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Effect of growth stages and fertility levels on growth, yield and quality of fodder oats (*Avena sativa* L.)

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Abstract: A field experiment was conducted to evaluate the yield and quality parameters of oats (*Avena sativa* L.) at forage research farm in Punjab Agricultural University, Ludhiana. Four different nitrogen levels viz. 0 (control), 50, 75 (recommended) and 100 Kg N/hawere applied in the form of urea. Samples were collected at three different growth stages i.e. 30, 45 and 60 DAS. As the growth of plant continued decrease in total nitrogen (45%), non protein nitrogen (37%), ether extract (13%), ash content (24%) and digestibility (23%) was observed. But increase in free amino acids (48%) and cell wall constituents i.e. ADF (19%), NDF (31%) and CF (34%)with plant's growth was reported. The interactive effect of varying levels of inorganic fertilizer application on the chemical composition of the plant at various growth stages revealed an increase in total nitrogen (18%), non protein nitrogen (26%), ether extract (18%), free amino acids (32%), ash content (13%) and digestibility (7%) with increase in fertilizer level however ADF (7%), NDF (2%) and CF (3%)content decreased with increased levels of nitrogen fertilization.Correlation studies showed that significant negative correlation was present for*in vitro* dry matter digestibility with acid detergent fiber (r= -.861**), neutral detergent fiber (r= -.891**) and crude fiber (r= -.740**) at recommended dose of N fertilization. The objective of this study was to investigate the effect of different doses of nitrogen fertilization at different growth stages on quality components in oats fodder.

Keywords: Chemical composition, Growth stages, Nitrogen levels, Oats, Yield

INTRODUCTION

In agriculture the significance of fodder crops needs no emphasis due to the fact that livestock needs nutritious and regular fodder availability to meet the demand of milk, meat, butter and other by- products as per human demands (Devi, 2002). Among the different *rabi* fodder crops, oats (*Avena sativa* L.) is one of the most important *rabi* fodder crop. Oats requires the cool and moist weather for germination, tillering, booting and heading stage.It was produced in 10212 million ha area with an annual production of 233 million tons in the world. In India, cultivated fodder is limited to 4.9% of the total cropped area (Kumar *et al.,* 2012). The total area under cultivated fodders is 8.6 million ha on individual crop basis. The crop occupies maximum area in Uttar Pradesh (34%), followed by Punjab (20%), Bihar (16%), Haryana (9%) and Madhya Pradesh (6%).

Oats rank fifth in terms of world cereal production. It is extensively grown as forage crops and becoming increasingly importance in many regions of the world. It is the most important winter cereal fodder which is highly palatable, rich source of energy, protein, vitamin B1, phosphorus, iron and other minerals. Amongst various practices, cutting management and nutritional demands are important considerations to make the fodder available to livestock especially during long lean period of winter. Fodder quality is of great importance as well as higher forage yield. The fodder quality of oats depends on many factors such as fertilization, irrigation, genotype, plant density and harvesting time. Maturity stage at harvest is the most important factor determining forage quality, and forage quality decreases with advancing maturity. Also, the maturity of forage crops influence forage digestibility and consumption by animals (Ball *et al.,* 2001).

The most common variations associated with harvesting time are forage yield (Gul *et al.,* 2008; Ayub *et al.,* 2003), dry matter % age, neutral and acid detergent fibre, CP (Khan *et al.,* 2007) and in-vitro dry matter digestibility (Bayble *et al.,* 1995). A high percentage of protein is required in the diet of ruminants because production of milk, meat and reproduction mainly depends on protein ingredient of the animals' diet (Arshadullah *et al.,* 2011). The previous studies reflected that the quality of forages can be regulated by just selecting the harvest time at which plants are rich in nutrients concentration. Generally, fiber concentration of the forage crops increases while quality and digestibility decreases as aging prolongs (Ball *et al.,* 2001). Forage digestibility is related to chemical compositions particularly of fiber, lignin and to some ex-

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tent of crude protein. Acid detergent fiber (ADF), and neutral detergent fiber (NDF) are commonly used as standard forage testing techniques for fiber analysis. ADF can be used to calculate digestibility, while intake potential is predicted through NDF (Ball *et al.,* 2001). Crude fiber (CF) mainly consists of cellulose, hemicelluloses and lignin.

Nitrogen (N) is major limiting nutrient for growth of forage crops and this explains the improvement in forage yield by external supply of N to soils that are deficient. (Tena and Beyene 2011). In most forage crops, the nitrogen fertilization resulted higher dry matter production (Ayub*et al.,* 2007; Karasu *et al.,* 2009), with higher protein (Keskin *et al.,* 2005). While limited supply of nitrogen keeps the crops greenish for longer time (Russel *et al.,* 1992) and reduces synthesis of organic nitrogen (Karic *et al.,* 2005) in plants. Therefore, judicious rates of nitrogen application must be ensured for obtaining higher dry matter with good quality.

MATERIALS AND METHODS

Four oats genotypes OL-9, Kent, OL-10 and OL-125 were raised in experimental area of Department of Plant Breeding and Genetics PAU, Ludhiana (30.9^{o} N, 75.85^{O} E and 252 m asl), India. The crop was sown on 12 November, 2014 in plots consisting of 15 rows with 20 cm spacing. The experiment was conducted in randomized block design (RBD) in factorial arrangement with three replications. For each genotype, four nitrogen treatments (0, 50, 75 (recommended dose), 100 Kg N/ha) were given. Nitrogen was applied through urea in split doses as per the treatments. Half dose of N was applied at the time of irrigation and the remaining half was applied after one week of previous application. Whole plant samples were collected at three different growth stages i.e. 30, 45 and 60 DAS to determine quality components. Yield and growth attributes were determined after 60 DAS. Fresh plant leaf samples were collected after every harvest, sun dried and then completely dried in hot air oven till a constant weight was obtained. This dried plant material was ground using Willy grinder to a uniform mesh size. The standard methods were used for neutral detergent fiber and acid detergent fiber (Georing and Van Soest, 1970), *in vitro* dry matter digestibility (Tilley and Terry, 1963), ether extract, ash, crude fiber, crude protein and non protein nitrogen (AOAC 1970) and Free amino acids (Lea and Takahashi, 1966). Data was statistically analyzed using analysis of variance (ANOVA). Further, mean separation of treatment effects was accomplished using Tukey's least significant difference test. All data analysis was carried out using SAS software.

