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Yield and yield components of greengram [*Vigna radiata* (L.) Wilczek] as influenced by cropping system, row proportions and greengram population levels

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Abstract : A field experiment was conducted at Agricultural Research Station, Gulbarga, Karnataka on vertisols during *Kharif* seasons of 1992-93 and 1993-94 to study the influence of cropping system, row proportions and greengram population levels on yield and yield components of greengram viz., number of seeds pod^{-1}, number of seeds plant^{-1}, seed weight plant^{-1}, number of pods plant^{-1}, dry matter accumulation in pods plant-1, 100 seed weight and protein content and its yield. Intercropping of greengram with pigeonpea significantly reduced the seed yield of greengram (5.56 q ha^{-1}) as compared to the sole crop of greengram (11.04 q ha^{-1}). Similarly, efffect of intercropping was reflected on all the yield attributes. The protein content of greengram was not influenced by cropping system whereas protein yield was significantly reduced under intercropping when compared to sole cropped greengram. The reduction in the seed yield of greengram under 2:1 was 26 per cent when compared to 2:2 row proportion of pigeonpea and greengram. The protein content of greengram was not sigfnificantly influenced by row proportions while significantly higher protein yield of 1.33 q ha^{-1} was recorded under 2:2 row proportion. Seed and protein yields were significntly higher under 100 per cent population level of greengram when compared to 50 per cent population level. *(Key words : Greengram, Cropping system, Yield, Yield component, Row proportion, Population level)*

Greengram [*Vigna radiata* (L.) Wilczek] is one of the most important pulse crops of India. It is grown in almost all parts of the country. Greengram is an excelent source of high quality protein. It is consumed in different ways as dal, halwa, snack and so many other preparations. Sprouted seeds of greengram contain good amount of riboflavin, thiamine and ascorbic acid (Vitamin C). Being a leguminous crop, it has the capacity to fix atmospheric nitrogen through symbiotic nitrogen fixation. It is also used as a green manure crop. It also provides an excellent green fodder to the animals. Being a short duration crop, it is fits well in various multiple and intercropping systems. Pigeonpea is being cultivated in Gulbarga district on a vast area mainly as a sole crop. Pigeonpea, a wide spaced crop, by growing slowly in the early part of its life span, facilitates introduction of short duration, short statured intercrop like greengram. Rao and Mishra (1989) stated that growing two legumes together helped in increasing productivity as well as achieving higher LER. Intercropping of pigeonpea with greengram and blackgram produced signifiantly higher pigeonpea equivalents than in pure stands at Hisar (Singh *et al* 1986). Madhusudan Rao *et al* (1980) stated that the monetary advantage was highest when pigeonpea was intercropped with greengram in 1:2 row proportion at Lam, Andhra Pradesh. Hence, the present investigation was planned and carried out at ARS, Gulbarga to introduce greengram in the region as an intercrop with pigeonpea. The objective was to study the effect of cropping system, row proportions and greengram population levels in pigeonpea based intercorpping systems on yield and yield components of greengram.

Materials and Methods

A field experiment was conducted during *Kharif* seasons of 1992-93 and 1993-94 at the gricultural Research Station, Gulbarga on Vertisols. The soil pH was 8.3 with 0.54 per cent organic carbon, 25 kg ha^{-1} of available phosphorus and 350 kg ha^{-1} of available potassium. There were 10 treatments comprising of four row proportions of pigeonpea and greengram (1:1, 1:2, 2:1 and 2:2) and two levels of greengram populations (50 and 100%) with sole crops of pigeonpea and greengram. The experiment was laid out in a Randomised Block Design with three replications. The gross plot size was 4.8 m x 3.6 m and the net plot size varied under different row proportions. The varieties used were Pragati (ICPL-87) and Pusa baisaki of pigeonpea and greengram respectively. The population of pigeonpea was maintained at 100 per cent of its sole optimum (166708 plants ha^{-1}) in all the intercropping treatments by adjusting the intra row space while greengram was maintained at two population levels viz. 50 and 100 per cent of sole optimum for each row proportion by adjusting intra row space (Table-1). The sole crop of pigeonpea was sown at a spacing of 45 cm x 13.33 cm, sole greengram was sown at a spacing of 30 cm x 10 cm. The

ecommended dose of fertilizer for pigeonpea (25:50 N: P kg ha^{-1}) and greengram (25:50 N: P kg ha^{-1}) were pplied as basal dose. In case of intercropping reatments, the fertilizers were applied in proportionate o the sole optimum population for main crop and ntercrop separately. Five tagged plants used for ecording growth parameters were used for recording arious yield components. For recording dry matter ccumulation in pods, five plants at random were prooted and the pods separated were dried at 70°C nd weighed. The rainfall received during crop growth eriod was 567.8 mm distributed over 33 days and 603.6 nm distributed over 37 days during 1992-93 and 1993-94 respectively. The crops were harvested at their hysiological maturity.

