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Genotypic responses of pearl millet to integrated nutrient management

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Field experiments were conducted in two successive summer seasons to find out the genetic responses of pearl millet to integrated nutrient management with complete block design in four replicates. Treatments included three pearl millet genotypes *viz.,* Gizani, FH-50 and Shandaweel-1 and nine fertilization treatments *viz.,* recommended dose of NPK fertilizer (150:150:60 kg ha^{-1}), three types of compost manure (10 % cow , 10 % poultry and 10 % camel and sheep manure (10 t ha^{-1}), mixture of the three types (10 t ha^{-1}), mixture of the three types (10 t ha^{-1}) + 75 % of recommended dose of NPK, mixture of the three types (10 t ha^{-1}) + 75 % of recommended dose of NPK + Bio fertilizer (*Rhizobium*), mixture of the three types (10 t ha^{-1}) + 50 % of recommended dose of NPK and mixture of the three types (10 t ha^{-1}) + 50 % of recommended dose of NPK + Bio fertilizer. Results showed that FH-50 recorded highest values during different growth stages for yield parameters including plant height, stem thickness, number of tillers, leaf stem ratio, leaf area index, green and dry fodder yield. Similarly, nutrient concentrations and quality traits were also higher for FH-50 than the two other genotypes. Furthermore, the combination of mixture of the three types of manures 10 t ha^{-1} + 75 % of NPK fertilizer + bio fertilizer recorded the highest values for different growth, yield and quality traits, followed by mixture of the three types manures 10 t ha^{-1} + 50 % of NPK fertilizer + bio fertilizer. Finally, results highlighted that, combined use of organic fertilizers with inorganic, instead of sole application of inorganic fertilizers produced higher forage and grain yield as well as better quality traits in pearl millet.

Keywords: Biofertilizer, Organic manure, Nutrient management, Forage crop, Inorganic fertilizers.

INTRODUCTION

Pearl millet (*Pennisetum glaucum* (L.) is an important grain crop ranking sixth important cereal crops, (Henry and Kettlewell, 1996; Singh et al. 2003), it is grown especially in drought-prone semi-arid regions of Africa and Southeast Asia (Baltensperger, 2002 and Selim, 2008). The crop is cultivated as double purpose crop, for grain and fodder use (forage). It has great potential to grow in low fertile soils with low moisture contents, as compared to other summer cereal crops like maize or sorghum (Tabosa et al. 1999; Ali, 2010).

Early studies were carried out by Selim, (2008) aimed at comparing pearl millet with Sudan grass grown under limited environment, who found that Pearl millet surpassed Sudan grass in fresh weight (6.56 t/ha) and dry yield (2.91 t/ha), achieved an increase 8.89 % and 5.26 % , respectively, more than Sudan grass. As regards the forage quality, Pearl millet had good digestibility and was lower in fiber than Sudan grass. Although, pearl millet can successfully grow in low soils nutrients content , but can produce appreciable yield with adequate nutrients supply (Maman et al. 2000; Selim, 2008), keeping in consideration that applications of chemical fertilizers have caused ecological problems, and degraded soil physio-chemical and biological qualities thereby lead to poor crop yields (Swarup, 2002). Likewise, application of inorganic fertilizers alone in large quantities over a long period of time resulted in imbalance supply of other nutrients (Kanzaria et al. 2010). Most of the soil applied chemical fertilizers leach down below the root zone or into the ground water, which pollute the ground water and causing diseases mainly “Methemoglobinemia” (Choudhry and Kennedy 2005). Further, an imbalanced continuous use of fertilizers may result in micronutrient deficiencies, which is becoming a major constrain for productivity, stability and sustainability of soil health (Yadav and Meena, 2009).Organic manure and different microbial strains led to reduction in usage of chemical fertilizers being cost effective and has provided high quality product free of harmful agrochemicals for human safety (Kumudha, 2005; Kumudha and Gomathinayagam, 2007; Amudha et al. 2014). Integrated nutrient management practices receive worldwide great attention. These practices reduce the dependence of costly inorganic fertilizers, the degradation of the soil properties and in the same time improves economic returns from the green manure (Thiessen Martens and Entz 2011). Compost producing from recycling agriculture wastes is integration in organic systems has been suggested as a mean to recycle and transfer most nutrients from plant material to rumen and back to the soil in more available forms. Similarly, plant demand for P and K increases with increasing availability of N and needs solution (Kayser and Isselstein, 2005; Fortuna et al. 2008). Likewise, integration nutrient supply of chemical fertilizer, organic fertilizer or biofertilizer has advantages for crop growth, additionally its ecofriendly (Ghadge et al. 2013; Javed and Panwar, 2013 and Sabrina et al. 2013). The advantages need to be integrated in order to make optimum use of each and achieve balanced nutrient management for optimum crop growth. The present study was therefore, planned to find out the effect of different integrated nutrient management practices on the growth, grain and forage yield as well as quality traits of some pearl millet genotypes that maintain a stable yield across the low soil fertility and drought stressed conditions of Saudi Arabia.

