

Biological indices influence by sesame based intercropping system with different levels of nitrogen

ABSTRACT

A field experiment was conducted at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during the summer season of the year 2021 and 2022. The experiment was laid out in Randomized Block Design with Factorial concept and replicated three times. Fourteen treatment combinations comprising of seven intercropping treatments of sesame viz., I₁ - sole sesame, I₂ - sole cowpea, I₃ - sole green gram, I₄ - sesame + cowpea (paired 2:1), I₅ - sesame + green gram (paired 2:1), I₆ - sesame + cowpea (paired 3:2) and I₇ - sesame + green gram (paired 3:2) and two nitrogen levels viz., 75% RDN (N₁) and 100% RDN (N₂) were evaluated in the study. The experiment was conducted for two consecutive years with same randomization. Significantly higher seed and stover and biological yields, sesame equivalent yield and Land equivalent yield. Seed, stover and biological yields, sesame equivalent yield and Land equivalent yield of sesame were found superior with 100 % RDN (N₂) on pooled basis.

Key words: Sesame, Intercropping, Nitrogen, Soil fertility, content and uptake

Introduction

Sesame (*Sesamum indicum* L.) is one of the most ancient oilseed crops grown for over 5000 years. Sesame is also popularly known as sesame, til, simsim, benised, gingelim, etc., and it is generally cultivated throughout the year, i.e., during *kharif*, semi *rabi* and summer as a sole as well as mixed/inter crop. Sesame is a rich source of oil (46-52%) and protein (18-20%). In India during 2020-2021 sesame is cultivated in an area of 17.22 lakh ha with a production of 8.16 lakh tonnes and productivity of 474 kg/ha (Anon., 2021a). In India, it is mainly grown in Rajasthan, Uttar Pradesh,

Madhya Pradesh, Gujarat, West Bengal and Andhra Pradesh. In Gujarat, major sesame growing district are Surendranagar, Kutch, Rajkot, Junagadh, Jamnagar, Bhavnagar, Banaskantha and Amreli. It occupied about 2 lakh hectare area and production of 0.4 million tonnes of sesame during 2020-2021 (Anon., 2021b).

Any scheme or plan to increase food and oil production cannot be a total success unless and until an appropriate production oriented cropping system and production technology are developed and implemented properly. The practice of multi-cropping in the form of intercropping has been a unique asset of tropical and sub-tropical areas and is becoming popular day by day among small farmers. The advantages of intercropping may be especially important because they are achieved not by means of costly inputs, but by the simple expedient of growing crops together. Spatial arrangement in intercropping is one of the most important factors for higher yield. In sesame + legume intercropping system, sesame is an oilseed crop. The suggested benefits of legumes are better root stratification, utilization of soil nutrients and nitrogen fixation by the legume which allow the legume become independent of soil nitrogen and making some nitrogen available to non-legume.

Among the plant nutrient, nitrogen is the most important and expensive nutrient and it has marked effect on the growth and yield of sesame crop. Inclusion of pulses in intercropping system has many ramifications. They are less demanding on soil resources, many of them can tolerate some amount of shading; they can fix atmospheric nitrogen (N) in the root nodules, contributing part of the fixed nitrogen (N) to the associated crop and enriching the soil. The residues and the root nodules release nitrogen during decomposition. There are reports to show that inclusion of pulses in the cropping systems had indeed benefited the associated as well as succeeding crops (Saxena and Yadav, 1979; Tiwari and Bisen, 1975). Inclusion of pulses as intercrop helped to save up to 25 % of recommended level of nitrogen application to the associated cereal (Morachan *et al.*, 1977) and improve the soil nitrogen status and thus, reduce nitrogen application to the succeeding crop (Palanippan *et al.*, 1985).

MATERIALS AND MATHOD

A field experiment was taken up on the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari during the summer season of the year 2021 and 2022. The soil of experimental site was dark grayish brown type

with flat topography. The soil is characterized by medium to poor drainage capacity and good water holding capacity. Because of predominance of montmorillonite clay mineral, soil cracks heavily on drying.

