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Effect of sesame based intercropping system with different levels of nitrogen on nutrient content, uptake and post-harvest soil status

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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 seven intercropping treatments of sesame *viz*., I_1 - sole sesame, I_2 - sole cowpea, I_3 - sole green gram, I_4 - sesame + cowpea (paired 2:1), I_5 - sesame + green gram (paired 2:1), I_6 - sesame + cowpea (paired 3:2) and I_7 - sesame + green gram (paired 3:2) and two nitrogen levels *viz*., 75% RDN (N_1) and 100% RDN (N_2) were evaluated in the study. The experiment was conducted for two consecutive years with the same randomization. Significantly higher seed and stover and biological yields and N, P_2O_5 as well as K_2O uptake of sesame were obtained under sole sesame on pooled basis. Sole green gram (I_3) intercropping system recorded significantly higher available nitrogen in soil. Seed, stover and biological yields as well as nitrogen Content, N, P_2O_5 and K_2O uptake of sesame were found superior with 100% RDN (N2) on pooled basis.

Keywords: 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) [3]. 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) [3].

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 to become independent of soil nitrogen and make 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 crops. Inclusion of pulses in the 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) [28, 33].

Inclusion of pulses as intercrop helped to save up to 25% of the recommended level of nitrogen application to the associated cereal (Morachan *et al*., 1977) [19] and improve the soil nitrogen status and thus, reduce nitrogen application to the succeeding crop (Palanippan *et al*., 1985) [21].

Materials and Method

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 the predominance of montmorillonite clay mineral, soil cracks heavily on drying. Initial soil analysis indicated that the experimental site was clay in texture, low in organic carbon (0.39% and 0.42%) and low in available nitrogen (196.30 kg/ha and 203.42 kg/ha), while medium in available phosphorus (38.30 kg/ha and 40.55 kg/ha) and high in potassium (294.50 kg/ha and 311.27 kg/ha), during the crop season of the year 2021 and 2022, respectively.

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*., I_1 - sole sesame, I_2 - sole cowpea, I_3 - sole green gram, I_4 - sesame + cowpea (paired 2:1), I_5 - sesame + green gram (paired 2:1), I_6 - sesame + cowpea (paired 3:2) and I_7 - sesame + green gram (paired 3:2) and two nitrogen levels *viz*., 75% RDN (N_1) and 100% RDN (N_2) were evaluated in the study. The experiment was conducted for two consecutive years with the same randomization. Available N, P_2O_5 and K_2O were determined as per different methods likewise the Alkaline $KMnO_4$ method, Olsen's Method and Flame Photometry method respectively.

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 systems examined, significantly higher seed yield of sesame was recorded with the treatment (I_1) sole sesame during both years and pooled analysis being at par with the treatment I_4 - sesame +cowpea (paired 2:1) and treatment I_5 - sesame + green gram (paired 2:1) during both year but only treatment I_5 - sesame + green gram (paired 2:1) in the pooled analysis. The lower seed yield was recorded under treatment I_6 - sesame + cowpea (paired 3:2) and treatment I_7 - 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 (I_1) sole sesame during both the years and pooled analysis and it was remained at par with the treatment I_4 - sesame + cowpea (paired 2:1) and treatment I_5 - sesame + green gram (paired 2:1) during the both year as well as higher biological yield of sesame was obtained under sole sesame treatment (I_1) during both the years and in pooled results which remained at par with the treatment I_5 - sesame + green gram (paired 2:1) for both the year only. Seed, stover and biological yield of sesame were 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 capsules 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 sunlight, space, moisture and plant nutrients. Reduction in seed yield of sesame owing to legume intercropping was also reported by Sarkar and Kundu (2001) [27], De *et al*. (2002) [10] and Yadav *et al*. (2013) [36]. 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 suppresses the growth of sesame. Similar results are also in agreement with the findings of Bhatti *et al*. (2005) [6].

