ISSN: 2394-1391

Indian Journal of Biology
Volume 5 Number 1, January - June 2018
DOI: http://dx.doi.org/10.21088/ijb.2394.1391.5118.2

Original Article

Effect on Growth and Yield of Summer Green Gram (*Vigna Radiata* L. Wilczek) under Different Hydrothermal Regimes

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Abstract

Effects of changed hydrothermal regimes was studied on summer green gram (*Vigna radiata* L. Wilczek) cv SML – 134 at Punjab Agricultural University Ludhiana in summer season of 1999 and 2000. The treatments included 3 dates of sowing viz. 12th April (D_1), 19th April (D_2) and 26th April (D_{-3}) (in main plots); 3 irrigation levels viz. 0.5 IW: CPE ratio (I_1), 0.75 IW: CPE ratio (I_2) and 1.0 IW: CPE ratio (I_3) (in sub plots); and mulched (M_1) (@ 5t/ha wheat straw mulch) and unmulched crop (in sub-sub plots), in a split-split plot design.

The first sowing date D_1 showed better results than by D_2 and D_3, respectively in terms of growth and yield. I_3 had more vigorous growth than I_2 and I_1, respectively. Mulched crop performed better than unmulched crop. The crop yielded was less during 2000 than 1999. This may be due to more vegetative growth during 2000 and infestation of whitefly, in which crop experienced more frequent rainfall than 1999.

Keywords: *Vigna Radiata* L. Wilczek; Plant Height; Sowing Dates; Irrigation; Straw Mulching; Grain Yield; Straw Yield; Harvest Index.

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Received on 25.05.2018, **Accepted on** 08.06.2018

Introduction

Mungbean (*Vigna radiata* L. Wilczek) is an important pulse crop It is grown in an area of 3.42 million ha with production of 1.70 million tonnes in India (Anonymous, 2013). Mungbean is grown both in *Kharif* and summer seasons. Being a short duration crop (70 days), summer mungbean acts as a catch crop, therefore holds promise for increasing cropping intensity and improving soil productivity by fixing atmospheric nitrogen. The final yield of any crop is a continuous interaction of genetic variables and environmental factors to which crop is exposed.

Sowing dates plays an important role for optimum yield of this crop (Singh *et al.*, 2010). Summer/spring mungbean is sown from mid March to first week of April after the harvest of *Brassica* spp., lentil, potato, toria; and in the second fortnight of April after the harvest of wheat in most of the northern part of India. Sowing dates and irrigation regimes depict varied performance and productivity of summer mungbean due to changed environment plant interactions. Crop grown during April-June needs frequent irrigation due to higher evaporative demand and intense radiation. The recommended sowing window under Punjab is from 20 March to April 10 (Anonymous, 2015).

Supraoptimal temperature (> 35°C) and reduced water availability during pre-monsoon summer period restricts the growth of summer mungbean. The use of different types of mulches have been reported to lower evaporation losses and to reduce soil temperature fluctuation resulting into favourable modification of soil hydrothemal regimes. Straw mulch offers a mean of modifying supraoptimal temperature, conserving moisture and also increasing the crop productivity.

Keeping this in view the present investigation was planned, to see the effect of modified hydrothermal regimes in ameliorating the harsh field climatic extremes and its consequences on the growth and yield of summer mungbean.

Material and Methods

The field experiment was carried out at the Research Farm, Department of Agricultural Meteorology, Punjab Agricultural University, Ludhiana, during summer season 1999 and 2000. Ludhiana in located at 30° 54′N latitude and 75° 56′E longitude, at an altitude of 247 m above mean sea level. The area is characterized by semi arid subtropical climate with very hot summer and cold winter during April - June and December - January, respectively. During summer maximum temperature ranges between 40-45°C and occasionally goes up to 47°C while during winter, the minimum air temperature ranges between 5-8°C and occasionally goes as low as 0°C. This region in dominated by hot dry westerly winds during summer season. The average annual rainfall of this region is 677 mm, more than 75 percent of it is received during July-Sept. Weekly average weather parameters has been shown in the Fig. 1a and 1b The treatments included three dates of sowing viz.12th April (D1), 19th April (D2) and 26th April (D3) (main plots); three irrigation levels viz. 0.5 IW/ CPE ratio (I1), 0.75 IW/CPE ratio (I2) and 1.0 IW/CPE ratio (I3) (sub plots); and mulched (M1) (@ 5t/ha wheat straw mulch) and unmulched crop (in sub-sub plots), in a split-split plot design. All the recommended practices were followed as per the Package and Practices, Punjab Agricultural University, Ludhiana.

