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Influence of spacing and scheduling of irrigation on growth, yield, yield attributes and economics of summer greengram (*Vigna radiata* L.)

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ABSTRACT

A field experiment was carried out during the summer season of the year 2013 to study the "Influence of spacing and scheduling of irrigation on growth, yield and yield attributes of summer green gram (*Vigna radiata* L.)". The plant height at harvest significantly influenced and recorded highest under treatment I_3 (1.0 IW:CPE ratio). Number of branches plant^{-1} was significantly the highest, while number of pods plant^{-1}, pod length, number of seeds pod^{-1}, seed yield (1107 kg ha^{-1}) and stover yield (1970) were observed significantly higher under the irrigation treatment of I_3 (1.0 IW:CPE ratio) followed by I_2 (0.8 IW:CPE ratio). In case of spacing, the number of branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1} were significantly higher under treatment S_1 (30 x 10 cm) followed by treatment S_{10} (22.5 x 10 cm). An interaction effect between irrigation schedule and spacing levels on number of pod plant^{-1} and seed yield were found to be significantly higher under treatment combination I_3S_1 (1.0 IW/CPE ratio with 30 x 10 cm spacing) followed by treatment combination I_2S_1 (0.8 IW/CPE ratio with 30 x 10 cm spacing). Treatment combination I_3S_1 (1.0 IW:CPE ratio with 30 x 10 cm) registered highest net realization of Rs. 49118 ha^{-1} with BCR value of 1:3.14 followed by treatment combination I_2S_1 (0.8 IW:CPE ratio with 30 x 10 cm).

Key words *: Irrigation, Spacing, Green gram, Yield, Yield attributing characters, Economics*

Introduction

Green gram (*Vigna radiata* L. Wilczek) belongs to the family Leguminoseae and sub family Papilionaceae. Green gram is a principle source of cheap protein (i.e. 22-24%) and essential amino acids. It improves the soil fertility through N2-fixation and fits well in the existing cropping system. In Gujarat, it is cultivated in 7.10 lakh hectares with an annual production of 3.90 lakh metric tonnes leading to average productivity of 549 kg ha^{-1} (Anon, 2010-11). The yield gap of green gram may be attributed to improper agro-technology being used by the farmers. Water is limiting and costly input in summer season and it's judicious application needs special attention for the maximizing yield per unit area and time and hence, it is necessary to find out suitable approach for scheduling irrigation. Water stress reduces the rate of photosynthesis and uptake of nutrient in green gram (Phogat *et al*., 1984). Water stress also affects crop phenology, leaf area development, flowering, pod setting and finally results in low yield. Prasad *et al*., (1989) found higher straw and grain yield of green gram with three irrigations as com-

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pared to one or no irrigation. Similarly, Sukhivinder *et al*., (1990) found highest dry matter and grain yield of green gram when crop was irrigated thrice. Spacing is a non monetary input, optimum spacing provides enough space for easy inter culturing, weeding, application of fertilizers and other aftercare operations. Optimum row spacing plays an important role in contributing to the high yield because thick plant population will not get proper light for photosynthesis and can easily be attacked by diseases. On the other hand, very small population will also reduce the yield (Pookpakdi and Pataradilok, 1993). Due to this reason normal population is necessary for high yield. Denmead *et al*. (1962) estimated that 60 cm inter row spacing might increase the energy available for photosynthesis 15-20%, compared with 100cm spaced row in corn. Uniform spacing generally gives a greater yield than hill groupings under favorable moisture conditions. However when moisture is a limiting factor, the advantage may be small or mild (Dungan *et al*., 1958). Donald (1963) suggested that the advantage of uniform spacing under irrigated conditions is due to reduced competition for light because when the moisture is lacking, light is no longer the limiting factor and the advantage of uniform spacing is lost. Pookpakdi and Pataradilok (1993) conducted study during wet season in Mungbean and in dry seasons on black gram, reported that yield of both crops generally decreased with decreasing plant density, while pod number/plant increased with decreasing density. Thus, the present study was contemplated with the objective to find out the cost benefit analysis of different levels of input and to find out the optimum level of productivity per hectare for summer green gram, when levels of irrigation and different row spacing were used.

