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INFLUENCE OF DIFFERENT AGROCLIMATIC CONDITIONS ON PROTEIN AND TRACE ELEMENT CONTENTS IN TRITICALES

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Four true breeding strains of triticale (NIAB-T-77, NIAB-T-157, NIAB-T-158 and NIAB-T-164) were grown at nine different locations at similar fertilizer level. Differences in the concentrations of protein, and trace elements (Zn, Cu, Mn and Fe) were determined. The soils corresponding to each location also were analysed for pH, EC_e and available Zn, Cu, Mn and Fe. Highly significant differences were obtained among varieties and locations for the variables under study. Similarly the soil characteristics also varied among different locations. Protein contents were markedly higher at two locations i.e. Islamabad, Rawalpindi, than other rainfed and even irrigated sites. Comparatively lower levels of Zn in soil at Islamabad resulted in lower seed-Zn contents. Correlations between mean values of essential nutrients (protein, Zn, Cu, Mn and Fe) and mean yield and mean grain weight with respect to locations, were non significant. Negative correlation existed between protein content and grain weight (r= -0.754).

INTRODUCTION

Triticale is a man made cereal, resulting from a cross between wheat *(Triticum durum)* and rye *(Secale cereale),* which has found increased use as an animal feed. Its importance is gradually expanding due primarily to its higher yield potential [1]. It's use in feed and food products is increasing due to its higher protein and nutritional value than many wheats [2-4]. In view of the potential value of triticale as a food for human consumption, various aspects regarding its commercial cultivation in Pakistan are being investigated at this Institute. Composition of triticale and the parental species, wheat and rye, have been reported [1] however, variation in the environment (Soil-weather) and agronomic factors could exert significant effects on the concentrations of various nutrients [5]. Marked changes in the composition of wheat varieties grown under dry land and irrigated conditions and in different years in Iran have been reported [6,7]. This study was initiated to determine the relative amounts of protein and trace elements in the grains of different strains of hexaploid triticale grown at different rainfed locations in Pakistan.

MATERIALS AND METHODS

The experiment was conducted at nine different locations representing mainly the rainfed areas of the North Western part of Pakistan. Four spring type triticales T-77, T-157 T-158 and T-164 of the same parent "Armadillo" developed at the Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad, were used. The experiments were carried out in a randomized complete block design with four replications with a plot size of (5 X 2 meter). Seed rate in each case was 100 kg/ha and the fields were uniformly fertilized at the rate of 90-67 NP kg/ha broadcasted at seeding. Only one trial at Govt. farm-Gujranwala received three irrigations while the rest depended on rains received during the growth period.

At maturity the crop was harvested to record data on yield, and from each treatment 100 g. sample was ground in a stainless steel mill and stored in plastic bags until analysed. Protein (N x 5.7) and moisture were determined by AACC methods [8]. The grain samples were digested in $HNO_3/HCLO_4$ by a modification of the method described by O' Dell *et al.* [9] . Concentrations of Fe, Zn Cu and Mn were determined on a Beckman Model 485 atomic absorption spectrophotometer. Soil samples from respective locations were taken from two depths i.e. 0–15, 0–30 cm and stored in plastic bags and analysed for pH, EC_e (saturated paste extract) and available Fe, Zn, Cu and Mn (DTPA extract) [10, 11].

Data for the characters in each treatment were subjected to the analysis of variance and means compared using LSD at the 5% probability level [12].

RESULTS AND DISCUSSION

Table 1 shows the characteristics of the soils for pH, EC_e and Zn, Cu, Mn and Fe contents for each location where the trials were conducted. At both depths the pH of

the soil ranged from 7.15–8.30, and in most of the cases EC_e ranged from 0.35–0.91 mmhos cm^{-1}. However, the EC_e values for soils of Muzzaffarabad and Gujranwala were comparatively higher (5.90 and 1.90 mmhos cm^{-1} respectively) upto a depth of 15 cm. As for the DTPA-extracted elemental concentrations of the soils, the range values were 0.14–3.20 ppm Zn, 0.25–2.60 ppm Cu, 10.8–65.10 ppm Mn and 7.30–75.60 ppm Fe. Viets and Lindsay [13] have reported 0.5 ppm DTPA-Zn, 0.2 ppm DTPA-Cu, 2.5 ppm DTPA-Fe and 1.0 ppm DTPA-Mn minimum levels of these elements in the soil for normal crop growth. For calcareous soils, the critical limits for Zn and Cu have been reported as 0.34 ppm and 0.86 respectively [14]. Considering the reported critical values, most of these soils appear to be deficient in Zn and Cu whereas adequate in the contents of Mn and Fe. Factors such as presence of other cations, organic matter, pH and soil depth also contribute in the differential absorption of mineral elements to the plant. A decrease in the availability of some elements with the increase in the soil pH and decrease in the organic matter have been reported [15].