The area is characterised by semi arid subtropical climate with very hot summer and cold winters during April - June and December - January, respectively. During summer maximum temperature ranges between 40-50°C and occasionally goes upto 47°C while during winter, the minimum air temperature ranges between 5-8°C and occasionally goes as low as 0°C. This region in dominated by hot dry westerly winds during summer season. The average annual rainfall of this region is 677 mm, more than 75% of which is received during the period from July to September. The weekly meteorological data of summer season 1999 and 2000 is presented in Table 3.1 and 3.2, respectively.

The experimental field was given a pre-sowing irrigation to maintain optimum soil moisture for germination. After two days, ploughing was done twice with disc harrow and cultivators, followed by planking. The crop was fertilized with 12.5 kg nitrogen/ha in the form of urea and 40 kg P_2O_5/ha in the form of single super phosphate, at the time of sowing. Summer mungbean (*Vigna radiata* L. Wilczek) was sown on 12th, 19th and 26th April in 1999 and 2000, by using the seed @25 kg/ha with '*Kera*' method, keeping row spacing of 22.5 cm and plant to plant spacing of 5 cm.First hoeing was done 25 days after sowing and second hoeing, as per requirement, about two weeks after the first hoeing.The irrigation schedule of the crop for 1999 and 2000 is given in the Table 3.3 and 3.4. The depth of each irrigation was 7.5 cm. Summer mungbean crop is mostly affect by

Table 1: Cropping history of the field

Year	Crop Grown *Kharif*	*Rabi*
1996-97	Fallow	Winter maize
1997-98	*Dhaincha*	Sunflower
1998-99	Groundnut	Potato
1999-2000	Summer mungbean*	Potato
2000-2001	Summer mungbean*	Potato

Table 2: Physico-chemical properties of soil.

Depth (cm)	Bulk density (g/cc)	pH 1:2 soil water	EC (mmhos cm^{-1} at 25°C)	Field capacity (w/W)
0-15	1.48	7.9	0.3	12.5
15-30	1.50	7.9	0.2	14.5
30-45	1.52	7.8	0.2	16.5
45-60	1.52	7.9	0.2	17.0
60-90	1.54	7.6	0.2	17.2
90-120	1.55	7.5	0.2	17.4

Table 3: Dates of differential irrigations for first, second and third dates of sowing after a common irrigation at 25 DAS in 1999

Treatments	Dates of irrigation I	II	III
$D_1 I_1 M_1$	25 May		
M_2	(43)*		
$D_1 I_2 M_1$	17 May	30 May	
M_2	(35)	(48)	
$D_1 I_3 M_1$	14 May	25 May	1 June
M_2	(32)	(43)	(50)
$D_2 I_1 M_1$	31 May		
M_2	(42)		
$D_2 I_2 M_1$	27 May	8 June	
M_2	(38)	(50)	
$D_2 I_3 M_1$	21 May	30 May	10 June
M_2	(32)	(41)	(52)
$D_3 I_1 M_1$	10 June		
M_2	(36)		
$D_3 I_2 M_1$	3 June	16 June	
M_2	(38)	(51)	
$D_3 I_3 M_1$	30 May	11 June	20 June
M_2	(34)	(46)	(55)

*Figures in parenthesis shows the days after sowing

Table 4: Dates of differential irrigations for first, second and third dates of sowing after a common irrigation at 25 DAS in 2000