Results and Discussion

Effect of cropping system

The seed yield of sole greengram was found e significantly higher than that recorded in ntercropping syetem (Table 2). The extent of eduction was by 50 per cent. This could be attributed hainly to higher total population of greengram and igeonpea per unit area resulting in increased ompetition for growth resources, specially for noisture, nutrients and light. Similar reduction in seed ield of greengram has been reported by Bishnoi *et al* (1987); and Dharam Singh and Singh (1992). The eduction in the yield of intercropped greengram may e related to differences in the yield components viz. umber of pods plant^{-1}, number of seeds pod^{-1} and eed weight plant^{-1} which were reduced significantly hen greengram was intercropped with pigeonpea as ompared to sole crop of greengram (Table-2 and 3). Similar reductions in yield attributes such as number f pods plant^{-1} was reported by Bishnoi *et al* (1987) nd Dharam Singh and Singh (1992) under ntercropped greengram when compared to sole crop f greengram. The protein content of greengram was ot altered significantly due to intercropping Table 4). However, protein yield of greengram was educed by 49 per cent when compared to sole crop of reengram which was mainly due to higher seed yield. The data on dry matter accumulation in pods of reengram indicate that intercropped greengram ndicate that intercropped greengram accumulated 29 er cent lowern dry matter in pods when compared to hat observed under sole crop of greengram at harves. Similar reduction in dry matter of greengram ntercropped with pigeonpea has been reported by Hunshal and Malik (1988). The reduction in dry matter ccumulation in pods of intercropped greengram was ainly attributed to the lower dry matter producing ability due to the presence of associated crop of pigeonpa. This reduction in the sink is the cumulative effect of competition posed by pigeonpea for water and nutrients supply under increased population pressure a part from obstruction of sun rays by pigeonpea due to its higher height.

Effect of Row Proportions

Th reduction in the seed yield of greengram under 2:1 was 26 per cent when compared to 2.2 row proportion of pigeonpea and greengram. The reduction in the seed yield under 2:1 row proportion could be due to the difference in the yield components viz. number of pods plant^{-1} and seed weight plant^{-1} (Table 3). The reduction in number of pods plant^{-1} and seed weight plant^{-1} were 24 and 22 per cent respectively under 2:1 as compared to 2:2 row proportion which could be due to differential dry matter accumulation in pods (Table 3). The data on the dry matter accumulation in pods of intercropped greengram indicate that 2:1 row proportion recorded 27 per cent lower dry matter accumulation in pods when compared to 2:2 row proportion of pigeonpea and greengram at harvest. Under 2:2 row proportion the competition for growth resources especially for light was least because the pigeonpea plants did not cover its canopy fully over greengram because of wider space, while under 2:1 row proportion the pigeonpea plants covered the greengram because of less space between two pairs of pigeonpea rows. The protein content of greengram did not differ significantly due to row proportions (Table 4). The protein yield of greengram under 2:2 row proportion was higher by 36 per cent when compared to 2:1 row proportion by virtue of higher seed yield of greengram.

Effect of Greengram Population Levels

The seed yield of intercropped greengram was significantly influenced by greengram population levels (Table 2). The seed yield under 100 per cent population level was significantly higher by 51 percent when compared to that under 50 per cent population level which could be due to higher plant population. Increasing population of intercropped greengram from 50 to 100 per cent caused significant difference in yield components viz. number of pods per plant and seed weight per plant (Table 3). The reduction in the number of pods per plant and seed weight per plant were 20 and 25 per cent under 100 per cent population level when compared to 50 per cent population level of intercropped greengram. Similar results of reduction in the yield attributes on intercrops were reported by Hunshal and Malik (1988) with increased population of intercrops with pigeonpea. Dry matter accumulation

in pods of intercropped greengram was significantly lower by 23 per cent under higher population level when compared to lower plant population at harvest. The reduction in the yield attributes under higher population level could be due to increased competition among plants for moisture and nutrients. The protein content of greengram was not influenced by greengram population levels, However, protein yield was significantly higher under 100 per cent population level than 50 per cent population level (Table 4) due to higher seed yield of greengram.

Interaction Effects

Yield and yield attributes of intercropped greengram were not significantly influenced by the interaction effects of row proportions and greengram population levels.

