Pak. j. sci. ind. res., vol. 32, no. 12, December 1989

EFFECT OF COMBINATION OF SOIL AND FOLIAR APPLICATION OF UREA ON THREE WHEAT GENOTYPES*

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(Received May 25, 1989; revised January 14, 1990)

The performance of three wheat genotypes at different combinations of soil and foliar application of urea applied at the rate of 120 kg N/ha was evaluated. Of the three cultivars, Sind 81 responded significantly ($P<0.05$) to different fertilizer treatments with the highest yield when all N was supplied foliarly. The grain yield of Jauhar 78 and Sarsabz was not stimulated by any fertilizer combination as compared with standard top dressing treatment. The proportion of grain in total dry matter produced and grain protein content were also enhanced significantly ($P<0.05$) by different urea combinations. The increase in protein content over the control varied from 22.3 to 34.6 percent and from 3.7 to 10.1 percent over standard top dressing. Significant genotype x N treatment interactions were found for grain and dry matter yields but not for grain protein content and harvest index.

Key words: Urea, Wheat genotypes, Foliar spray.

Introduction

Foliar spraying has gained widespread practical acceptance in recent years and is often more effective than soil fertilization due to a higher degree of applied nutrient utilization [1,2]. Foliar applications of N have been shown to increase the yield and protein level in many crops including wheat [3–9]. The efficiency of N assimilation through foliage, however, depends upon several factors including variety or genotype [1,10]. The present studies were undertaken to determine the efficacy of this technique in different wheat genotypes.

Materials and Methods

A field study was carried out at AEARC, Tandojam during 1987-88. The soil contained 0.067% N, 1.1% organic matter, 11 mg/kg available P (Olsen's method) and 293 mg/kg available K (1 N NH_4OA_c extractable). The pH and EC x 10^3 of 1:1 soil water extract was 7.8 and 1.15 respectively. The treatments employed in the experiment were as follows.

T_1 = Control (no nitrogen)
T_2 = 120 kg N/ha through soil (standard top dressing)
T_3 = 100 kg N/ha through soil + 20 kg N/ha through foliage.
T_4 = 80 kg N/ha through soil + 40 kg N/ha through foliage.
T_5 = 60 kg N/ha through soil + 60 kg N/ha through foliage.
T_6 = 40 kg N/ha through soil + 80 kg N/ha through foliage.
T_7 = 20 kg N/ha through soil + 100 kg N/ha through foliage.
T_8 = 120 kg N/ha through foliage.

Three wheat genotypes, viz. Sind 81, Jauhar 78 and Sarsabz, were seeded in a randomized complete block design with two factor factorial arrangements. Phosphorus as SSP and Potash in the form of K_2SO_4 were applied as a basal dose of 60 and 30 kg/ha respectively to each plot, which measured 4 x 5 meters. Soil application of fertilizer N in all treatments including standard top dressing (T_2) was made in three splits. One half of the N was applied at sowing and remaining half in two equal parts, each at tillering and flag leaf stages of the crop. A 2% W/V solution of urea mixed with 0.1% V/V Tween 80 was sprayed in three splits using a 10 litre hand compression sprayer. The first spray was applied at tillering stage and subsequent sprays after 15 days intervals. There was not precipitation after foliar fertilization. Total dry matter and grain yields were recorded at harvest. Harvest index (HI) [(wt. of grain/(wt. of grain + straw)] was calculated using yield from 3 x 3 meter samples. Nitrogen content in grain was estimated by the micro kjeldahl method. Grain protein content was obtained by multiplying kjeldahl N by a factor of 5.7 [11,12]. The data were analysed statistically by analysis of variance (ANOVA) and Duncan's Multiple Range test was employed to compute the significance between different treatment means.

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Results and Discussions

Grain yield. Grain yield averaged over cultivars was increased progressively with successive increases in the foliar fraction of fertilizer nitrogen (Table 1). Various urea combinations produced significantly ($P<0.05$) higher yields than the control. When compared with the standard top dressing treatment (120 kg N/ha through soil), significant yield increases were obtained only from treatments T_6, T_7 and T_8. The results closely agree with the findings of Reeves [3], Finney *et. al.*[4], Sadaphal and Das [5], Mosluh *et. al.* [7] and Jagdish and Mosluh [8].

The interaction of genotypes and treatments was significant ($P<0.05$), indicating different response of genotypes to different urea treatments. Among the three wheat cultivars,

TABLE1. EFFECT OF COMBINATIONS OF SOIL AND FOLIAR APPLICATION OF UREA ON GRAIN YIELD OF WHEAT.