RESULTS AND DISCUSSION

Chemical composition of oats fodder at different growth stages and N treatments: Total nitrogen content decreased significantly (F= 13968.22, p<0.001) as the growth of plant continued (Table 1). At 60 DAS, maximum total nitrogen content was observed in OL-125 genotype (2.80 %). Total nitrogen content generally decreased with the advancement of the plant growth due to the synthesis of structural carbohydrates with advancing plant age. Similar results were observed in wild soyabean (Zhai *et al.,* 2008). N treatment resulted in significant (F= 1376.05, p<0.001) increase in total nitrogen content. Similar results were reported in fodder oats (Kumari*et al.,*2014), maize varieties (Tajul*et al.,* 2013) and lettuce (Liu *et al.,* 2014). This may be due to increased availability of nitrogen there by more uptake and corresponding increase in protein content of herbage. Maximum total nitrogen content in all genotypes was observed at 100 Kg N/ha and minimum at 0 Kg N/ha.Non protein nitrogen (NPN) content decreased significantly (F=3227.27, p<0.001) as the growth of plant continued. Maximum NPN content was observed at 30 DAS. Nitrogen fertilization increased significantly (F=559.10, p<0.001) NPN content. Maximum NPN content was observed at 100 Kg N/ha in all genotypes at different growth stages. Eppendorfer (1971) reported that non-protein nitrogen is stored in the vegetative tissue at the expense of protein N. Among different genotypes, maximum NPN content was observed in OL-10 (2.10 %) genotype.

In vitro dry matter digestibility **(**IVDMD) content decreased significantly with plant's growth (F=2297.75, p<0.001) as shown in Table 1. Among growth stages, overall mean was observed maximum at 30 DAS (88.39%) followed by 45 DAS (82.61 %) and 30 DAS (67.67 %). This may be due to the fact that in mature plants, stem comprise a much larger portion of the plant than leaves (Mcdonald *et al.,* 2001). Similar results were observed in *Panicum maximum* (Taute *et al.,* 2002). Moderate levels of NDF and ADF at early growth stages may be responsible for generally high IVDMD in fodders (Njidda, 2014). Increasing N levels significantly (F= 116.77, p<0.001) increased the IVDMD content in fodder oats. Pathan *et al.* (2012) also reported similar findings in Napier bajra hybrid. Maximum digestibility at different N levels was observed in Kent genotype.

Acid detergent fiber (ADF) content increased significantly (F= 899.20, p<0.001) as the growth of plant continued and maximum ADF content in all genotypes was observed at 60 DAS (Table 2). Similar results were reported in maize (Firdous and Gilani 1998) and sorghum (Firdous and Gilani 2001). The significant (F= 649.75, p<0.001) decrease in ADF content was observed with N fertilization in fodder oats. This may be due to the fact that increased uptake of nitrogen imparts succulence to green plants by reducing fiber content. Similar results have been reported for fodder oats (Kumari *et al.,* 2014), *Brassica rapa* L. (Paul *et al.,* 2014), Napier bajra hybrid (Sharma *et al.,* 2012)

Table 1. Total nitrogen, non protein nitrogen and *in vitro* dry matter digestibility of oats at different growth as influenced by different N levels.

Nitrogen application	**Total Nitrogen (%)**				**Non protein nitrogen (%) Days after Sowing (DAS)**				***in vitro* dry matter digestibility (%)**			
Nitrogen doses	**30**	**45**	**60**	Mean	**30**	**45**	**60**	Mean	**30**	**45**	**60**	Mean
0 Kg N/ha	4.165d	2.635i	2.32k	2.32	2.23d	1.43hi	1.36i	1.67	86.22cd	76.77f	65.01i	76.00
50 Kg N/ha	4.6c	3.73g	2.54j	2.54	2.53c	1.68g	1.49h	1.90	88.37ab	81.56e	67.09hi	79.01
75 Kg N/ha	5.04b	3.45f	2.72i	2.72	2.70b	1.87f	1.75g	2.11	89.00ab	84.48d	68.39gh	80.62
100 Kg N/ha	5.35a	3.73e	2.86h	2.86	2.90a	2.00e	1.87f	2.26	89.98a	87.59bc	70.17g	82.58
Genotypes												
OL-9	4.82^{b}	3.32^{d}	2.63^{g}	3.61^{P}	2.74^{a}	1.86^{d}	1.59^{g}	2.06^{P}	88.50^{a}	79.90^{d}	66.00^{f}	78.13^{R}
Kent	4.86^{b}	3.21^{e}	2.35^{h}	3.47^{Q}	2.61^{b}	1.73^{e}	1.38^{h}	1.91^{Q}	89.18^{a}	85.63^{b}	69.23^{e}	81.34^{P}
OL-10	5.05^{a}	3.22^{e}	2.68^{g}	3.63^{P}	2.71^{a}	1.78^{de}	1.80^{de}	2.10^{P}	87.71^{ab}	81.93^{cd}	66.53^{f}	78.72^{R}
OL-125	4.43^{c}	3.22^{e}	2.80^{f}	3.48^{Q}	2.27^{c}	1.63^{fg}	1.72^{ef}	1.87^{Q}	88.19^{a}	82.96^{c}	68.92^{e}	80.02^{Q}
Overall mean	4.79^{X}	3.24^{Y}	2.62^{Z}		2.58^{X}	1.75^{Y}	1.62^{Z}		88.39^{X}	82.61^{Y}	67.67^{Z}	
CD (5%)	A= Genotype 0.031, B=N level 0.031,C=Growth stage 0.027, AB = 0.0615, ABC=0.106				A= Genotype 0.030, B=N level 0.030, C=Growth stage 0.026, AB = 0.060, AC=0.052, BC=0.052, ABC= 0.104				A= Genotype 0.724, B=N level 0.724, C=Growth stage 0.627, AB = 1.44, AC=1.25, BC=1.25, ABC= 2.51			

Values with same letter(s) are not significantly different at $P< 0.05$ (Tukey's post-hoc test)

Table 2. Acid detergent fiber, neutral detergent fiber and crude fiber of oats at different growth as influenced by different N levels.