Effect of nitrogen levels

It is evident from Table 1 that seed, stover and biological yield of sesame were 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 were recorded with application of 100% RDN (N_2) to sesame crops during both the years and pooled analysis. The minimum seed stover and biological yield was recorded by 75% RDN (N_1) may be due to an insufficient supply of N for achieving the proper growth and development of sesame crops. 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) [26], Chakraborty (2013) [9], Patel *et al*. (2014) [13] Hasan (2015) [13], Gebremariam (2015) [11], Kithan *et al*. (2017) [16], Shamsuzzoha *et al*. (2019) [29], Adisu *et al*. (2020) [1] and Jose *et al*. (2021) [15].

Interaction effect

The findings indicated significant interaction between the intercropping and different nitrogen levels in sesame crop during both the years and in pooled analysis. The data on the interaction effect on seed yield are presented in Table 2. During both years, 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 years 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 the 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 existing due to lower nitrogen levels. The result corroborates with the findings of

Tanwar *et al*. (2011) [32], Ghosh *et al*. (2016) [12], Aminifer *et al*. (2017) [2], Kumar *et al*., (2017) [17] in pearl millet.

Nutrient content and uptake
Nitrogen Content (%) and Uptake (kg/ha)
Effect of intercropping

An examination of data given in Table 3 revealed that various intercropping system along with sesame exerted non-significant influence on nitrogen content (%) by sesame seed and stover during both the years and in pooled analysis. But nitrogen content in sesame seed and stover were significantly influenced by different nitrogen levels applied to sesame during both the years and in pooled analysis. Among the different intercropping system examined, significantly higher nitrogen uptake of sesame seed was recorded with treatment (I_1) sole sesame during both the years and pooled analysis but it remained at par with the treatment I_4 - sesame + cowpea (paired 2:1) and treatment I_5 - sesame + green gram (paired 2:1) in both the years and pooled analysis. While significantly higher nitrogen uptake of sesame stover was recorded with treatment (I_1) sole sesame during both the years and pooled analysis but it remained at par with the treatment I_5 - sesame + green gram (paired 2:1) in both years only. However, the highest nitrogen uptake by seed and stover was observed in sole sesame might be due to the fact that sesame fertilized with an appropriate dose utilizing nitrogen more efficiently than that of the system wherein more competition existed due to intercrop. However, intercrops like green gram showed more compatibility with sesame in utilizing the applied nitrogen than cowpea. The results are in conformity with the work of Prajapat *et al*. (2011) [25], Yadav *et al*. (2017) [35] and Pragatheeswaran *et al*. (2021) [24] in sunflower.

Effect of Nitrogen

The Data Table 3 indicated that nitrogen content in sesame seed and stover were significantly influenced by different nitrogen levels applied to sesame during both the years and in pooled analysis. Sesame fertilized with 100% RDN (N_2) recorded significantly higher nitrogen content (%) and uptake (kg/ha) in seed and stover during both the years and pooled analysis. The increase in nitrogen concentration might be outcome of the increased availability of nitrogen to plant. These results are in confirmation with the findings of Vaghani *et al*. (2010) [34], Patel *et al.* (2014) [13] and Bijarnia *et al.* (2019) [7].

Interaction effect

The data on the interaction effect on nitrogen content and uptake are presented in Table 4. With regard to N content (%) in seed and stover, the interaction between intercropping system and different nitrogen levels applied to sesame crop failed to reach the level of significance in the individual years as well as pooled analysis. But interaction effect between intercropping system and different nitrogen levels applied in sesame was found significant for nitrogen uptake by seed and stover during individual years and pooled analysis. Data in Table 4 revealed that treatment combination (I_1N_2) with sole sesame and 100% RDN to sesame resulted significantly higher nitrogen uptake in sesame seed during both year and pooled analysis and it was at par with treatment I_4N_2 and I_5N_2 in the first season and pooled data as well as treatment I_4N_2, I_5N_2 and I_7N_2 in second year. Data in Table 4.11b revealed that treatment combination (I_1N_2) with sole sesame and 100% RDN to sesame resulted in significantly higher nitrogen uptake in sesame stover during both year. It was at par with treatment I_4N_2, I_5N_2 and I_7N_2 in first year and I_4N_2, I_5N_2, I_6N_2 as well as I_7N_2 in second year and I_4N_2, I_5N_2 on pooled basis. The findings are in close agreement with those obtained by Sharma and Gupta (2002) [30] in pearl millet.