Treatments (kg N/ha)	Genotypes			Treatment mean
	Sind 81	Jauhar 78	Sarsabz	
	metric ton/ha			
T1 Control (no N)	2.46 g	2.94 fg	3.07 efg	2.82 e
T2 120 kg Soil	3.56 def	4.22 abcd	4.31 abcd	4.03 d
T3 100 kg S*+20 kg F**	3.79 cde	4.22 abcd	4.41 abcd	4.14 cd
T4 80 kg S+40 kg F	3.81 cde	4.23 abcd	4.64 abc	4.23 bcd
T5 60 kg S+60 kg F	4.16 bcd	4.30 abcd	4.77 ab	4.40 abcd
T6 40 kg S+80 kg F	4.28 abcd	4.50 abc	4.90 ab	4.56 abc
T7 20 kg S+100 kg F	4.38 abcd	4.62 abc	4.91 ab	4.63 ab
T8 120 kg Foliage	4.67 abc	4.71 ab	5.10 a	4.82 a
Genotype mean	3.89 c	4.22 b	4.51 a	

Means sharing same letters do not differ significantly at 5% level of Duncan's Multiple Range test.
*S = Soil application., **F = Foliar application.

Sind 81 responded significantly to various N treatments whereas the grain yield of Jauhar 78 and Sarsabz remained unchanged in all treatments except the control. This indicates that the genotypes differ in ability to assimilate foliar applied N [10]. Visual observations showed that Jauhar 78 was most susceptible to foliar toxicity followed by Sarsabz and Sind 81 respectively. Comparatively higher foliar toxicity in Jauhar 78 and Sarsabz might be the cause for lack of response of these genotypes to foliar applied N. Concordant observations have also been reported by Parker and Boswell [13] and Pool *et. al.* [14]. Sind 81 yielded 4.67 metric ton/ha for the treatment receiving 120 kg N/ha through foliage and was significantly ($P<0.05$) greater than standard top dressing treatment (3.56 metric ton/ha) Significant N fertilization x genotype interaction for grain yield was also observed by Altman *et. al* . [9]. However, other research workers found no differences among genotypes in response to foliar urea applications [3,6]. There were significant ($P<0.05$) differences in the yield of the genotypes. The ranking of genotypes with regard to grain yield was Sarsabz (4.51 metric ton/ha), Jauhar 78 (4.22) and Sind 81 (3.89).

Dry matter yield. Different soil and foliar combinations of urea did not affect dry matter production compared with the top dressing treatment receiving 120 kg N/ha through soil (Table 2). Compared to the control the dry matter yields were significantly higher in all treatments with the maximum yield of 13.84 metric ton/ha when all urea was sprayed on the plant foliage. Analogous results were reported by Sadaphal and Das [5]. There was significant interaction between genotypes and urea combinations indicating apparent differences in response of the three genotypes. The dry matter yields of Sind 81 and Jauhar 78 were not altered, whereas Sarsabz significantly out yielded the top dressing treatment by producing 13.82 metric ton/ha in treatments T_6 and T_7. There were significant ($P<0.05$) differences between cultivars for dry matter production.

TABLE 2. DRY MATTER YIELD OF DIFFERENT WHEAT GENOTYPES AS AFFECTED BY FOLIAR SPRAY OF UREA.

Treatments (kg N/ha)	Genotypes			Treatment mean
	Sind 81	Jauhar 78	Sarsabz	
	metric ton/ha			
T1 Control (no N)	8.76 f	10.69 e	9.44 f	9.63 b
T2 120 kg Soil	12.43 d	14.93 a	12.57 d	13.31 a
T3 100 kg S*+20 kg F**	13.20 bcd	14.51 abc	12.71 d	13.47 a
T4 80 kg S+40 kg F	12.64 d	14.31 abc	13.12 cd	13.36 a
T5 60 kg S+60 kg F	12.78 d	14.31 abc	13.39 bcd	13.49 a
T6 40 kg S+80 kg F	12.78 d	14.44 abc	13.82 abc	13.68 a
T7 20 kg S+100 kg F	12.78 d	14.66 ab	13.82 abc	13.75 a
T8 120 kg Foliage	13.39 bcd	14.38 abc	13.76 abcd	13.84 a
Genotype mean	12.34 c	14.03 a	12.83 b	

Means sharing same letters do not differ significantly at 5% level of Duncan's Multiple Range test.
*S = Soil application., **F = Foliar application.

