YIELD AND COMPOSITION OF WHEAT AS AFFECTED BY DIFFERENT METHODS AND RATES OF UREA APPLICATION

MOHAMMAD SADIQ, M. ASLAM MIAN AND R. ED. CLARK*

The effect of different rates and methods of urea application on yield and composition of wheat varieties was investigated at West Pakistan Agricultural University, Lyallpur from 1965 to 1967. The grain and dry matter yield of Larma Rajo exceeded Penjamo, C. 271 and Dirk. Band placement of urea between the rows produced more total dry matter, grain yield, protein contents of all the varieties studied thar equivalent rates broadcast. Nitrogen rates (60 and 120 lbs per acre) produced more total dry matter, grain yield and grain proteins than the non-fertilized plots. Application of urea at 60 lbs per acre was more efficient than the 120 lbs per acre. Nitrogen fertilization had a depressing effect on ash, phosphorus and potassium contents of wheat grain.

INTRODUCTION

High yielding varieties of wheat responsive to nitrogen fertilization can alleviate the problem of food shortage to a great extent. Optimum rates of nitrogen have been studied extensively for the prevailing wheat varieties in Pakistan, which are generally tall growing and highly susceptible to lodging at high fertility level, resulting in uneconomical yields. Wahhab and Hussain (1957) and Asif and Larson (1962) obtained maximum yield of wheat grain by broadcast application of 60 lbs. nitrogen per acre as ammonium sulphate before sowing. Higher rates generally result in lodging with adverse effects on yield (Singh, 1954; Iqbal and Wahhab, 1962). However, the recently introduced, short-statured Mexican varieties have the potential of greater response to higher levels of nitrogen fertilization. This potential has not yet been sufficiently explored under the conditions obtaining in West Pakistan.

Urea seems to be a satisfactory source of nitrogen because of its high nitrogen, low cost of transportation, a competitive price and safety. Band placement of fertilizers has been shown to be superior to broadcast method generally practised in this area (Wahhab, 1960; Sabir, 1966). In view of the aforesaid reasons, the effect of different methods and rates of urea application on the yield and composition of recently introduced Mexican varieties was investigated and is reported in this paper.

*Department of Soil Science, Faculty of Agriculture, West Pakistan Agricultural University, Lyallpur.

MATERIAL AND METHODS

The experiments reported in this paper were laid out at the West Pakistan Agricultural University, Lyallpur on sandy clay loam, non-saline, calcareous soils over a period of two years (1965-67). Organic matter, total nitrogen and available phosphorus ranged between 0.67-0.76 per cent, 0.050-0.061 per cent and 10.30-12.50 ppm, respectively, in the surface soil (Table 1). The split plot design consisted of 18 treatments during first year and 24 during second year with three replications each year. The levels of fertilization were: 0, 60 and 120 lbs. nitrogen per acre in urea and 80 lbs. P_2O_5 in superphosphate (19 per cent P_2O_5) as a basal dose. The nitrogen fertilizer was broadcast and

TABLE 1. *Analysis of Soil before Sowing*

Mechanical Analysis

Year	Sand (%)	Silt (%)	Clay (%)	Textural Class
1965-66 ...	71.50	12.58	15.92	Sandy clay loam
1966-67 ...	70.06	13.50	16.44	Sandy clay loam

Chemical Analysis

1965-66	pH	Electrical conductivity m. mhos/cm	Organic matter (%)	Total nitrogen (%)	Available P_2O_5 (ppm)	Cation Exchange capacity (meq/100 gm of soil)	1966-67
0-6"	7.88	2.28	0.67	0.050	10.30	10.00	
	7.72	2.52	0.76	0.061	12.50	11.00	0-6"
6-12"	7.78	1.92	0.54	0.047	9.80	9.80	
	7.78	2.08	0.60	0.054	12.00	10.60	6-12"

banded between the wheat rows spaced 9 inches apart at the time of sowing. Wheat varieties tested were C 271, Larma Rojo, and C 273 in 1965-66 and C 271, Larma Rojo, Penjamo and Dirk during 1966-67. The crop was sown

on different fields after sorghum on Nov. 13 in 1965 and on Oct. 26 during 1966 using a single row drill and harvested in the last week of April during both the years. Three irrigations were applied to the first year and 4 irrigations to the second year crop. The seed rate used for the local varieties (C 271, C273 and Dirk) was 32 seers per acre. Mexican varieties (Larma Rojo and Penjamo) had relatively lower germination capacity, hence 40 seers of seed was sown.

The data on total dry matter and grain yield from each plot were recorded and the grain analysed for ash, crude proteins (NX 6.25), phosphorus and potassium by dry ashing, Microkjeldahl, colorimetric and flame photometric methods, respectively (U.S. Salinity Laboratory Staff, 1954). The data were subjected to analysis of variance and means tested by Duncan's Multiple Range test.

RESULTS AND DISCUSSIONS

1. Effect of Rates and Methods of Urea Application on Dry Matter and Grain Yield of Wheat Varieties.

Varieties did not reveal significant differences in total dry matter during the first year but significant differences were observed during the second year. The earlier sowing date and the extra irrigation in 1966-67 gave the expected greater average total dry matter. In general, Larmo Rojo gave relatively higher total dry matter on account of its greater tillering habit.

