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FORAGE AND GRAIN PRODUCTION DYNAMICS OF *TRITICALE* SOWN ON DIFFERENT DATES UNDER IRRIGATED CONDITIONS

SUMMARY

To study the forage and grain production dynamics of *triticale*, a trial was c arried out having four genotypes planted on three different dates under irrigated conditions at Dera Ismail Khan, Pakistan (31°49'53"N 70°54'7"E). All the four genotypes were of different pedigree/parentage background. Trial was laid out in split-plot design with genotypes in main plots while dates of sowing in sub-plots. The trial was replicated three times. First date of sowing started with planting the genotypes on Oct. 25 (T_1) followed by Nov. 15 (T_2), and Dec. 05 (T_3). All the genotypes planted at each date were harvested 50 days after planting. The results showed that the earliest planting produced significantly the highest green forage yield, maximum plant height and grain spike^{-1}. However, grain yield remained similar statistically when planted the *Triticale* on different dates. Comparing the results of four genotypes studied, it was observed that each genotype behaved significantly different for green forage yield, days to 50% heading, plant height, tiller m^{-2}, grains/spike, 1000-grain weight and bio-mass yield. Genotypes 3 and 4 produced maximum green forage yield i.e. 3.70 and 3.65 t ha^{-1}, respectively, however differences among the four genotypes for grain yield were found non-significant statistically. Net Photosynthesis Rate and Chlorophyll content recorded for all genotypes and dates of sowing remained similar statistically. The highest Benefit-Cost ratio (3.23) was calculated for gynotyp-4 when planted on the earliest dates i.e. Oct-05. It was, however, observed that net benefit decreased with delay in each planting date irrespective of the genotypes.

Keywords: *Triticale*, Sowing Dates, Genotypes, Forage Yield, Grain Yield.

INTRODUCTION

Triticale (*Triticosecale*) is a self-pollinated cereal crop belongs to the family *Gramineae* or *Poaceae* and is similar in appearance with wheat. It is a crop having maximum protein and is used for grain as well as forage purposes in many parts of the world. Wojtkowiak *et al*. (2015) reported that the highest grain and protein yield of Milewo variety spring triticale was obtained after the

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application of nitrogen fertilization at the rate of 120 kg ha^{-1}. In Pakistan it is normally cultivated in cool and dry rabi season in some districts of KPK (from November to March) when small growers face severe shortage of hay in the month of November to March, usually obtain 6 to15 t/ha green fodder of triticale. Green triticale fodder contains approximately 25% crude protein, grains and straw are extremely nutritive feedstuffs (Ahmed and Meisner, 2002). It has potential to give maximum yield under drought condition as compared to wheat crop due to it's well develop root system. Thus the use of triticale for dual purpose was known as an exhilarating new choice for green fodder and grain production (Ahmed and Meisner, 2002). Triticale produces more fresh fodder, approximately 20%, than wheat and is rich in quality than rye or wheat (Koch and Paisley, 2004). Acar *et al.* (2011) observed that the assessment of total yield obtained at the end of the experiment showed that the highest hay yield was realized at the milk dough stage with 500 or 650 seed m^{-2} of triticale. It is used in the preparation of alcoholic drinks and other bakery products. The only disadvantage of the triticale is that its floor could not be made in to bread alone because of lower gluten content in it. It can be used as sustainable agriculture crop by rotating it with vegetable and other cereal crops. Triticale is a long day crop and produces maximum tillers and other yield components when it is planted on optimum sowing date. Tillering in triticale increases when temperature rises and days become long (Wladyslaw and Bogdan, 2012). Late sowing of winter cereal never allows plant to produce maximum number of tillers. Normal planting of triticale like wheat crop gives high grain yield due to the availability of long photo period and optimum grain filling duration. Both the varieties and sowing time significantly affect the yield and yield parameters of triticale. On the other hand, late planting not only reduces forage yield but the grain yield as well. Triticale varieties were planted on various sowing dates on two different seasons due to delaying in both season grain yields was adversely affected. Early planted (Nov. 15- December-01) showed more hay yield and late planted (from Nov. 15 to Dec. 15), which affected grain yield up to 22.9% - 46.07% respectively (El-Metwally *et al.*, 2012). Being a new crop (in Dera Ismail Khan, KPK. Pakistan), no work has been done on triticale agronomic management for fodder or grain production. Therefore, the present study is being conducted to evaluate the various genotypes production potential under different sowing dates under agro-ecological condition of D.I. Khan.