Nitrogen application	**Acid detergent fiber (%)**				**Neutral detergent fiber (%) Days after sowing (DAS)**				**Crude fiber (%)**			
Nitrogen doses	**30**	**45**	**60**	Mean	**30**	**45**	**60**	Mean	**30**	**45**	**60**	Mean
0 Kg N/ha	33.84c	33.68c	37.08a	34.87	38.98h	48.90d	54.75a	47.54	18.80h	24.42bc	26.36a	23.23
50 Kg N/ha	27.76e	30.80d	35.15b	31.24	36.23i	45.80e	52.37b	44.80	17.15i	23.22de	24.68b	21.68
75 Kg N/ha	25.66f	28.80e	33.22c	29.23	34.15j	43.95f	50.89c	43.00	15.09j	22.22f	23.75cd	20.35
100 Kg N/ha	23.89g	26.37f	31.60d	27.29	32.44k	41.16g	48.17d	40.59	13.31k	20.98g	22.73ef	19.01
Genotypes												
OL-9	25.98^{h}	31.19^{cd}	34.79^{a}	30.66^{Q}	34.12^{g}	43.47^{e}	53.36^{a}	43.65^{Q}	17.03^{e}	23.01^{c}	23.05^{c}	21.03^{Q}
Kent	31.73^{c}	29.34^{ef}	34.15^{a}	31.74^{P}	36.99^{f}	44.62^{de}	49.38^{b}	43.66^{Q}	14.53^{g}	22.26^{c}	24.00^{b}	20.26^{R}
OL-10	27.48^{g}	30.27^{de}	35.13^{a}	30.96^{Q}	33.93^{g}	46.53^{c}	53.28^{a}	44.58^{P}	15.59^{f}	24.79^{ab}	24.88^{ab}	21.75^{P}
OL-125	25.98^{h}	28.87^{f}	32.99^{b}	29.28^{R}	36.78^{f}	45.19^{d}	50.18^{b}	44.05^{PQ}	17.20^{e}	20.79^{d}	25.62^{a}	21.20^{Q}
Overall mean	27.79^{Z}	29.92^{Y}	34.27^{X}		35.45^{Z}	44.95^{Y}	51.55^{X}		16.09^{Z}	22.71^{Y}	24.39^{X}	
CD (5%)	A= Genotype 0.357, B=N level 0.357, C=Growth stage 0.309, AB = 0.714, AC=0.618, BC=0.618, ABC=1.23				A= Genotype 0.418, B=N level 0.418, C=Growth stage 0.362, AB = 0.836, AC= 0.724, BC= NS, ABC= 1.448				A= Genotype 0.306, B=N level 0.306, C=Growth stage 0.266, AB = 0.614, AC=0.531, BC=0.531, ABC=1.063			

Values with same letter(s) are not significantly different at $P< 0.05$ (Tukey's post-hoc test)

Table 3. Ether extract, ash content and free amino acids content of oats at different growth as influenced by different N levels.

Nitrogen application	Ether extract (%)				Ash content (%) Days after sowing (DAS)				Free amino acids content (mg/g)			
Nitrogen doses	30	45	60	Mean	30	45	60	Mean	30	45	60	Mean
0 Kg N/ha	4.05f	3.07k	3.51h	3.54	14.62de	14.28e	11.34h	13.41	1.38i	2.34g	3.32	2.35
50 Kg N/ha	4.44c	3.29j	3.83g	3.85	15.14cd	14.96cde	11.77gh	13.96	1.79h	2.83e	3.70c	2.77
75 Kg N/ha	4.78b	3.43i	4.14e	4.15	16.00b	15.57bc	12.23fg	14.60	2.19g	3.22d	4.03b	3.15
100 Kg N/ha	4.98a	3.79g	4.34d	4.37	17.4a	16.17b	12.92f	15.50	2.56f	3.57d	4.32a	3.48
Genotypes												
OL-9	5.14^{a}	3.30^{j}	4.23^{d}	4.22^{P}	15.55^{c}	14.55^{d}	12.52^{e}	14.21^{QR}	2.20^{g}	3.37^{d}	3.96^{b}	3.17^{P}
Kent	4.84^{b}	3.17^{k}	3.50^{i}	3.83^{S}	16.37^{ab}	15.63^{bc}	11.94^{e}	14.65^{P}	1.85^{h}	2.78^{f}	3.47^{cd}	2.70^{Q}
OL-10	4.41^{c}	3.49^{i}	3.95^{f}	3.95^{Q}	15.84^{abc}	14.38^{d}	12.01^{e}	14.08^{R}	2.15^{g}	3.10^{e}	4.34^{a}	3.20^{P}
OL-125	3.88^{g}	3.63^{h}	4.14^{e}	3.88^{R}	15.41^{c}	16.43^{a}	11.80^{e}	14.54^{PQ}	1.73^{h}	2.72^{f}	3.61^{c}	2.69^{Q}
Overall mean	4.56^{X}	3.40^{Z}	3.96^{Y}		15.79^{X}	15.25^{Y}	12.07^{Z}		1.98^{Z}	2.99^{Y}	3.85^{X}	
CD (5%)	A= Genotype 0.022, B=N level 0.022, C=Growth stage 0.019, AB = 0.044, AC=0.038, BC=0.038, ABC=0.076				A= Genotype 0.264, B=N level 0.264, C=Growth stage 0.228, AB = NS, AC=0.457, BC=0.457, ABC= NS				A= Genotype 0.065, B=N level 0.065, C=Growth stage 0.057, AB = 0.131, AC=0.113, BC=NS, ABC= 0.277			

Values with same letter(s) are not significantly different at $P< 0.05$ (Tukey's post-hoc test)

Table 4. Yield and yield parameters of oats (*Avena sativa* L.) at 60 DAS as influenced by different N levels.

Nitrogen doses	Green fodder yield	Dry fodder yield	Plant height	Leaf length	Leaf breadth	No. of tillers	Leaf/stem
0 Kg N/ha	42613a	57.77d	100.43c	113.42d	2.69d	52.75c	0.52c
50 Kg N/ha	324.47b	87.22c	118.67b	127.50c	3.00c	69.75b	0.61bc
75 Kg N/ha	337.47b	94.03b	123.38ab	138.92b	3.24b	75.21b	0.65ab
100 Kg N/ha	426.13a	130.13a	130.98a	149.58a	3.51a	88.25a	0.73a
Genotypes							
OL-9	320.56^{c}	86.47^{c}	118.3^{ab}	140.7^{a}	3.1^{c}	83.8^{b}	0.66^{a}
Kent	333.63^{b}	97.51^{a}	124.0^{a}	125.7^{b}	2.4^{d}	91.4^{a}	0.66^{a}
OL-10	341.86^{a}	92.36^{b}	118.2^{ab}	140.9^{a}	3.5^{a}	76.2^{b}	0.59^{a}
OL-125	325.64^{c}	92.80^{b}	110.5^{b}	122.2^{b}	3.4^{b}	72.3^{b}	0.58^{a}
Overall mean	330.42	92.29	117.8	132.4	3.1	77.8	0.62
CD (5%)	A= Genotype 4.30, B= N level 4.30, AB= 8.61	A= Genotype 3.08, B= N level 3.08, AB= 6.16	A= Genotype 6.74, B= N level 6.74, AB= NS	A=Genotype 3.68 , B= N level 3.68, AB= 7.36	A= Genotype 0.07, B= N level 0.07, AB= 0.16	A=Genotype 5.67, B= N level 5.67, AB= 11.34	A= Genotype NS, B= N level 0.09, AB= NS

Values with same letter(s) are not significantly different at $P< 0.05$ (Tukey's post-hoc test)

Table 5. Correlation coefficient between quality components of oats at different growth stages.