Table 1. Details of intra row space, gross and net plot size followed for different treatments

Treatment	Intra row space (cm)		Gross plot size L x B = Area	Net plot size	
	MC	IC	(m^2)	Pigeon pea L x B = Area (m^2)	Green gram L x B = Area (m^2)
Sole pigeon pea (45 x 13.33 cm)	13.33	--	4.8 x 3.6 = 17.28	3.60 x 1.35 = 4.86	--
Sole green gram (3- x 10.00 cm)	--	10.00	4.8 x 3.6 = 17.28	--	3.6 x 1.8 = 6.48
PP:GG (1:1 RP-100:50% Population)	10.00	10.00	4.8 x 3.6 = 17.28	3.6 x 1.80 = 6.48	3.6 x 1.8 = 6.48
PP:GG (1:1 RP-100 :100% Population)	10.00	5.00	4.8 x 3.6 = 17.28	3.6 x 1.80 = 6.48	3.6 x 1.8 = 6.48
PP:GG (1:2 RP-100 : 50% Population)	6.66	13.33	4.8 x 3.6 = 17.28	3.6 x 1.80 = 6.48	3.6 x 1.8 = 6.48
PP:GG (2:1 RP-100 :100% Population)	6.66	6.66	4.8 x 3.6 = 17.28	3.6 x 1.80 = 6.48	3.6 x 1.8 = 6.48
PP:GG (2:1 RP-100 : 50% Population)	13.33	6.66	4.8 x 3.6 = 17.28	3.6 x 1.80 = 6.48	3.6 x 1.8 = 6.48
PP:GG (2:1 RP-100 :100% Population)	13.33	3.33	4.8 x 3.6 = 17.28	3.6 x 1.80 = 6.48	3.6 x 1.8 = 6.48
PP:GG (2:2 RP-100 : 50% Population)	10.00	3.33	4.8 x 3.6 = 17.28	3.6 x 1.20 = 4.32	3.6 x 1.2 = 3.32
PP:GG (2:2 RP-100 :100% Population)	10.00	5.00	4.8 x 3.6 = 17.28	3.6 x 1.20 = 4.32	3.6 x 1.2 = 4.32

PP : Pigeon pea GG : Green gram RP : Row Proportion

Table 2. Yield components of green gram as influenced by intercropping with pigeonpea (cv. ICP-87) at different row proportions and greengram population levels.

	Seed number			Seed yield			Seed weight		
Treatment	1992	1993	Pooled	1992	1993	Pooled	1992	1993	Pooled
Cropping system									
Sole green gram	212.26	196.50	204.38	11.49	10.59	11.04	3.26	3.20	3.23
Intercropped green gram	148.28	140.38	144.29	5.95	5.37	5.56	3.15	3.13	3.14
S. Ed±	2.01	2.22	2.11	0.10	0.15	0.09	0.01	0.01	0.01
C.D. at 5%	4.26	4.70	2.47	0.21	0.32	0.19	0.02	0.02	0.02
Row proportions (RP) PP:GG									
1:1	147.71	139.35	142.53	5.80	5.32	5.57	3.16	3.14	3.15
1:2	159.92	150.49	154.98	6.30	5.71	5.71	3.16	3.14	3.15
2:1	124.80	116.58	120.69	489	4.53	6.00	3.13	3.07	3.10
2:2	162.91	155.09	159.00	6.76	5.94	4.71	3.15	3.17	3.16
S.Em±	1.37	1.24	1.27	0.07	0.10	0.08	0.02	0.04	0.03
C.D. at 5%	4.16	3.77	3.80	0.20	0.31	0.24	NS	NS	NS
Greengram population Level (GGPL)									
50 per cent	164.86	158.62	161.74	4.75	4.25	4.50	3.18	3.18	3.18
100 per cent	131.55	122.15	126.89	7.12	6.50	6.81	3.12	3.08	3.10
S. Em±	0.97	0.88	0.91	0.05	0.07	0.06	0.03	0.03	0.03
C.D. at 5%	2.97	2.66	2.68	0.41	0.22	0.18	NS	NS	NS
Interaction (RP x GGPL)									
S. Em±	1.94	1.76	1.85	0.95	0.15	0.12	0.02	0.02	0.02
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Dry matter accumulation (DMA) in pods (g plant^{-1}). Number of pods (plant^{-1}), seed weight (g plant^{-1}) and seed number (pod^{-1}) of green gram as influenced by intercropping with pigeon pea (cv. ICPL-87) at different row proportions and green gram population levels