MATERIAL AND METHODS

The experiment was conducted in a randomized complete block design with split plot arrangement having three replications during 2013-2014 in Pakistan. The net plot size was 1.8 m x 5 m (9 m^2) with six rows, 5 m long and 30 cm apart. The main plots consist of three sowing dates while the triticale genotypes were assigned to sub-plot. Total six (6) numbers of irrigations were applied by canal water throughout the life of experimental period. All the culture practices and recommended doses of NPK were applied accordingly. The 100 kg

ha^{-1} seed rate was used for sowing of experiment. Sowing dates were: Oct. 25, Nov. 15, and Dec. 05. Four genotypes tested were as follow with given pedigree record.

Table: Factor B (Genotypes) sub- plot

Triticale Line	Pedigree/Parantage
Genotype 1	POLLMER_1.2//ANOAS_5/STIER_13/4/GAUR_2/HARE_3//JLO97/CIVET/3/ ARDI_1/TOPO 1419//ERIZO_9 CTSS00B00127S-0M-9Y-010M-1Y-2M-0Y
Genotype 2	POLLMER_2.2.1*2//FARAS/CMH84.4414 CTSS99B00990F-0TOPY-0M-2Y-2M-1Y-1M-0Y
Genotype 3	ALPACA_1/3/ZEBRA 31/CIVET//URON_ 5/7/CIN/PI//PATO/3/BGL/4/DRIRA/5/ DLF99/3/M2A/SNP//BGL/4/TESMO_1 /6/FAHAD_1/8 /GAUR_3/ANOAS_2//BANT_1CTSS01Y00781T-0TOPB-7Y-010M-7Y-10M-0Y
Genotype 4	DAHBI/3/FAHAD_8-2*2//PTR/PND-T/7/LIRON_2/5/DISB5/3/SPHD/PVN// YOGUI_6/4/KER_3/6/BULL_10/MANATI_1 CTSS02Y00771S-040Y-5Y-3M-0Y

Data were collected for forage yield (t ha^{-1}), chlorophyll contents (µ g cm^{-2}), net photosynthesis rate (µ mole m^{-2} sec^{-1}), number of tillers (m^{-2}), number of grains ($spike^{-1}$), 1000- grain weight (g), biological yield (t ha^{-1}), grain yield (t ha^{-1}) and harvest index (%). The data were analyzed statistically by using the analysis of variance technique and subsequently least significance test (LSD) were applied for comparing the treatment means using computer software (Statistix version 9).

RESULTS AND DISCUSSION

The data presented in Table 3 regarding forage yield indicated that sowing dates, triticale genotypes/lines and their interaction showed significant variation among the treatment means. Data regarding interaction clearly indicated that line 3 produced maximum (7.29 t ha^{-1}) green forage yield on D1 (Oct. 25) followed by (6.70 t ha^{-1}) in line 4 on the same date D1, where as the lowest (1.33 t/ha^{-1}) green forage yield was noted in line 3 when planted on D3 (Dec. 05).The lowest green forage yield in the late sowing dates may be due to less vegetative growth period from sowing, that resulted in lower canopy development of the triticale lines. The higher green forage yield among the genotypes/lines may be due to the genetic potential for rapid growth during the early stages which got maximum time for vegetative growth.

