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Competitive behaviour in groundnut + sesame in different row proportions

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Abstract
A field experiment entitled "Production potential and economic feasibility of groundnut + sesame intercropping in different row proportion" was conducted at Research Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Summer* season of 2016-17. The experiment was laid out in randomized block design with seven treatments replicated four times. The treatments constituted of Sole groundnut, Sole sesame, 1:1 Groundnut+ sesame, 2:1 Groundnut+ sesame, 3:3 Groundnut+ sesame, 4:2 Groundnut+ sesame, Groundnut at 30 cm row spacing in between them one line of sesame. The net plot size was 3.9 m x 3.8 m. Sowing of Groundnut and Sesame was undertaken during 13rd Feb., 2017. The highest LER (1.64) was recorded under Groundnut at 30 cm row spacing in between them one line of sesame. The maximum % RYL was 59.45 was observed in treatment Groundnut at 30 cm row spacing in between them one line of sesame indicated that the highest performance of sesame was recorded in the treatment Groundnut at 30 cm row spacing in between them one line of sesame. 4:2 Groundnut + sesame registered higher groundnut equivalent yield 15.27. Aggressivity index was maximum in groundnut + sesame in 3:3 ratio (0.212) in case of groundnut over all the treatment combinations. Groundnut crop recorded the least RCC in 3:3 groundnut + sesame (1.75) where it gave less yield than expected. The maximum competitive ratio of groundnut (1.63) was recorded with groundnut +sesame in 3:3 row ratio.

Keywords: groundnut, sesame, intercropping, row proportion, aggressivity, land equivalent ratio

1. Introduction
Oilseeds occupy a significant place in Indian economy and served as a raw material for more than 88 percent of countries vegetable oil. Oilseeds are the second largest agricultural commodity in India, sharing 15.07 percent of gross cropped area accounting for nearly 5 percent of the national gross product and 10 percent of the value of all agricultural products.

Groundnut (*Arachis hypogeae* L.) is one of the most important oilseed crop in India. Groundnut contributes more than 50 percent edible oil production of the country. The demand for edible oil is rising day by day. Area as well as productivity of this crop declined drastically. Therefore, concentrated efforts are being made to increase and to stabilise the oilseed production. Gujrat is the leading producer with 29.63 percent of the total production followed by Tamil Nadu 20.78 percent, Andhra Pradesh 15.23 percent, Rajasthan 8.23 percent, Maharashtra 8.23 percent and Karnataka 7.82 percent. The total oilseed acreage stood at 18.65 million ha. against last year 16.20 million ha. During 2013-14 groundnut area has increase in all growing states besides the weather was also kind enough for an optimistic view of expected groundnut production (Anonymous 2014) [1].

Sesame [*Sesamum indicum* L. (Family- Pedaliaceae)]:- "Queen of oilseed crops" by virtue of excellent quantity of oil produces and its use in domestic purpose. It is one of the most important ancient edible crops grown next to groundnut, rapeseed and mustard. This crop is probably the oldest oilseeds known and grown by man. Archeological evidence indicates that sesame found in 'Harappa Culture' the oldest archaeological site in 3 region, in addition the largest sesame acreage and diverse forms of sesame are seen in India. Same species are also found in Africa. India now considered as the basic Centre of origin. India ranks 1st in acreage (45 percent) of sesame in the world. The total area of sesame in India during 2015-16 is 16.67 lakh ha. and production is 6.75 lakh tonnes. In Maharashtra state, area under sesame crop during 2015-16 was 0.30 lakh hectare with production of 0.04 lakh tonnes and productivity of 355 kg/ha (Anonymous 2016) [2].

In groundnut + sesame intercropping system, groundnut is a leguminous oilseed crop. The suggested benefits of legumes are better root stratification, utilization of soil nutrients and nitrogen fixation by the legumes which allows the legume become independent of soil nitrogen and making some nitrogen available to non-legume. While sesame is non leguminous oilseed crop which grows taller than groundnut. It receives more light and provides more shade to the ground which ultimately helps to conserve the soil moisture.

2. Materials and Methods

Field study entitled, "production potential and economic feasibility of groundnut + sesame intercropping in different row proportion" was conducted at Agronomy farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *summer* season of 2016-17**.** Soil of experimental plot was clayey in texture having PH 7.88 and EC 0.88 (d Sm^{-1}), slightly alkaline in reaction, low in available nitrogen (176.4 kg ha^{-1}) and phosphorus (14.44 kg ha^{-1}) and fairly high in available potassium (380.3 kg ha^{-1}). Agro climatically experimental site fall in semi-arid tropics with an average annual rainfall of 840 mm. The experiment was laid out in randomized block design with four replication. The experiment consist of seven treatments comprising of cropping system viz., sole groundnut (T_1), sole sesame (T_2), 1:1 groundnut+ sesame (T_3), 2:1 groundnut + sesame (T_4), 3:3 groundnut + sesame (T_5), 4:2 groundnut+ sesame (T_6), groundnut at 30 cm row spacing in between them one line of sesame(T_7).

