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Research Article

FINAL COMPARISON OF QUANTITATIVE AND QUALITATIVE OF FORAGE AND GRAIN YIELDS OF DIFFERENT FOXTAIL MILLET (*SETARIAITALICA*) CULTIVARS IN KARAJ REGION

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ABSTRACT
In order to evaluate and compare the top 20 genotypes of foxtail millet in Karaj weather conditions, a trial based on a randomized complete block with 3 replications was carried out in 2013, in Karaj Institute of Plant Breeding. In this experiment, 20 superior genotypes preliminary and semi-final stage of foxtail millet were selected, and compared. Genotypes studied were grown on Jun 7th 2013. Statistical analysis was using SPSS version 19. The means comparison was carried out using the Duncan test at 5%. The samples were taken on two occasions. The first turn for yield was done after removal of the first line from second and third line of 2.4 square meters and in the maximum vegetative growth stage and grains readiness, and picking up the second time was carried out form the fifth line at 2.1 square meters and at the time of seeds readiness. The results of analyzing of variance showed that: Genotypes KFM92 / 3, KFM92 / 18, KFM92 / 16 and KFM92 / 6 among were genotypes with many positive traits, and to introduce better varieties can be recommended. In some genotypes, plant heights were higher than other researchers' reports on foxtail millet varieties and the genotypes KFM92 / 3 was up to 123 cm and even was higher than Bastan variety than that can be very important on the term of producing forage. The genotype KFM92 / 3 were the most precocious genotypes and can be used to correct for premature.
Foxtail millet especially early premature genotype (Bastan, KFM92 / 3 and KFM92 / 18) for a period of 60 days is able to produce about 30 tons of forage. In many countries of the world these characteristics of millet are considered and it is used as an emergency food. Genotype KFM92 / 16 on the term of dry weight of forage, and the number of leaves are in the first grade and on the term of height and the amount of total protein were higher among genotypes. The result it can be introduced as promising genotypes into the next test.

Keywords: *Foxtail Millet, Precocity, Plat Height, Wet Forage*

INTRODUCTION
Millets are one of the traditional crops in arid and semi-arid tropical regions and among cereal after wheat, rice, maize, barley and sorghum is in sixth place of importance. Thus, in terms of cultivated area and their contribution to food security in areas of Africa and Asia is of utmost importance.
Millet grain is used for human nutrition (food and bread) for dried forage chord to feed livestock.
Millet has fiber and protein and is highly digestible and on the term of food value equals maize and sorghum.
Millet to feed through in a short period can be used further cultivated as a supplement and warm temperate regions of the country (before the main crop after the main crop). It does not cause any toxicity and bloating bowls and almost for most of birds and livestock can be used. Millets due to low yield compared to other cereal grains were not considered and now regarding the ideal performance of wet forage in a short time can be used instead of forage.
Setaria viridis aka is another name of foxtail millet in Iran. It is one of the oldest crops that require warm weather and in the hot summer months quickly reaches the maturity. Typically grows in semi-arid areas and has low water requirements. Due to the shallow root system cannot tolerate the severe drought conditions. The importance of forage crops for livestock and consequently supplying food for human is deniable. However, unfortunately, in our country it is not considered to produce and manage forage crops compared to other crops. Thus, on the one hand the lack of attention to increasing the quality and quantity

of forage caused a shortage of meat and dairy products and caused decreasing their quality and on the other hand excessive grazing pressure on pastures livestock and resulted in the destruction of much of the existing vegetation and soil erosion. The main objective of the study is comparing the performance of different varieties of foxtail millet grain and forage quality and quantity in Karaj region.

In order to evaluate and compare the top 20 varieties of foxtail millet in Karaj weather conditions, a trial based on a randomized complete block with 3 replications was conducted in 2013.In this experiment, 20 superior genotypes preliminary and semi-final stage of foxtail millet had been selected were compared.

The experiment was done by taking a piece of land of 1200 square meters. Each genotype was planted in 6 lines with a length of 4 meters per plot and spacing between the lines were 60 cm. This piece of land was prepared for planting in the spring with a trowel disc plow. The rows were created by furrower and after the implementation of the plan; various treatments were planted at specified time and amount. The maintenance operations have included irrigation, tights cultivation, crust breaking and ultimately weeding was done on time. In this study of Bastan variety was used, which is one of the varieties of foxtail millet, has been introduced in late 2009 as the control.