Quality components	DAS	Total Nitrogen	Non protein nitrogen	Ether extract	Ash	Free amino acids	*In vitro* dry matter digestibility	Acid detergent fibre	Neutral detergent fibre
Non protein nitrogen	30	.906**							
	45	.934**							
	60	.892**							
Ether extract	30	.662**	.777**						
	45	.701**	.576*						
	60	.849**	.816**						
Ash	30	.805**	.744**	.603*					
	45	.561*	.330	.540*					
	60	.538*	.606*	.728**					
Free amino acids	30	.792**	.831**	.706**	.770**				
	45	.872**	.970**	.591*	.215				
	60	.731**	.835**	.712**	.693**				
In vitro dry matter digestibility	30	.662**	.638**	.615*	.719**	.679**			
	45	.700**	.640**	.571*	.661**	.533*			
	60	.496	.413	.286	.381	.217			
Acid detergent fibre	30	-.594*	-.550*	-.369	-.480	-.751**	-.607*		
	45	-.795**	-.682**	-.774**	-.707**	-.601*	-.900**		
	60	-.740**	-.662**	-.656**	-.628**	-.500*	-.884**		
Neutral detergent fibre	30	-.886**	-.879**	-.636**	-.697**	-.906**	-.609*	.809**	
	45	-.936**	-.902**	-.599*	-.569*	-.849**	-.659**	.730**	
	60	-.455	-.383	-.308	-.500*	-.204	-.934**	.833**	
Crude fibre	30	-.610*	-.456	-.129	-.750**	-.581*	-.606*	.460	.518*
	45	-.860**	-.800**	-.751**	-.668**	-.723**	-.857**	.887**	.801**
	60	-.752**	-.679**	-.724**	-.746**	-.700**	-.657**	.817**	.620*

** - Significant at p 0.01, * - Significant at p 0.05

Table 6. Correlation coefficient between quality components of oats at recommended (75 Kg N/ha) nitrogen dose.

	Total Nitrogen	Non protein nitrogen	Ether extract	Ash	Free amino acids	*In vitro* dry matter digestibility	Acid detergent fibre	Neutral detergent fibre
Non protein nitrogen	.924**							
Ether extract	.587*	.767**						
Ash	.725**	.551	.127					
Free amino acids	.835**	.661*	.140	.903**	-.890**			
Acid detergent fibre	-.855**	-.679**	-.225	-.707*	.886**	-.861**		
Neutral detergent fibre	-.968**	-.837**	-.447	-.768**	.922**	-.891**	.890**	
Crude fibre	-.917**	-.852**	-.690*	-.716**	.871**	-.740**	.686*	.909**

** - Significant at p 0.01, * - Significant at p 0.05

and Bermuda grass (Kering *et al.,* 2011). From high yielding mal feeding point of view, fodder with low ADF as well as NDF is always preferred.

The content of Neutral detergent fiber (NDF) increased significantly (F= 3946.48, p<0.001) with growth of plant (Table 2). On average at each growth stage, maximum content was observed at 60 DAS (51.55%). Firdous and Gilani (2001) also observed increased NDF content with plant's growth in sorghum species. N fertilization resulted in significant (F= 389, p<0.001) decrease in NDF content in fodder oats. On average, minimum NDF content was observed in OL-9 genotype (43.65 %). Patel *et al.* (2007) reported that increased supply of N fertilization and other minerals resulted in decreased levels of NDF content in fodder maize. Balabanli *et al.* (2010) also reported that NDF content peaked at low fertilizer levels and then decreased with increasing fertilizer rates.

Crude fiber (CF) mainly consists of cellulose, hemicelluloses and lignin. CF content above 30-35% is usually considered undesirable component in forages (Table 2). CF content increased significantly (F= 2152.67, p<0.001) with growth of plant and was found maximum at 60 DAS (24.39%) and minimum at 30 DAS (16.09%). Similar results were observed in oats (Xiangfeng *et al.,* 2007). Higher doses of N fertilization resulted in significant (F= 8.27, p<0.001) decrease in the CF content. This might be due to the fact that nitrogen application increased the uptake of nitrogen which is the constituent of amino acids and protein and decreased the pectin, cellulose and hemicellulose content which are major constituents of fibre (Babu *et al.,* 1995). Maximum CF content in all genotypes was observed at control conditions (0 Kg N/ha). Among different N fertilization rates, mean values showed minimum CF content in Kent genotype (20.26 %). Similar results were reported in oats (Iqbal *et al.,* 2013), fodder sorghum (Singh and Sumeriya, 2012), pearl millet (Rostamza *et al.,* 2011) and cowpea (Hasan *et al.,* 2010). The fodder having less crude fiber percentage is considered a good quality because higher the crude fiber percentage lesser will be digestibility. Therefore, because the application of nitrogen decreased fiber content, so it increased digestibility of the plants. Significant differences were depicted in crude fiber among genotypes and maximum CF content was observed in OL-10 genotype (21.75%).

Ether extract (EE) is composed of fats, oils, waxes, organic acids, pigments, sterols and vitamins A, D, E and K.Ether extractcontent varied significantly among different growth stages (F= 7446.57, p<0.05). At 30 and 60 DAS maximum EE content in OL-9 genotype (5.14 % and 4.23 % resp.) and at 45 DAS in OL-125 genotype (3.63 %) was observed (Table 3). Increasing N levels, increased EE content significantly (F= 2055.74, p<0.001) at different growth stages of fodder oats. Earlier investigation by Uddin *et al.,* (2005) who reported that EE content of oat forage increased significantly (P<0.01) with the increasing level of N fertilizer from 0 to 115 kg N/ha. Similar trend of EE content with increasing dose of N fertilization was observed in fodder oats (Kumari *et al.,* 2014 ;Vuckovic *et al.,* 2005) and fodder pearl millet (Meena *et al.,* 2012).