The experiment was laid out in Randomized Block Design with Factorial concept and replicated three times. Fourteen treatment combinations comprising of seven intercropping treatments of sesame viz., I₁ - sole sesame, I₂ - sole cowpea, I₃ - sole green gram, I₄ - sesame + cowpea (paired 2:1), I₅ - sesame + green gram (paired 2:1), I₆ - sesame + cowpea (paired 3:2) and I₇ - sesame + green gram (paired 3:2) and two nitrogen levels viz., 75% RDN (N₁) and 100% RDN (N₂) were evaluated in the study. The experiment was conducted for two consecutive years with same randomization.

Sesame equivalent yield

Seed yield of the intercrops was converted to sesame seed equivalent on the basis of price of grain of different crops involved in the treatments.

$$SEY = \frac{\text{Gross profit of system}}{\text{Price of sesame seed}}$$

Land equivalent ratio

Relative area of sole crop that would be required to produce the yield achieved by intercropping was calculated for each treatment.

$$LER = \frac{Y_{ab}}{Y_{aa}} + \frac{Y_{ba}}{Y_{bb}}$$

Where,

Y_{ab} = Yield of sesame in intercropping

Y_{aa} = Yield of sesame as sole crop

Y_{ba} = Yield of intercrop in intercropping

Y_{bb} = Yield of intercrop as sole crop

RESULTS AND DISCUSSION

Seed, stover and biological yield

Effect of intercropping

The data presented in Table 1 revealed that different intercropping systems significantly increased the seed, stover and biological yield of sesame during both the years as well as in pooled analysis. Among the different intercropping system examined, significantly higher seed yield of sesame was recorded with the treatment (I₁) sole sesame during both the years and pooled analysis being at par with the

treatment I₄ - sesame + cowpea (paired 2:1) and treatment I₅ - sesame + green gram (paired 2:1) during the both year but only treatment I₅ - sesame + green gram (paired 2:1) in pooled analysis. The lower seed yield was recorded under treatment I₆ - sesame + cowpea (paired 3:2) and treatment I₇ - sesame + green gram (paired 3:2) during both the years and over the pooled analysis and significantly higher stover yield of sesame was recorded with treatment (I₁) sole sesame during both the years and pooled analysis and it was remained at par with the treatment I₄ - sesame + cowpea (paired 2:1) and treatment I₅ - sesame + green gram (paired 2:1) during the both year as well as higher biological yield of sesame was obtained under sole sesame treatment (I₁) during both the years and in pooled results which remained at par with the treatment I₅ - sesame + green gram (paired 2:1) for both the year only. Seed, stover and biological yield of sesame was significantly reduced in intercropping, whereas lowest seed, stover and biological yield of sesame was noted when it was intercropped with cowpea. The reduction in seed, stover and biological yield of sesame under intercropping treatments could be assigned to lower values of almost all yield attributes viz., number of capsule per plant, capsule length, number of seeds per capsule and test weight under intercropping treatments resulting from poor plant growth due to competition effect between sesame and intercrops for resources like sun light, space, moisture and plant nutrients. Reduction in seed yield of sesame owing to legume intercropping was also reported by Sarkar and Kundu (2001), De et al. (2002) and Yadav et al. (2013). The maximum reduction in seed yield of sesame due to cowpea intercropping can be ascribed to its relatively luxuriant vegetative growth of cowpea as compared to green gram which suppress the growth of sesame. Similar results are also in agreement with the findings of Bhatti *et al.* (2005).

Effect of nitrogen levels

It is evident from Table 1 that seed, stover and biological yield of sesame was significantly affected by varying nitrogen levels to sesame crop in both the years and in pooled analysis. Among the different nitrogen levels examined, significant superior seed stover and biological yield of sesame was recorded with application of 100 % RDN (N₂) to sesame crop during both the years and pooled analysis. The minimum seed stover and biological yield was recorded by 75% RDN (N₁) may be due to insufficient supply of N for achieving the proper growth and development of sesame crop. This might be due to the improvement in growth characters that favorably modified the yield attributes. Amount of nitrogen plays an important role in plant

metabolism by virtue of being an essential constituent of diverse types of metabolically active compounds like amino acids, proteins, nucleic acid, enzymes, co-enzymes and alkaloids which are important for higher growth and yield. This increase in growth and yield attributes ultimately helped in realization of higher seed yield. The results obtained in this study are in agreement with those reported by Sarala and Jagannatham (2002), Chakraborty (2013), Patel *et al.* (2014) Hasan (2015), Gebremariam (2015), Kithan *et al.* (2017), Shamsuzzoha *et al.* (2019), Adisu *et al.* (2020) and Jose *et al.* (2021).