Treatments	Dates of irrigation I	II	III
$D_1 I_1 M_1$	22 May		
M_2	(40)*		
$D_1 I_2 M_1$	18 May	28 May	
M_2	(36)	(47)	
$D_1 I_3 M_1$	16 May	23 May	1 June
M_2	(34)	(41)	(50)
$D_2 I_1 M_1$	29 May		
M_2	(40)		
$D_2 I_2 M_1$	29 May	2 June	
M_2	(34)	(44)	
$D_2 I_3 M_1$	20 May	28 May	
M_2	(31)	(39)	
$D_3 I_1 M_1$	17 June		
M_2	(52)		
$D_3 I_2 M_1$	30 June		
M_2	(34)		
$D_3 I_3 M_1$	27 May	18 June	
M_2	(31)	(53)	

*Figures in parenthesis shows the days after sowing

Table 5: Effect of sowing dates, irrigation levels and mulching on periodic plant height (cm) of summer mungbean

Treatment	28 DAS 1999	28 DAS 2000	35 DAS 1999	35 DAS 2000	42 DAS 1999	42 DAS 2000	49 DAS 1999	49 DAS 2000	56 DAS 1999	56 DAS 2000	63 DAS 1999	63 DAS 2000	Harvest 1999	Harvest 2000
D_1	5.98	6.25	9.20	9.60	12.02	14.21	16.52	17.25	20.98	23.66	25.35	26.12	26.90	27.66
D_2	5.82	6.29	9.00	8.99	11.42	12.84	15.38	15.03	19.79	20.69	23.45	24.87	24.89	26.05
D_3	5.68	5.98	8.75	8.84	9.58	10.70	13.69	12.99	16.52	17.43	21.54	21.63	22.96	22.61
CD (P =0.05)	**NS**	**NS**	**0.43**	**NS**	**0.81**	**1.32**	**2.06**	**1.86**	**1.25**	**1.29**	**1.17**	**2.61**	**1.36**	**0.49**
I_1	5.68	5.97	7.59	8.84	10.04	11.49	14.58	13.83	17.62	19.05	20.87	20.73	22.15	21.96
I_2	5.89	6.20	8.92	8.88	10.64	12.66	14.09	15.20	18.61	20.06	22.85	24.90	24.50	26.07
I_3	5.92	6.27	9.45	9.61	12.34	13.60	16.86	16.20	21.06	22.67	26.62	26.99	28.17	28.29
CD (P =0.05)	**NS**	**NS**	**0.30**	**NS**	**0.62**	**1.29**	**1.39**	**0.78**	**0.73**	**0.81**	**0.58**	**1.91**	**0.67**	**0.58**
M_1	5.89	6.22	8.94	8.47	11.61	13.13	15.58	15.67	19.85	21.40	24.43	25.23	25.90	26.10
M_2	5.76	6.12	8.37	8.61	10.41	12.09	14.54	14.51	18.34	19.70	22.40	23.18	23.93	24.70
CD (P =0.05)	**NS**	**NS**	**0.14**	**NS**	**0.66**	**0.72**	**0.62**	**0.69**	**0.44**	**0.77**	**0.62**	**1.58**	**0.97**	**1.06**

CD (P = 0.05) for interaction: Non-significant

Table 6: Effect of sowing dates, irrigation levels and mulching on periodic dry matter accumulation (g/plant) in summer mungbean