Materials and Methods

A field experiment was carried out at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University. Sardarkrushinagar during the summer season of the year 2013 "Influence of spacing and scheduling of irrigation on growth, yield and yield attributes" by using variety GM 4. The soil of experimental field was loamy sand in texture having good drainage with 7.4 pH. The soil was low in organic carbon (0.20%) and available nitrogen (185.12 kg/ha), low in available phosphorus (40.10 kg/ha) and high in potassium (290.12 kg/ha). Twelve treatment combinations comprised of four irrigation treatments *viz.,* I_0 (Critical growth stages), I_1 (0.6 IW:CPE ratio), I_2 (0.8 IW:CPE ratio) and I_3 (1.0 IW:CPE ratio) with 50 mm depth and three spacing treatments *viz.,* S_0 (22.5 × 10 cm), S_1 (30 × 10 cm) and S_2 (45 × 10 cm) were tried in Split Plot Design with three replications. A common application of 20 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} in the form of urea and DAP, respectively as basal dose was given to all the treatments at the time of preparation of field.

Results and Discussion

The growth characters viz, plant height at harvest and no. of branches $plant^{-1}$ and yield attributing characters and yield *viz*., number of pods $plant^{-1}$, number of seeds pod^{-1}, seed and stover yield were significantly influenced by the irrigation schedule. Data presented in the Table 1 revealed that the plant height and no of branches $plant^{-1}$ were significantly influenced by irrigation schedules. The highest plant height (50.33 cm) and no of branches $plant^{-1}$ (5.13) were observed with irrigating the crop at 1.0 IW/CPE ratio (I_3) which was at par with I_2 (48.37 cm and 4.64, respectively). The lowest plant height and no of branches $plant^{-1}$ were recorded under the treatment I_0. Significantly highest no of pod $plant^{-1}$ (35.24) was recorded under I_3, while no. of seed pod^{-1} was significantly higher under I_3 (8.86), which was at par with I_2 (8.77). Significantly highest seed yield (1107 kg ha^{-1}) was recorded at 1.0 IW/CPE ratio (I_3) which was at par with I_2 i.e. 1036 kg ha^{-1}(0.8 IW/CPE) Increase in yield due to higher irrigation ratio I_3 and I_2 to the tune of 34.8 % and 6.8 % over I_0. The lowest seed yield (821 kg ha^{-1}) was obtained when crop was irrigated at critical growth stages (I_0). Stover yield (1970 kg ha^{-1}) was significantly higher under I_3 which was at par with I_2. Maximum seed and dry stover yields under treatment I_3 might be due to increased irrigation frequency increased the soil moisture status which in turn resulted into higher leaf water potential, stomatal conductance, higher photosynthesis, consequently increased the dry matter production and ultimately increased seed and stover yields. These results are in conformity with the results of those reported by Kavitha and Wahab (2001) for number of branches $plant^{-1}$ and Idnani and Gautam (2008) for plant height, yield and yield attributes in green gram.

The plant height at harvest was significantly

Table 1. Growth parameters and yield attributes as influenced by irrigation schedule and spacing in green gram.