Maximum dry matter yield of 14.07 metric ton/ha was produced by Jauhar 78 followed by Sarsabz and Sind 81, respectively.

Harvest index (HI). The harvest index did show considerable improvement with different N treatments (Table 3) and serves as a potential indicator of the influence of fertilization on grain production [15,16]. The highest HI value of 0.35 was recorded in the treatment receiving all N through foliage and lowest (0.29) where no N was applied. Interaction between

TABLE 3. HARVEST INDEX (HI) OF DIFFERENT WHEAT GENOTYPES AS INFLUENCED BY FOLIAR SPRAY OF UREA.

Treatments (kg N/ha)	Genotypes			Treatment mean
	Sind 81	Jauhar 78	Sarsabz	
T1 Control (no N)	0.28	0.27	0.32	0.29 e
T2 120 kg Soil	0.29	0.28	0.34	0.30 de
T3 100 kg S*+20 kg F**	0.29	0.29	0.35	0.31 cde
T4 80 kg S+40 kg F	0.30	0.30	0.35	0.32 bcde
T5 60 kg S+60 kg F	0.33	0.30	0.36	0.33 abcd
T6 40 kg S+80 kg F	0.33	0.31	0.35	0.33 abc
T7 20 kg S+100 kg F	0.34	0.31	0.36	0.34 ab
T8 120 kg Foliage	0.35	0.33	0.37	0.35 a
Genotype mean	0.31 b	0.30 b	0.35 a	

Means sharing same letters do not differ significantly at 5% level of Duncan's Multiple Range test.
*S = Soil application., **F = Foliar application.

genotypes and N treatments for this trait was non significant. Data summarized in Tables 1 and 2 revealed that urea sprays significantly ($P<0.05$) increased grain yield of Sind 81 whereas the dry matter yield remained unaffected. The augmentation of grain yield due to urea sprays could be attributed to their effectiveness in increasing the proportion of grain in total dry matter produced. This is in accordance with the observations of Sadaphal and Das [5], who reported appreciable increases in the harvest index of wheat with foliar spray of urea at different concentrations.

Grain protein content. The response of wheat to different urea combinations with regard to percentage of protein in grain was appreciable (Table 4). All N treatments significantly increased the grain protein content over control of no applied nitrogen. The increase varied from 22.3to 34.6 percent. The increase over standard top dressing however, was significant only when urea was applied at the rate of 20 kg N/ha through soil + 100 kg N/ha through foliage or 120 kg N/ha through foliage. Marked increases in grain protein content due to foliar spray of urea have also been reported by Finney *et. al.* [4], Pushman and Bingham [6], Altman *et. al.* [9] and Sharma [17]. There was no fertilizer N x genotype interaction (Table 4) showing almost similar repsonse of genotypes to various N treatments. Moreover, the genotypes under study did not differ in grain protein content. These results differ from the findings of Pushman and Bingham [6], Altman *et. al.* [9] and Dubetz and Gardiner [12]. Different factors have been reported to influence the efficacy of foliar fertilization [1]. The location and genotypes used in our experiment may account for these variations.

TABLE 4. GRAIN PROTEIN CONTENT OF DIFFERENT WHEAT CULTIVARS AS AFFECTED BY FOLIAR SPRAY OF UREA.

Treatments (kg N/ha)	Genotypes			Treatment mean	
	Sind 81	Jauhar 78	Sarsabz		
	% Protein				
T1 Control (no N)	8.32	8.82	9.12	–	8.75 c
T2 120 kg Soil	10.33	10.83	10.94	+(22.3)	10.70 b
T3 100 kg S*+20 kg F**	11.16	11.07	11.07	(26.9)	11.10ab
T4 80 kg S+40 kg F	11.47	11.07	11.12	(28.2)	11.22ab
T5 60 kg S+60 kg F	11.56	11.17	11.23	(29.4)	11.32ab
T6 40 kg S+80 kg F	11.69	11.19	11.23	(29.9)	11.37ab
T7 20 kg S+100 kg F	12.06	11.29	11.34	(32.2)	11.56ab
T8 120 kg Foliage	12.31	11.40	11.63	(34.6)	11.78 a
Genotype mean[n.s]	11.12	10.86	10.96		

Means sharing same letters do not differ significantly at 5% level of Duncan's Multiple Range test.
n.s. = non significant. + = The figures in the parentheses shows percent increase over control., *S = Soil application., **F = Foliar application.

Recommendations regarding the foliar applications of N cannot be made at present. Lack of information regarding optimum rates, time of application and sources and the variability in genotypic response point to the need for additional research.

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