Four different lines of *Triticale* showed significant differences for various yield and yield contributing parameters (Table 1). Line-3 and Line-4 produced maximum forage yield of 3.67 and 3.65 t ha^{-1}. Chlorophyll content remained same for all the lines tested, however, Line-1 found to be more efficient than other showing maximum chlorophyll content of 52.19. Similarly net

photosynthesis rate was recorded the same for all lines. Line-1 significantly took maximum number of days (106) in producing 50% heading as compared to all other lines which took statistically similar number of days to 50% heading. Line-2 produced the tallest plants with height of 113.13 cm while all other lines had statistically similar plant height. Maximum numbers of tillers were produced by line-3 and line-4 i.e. 247.36 and 255.52 tillers m^{-2}. The highest number of grains $spike^{-1}$ was produced by line-1 (60.56) while minimum grain spike were produced by line-3 (48.56 grains $spike^{-1}$). Line-1 and Line-2 produced highest 1000-grain weight with 44.91 and 45.48 g, respectively. Biological yield remained similar statistically for all lines tested (Table-1). Grain yield was also found similar statistically for all lines. Harvest Index was maximum (41.69%) for line-4 and minimum for line-3 (36.55%). Similar biological yield, grain yield in all the lines test might be due to start of rains (favorable environment) during the final grain filling stage, which prolonged to more than a month, in which the late planted lines recovered their photosynthates which otherwise might be much lower if the season remained normal (dry and hot).

Table 2. Yield and other parameters as influenced by three sowing dates

Parameters	Date of sowing		
	Oct-25	**Nov-15**	**Dec-05**
Forage Yield (t ha^{-1})	6.3609 a	2.2593 b	1.4077 c
Chlorophyll content	49.783ab	46.750b	53.175a
Net Photosynthesis Rate (Pn)	54.083	36.683	25.283
Days to 50% heading	110.92 a	102.17 b	99.50 b
Plant height (cm)	117.74 a	121.13 a	109.60 b
Tillers (m^{-2})	224.91	228.33	227.89
grains ($spike^{-1}$)	56.750 a	50.833 b	53.167 b
1000- grain weight (g)	44.943	43.829	41.293
Biological yield (t ha^{-1})	14.544 a	15.099 a	11.342 b
Grain yield (t ha^{-1})	5.6813	5.0405	4.9584
Harvest Index (%)	39.068ab	33.641 b	44.238 a

Means followed by different letters in respective column are significant ($P<0.05$)

Interaction between the two factors was found non-significant for all the parameters studied except forage yield (Table 3). Maximum forage yield of 7.29 t ha^{-1} was obtained from D1L3 followed by D1L4 (6.70 t ha^{-1}), D1L2 (6.16 t ha^{-1}) and D1L1 (5.28 t ha^{-1}). The plausible reason for higher green forage yield in early planting might be due to more available time for vegetative growth and development which accumulated more food and attained maximum height and gave the maximum forage yield as compared to late planted lines which remained smaller in height due to low temperature during the month of December and January.

Economic Analysis

Economic analysis of the data regarding different triticale genotypes sown at various dates has been presented in Table 4. The highest net income of Rs.

155800 was received from the sale of green fodder (GF) and grain yield (GY) of triticale in treatment T4 (D1L4), followed by T1(D1L1), T2(D1L2) and T3(D1L3) with Rs. 132,200/-, 122,150/- and 117, 950/-, respectively. The least net income of Rs. 71,700/- was recorded in treatment T9 (D3L1). The data regarding benefit cost ratio (BCR), the maximum BCR of 3.23 was recorded in T4 (D1L4) followed by T1(D1L1), T2 (D1L2) and T3 (D1L3) 2.8 ,2.75 and 2.69 respectively, while the least BCR of 2.02 was recorded in T9 (D3L1).