Treatment	Plant population ha^{-1} (Initial)	Plant population ha^{-1} (At Harvest)	Plant height (cm) At 30 DAS	Plant height (cm) At 45 DAS	Plant height (cm) At harvest	Days to maturity	Number of branches $plant^{-1}$	Number of pods $plant^{-1}$	Pod length (cm)	Number of seeds pod^{-1}
A. Main plot treatments (Irrigation Schedule: I)										
I_0=At critical growth stages	306468	291734	23.36	29.78	44.11	73	4.08	23.73	6.00	7.81
I_1=0.6 IW/CPE ratio	305521	292532	23.83	31.80	44.18	74	4.23	26.17	6.22	7.90
I_2=0.8 IW/CPE ratio	306521	295188	24.39	34.94	48.37	75	4.64	28.07	6.69	8.77
I_3=1.0 IW/CPE ratio	312750	300728	25.11	36.11	50.33	82	5.13	35.24	7.10	8.86
S.Em. ±	4732.44	7450.17	1.05	1.15	1.28	1.66	0.20	0.97	0.22	0.22
C.D. (P=0.05)	NS	NS	NS	3.97	4.43	5.75	0.69	3.34	0.77	0.78
C.V. (%)	4.61	7.58	12.99	10.38	8.21	6.56	13.25	10.24	10.32	8.07
B. Sub plot treatments (Spacing (cm) : S)										
S_0= 22.5 × 10	419398	404198	24.33	33.71	47.75	77	3.98	25.12	5.98	7.85
S_1= 30 × 10	289932	278390	24.35	33.75	48.10	77	4.63	28.26	6.58	8.47
S_2= 45 × 10	214115	202549	23.83	33.02	44.39	75	4.96	31.53	6.94	8.68
S.Em. ±	2829.82	4609	0.79	0.86	1.01	1.16	0.16	0.59	0.18	0.19
C.D. (P=0.05)	8483.81	13819.86	NS	NS	3.02	NS	0.48	1.75	0.55	0.58
I x S interaction	NS	NS	NS	NS	NS	NS	NS	Sig.	NS	NS
C.V. %	3.18	5.41	11.25	9.03	7.47	5.28	12.25	7.16	9.83	8.01

higher (48.10 cm) under spacing treatment of S_1 (30 x 10 cm) which was at par with treatment of S_0 (22.5 x 10 cm). While number of branches $plant^{-1}$ (4.96) was significantly higher under treatment S_2 (45 x 10 cm) followed by treatment S_1 (30 x 10 cm), i.e. 4.63. This might be due to plant get sufficient space under wider spacing for light, air and nutrition for better growth and development.

The yield attributing characters *viz*., number of pods $plant^{-1}$(31.53), number of seeds pod^{-1} (8.68) were significantly higher under treatment S_2 (45 x 10 cm) followed by treatment S_1 (28.26 and 8.47, respectively). Significantly highest seed yield (1062 kg ha^{-1}) was observed due to 30 cm X 10 cm spacing (S_1). Same trend was observed in case of stover yield (1823 kg ha^{-1}), but it was at par with rest of treatment. Increase in seed and stover yield over wider spacing was to the tune of 18.6 % and 12.9 %, respectively, while in closer spacing it was to the tune of 10.7 % and 5.7 %, respectively. These results are in agreement with the findings reported by Kotwal and Prakash, (2006).

An interaction effect (Table 3) between irrigation schedule and spacing levels were found to be significant with respect to pods $plant^{-1}$ and seed yield and they were significantly influenced by treatment combination. Significantly highest seed yield (1300 kg ha^{-1}) was recorded under the treatment combination I_3S_1 (1.0 IW/CPE ratio with 30 x 10 cm spacing) followed by treatment combination I_3S_0 (1.0 IW/CPE ratio with 22.5 x 10 cm spacing). The lowest was observed with I_0S_2 (793 kg ha^{-1}). In case of number of pod $plant^{-1}$, significantly higher with the treatment combination I_3S_2 (35.9), which was at par with I_3S_1 (35.0), I_3S_0 (34.8) and I_2S_2 (32.4). The increase in seed yield under I_3S_1 to the tune of 63.3 % over I_0S_2. The treatment combination I_0S_0 registered lowest no. of pod $plant^{-1}$(20.6). The results are in line with those reported by Dwangn *et al*., (1992).