The competitive behaviors of groundnut in groundnut + sesame association determined are: Land Equivalent Ratio (LER), Relative yield total (RYT), Relative yield loss (RYL), Crop equivalent yield (CEY), Aggressivity (A), Competitive ratio (CR), Relative crowding coefficient (RCC) which were determined using the following formulae:

Land equivalent ratio (LER)

$$\text{Land Equivalent Ratio} = \frac{Yab}{Yaa} \times \frac{Yba}{Ybb}$$

Where, Yaa and Ybb were sole yield of crops 'a' and 'b' respectively, Yab and Yba were mixture yield of crops 'a' and 'b' respectively (Willey, 1979) [7].

Relative yield total (RYT)

The relative yield total of two crops is equal to the mean of the relative yields and is given by (de Wit and Van Den Berg, 1965) [4].

$$RYT = \left(\frac{Yij}{yij} + \frac{Yji}{yjj}\right)$$

Where
yii – Sole crop (pure stand) yield of crop A.
yjj – Sole crop (pure stand) yield of crop B.
yij – Intercrop yield of crop A, when grown with crop B as intercrop.
yji – Intercrop yield of crop B when grown with crop A as intercrop

Relative yield loss (RYL)

$$RYL\ (\%) = \left(\frac{Y^1ij}{Yii} - 1\right) \times 100$$

Where, y`ij = yij/a and y"ii = yii/a are yields per hectare (unit area) of intercrop and sole crop A when „a" is the area under crop A (either in intercropped or mono crop situation). This index is nothing but the deviation of the ratio of productivity of intercrop and sole crop from unity and it gives whether per cent productivity in intercrop is more than sole crop, which gives per cent loss or gain in yields of crop A due to intercropping (Banik and Bagchi, 1996) [3].

Crop equivalent yield (CEY)

Lal and Ray (1976) [5], proposed economics of crops by converting grain/seed/fodder etc. in terms of gross returns for valid comparison and obtained wheat equivalent yields as,

CEY = CIYIJ+ CJYJI

Where, CI = PCI/PW
Pci and Pw are per unit prices of ith crop and main crop, respectively.

Aggressivity (A)

Aggressivity of crop A with crop B gives the simple difference between the expected relative yields only. Aggressivity of crop A with crop B is given by McGilchrist and Trenbath (1971) [6],

$$Aij = \frac{\text{Intercrop yield of crop A}}{\text{Expected yield of crop A}} - \frac{\text{intercrop yield of crop B}}{\text{Expected yield of crop A}}$$

= Expected relative yield of crop A – Expected relative yield of crop B

$$= \frac{Yij}{yii - aij} - \frac{yji}{yii - aji}$$

If the aggressively value of a component crop with other component crop is zero, then the two component crops are said to be equally competitive. Aggressively values of greater than zero indicate that one crop is dominating over the other. As it is based on a sample difference, the interpretation of intercropping treatments may become difficult if the values are identical in different treatments.

Competitive ratio (CR)

The competitive ratio of two crops is given by the ratio of their respective expected relative yields. The competitive ratio of crop A with crop B is given by,

$$= \frac{yij}{yii - aij} / \frac{yji}{yii - aji}$$

Where, yii – Sole crop (pure stand) yield of crop A.
yjj – Sole crop (pure stand) yield of crop B.
yij – Intercrop yield of crop A, when grown with crop B as intercrop.
yji – Intercrop yield of crop B when grown with crop A as intercrop

Relative crowding coefficient (RCC)

The RCC is useful for replacement series of intercropping experiments. RCC for each crop gives a measure of wheather

that crop has produced more or less yield than expected yield. For examples, RCC for crop A is,

$$Kij = \frac{\text{Inter crop of yield crop A x proportions of area under B in intercropping}}{\text{(A crop sole of Yield - crop of yield Intercrop A) x proportions of area under B in intercropping}}$$

$$Kij = \frac{Yij \ .aji}{(yii - yij) \times aij}$$

If kij >1, then there is yield advantage of crop A in intercropping. If there is no effect of intercropping on the yield of crop A, then kij =1; kij <1 indicates the yield disadvantage due to intercropping. Similarly one can compute kji, the RCC for crop B. The component crop with higher relative crowding coefficient is the dominant one and is more competitive than the associated crop.

3. Results and Discussion

3.1 Land Equivalent Ratio

Data presented in Table 1 indicated that the land equivalent ratio was more than 1.0 in case of all the intercropping ratios. The highest LER (1.64) was recorded under Groundnut at 30 cm row spacing in between them one line of sesame. This is an indication that there was a yield advantage of intercropping groundnut with sesame over growing either of the crops as a sole. The highest LER was recorded under Groundnut at 30 cm row spacing in between them one line of sesame while lower LER was produced by sole groundnut and sole sesame. Groundnut at 30 cm row spacing in between them one line of sesame out yielded because there was effect of shading of sesame on groundnut under groundnut at 30 cm row spacing in between them one line of sesame as compared to others. hence the higher yield that translated to higher LER in groundnut at 30 cm row spacing in between them one line of sesame.

