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Response of Wheat Yield Components to Type of N-Fertilizer, their Levels and Application Time

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Abstract: Field experiment was conducted to study the effect of N-type fertilizers on the yielding components of wheat (*Triticum aestivm* L.), applied at sowing, vegetative and boot stage. Spike population and number of grains per spike had a significant linear increased with increase in fertilizer levels. Grain weight remained unaffected by fertilizer levels. Types of fertilizer (Ammonium sulphate and Ammonium nitrate) had no significant effect on spike population, number of grain and 1000 grain weight. Split dose (50 kg N ha^{-1}) of fertilizer application at sowing and vegetative stage (S1 + S2) or at vegetative and boot stage (S2 + S3) significantly increased number of productive tillers per unit area. Generally 50 kg N ha^{-1} applied at boot stage increased grain weight, while number of grains per spike showed no response to split application at any growth stage.

Key words: N-fertilizer, type, application time, yield components, wheat

Introduction

Proper amount and time of fertilizer application is considered a key to the bumper crop. Nitrogen is considered a major element of the fertilizer for a good yield. Nitrogen is closely linked to control the vegetative growth of plant and hence determine the fate of reproductive cycle. Researchers argue that grain yield, grain weight and spikes per unit area reduced (Kelley, 1993) and lodging (Mazurek *et al*., 1992; Ayoub *et al*., 1994) LAI, dry matter production (Das *et al*., 1993; Ragheb *et al*., 1993; Geleto *et al*., 1995) and disease severity (Ugalde *et al*., 1993) increases with higher level of Nitrogen. While many found increased number of spike, grain weight (Ragheb *et al*., 1993; Geleto *et al*., 1995) and grain yield (Singh *et al*., 1992; Ragheb *et al*., 1993; Verma *et al*., 1993; Geleto *et al*., 1995) with increase level of N fertilizer. Time of fertilizer application can affect the N-utilization efficiency by cereals (Ragheb *et al*., 1993). Banziger *et al*. (1994) stated that photosynthetic capacity of the canopy increased with late N application. Latiri *et al*. (1992) observed that maximum level of yield components during wet year with 60 kg N ha^{-1}, when applied at tillering and the start of stem elongation. Ayoub *et al*. (1994) stated that split N application had a little effect on yield, but decreased lodging and spikes population, while grain weight increased. Most of the workers recommended 120 kg N ha^{-1} for wheat (Lathwal *et al*., 1992; Verma *et al*., 1993; Das *et al*., 1993). The objective of this study was to understand the response of yielding components i,e, productive tillers per unit area, grains per spike and grain weight under various level of N-fertilizers at different growth stages.

Materials and Methods

The experiment was conducted at Malakandher Research Farm, NWFP Agricultural University, Peshawar. Two type of N-fertilizers (ammonium sulphate and ammonium nitrate) and 50, 100 and 150 kg N ha^{-1} were applied in sole or split dose (50 kg N ha^{-1} each) at three different stages i.e. sowing, vegetative and boot. Treatments were consisted of control (no nitrogen) and all possible combinations of N levels at various growth stages (Table 1). The experiment was laid out in Randomized Complete Block (RCB) design having four replications with nineteen treatments in each. The plot size was 4 × 2 m, having six rows of 30 cm apart. Wheat cultivar Pirsabak-85 was sown on November 21, 1993.

The number of productive spikes were counted in one meter long row at three different points in each plot and average number of spikes per square meter was calculated. The number of grains per spike was calculated by counting the number of grains of ten randomly selected spikes from each plot. The total number of grains from selected spikes was divided by 10, to get average number of grains per spike. Grain weight was recorded by weighing 1000 grains from each treatment. The data collected were analyzed statistically according to the appropriate design. F-test was used to detect the significance of treatments effect and the LSD was applied for means comparison. ANOVA was further split to understand and compare the means in detail, for which contrasts were done.

Results

All the fertilizer levels significantly produced more spikes per unit area than non fertilized treatments (Table 2). The number of spikes m^{-2} linearly increased with increase in fertilizer level. The highest number of spikes per unit area was produced by the highest level of 150 kg N ha^{-1}. Different types (ammonium sulphate and ammonium nitrate) showed non significant effect on spike population. Application time of N-fertilizer had a significant effect on number of spikes. When 50 kg N ha^{-1} was applied at sowing and vegetative stage, their effect on spike population was significant. At vegetative stage, fertilizer application significantly increased the number of spikes compared to application of fertilizer at sowing. While same dose of fertilizer at sowing or boot stage had the same effect on spike population. A 100 kg N ha^{-1} in a split dose at S1 + S2 produced significantly more number of spikes per unit area than applied at S1 + S3. Control plots produced significantly less grains per spike compared to fertilized plots (Table 3). On average, fertilized plots produced 45 grains per spike as compared to 38 grains per spike from control plots. Fertilizer levels had a significant