I_3 (1.0 IW/CPE ratio) fetched the highest net realization (Rs. 40673 ha^{-1}) with higher BCR value of 1:2.95. The next best treatment was I_2 (0.8 IW/CPE ratio) which realized net income of Rs. 37741 ha^{-1} with the BCR value of 1:2.91. Among the spacing, S_1 (30 x 10 cm) ac-

Table 2. Water use efficiency, protein content, yield and economics as influenced by irrigation schedule and spacing in greengram.

A. Main plot treatments (Irrigation Schedule: I)						
Treatment	Water Use efficiency (kg ha^{-1} mm)	Protein content (%)	Seed Yield (kg ha^{-1})	Stover Yield (kg ha^{-1})	Net realization (Rs ha^{-1})	BCR
I_0 = At critical growth stages	3.28	22.79	821	1554	28766	1: 2.68
I_1 = 0.6 IW/CPE ratio	2.31	22.93	925	1618	32754	1: 2.75
I_2 = 0.8 IW/CPE ratio	2.07	22.98	1036	1741	37741	1: 2.91
I_3 = 1.0 IW/CPE ratio	1.84	23.24	1107	1970	40673	1: 2.95
S.Em. ±	0.08	0.23	41.65	77.44	-	-
C.D. (P=0.05)	0.27	NS	144.11	267.99	-	-
C.V. (%)	9.99	3.07	12.85	13.50	-	-
B. Sub plot treatments (Spacing (cm) : S)						
S_0 = 22.5 × 10	2.35	22.70	959	1724	35363	1: 2.96
S_1 = 30 × 10	2.56	23.08	1062	1823	41489	1: 3.37
S_2 = 45 × 10	2.22	23.18	895	1615	32974	1: 2.95
S.Em. ±	0.06	0.14	22.46	54.26	-	-
C.D. (P=0.05)	0.18	NS	67.34	162.66	-	-
I x S interaction	NS	NS	Sig.	NS	-	-
C.V. %	8.78	2.09	8.0	10.92	-	-

Table 3. Interaction effect of irrigation and spacing on number of pods par plant and seed yield of summer green gram.

Irrigation treatment	S_0 (22.5×10)		S_1 (30×10)		S_2 (45×10)	
	Number of pods plant^{-1}	Seed yield (kg ha^{-1})	Number of pods plant^{-1}	Seed yield (kg ha^{-1})	Number of pods plant^{-1}	Seed yield (kg ha^{-1})
I_0= At critical growth stages	20.6	819	23.6	852	26.9	793
I_1=0.6 IW/CPE ratio	22.1	914	25.5	950	30.8	910
I_2=0.8 IW/CPE ratio	22.97	1027	28.8	1146	32.4	933
I_3= 1.0 IW/CPE ratio	34.8	1076	35.0	1300	35.9	945
S.Em. ±	0.59	23	0.59	23	0.59	23
C.D. (P=0.05)	3.51	135	3.51	135	3.51	135
C.V. %	7.16	8.0	7.16	8.0	7.16	8.0

crued the highest net realization (Rs. 41489 ha^{-1}) with higher BCR value of 1:3.37. Under treatment combination I_3S_1 (1.0 IW:CPE ratio with 30 x 10 cm) registered highest net realization of Rs. 49118 ha^{-1} with BCR value of 1:3.14. The treatment combination I_2S_1 (0.8 IW:CPE ratio with 30 x 10 cm) was ranked second with respect to net realization (Rs. 41651 ha^{-1}) and BCR value of 1:2.91. While the treatment combination I_0S_2 (Critical growth stages with 45 x 10 cm) recorded the lowest value of net return (Rs. 25887 ha^{-1}) with BCR value of 1:2.40.

For securing higher grain yield and net monetory return of summer greengram variety GM 4, Crop should be raised at 30 × 10 cm spacing and irrigated at 1.0 IW:CPE ratio under North Gujarat condition.

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