The samples were taken on two occasions. First turn was done for yield after removal of the first line from the second and third line of 2.4 square meters and the maximum vegetative growth stage and before grains readiness and picking up for the second time from the fifth line was done at 2.1 square meters at the time when grains were ready.

After weighing the harvested lines, randomly a sample of 2 kg was separated from the forage then dried and was grinded to determine the dry and qualitative indicators, including protein (CP), the percentage of soluble fiber in acid detergent fiber (ADF) and neutral detergent fiber (NDF). At the same time with the operations of traits such as leaf area, number of tillers, plant height at the time to determine dry forage yield, 1 kg of wet forage for 72 hours (The usual time for calculation of dry weight) was kept in an oven at 70 ° C and after drying the samples dry the percentage of dry matter and the yield of forage were calculated. To determine the leaf area after separating leaves of 5 mentioned plants by using Acupar system (Delta T model) leaf area meter was measured.

Calculation of gradient of developing day (GDD) from the time of cultivating up to the time of completing seeds is the other factor that was measured and for this issue from the planting time up to the seed completing stage the minimum and maximum daily temperature Karaj weather data were received. Then, according to formula GDD calculation is made for each day. With the number of days to seed completing stage any of the varieties, the total temperature required to calculate the aggregation occurs.

Forage quality traits were measured using NIR technology which is based on the absorption and reflection of infrared radiation at wavelengths between 2500-700 nm.

An improved method of Vitham *et al.*, (1971) was used.5.0 g of sample was mixed with 15 ml acetone as well. The extract was passed through the filter paper, and then the filter paper washed out several times with acetone until no pigment remained. The refined extract with the filter paper was reached to 25 ml with the acetone. And its absorption by the Perkin-Elmer spectrophotometer (Lambda-A.Z 201) at 663 and 645 nm wavelength was read.

With quantitative and qualitative data which was obtained through weighing and analysis of samples, sorting data were done using Excel software and required statistical analysis was done using SPSS version 19. Means comparison using the Duncan test was conducted at 5%.

RESULTS AND DISCUSSION

The total amount of protein (CP) comparing the average of genotypes and Bastan variety showed that the highest amount of protein with 37/11% belongs to KFM92 / 1 genotype, and the lowest amount of protein was observed in genotype KFM92 / 14 with 39/6 percent. That showed significant differences between the genotypes.

The variety Bastan with an average of 4/8 percent of total protein had an intermediate condition between the studied genotypes. If the amount of protein is considered by the corrector, can genotypes KFM92 / 1, KFM92 / 4 and KFM92 / 16 to be used for manipulation or cross.

Percent WSC: WSC water content in the range of 16/7 to 25/11 percent in the studied millets was variable. Most of the genotype was related to KFM92 / 13 and the lowest to KFM92 / 2genotype. The amount of sugar dissolved in water, the variety Bastan had no significant difference with many genotypes. Most of foxtail millet genotypes in Karaj in the percentage of soluble sugars, high potential and can be used for breeding and many foxtail millet genotypes in Karaj in the percentage of soluble sugars have high potential and can be paid attention and used for breeding.

Saghatoleslami *et al.*, (2011) in their studied millet genotypes reported the amount of sugar between 2/45 to 88 mg per g dry weight in Birjand.

The percentage of soluble fiber in neutral detergent

The percentage of soluble fiber in neutral detergent in the studied genotypes and the variety Bastan as control in Karaj, were in the range of 03/56% of (genotype KFM92 / 4) up to 38/65 percent (genotype KFM92 / 17). By the results of other researchers (Eizadiyazdan Abadi *et al.*, 1991) match with foxtail millet. The variety Bastan with this attribute had a value of 05/60 percent were in the medium level and with none of the genotypes KFM92 / 4 and KFM92 / 17 showed no significant difference. After genotyping KFM92 / 17, genotype KFM92 / 3 of the amount of soluble fiber in neutral detergent (NDF) (63/47%) was in second rate.