Interaction effect

The findings indicated significant interaction between the intercropping and different nitrogen levels to sesame crop during both the years and in pooled analysis. The data on interaction effect on seed yield are presented in Table 2. During both year, the treatment combination of I_1N_2 i.e., 100% RDN applied to sole sesame (I_1) intercropping system recorded significantly higher seed yield, but it was at par with treatment combinations I_4N_2 and I_5N_2 in both year and at par with treatment I_5N_2 only pool analysis. Treatment combination of I_1N_2 i.e. 100% RDN applied to sole sesame intercropping system recorded highest stover and biological yield, but it was at par with treatment combinations I_4N_2 and I_5N_2 during both years. During pooled analysis the treatment combination of I_1N_2 i.e. 100% RDN applied to sole sesame intercropping system recorded highest stover and biological yield. The lowest yield was obtained under treatment combination I_6N_1 (sesame + cowpea paired 3:2) with 75% RDN due to competition exist due to lower nitrogen level. The result corroborate with the findings of Tanwar *et al.* (2011), Ghosh *et al.* (2016), Aminifer *et al.* (2017), Kumar *et al.*, (2017) in pearl millet.

Sesame equivalent yield (kg/ha)

Effect of intercropping

Sesame equivalent yield was significantly influenced by sole crop sesame and intercropping systems during both the years and pooled analysis in Table 3. Significantly higher SEY was produced when treatment I_5 - sesame + green gram (paired 2:1) and at par with treatment I_4 - sesame + cowpea (paired 2:1) as compared to other treatments during the first year. The lowest SEY was recorded with sole crop of cowpea (I_2). It may be attributed due to additional seed yield of intercrops viz., cowpea and green gram. Higher sesame equivalent yield in these intercropping treatments indicated yield advantages over sole sesame. Higher sesame equivalent

yield due to introducing of legumes in sesame were also reported by Sharma and Singh (2008) in sesame + green gram (2:2), Mandal and Pramanick (2014) in sesame + green gram (2:2) and Sarma *et al.* (2016) sesame + black gram (1:1).

Effect of nitrogen levels

It is evident from Table 3 that sesame equivalent yield was significantly affected by varying nitrogen levels to sesame crop in both the years and in pooled analysis. Among the different nitrogen levels examined, significantly superior sesame equivalent yield was recorded with application of 100 % RDN (N_2) to sesame crop during both the years and pooled analysis. These findings are in conformity with those reported by Sharda *et al.* (2004) in pearl millet + mung beans (2:1).

Interaction effect

The findings indicated significant interaction between the intercropping and different nitrogen levels to sesame crop during both the years and in pooled analysis. Data in Table 4 indicated that treatment combination with sesame + green gram (I_5) and 100% RDN to sesame (I_5N_2) applied to sesame recorded significantly higher sesame equivalent yield in both years and pooled analysis. It was found at par with treatment combinations I_4N_2 , I_6N_2 and I_7N_2 in the first years and treatment combinations I_4N_2 and I_7N_2 in second year as well as treatment I_4N_2 in pooled analysis. This was also due to additional advantage of intercrop yield and higher yield of green gram with sesame due to better complementary relationship resulted in to the highest sesame equivalent yield. These results are in accordance with the results of Vari and Sadhu (2013) in pearl millet, Ghosh *et al.* (2016) and Kumar *et al.* (2017) in pearl millet.

Land equivalent ratio

The data with respect to land equivalent ratio (LER) revealed that all intercropping treatments increased the LER as compared to sole crops. Here, sole sesame, sole green gram and cowpea recorded LER (1.00). The highest LER was recorded in treatment I_5 sesame + green gram (paired 2:1) followed by I_4 sesame+ cowpea (paired 2:1) during both year and pool analysis. The results are in conformity with the findings of Sharma and Singh (2008) in sesame + black gram (2:2), Mandal and Pramanick (2014) in sesame + green gram (4:2) and Sarma *et al.* (2016) in sesame + black gram (1:1).

Effect of nitrogen levels

The data indicated that maximum land equivalent ratio of sesame was obtained in N₂ (application of 100 % RDN) during both year and pool data. These results corroborated with the findings of Sharda *et al.* (2004) pearl millet + mung bean (1:2).