Treatment	DMA in pods						Number of pods						Seed weight			Seed number		
	50 DAS			At harvest			50 DAS			At harvest								
	1992	1993	Pooled	1992	1993	Pooled	1992	1993	Pooled	1992	1993	Pooled	1992	1993	Pooled	1992	1993	Poc
Cropping system																		
Sole GG	4.46	4.06	4.26	8.34	7.94	8.14	18.60	16.06	17.33	22.14	20.40	21.27	6.90	6.40	6.65	10.48	9.80	10.14
Intercropped GG	3.49	2.71	3.10	5.98	5.56	5.77	13.75	11.17	12.46	15.98	14.22	15.10	4.78	4.40	4.59	10.48	9.86	10.17
S.E$_d$±	0.04	0.11	0.06	0.05	0.05	0.04	0.19	0.16	0.13	0.07	0.16	0.08	0.25	0.06	0.13	0.05	0.13	0.06
C.D. at 5%	0.09	0.23	0.13	0.11	0.11	0.09	0.40	0.34	0.27	0.15	0.34	0.17	0.53	0.13	0.27	0.11	0.27	0.13
Row proportion (RP)																		
PP:GG																		
1:1	3.38	2.90	3.14	5.92	5.60	6.76	14.37	11.63	13.00	16.10	14.14	15.12	4.66	4.38	4.52	10.46	9.84	10.15
1:2	3.53	2.99	3.26	6.40	5.94	6.17	14.70	12.22	13.46	16.90	15.16	16.03	5.05	4.73	4.89	10.53	9.91	10.22
2:1	2.66	2.18	2.42	4.98	4.44	4.71	11.47	8.73	10.10	13.43	11.87	12.65	4.25	3.59	3.92	101.48	9.78	10.13
2:2	4.40	2.78	3.59	6.62	6.24	6.43	14.46	12.10	13.38	17.48	15.70	16.59	5.14	4.92	5.03	10.45	9.87	10.16
S. Em±	0.03	0.08	0.07	0.04	0.04	0.04	0.11	0.10	0.11	0.05	0.09	0.08	0.18	0.04	0.09	0.03	0.08	0.07
C.D. at 5%	0.09	0.25	0.21	0.11	0.13	0.12	0.34	0.31	0.21	0.15	0.28	0.24	0.54	0.13	0.28	NS	NS	NS
Green gram population level (GGPL)																		
50 per cent	3.82	3.00	3.41	6.74	6.30	6.52	15.05	12.35	13.70	17.78	15.90	16.81	5.44	5.04	5.24	10.44	9.96	10.20
100 per cent	3.17	2.43	2.80	5.23	4.81	5.02	12.46	10.00	11.23	14.22	12.54	13.38	4.10	3.78	3.94	10.51	9.75	10.13
S. Em±	0.02	0.06	0.04	0.03	0.03	0.03	0.08	07	0.08	0.03	0.07	0.06	0.13	0.03	0.08	0.03	0.08	0.05
C.D. at 5%	0.06	0.17	0.12	0.08	0.09	0.09	0.24	0.22	0.23	0.11	0.20	0.17	0.39	0.09	0.24	NS	NS	NS
Interaction (RP x GGPL)																		
S. Em±	0.04	0.12	0.10	0.05	0.06	0.05	0.16	0.15	0.15	0.07	0.13	0.09	0.25	0.06	0.17	0.08	0.12	0.08
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4. Protein percentage and protein yield (q ha^{-1}) of green gram as influenced by intercropping with pigeonpea (cv. ICPL-87) at different row proportions and green gram population levels.

Treatment	Protein percentage			Protein yield		
	1992	1993	Pooled	1992	1993	Pooled
Cropping system						
Sole green gram	20.98	20.94	20.96	2.41	2.21	3.31
Intercropped green gram	20.88	20.90	20.89	1.24	1.12	1.18
$S.E_d\pm$	0.08	0.07	0.09	0.14	0.16	0.15
C.D. at 5%	NS	NS	NS	0.29	0.32	0.30
Row proportion (RP) PP:GG						
1:1	20.92	20.92	20.92	1.21	1.11	1.16
1:2	20.84	20.92	20.88	1.31	1.19	1.25
2:1	20.90	20.82	20.86	1.02	0.94	0.98
2:2	20.89	20.9	20.90	1.41	1.25	1.33
S.Em±	0.09	0.08	0.08	0.07	0.06	0.06
C.D. at 5%	NS	NS	NS	0.20	0.18	0.17
Green gram population levels (GGPL)						
50 per cent	20.86	20.96	20.91	0.99	0.89	0.94
100 per cent	20.92	20.84	20.88	1.49	1.35	1.42
S. Em±	0.05	0.04	0.04	0.08	0.09	0.08
C.D. at 5%	NS	NS	NS	0.24	0.27	0.24
Interaction (RP x GGPL)						
SEm±	0.08	0.09	0.09	0.10	0.09	0.09
C.D. at 5%	NS	NS	NS	NS	NS	NS

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