Ash content was observed maximum at early growth stages of oats fodder (Table 3) and decreased significantly with plant's growth (F= 610.75, p<0.05). Similar results were observed in baby corn that mineral content was observed higher at early growth stages as compared to later growth stages (Thavaprakaash *et al.,* 2008). N application significantly increased total ash content (F= 90.31, p<0.001). Increase in ash content with increasing dose of N fertilization may be due to the increased availability of N to the plants and mineral matter. Ruso (2006) explained that rates of nitrogen inputs are to maximize the level of nutrients in plants.Similar results were observed in fodder oats (Kumari *et al.,* 2014 and Mahale *et al.,* 2003), mustard (Paul *et al.,* 2014) and fodder sorghum (Ayub*et al.,* 2002). The data presenting the ash contents showed that oats genotypes exhibited significant (F= 8.36, p<0.05) variations for ash contents. Mean values showed maximum ash content in Kent genotype (14.65%) and minimum in OL-10 genotype (14.08 %). The significant variations in ash contents among oats genotypes have already been confirmed (Khan *et al.,*2014). This may be due to differences in nutrient absorption from soil and utilization within the plants by different genotypes.

Free amino acid content was observed maximum at 60 DAS (3.85 mg/g) followed by 45 DAS (2.99 mg/g) and 30 DAS (1.98 mg/g) (F= 2128.87, p<0.001) (Table 3). Roy *et al.* (2013) observed highest amino acid content in mature leaves followed by young and senescent leaves in sunflower. Treatment with nitrogen fertilization resulted in significant increase in free amino acids content (F=439.18, p<0.001). Similar results were observed in wheat (Kaur *et al.,* 2015) and maize (Losak *et al.,* 2010) crop.

Yield: GFY increased significantly (F= 2781.08, p<0.001) with N fertilization. Khogali *et al.,* (2011) observed increasing trend of GFY with N fertilization in fodder oats. Similar results were observed by some other researchers in maize (Paschalidis X *et al.,* 2015 and Sharma *et al.,* 2016), oats (Kumari *et al.,* 2014), pearl millet (Shahin *et al.,*2013 and Ayub *et al.,* 2007) and napierbajra hybrid (Tiwana*et al.,* 2004). The yield of an agricultural crop strongly dependent on the supply of mineral nutrients, particularly N (Sawan, 2006). Among genotypes, mean values showed maximum GFY content in OL-10 (341.86 q/ha) and minimum in OL-9 (320.56 q/ha). Genotypic differences were also observed in pearl millet (Damame *et al.,* 2013) and fodder sorghum (Singh and Sumeriya, 2012). Significant interaction was observed between genotypes and N levels (F= 67.74, p<0.001).

Dry fodder yield (DFY) increased significantly (F=775.9, p<0.001) with N fertilization. Similar results were observed in fodder sorghum (Somashekar*et al.,*2014 ; Damame *et al.,* 2013), *Brassica rapa* L (Paul *et al.,*2014), and fodder maize (Gasim, 2001). In a study, DM yield of some tropical grasses had peaked at N application of 300 Kg/ha (Rahman *et al.,* 2008). Among genotypes, mean values showed maximum DFY in Kent (97.51 q/ha) and minimum in OL-9 (86.47 q/ha). Genotypic differences were also observed in pearl millet (Damame *et al.,* 2013) and fodder sorghum (Dixit *et al.,* 2005). Significant interaction (F=7.14, p<0.001) between genotypes and N levels were observed.

Growth attributes: Plant height increased significantly (F=30.96, p<0.001) with N fertilization. Maximum plant height was observed at 100 Kg N/ha. An increase in plant height with N fertilization was observed in maize (PaschalidisX *et al.,*2015 and Sharma *et al.,* 2016)*,* oats (Dawit and Wegi 2014) and rice (Mizan*et al.,*2010). Several other researchers also found positive relation of N fertilization with plant height (Dubey *et al.*2013, Shahin *et al.,*2013, Oad*et al.,*2004 and Gasim, 2001). Genotypes varied significantly (F=7.86, p<0.01) in terms of plant height. Among genotypes mean values showed maximum plant height in Kent (124 cm).

Leaf length increased significantly (F= 147.93, p<0.001) with N fertilization. Similar results of increasing leaf length with N fertilization were reported in fodder maize varieties (Amin and Hasan, 2011). An increased leaf area index with N fertilization was observed in oats varieties (Dubey *et al.,*2013) and in chickpea (Namvar*et al.,*2011). Among genotypes, mean values showed maximum leaf length in OL-10 (140.9 cm) and minimum in OL-125 (122.2 cm). Similar results were observed in oats varieties (Dubey *et al.,*2013).

Leaf breadth increased significantly (F=158.24, p<0.001) with N fertilization. An increase in leaf area index with N fertilization was observed in maize (Tajul *et al.,* 2013, Amin and Hasan, 2011, Aslam *et al.,* 2011 ;Onasanya *et al.,* 2009), wheat (Kibe *et al.,* 2006), soyabean (Malik *et al.,* 2006), barley (Alam and Haider, 2006) and mottgrass (Zahid *et al.,* 2002). Among genotypes, mean values showed maximum leaf breadth in OL-10 (3.5 cm) and minimum in Kent (2.4 cm).

No. of tillers increased significantly (F=56.03, p<0.001) with nitrogen fertilization. Similar results were obtained in oats fodder by several researchers (Ahmad *et al*., 2011, Hasan and Shah, 2000). The number of tillers increased with increase in N fertilization in the second growth of crop in Ruzi grass (Batista *et al.,* 2014). Among genotypes, maximum no. of tillers was observed in Kent (91.4). Significant interaction (F= 3.04, p>0.01) between genotypes and N levels.

Leaf/stem ratio is an important component of forage quality. It varied non- significantly (F=7.80, p<0.05) with N fertilization. An increase in L/S with N application upto 80 Kg N/ha and then decrease at 120 kg N/ha in fodder oats (Luikham*et al.,* 2012). Similar results were reported in oats (Dawit and Wegi, 2014) and fodder maize (Sharma *et al.,* 2016 and Gasim, 2001). Among genotypes, mean values showed maximum leaf/stem was in OL-9 (0.66) and Kent (0.66). Non-significant (F= 0.31, p>0.05) interaction was observed between genotype and N level.

Correlation studies: At recommended dose of nitrogen fertilization (75 Kg N/ha) significant positive correlation was observed between total nitrogen, non protein nitrogen, ash and *in vitro* dry matter digestibility (Table 5). However, negative correlation was observed N levels with acid detergent fiber, neutral detergent fiber and crude fiber (Table 6). At different growth stages significant negative correlation was observed between ADF, NDF and CF content.

Conclusion

From present study it can be concluded that nitrogen doses and growth stages significantly affect the quality of fodder oats. As the growth of plant continued; non protein nitrogen, total nitrogen and ether content decreased significantly but ADF, NDF and CF increased affecting the digestibility of crop. With increased dose of N application cell wall constituents i.e. ADF, NDF and CF decreased significantly.