MATERIALS AND METHODS

Description the experimental site and plant material

Three pearl millet genotypes *viz.,* Gizani, FH-50 and Shandaweel-1 were procured from commercial supplying companies in Riyadh City. Experiments were carried out at Agriculture and Research Station, College of Food and Agriculture Sciences, Derab, near Riyadh, King Saud University, Saudi Arabia (24^{o}42 N latitude and 46 ^{o} 44 E Longitudes, Altitude 600 m), during summer season of 2015 and 2016. The climate of the experimental region is characterized by low rainfall, high evaporation rates and high temperatures during summer accompanied by high relative humidity. Mean annual temperature is 39 ºC with maximum air temperature reaching as high as 48ºC during the summer period. Mean relative humidity in the region is 13%, with a maximum of 17%, mean annual rainfall 1.25 mm during summer season.

Soil and water analyses

Table 1: Physio-chemical properties of the experimental site (mean of two seasons).

Properties	value
pH	8.16
Saturation percentage (%)	29.70
EC (dS m^{-1})	3.88
Organic matter (%)	0.46
$CaCO_3$ (%)	29.42
Field capacity (%)	16.30
Wilting point (%)	7.67
Sand (%)	57.92
Silt (%)	27.20
Clay (%)	14.88
Texture	Sandy loam

Table 1: continue

Available macro. and micro nutrients (ppm)						
N	P	K	Fe	Mn	Zn	Cu
35.40	14.80	243.50	3.27	2.44	6.07	0.70

Prior to the field experiment, soil was sampled at 0-60 cm depth from five different sites for physical and chemical analysis which was done according to the methods described by Cottenie et al. (1982) and But (2004). A summary of results is presented in Table 1. Chemical properties of the irrigation water used were also analyzed according to the methods described by American Public Health Association, APHA (1992) and results are presented in Table 2.

Table 2: Chemical properties of the irrigation water

pH	EC (dS/ m^{-1})	OM %	Soluble cations (meq/l^{-1})				Soluble anions (meq/l^{-1})			Macronutrients (ppm)		
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	Cl^-	SO_4^-	N	P P	K
7.1	1.45	0.02	6.30	1.75	7.35	0.44	2.40	4.85	9.24	10.50	9.23	17.0

Table 3: Effect of integrated nutrient management on green and dry fodder yield of different genotypes of pearl millet (combined analysis of two seasons).

Treatment	Plant height (cm)		Stem thickness (cm)	
	First cut	Second cut	First cut	Second cut
Genotypes (V)				
Gizani	111.21 B	117.51 B	1.47 B	1.54 B
FH-50	113.37 A	119.89 A	1.51 A	1.60 A
Shandaweel-1	107.48 C	117.17 B	1.38 C	1.49 C
LSD	**0.69**	**1.01**	**0.020**	**0.288**
Integrated nitrogen treatments (T)				
T1	107.90 e	114.41 e	1.40 c	1.47 d
T2	96.830 g	101.65 g	1.17 e	1.29 f
T3	101.58 f	111.78 e	1.26 d	1.38 e
T4	100.73 f	107.17 f	1.17 e	1.18 g
T5	107.76 e	118.17 d	1.30 d	1.48 d
T6	110.22 d	121.31 c	1.46 c	1.55 c
T7	131.31 a	142.51 a	1.94 a	1.89 a
T8	116.67 c	119.24 cd	1.67 b	1.79 b
T9	123.18 b	127.44 b	1.72 b	1.87 a
LSD 0.05	**1.017**	**3.002**	**0.061**	**0.046**
Interaction between millet genotypes (V) and integrated nitrogen treatments (T)				
T1 V1	111.10 g	117.81 fg	1.40	1.42
T1 V2	108.15 h	108.70 i	1.46	1.49
T1 V3	104.46 ij	116.73 g	1.34	1.49
T2 V1	96.88 n	103.20 j	1.20	1.28
T2 V2	99.90 m	105.23 j	1.24	1.36
T2 V3	93.71 o	96.52 k	1.07	1.22
T3 V1	101.45 lm	109.53 i	1.25	1.38
T3 V2	102.40 kl	113.33 h	1.32	1.45
T3 V3	100.90 lm	112.47 h	1.21	1.32
T4 V1	100.50 lm	104.43 j	1.21	1.18
T4 V2	101.77 lm	112.93 h	1.23	1.23
T4 V3	99.93 m	104.13 j	1.07	1.13
T5 V1	103.13 jk	114.2 gh	1.29	1.47
T5 V2	111.87 g	118.00 fg	1.35	1.52
T5 V3	108.27 h	122.23 e	1.26	1.44
T6 V1	105.28 i	116.43 g	1.46	1.54
T6 V2	118.25 ef	120.03 ef	1.49	1.67
T6 V3	107.13 hi	127.47 d	1.42	1.44
T7 V1	137.17 a	144.70 b	1.94	1.88
T7 V2	133.50 b	149.83 a	1.99	1.91
T7 V3	123.27 d	133.00 c	1.88	1.88
T8 V1	117.33 f	120.50 ef	1.72	1.82
T8 V2	120.18 e	122.63 e	1.74	1.87
T8 V3	112.50 g	114.60 gh	1.54	1.68
T9 V1	128.03 c	126.70 d	1.74	1.86
T9 V2	124.33 d	128.27 d	1.76	1.91
T9 V3	117.17 f	127.37 d	1.66	1.84
LSD 0.05	**2.0855**	**3.0311**	**NS**	**NS**