Significant increase in dry matter was obtained as a result of band placement of urea as compared to broadcast during both the years. The most efficient and effective placement of fertilizer is that which provides for an adequate supply of soluble nutrients in well-aerated zone of moist soil occupied by actively absorbing plant roots at periods of maximum growth when the demands of plant for nutrients are most acute. The matter of proper placement becomes of increasing importance when higher rates of concentrated fertilizer such as urea are employed. The band placement resulted in greater efficiency possibly because the fertilizer remained in contact with the moist soil for a longer time, because of reduced nitrification of ammonium to nitrate. Leaching losses were reduced by irrigations and because upward movement of ammonium nitrogen might have been retarded as the soil dried out periodically.

Nitrogen rates produced significant differences in total dry matter during both the years. The highest rate, 120 lbs nitrogen per acre, resulted in the greatest increase in total dry matter followed by 60 lbs nitrogen rate, while the lowest yield was recorded in case of unfertilized plots.

The differences in grain yield due to varieties, methods, and rate of fertilizer application were significant during both the years. Highest grain yield was obtained from Larma Rojo and was attributed to its relatively higher

Table 2. *Effects of Rates and Methods of Urea Application on Some Characters of Different Wheat Varieties at Lyallpur**

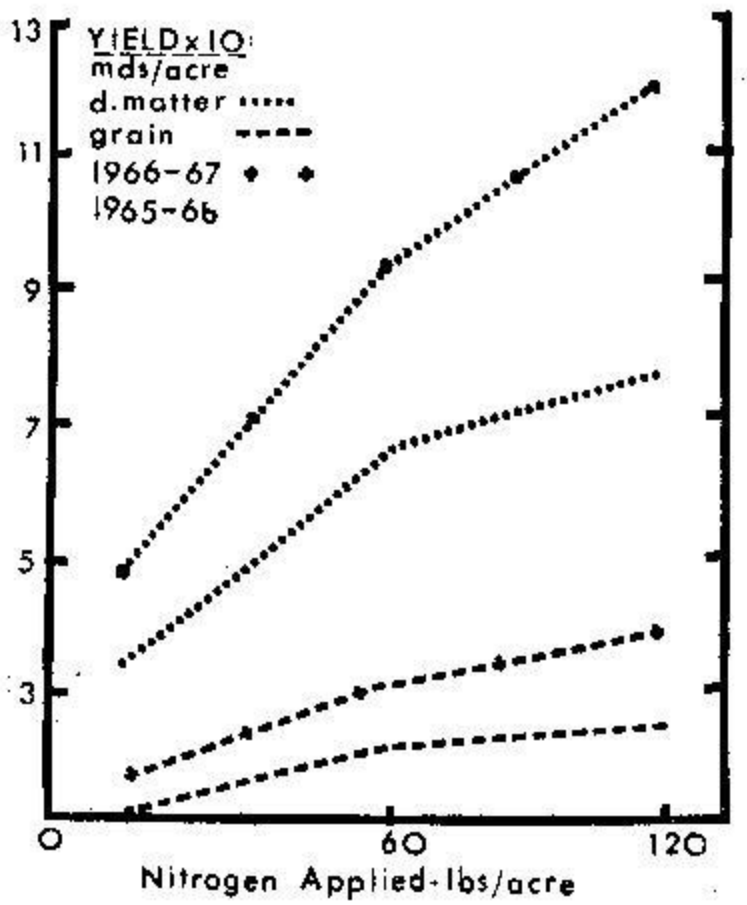
Characteristics and Units	Varieties				Methods		Rates of Fertilizer		
	C 271	Larma Rajo	C 273	Dirk	Broadcast	Band	No nitrogen	60 lbs nitrogen	120 lbs nitrogen
				1965-66					
Total dry matter, mds/acre	53.66	62.90	56.49		56.21*b*	59.16*a**	32.71*e**	64.04*d*	76.30*c*
Grain yield, mds/acre	16.86*b*	21.27*a*	18.26*b*		18.32*d*	19.27*c*	10.89*g*	20.82*f*	24.69*e*
Proteins %	12.44*c*	13.35*a*	12.81*b*		12.76*e*	12.96*d*	11.24*h*	13.24*g*	14.11*f*
Ash %	1.757	1.755	1.788		1.765	1.769	1.847*a*	1.753*b*	1.707*c*
Phosphorus %	0.263	0.263	0.260		0.263	0.261	0.283*a*	0.267*b*	0.236*c*
Potassium %	0.384	0.389	0.388		0.388	0.386	0.403*a*	0.386*b*	0.373*c*
				1966-67					
Total dry matter, mds/acre	81.85*b*	93.47*a*	78.83*b***	91.26*a*	83.11*d*	89.60*c*	46.52*g*	93.32*f*	119.21*e*
Grain yield, mds/acre	26.41*b*	29.80*a*	27.64*b*	27.16*b*	26.76*d*	28.74*c*	15.19*g*	30.14*f*	37.93*e*
Proteins %	12.870	13.68*a*	12.12*c*	12.34*c*	12.64*e*	12.87*d*	11.22*h*	13.15*g*	13.89*f*
Ash %	1.721	1.747	1.756	1.739	1.738	1.744	1.860*a*	1.714*b*	1.649*c*
Phosphorus %	0.250	0.268	0.256	0.258	0.258	0.258	0.280*a*	0.261*b*	0.234*c*
Potassium %	0.389	0.389	0.373	0.396	0.389	0.385	0.409*a*	0.385*b*	0.366*c*

* Averages followed by the same letter are satistically alike at 5 per cent probability level within the same year Non-significant averages are shown without letters.