REFERENCES

Ahmad, A. H., Tariq, M., Ayub, M., Elahi, M., Chaudhary, M. N. and Nadeem, M. A. (2011). Forage yield and some quality attributes of mille (*Pennisetuma mericanum* L.) hybrid under various regimes of nitrogen fertilization and harvesting dates. *African Journal of Agricultural Reserach,* 6(16): 3883-90.

Alam, M. Z. and Haider, S. A. (2006). Growth attributes of barley (*Hordeum Vulgare* L.) cultivars in relation to different doses of nitrogen fertilizer. *Journal of Life and Earth Science,*1(2): 77-82.

Amin, M. and Hasan, E. M.,(2011). Effect of different nitrogen sources on growth, yield and quality of fodder maize (*Zea mays* L.). *Journal of Saudi Society of Agricultural Sciences,*10: 17-23.

AOAC (1970). *official Methods of Analysis* (11th ed.) Association of official analytical chemists, Washington, D.C.

Arshadullah, M., Malik, M. A., Rasheed, M., Jilani, G., Zahoor, F. and Kaleem, S. (2011). Seasonal and Genotypic Variations Influence the Biomass and Nutritional Ingredients of Cenchrusciliaris Grass Forage. *International Journal Of Agriculture & Biology,*13:120-124.

Aslam, M., Iqbal, S., Zamir, M. S. I., Mubeen, M. and Amin, M. (2011). Effect of different nitrogen levels and seed rates on yield and quality of maize fodder. *Crop & Environment,* 2(2): 47-51.

Ayub, M., Nadeem, M. A. andSuleheri, M. J. (2003). Effect of harvesting times on maize fodder yield and quality. *Bangladesh Journal of Agriculture*, 27: (28) 71-5.

Ayub, M., Nadeem, M. A., Tanveer, A. and Husnain, A. (2002). Effect of different levels of nitrogen and harvesting times on growth, yield and quality of sorghum fodder. *Asian Journal of Plant Sciences,*4: 304-7.

Ayub, M., Nadeem, M. A, Tanvir, A, Tahir, M., Khan, R. M. A. 2007. Interactive effect of different nitrogen levels and seeding rates on fodder yield and quality of pearl millet. *Pakistan Journal of Agricultural Science,* 44: 592-6.

Babu, R., Gumaste, S., Patil, T.C. and Prabhakar, A.S. (1995). Effect of stage of cutting, nitrogen and phosphorus levels on forage pearl millet [*Pennisetum glaucum* (L.)]. *Forage research*,20(4): 225-31.

Balabanli, C., Albayrak, S. and Yüksel, O. (2010). Effects of nitrogen, phosphorus and potassium fertilization on the quality and yield of native rangeland. *Turkish Journal of Field Crops,* 15(2): 164-8.

Ball, D. M., Collins, M., Lacefield, G. D., Martin, N. P., Mertens, D. A., Olson, K. A., Putnam D. H., Undersander, D. J. and Wolf, M. W. (2001). Understanding Forage Quality. American Farm Bureau Federation Publication 1-01, Park Ridge, Illinois, USA.

Batista, K., Giacomini, A. A., Gerdes, L., Mattos, W. T., Colloza, M. T. and Otsuk, I. P. (2014). Influence of Nitrogen on the production characteristics of ruzi grass. *African Journal of Agricultural Research,* 9(5):533-8.

Bayble, T., Melaku, S. and Prasad, N. K. (1995). Effects of cutting dates on nutritive value of Napier (*Pennisetum purpureum*) grass planted sole and in association with Desmodium (*Desmodium intortum*) or Lablab (*Lablab purpureus*). In: Proceedings of 3rd National Conference of the Ethiopian Society of Animal Production, Pp. 316-322

Damame, S. V., Bhingarde, R. N. and Pathan, S. H. (2013). Effect of different nitrogen levels on nutritional quality and nitrate nitrogen accumulation in forage pearl millet genotypes grown under rainfed conditions. *Forage Research,* 39(2): 93-95

Dawit, A. and Wegi, T. (2014). Determination of optimum seed and fertilizer rate for fodder oat in Bale Highland South eastern Ethopia. *International Journal of Soil and Crop Science,* 2(7): 73-76

Devi, L. G. (2002). Forage yield of maize (*Zea mays* L.) as influenced by nitrogen levels and bio-fertilizers. Forage Research 27: 263-6

Dixit, A. K.., Kachroo, D. and Bali, A. S. (2005). Response of promising rainy season sorghum [*Sorghum bicolor* (L.) Moench] genotypes to nitrogen and phosphorus fertilization. *Indian Journal of Agronomy*, 50 : 206-9

Dubey, A., Rathi, G. S. and Sahu, R. (2013). Effect of nitrogen levels on green fodder yield of oat (*Avena sativa*) varieties. *Forage Research,* 39(1): 39-41

Eppendorfer, W. H. (1971). Effect of sulfur, nitrogen and phosphoruson the amino acid composition of the field bean (*Viciafaba*) and responses of the biological value of the seed protein and sulfur-amino acid content. *Journal of Science and Food Agriculture,* 22:501-5

Firdous, R. and Gilani, A. H. (1998). Effect of stage of growth and cultivator on chemical composition of whole maize plant and its morphological fractions. *Asian-Australian Journal of Animal Sciences,* 12(3): 366-370

Firdous, R. and Gilani, A H. (2001). Changes in chemical composition of sorghum as influenced by growth stage and cultivar *Asian-Australian Journal of Animal Sciences,* 7:935-40

Gasim, S. H. (2001). *Effect of nitrogen, phosphorus and seed rate on growth, yield and quality of forage maize* (*Zea mays* L.). M.Sc.Thesis, Faculty of Agric Univ of Khartoum.

Georing, H. K. and Van Soest, P. J. (1970). *Forage fibre analysis*, Apparatus reagents, procedures and some application. Agriculture hand book No. 379, USA Washington, D.C.

Gul, I., Demirel, R., Kilicalp, N., Sumerli, M. and Kilc, H. (2008). Effect of crop maturity stages on yield, silage chemical composition and in-vivo digestibilities of maize, sorghum and sorghum-sudangrass hybrids grown in semi-arid conditions. *Journal of Animal and Veterinary*, 7: 1021-28.

Hasan, B. and Shah, W. A. (2000). Biomass grain production and quality of oat (*Avena sativa*) under different cutting regimes and nitrogen levels. *Cereal Reserach Communication,* 28:203-10.

Hasan, M. R., Akbar, M. A., Khandaker, Z. H. and Rahman, M. M. (2010). Effect of nitrogen fertilizer on yield contributing character, biomass yield and nutritive value of cowpea forage. *Bangaldesh Journal of Animal Sciences,* 39(1&2): 83-88.