3.2 Relative yield total (RYT)

It is clear from value of relative yield total (RYT) of intercropping treatments that relative values were more than 0.5 indicating that intercropping of groundnut + sesame is advantageous over sole sesame and sole groundnut.

3.3 Relative yield loss (RYL)

Data presented in Table 1 indicated that present relative yield loss of intercropping treatments. As regards sesame it is observed that % RYL was negative indicating that as compared to sole crop treatment relatively in all the intercropping treatments sesame had performed better than sole sesame treatments. The maximum % RYL was 59.45 was observed in treatment Groundnut at 30 cm row spacing in between them one line of sesame indicated that the highest performance of sesame was recorded in the treatment Groundnut at 30 cm row spacing in between them one line of sesame.

As regards groundnut it is observed that % RYL was negative indicating that as compared to sole crop treatment relatively in all the intercropping treatments groundnut had performed better than sole groundnut treatments. The maximum % RYL was 59.45 observed in treatment Groundnut at 30 cm row spacing in between them one line of sesame indicated that the highest performance of groundnut was recorded in the treatment Groundnut at 30 cm row spacing in between them one line of sesame.

3.4 Crop equivalent yield (CEY)

Data depicted in Table 1 indicated that 4:2 Groundnut + sesame registered higher groundnut equivalent yield 15.27, which was at par with 2:1 Groundnut+ sesame and Groundnut at 30 cm row spacing in between them one line of sesame.

Table 1: Mean land equivalent ratio (LER), Relative yield total (RYT), Relative yield loss (RYL) and crop equivalent yield (CEY) of the cropping system as affected by different treatments.

Treatments	Land equivalent ratio (LER)	RYT	RYL (G.nut)	RYL (Sesame)	CEY (G.nut)
T1: Sole groundnut	1	0.50	0	-	11.94
T2 : Sole sesame	1	0.50	-	0	-
T3 : 1:1 Groundnut +sesame	1.22	1.08	28.67	18.05	11.64
T4 : 2:1 Groundnut+ sesame	1.3	0.87	24.69	-27.62	15.04
T5 : 3:3 Groundnut+ sesame	1.26	1.03	26.27	22.11	11.43
T6 : 4:2 Groundnut +sesame	1.5	0.63	26.48	0.45	15.27
T7: Groundnut at 30 cm row spacing in between them one line of sesame	1.64	1.18	59.45	59.45	14.45
SE (m) ±	0.02	-	-	-	0.28
CD @ 5%	0.07	-	-	-	0.86
GM	1.32	-	-	-	13.29

3.5 Aggressivity (A)

As regards to aggressivity index it was observed that aggressivity index was maximum in groundnut + sesame in 3:3 ratio (0.212) in case of groundnut over all the treatment combinations. Aggressivity index of sesame was negative indicating the dominance of groundnut in the intercropping system.

3.6 Competitive ratio (CR)

The competitive ratio of groundnut with sesame (Table 2) recorded due to different treatment combinations indicated that competitive ratio values for sesame were less than 1 while that of groundnut were more than 1 indicating dominance of groundnut in all the treatment combinations under study. The maximum competitive ratio of groundnut (1.63) was recorded groundnut +sesame in 3:3 row ratio.

3.7 Relative crowding coefficient (RCC)

Regarding the RCC (Relative Crowding Coefficient) of both the crops was recorded maximum in groundnut +sesame in 4:2 (24.76). Treatment combination indicating that the groundnut (6.01) and sesame (4.12) was maximum RCC

observed in groundnut +sesame in 4:2 treatment combination indicating its more yield than expected one.

Groundnut crop recorded the least RCC in 3:3 groundnut + sesame (1.75) where it gave less yield than expected.

Table 2: Aggressivity (A), Compitative ratio, Relative crowding coefficient (RCC) of the cropping system as affected by different treatments

Treatments	Aggressivity (A)		CR		RCC OF G. nut (Kgs)	RCC OF sesame (Ksg)	RCC (K)
	G. nut	Sesame	G. nut	Sesame			
T_1: Sole groundnut	-	-	-	-	-	-	-
T_2 : Sole sesame	-	-	-	-	-	-	-
T_3 : 1:1 Groundnut+ sesame	0.05	-0.05	1.08	0.51	1.85	1.45	2.68
T_4 : 2:1 Groundnut+ sesame	-0.06	0.06	1.17	0.61	6.18	0.94	5.8
T_5 : 3:3 Groundnut+ sesame	-0.21	0.21	1.03	0.48	1.75	1.59	2.78
T_6: 4:2 Groundnut+ sesame	-0.12	0.12	1.63	0.71	6.01	4.12	24.7
T_7: Groundnut at 30 cm row spacing in between them one line of sesame	0.11	-0.21	1.18	0.64	4.06	2.16	8.76

4. Conclusion

From the foregoing, it can be very well concluded that groundnut + sesame intercropping is more efficient than growing either of the crop alone. Groundnut was more competitive than Sesame in the mixture because it had higher values of LER, RYT, RYL, CEY, Aggressivity, Compitative ratio. The performance of Groundnut at 30 cm row spacing in between them one line of sesame was found superior.

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