Conclusion

Based on the findings of two years experimental results, it can be concluded that application of 100 % recommended dose of nitrogen to sesame and green gram crop (50 kg N/ha and 20kg N/ha, respectively) to sesame + green gram (paired 2:1) in intercropping system recorded higher yield, Sesame Equivalent yield and Land Equivalent ratio.

Table 1: Seed yield and stover yield of sesame as influenced by intercropping and nitrogen levels

Treatments	Seed yield (kg/ha)			Stover yield (kg/ha)			Biological yield (kg/ha)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
A. Intercropping									
I ₁ : Sole crop sesame	783	813	798	1172	1218	1195	1955	2030	1993
I ₂ : Sole crop cowpea	-	-	-	-	-	-	-	-	-
I ₃ : Sole crop green gram	-	-	-	-	-	-	-	-	-
I ₄ : Sesame + cowpea (paired 2:1)	727	750	738	1083	1127	1105	1810	1876	1843
I ₅ : Sesame + green gram (paired 2:1)	752	769	761	1104	1133	1119	1857	1902	1879
I ₆ : Sesame + cowpea (paired 3:2)	604	622	613	905	928	916	1509	1550	1529
I ₇ : Sesame + green gram (paired 3:2)	622	635	628	942	961	951	1563	1596	1579
SEm ±	20.01	21.44	14.66	29.96	31.33	21.68	44.96	46.19	32.33
CD (P=0.05)	59	64	42	89	93	62	134	137	92
B. Nitrogen levels									
N ₁ : 75 % RDN	614	629	622	917	937	927	1531	1566	1548
N ₂ : 100 % RDN	781	806	794	1166	1209	1187	1947	2016	1981
SEm ±	12.66	13.54	9.27	18.95	19.82	13.71	28.44	29.21	20.38
CD (P=0.05)	38	40	27	56	59	39	85	87	58
Interaction effect (I × N)									
SEm ±	28.30	30.32	20.74	42.37	44.31	30.65	63.59	65.33	45.58
CD (P=0.05)	84	90	60	126	132	88	189	194	131
Sig. int. with Y	-	-	NS	-	-	NS	-	-	NS
CV (%)	7.03	7.32	7.18	7.05	7.15	7.10	6.33	6.32	6.33

Table 2 : Seed, Stover and Biological yield by sesame stover as influenced by interaction I x N

Treatment	Seed yield (kg/ha)		Stover yield (kg/ha)		Biological yield (kg/ha)	
	B. Nitrogen levels		B. Nitrogen levels		B. Nitrogen levels	
	2021		2021		2021	
A. Intercropping	N₁. 75% RDN	N₂. 100% RDN	N₁. 75% RDN	N₂. 100% RDN	N₁. 75% RDN	N₂. 100% RDN
I ₁ : Sole crop sesame	720	846	1069	1275	1789	2121
I ₄ : Sesame + cowpea (paired 2:1)	670	783	1009	1158	1680	1940
I ₅ : Sesame + green gram (paired 2:1)	696	808	1019	1190	1715	1998
I ₆ : Sesame + cowpea (paired 3:2)	481	727	721	1089	1202	1816
I ₇ : Sesame + green gram (paired 3:2)	502	741	767	1116	1269	1857
S.Em.±	28.30		42.37		63.59	
CD (P=0.05)	84		126		189	
CV (%)	7.03		7.05		6.33	
	2022		2022		2022	
I ₁ : Sole crop sesame	746	879	1109	1327	1855	2206
I ₄ : Sesame + cowpea (paired 2:1)	690	810	1039	1216	1726	2025
I ₅ : Sesame + green gram (paired 2:1)	710	828	1038	1228	1748	2056
I ₆ : Sesame + cowpea (paired 3:2)	491	753	726	1129	1217	1883
I ₇ : Sesame + green gram (paired 3:2)	509	761	775	1147	1284	1908
S.Em.±	30.32		44.31		65.33	
CD (P=0.05)	90		132		194	
CV (%)	7.25		7.15		6.32	
	Pooled		Pooled		Pooled	
I ₁ : Sole crop sesame	733	863	1089	1301	1822	2164
I ₄ : Sesame + cowpea (paired 2:1)	680	796	1024	1187	1703	1983
I ₅ : Sesame + green gram (paired 2:1)	703	818	1028	1209	1731	2027
I ₆ : Sesame + cowpea (paired 3:2)	486	740	723	1109	1209	1849
I ₇ : Sesame + green gram (paired 3:2)	505	751	771	1131	1277	1882
S.Em.±	20.74		30.65		45.38	
CD (P=0.05)	60		88		131	
CV (%)	7.15		7.10		6.33	