Iqbal, M. F., Iqbal, Z., Farooq, M., Ali, L. and Fiaz, M. (2013). Impact nitrogenous fertilizer on yield and quality of oat. *Pakistan Journal of Science,* 65(1): 1-4.

Karasu, A., Oz, M., Bayram, G., Turgut, I. (2009). The effect of nitrogen levels on forage yield and some attributes in some hybrid corn (*Zeamays*indentata Sturt.) cultivars sown as second crop for silage. *African Journal of Agricultural Research*., 4:166-70.

Karic, L., Vukasinovic, S. and Znidarcic, D. (2005). Response of leek (*Allium porrum* L.) to different levels of nitrogen dose under agro-climate conditions of Bosnia and Herzegovina. *Acta AgriculturaeSlovenica*, 85: 219-6.

Kaur, G., Asthir, B., Bains, N. S. and Farooq, M. (2015) Nitrogen nutrition, its assimilation and remobilization in diverse genotypes.*International Journal of Agricultural Biology,* 17:531-8.

Kering, Maru, K., Guretzky, J., Funderburg, E. and Mosali, J. (2011). Effect of nitrogen fertilizer rate and harvest season on forage yield, quality and macronutrient concentrations in midland bermuda grass. *Communication in Soil Sciences and Plant Analysis Journal,* 42:1958-71.

Keskin, B., Akdeniz, H., Yilmaz, I. H., Turan, N. (2005). Yield and quality of forage corn (*Zea mays* L.) as influenced by cultivars and nitrogen rates.*Jouranl of Agronomy*, 4: 138-41.

Khan, A., Anjum, M. H., Rehman, M. K. U., Zaman, Q. and Ullah, R.(2014). Comparative Study on Quantitative and Qualitative Characters of Different Oat (*Avena sativa L.*) genotypes under Agro-Climatic conditions of Sargodha,Pakistan. *American Journal of Plant Sciences,* 5: 3097-103.

Khan, H. K., Khan, A. G., Sarwar, M., Azim, A. (2007). Effect of maturity on production efficiency, nutritive value, and in-situ nutrient digestibility of three cereal fodders. *International Journal of Agricultural Research,* 2: 900-9.

Khogali,Muna, E., DagashYassin, M. I. and EL-Hag Mahgoub, G. (2011).Productivity of fodder beet (*Beta vulgaris* var. Crassa) cultivars affected by nitrogen and plant spacing. *Agriculture and Biology Journal North America,* 2(5): 791-98.

Kibe, A. M., Singh, S. and Karla, N. (2006). Water nitrogen relationship for wheat growth and productivity in late sown conditions. *Agricultural water Management,* 8(4): 221-28.

Kumar, S., Agrawal, R. K., Dixit, A. K., Rai, A. K., Singh, J. B., Rai, S. K. (2012). Forage Production Technology for Arable Lands. Technology Bulletin No. 01/2012.

Kumari, A., Kumar, P., Ahmad, E., Singh, M., Kumar, R., Yadav, R. K., Datt, C. and Chinchmalatpure, A. (2014). Fodder yield and quality of oat fodder (*Avena Sativa*) as influenced by salinity of irrigation water and applied nitrogen levels. *Indian Journal of Animal Nutrition,*31 (3): 266-71.

Lea, Y. P. and Takahashi, T. (1966). An improved colorimetric determination of amino acid with the use of ninhydrin. *Analytical Biochemistry,* 14: 71-77.

Liu, C. W., Sung, Y., Chen, B. C. and Lia, H. Y. (2014). Effects of nitrogen fertilizers on the growth and nitrate content of lettuce (*Lactuca sativa* L.). *International Journal of Environmental Research and Public Health,* 11:4427-40.

Losak, T., Vollmann, J., Hlusek, J., Peterka, J., Filipik, R. and Praskova, L.(2010). Influence of combined nitrogen and sulphur fertilization on false flax (*Camelina sativa* L. Crtz.) yield and quality. Acta Aliment, 39:431-44.

Luikham, E., Kamei, S. and Mariam, Anal, P. S.,(2012). Yield, quality and economics of oat fodder (*Avena sativa* L.) as influenced by nitrogen and varieties. *Forage Research,* 38(2): 112-4.

Mahale, B. B., Nevase, V. B., Thorat, S. T. and Dhekale, J. S. (2003). Effect of non-symbiotic nitrogen fixers on the forage yield of oat (*Avena sativa* L). *Annals of Agriculture Research Indian Society of Agriculture Sciences,* 24: 121-3.

Malik, M. A., Cheema, M. A., and Khan, H. Z. (2006). Growth and yield response of soybean (*Glycine max* L.) to seed inoculation and varying phosphorus levels. *Journal of Agricultural Research,* 44(1): 47-53.

McDonald, P., Edwards, R. A., Greenhalgh, J. F. D. and Morgan, C. A. (2001). Animal Nutrition (6th ed.). Prentice Hall, Essex. Pp. 495-514.

Meena, S. N., Jain, K. K., Prasad, D. and Ram, A. (2012). Effect of nitrogen on growth, yield and quality of fodder pearl millet (*Pennisetum glaucum*) cultivars under irrigated conditionof North-Western Rajasthan. *Annals of Agriculture Research New Series,* 33 (3) : 183-188

Mizan, R. (2010). Effect of nitrogen and plant spacing on the yield of *Boro rice* cv. BRRI dhan45. Pp. 32

Namvar, A., Sharifi, R. S. and Khandan, T. (2011). Growth analysis and yield of chickpea (*Cicerarietinum* L.) in relation to organic and inorganic nitrogen fertilization. *Ekologija,* 57(3): 97–108.

Njidda, A. A. (2014). Determining dry matter degradability of some semi-arid browse species of north- eastern Nigeria using the in vitro technique. *Nigerian Journal of Basic and Applied Science,* 18(2): 160-167.

Oad, F. C., Buriro, U. A. and Agha, S. K. (2004). Effect of organic and inorganic fertilizer application on maize fodder production. *Asian Journal of Plant Sciences,* 3:375-7.

Onasanya, R. O.,Aiyelari, O. P., Onasanya, A., Oikeh, S., Nwilene, F. E., and Oyelakin, O. O.,(2009). Growth and yield response of maize (*Zea mays* L.) to different rates of nitrogen and phosphorus fertilizers in southern Ngeria. *World Journal of Agricultural Sciences,* 5 (4): 400-7.

