

Yield of rainfed wheat (*Triticum aestivum*) in relation to seeding zone moisture and seed rate

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ABSTRACT

A field experiment was conducted during winter seasons of 1990-93 to study the effect of 3 seeding zone moisture conditions created by applying 0, 2.5 and 5.0 cm of water and 3 seed rates (60, 80 and 100 kg/ha). Application of 2.5 and 5.0 cm pre-sowing irrigation increased wheat (*Triticum aestivum* L. emend. Fiori & Paol.) yield significantly over the control in all the 3 years, the respective increase in yields being 4.4 to 5.5 q/ha with 2.5 cm and 6.2 to 8.9 q/ha with 5.0 irrigation. Higher seed rate too increased the wheat yield under all the 3 seeding zone moisture conditions. Seed rate of 80 kg/ha was at par during 1990-91 and 1991-92 with 100 kg/ha whereas in 1992-93, seed rate of 100 kg/ha gave more yield than 80 kg/ha.

Key words : Rainfed wheat, Yield, Seeding zone moisture, Seed rate

Maize-wheat is the major cropping sequence of the rainfed belt in the north-west submontane (*kandi*) areas of north-west India where rainfall is the only source of water supply (Singh *et al.*, 1983). Normally, monsoon in this region recedes much earlier (by end of September) than the optimum time of sowing for wheat (end of October/early November). This causes deficient seed zone moisture conditions leading to poor germination and thin stands of wheat. Higher seed rate of rainfed wheat at the rate of 100 kg/ha is used to take care of poor germination percentage (Verma *et al.*, 1984). Some-

times, this higher seed rate gives very high plant population, particularly when a very light rain is received during November. But it results in severe moisture stress at CRI stage. The probability of receiving such rains in November is very low (<10%) and chances of deficient seeding zone moisture are very high (>93%) (Verma, 1987). However, yield increases with higher seed rate under rainfed conditions (Misra, 1993).

There is a great scope to harvest excess rain water in tanks especially during July and August for use as presowig irrigation to rainfed wheat (Verma *et al.*, 1984; Verma,

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1988). To develop rainfed farming package for the region an experiment was carried out to study the effect of added seeding zone moisture and seed rate for wheat cultivation after maize.

MATERIALS AND METHODS

The field experiment was conducted during 1990-91 to 1992-93 on silt loam soil in the Operational Research Project village Majari in district Hoshiarpur, Punjab under the All-India Co-ordinated Research Project on Dryland Agriculture, where maize-wheat sequence was being followed in the experimental field for many years. The soil was very deep, non-saline, low in available N and medium in available P and K with organic carbon 0.8%.

The experiment was laid out in a split plot design with 4 replications. Three seeding zone moisture conditions, S₁, S₂ and S₃ designated as low, medium and high were created by applying 0, 2.5 and 5 cm pre-sowing irrigation to main plots by lifting water from a nearby water harvesting tank 1 week before sowing. In subplots, 3 seed rates of a drought-tolerant wheat variety 'PBW 175' (60, 80 and 100 kg/ha) were tried. The wheat was sown in the second week of November

in rows, 30 cm apart, fertilized at the rate of 80 kg N + 20 kg P₂O₅ + 10 kg K₂O/ha, and harvested in the fourth week of April. One-half of N and full quantity of P and K was drilled below seeding depth at sowing and the rest of N was applied with first winter rains as top dressing.

A crop of local variety of maize with improved package was raised during monsoon in the experimental field and there was no change in the experimental plots and layout during the study period.

RESULTS AND DISCUSSION

Effect of seeding zone moisture and rainfall on crop growth

The rainfall distribution (Table 1) during all the 3 wheat growing seasons was quite favourable. The growth of drought tolerant wheat 'PBW 175' did not suffer much due to non receipt of rains in November 1991 and December 1992 because there were good rains at CRI stage in first week of December 1991 and last week of November 1992. Rainless January 1991 too did not damage the crop because of heavy showers in the last week of December, 1990 which saturated the upper layers of the soil profile. The rainfall distribution during the latter stages of wheat

Table 1. Rainfall distribution (cm) at experimental site during the wheat growing season over the 3 years of the study

Year	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Total	Remarks
1990-91	1.7	8.2	Nil	6.9	3.7	2.1	22.6	Good early and mid-season rain
1991-92	Nil	5.8	6.7	4.7	5.6	3.3	26.1	Well distributed, good rains, throughout the year
1992-93	2.1	Nil	1.9	2.8	5.8	1.9	14.5	Generally deficient with late rains in March