Table 3: Sesame equivalent yield of sesame as influenced by intercropping and nitrogen levels

Treatments	Sesame equivalent yield		
	2021	2022	Pooled
A. Intercropping			
I ₁ : Sole crop sesame	797	828	812
I ₂ : Sole crop cowpea	751	762	757
I ₃ : Sole crop green gram	895	922	909
I ₄ : Sesame + cowpea (paired 2:1)	1004	1004	1004
I ₅ : Sesame + green gram (paired 2:1)	1045	1075	1060
I ₆ : Sesame + cowpea (paired 3:2)	896	911	904
I ₇ : Sesame + green gram (paired 3:2)	930	932	931
SEm ±	23.18	21.03	15.65
CD (P=0.05)	67.39	61.12	44.41
B. Nitrogen levels			
N ₁ : 75 % RDN	805	833	817
N ₂ : 100 % RDN	1000	1009	1005
SEm ±	12.39	11.24	8.36
CD (P=0.05)	36.02	32.67	23.74
Interaction effect (I × N)			
SEm ±	32.79	29.73	22.13
CD (P=0.05)	95.31	86.44	62.80
Sig. int. with Y	-	-	-
CV (%)	6.32	5.61	5.95

Table 4: Sesame equivalent yield of sesame as influenced by interaction I x N

Treatment	Sesame equivalent yield	
	B. Nitrogen levels	
	2021	
A. Intercropping	N ₁ . 75% RDN	N ₂ . 100% RDN
I ₁ : Sole crop sesame	733	862
I ₂ : Sole cowpea	686	816
I ₃ : Sole green gram	827	963
I ₄ : Sesame + cowpea (paired 2:1)	891	1117
I ₅ : Sesame + green gram (paired 2:1)	964	1126
I ₆ : Sesame + cowpea (paired 3:2)	750	1041
I ₇ : Sesame + green gram (paired 3:2)	784	1076
SEm ±	32.79	
CD (P=0.05)	95.31	
CV (%)	6.32	
	2022	
A. Intercropping	N ₁ . 75% RDN	N ₂ . 100% RDN
I ₁ : Sole crop sesame	760	896
I ₂ : Sole cowpea	698	826
I ₃ : Sole green gram	868	976
I ₄ : Sesame + cowpea (paired 2:1)	930	1078
I ₅ : Sesame + green gram (paired 2:1)	990	1159
I ₆ : Sesame + cowpea (paired 3:2)	766	1057
I ₇ : Sesame + green gram (paired 3:2)	789	1075
SEm ±	29.73	
CD (P=0.05)	86.44	
CV (%)	5.61	
	Pooled	
A. Intercropping	N ₁ . 75% RDN	N ₂ . 100% RDN
I ₁ : Sole crop sesame	746	879
I ₂ : Sole cowpea	692	821
I ₃ : Sole green gram	848	970
I ₄ : Sesame + cowpea (paired 2:1)	910	1097
I ₅ : Sesame + green gram (paired 2:1)	977	1143
I ₆ : Sesame + cowpea (paired 3:2)	758	1049
I ₇ : Sesame + green gram (paired 3:2)	786	1075
SEm ±	22.13	
CD (P=0.05)	62.80	
CV (%)	5.95	

Table 5: Land equivalent ratio of sesame as influenced by intercropping and nitrogen levels

Treatments	Land equivalent ratio		
	2021	2022	Pooled
A. Intercropping			
I ₁ : Sole crop sesame	1.000	1.000	1.000
I ₂ : Sole crop cowpea	1.000	1.000	1.000
I ₃ : Sole crop green gram	1.000	1.000	1.000
I ₄ : Sesame + cowpea (paired 2:1)	1.244	1.242	1.243
I ₅ : Sesame + green gram (paired 2:1)	1.276	1.261	1.268
I ₆ : Sesame + cowpea (paired 3:2)	1.129	1.097	1.113
I ₇ : Sesame + green gram (paired 3:2)	1.118	1.081	1.099
B. Nitrogen levels			
N ₁ : 75 % RDN	1.083	1.072	1.077
N ₂ : 100 % RDN	1.136	1.123	1.129

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