** Penjamo instead of C. 273.

dry matter yield. Band placement of urea resulted in higher grain yield over the broadcast method. This increase in yield was atttributable to more efficient utilization of nitrogen from the banded fertilizer especially in the grain. Similar observations were also reported by Wahhab (1960) and Sabir (1966). As regards the fertilizer application, all nitrogen rates consistently increased grain yield over control during both the years.

The total dry matter and grain yield increases obtained with 60 and 120 lbs nitrogen rates as urea were consistent during both the years as shown in Fig. 1. The law of diminishing returns fitted the yield response of these three nitrogen rates of urea. Neither the maximum yield nor a yield decline at higher urea rate were found in this study. Search for the "yield maxima" at still higher nitrogen rates would accordingly warrant investigation.



2. Effect of rates and Methods of urea application on the Composition of Wheat Varieties.

Differences in protein content (NX 6.25) of the varieties were significant. The grain of Larma Rojo contained higher protein content than C271, C273, Penjamo and Dirk. The protein content of the grain was higher from the band placement than from broadcast application and increased with the increasing nitrogen rates during both the years. The highest protein contents of 14.11 per cent during first year and 13.89 per cent during second year were obtained with 120 lbs of nitrogen per acre. The grain from the unfertilized plots contained least amount of grain proteins. These observations are suggestive that higher rates of nitrogen resulted in greater nitrogen uptake and synthesis of higher protein content in the grain. Asif and Larson (1962), Iqbal and Wahhab (1962), Wahhab and Hussain (1957), Mehrotra *et al.* (1967) also found greater protein content of wheat grain following the application of higher nitrogen rates.

Table 2 also reveals that varieties and methods of application did not measurably influence ash content of wheat grain which actually was reduced by the higher nitrogen rates. Similar results were obtained by Wahhab and Hussain (1957) and Iqbal and Wahhab (1962) by the application of nitrogen. Nitrogen is recognized to increase the protein content of the fertilized crop. This increase in protein content and possibly of some other organic cellular constituents might have resulted in this observed change in the mineral content of grain by affecting the ratio of inorganic to organic cell constituents. This mechanism of lowering the ash content of fertilized plots as compared to unfertilized plots is called the "growth dilution effect" (Smith, 1962). Similar results of reduction in phosphorus and potassium content of grain were also recorded. Iqbal and Wahhab (1962), Asif and Larson (1962), and Wahhab (1960) also found a decrease in phosphorus and potassium content due to nitrogen fertilization.

LITERATURE CITED

Asif, M., and C. A. Larson. 1962. The relationship of some chemical fertilizer applied to the soil to the composition of wheat and maize grain grown under four different moisture conditions. *Research Studies*, West Pak. Agr. Univ., Lyallpur. **1** : 218-221.

Iqbal, M., and A. Wahhab. 1962. The effect of nutrients on lodging in wheat and its chemical composition and plant characteristics. *Research Studies*, West Pak. Agr. Univ., Lyallpur. **1** : 212-217.

Mehrotra, O. N., N. S. Sinha, and R. D. L. Srivastava. 1967. Studies on nutrition of Indian Cereals. 1. The uptake of nitrogen by wheat plants at various stages of growth as influenced by phosphorus. *Plant and Soil.* **26** : 361-368.

Sabir, B. A. 1966. Fertilizers and their application on wheat. Effect of different rates of fertilizers with different methods of application on the yield of wheat. *M.Sc. Agr. Thesis,* West Pak. Agri. Univ., Lyallpur.

Singh, R. 1954. Effect of excessive nitrogenous manuring on the lodging and yields of wheat. *Current Sci.* **23**: 199-200.

Smith, P. F. 1962. Mineral analysis of plant tissues. *Ann. Rev. Plant phys.* **13** : 81-108.

U. S. Salinity Laboratory Staff. 1954. Diagnosis and improvement of Saline and Alkali soils. *U. S. D. A. Handbook* No. 60.

Wahhab, A. 1960. *Fifty Years of Agricultural Education and Research.* **2**: 26, 43.

Wahhab, A. 1965. *Fertilizer Trials in Farmer's Fields.* Bureau Agr. Inform. West Pak. 55, Lahore.

Wahhab, A. and I. Hussain, 1957. Effect of nitrogen on growth, quality and yield of irrigated wheat in West Pakistan. *Agron. Jour.* **49** : 116-119.