Treatment	28 DAS		35 DAS		42 DAS		49 DAS		56 DAS		63 DAS		Harvest	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
D_1	1.07	1.13	2.61	2.74	5.74	6.0	8.71	8.97	9.90	10.01	12.18	12.90	12.12	12.73
D_2	0.99	1.05	2.22	2.54	5.28	5.49	8.43	8.33	9.50	9.41	11.60	11.70	12.06	12.52
D_3	0.97	1.04	1.93	2.36	4.73	4.92	8.12	7.83	8.90	8.73	11.65	11.80	11.32	11.83
CD (P =0.05)	**NS**	**NS**	**0.14**	**6.09**	**0.52**	**0.51**	**0.33**	**0.33**	**0.59**	**0.70**	**0.80**	**0.71**	**0.23**	**0.70**
I_1	1.02	1.07	2.08	2.31	4.24	4.44	6.87	6.83	7.80	7.77	9.29	9.32	10.14	10.63
I_2	1.02	1.07	2.24	2.56	5.59	5.90	9.07	8.83	9.50	10.04	12.22	12.40	12.44	13.04
I_3	1.01	1.09	2.47	2.77	5.92	6.07	9.32	9.42	11.0	10.34	12.92	12.70	12.90	13.41
CD (P =0.05)	**NS**	**NS**	**0.04**	**0.11**	**0.24**	**0.28**	**0.28**	**0.27**	**0.24**	**0.43**	**0.50**	**0.42**	**0.38**	**0.64**
M_1	1.02	1.09	2.25	2.60	5.42	5.65	8.70	8.64	9.70	9.60	11.87	11.90	12.25	12.73
M_2	1.01	1.06	2.26	2.49	5.07	5.29	8.14	8.08	9.21	9.14	11.07	11.06	11.41	11.99
CD (P =0.05)	**NS**	**NS**	**NS**	**NS**	**0.20**	**0.32**	**0.33**	**0.34**	**0.17**	**0.38**	**0.48**	**0.53**	**0.45**	**0.42**

CD (P = 0.05) for interaction: Non-significant

Table 7: Effect of sowing dates, irrigation levels and mulching on grain yield (q/ha), straw yield (q/ha) and biological yield (q/ha) in summer mungbean

Treatment	Grain yield (q/ha)			Straw yield (q/ha)			Biological yield (q/ha)		
	1999	2000	Pooled	1999	2000	Pooled	1999	2000	Pooled
D_1	8.74	8.26	8.50	35.12	37.90	36.51	43.86	46.16	45.01
D_2	7.88	7.76	7.81	34.00	35.54	34.77	41.88	43.29	42.58
D_3	7.47	7.16	7.37	33.25	33.49	33.37	40.72	40.65	40.68
CD (P =0.05)	**0.74**	**0.65**	**0.41**	**0.98**	**1.33**	**0.68**	**1.01**	**1.88**	**0.88**
I_1	6.97	6.60	6.78	31.23	30.63	30.93	38.20	37.23	36.73
I_2	7.50	8.05	7.77	34.09	35.10	34.59	41.59	43.15	42.37
I_3	9.62	8.51	9.06	37.04	41.21	39.12	46.67	48.18	49.19
CD (P =0.05)	**0.98**	**0.74**	**0.58**	**1.03**	**1.12**	**0.72**	**1.40**	**1.43**	**0.94**
M_1	8.60	8.29	8.44	35.76	36.38	36.67	44.36	44.68	44.52
M_2	7.46	7.14	7.30	32.48	34.91	33.69	39.95	42.66	41.00
CD (P =0.05)	**0.68**	**0.82**	**0.51**	**1.03**	**1.16**	**0.75**	**1.44**	**1.65**	**1.06**