Table 1: Analysis of Variance Qualitative Traits in the Studied Foxtail Millet Genotypes in Karaj

Resource Change	**Average of Squares**					
	CP	**WCS**	**ADF**	**NDF**	**DMD**	**ASH**
Repetition	0/087^{ns}	0/16^{ns}	2/96^{ns}	2/3^{ns}	42/2*	1/42**
Treatment	6/9**	2/96*	23/85**	18/26*	16/6^{ns}	0/3^{ns}
Testing Error	1/41	1/5	6/67	9/65	12/1	0/223
Coefficient of Variation	8/7	9/83	10/1	7/29	10/01	9/4

* And **, respectively, mean non-significant significant at the 5% and 1%

(CP = total protein, WSC = water soluble carbohydrates contents, ADF =ADF = acid detergent insoluble fiber, NDF = percent of soluble fiber in neutral detergent, DMD= Percent digestible dry matter, ASH = the amount of ash).

Weight of Dry Forage per Hectare:

The weight of dry forage for the studied cultivars in Karaj and Bastan variety, were between 13176/3 kg (genotype KFM92 / 16) and 6524/6 kg ha (genotype KFM92 / 19) Meta Ahmadi Aghtapeh *et al.*, (2013) reported the yield of dry forage in different genotype of foxtail millet under different dietary treatments between 5/6962 kg to 12462 kg per hectare. The yield of forage will depend entirely on the amount of vegetative growth; the vegetative growth is also affected by soil nutrition, the elements and the climate, however, plant genetics and the role of variety have the undeniable and separated roles. This test also showed that despite the growing and planting conditions were the same but a lot of variety was observed.

Leaf Area Index

Leaf area index in the studied genotypes, was variable from 1044/8 (genotype KFM92 / 8) and 1866/5 (genotype KFM92 / 6).

Genotypes KFM92 / 6, KFM92 / 4, KFM92 / 1 and KFM92 / 18 had the highest amount of Leaf area index and were at the same statistical level. The variety Bastan in the terms of LAI was moderate and compared to genotypes KFM92 / 6 and KFM92 / 8, the difference was significant.

The Amount of Chlorophyll

The amount of chlorophyll in the studied genotypes and the variety Bastan of 19/24 mg per 100 g in Karaj (genotype KFM92 / 17) up to 41/60 in (genotype KFM92 / 15) was variable. The results of mean comparison showed that genotypes KFM92 / 5 and KFM92 / 15, have the highest Chlorophyll, respectively, were put on a statistical level, and with other genotypes showed significant differences.

The amount of chlorophyll of is important and decisive traits in yield, the weight of dry forage and protein and the leaf area index, dry forage yield, number of leaves and number of tillers showed significant positive correlation (Ahmadi Aghtapeh *et al.*, 2013).

Table 2: Compares the Studied Average Quality Traits of the Genotypes of Foxtail Millet and Bastan Variety (Control) in Karaj Region

	CP (%)	WSC (%)	ADF (%)	NDF (%)
The variety Bastan	defg8/406	abcd9/56	abcde38/67	abcd60/05
KFM92/1	a11/37	bcd8/06	abc40/85	cd57/15
KFM92/2	bcde8/97	b7/16	abcd39/29	abcd59/53
KFM92/3	bcd9/81	bcd8/67	ab42/53	ab63/47
KFM92/4	ab10/99	bcd8/19	abcd39/25	d56/03
KFM92/5	cdef8/52	abcd8/86	def35/51	bcd57/96
KFM92/6	fghi7/49	abc9/75	ef34/2	bcd58/4
KFM92/7	Ghi7/01	Ab10/28	Bcdef37/79	Bcd57/35
KFM92/8	bcd10/05	cd7/7	cdef37/4	bcd59/18
KFM92/9	abc10/66	cd7/58	a44/33	abcd61/17
KFM92/10	efgh7/98	abcd8/96	abc41/42	cd56/91
KFM92/11	bcde9/44	abcd9/03	ab42/55	cd57/25
KFM92/12	cdef8/72	bcd8/62	abc40/95	bcd58/7
KFM92/13	hi6/51	a11/25	abcd39/91	abcd60/95
KFM92/14	i6/39	bcd8/59	abcd39/13	abcd59/95
KFM92/15	abc10/46	abcd9/07	f33/42	cd56/58
KFM92/16	a11/2	bcd8/75	abc41/93	abc62/72
KFM92/17	bcd10/28	cd7/78	bcdef37/64	a65/38
KFM92/18	bcde8/84	abc10/02	bcdef37/77	abcd59/41
KFM92/19	bcde9/23	abcd9/2	ab42/53	bcd57/55

