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Effect of nitrogen levels on intercrop yields of sesame, greengram and groundnut in new alluvial zone of West Bengal

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ABSTRACT

A field experiment was conducted during in Gangetic Alluvial soil on intercropping of sesame at two levels of nitrogen with two varieties of each greengram and groundnut to analyze the growth, productivity and effect of intercropping on individual crops. The highest seed yield of sesame was obtained from sole crop of sesame with 50 kg N ha^{-1} in both the years. The significantly highest greengram yield was obtained from sole crop of greengram cv. T-44, in both the years with 25 kg N ha^{-1} than that of same variety of greengram in association with sesame at 50 kg N ha^{-1}. The highest groundnut pod yield was obtained from sole crop of groundnut cv.-JL-24. The highest intercrop yield was obtained from cv.JL-24, grown with sesame at 25 kg N ha^{-1} and lowest from cv.AK-12/24, grown with sesame at 50 kg N ha^{-1}, in both the years. Intercropping of sesame with groundnut varieties recorded higher total sesame equivalent yield than that with greengram at 50 kg ha^{-1} nitrogen level.

Keywords: Greengram, groundnut, intercropping, nitrogen levels, sesame

India has now achieved self-sufficiency in cereal food production, with the advancement of agriculture technologies, but is still lagging behind to meet its need for protein and vegetable oil. Oilseed and pulses constitute the total area of 26.81 and 23.19 million ha, respectively in India with annual production of 30 million tons oilseeds and 19 million tons of pulses. Intercropping is an improved practice developed from age old practice of mixed cropping. Recently it has become a prominent subject of research for its scope in sustainable agriculture and yield maximization. The main purpose of intercropping is to produce a greater yield on a given piece of land by making use of resources that would otherwise not be utilized by a single crop efficiently (Evan *et al*., 2001). Moynihan *et al*. (1996) mentioned that intercropping annual legumes with grain crops has been proposed as a cropping strategy to enhance ground cover, thereby reducing weed competition, suppressing soil erosion, and providing N for use by subsequent crops. So, with such systems synthetic N-fertilizer and herbicide use might be reduced. The most common reason for the adoption of intercropping systems is yield advantage, which is explained by the greater resource depletion by intercrops than monocultures, and N2 fixation, particularly when cereal and legume crops; i.e. barley/fababean (Agegnehu *et al*., 2006), wheat/chickpea (Banik *et al*., 2006) and corn/cowpea (Geren et al., 2008) are grown together. Intercropping groundnut with sesame was most beneficial as compared to sole stand of sesame Sarkar *et al*., 2000). The present experiment on intercropping of sesame (cv. B-67) at two levels of nitrogen (25 kg & 50 kg N ha^{-1}) with two varieties of greengram (cv. T-44, cv. B-105) and two varieties of groundnut (cv. JL-24, cv. AK-12/24), in 2:2 row ratio has been framed to study the performance of yield of component crops as compared with sole crops of cropping systems.

MATERIALS AND METHODS

A field experiment was conducted on new alluvial soil at Instructional farm, Jaguli, BCKV (22.95^0 N latitude, 88.57^0 E longitude) during summer month of 2014 and 2015 on intercropping of sesame at two levels of nitrogen with two varieties of greengram and two varieties of groundnut, in 2:2 row ratio, in Randomized Block Design with three replications and 14 treatment combinations. The plot sizes of 5 x 2.4 m and spacing of 30 x 15 cm for sesame and greengram and 30 x 7 cm for groundnut to study their growth, yield and nitrogen economy. All the crops were sown in 20th and 25th February of 2014 and 2015, respectively. The soil pH was 6.8, sandy loam in texture with total N of 0.076 per cent, available P_2O_5 of 17.80 kg ha $^{-1}$, available K_2O of 81.8 kg ha^{-1} and organic Carbon of 0.59 per cent. Sesame (cv. B-67), greengram (cv.T-44 and cv. B-105) and groundnut (cv. JL-24 and cv. AK-12/24) were grown with fertilizer doses of 25 kg N, 60 kg P_2O_5 and 40 kg K_2O per ha through Urea, SSP and MOP respectively as basal and another 25 kg N as topdressing to sesame rows scheduled to be applied 50 kg N ha^{-1} at 21 DAS. The Treatment combinations are T_1- S-$N_{25:}$ sole sesame with 25 kg N ha^{-1}, T_2 - S-N_{50} : Sole sesame with 50 kg N ha^{-1}, T_3 - GG-1 : Sole greengram cv. T-44, T_4- GG-2 : Sole greengram cv. B-105, T_5 - GN--1 : Sole groundnut cv. JL-24, T_6 - GN-2 : Sole groundnut cv. AK-12/24, T_7 - S-N_{25} / GG-1: Intercropping of sesame with 25 kg N ha^{-1} and greengram cv.T-44, T_8 - S-N_{50} / GG-1: Intercropping of sesame with 50 kg N ha^{-1} and greengram cv. T-44, T_9