CD (P = 0.05) for interaction: Non-significant

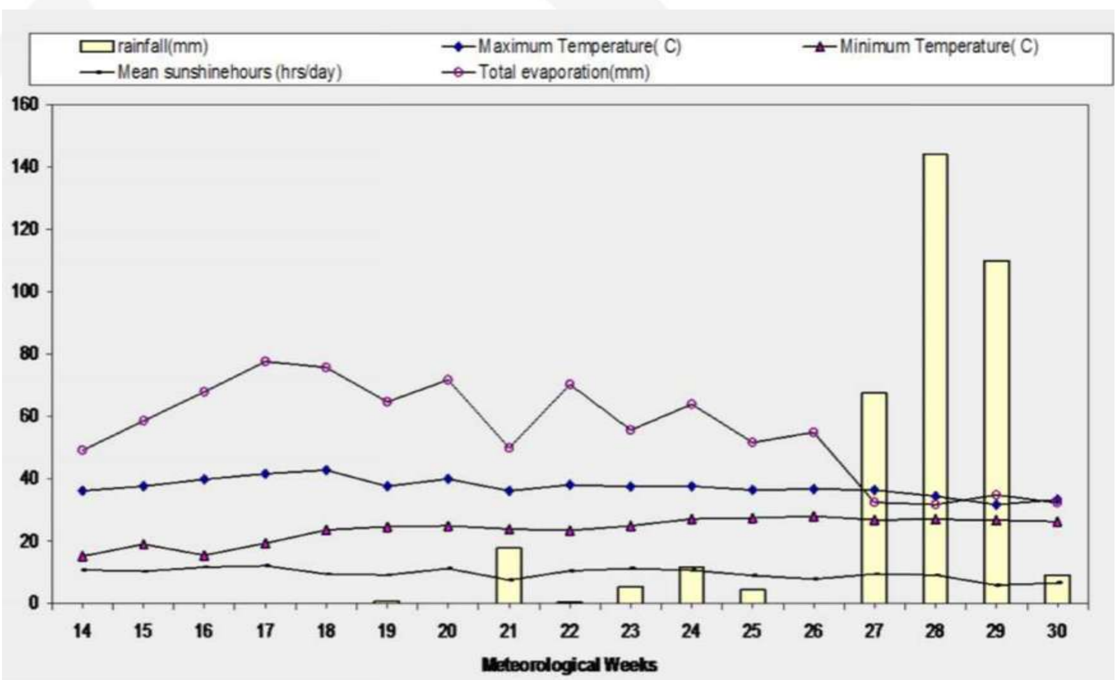

Fig. 1a: Weekly average weather parameter during crop growing period in 1999.

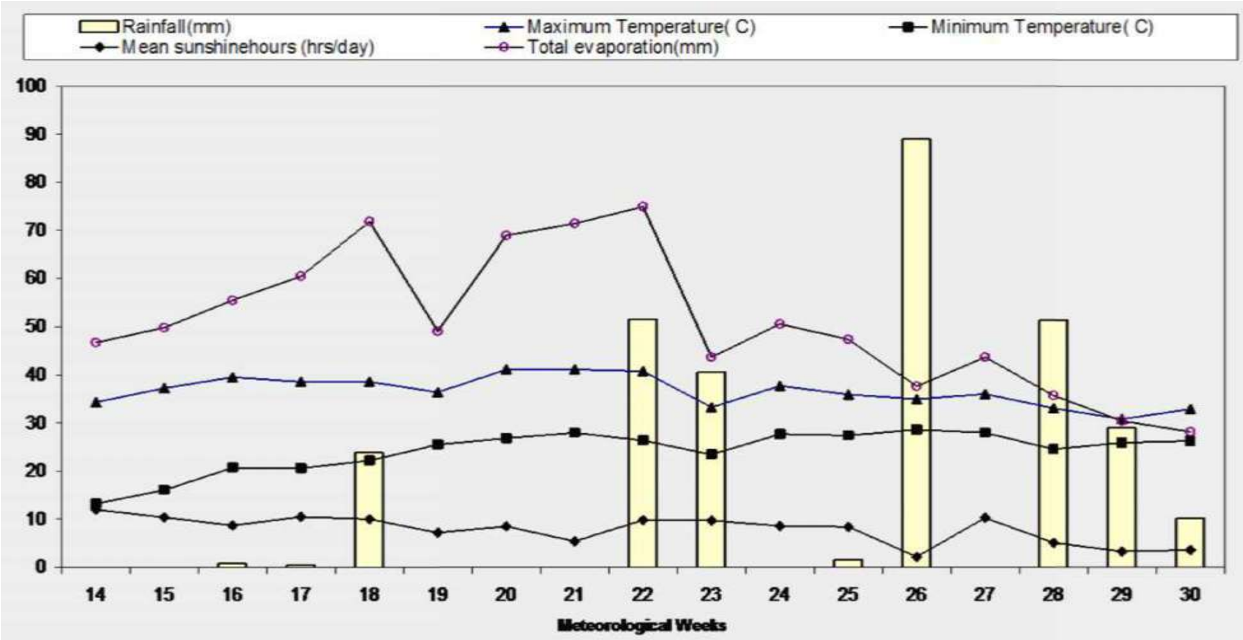

Fig. 1b: Weekly average weather parameter during crop growing period in 2000.