(In any columns the means that have at least one letter in common, have significant differences at 5% in Duncan multiple range test)
(CP = total protein, WSC = percent of Water solvable Carbohydrate, ADF = acid detergent insoluble fiber, NDF = percent of soluble fiber in neutral detergent)

The Number of Tillers

The tillers varied between genotypes and showed changes from 3/73 per genotype KFM92 / 19 the number of 5/36 per genotype KFM92 / 16.

And the number of tillers in genotypes KFM92 / 16, KFM92 / 6, KFM92 / 4, KFM92 / 1 and KFM92 / 17 was higher than the other genotypes and the number of tillers is important in forage yield. Other researchers reported the number of tillers in different foxtail millet genotypes in the range of 8 to 17 (Eyshy Rezai *et al.*, 1389). In studying 10 genotypes of ordinary millet in Karaj region, the number of tillers was reported between 4/35 to 22/5 (MehranyRezaee *et al.*, 2010).

The Number of Leaves

The number of leaves among studied genotypes, was variable from the average 6/8 (genotype KFM92 / 8) to an average of 12/66 (genotype KFM92 / 17).

Genotypes KFM92 / 6 and KFM92 / 18 after genotype KFM92 / 17 in the next rankings and all three were in the same statistical level.

The Bastan variety with an average of 86/7 leaves per plant among the studied genotypes had rather low status and had no significant difference on the terms of the number of leaves (KFM 92/8). Mehrani and colleagues (2013) reported the number of leaves for the Bastan variety 81/10 per bush. In other studies they reported, the number of leaves of different genotypes of ordinary millet and foxtail millet in Karaj 22/5 to 33/10 per bush (Mehrani *et al.*, 2007).

The Height of Bush

The mean comparison showed that genotypes KFM92 / 3 with an average height of 123/2 cm had the maximum height between the studied genotypes and despite this, the genotypes KFM92 / 16, KFM92 / 18 and the Bastan variety did not show significant differences. The genotype KFM92/9 had the lowest height with the amount of 70/4 cm and after that varieties such as KFM92 / 7, KFM92 / 6 and KFM92 / 17 had the lowest values.

The Bastan variety (122 cm height) as previously mentioned among the varieties was with high height (EyshyRezai *et al.*, 2010) reported the height of foxtail millet between 62/97 to 187/33.

Table 3: Analysis of Variance of Qualitative Traits of the Studied Foxtail Millet Genotypes in Karaj Region

The Sources of Changes	The Average of Squares					
	CP	**WSC**	**ADF**	**NDF**	**DMD**	**ASH**
Repeat	0/078^{ns}	0/16^{ns}	2/96^{ns}	2/3^{ns}	42/2*	1/42**
Treatment	6/9**	2/96*	23/85**	18/26*	16/6*	0/3^{ns}
Testing Error	1/41	1/5	6/67	9/65	12/1	0/223
Coefficient of Variation	8/7	9/83	10/1	7/29	10/01	9/4

* And **, respectively, are non- significant and significant at the 5% and 1%
(CP = total protein, WSC = percent water dissolvable carbohydrate, ADF = acid detergent fiber soluble, NDF = percent soluble fiber in neutral detergent, DMD = dry matter digestibility, ASH = the ash).