Paschalidis, X., Ioannou, Z., Mouroutoglou, X., Koriki, A., Kavvadias, V., Baruchas, P., Chouliaras, I. and Sotiropoulos, S. (2015). Effect of Fertilization and Irrigation on Plant Mass Accumulation and Maize production (*Zea mays*). *International Journal of Waste Resources,* 5(1): 1000173.

Patel, A. S., Sadhu, A. C., Patel, M. R. and Patel, P. C. (2007) Effect of zinc, FYM and fertility levels on yield and quality of forage maize *Forage Research,*32(4): 209 -12.

Pathan, S. H., Tumbare, A. D. and Kamble, A. B. (2012). Impact of planting material, cutting management and fertilizer levels on nutritional quality of bajra x napier hybrid. *Forage Research,*38(2): 74-79

Paul, K., Chopra, N. K., Soni, P. G., Kumar, R. and Mondal, G. (2014). Influence of Different Nitrogen Levels and Weed Control on Yield and Chemical Composition of Mustard (*Brassica rapa L. sub. chinensis*) Fodder. *Indian Journal of Animal Nutrition,* 31 (4): 400-3.

Rostamza, M., Mohammad-Reza, C., Mohammad-Reza, J. and Ahmad, A. (2011). Forage quality, water use and nitrogen utilization efficiencies of pearl millet (*Pennisetumamericanum*L.) grown under different soil moisture and nitrogen levels. *Agricultural Water Management,*98: 1607-14.

Roy, N., Laskar, S. and Barik, A. (2013). Amino acids through developmental stages of sunflower leaves.*Acta Bot Croat,* 72 (1): 23–33.

Ruso, V. M. (2006). Mineral nutrient and protein contents in tissues and yield of navy bean, in response to nitrogen fertilization and row spacing. *Journal of Food Agriculture and Environment,* 4(2): 168-71.

Russel, J. R., Irlbeck, N. A., Hallauer, A. R., Buxton, D. R. (1992). Nutritive value and ensiling characteristics of maize herbage as influenced by agronomic factors. *Animal Feed Science Technology*, 38: 11-24.

Sawan, Z. M. (2006). Egyptian cotton (*Gossypiumbarbadense*L.) yield as affected by nitrogen fertilization and foliar application of potassium and mepiquat chloride. *Commun Bio Crop Science,* 1(2): 99 -105.

Shahin, M. G., Abdrabou, R. Th., Abdelmoemn, W. R. and Hamada, M. M. (2013). Response of growth and forage yield of pearl millet (*Pennisetumgalucum*) to nitrogen fertilizer rates and cutting height. *Annals of Agricultural Sciences,* 58(2): 153–62.

Sharma, A. K., Sharma, A. K., Sharma, R. K., Rajiv, B. and Rai, P. K. (2012). Effect of different levels of nitrogen, organic manure and planting time on yield and quality of hybrid napier. *Indian Journal of Animal Nutrition,* 29 (1): 33-39.

Sharma, P. K., Kalra, V. K. and Tiwana, U. S. (2016). Effect of farmyard manure and nitrogen levels on growth, quality and fodder yield of summer maize (*Zea mays* L.). *Agricultural Research Journal,* 53(3): 355-59.

Singh, P. and Sumeriya, H. K. (2012). Effect of nitrogen on yield, economics and quality of fodder sorghum genotypes. *Annals of Plant and Soil Research,* 14(2):133-5.

Somashekar, K. S., Shekara, B. G., Kalyana, Murthy, K. N. and Harish, L. (2014). Yield, nitrogen uptake, available soil nutrients and economics of multicut fodder sorghum (*Sorghum sudanense* L.) to different seed rates and nitrogen levels. *Forage Research,* 40(1): 23-27.

Tajul, M. I., Alam, M. M., Hossain, S. M. M., Naher, K., Rafii, M. Y. and Latif, M. A. (2013). Influence of Plant Population and Nitrogen-Fertilizer at Various Levels on Growth and Growth Efficiency of Maize. *Scientific World Journal,* 1-9.

Taute, A., Van Niekerk, W. A., Rethman, N. F. G. and Coertze, R. J. (2002). An evaluation of nitrogen fertilised-*Panicum maximum* cv. Gatton at different stages of maturity during autumn: 1. Dry matter yield and certain qualitative parameters. *South African Journal of Animal Sciences,* 32(3): 208-15.

Tena, W. and Beyene, S. (2011). Identification of growth limiting nutrient(s) in alfisols: Soil physico-chemical properties, nutrient concentrations and biomass yield of maize. *American Journal of Plant Nutrition Fertilizer Technology,* 1: 23-35

Thavaprakaash, N., Velayudham, K. and Muthukumar. (2008). Response of crop geometry, intercropping systems and INM practices on yield and fodder quality of baby corn. *Asian Journal of Scientific Research,* 1(2): 153-59.

Tilley, J. M. A. and Terry, R. A. (1963). A two stage technique for the *in vitro* digestion of force crops. *British Journal of Grassland Society,* 18:104-11.

Tiwana, M. S., Puri, K. P., Tiwana, U. S. and Singh, A. (2004). Forage production potential of napier-bajra hybrid varieties under different nitrogen levels. *Forage Research,* 30: 80-85.

Uddin, M. M., Khandaker, Z. H., Sultana, M. N. (2005). Effect of levels of nitrogen with or without phosphorus fertilizer on oat (*Avena sativa*) forage production harvested at various ages: II. Nutritive value and macro mineral contents. *Bangladesh Journal of Animal Sci*ences, 34 (1-2): 73-81.

Vuckovic, S., Simic, A., Dordivic, N., Zivanovic, T., Stojanovic, I. and Stanisavljevic, R. (2005). Effect of nitrogen fertilizer and underseeding on the productivity and chemical composition of *Cynosuretumcristati*type meadows on hilly-mountains grassland in Serbia. *Grassland Science in Europe,* 10: 489-92.

Xiangfeng, Z., Shikui, D., Xujiang, Y. and Zizhi, H. (2007). Variation of productivity and nutritive values of oat (*Avena sativa*) with geographical locations in Gansu Province of Northwest China under irrigation and fertilization conditions. *African Journal of Biotechnolgy,* 6 (5):553-60.

Zahid, M. S., Haqqani, M. S., Mufti, M. S. and Shafeeq, M. S. (2002). Optimization of N and P fertilizer for higher fodder yield and quality in mottgrass under irrigation-cum rainfed conditions of Pakistan. *Asian Journal of Plant Sciences,* 1(6):690-3

Zhai, G., Shen, Y., Zhai, Y., Liu, X. and Jiang, H. (2008). Forage yield performance and nutritive value of selected wild soybean ecotypes. *Canadian Journal of Plant Sciences,* 88: 465-72.