Table 4: Effect of integrated nutrient management on morphological characters of different pearl millet genotypes (combined analysis of two seasons)

Treatment	No. of Leaves/ Plant		No. of Tillers/ Clump		Leaf-Stem Ratio		Leaf Area Per Plant (dm^2)		Leaf Area Index	
	First Cut	Second Cut	First Cut	Second Cut	First Cut	Second Cut	First Cut	Second Cut	First Cut	Second Cut
Genotypes (V)										
Gizani	8.80A	9.29	9.72A	12.82B	0.80B	0.77B	16.79	17.53B	1.68B	1.75C
FH-50	8.83A	9.27	9.79A	12.92A	0.87A	0.79A	16.73	17.57B	1.71A	1.84A
Shandaweel-1	8.44B	9.29	9.47B	12.31C	0.74C	0.76B	16.91	17.99A	1.67B	1.79B
LSD	0.049	NS	0.2786	0.052	0.025	0.020	NS	0.319	0.027	0.024
Integrated nutrient management treatments (T)										
T1	8.30f	9.05f	8.94f	11.24f	0.84bc	0.90a	16.48de	17.90c	1.66de	1.78c
T2	7.43i	8.16h	8.07h	10.51i	0.78d	0.83b	14.23g	14.58e	1.43g	1.49e
T3	7.64h	8.21g	8.81g	10.90g	0.78d	0.76c	16.27ef	16.54d	1.63e	1.66d
T4	7.86g	8.12h	8.01h	10.60h	0.89a	0.85b	15.58f	16.46d	1.58f	1.67d
T5	8.61e	9.24e	9.13e	12.26e	0.82bc	0.81b	16.80cde	17.71c	1.67d	1.88b
T6	8.77d	9.49d	9.67d	13.84d	0.85b	0.72d	17.08cd	18.67b	1.72c	1.91ab
T7	10.61a	10.71a	12.90a	15.75a	0.70f	0.67e	19.27a	19.62a	1.92a	1.96a
T8	9.24c	10.19c	10.78b	14.26c	0.80cd	0.73cd	17.50bc	18.68b	1.74c	1.87b
T9	9.76b	10.38b	10.65c	14.79b	0.74e	0.69de	18.07b	19.10ab	1.82b	1.92ab
LSD	0.136	0.049	0.121	0.084	0.032	0.043	0.703	0.691	0.030	0.059

Table 5: Effect of integrated nitrogen nutrient management on green and dry fodder yield of different genotypes of pearl millet (combined analysis of two seasons)

Treatment	Green Fodder Yield (t ha^{-1})		Dry Fodder Yield (t ha^{-1})	
	First Cut	**Second Cut**	**First Cut**	**Second Cut**
Genotypes (V)				
Gizani	92.05 B	114.40B	19.57B	23.74B
FH-50	103.41A	126.98A	21.63A	26.45A
Shandaweel-1	87.94 C	106.20C	17.68C	21.44C
LSD	**3.465**	**3.138**	**1.796**	**1.293**
Integrated nitrogen treatments (T)				
T1	69.75 e	87.46d	17.60e	20.57d
T2	74.13 d	90.35d	18.59de	22.39cd
T3	62.52 f	73.68e	10.72g	12.13e
T4	65.52 f	77.78e	12.06f	14.07e
T5	97.46 c	115.35c	19.88c	23.32c
T6	119.55 b	148.93b	24.17b	29.94b
T7	141.61 a	177.30a	29.84a	37.78a
T8	97.82 c	120.37c	19.64cd	24.18c
T9	121.84 b	151.52b	24.12b	30.49b
LSD	**3.778**	**7.911**	**1.162**	**2.217**
Interaction between genotypes (V) and integrated nitrogen treatments (T)				
T1 V1	64.78 g	80.62 j	16.52	19.50 fgh
T1 V2	82.83 de	105.25 h	20.58	24.11ef
T1 V3	61.64 g	76.50 j	15.70	18.10 gh
T2 V1	76.73 e f	94.43 i	21.39	25.41 de
T2 V2	82.48 de	102.78 hi	18.75	23.30 ef
T2 V3	63.17 g	73.83 jk	15.62	18.47 gh
T3 V1	61.37 g	76.20 jk	10.76	12.45 ij
T3 V2	63.19 g	78.66 j	10.75	12.47 ij
T3 V3	62.99 g	66.19 k	10.65	11.46 ij
T4 V1	68.64 fg	82.90 j	14.06	16.71 h
T4 V2	63.15 g	75.21 jk	12.38	15.25 hi
T4 V3	64.78 g	75.23 jk	9.75	10.24 j
T5 V1	88.98 d	110.56 gh	18.60	22.42 ef
T5 V2	114.38 c	130.22 f	23.66	26.34 de
T5 V3	89.03 d	105.28 h	17.38	21.22 fg
T6 V1	115.35 c	144.92 d	23.70	29.38 cd
T6 V2	133.02 b	162.80 c	26.53	32.27 bc
T6 V3	110.29 c	139.08 de	22.28	28.17 d
T7 V1	141.78 ab	177.39 ab	28.70	35.39 b
T7 V2	148.93 a	186.37 a	33.60	43.61 a
T7 V3	134.12 b	168.15 b	27.21	34.36 b
T8 V1	92.76 d	115.36 g	18.96	23.34 ef
T8 V2	108.35 c	135.24 ef	21.89	27.06 de
T8 V3	92.33 d	110.50 gh	18.08	22.13 ef
T9 V1	118.07 c	147.20 d	23.39	29.07 cd
T9 V2	134.36 b	166.27 c	26.53	33.60 b
T9 V3	113.09 c	141.09 de	22.45	28.81 cd
LSD	**10.396**	**9.4133**	**NS**	**3.8796**

