Indian J. Plant Physiol., Vol. 12, No. 2, (N.S.) pp. 194-198 (April-June, 2007)

SHORT COMMUNICATION

GROWTH AND YIELD OF WHEAT AS INFLUENCED BY EVAPOTRANSPIRATION CONTROL MEASURES AND LEVELS OF FERTILIZER UNDER RAINFED CONDITION

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Received on 7 May, 2005, Revised on 28 May, 2007

An experiment was carried out to study the growth and productivity of wheat (*Triticum aestivum* L.) as influenced by different levels of evapotranspiration control measures and different levels of fertilizer under rainfed condition. The combined application of straw mulch @ 6 t ha^{-1} + kaolin spray @ 6.0% w/v significantly influenced leaf area index (LAI), dry matter accumulation (DMA), crop growth rate (CGR), net assimilation rate (NAR) and yield during both the years of 2000-2001 and 2001-2002. Similar effects on growth parameters and yield were observed due to increased levels of fertilizer upto 120: 60: 60 kg ha^{-1} of N, P_2O_5 and K_2O respectively.

Key words: **Evapotranspiration control measure, fertilizer level, growth parameters, wheat, yield**

In terai agro-climatic zone of West Bengal where average rainfall is about 3000 mm per annum, the wheat crop is generally grown under residual soil moisture condition. Under such a situation it would be imperative to utilize this residual soil moisture by conserving it with suitable mulch materials. Ahmed and Srivastava (1980) and Rahman *et al.* (2004) reported that adequate soil moisture conserved by mulch in conjunction with nitrogen increased the crop yield significantly over control. Yang *et al.* (2006) reported that straw mulch conserved more soil water than any other mulch tried. Gao *et al.* (1999) reported that straw mulch was the best way to store and conserve soil moisture and more than 20% of wheat grain yield was increased due to application of straw mulch. De and Giri (1978) observed higher grain yield of wheat due to application of kaolin @ 6% w/v at 45 DAS. Kaolin spray on wheat increased grain yield due to increased tiller number, longer ears and greater spikelets fertility (De *et al.* 1983). The productivity of crop is mainly dependent on its potentiality for photosynthesis and photosynthetic area developed. Generally for the quantification of growth parameters dry matter weight was taken into account. But the determination of crop growth rate and relative growth rate have special significance as these parameters provide distinct information about some of the physiological functions like rate of dry matter accumulation, net photosynthetic area. Therefore, the present investigation was undertaken to study the analysis of growth and productivity of wheat (*Triticum aestivum* L.) as influenced by evapotranspiration control measures and levels of fertilizer under rainfed condition.

Field experiments were conducted during winter seasons of 2000-2001 and 2001-2002 at the Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India where the soil is sandy-loam in texture having pH 5.9 with total nitrogen 0.45%, available P 31 kg ha^{-1} and available K 160 kg ha^{-1}, medium in organic carbon content 0.22%. The experiment was laid out in split-plot design replicated thrice. The treatments consisted of four levels of

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evapotranspiration control measures (ET) in the main plot viz. control (ET_0), straw mulch @ 6 t ha^{-1} (ET_1), kaolin spray @ 6.0% w/v (ET_2), and straw mulch + kaolin (ET_3). Where as sub-plot consisted of four levels of fertilizer as (i) control (F_1), (ii) 90:45: 45 (F_2), (iii) 120:60:60 (F_3) and (iv) 150: 75: 75 (F_4) kg ha^{-1} of N, P_2O_5 and K_2O respectively. The mulch materials were applied immediately after sowing of wheat. Wheat variety HP 1731 (Rajlakshmi) was sown in lines 22.5 cm apart at a depth of 4-5 cm with 125 kg seed ha^{-1} in mid November during both the years of experimentation. Fertilizers were applied in the form of urea, single super phosphate and muriate of potash respectively. Half of the nitrogen fertilizer and entire dose of P_2O_5 and K_2O were applied at the time of sowing and rest half of nitrogen was applied at crown root initiation stage.

Leaf area index (LAI) at 90 days after sowing (DAS) when it reached at its peak and thereafter declined towards maturity of the crop irrespective of the treatments tried during the two consecutive years of experimentation (Table 1). The effect of different treatments on LAI was observed throughout the crop growth period and it was highest at 90 DAS in straw mulch + kaolin spray (ET_3) treated plots as compared to other treatments during both the years of experimentation and it was followed by ET_1, ET_2 and ET_0 in sequence and thereafter the LAI decreased. Straw mulch prevented the evaporation loss from the soil and subsequent application of kaolin minimized transpiration loss and it showed greater LAI over rest of the treatments. Significant variation in LAI was noted due to different levels of fertilizer tried in the experiment and it was recorded highest under the treatment where fertilizer was applied @ 120: 60: 60 kg ha^{-1} of N, P_2O_5 and K_2O respectively (F_3) at 90 DAS and it was followed by treatments F_4, F_2 and F_1 in sequence during both the years of experimentation (Table 1). Lower LAI was observed in control treatment. The similar dose of fertilizer resulted greater LAI in wheat crop as reported by Nehra *et al.* (2001).