Phosphorus content and uptake (kg/ha)
Effect of intercropping

An examination of data given in Table 5 revealed that various intercropping system along with sesame exerted non-significant influence on phosphorus content (%) by sesame seed and stover during both the years and in pooled analysis. But among the intercropping system along with sesame exerted significant influence on phosphorus uptake by sesame seed and stover during both the years and in pooled. Among the different intercropping system examined, significantly higher phosphorus uptake of sesame seed and stover were recorded with treatment (I_1) sole sesame during both the years and pooled analysis and it remained at par with the treatment I_4 - sesame + cowpea (paired 2:1) and treatment I_5 - sesame + green gram (paired 2:1) in both the years and only with treatment I_5 - sesame + green gram (paired 2:1) in pool analysis. While lowest phosphorus uptake by sesame seed and stover was observed under I_6 - sesame + cowpea (paired 3:2) and treatment I_7 - sesame + green gram (paired 3:2) in both year and pooled analysis. The findings are in close agreement with those obtained by Yadav *et al*. (2017) [35], Pragatheeswaran *et al*. (2021) [24] in sunflower.

Effect of nitrogen levels

The data in Table 5 further indicated different nitrogen levels applied to sesame crop significantly influenced the phosphorus uptake by seed and stover in both the years and in pooled data. Application of 100% RDN (N_2) resulted in significantly higher phosphorus uptake by seed and stover in both years. While the lowest uptake of P and K by seed and stover of sesame was seen in the lowest nitrogen level *i.e*., 75% RDN. The findings are in close agreement with those obtained by Vaghani *et al*. (2010) [34] Patel *et al*. (2014) [13] and Patel and Raj (2017) [22].

Interaction Effect

The interaction between intercropping system and different nitrogen levels applied in sesame crop failed to reach the level of significance with respect to phosphorus uptake (kg/ha) in the individual years as well as pooled analysis.

Potassium content (%) and Uptake (kg/ha)
Effect of Intercropping

An examination of data given in Table 6 revealed that various intercropping system along with sesame exerted non-significant influence on potassium content (%) by sesame seed and stover during both the years and in pooled analysis. But among the intercropping system along with sesame exerted significant influence on potassium uptake by sesame seed and stover during both the years and in pooled. Among the different intercropping system examined, significantly higher potassium uptake of sesame seed and stover were recorded with treatment (I_1) sole sesame during both the years and pooled analysis and it was remained at par with the treatment I_4 - sesame + cowpea (paired 2:1) and treatment I_5 - sesame + green gram (paired 2:1) in both the years and only with treatment I_5 - sesame + green gram (paired 2:1) in pool analysis. While lowest potassium uptake by sesame seed and stover observed under I_6 - sesame + cowpea (paired 3:2) and treatment I_7 - sesame + green gram (paired 3:2) in both year and pooled analysis. The findings are in close agreement with those obtained by Yadav *et al*. (2017) [35], Pragatheeswaran *et al*. (2021) [24] in sunflower.

Effect of nitrogen levels

The data in Table 5 further indicated different nitrogen levels applied to sesame crop significantly influenced the potassium uptake by seed and stover in both the years and in pooled data. Application of 100% RDN (N_2) resulted in significantly higher potassium uptake by seed and stover in both the years. While the lowest uptake of P and K by seed and stover of sesame was seen in the lowest nitrogen level *i.e*., 75% RDN. The findings are in close agreement with those obtained by Vaghani *et al*. (2010) [34] Patel *et al*. (2014) [13] and Patel and Raj (2017) [22].

Interaction Effect

The interaction between intercropping system and different nitrogen levels applied in sesame crop failed to reach the level of significance with respect to potassium uptake (kg/ha) in the individual years as well as pooled analysis.

Available N, P_2O_5 and K_2O

Effect of intercropping

Data in Table 7 revealed that intercropping system had significantly influenced the available N in soil after harvest of the crop. Sole green gram was recorded significantly higher available nitrogen after crop harvest in soil which was at par with treatment (I_2) sole cowpea, I_6 - sesame + cowpea (paired 3:2) and I_7 - sesame + green gram (paired 3:2) intercropping system. The findings are in close agreement with those obtained by Bindhu *et al*. (2014) [8] and Kumar *et al*. (2017) [17]. But among intercropping system not significantly influenced the available phosphorus and available potassium in soil sesame harvest during both the years.