Table 4: Comparing the Average of Quantity Traits of the Foxtail Millet Genotypes in Karaj

Variety	Fresh Weight Kg/h	Dried Weight kg/ha	LAI	Number of Seeds per Cluster	Grain Performance Kg/ha	Total Chlorophyll Mg/100g
Bastan	16576bcde	9289/3bcde	1541/7def	3050a	4019a	56b
KFM92/1	20876b	10084/6bcd	1722/3abc	463/3i	2702/6fg	25/23k
KFM92/2	2866/3b	10220/3bc	1437/4efg	1750bcd	33483abcde	37/19h
KFM92/3	13166/3de	7170/3cde	1549/7cdef	2693/a	3864abc	53/91c
KFM92/4	16347/6bcde	7816/3bcde	1844/6a	1063fgh	3500abcde	40/47g
KFM92/5	17904/6cde	9317bcde	1219/6hi	1760bcd	3600abcd	60a
KFM92/6	14714/3de	6982/3de	1866/5a	756/7ghi	2723/6fg	41/73f
KFM92/7	15261/6de	7599/6bcde	1439/2efg	2907a	4028/6a	30/38j
KFM92/8	15528/6de	7316/3cde	1044/8j	1723bcd	3757/3abcd	4058/g
KFM92/9	20281bc	10690/6ab	14181/1fg	2167b	3859/3abc	225/2k
KFM92/10	15457de	7170/6cde	1275/9gh	2017bc	3895ab	50/52d
KFM92/11	1623/6bcde	8799/3bcde	1268/9gh	1130efg	3224cdef	56/25b
KFM92/12	15857cde	8497bcde	1653/5bcd	1533cde	1985/6h	36/61h
KFM92/13	16285/3bcde	8637bcde	1458/5ef	1497def	2938efg	45/7e
KFM92/14	16428/6bcde	8163/3bcde	1619/2cde	1817bcd	3183/3def	55/91b
KFM92/15	16548bcde	8009bcde	1204/8hig	1757bcd	3893ab	60/41a
KFM92/16	26476/3a	13176/3a	1538/1def	656/7hi	3238/3cdef	30/21j
KFM92/17	17585/6bcd	8977/3bcde	1713/9abcd	1600cd	2516/3gh	24/19l
KFM92/18	15847/6cde	7825/6bcde	1807ab	1717bcd	3290/3bcdef	34/38i
KFM92/19	12290/3d	6524/6e	1093/2ij	2167b	3652/3abcd	54/75c

(In each column the averages that have at least one word in common, don't have statistical difference at %5 in Duncan multiple range test)

The Length of Panicle

The length of Panicle of the studied genotypes and Bastan variety varied between 30/33 cm (genotype KFM92 / 3) and 53/8 cm (genotype KFM92 / 9).

After genotype KFM92 / 3, KFM92 / 18 was the next ranking but did not show significant differences with each other.

Khatami Pour *et al.*, (2014) reported the length of panicle in foxtail millet from 9/36 to 21/71 cm.

Shushi Dezfooli and Mehrani (2009) study a number of promising millet genotypes in three regions and three years reported that among all genotypes studied in Karaj in terms of morphological and phonological characteristics except from the number of tillers in the bush had significant difference. The tallest tiller in this study was reported 29/23 and the shortest one 20/86.

GDD 50 Percent Of Flowering

The studied genotypes of foxtail millet in Karaje region in terms of total required heats up to 50% of flowering have differences.

The maximum amount of GDD 50% flowering was belonged to genotype KFM 92/9 3/1205 with 1205/3 degrees Celsius.

And the lowest GDD 50% flowering was belonged to genotype KFM92/19 with 1/769 degrees Celsius. So, the earliest flowering was for genotype KFM92/1, and the latest flowering was for genotype KFM92/9.

GDD Harvesting Forage:

The maximum amount of GDD up to harvesting forage were belong to KFM92 / 9, KFM92 / 1 and KFM92 / 16 respectively 1322, 1262/5, 3/1298 degrees centigrade. As a result these genotypes in term of harvesting forage were later than the other genotypes but genotypes KFM92/3 and KFM92/19 respectively 924/16 and 3/948 degrees centigrade, were the earliest genotypes and needed less heat to grow to harvesting stage of forage.

GDD Physiologic Grain Maturity:

The minimum growing degree day for harvesting the grain was related to genotype KFM 92/3 with an average of 1292/6 degrees centigrade and so was the earliest genotype.

The maximum growing degree days needed to harvest grains related to the genotypes KFM92 / 9 and KFM92 / 16 was with 5/1632 and 5/1610 degrees centigrade and these two genotypes were the latest studied genotypes.

Saghatoleslami *et al.*, (2005) reported GDD different phonological stages of germination, tillering, stem elongation, heading and seeding for foxtail millet, respectively, 100/4, 480/9, 7/713, 6/1336 and 1957 ° C.