Table 6: Effect of integrated nutrient management on nutrient concentrations of different pearl millet genotypes (combined analysis of two seasons)

Treatment	Nitrogen (N) (kg h^{-1})	Phosphorous (P) (kg h^{-1})	Potassium (K) (kg h^{-1})	Iron (Fe) (ppm)	Copper (Cu) (ppm)	Zinc (Zn) (ppm)
Genotypes (V)						
V1	129.06C	27.33C	122.67C	144.26C	18.36B	18.36B
V2	161.06A	31.23A	135.49A	146.01A	18.88A	18.94A
V3	145.90B	28.94B	126.97B	145.23B	18.49B	18.69AB
LSD	6.545	1.377	2.962	0.429	0.329	0.338
Integrated nutrient management treatments (T)						
T1	138.19c	23.15d	125.77d	143.30e	17.93de	18.23d
T2	142.80c	23.89d	99.83f	144.25d	18.55bcd	18.34d
T3	103.17d	24.33d	95.13g	142.71f	17.90e	16.32f
T4	110.03d	29.82c	104.70e	143.41e	18.31cde	17.44e
T5	146.53c	36.37a	128.37d	144.55d	18.24cde	18.54d
T6	115.37d	24.34d	133.88c	146.81c	18.81bc	19.47b
T7	221.43a	36.33a	200.31a	148.92a	19.59a	20.81a
T8	147.46c	31.87b	99.04f	144.46d	18.72bc	19.01c
T9	183.09b	32.38b	168.35b	148.09b	19.17ab	19.83b
LSD	12.819	1.349	3.407	0.571	0.628	0.043
Interaction between millet genotypes (V) and integrated nutrient management treatments (T)						
T1 V1	118.79 f	21.25	120.23	141.30	17.23	17.52
T1 V2	153.97 de	25.26	133.80	144.66	18.45	18.73
T1 V3	141.82 ef	22.94	123.29	143.93	18.09	18.43
T2 V1	121.88 f	22.71	97.48	142.90	17.85	17.22
T2 V2	157.77 d	25.32	106.33	145.59	19.34	19.02
T2 V3	148.75 de	23.63	95.67	144.28	18.45	18.77
T3 V1	109.71 f	23.22	89.23	141.54	18.03	16.26
T3 V2	122.16 f	25.72	103.74	144.22	18.22	16.40
T3 V3	77.64 g	24.05	92.42	142.37	17.45	16.31
T4 V1	105.06 f	28.79	102.72	142.95	18.31	17.45
T4 V2	120.18 f	31.41	104.25	143.75	18.52	17.64
T4 V3	104.85 f	29.27	107.15	143.52	18.11	17.24
T5 V1	123.20 f	34.52	122.48	144.35	18.07	18.21
T5 V2	161.31 d	39.30	135.75	145.00	18.22	18.58
T5 V3	155.07 de	35.29	126.88	144.30	18.43	18.82
T6 V1	112.59 f	21.29	126.91	144.54	18.58	18.98
T6 V2	122.46 f	26.30	140.91	148.29	18.94	19.77
T6 V3	111.08 f	25.43	133.83	147.60	18.91	19.66
T7 V1	198.03 c	32.29	192.37	148.90	19.47	20.71
T7 V2	245.18 a	40.50	214.37	149.00	19.78	20.89
T7 V3	221.07 b	36.19	194.19	148.88	19.51	20.82
T8 V1	123.29 f	30.31	93.91	144.31	18.76	18.97
T8 V2	163.78 d	34.46	104.79	144.66	18.88	19.55
T8 V3	155.29 de	30.85	98.42	144.40	18.51	18.52
T9 V1	149.00 de	31.55	158.69	147.53	19.00	19.93
T9 V2	202.70 bc	32.82	175.51	148.94	19.54	19.88
T9 V3	197.57 c	32.78	170.85	147.80	18.97	19.67
LSD	19.634	NS	NS	NS	NS	NS