Effect of nitrogen

The results further revealed that different nitrogen levels in sesame exerted their non-significant effect on available phosphorus and available potassium in the soil during both years.

Interaction Effect

The interaction between an intercropping system and different nitrogen levels in sesame was found non-significant for available phosphorus and available potassium status in soil during both years of experimentation.

Conclusion

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

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
S.Em $\pm$	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
S.Em $\pm$	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)									
S.Em $\pm$	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	N_1. 75% RDN	N_2. 100% RDN	N_1. 75% RDN	N_2. 100% RDN	N_1. 75% RDN	N_2. 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: Nitrogen Content (%) and Uptake (kg/ha) of sesame as influenced by intercropping and nitrogen levels

Treatments	Nitrogen content in seed (%)			Nitrogen content in stover (%)			Nitrogen uptake in seed (kg/ha)			Nitrogen uptake in stover (kg/ha)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
A. Intercropping												
I_1: Sole crop sesame	3.02	3.02	3.02	1.03	1.01	1.02	23.74	24.58	24.16	12.14	12.33	12.23
I_2: Sole crop cowpea	-	-	-	-	-	-	-	-	-	-	-	-
I_3: Sole crop green gram	-	-	-	-	-	-	-	-	-	-	-	-
I_4: Sesame + cowpea (paired 2:1)	3.11	3.09	3.10	1.05	1.03	1.04	22.49	23.15	22.82	11.36	11.59	11.48
I_5: Sesame + green gram (paired 2:1)	3.15	3.13	3.14	1.08	1.07	1.07	23.63	24.03	23.83	11.92	12.11	12.01
I_6: Sesame + cowpea (paired 3:2)	2.97	2.95	2.96	0.95	0.95	0.95	18.11	18.50	18.30	8.79	9.03	8.91
I_7: Sesame + green gram (paired 3:2)	3.01	3.01	3.01	0.97	0.97	0.97	18.83	19.35	19.09	9.25	9.46	9.35
S.Em.±	0.06	0.07	0.05	0.05	0.05	0.03	0.69	0.74	0.51	0.47	0.51	0.35
CD (P=0.05)	NS	NS	NS	NS	NS	NS	2.04	2.21	1.45	1.39	1.53	1.00
B. Nitrogen levels												
N_1: 75% RDN	2.97	2.98	2.97	0.95	0.95	0.95	18.24	18.82	18.53	8.77	9.00	8.88
N_2: 100% RDN	3.13	3.11	3.12	1.08	1.06	1.07	24.48	25.02	24.75	12.62	12.80	12.71
S.Em.±	0.04	0.04	0.03	0.03	0.03	0.02	0.43	0.47	0.32	0.30	0.32	0.22
CD (P=0.05)	0.12	0.12	0.08	0.09	0.09	0.06	1.29	1.40	0.92	0.88	0.97	0.63
Interaction effect (I × N)												
S.Em.±	0.09	0.09	0.06	0.07	0.06	0.05	0.97	1.05	0.71	0.66	0.73	0.49
CD (P=0.05)	NS	NS	NS	NS	NS	NS	2.88	3.12	2.05	1.97	2.16	1.41
Sig. int. with Y	-	-	NS	-	-	NS	-	-	NS	-	-	NS
CV (%)	5.04	5.32	5.18	11.28	11.12	11.20	7.86	8.30	8.09	10.73	11.54	11.15

Table 4: Nitrogen uptake by seed and stover of sesame as influenced by interaction I x N