Table 3. Interactive effect of sowing dates and *Triticale* lines for yield and yield parameters

Treatments	Forage Yield t ha^{-1}	Chlorophyll content	Net Photosyn. Rate (Pn)	Days to 50% head.	Plant height (cm)	tillers (m^{-2})	grain (spike^{-1})	1000-grain weight (g)	Biolog. yield (t ha^{-1})	Grain yield (t ha^{-1})	Harv. Index (%)
D1L1	5.28 d	48.47	35.77	111.00	116.27	183.55	68.00	46.57	15.19	5.87	38.45
D2L1	1.41 g	54.47	43.80	105.00	116.73	197.77	58.33	44.79	17.02	5.14	23.23
D3L1	1.41 g	53.63	20.67	103.00	106.40	186.89	55.33	43.38	10.54	4.49	43.05
D1L2	6.16 c	51.63	51.37	112.00	124.21	213.65	54.00	46.79	13.93	5.39	39.25
D2L2	2.33 f	45.67	49.67	103.33	128.43	227.66	51.67	46.80	15.63	5.49	35.13
D3L2	1.48 g	54.73	30.97	98.00	113.98	206.33	53.67	42.75	10.30	4.70	46.96
D1L3	7.29 a	48.60	58.00	111.67	116.37	244.99	50.33	41.14	13.62	5.05	37.25
D2L3	2.47f	39.03	28.17	99.00	119.22	245.66	43.67	41.14	14.42	4.44	30.69
D3L3	1.33 g	54.03	29.27	98.33	109.36	251.44	51.67	40.11	12.48	5.21	41.72
D1L4	6.70 b	50.43	71.20	109.00	114.13	257.44	54.67	45.28	15.43	6.41	11.32
D2L4	2.83 e	47.83	25.10	101.33	120.13	242.22	49.67	42.59	13.33	5.10	38.52
D3L4	1.41 g	50.30	20.23	98.67	108.67	266.89	52.00	38.93	12.05	5.43	45.22

Means followed by different letters in respective column are significant (P<0.05)

Table 4. Benefit Cost Ratio (BCR) of triticale grain and green fodder yield as affected by various sowing dates

Treatment	Cost of Production	GFY	Grain Yield	Income (Rs:)		Total Income	Net Income	BCR
				Green fodder	Grain yield			
T1(D1V1)	70,000	5.28	5.86	26400	175,800	202,200	132,200	2.89
T2 (D1V2)	70,000	6.15	5.38	30750	161,400	192,150	122,150	2.75
T3(D1V3)	70,000	7.29	5.05	36450	151,500	187,950	117,950	2.69
T4 (D1V4)	70,000	6.7	6.41	33500	192,300	225,800	155,800	3.23
T5 (D2V1)	70,000	1.41	5.14	7050	154,200	161,250	91,250	2.30
T6 (D2V2)	70,000	2.32	5.48	11600	164,400	176,000	106,000	2.51
T7 (D2V3)	70,000	2.46	4.43	12300	132,900	145,200	75,200	2.07
T8 (D2V4)	70,000	2.83	5.09	14150	152,700	166,850	96,850	2.38
T9 (D3V1)	70,000	1.4	4.49	7000	134,700	141,700	71,700	2.02
T10 (D3V2)	70,000	1.48	4.7	7400	141,000	148,400	78,400	2.12
T11 (D3V3)	70,000	1.33	5.2	6650	156,000	162,650	92,650	2.32
T12 (D3V4)	70,000	1.4	5.4	7000	162,000	169,000	99,000	2.41

Market price for green fodder/kg = Rs: 5/- (Pakistani rupees)
Market price for grains/kg = Rs: 30/- (Pakistani rupees)

CONCLUSIONS

It can be inferred from the data in Table 4 that the late planted treatments (D2 and D3) gave lower yield of green fodder thus resulted in low net return and BCR, respectively. Hence it is recommended that the treatments (T4, T1, T2, and T3) with reasonable BCRs are the most suitable combinations of early sowing dates (Oct. 25) for excellent fodder and grain yield.

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