Table 2. Soil moisture (cm) at the time of sowing in the seeding zone (0-30 cm) and in the rhizosphere (0-180 cm)

Water applied (cm)	Seeding zone (0-30 cm)				Rhizosphere (0-180 cm)			
	1990-91	1991-92	1992-93	Mean	1990-91	1991-92	1992-93	Mean
S ₁ Low (0 cm)	5.5	4.9	5.1	5.2	39.6	39.6	41.4	39.9
S ₂ Medium (2.5 cm)	6.3	5.5	5.9	5.9	42.5	40.6	43.1	42.1
S ₃ Adequate (5.0 cm)	7.4	6.7	7.0	7.0	46.0	43.3	45.0	44.7

Field capacity moisture values in 0-30 cm = 10.5 cm; field capacity moisture values in 0-180 cm = 63.0 cm

in February, March and April was quite favourable in all the 3 years of the study and ensured safe maturity of the crop.

There was deficient moisture conditions in the seeding zone in all the 3 years of the study and application of 2.5 cm pre-sowing irrigation raised the seeding zone moisture by 0.8, 0.6 and 0.8 cm and total profile moisture by 2.9, 1.0 and 1.7 cm during 1990-91, 1991-92 and 1992-93 respectively in the medium seeding zone moisture treatment S₂ (Table 2). This improved the germination by 8, 12 and 25/m² in 60, 80 and 100 kg seed rate treatments, S₁ (nil pre-sowing irrigation). Similarly, application of 5 cm pre-sowing irrigation increased seeding zone moisture by 1.9, 1.8 and 1.9 cm and total profile moisture by 6.4, 3.7 and 3.6 cm during the corresponding 3 years in high seeding zone moisture treatment S₃ over (Table 2). This in turn, increased germination by 27, 33 and 45/m² over the low seeding zone moisture treatment, S₁ (Table 3). The increased population stands of wheat thus obtained with pre-sowing irrigation, improved the total tillers/m² from 432 to 488 and 522 in 60 kg; from 488 to 565 and 617 in 80 kg and from 559 to 617 and 677 in 100 kg seed rate in medium and high moisture treatments, S₂,

over low moisture treatment, S₁, respectively (Table 3). This increased tiller population also improved the effective ear bearing tillers/m² (Table 3). The effective tillers/m² too were improved from low to medium and high initial seeding rate moisture treatments, respectively from 360 to 385 and 416/m² in 60 kg, from 403 to 435 and 457 in 80 kg and from 433 to 68 and 88 tillers/m² in 100 kg seed rate. Thus the effect of initial seeding zone moisture proved very critical in achieving near normal high number of effective tillers/m², considered so important in achieving assured high grain yield ultimately.

Effect of initial moisture treatments on yield

The increase in seeding zone moisture which increased the critical germination and population stand and subsequently the ear-bearing tillers/m² resulted in significant increased grain yield in all the 3 years of the study (Table 4). Medium seeding zone moisture created by applying 2.5 cm pre-sowing irrigation significantly increased the mean wheat yield. The increased mean yield (q/ha) with medium level initial moisture level was 5.5 in I year, 4.4 in II year and 5.2

Table 3. Effect of initial seeding zone moisture on germination, total tillers and effective ear-bearing tillers/m² under different seeding rates of wheat (average of 2 years : 1991-92 and 1992-93)

Initial seeding zone moisture*	Plant count/m ² at germination				Tiller count at harvest							
	Seed rate (kg/ha)				Total tillers/m ² at seed rate (kg/ha)				Effective tillers/m ² at seed rate (kg/ha)			
	60	80	100	Mean	60	80	100	Mean	60	80	100	Mean
S ₁ Low (0.0 cm)	84	103	118	102	432	488	559	493	360 (83%)	403 (83%)	433 (77%)	399 (81%)
S ₂ Medium (2.5 cm)	92	115	143	117	488	365	617	557	385 (79%)	435 (77%)	468 (76%)	429 (77%)
S ₃ High (5.0 cm)	111	136	163	137	522	617	677	605	416 (80%)	457 (76%)	488 (72%)	454 (75%)
Mean	96	118	141		481	557	618		387 (81%)	432 (78%)	463 (75%)	

Figures in parentheses indicate per cent conversion of total tillers into effective ear-bearing tillers

in III year over the mean yield of low seeding zone moisture treatment (nil irrigation), in the respective years.