Concentrations of protein and mineral elements (Zn, Cu, Mn and Fe) in various triticale strains for different locations are presented in Tables 2 and 3. There were significant variations ($P < 0.01$) in the concentration of these nutrients in each strain of triticale and also in respect to every location. Varietal variation in protein at different locations ranged from 9.43–16.25% and for Zn from 15.3–44.0 ppm, for Cu from 5.3–8.5 ppm, for Mn from 30.6–55.4 ppm and for Fe from 45.6–202.1 ppm. The coefficient of variation values for concentration of these nutrients in each triticale strain in relation to the locations exhibited greater variation in the contents of Zn and Fe than protein, Cu and Mn. It was interesting to note that the amounts of protein, Mn and Fe were comparatively higher while Zn contents were lower in the triticale grain harvested from Rawalpindi and Islamabad than that from other locations. The strains having the lowest values for protein were those grown at Gujrat and Muzzaffarabad. Comparative concentrations of Zn in the soil and the grains in relation to the locations (Islamabad, Muzzaffarabad) is an instance of soil–plant grain relationship, which warrants special attention.

The protein contents and mineral composition of triticales and wheats have been reported previously [4,9,16,17]. Many of these analyses were conducted on samples of unknown origin without information about the soil and climatic factors. Although the influence of variety, irrigation, fertilizer and soil on the protein and mineral contents of wheat is available [5,18,19] such an information is lacking for triticale. For Iranian wheats, it has been reported

Table 1. Characteristics of soils under dry land and irrigated conditions.

Location-district	Soil depth (cm)	pH (saturated paste)	EC x 10^3 (mmhos cm^{-1})	Zn	Cu	Mn	Fe
				ppm			
Government Farm,[a]	0-15	8.10	1.90	3.20	–	65.10	12.40
Gujranwala	0.30	7.90	0.86	1.40	–	25.20	12.80
Marala, Sialkot	0-15	7.80	0.59	0.26	1.55	25.20	35.70
	0-30	8.00	0.74	0.20	1.50	21.00	21.00
Dolat Nagar, Gujrat	0-15	7.20	0.26	0.46	2.15	54.60	75.60
	0-30	7.15	0.35	0.36	1.55	37.80	35.70
Govt. Farm-Heer, Mirpur.	–	–	–	–	–	–	–
Dina, Jhelum	0-15	7.80	0.91	0.38	1.15	14.70	25.2
	0-30	8.30	0.62	0.34	0.70	10.80	–
Mangla, Mirpur	0-15	7.25	0.57	0.34	0.25	23.10	9.50
	0-30	7.30	0.49	0.20	0.30	14.70	7.50
Wheat Res. Station,	0-15	7.20	0.44	0.24	0.55	27.30	14.00
Rawalpindi	0-30	7.65	0.44	0.22	0.50	18.90	7.50
Pak. Agric. Res. Council,	0-15	7.80	0.82	0.19	0.50	14.70	10.40
Islamabad	0-30	7.70	0.52	0.15	0.40	16.80	7.30
Govt. Farm, Chattar-	0-15	7.70	5.90	2.40	2.60	52.50	29.40
Kalas, Muzzaffarabad	0-30	7.60	6.80	1.44	2.35	32.60	21.00

a) Only irrigated site.

Table 2. Concentration of protein, Zn and Cu in grains of triticales grown under dry land and irrigated conditions[1].