Table 1: Details of the experimental treatments

	Type of N			Amount of N (kg ha^{-1})		
	At sowing (S1)	Vegetative stage (S2)	Boot stage (S3)	At sowing (S1)	Vegetative stage (S2)	Boot stage (S3)
T1	0	0	0	0	0	0
T2	AS	0	0	50	0	0
T3	AN	0	0	50	0	0
T4	0	AS	0	0	50	0
T5	0	AN	0	0	50	0
T6	0	0	AS	0	0	50
T7	0	0	AN	0	0	50
T8	AS	AS	0	50	50	0
T9	AS	0	AS	50	0	50
T10	0	AS	AS	0	50	50
T11	AN	AN	0	50	50	0
T12	AN	0	AN	50	0	50
T13	0	AN	AN	0	50	50
T14	AS	AS	AS	50	50	50
T15	AS	AS	AN	50	50	50
T16	AS	AN	AN	50	50	50
T17	AN	AN	AN	50	50	50
T18	AN	AN	AS	50	50	50
T19	AN	AS	AS	50	50	50

AS = Ammonium sulphate AN = Ammonium nitrate

Table 2: Number of spikes per square meter as affected by type, level and application time of N-fertilizers

Treatments-wise data		Means of planned comparisons with statistical significance		
Treatment N kg ha^{-1} Type, Stage	Spikes m^{-2}	Treatment N kg ha^{-1} Type, Stage	Spikes m^{-2}	Contrast $
0 (control)	281	No fertilizer	281	F vs No F *
50 AS S1	308	Fertilizer	347	
50 AN S1	296			
50 AS S2	348	50	325	Linear *
50 AN S2	376	100	351	Quadratic
50 AS S3	300	150	364	
50 AN S3	321			
100 AS S1 + S2	361	AS	341	AS vs AN
100 AS S1 + S3	324	AN	341	
100 AS S2 + S3	377			
100 AN S1 + S2	382	50(AS)	319	50 AS vs 50 AN
100 AN S1 + S3	301	50(AN)	331	
100 AN S2 + S3	363			
150 AS S1 + S2 + S3	370	100(AS)	354	100 AS vs 100 AN
150 AS S1 + S2 AN S3	353	100(AN)	349	
150 AS S1 AN S2 + S3	361			
150 AN S1 + S2 + S3	349	150(AS)	370	150 AS vs 150 AN
150 AN S1 + S2 AS S3	386	150(AN)	349	
150 AN S1 AS S2 + S3	366			
		50at S1	302	S1 vs S2 *
LSD(0.05)	48.3	50at S2	362	S1 vs S3
		50at S3	311	
		50 at S1 + S2	372	S1 + S2 vs S1 + S3*
		50 at S1 + S3	312	S1 + S2 vs S2 + S3
		50 at S2 + S3	370	
		Sole	359	Sole vs Mixture
		Mixture	366	

AS = Ammonium sulphate AN = Ammonium nitrate S1 = At sowing S2 = Vegetative stage
S3 = Boot stage $ = contrasts followed by * are significant at the 0.05 level of probability, others are not significant.

Table 3: Number of grains per spike as affected by type, level and application time of N-fertilizers

Treatments-wise data		Means of planned comparisons with statistical significance		
Treatment N kg ha^{-1} Type, Stage	Grains/ spike	Treatment N kg ha^{-1} Type, Stage	Grains/spike	Contrast $
0 (control)	38	No fertilizer	38	F vs No F *
50 AS S1	45	Fertilizer	46	
50 AN S1	44			
50 AS S2	42	50	43	Linear *
50 AN S2	45	100	45	Quadratic
50 AS S3	42	150	51	
50 AN S3	41			
100 AS S1 + S2	47	AS	45	AS vs AN
100 AS S1 + S3	44	AN	46	
100 AS S2 + S3	44			
100 AN S1 + S2	41	50 (AS)	43	50 AS vs 50 AN
100 AN S1 + S3	50	50 (AN)	43	
100 AN S2 + S3	46			
150 AS S1 + S2 + S3	52	100 (AS)	45	100 AS vs 100 AN
150 AS S1 + S2 AN S3	50	100 (AN)	46	
150 AS S1 AN S2 + S3	51			
150 AN S1 + S2 + S3	54	150 (AS)	52	150 AS vs 150 AN
150 AN S1 + S2 AS S3	50	150 (AN)	54	
150 AN S1 AS S2 + S3	50			
		50 at S1	44	S1 vs S2
LSD(0.05)	7.9	50 at S2	44	S1 vs S3
		50 at S3	41	
		50 at S1 + S2	44	S1 + S2 vs S1 + S3
		50 at S1 + S3	47	S1 + S2 vs S2 + S3
		50 at S2 + S3	45	
		Sole	53	Sole vs Mixture
		Mixture	50	

AS = Ammonium sulphate AN = Ammonium nitrate S1 = At sowing S2 = Vegetative stage S3 = Boot stage
$ = contrasts followed by * are significant at the 0.05 level of probability, others are not significant.

