2001) <sup>[7]</sup>. Abdel and Abdel (2014) <sup>[1]</sup> also reported the maximum LER and beneficial effect of groundnut + sesame intercropping.

**Economics:** Intercropping of groundnut + sesame in 4:1 row proportions gave significantly maximum net returns (Rs.54768 ha<sup>-1</sup>) and B/ C ratio 2.54 followed by groundnut + sesame in 3:1 row proportion (net returns Rs.53560 ha<sup>-1</sup> and B: C ratio 2.52). Here higher net monetary returns and benefit cost ratio was obtained due to higher gross monetary returns and higher yields due to intercropping of groundnut + sesame. Higher economic returns were recorded in intercropping of groundnut + sesame, owing to additional yield advantage, higher market price of and lower cost of production of sesame. Bhuva *et al.* (2017) <sup>[3]</sup> also reported the higher net returns and benefit cost ratio from groundnut + sesame intercropping.

### Conclusion

It can be concluded that groundnut + Sesame inter cropping in 4:1 or 3:1 found to be beneficial to achieve higher yield and maximum economics in groundnut with sesame intercropping under rainfed conditions.

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