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- $S-N_{25}$ / GG-2: Intercropping of sesame with 25 kg N ha^{-1} and greengram cv. B-105, T_{10}- $S-N_{50}$ / GG-2: Intercropping of sesame with 50 kg N ha^{-1} and greengram cv. B-105, T_{11} - $S-N_{25}$ / GN-1: Intercropping of sesame with 25 kg N ha^{-1} with groundnut cv. JL-24, T_{12}- $S-N_{50}$ / GN-1: Intercropping of sesame with 50 kg N ha^{-1} with groundnut cv. JL-24, T_{13} - $S-N_{25}$ / GN-2: Intercropping of sesame with 25 kg N ha^{-1} with groundnut cv. AK-12/ 24 and T_{14}- $S-N_{50}$ / GN-2: Intercropping of sesame with 50 kg N ha^{-1} with groundnut cv. AK-12/24. Sesame was harvested 95 days after sowing, greengram (cv.T-44; cv. B-105) was harvested 75 days after sowing and groundnut (cv. JL-24; cv. AK-12/24) was harvested 110 days after sowing. The seeds and pods were sun dried, cleaned and weighed. The yield attributes like number of plants m^{-2}, number of pods per capsule per plant, number of seeds per pod, test weight were observed under different treatments. Greengram and groundnut yields were calculated and converted into sesame equivalent yield on the basis of their prices for benefit of comparison of different cropping systems. The data of parameters studied during the course of study were statistically analyzed, applying the technique of analysis of variance described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Sesame

The data regarding sesame was given in table.1 and 4. Number of plants per square meter of sesame was affected significantly by different treatments in both the years. Number of plants per square meter was maximum in sole cropping, and reduced in intercropping. Population of sesame in intercropped situation was 50 per cent of sole crop population. No significant variation in number of sesame plants was observed among different intercropping situations. Number of filled capsules per plant of sesame increased significantly, when sesame at 50 kg N ha^{-1} was intercropped with any variety of legumes, and at 25 kg N ha^{-1} with groundnut cv.Ak-12/24, over that of respective pure stand sesame in both the years. Higher level of nitrogen significantly increased the capsule number over that of lower level under intercropping situations. ariation in number of seed per capsule followed more or less similar trend as observed in case of number of capsules per plant of sesame. Test weight (1000 seed weight) of sesame did not vary significantly due to different cropping treatments, in both the years. Sesame yield varied significantly due to different treatments, in both the years.

The highest seed yield of sesame was obtained from sole crop of sesame with 50 kg N ha^{-1}, followed by 25 kg N ha^{-1}, in both the years. Intercrop population of sesame was 50 per cent of sole crop whereas the yield reduction was less than 50 per cent. The highest intercrop yield of sesame was obtained with 50 kg N ha^{-1}, in association with groundnut AK-12/24, which was significantly superior to that of any variety of greengram or groundnut at 50 kg N ha^{-1}, but *at par* with the remaining treatments, in both the years. These data may be due to increase rate of nitrogen fertilization enhanced root development which improved the supply of other nutrients and water to the growing parts of the plants and resulted in an increase in photosynthetic area and thereby more dry matter accumulation in different parts of sesame organs. Sesame grain yield increased significantly with increase in the rate of nitrogen fertilization, implying that sesame yields could be boosted through an increase in nitrogen fertilizer application (Haruna, 2011).