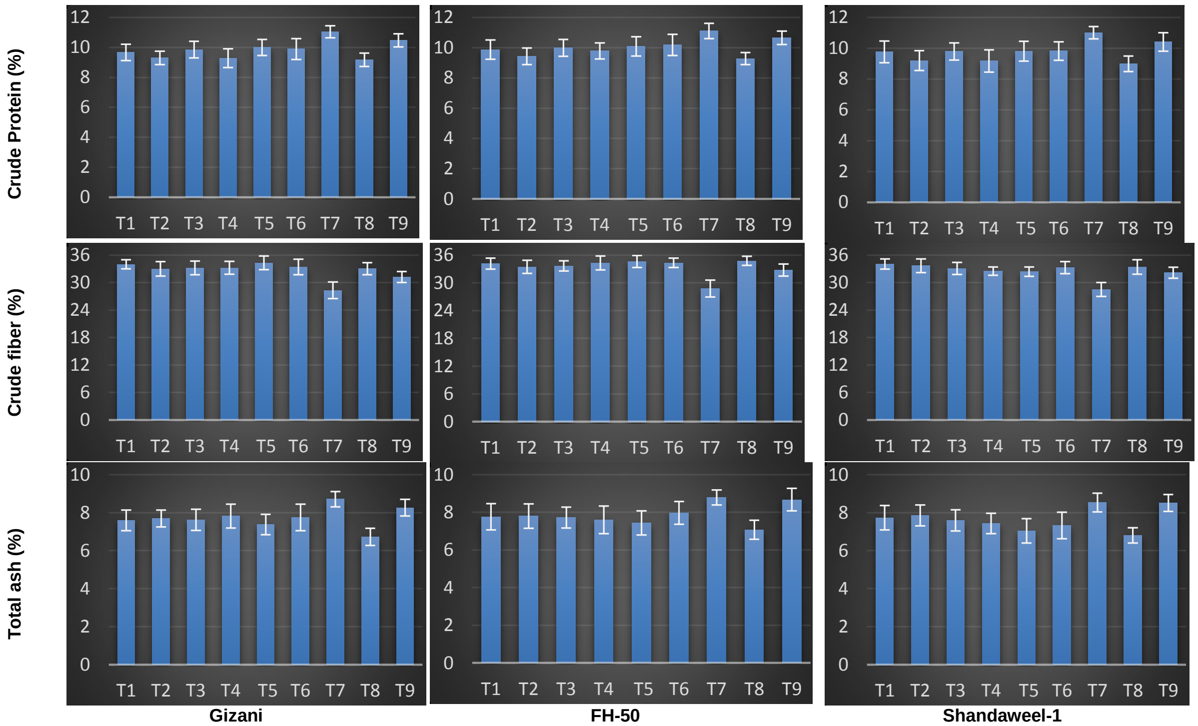

Figure 1: Effect of integrated nutrient management treatments on quality traits of pearl millet (combined analysis of two seasons)