Dry matter accumulation (DMA) increased with the advancement of crop age and maximum accumulation

Table 1. Effect of evapotranspiration control measures and levels of fertilizer on leaf area index (LAI) and dry matter accumulation of wheat at different stages of crop growth

Treatments	Leaf area index (LAI) Days after sowing (DAS)								Dry matter accumulation (DMA) ($g\ m^{-2}$) Days after sowing (DAS)							
	60		75		90		105		60		75		90		105	
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Evapotranspiration control measures																
Control	2.82	2.98	3.61	3.69	3.87	3.94	3.27	3.29	78.66	89.53	159.71	177.43	327.97	357.96	470.39	516.55
Straw mulch @ 6.0 t ha^{-1}	3.20	3.45	3.89	4.05	4.02	4.13	3.51	3.72	138.92	150.34	251.49	270.24	484.50	501.25	688.05	709.86
Kaolin spray @ 6% w/v	3.02	3.22	3.74	3.86	3.96	4.01	3.33	3.38	108.26	119.82	204.73	223.24	423.07	440.17	603.41	628.87
Straw mulch + Kaolin spray	3.47	3.77	4.00	4.17	4.14	4.27	3.65	3.73	159.35	171.84	281.32	303.19	556.28	573.69	803.89	824.53
C.D. (P=0.05)	**0.33**	**0.42**	**0.24**	**0.36**	**0.13**	**0.18**	**N.S**	**0.39**	**19.77**	**20.34**	**21.06**	**22.35**	**18.36**	**20.25**	**18.12**	**20.46**
Levels of fertilizer	**N: P_2O_5: K_2O (kg ha^{-1})**															
Control	2.88	3.11	3.50	3.64	3.75	3.81	3.04	3.25	76.59	87.95	164.25	182.25	354.71	366.02	515.21	53.99
90: 45: 45	3.04	3.27	3.75	3.88	3.96	4.00	3.40	3.49	110.53	122.09	213.45	232.16	432.87	454.41	620.37	643.64
120: 60: 60	3.36	3.58	4.07	4.20	4.21	4.35	3.72	3.75	152.21	163.57	263.00	281.90	510.37	527.02	724.94	754.95
150: 75: 75	3.23	3.46	3.92	4.05	4.07	4.19	3.61	3.62	145.86	157.92	256.55	277.79	493.87	525.62	705.22	749.23
C.D. (P=0.05)	**0.14**	**0.18**	**0.21**	**0.24**	**0.11**	**0.15**	**0.21**	**N.S**	**17.60**	**18.33**	**19.79**	**20.46**	**17.63**	**17.89**	**16.72**	**17.86**

Y_1 = 2000-2001; Y_2 = 2001-2002

of dry matter was recorded at 105 DAS in irrespective of the treatments tried (Table 1). It is indicated that the initial growth rate as measured by dry matter production was slow at vegetative stage of crop growth and thereafter it was triggered as the crop approached reproductive stage during both the years. Dry matter accumulation varied significantly due to different evapotranspiration control measures tried in the experiment and it was noted significantly higher due to the treatment where straw mulch + kaolin (ET_3) were applied and it was followed by ET_2, ET_1 and ET_0 in sequence during both the years of experimentation. Beneficial effect of straw mulch for preventing evaporation loss of moisture from the soil surface and subsequent application of kaolin to minimize the transpiration loss influenced higher DMA in the treatment over others (Table 1). Significant variation in DMA was noted due to different levels of fertilizer tried which was significantly higher at 105 DAS where 120: 60: 60 kg ha^{-1} of N, P_2O_5 and K_2O respectively (F_3) were applied and it was at par with highest levels of fertilizer (F_4) tried. Dry matter accumulation at all the stage of crop growth increased with increase in the levels of fertilizer upto 120: 60: 60 kg ha^{-1} of N, P_2O_5 and K_2O respectively (F_3) irrespective of the dates of observation and thereafter it decreased. Better crop growth and nutrient uptake in F_3 treatment influenced higher DMA. The dry matter accumulation was noted to be the lowest under the control treatment (Table 1).

The crop growth rate (CGR) slowed during 60-75 days crop age in irrespective of evapotranspiration control measures and levels of fertilizer tried during both the years of experimentation and there after it started increasing and reached at its maximum at 76-90 days crop age because of fullest manifestation of all the vegetative parts of the plant and panicle initiation thereby increasing CGR in this phase to a greater extent. Crop growth rate was noted decreasing progressively from 91 days crop age to till maturity as the crop reached at its ripening phase and had no further vegetative growth (Table 2). Application of different evapotranspiration control measures significantly influenced CGR in irrespective of the period of observation (Table 2). The combined application of straw mulch + kaolin (ET_3) spray treated plots recorded significantly highest CGR between 76 and 90 DAS and it was followed by the treatments ET_1, ET_2 and ET_0 in sequence. Application of straw mulch and subsequent spray of kaolin favoured growth of the crop to a considerable extent particularly during the vegetative phase and resulted thereby increased CGR under the treatment as compared to others tried in the experiment. Crop growth rate varied significantly due to different levels of fertilizer tried in the experiment (Table 2). Application of 120: 60: 60 kg ha^{-1} of N, P_2O_5 and K_2O respectively (F_3) recorded the highest CGR in irrespective of the period of observation and it was followed by the treatment F_4, F_2 and control (F_1) in sequence. However there was no appreciable difference in CGR due to F_3 and F_4 treatments.