Greengram

The data regarding greengram was given in table.2 and 4. Plant population of greengram per unit area was lesser in intercropping situations due to reduction in number of rows as compared to sole cropping in both the years. Under intercropping situations, effect of N levels in associated sesame crop and greengram varieties had no significant effect on plant population. Number of filled pods per plant of greengram varied significantly due to different cropping treatments in 2014, but not in 2015. Under intercropping situations, effect of N levels in associated sesame crop and greengram varieties had no significant effect on number of filled pods per plant of greengram. Number of seeds per pod and test weight (1000 seed weight) did not vary significantly due to different cropping treatments in both the years.

The highest greengram yield was obtained from sole crop of greengram cv. T-44, followed by cv. B-105, in both the years. The highest intercrop yield of greengram was obtained from cv. B-105 in association with sesame with 25 kg N ha^{-1} which was significantly higher than that of same variety of greengram in association with sesame at 50 kg N ha^{-1}. Under intercropping situation, higher doses of nitrogen of associated sesame crop reduced the greengram yield significantly by 15 per cent as compared to lower dose. Intercrop yield of two greengram varieties did not vary significantly in both the years.

Groundnut

The data regarding groundnut was given in table.3 and 4. Number of groundnut plants per square meter was reduced significantly in intercropping as compared to respective sole crop due to reduction in number of rows. Number of filled pods per plant of groundnut, number of kernels per pod and test weight (100 kernel weight) of peanut did not vary significantly due to the different cropping treatments. The highest groundnut pod yield was obtained from sole crop of groundnut cv.JL-24, followed by cv.AK-12/24. The highest intercrop yield was obtained from cv.JL-24, grown with sesame at 25kg N ha^{-1} and lowest from cv.AK-12/24, grown with sesame at 50 kg N ha^{-1}, in both the years, but the difference was not significant. Higher doses of nitrogen of associated sesame crop reduced the yield of groundnut by 9 per cent, as compared to lower dose (25 kg). Under intercropping situation nitrogen levels in associated sesame crop and the groundnut varieties did not have any significant effect on pod yield of groundnut, in both the years. Increased nitrogen inside the plant may be helped the chlorophyll in leaves to increase and thus the groundnut yield increased as well. On the other hand, nitrogen shortage accelerated the aging process in vegetative organs such as leaves which are known as photosynthesizing organs (Gohari and Niyaki, 2010).

Sesame Equivalent Yield

Greengram and groundnut yields were converted into sesame equivalent yield, on the basis of their prices for benefit of comparison of different cropping treatments. Sesame equivalent yield in different intercropping situations were appreciably higher than that of sole crops of sesame or greengram, but were lower than the sole crop of groundnut, in both the years. Groundnut producing much higher yield showed superiority to both sole and intercropping systems in this case. Intercropping of sesame with groundnut varieties recorded higher total sesame equivalent yield than that with greengram (471 to 474 kg ha^{-1} sesame seed yield, 1123 to 1250 kg ha^{-1} pod yield, thus 1369 to 1474 kg ha^{-1} of total sesame equivalent yield at 50 kg ha^{-1} nitrogen level (cv. AK- 12/24). In case of sesame with greengram (cv. T-44) at 50 kg ha^{-1} nitrogen level, it was recorded 470 to 471 kg ha^{-1} sesame yield, 434-494 kg ha^{-1} greengram yield and thus