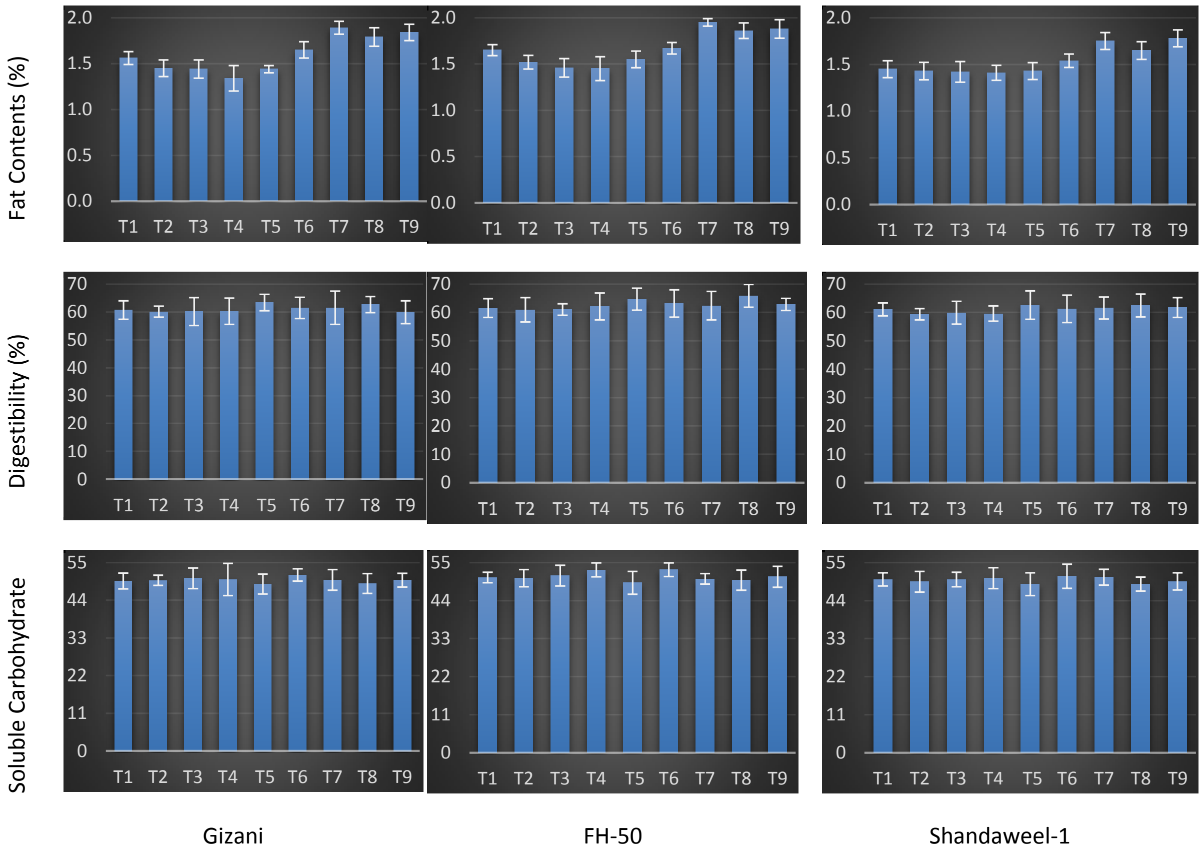

Figure 1: Continue

Experimental design and treatments details

The experiment was conducted using randomized complete block design in four replicates. Treatments included nine treatments *viz.*, recommended dose of NPK fertilizer (150:150:60 kg ha^{-1}), compost prepared from agricultural wastes + 10 % cow manure (10 t ha^{-1}), compost prepared from agricultural wastes + 10 % poultry manure (10 t ha^{-1}), compost prepared from agricultural wastes + 10% mixture of camel and sheep manure (10 t ha^{-1}), mixture of the three types of composts (10 t ha^{-1}), mixture of the three types of composts (10 t ha^{-1}) + 75 % of the recommended dose of NPK fertilizer, mixture of the three types of composts (10 t ha^{-1}) + 75 % of the recommended dose of NPK fertilizer + Bio fertilizer (*Rhizobium*) (8 g kg^{-1} of seed), mixture of the three types of composts (10 t ha^{-1}) + 50 % of the recommended dose of NPK fertilizer and mixture of the three types of composts (10 t ha^{-1}) + 50 % of the recommended dose of NPK fertilizer + Bio fertilizer (*Rhizobium*) (8 g kg^{-1} of seed).

Agronomic management

For seed bed preparation, field was ploughed with tractor followed by a thorough harrowing to break the clods. The field was properly leveled and divided into plots, each one of 3 m × 3 m earmarked with raised bunds all around to minimize the movement of nutrient. Pipeline was laid to facilitate irrigation to plots individually (irrigation network). The preceding crop was wheat in the winter during both seasons. Chemical fertilizer was applied as recommended dose (control) *viz.*, 150 kg N ha^{-1}, 150 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1}, whereas, organic fertilizers (compost) as per the treatment details were applied during the final ploughing and leveling of ground. For biofertilizer, seeds were treated with an adhesive material (Arabic gum) to make the seed surface sticky, immediately mixed with mixture of multiple bacterial strains. Seeds were sown on April 20 in 2015 and 2016 seasons by hand drill, using the usual dry method of sowing millet. Recommended seed rate i.e. 24 kg ha^{-1} was used for sowing every genotype. After about 21 days from sowing, seasonal grasses were weeded in all plots by hand hoeing and 21 days later the second hoeing was also done.

Data recorded

Data for different growth and yield related parameters were recorded according to standard procedures. Different biometric observations on growth in two cuts, first one after 50 days from complete emergence followed by a second cut 60 days later during the two growing seasons were recorded. For different proximate analysis, samples were collected from each plot at each cut and dried in oven at 70 $^{\circ}$C till constant weight and finely ground in a willey mill. A composite sample from each sample was drawn and used for various analyses. For N contents, by Modified Micro-kjeldhal method as described by AOAC (1970), while for P and K, Vanado-molybdo - phosphoric yellow color method and flame photometric method were used, respectively. Micronutrients content iron (Fe), zinc (Zn) and copper (Cu)) were determined by atomic absorption spectrophotometer. Different quality parameters *viz.,* crude protein, crude fiber, total ash, fat contents, digestibility, and total soluble carbohydrates were determined. Crude protein (CP) percentage was determinate by multiplying N percentage by 6.25 (Jones, 1931). For crude fiber, fat, digestibility, soluble carbohydrate content and total ash were determined by methods of AOAC (2000).

Statistical analysis

Data obtained for each season were statistically analyzed according to the methods described by Gomez and Gomez (1984), since the data in both seasons took similar trends and variance was homogeneous according to Barlet test, the combined analysis of the data of both seasons was carried out. Whenever the results were significant, means were compared using LSD test at 0.05 level of significance as suggested by Waller and Duncan (1969).