Table 4: Grain weight (g) of wheat as affected by type, level and application time of N-fertilizers

Treatments-wise data		Means of planned comparisons with statistical significance		
Treatment N kg ha^{-1} Type, Stage	1000 grain weight (g)	Treatment N kg ha^{-1} Type, Stage	1000 grain weight (g)	Contrast $
0 (control)	40.8	No fertilizer	40.8	F vs No F
50 AS S1	40.9	Fertilizer	42.9	
50 AN S1	42.2			
50 AS S2	43.4	50	42.6	Linear
50 AN S2	41.3	100	43.0	Quadratic
50 AS S3	44.3	150	43.1	
50 AN S3	43.8			
100 AS S1 + S2	42.3	AS	42.9	AS vs AN
100 AS S1 + S3	43.5	AN	43.1	
100 AS S2 + S3	42.4			
100 AN S1 + S2	44.0	50 (AS)	42.9	50 AS vs 50 AN
100 AN S1 + S3	43.1	50 (AN)	43.1	
100 AN S2 + S3	42.8			
150 AS S1 + S2 + S3	43.4	100 (AS)	42.7	100 AS vs 100 AN
150 AS S1 + S2 AN S3	41.6	100 (AN)	43.3	
150 AS S1 AN S2 + S3	43.9			
150 AN S1 + S2 + S3	44.5	150 (AS)	43.4	150 AS vs 150 AN
150 AN S1 + S2 AS S3	41.8	150 (AN)	44.5	
150 AN S1 AS S2 + S3	43.3			
		50 at S1	41.5	S1 vs S2
LSD(0.05)	1.68	50 at S2	42.3	S1 vs S3 *
		50 at S3	44.1	
		50 at S1 + S2	43.1	S1 + S2 vs S1 + S3
		50 at S1 + S3	43.3	S1 + S2 vs S2 + S3
		50 at S2 + S3	42.6	
		Sole	43.9	Sole vs Mixture
		Mixture	42.6	

AS = Ammonium sulphate AN = Ammonium nitrate S1 = At sowing S2 = Vegetative stage S3 = Boot stage
$ = contrasts followed by * are significant at the 0.05 level of probability, others are not significant.

linear effect on grains per spike. The highest number of 51 grains per spike were recorded from the highest level of 150 kg N ha^{-1}. Type of fertilizers and their application time had no significant effect on grains production. Type of fertilizers and their various levels did not affect the grain weight (Table 4). Among the application time, nitrogen fertilizer at boot stage significantly increased the grain weight. Application of 50 kg N ha^{-1} at boot stage (S3) produced significantly heavier 1000 grain of 44.1 g compared to 41.5 g from S1 treatment.

Discussion

Spikes per unit area is one of the important yield component. Geleto *et al*. (1995) stated that grain yield is closely related to the number of spikes per unit area. The combined effect of N-fertilizer levels, type and application time showed differences for spike population. Fertilized plots produced more spikes than non-fertilized plots. Such response can be attributed to the adequate nitrogen availability which might facilitate the tillering ability of the plants, resulting in greater spike population. Ayoub *et al*. (1994) and Verma *et al*. (1993) reported that spike population increased with increase in nitrogen level. The application of N-fertilizer at vegetative stage increased number of spike per unit area. It is concluded that N-fertilizer at vegetative stage could be the proper time, which provided supporting base for spike formation. Number of grains per spike is the productive efficiency of any cereal crop. Latiri *et al*. (1992) concluded that grain yield was best correlated with the number of grains per unit area. Fertilizer levels showed a significant linear response for number of grains per spike. Number of grains significantly increased with the increase in fertilizer level. This can be justified with a logic that nitrogen availability satisfied the plant requirement for growth and development, which enable the plants to produced more number of grains per spikes. Greater number of grains per spike from increased N-fertilizer rate was also obtained by Geleto *et al*. (1995) and Ayoub *et al*. (1994). Grain weight is highly correlated with photosynthate accumulation. It contributes significantly to the final grain yield. Single dose of 50 kg N ha^{-1} at boot stage significantly increased the grain weight as compared to its application at sowing. This can be attributed to the availability of nutrients at the grains formation stage, which might have enhanced the photosynthetic ability and its accumulation in the grains, resulted in greater weight. Banziger *et al*. (1994) observed greater photosynthetic capacity of the canopy by late N-application. Early application of N may be utilized in the formation of vegetative parts. Ayoub *et al*. (1994) also favored split application of N, which increased 1000 grain weight.

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