Table 1 : Effect of different treatments on yield components of sesame

Treatment	No. of plants m^{-2}		No. of filled capsules $plant^{-1}$		No. of seeds $capsule^{-1}$		1000 seed weight (g)	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
T_1 S-N_{25}	42	40	33.0	33.8	44.5	45.3	3.06	2.91
T_2 S-N_{50}	41	41	33.4	34.6	44.7	49.0	3.12	3.07
T_7 S-N_{25} / GG-1	22	20	36.5	38.2	48.1	52.8	3.27	3.34
T_8 S-N_{50} / GG-1	21	18	40.4	42.5	55.9	56.9	3.25	3.37
T_9 S-N_{25} / GG-2	20	21	36.8	36.6	49.4	53.5	3.14	3.13
T_{10} S-N_{50} / GG-2	22	17	39.4	41.4	53.8	56.9	3.18	3.19
T_{11} S-N_{25} / GN-1	21	17	33.5	35.7	44.3	51.3	3.14	3.08
T_{12} S-N_{50} / GN-1	20	18	38.7	38.8	50.4	52.7	3.21	3.17
T_{13} b S-N_{25} / GN-2	21	18	39.0	39.1	50.9	55.3	3.17	3.13
T_{14} S-N_{50} / GN-2	22	21	40.4	43.3	56.1	59.4	3.15	3.22
SEm(±)	**1.70**	**1.69**	**1.53**	**1.24**	**2.61**	**1.75**	**0.213**	**0.158**
LSD(0.05)	**5.05**	**5.02**	**4.57**	**3.71**	**7.73**	**5.22**	**NS**	**NS**
N-level in sesame								
N_{25}	20	18	36.0	37.1	48.3	53.7	3.14	3.19
N_{50}	22	20	39.6	41.0	54.2	56.2	3.23	3.26
SEm(±)	**0.85**	**0.86**	**0.76**	**0.62**	**1.30**	**0.88**	**0.107**	**0.079**
LSD(0.05)	**NS**	**NS**	**2.26**	**1.84**	**3.86**	**2.61**	**NS**	**NS**
Legume crop variety								
GG-1	20	19	38.0	38.6	52.0	55.2	3.17	3.18
GG-2	21	20	36.1	40.3	51.9	54.6	3.38	3.31
GN-1	21	19	38.4	38.9	47.8	53.0	3.16	3.12
GN-2	22	18	39.7	41.4	54.0	57.4	3.22	3.17
SEm(±)	**1.20**	**1.20**	**1.08**	**0.88**	**1.84**	**1.24**	**0.151**	**0.124**
LSD(0.05)	**NS**	**NS**	**3.20**	**2.61**	**5.47**	**3.68**	**NS**	**NS**

Table 2 : Effect of different treatments on yield component of greengram

Treatment	No. of plants m^{-2}		No. of filled capsule plant $^{-1}$		No. of seed capsule $^{-1}$		1000 seed weight (g)	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
T_3 GG-1	42	40	14.5	15.0	7.8	8.4	32.62	31.11
T_4 GG-2	41	41	13.5	14.3	6.8	8.1	31.23	30.70
T_7 S-N_{25}/GG-1	21	22	15.3	17.9	8.1	9.1	35.74	33.43
T_8 S-N_{50}/GG-1	20	22	15.6	16.8	7.7	8.8	34.53	33.73
T_9 S-N_{25}/GG-2	20	23	15.7	17.1	8.4	9.2	38.45	31.33
T_{10} S-N_{50}/GG-2	20	22	14.9	16.2	7.7	8.7	34.83	31.94
SEm(±)	**1.36**	**1.83**	**1.11**	**0.92**	**0.75**	**0.48**	**1.21**	**0.96**
LSD(0.05)	**4.28**	**5.93**	**NS**	**2.86**	**NS**	**NS**	**NS**	**NS**
N-level in sesame								
N_{25}	21	23	37.1	17.6	8.1	9.2	3.70	3.19
N_{50}	20	22	41.0	16.5	7.7	3.23	3.46	3.26
SEm(±)	**0.96**	**1.34**	**0.62**	**0.65**	**0.56**	**0.37**	**0.089**	**0.069**
LSD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Legume crop variety								
GN-1	21	22	17.5	7.8	9.0	3.56	3.52	3.12
GN-2	20	23	16.6	7.9	9.0	3.62	3.67	3.27
SEm(±)	**0.96**	**1.33**	**0.68**	**0.54**	**0.34**	**0.35**	**0.087**	**0.065**
LSD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 3 : Effect of different treatments on yield component of groundnut