Treatment	Nitrogen uptake in seed (kg/ha)		Nitrogen uptake in stover (kg/ha)	
	B. Nitrogen levels		B. Nitrogen levels	
	2021		2021	
A. Intercropping	**N_1. 75% RDN**	**N_2. 100% RDN**	**N_1. 75% RDN**	**N_2. 100% RDN**
I_1: Sole crop sesame	21.22	26.27	10.65	13.63
I_4: Sesame + cowpea (paired 2:1)	19.99	25.00	10.23	12.50
I_5: Sesame + green gram (paired 2:1)	21.82	25.44	10.50	13.33
I_6: Sesame + cowpea (paired 3:2)	13.41	22.81	6.10	11.48
I_7: Sesame + green gram (paired 3:2)	14.77	22.89	6.36	12.14
S.Em.±	0.97		0.66	
CD (P=0.05)	2.88		1.97	
CV (%)	7.86		10.73	
	2022		2022	
I_1: Sole crop sesame	N_1. 75% RDN	N_2. 100% RDN	N_1. 75% RDN	N_2. 100% RDN
I_4: Sesame + cowpea (paired 2:1)	22.43	26.73	10.89	13.77
I_5: Sesame + green gram (paired 2:1)	21.14	25.15	10.78	12.40
I_6: Sesame + cowpea (paired 3:2)	21.89	26.17	10.67	13.55

I_7: Sesame + green gram (paired 3:2)	14.08	22.92	6.14	11.91
S.Em.±	1.05		0.73	
CD (P=0.05)	3.12		2.16	
CV (%)	8.30		11.54	
	Pooled		Pooled	
I_1: Sole crop sesame	N_1. 75% RDN	N_2. 100% RDN	N_1. 75% RDN	N_2. 100% RDN
I_4: Sesame + cowpea (paired 2:1)	21.82	26.50	10.77	13.70
I_5: Sesame + green gram (paired 2:1)	20.57	25.08	10.50	12.45
I_6: Sesame + cowpea (paired 3:2)	21.85	25.80	10.59	13.44
I_7: Sesame + green gram (paired 3:2)	13.75	22.86	6.12	11.69
S.Em.±	0.71		0.49	
CD (P=0.05)	2.05		1.41	
CV (%)	8.09		11.15	

Table 5: Phosphorus Content (%) and Uptake (kg/ha) of sesame as influenced by intercropping and nitrogen levels

Treatments	Phosphorus content in seed (%)			Phosphorus content in stover (%)			Phosphorus uptake in seed (kg/ha)			Phosphorus uptake in straw (kg/ha)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
A. Intercropping												
I_1: Sole crop sesame	1.24	1.23	1.24	0.27	0.27	0.27	0.27	0.27	0.27	3.12	3.21	3.17
I_2: Sole crop cowpea	-	-	-	-	-	-	-	-	-	-	-	-
I_3: Sole crop green gram	-	-	-	-	-	-	-	-	-	-	-	-
I_4: Sesame + cowpea (paired 2:1)	1.21	1.21	1.21	0.26	0.25	0.25	0.26	0.25	0.25	2.80	2.80	2.80
I_5: Sesame + green gram (paired 2:1)	1.23	1.21	1.22	0.27	0.26	0.26	0.27	0.26	0.26	2.96	2.90	2.93
I_6: Sesame + cowpea (paired 3:2)	1.20	1.20	1.20	0.24	0.23	0.24	0.24	0.23	0.24	2.16	2.19	2.18
I_7: Sesame + green gram (paired 3:2)	1.21	1.21	1.21	0.25	0.24	0.25	0.25	0.24	0.25	2.35	2.33	2.34
S.Em.±	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.14	0.15	0.10
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.40	0.44	0.29
B. Nitrogen levels												
N_1: 75% RDN	1.22	1.21	1.21	0.26	0.25	0.25	7.48	7.60	7.54	2.37	2.33	2.35
N_2: 100% RDN	1.22	1.21	1.21	0.26	0.25	0.25	9.51	9.80	9.65	2.99	3.04	3.01
S.Em.±	0.02	0.02	0.01	0.01	0.01	0.00	0.23	0.24	0.17	0.09	0.09	0.06
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.69	0.71	0.48	0.25	0.28	0.18
Interaction effect (I × N)												
S.Em.±	0.04	0.04	0.03	0.01	0.01	0.01	0.52	0.53	0.37	0.19	0.21	0.14
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sig. int. with Y	-	-	NS	-	-	NS	-	-	NS	-	-	NS
CV (%)	6.17	6.20	6.18	0.01	0.01	0.01	10.64	10.60	10.62	12.36	13.51	12.95