thrips, on flower causing flower drop, deformation of pods, deterioration of grain quality and ultimately high reduction in yield. To prevent the attack of thrips, the crop was sprayed with 120 ml metasystox 25 EC spray in 80-100 liter/ha. To prevent the attack of whites fly 375 ml malathion 50 EC spray in 80-100 liter/ha. The crop was harvested on 20th June, 23rd June and 25th June, 1999 and on 26th June, 26th June, 9th July, 2000, respectively, in case of D_1, D_2 and D_3. Sun dried pods were threshed and grain yield and straw yield was recorded and converted into q/ha.

Result and Discussion

Plant height

Plant height, an index of growth and development of plant, is an important physiological character to assess the vegetative growth. A persual of data in Table 4.6 shown that plant height increased progressively with the advancement of crop growth stages with different dates under different treatments. At initial stages of crop (28 DAS, 35 DAS), there was no significant differences within different treatments but later on it became significant due to advancement of crop and due to differential soil moisture regimes to which crop was exposed. The plant height was significantly different among sowing date treatments and was highest in D_1 (26.9 cm) followed by D_2 (24.8 cm) and D_3 (22.9 cm) during 1999 and D_1 (27.6 cm) followed by D_2 (26.0 cm) and D_3 (22.6 cm) during 2000, respectively. Plant height was higher in 2000 than 1999 due to more rainfall in 2000.

Irrigation treatments depict that differential irrigation significantly affected the plant height. Plant height was maximum in I_3 (28.1 cm) followed by I_2 (24.5 cm) and I_1 (22.1 cm), respectively, at harvest during 1999. During 2000, again the plant height was found maximum at I_3 (28.2 cm) followed by I_2 (26.0 cm) and I_1 (21.9 cm), respectively.

Mulched crop showed significantly higher plant height than that of unmulched crop, at each stage of the crop, 42 DAS onwards till harvest. The mulched crop had 25.9 cm, 23.9 cm plant height in 1999 and 26.1 cm, 24.7 cm in 2000, respectively.

Plant height was directly affected by the microclimate to which plant was exposed. Early sowing dates, highly irrigated and mulched treatments had higher plant height due to optimize growth conditions. In a study at New Delhi Gupta *et al.* (1994) also reported higher plant height in mulched summer mungbean than that of unmulched crop.

Dry Matter Accumulation

Dry matter accumulation is directly influenced by plant height and leaf area index. During both the years the dry matter accumulation differed significantly among the different dates of sowing, irrigation levels and mulching treatments and was found higher in

2000 than in 1999 due to higher rainfall in 2000. Peak dry matter accumulation was found at 63 DAS.

D_1 showed highest dry matter (in g/plant) at 63 DAS (12.18) followed by D_3 (11.65) and D_2 (11.60), respectively, during 1999. During 2000 the dry matter in D_1, D_2 and D_3 was 12.90, 11.70 and 11.80, respectively. Among irrigation treatments the dry matter (in g/plant) at 63 DAS in I_1, I_2 and I_3 was 9.29, 12.22 and 12.92 in 1999; and 9.32, 12.40 and 12.70, in 2000, respectively. The dry matter (in g/plant) in mulched and unmulched crop at 63 DAS was 11.87 and 11.07, during 1999; and 11.90 and 11.06, during 2000, respectively.