The high seeding zone moisture treatment S_3 correspondingly increased the mean yield by 8.9, 6.2 and 8.0 q/ha over the control, (i.e. low seeding zone moisture treatment) during the 3 years. The advantage of increased yield varied from 7 to 11% with medium moisture level and it was 11-18% with high moisture level.

The year-wise yield (Table 4) was directly

related to water supply (Table 1). During 1991-92, the highest yield of 68.5 q/ha was obtained in S_3 treatment when the seasonal rainfall was the highest (26.1 cm). As compared to this the lowest yields were recorded in the third year when the rainfall was the lowest (14.5 cm) and the seeding zone moisture condition continued to be low over most of the growing periods. Chaudhary (1985) observed that even a small quantity of irrigation water applied proved highly productive when crop productivity was limited by

Table 4. Grain yield of rainfed wheat (q/ha) as influenced by initial seeding zones moisture under 3 seeding rate treatments during the 3 years

Initial seeding zone moisture and quantity of water applied (cm) 1 week prior to seeding		Seeding rate (kg/ha) [R]				Increase (q/ha)
		60 (R_1)	80 (R_2)	100 (R_3)	Mean	
<i>1990-91</i>						
S_1 Low	(0.0 cm)	47.1	49.1	51.5	49.3	
S_2 Medium	(2.5 cm)	50.4	56.7	57.2	54.8	5.5
S_3 High	(5.0 cm)	54.6	58.8	61.3	58.2	8.9
Mean		50.7	55.0	56.7		
CD (P = 0.05)		S = 2.7, R = 3.5, S × R = N. S.				
<i>1991-92</i>						
S_1 Low	(0.0 cm)	54.5	60.4	62.3	59.1	
S_2 Medium	(2.5 cm)	58.5	65.0	66.9	63.5	4.4
S_3 High	(5.0 cm)	60.6	66.7	68.5	65.3	6.2
Mean		57.9	64.0	65.9		
CD (P = 0.05)		S = 4.4, R = 3.1, S × R = N. S.				
<i>1992-93</i>						
S_1 Low	(0.0 cm)	44.0	46.5	48.6	46.4	
S_2 Medium	(2.5 cm)	48.5	52.5	53.7	51.6	5.2
S_3 High	(5.0 cm)	52.3	54.3	56.7	54.4	8.0
Mean		48.3	51.1	53.0	50.4	
CD (P = 0.05)		S = 0.6, R = 0.3, S × R = 0.5				

poor stand establishment due to a dry seed bed moisture. Mittal *et al.* (1987) while studying the effect of minimal irrigation from harvested water on yield of wheat in the Shivaliks foot-hills showed that one irrigation to wheat at CRI (crown root initiation) or tillering, 2 irrigations at CRI and late tillering gave 30.0, 15.2 and 38.5% increase in grain yield respectively over the pre-sowing/pre-emergence irrigation alone. They advocated that 1 early life saving supplemental irrigation at CRI could be more effective and economical to cover large area with minimal loss of the harvested rain water than a latter irrigation. They further observed supplemental irrigation is crucial for high yield, is well-known. Singh *et al.* (1983) worked out response of wheat as a function of control yield in relation to supplement irrigation. They observed that response increased initially and after a threshold, it decreased with increasing yield of unirrigated plots.

Effect of seed rates

Higher seed rates increased wheat yield in all the years under the 3 seeding zone moisture conditions (Table 4). Seeding at the rate of 80 kg/ha gave significantly more yield than 60 kg/ha under all the seeding zone moisture treatments in all the 3 years (except in low seeding zone moisture during 1990-91). In all the 3 treatments of seeding zone moisture, the wheat yield under 80 and 100 kg/ha seed rate was at par during 1990-91 and 1991-92, whereas in 1992-93, 100 kg/ha seed rate gave significantly more yield than that of 80 kg/ha. The first increment of seed rate from 60 to 80 kg/ha increased the mean grain yield by 4.3, 6.1 and 2.8 q/ha, whereas the second increment in seed rate from 80 to 100 kg/ha increased the mean

yield by only 1.7, 1.9 and 1.9 q/ha during 1990-91, 1991-92 and 1992-93 respectively. The quantum of increase with high seed rate, 100 kg over that of 60 kg/ha was a function of initial seeding zone moisture. It was quite high during the first 2 years in medium and high initial seeding zone moisture treatments, i.e. 54.6 to 61.3 q/ha in 1990-91 and 60.6 to 68.5 q/ha in 1991-92 respectively when the rainfall was well distributed and sufficiently high. But it was rather low in 1991-92 (52.3 to 56.7 q/ha) when the rainfall was low and rather deficient over most of growth season.

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