Net assimilation rate (NAR) at different stage of crop growth was noted increasing successively till the period of 76 to 90 DAS when it reached its maximum and thereafter it declined till 91-105 DAS in irrespective of the evapotranspiration control measures and levels of fertilizer tried during both the years of experimentation (Table 2). NAR varied significantly due to application of evapotranspiration control measures and it was highest in the treatment where combined application of straw mulch + kaolin (ET_3) were applied during both the years as compared to other treatments and it was affected in control plot. Among the different levels of fertilizer tried, the NAR was recorded significantly highest at 120: 60: 60 kg ha^{-1} of N, P_2O_5 and K_2O respectively (F_3) levels of fertilizer as compared to others. However, there was no appreciable difference in NAR due to F_3 and F_4 treatments. The lowest NAR value was noted under unfertilized control plot (Table 2).

The combined application of straw mulch + kaolin (ET_3) spray resulted in highest grain yield of wheat and it was followed by the treatments ET_1, ET_2 and ET_0 in sequence. The straw mulch leads to reduced evaporation loss from the soil and subsequent application of kaolin reduces leaf temperature by reflecting the solar radiation there by minimizing the evapotranspiration loss and influenced grain yield to a considerable extent. Increased grain yield due to application of straw mulch was reported by Misra (1996), Rahmat *et al.* (1998) and Rahman *et al.* (2004). Soni and Lehria (1999) reported that mulching with 5 t ha^{-1} increased grain yield of wheat compared

Table 2. Effect of evapotranspiration control measures and levels of fertilizer on crop growth rate (CGR), Net Assimilation Rate (NAR) and Grain yield (q ha^{-1}) of wheat at different stages of crop growth

Treatments	Crop growth rate (CGR) (g m^{-2} day^{-1}) Days after sowing (DAS)						Net assimilation rate (NAR) (g m^{-2} day^{-1}) Days after sowing (DAS)						Grain yield (q ha^{-1})		
	61-75		76-90		91-105		61-75		76-90		91-105				
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Mean
Evapotranspiration control measures															
Control	5.40	5.86	11.22	12.04	9.49	10.57	1.70	1.76	3.02	3.12	2.79	2.95	16.23	17.92	17.07
Straw mulch @ 6.0 t ha^{-1}	7.51	7.99	15.40	15.53	13.57	13.91	2.11	2.12	3.59	3.66	3.51	3.63	25.23	27.01	26.12
Kaolin spray @ 6% w/v	6.43	6.89	14.46	14.55	12.02	12.58	1.92	1.96	3.58	3.78	3.37	3.50	22.46	23.21	22.83
Straw mulch + Kaolin spray	8.14	8.76	18.03	18.33	16.51	16.72	1.99	2.19	4.15	4.47	4.05	4.13	31.93	33.89	32.91
C.D. (P=0.05)	**1.38**	**1.59**	**1.66**	**1.76**	**1.21**	**1.42**	**0.48**	**0.55**	**0.59**	**0.66**	**0.52**	**0.62**	**3.59**	**3.81**	**-**
Levels of fertilizer N: P_2O_5: K_2O (kg ha^{-1})															
Control	5.85	6.29	12.25	12.69	10.70	11.06	1.66	1.87	3.27	3.49	3.15	3.21	16.50	17.46	16.98
90: 45: 45	6.86	7.34	14.63	14.82	12.50	12.62	2.02	2.04	3.48	3.79	3.36	3.45	21.82	23.31	22.56
120: 60: 60	7.39	7.89	16.34	16.52	14.30	15.19	2.06	2.08	3.80	3.92	3.69	3.87	29.30	30.88	30.09
150: 75: 75	7.38	7.98	15.82	16.49	14.09	14.91	1.98	2.04	3.78	3.84	3.52	3.68	28.38	30.38	29.38
C.D. (P=0.05)	**1.14**	**1.23**	**1.34**	**1.37**	**1.16**	**1.19**	**0.46**	**0.49**	**0.37**	**0.44**	**0.43**	**0.47**	**3.01**	**3.12**	**-**

Y_1 = 2000-2001; Y_2 = 2001-2002

with mulching with 2.5 t or 7.5 t straws. Gao *et al.* (1999) reported that straw mulch was the best way to store and conserve soil moisture and more than 20% of wheat grain yield was increased due to application of straw mulch.

Application of 120: 60: 60 kg ha^{-1} of N, P_2O_5 and K_2O respectively (F_3) resulted in highest mean grain yield as compared to others except F_4 levels of fertilizer which remained at par with each other. Auti *et al.* (1999) and Rahman *et al.* (2004) also reported increased grain yield due to application of 120: 60: 60 kg ha^{-1} of N, P_2O_5 and K_2O. The grain yield in the second year was higher (Table 2) because of good rainfall during the vegetative phase which may have influenced greater uptake of nutrients first year of experimentation.

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