Treatment	No. of plants m^{-2}		No. of filled capsule plant $^{-1}$		No. of seed capsule $^{-1}$		100 seed weight (g)	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
T_5 GN-1	22	22	15.5	14.6	1.66	1.64	34.8	34.7
T_6 GN-2	21	22	15.8	13.7	1.64	1.63	34.5	34.0
T_{11} S-N_{25}/GN-1	11	13	17.6	15.5	1.71	1.74	36.4	36.0
T_{12} S-N_{50}/GN-1	10	12	16.2	15.1	1.68	1.70	35.2	35.9
T_{13} S-N_{25}/GN-2	11	13	17.2	15.2	1.70	1.72	36.2	35.7
T_{14} S-N_{50}/GN-2	10	12	16.2	14.7	1.68	1.69	35.3	34.7
SEm(±)	**1.46**	**1.08**	**0.62**	**0.89**	**0.038**	**0.042**	**0.97**	**1.16**
LSD(0.05)	**4.48**	**3.40**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
N-level in sesame								
N_{25}	12	13	17.4	15.3	1.71	1.73	36.3	35.9
N_{50}	10	12	16.2	14.9	1.70	1.70	35.3	35.26
SEm(±)	**1.00**	**0.74**	**0.43**	**0.63**	**0.027**	**0.030**	**0.68**	**0.82**
LSD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
Legume crop variety								
GN-1	11	13	16.9	15.3	1.71	1.72	35.8	35.9
GN-2	11	13	16.6	15.0	1.69	1.71	35.7	35.3
SEm(±)	**1.00**	**0.76**	**0.43**	**0.62**	**0.026**	**0.030**	**0.67**	**0.82**
LSD(0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 4 : Effect of different treatments on seed pod $^{-1}$ yield (kg ha^{-1}) and sesame equivalent yield (kg ha^{-1})

Treatment	Sesame		Greengram		Groundnut		Sesame equivalent yield	
	2014	2015	2014	2015	2014	2015	2014	2015
T_1 S-N_{25}	612	649					612	649
T_2 S-N_{50}	691	707					691	708
T_3 GG-1			773	886			618	709
T_4 GG-2			736	849			589	680
T_5 GN-1					2333	2059	1868	1567
T_6 GN-2					2250	1909	1800	1447
T_7 S-N_{25}/GG-1	396	389	496	550			797	829
T_8 S-N_{50}/GG-1	471	470	434	494			819	862
T_9 S-N_{25}/GG-2	366	385	502	577			768	848
T_{10} S-N_{50}/GG-2	431	425	414	460			762	793
T_{11} S-N_{25}/GN-1	347	368			1395	1293	1463	1402
T_{12} S-N_{50}/GN-1	403	402			1283	1152	1437	1324
T_{13} S-N_{25}/GN-2	413	418			1372	1202	1510	1380
T_{14} S-N_{50}/GN-2	474	471			1250	1123	1474	1369
SEm(±)	**24.3**	**27.2**	**81.0**	**98.3**	**85.1**	**81.6**	**39.9**	**43.2**
LSD(0.05)	**72.3**	**80.8**	**NS**	**NS**	**267.9**	**257.0**	**116.0**	**127.1**
N-level in sesame								
N_{25}	381	390	496	564	1387	1248	1127	1115
N_{50}	445	442	424	477	1267	1138	1123	1081
SEm(±)	**12.2**	**13.6**	**18.2**	**22.1**	**60.1**	**57.7**	**20.0**	**21.5**
LSD(0.05)	**36.2**	**40.4**	**57.2**	**69.5**	**NS**	**NS**	**NS**	**NS**
Legume crop variety								
GG-1	434	430	465	522			808	846
GG-2	394	405	458	519			765	821
GN-1	374	385					1141	1363
GN-2	444	445					1485	1362
SEm(±)	**17.2**	**19.2**	**18.2**	**22.1**	**60.1**	**57.7**	**28.2**	**30.6**
LSD(0.05)	**51.1**	**57.0**	**57.2**	**69.5**	**NS**	**NS**	**82.0**	**88.9**

Note: S-Sesame,GG-1-greengram cultivar 1,GG-2 –greengram cultivar 2,GN-1- Groundnut cultivar 1, GN-2-Groundnut cultivar 2, N_{25}-N level of 25kg ha^{-1},N_{50}-N level of 50kg ha^{-1}

produced 819 to 862 kg ha^{-1} sesame equivalent yield. Two nitrogen doses of sesame showed differential effect on component crops, but no variation was noticed in terms of yield advantage, so higher doses of nitrogen might not be essential for this intercropping system. Similar results on intercropping of oilseeds and legumes were also opined by Patra *et al*. (1994). Sesame-groundnut intercropping system gave higher yield even in limited water and nitrogen condition (Ghanbari & Tavassoli, 2013) which corroborated the findings of present investigation. It can be concluded that the intercropping of sesame at 25 kg N ha^{-1} with any variety of greengram and groundnut variety was advantageous and remunerative. Thus there is an ample scope to study the benefits of legume – non legume intercropping system as well as the constraints in the near future.

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