It is evident that leaf area plays important role in determining the total dry matter of plant. Due to higher leaf area, more photosynthate was synthesized and accumulated in plant resulting into the higher total dry matter accumulation. Similar results are also reported by Kundu (1988) and Gupta *et al.* (1994).

Grain Yield

Grain yield was found significantly different within the treatments during both the years. During 1999, the grain yield was highest in D_1 (8.74 q/ha) followed by D_2 (7.88 q/ha) and D_3 (7.47 q/ha), respectively. During 2000, the grain yield followed the same pattern and found highest in D_1 (8.26 q/ha) followed by D_2 (7.76 q/ha) and D_3 (7.16 q/ha), respectively. There was no significant difference in grain yield in D_2 and D_3 during both years.

Irrigation treatments also affected the grain yield, significantly. The yields were at par in I_2 and I_3 during both the years. Grain yield in I_1, I_2 and I_3 treatments were 6.97 q/ha, 7.50 q/ha and 9.62 q/ha during 1999 and 6.60 q/ha, 8.05 q/ha and 8.51 q/ha during 2000, respectively. Mulched crop was found to be higher yielding than that of unmulched crop. Grain yield in mulched and unmulched crop was found significantly different and was 8.60 q/ha and 7.46 q/ha during 1999; and 8.29 q/ha and 7.14 q/ha, during 2000, respectively. Higher grain yield was observed in 1999 than in 2000. This may be due to higher rainfall in 2000 that resulted into higher vegetative growth having an adverse effect on reproductive growth.

Straw Yield

The data reveal that straw yield was also found significantly different within the treatments, during both the years. The straw yield in D_1, D_2 and D_3 was 35.12 q/ha, 34.00 q/ha and 33.25 q/ha during 1999; and 37.90 q/ha, 35.54 q/ha and 33.49 q/ha during 2000, respectively. The straw yield in D_2 and D_3 in 1999 was statistically at par. Differential irrigation directly affected the straw yield during 1999 and 2000. The straw yield in I_1, I_2 and I_3 was found significantly different and was 31.23 q/ha, 34.09 q/ha and 37.04 q/ha during 1999; and 30.63 q/ha, 35.10 q/ha and 41.21 q/ha during 2000, respectively. Mulched crop had significantly higher straw yield than that of unmulched crop. The straw yield in mulched and unmulched crop was 35.76 q/ha and 32.48 q/ha during 1999 and 36.38 q/ha and 34.91 q/ha, during 2000, respectively.

Biological Yield

The data pertaining to the biological yield reveal that biological yield was found significantly different within treatments.

Among sowing dates, the biological yield in D_1, D_2 and D_3 was 43.86 q/ha, 41.88 q/ha and 40.72 q/ha during 1999; and 46.16 q/ha, 43.29 q/ha and 40.65 q/ha during 2000, respectively.

Irrigation levels showed significant effect on biological yield during both the years. The biological yield in I_1, I_2 and I_3 was 38.20 q/ha, 41.59 q/ha and 46.67 q/ha during 1999; and 37.23 q/ha, 43.15 q/ha and 49.19 q/ha, during 2000, respectively. The total biological yield (q/ha) in mulched and non mulched crop differed significantly and was 44.68 and 39.95 during 1999; and 44.68 and 42.66 during 2000, respectively.

These results also find support from the various research experiments conducted by research workers. Yadav *et al* (1992) also reported higher grain and straw yield with increased frequency of irrigation. Kumar *et al* (1995) reported higher total dry matter under straw mulched conditions in summer mungbean.

Conclusion

Grain yield and straw yield are the product of plant environmental interaction and genetic variables of the crop. This is directly affected by meteorological and micrometeorological conditions to which they are exposed. Early sowing of crop showed better results due to longer duration of crop. Frequently irrigated crop had better plant water status that ultimately affected the photosynthesis in a positive way and increased final yield. Mulching with wheat straw reduced the excess heat load on the soil, therefore, reduced the temperature variation in soil and improved soil water status, that ultimately affected the nutrient absorption by plant, Therefore, the mulched crop had better yield than that of unmulched crop.

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