RESULTS

Significant differences were recorded among genotypes with respect to different growth parameters *viz.* plant height, leaf area, leaf area index, stem thickness, number of leaves per plant, number of tillers per clump and leaf : stem ratio. Generally, FH-50 recorded higher plant height of 113.37 cm and 119.89 cm in the first and second cuts, respectively (Table 3). Furthermore, FH-50 recorded higher values of stem thickness i.e., 1.51 and 1.60 cm in the first and second cuts, respectively (Table 3). Similarly, significantly higher number of leaves per plant, number of tillers per clump, leaf : stem ratio, leaf area per plant and leaf area index, were recorded for FH-50 *viz.* 8.83 and 9.27, 9.79 and 12.92, 0.87 and 0.79, 16.73 dm^2 and 17.57 dm^2, 1.71 dm^2 and 1.84 dm^2 for first and seconds cuts, respectively (Table 4). In the same table data cleared that Gizani c.v remained second series for the most of the previous growth characters. Regarding, integrated used of inorganic fertilizers in combination with biodegraded organic wastes in the presence of biofertilizer recorded higher values of most of growth characters as compared to the sole application of each one. Among studied treatments, application of 75 % RDF + (10 t ha^{-1}) of mixture of the three types of compost + biofertilizer (T7) recorded the highest plant height (131.31 cm and 142.51 cm) in the first and second cuts, respectively. It was followed by application of mixture of the three types of compost (10 t ha^{-1}) + 50 % of NPK fertilizer + biofertilizer (T9). The lowest plant height was observed under the treatments of sole application of each types of compost at the rate of (10 t ha^{-1}) (Table 3). The same trend was also observed for stem thickness (Table 3). Concerning number of leaves per plant, number of tillers per clump, leaf: stem ratio, leaf area per plant and leaf area index, data obtained cleared that (T7 and T9) registered the highest values (Table 4).Significant differences among genotypes were also found in green and dry fodder yield (Table 5). Genotype FH-50 surpassed the other two genotypes over the two cuts in both seasons, in general the second cut produced higher values of green and dry fodder yield than the first cut (Table 5). Similarly, significant differences were recorded among various manuring treatments (Table 5). An increase in the green and dry fodder yield is facilitated with the application of integrated nutrients management. Generally, application of mixture of the three types of compost (10 t ha^{-1}) + 75 % of NPK fertilizer + Bio fertilizer (T7) recorded the highest value of green fodder yield amounted 141.61 and 177.30 (t ha^{-1}) followed by application of mixture of the three types of compost (10 t ha^{-1}) + 50 % of NPK fertilizer + Bio fertilizer (T9),recorded 121.84 and 151.52 (t ha^{-1}) in the first and second cuts, respectively, which was significantly higher than that of control treatment (T1) or sole application of the mixture of the three types of compost by (10 t ha^{-1}) ,T5 (Table 5). About the uptake of different nutrients among different genotypes of pearl millet was greatly varied (Table 6). Genotype FH-50 recorded significantly higher concentrations of all nutrients followed by Shandaweel-1 and Gizani occupied the last series (Table 6). Nitrogen (N) uptake (Kg ha^{-1}) by pearl millet was significantly influenced by integrated use of different fertilizer sources (Table 6). Mixture of the three types of compost 10 t ha^{-1} + 75 % of NPK fertilizer + Bio fertilizer (T7), recorded the highest N uptake amounted 221.80 Kg ha^{-1}, in the same trend it was at par with mixture of the three types of compost (10 t ha^{-1}) + 50 % of NPK fertilizer + Bio fertilizer (T9) which registered 182.65 Kg ha^{-1}. In the same context, application of compost manures mixed with 10 % of camel and sheep manure 10 t ha^{-1} (T4), recorded the lowest nitrogen uptake 110.19 Kg ha^{-1} (Table 6). Similarly, phosphorus (P) uptake was increased with application of mixture of the three types of compost 10 t ha^{-1} + 75 % of NPK fertilizer + Bio fertilizer (T7). The same trend was recorded regarding the uptake of potassium (K) (Table 6). Application of mixture of the three types of compost 10 t ha^{-1} + 50 % of NPK fertilizer + Bio fertilizer (T9) followed treatment (T7).Regarding micronutrients contents *viz.,* Fe, Cu and Zn, integrated nutrient management practices, and their interactions had significant influence. As shown in Table 6 application of mixture of the three types of compost (10 t ha^{-1}) + 75 % of NPK fertilizer + Bio fertilizer (T7), recorded the highest micronutrients content of Fe, Cu and Zn, respectively, followed by application of mixture of the three types of compost (10 t ha^{-1}) + 50 % of NPK fertilizer + Bio fertilizer (T9) which recorded 148.09, 19.17 and 19.83 for Fe, Cu and Zn, respectively as compared to application of recommended dose of NPK fertilizer (control), which amounted 143.30, 17.93 and 18.23 of Fe, Cu and Zn, respectively. About quality traits, data are presented in Fig. 1, worthy clear that, there are significant differences among genotypes, FH-50 being at the top of series followed by Shandaweel-1 and Gizani was the last series. Similarly, significant differences were recorded among integrated nutrient management treatments for crude protein (CP), crude fiber (CF), total ash, fat, digestibility total and soluble carbohydrates in dry matter as indicator of forage quality (Fig. 1). Mixture of the three types of compost (10 t ha^{-1}) + 75 % of NPK fertilizer + Bio fertilizer (T7) and/or mixture of the three types of compost (10 t ha^{-1}) + 50 % of NPK fertilizer + Bio fertilizer (T9) were recorded the highest values of CP % as compared to positive control treatment (T1) or application of each source of compost individually.