Location-district	Protein (%)				Zn (ppm)				Cu (ppm)			
	T-77	T-157	T-158	T-164	T-77	T-157	T-158	T-164	T-77	T-157	T-158	T-164
Govt. Farm[a], Gujranwala	14.41	14.85	12.03	13.57	32.8	31.7	33.0	33.3	6.4	6.7	5.8	6.3
Marala, Sialkot	12.35	12.87	10.89	12.01	23.6	23.6	24.2	23.7	5.47	5.6	5.9	6.0
Dolat Nagar, Gujrat	9.43	13.17	12.98	11.83	28.2	34.7	30.9	35.0	5.5	6.9	5.8	5.5
Govt. Farm Heer, Mirpur	12.30	13.04	12.22	12.40	23.4	25.6	23.9	23.6	5.4	5.9	6.6	5.0
Dina, Jhelum	12.12	12.54	14.16	13.09	38.7	34.6	33.4	34.8	8.5	6.8	7.5	6.9
Mangla, Mirpur	13.13	12.52	11.71	12.18	32.9	28.5	30.2	32.7	6.6	5.5	6.3	6.4
Wheat Res. Station, Rawalpindi	15.55	16.25	14.55	14.66	37.6	35.5	36.7	38.0	7.4	7.5	7.3	6.2
Pak. Agri. Res. Council, Islamabad	14.72	14.68	14.36	14.75	21.7	17.1	17.8	15.3	1.7	6.8	6.3	6.6
Govt. Farm Chatar-Kalas, Muzzaffarabad	11.61	12.99	13.00	11.11	43.9	44.5	38.1	34.7	6.9	5.7	5.3	5.3
Average	12.85	13.66	12.88	12.84	31.4	30.6	29.8	30.1	6.7	6.4	6.3	6.1
C.V. %	14.46	9.48	9.95	9.80	24.7	26.1	22.2	24.9	16.6	10.8	11.6	10.5
LSD 5%, Variety means within a location	0.40					1.78					0.72	
Locations means for variety	0.41					1.77					0.79	

a) Only irrigated site. 1-As is basis; Mean moisture 10.6%.

Table 3. Concentration of Mn, Fe and mean yield of triticale grains under dry land and irrigated conditions.

Location-district	Mn(ppm)				Fe(ppm)				Mean-yield and Grain weight	
	T-77	T-157	T-158	T-164	T-77	T-157	T-158	T-164	Yield kg/ha	Weight g/1000 grains
Govt. Farm, Gujranwala[a]	30.6	31.2	34.8	32.5	57.6	52.6	53.4	54.0	4559	32.3
Marala, Sialkot	35.0	35.6	36.9	33.8	61.5	55.5	56.8	61.2	4050	36.6
Dolat Nagar, Gujrat	39.2	33.7	30.5	31.8	52.9	61.1	45.6	55.8	4028	37.1
Govt. Farm, Heer, Mirpur	39.2	37.4	36.6	32.5	62.8	55.6	53.9	52.8	5035	37.3
Dina, Jhelum	38.2	32.6	32.7	33.4	66.0	53.3	103.4	57.8	4035	36.0
Mangla, Mirpur	51.7	44.6	47.9	50.1	77.7	54.0	66.0	69.3	3935	36.0
Wheat Res. Stat. Rawalpindi	42.6	37.9	43.0	37.9	93.4	61.2	59.6	104.1	4706	34.1
Pak. Agri. Res. Council, Islamabad	55.4	48.4	50.0	44.3	111.6	105.0	124.3	202.1	3909	39.8
Govt. Farm, Chattarkalas Muzzaffarabad	51.1	52.8	47.4	38.3	62.8	67.0	58.7	64.3	4292	37.5
Average	42.6	39.3	39.9	37.1	71.8	62.8	69.1	80.2	–	–
C.V. %	19.6	19.3	18.0	17.1	26.7	26.3	38.3	60.3	–	–
LSD 5%, Variety means within a location			2.6				10.2			
Location means for varieties			2.8				10.1			

(a) Only irrigated site. 1) As is basis; Mean moisture 10.0%.

that when wheat varieties were grown under dryland conditions, the grain yield and the concentrations of total P were significantly reduced while concentrations of Ca and Mg were higher as compared to the crop grown under irrigated conditions. The values of Zn and Fe were not affected. In the present study, the yield of grain and the grain weight of four triticales grown at different locations (irrigated and dryland) showed significant differences for all the parameters involved. The correlations of mean triticale values for protein, Zn, Cu, Mn and Fe with mean yield and grain weight also were determined in order to find an overall association, if any, among these characters. The correlation coefficients of nutrients (Zn, Cu, Mn and Fe) with yield and grain weight were non-significant. However, the correlation between protein content and grain weight was found to be negatively significant (r=–0.754) indicating a possible relationship between these factors. Johnson *et al.* [20] have reported that except under very high soil nitrogen conditions, high yields are usually associated with depressed protein content of the grain.

Although the comparison of the composition data with the corresponding yields of triticale for each location did not indicate a clear-cut association for all the factors, however, relatively low contents of Zn in the soil could be one of the causes of low yield and low Zn contents in grain. Studies of uptake and translocation of micronutrients in plants have their own merits, however, selection and development of crop varieties which could effectively extract micronutrients from deficient soils, is imperative. In this study the averages of each constituent in relation to the location shown at the bottom of the tables though significantly different, are practically alike in respect to the development of protein and in capacity to extract trace elements from soil.

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