Table 6: Potassium Content (%) and Uptake (kg/ha) of sesame as influenced by intercropping and nitrogen levels

Treatments	Potassium content in seed (%)			Potassium content in stover (%)			Potassium uptake in seed (kg/ha)			Potassium uptake in straw (kg/ha)		
	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled	2021	2022	Pooled
A. Intercropping												
I_1: Sole crop sesame	0.97	0.96	0.96	1.18	1.17	1.18	7.57	7.78	7.67	13.84	14.26	14.05
I_2: Sole crop cowpea	-	-	-	-	-	-	-	-	-	-	-	-
I_3: Sole crop green gram	-	-	-	-	-	-	-	-	-	-	-	-
I_4: Sesame + cowpea (paired 2:1)	0.95	0.94	0.94	1.16	1.15	1.16	6.93	7.01	6.97	12.61	13.02	12.82
I_5: Sesame + green gram (paired 2:1)	0.96	0.95	0.95	1.17	1.16	1.17	7.22	7.31	7.26	12.97	13.19	13.08
I_6: Sesame + cowpea (paired 3:2)	0.94	0.93	0.93	1.14	1.13	1.13	5.66	5.76	5.71	10.36	10.49	10.42
I_7: Sesame + green gram (paired 3:2)	0.94	0.94	0.94	1.15	1.14	1.15	5.86	5.98	5.92	10.89	11.00	10.94
S.Em.±	0.02	0.02	0.02	0.03	0.03	0.02	0.27	0.27	0.19	0.53	0.52	0.37
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.81	0.81	0.56	1.58	1.56	1.07
B. Nitrogen levels												
N_1: 75% RDN	0.94	0.94	0.94	1.15	1.14	1.15	5.81	5.92	5.87	10.60	10.75	10.68
N_2: 100% RDN	0.96	0.94	0.95	1.17	1.16	1.17	7.48	7.62	7.55	13.67	14.04	13.85
S.Em.±	0.02	0.01	0.01	0.02	0.02	0.01	0.17	0.17	0.12	0.34	0.33	0.24
CD (P=0.05)	NS	NS	NS	NS	NS	NS	0.52	0.51	0.35	1.00	0.98	0.68
Interaction effect (I × N)												
S.Em.±	0.03	0.03	0.02	0.04	0.04	0.03	0.39	0.39	0.27	0.75	0.74	0.53
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sig. int. with Y	-	-	NS	-	-	NS	-	-	NS	-	-	NS
CV (%)	6.13	5.60	5.87	6.14	5.38	5.77	10.11	9.90	10.00	10.71	10.35	10.53

Table 7: Available N, P_2O_5 and K_2O status in soil after harvest of sesame as influenced by different treatments

Treatments	Available N		Available P_2O_5		Available K_2O	
	2021	2022	2021	2022	2021	2022
A. Intercropping						
I_1: Sole crop sesame	190	188	38	40	291	299
I_2: Sole crop cowpea	217	216	41	42	299	309
I_3: Sole crop green gram	218	219	42	43	302	312
I_4: Sesame + cowpea (paired 2:1)	194	197	39	40	293	302
I_5: Sesame + green gram (paired 2:1)	195	197	39	40	294	303
I_6: Sesame + cowpea (paired 3:2)	205	210	39	41	295	306
I_7: Sesame + green gram (paired 3:2)	210	211	40	41	297	307
S.Em ±	5.64	5.93	1.15	1.17	8.51	9.37
CD (P=0.05)	16.39	17.25	NS	NS	NS	NS
B. Nitrogen levels						
N_1: 75% RDN	202	202	40	41	294	304
N_2: 100% RDN	206	208	40	41	298	307
S.Em ±	3.01	3.17	0.61	0.63	4.55	4.99
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Interaction effect (I × N)						
S.Em ±	7.97	8.39	1.63	1.65	12.04	13.21
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Sig. int. with Y	-	-	-	-	-	-
CV (%)	6.77	7.08	7.12	7.04	7.05	7.49
Initial value	196.30	203.42	38.30	40.55	294.50	305.87

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