DISCUSSION

The present results concluded that, in general treated seeds before sowing with bio-fertilizers in the presence of either inorganic fertilizers or in combination of integrated nutrient management practices surpassed the sole application of each one. In general, application of bio-fertilizers in combination with organic and inorganic fertilizers produced plants with higher growth vigor and good quality traits as compared to treatments without bio-fertilizers. The increment in plant growth due to inoculation of *Azospirillum* in the present study might be due to higher availability of nutrients**.** Similar to the present results, several studies have revealed the positive effects of organic and bio-fertilizers in combination with inorganic fertilizers, Abdullahi et al. (2013) reported enhanced sesame growth and nutrients uptake with the combination of bio-fertilizer and poultry manure. In addition, Campo (2006); Osman and Abd El-Rahman (2010) and Galbiatti et al. (2011) observed that, high growth response of pearl millet with the application of poultry manure + *Azospirillum* +inorganic fertilizers compared to sole application of chemical fertilizers. These results are in a good accordance with those obtained by Puri and Tiwana, 2005; Pathan et al. 2010; Al-Suhaibani 2011 and Piri and Tavassoli 2012. Such effect was expected early since the same treatments recorded the great numbers of most of growth characters, which are proof of the availability of nutrients of plant requirements for optimum growth vigor. Many investigators came to similar conclusions (Puri and Tiwana 2005 and Shahin et al. 2013). Data in the Table 5 also showed that application of integrated nutrient management in the presence of biofertilizer recorded the highest fresh and dry yield in the first and second cuts (T7 and T9). These results may regard to the increases in leaf area plant^{-1}, leaf area index and number of tillers, all of these are dependency high rates of photosynthesis and consequently produced high accumulation rates which reflected in stem length and thickness, which consequently lead to increase biomass either fresh or dry. Many investigates came to similar conclusions (Singh et al.2003; Puri and Tiwana 2005). Bio-fertilizer and organic manure are cheap and eco-friendly source of plant nutrients for sustainable crop production in low-input agriculture. The role of biofertilizers alone or in combination with organic or inorganic fertilizers has recently gained recognition in sustainable crop production, through enhancing biological activities and availability of nitrogen, growth promoting hormones and phosphorus mobilization by *Azospirillum,* respectively (Kennedy et al. 2004; Bloemberg et al. 2000; Abdullahi and Sheriff, 2013). Enhanced effect of integrated nutrient practices in the presence of biofertilizer on N, P and K uptake by pearl millet might be due to the reason of more nutrient release in a sustained manner as well as increasing count of microorganism in root zone with the application of mixture of organic, inorganic fertilizers in the presence of biofertilizers. These results are in line with those obtained by Patidar and Mali, 2004, Sumit and Chandel 2005 and Murugesa et al. 2010. It is may be also due to the use of compost which is self-prepared helps to supply even micronutrients which may not be supplied in commercial inorganic fertilizers (Mughgho, 1992). Such effect may be due to more available of N in root zone and its absorption by plants (Table 6), such effect also confirmed the fact that a positive association between nitrogen rates and protein values. Then more CP contents with elevated nitrogen levels are connected with the buildup of amino acids as result of nitrogen being a structural component. Several studies have revealed the positive effects of organic and bio-fertilizers singly or in combination with inorganic fertilizers to increase plant nutrients availability and uptakes (Saxena and Tilak, 1994, Yildiz (2001), Galdamez-Cabrera et al. (2003), Nadar et al. 2008, Almodares et al. (2009), Ezhil Bama and Ramakrishnan, 2010 and Maman and Mason, 2013).

CONCLUSION

From the findings of this study, it can be concluded that genotypic difference exists in pearl millet concerning different growth, yield and quality traits. Similarly, application of integrated nutrient management of organic and inorganic with bio-fertilizer in combination could improve pearl millet production in low-input agriculture. Application the mixture of the three types of compost 10 t ha^{-1} + 75 % of NPK fertilizer + Bio fertilizer and/or mixture of the three types of compost 10 t ha^{-1} + 50 % of NPK fertilizer + Bio fertilizer recorded the highest forage yield and quality under low input condition. Finally application chemical fertilizers in combination with organic fertilizer can mitigate the application of low dose of chemical fertilizers From the findings of this study, it can be concluded that genotypic difference exists in pearl millet concerning different growth, yield and quality traits. Similarly, application of integrated nutrient management of organic and inorganic with bio-fertilizer in combination could improve pearl millet production in low-input agriculture. Application the mixture of the three types of compost 10 t ha^{-1} + 75 % of NPK fertilizer + Bio fertilizer and/or mixture of the three types of compost 10 t ha^{-1} + 50 % of NPK fertilizer + Bio fertilizer recorded the highest forage yield and quality under low input condition. Finally application chemical fertilizers in combination with organic fertilizer can mitigate the application of low dose of chemical fertilizers

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