Table 5: Analysis of Variance for GDD Needed in the Developmental Stages of Genotypes of the Studied Foxtail Millet in Karaj Region

Sources of Changes	**Average of Squares**			
	Degrees of Freedom	**GDD 50% Flowering**	**GDD of Harvesting Forage**	**GDD of Seed Harvesting**
Repetition	2	680/404^{ns}	822/961^{ns}	16228/817^{ns}
Treatment	19	47907/03**	43303/635**	31212
Testing Error	38	2551/356	2744/525	1579/246
Coefficient of Variation	60	7	10/01	8/72

ns, * and **, respectively, mean significant and non-significant at 5% and 1%

Table 6: Compares the Average of Quantitative Traits Studied Varieties of Foxtail Millet in Karaj

Variety	Number of Tillers	Number of Leaves	The Height of Plant	Panicle Length (Cm)	GDD 50% Flowering (˚C)	GDD of Harvesting Forage (˚C)	GDD of Seed Harvesting (˚C)
Bastan	fgh3/86	ijk7/86	ab122	cd23/4	def820/83	efg1004	ef1370/83
KFM92/1	abcd5	cde10/26	hi83/26	f13/8	b1077/3	ab1262/5	ab1582/8
KFM92/2	abcd5	cde10/26	hi83/26	f13/8	b1077/3	ab1262/5	Ab1582/8
KFM92/3	bcdef4/53	fgh9/06	a123/2	a30/33	f747/5	g924/16	g1292/6
KFM92/4	abc5/1	cd10/66	fg95/86	e17/46	def809/3	efg991	efg1353/5
KFM92/5	gh3/8	ijk7/66	gh89/06	ef16/46	cd906	cde1089/5	cd1445/8
KFM92/6	ab5/2	ab11/93	jk76/2	ef15	cde875	cd1121/16	cde1415/16
KFM92/7	fgh3/93	ijk7/8	jk73/06	e17/86	e937/16	cd1120/6	c1475/6
KFM92/8	fgh3/93	k6/8	e103/4	cd23/46	def820/83	efg1004	efg1365/3
KFM92/9	bcde4/73	fghi8/66	k70/4	g8/53	a1205/16	a1322	a1632/5
KFM92/10	defgh4/4	def9/66	cd114/8	d21/66	ef804/33	fg985/83	efg1349/16
KFM92/11	cdefg4/46	fghi8/66	fg90/73	e17/6	ef787/16	fg967/5	fg1331/8
KFM92/12	efgh4/2	ghij8/33	bcd 115/73	d22/13	def843	defg1027/5	def1387
KFM92/13	efgh4/3	def9/6	fg92/66	ef16/1	cde873/8	cdef1058/3	cde1415/3
KFM92/14	efgh4/2	efg9/33	e104/8	bc26/06	def820/83	efg1004	efg1365/3
KFM92/15	fgh3/93	hij8/1	de109/33	d21/53	ef782/16	fg962/3	fg1327/5
KFM92/16	a5/36	cd10/66	abc120/4	e17/26	b1114/5	ab1298/3	ab1610/5
KFM92/17	abcd5/06	a12/66	ijk76/93	ef1606	b1033/3	b1220/5	b1550/33
KFM92/18	Abcd5	Bc11	Abc118/6	Ab28/26	Def820/6	Efg1003	Efg1364/8
KFM92/19	H3/73	Jk7/26	Ij78/33	Ef16/46	F769/1	G948/3	Fg1313/8

Conclusion

Genotypes KFM92 / 3, KFM92 / 18, KFM92 / 16 and KFM92 / 6 among the genotypes had many positive traits and to introduce better varieties can be recommended. In some genotypes, plant height was higher than the ones researchers reported on foxtail millet varieties and about the genotype KFM92 / 3 was 123 cm and even was taller than the variety Bastan that can be very important in the term of producing forage.

The genotype KFM 92/3 was the most mature genotype and can be used for premature purposes. (Bastan, KFM92 / 3 and KFM 92 / 18), for a period of 60 days it is able to produce about 30 tons of fresh forage. In many countries of the world, this feature of millet has been considered, and millet is used as an emergency food.

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