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Agro-Economic Studies of Different Oat (*Avena sativa* L.) Cultivars under Varying Nitrogen Levels

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Abstract: Nitrogen application rates can be helpful in increasing fodder yield and improving quality of oat cultivars. A field trial was carried out to evaluate the green forage yield and quality of oat under various nitrogen rates. Experiment has two integrated approaches. First approach was oat cultivars viz. (Scott and S-2000) and second approach was nitrogen application rates viz. (control, 50, 60, 70, 80, 90 and 100 kg N ha^{-1}). Results revealed that maximum germination count (217.21 m^{-2}), plant height (148.99 cm), number of tiller (800.31 m^{-2}), green forage yield (82.60 t ha^{-1}), dry matter yield (12.63 t ha^{-1}), and crude protein (11.20) was recorded where 80 kg N ha^{-1} was applied in the Scott cultivar. In economic point of view maximum net profit (Rs. 86571.9 ha^{-1}) and benefit cost ratio (2.74) was given by the Scott cultivar with nitrogen application at the rate of 80 kg N ha^{-1}. Minimum benefit cost ratio was observed in cultivar S-2000 at control nitrogen levels. It is concluded that for getting best forage yield and quality with maximum net returns oat cultivar Scott grown with nitrogen application at the rate of 80 kg N ha^{-1} under semi-arid conditions of Pakistan.

Keywords: Plant nutrient interaction, oat, genotypic variation, yield

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1. Introduction

Oat (*Avena sativa* L.) is the important cereal and forage crop, grown during rabi season and is next to berseem in nutritive value. It is also rich in energy, protein, vitamin B, phosphorous and iron (Tiwana et al., 2008).Green forage is an essential constituent for livestock feed and nutrition. In winter season the continuous shortage of forage particularly from November to March is most important limiting factor for livestock production. Generally forage is less available in this season to feed livestock, subsequently it is the limiting factor for both meat and milk production. Livestock contribute 11.6% in national GDP of Pakistan which is a great contribution than other subsectors of agriculture sector (Govt. of Pakistan, 2016).Therefore we should increase the fodder production. To fulfill the availability of forage demand for livestock feeding during deficit period, winter forage crop can be grown in cool tropical and subtropical environmental condition (Jehangir et al., 2013).

The livestock is dominant segment of agriculture in Pakistan with a share of 11.53% in national GDP (Economic Survey of Pakistan, 2012).Growing more forage crops during rabi season is a viable option of several forage crops that can be grown, but growing oat have numerous advantages that is early and highly green forage per unit area (Aliparta et al., 2012).

In Pakistan forage yield is too low about (52-54%) to meet the definite requirements (Bhatti, 1981). There is need of efforts to increase forage crops quality to provide optimum and good quality feed for animals to maintain the quality of livestock byproducts such as butter, meat, milks and others byproducts for human daily uses. In Pakistan, milk production is too much less due to less availability of forages. Green forages production is very less due to low soil fertility (Iqbal et al., 2009). Nitrogen application has greater importance regarding the yield and quality of fodder (Fageria and Moreira, 2011).

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Globally fertilizers are the key input costs, in different cropping system (Derksen et al., 2002). Proper management of nutrients is capable of decrease weed infestation in crops (Anderson, 2003; Liebman et al., 2004). Nitrogen is the main nutrient added to enhance crop production (Camara et al., 2003; Smith and Chalk, 2018). It is one of the most yield limiting plant nutrients under most agroecological conditions and its efficient use is important for the economic sustainability of cropping systems (Fageria and Baligar, 2005; Kunrath et al., 2018). It is usually the main restrictive nutrient for crop yield in the main agricultural areas of the world and thus the adaptation of better nitrogen management approaches, is a conclusion for farmers to get greater economic benefits (Miao et al., 2006; Oikeh et al., 2007; Worku et al., 2007). It is a basic component of numerous elementary cell constituent such as enzymes, photosynthetic pigments, amino acids, and nucleic acids. Nitrogen is the prime nutrient for plants and becoming deficient in soils which is being supplemented by inorganic nitrogen fertilizers (Ata-Ul-Karim et al., 2017; Ata-Ul-Karim et al., 2016; Dar et al., 2016; Ding et al., 2011; Nasim et al., 2018). The molecular forms of nitrogen can be made available to crops through industrial and biological process (biological nitrogen fixation). The former process consumes the fossils fuels, degrades the soil and environment health through CO_2 and NO_2 enrichment and later is naturally eco-friendly which is carried out by prokaryotic micro-organisms. It has been estimated that half of the applied nitrogen is lost in various processes (Pindi, 2012). During the growth of plants; uptake and partition of nitrogen, into various parts of bodies, is totally depends on supply and demand of nutrients. Soil nitrogen contributes in stem development, heading, tillering, booting and grain filling; moreover for growth and development of its reproductive organs and for improved and a larger amount of proteins in the leaves it is a major constitute of plant's organization structure. Crop morphology is mostly affected by nitrogen application (Amanullah et al., 2008b). Realizing the importance of nitrogen in plant's growth under semi-arid conditions and at the same time seriousness of its deficiency in soils and plants, an attempt has been made to determine the best economical nitrogen application rates for obtaining maximum green forage and dry matter yield of oat cultivars with better nutritional quality.

2. Materials and Methods

The proposed study to check the yield and quality of forage oat cultivars as affected by nitrogen application rates was carried out at the Agronomic Research Area, University of Agriculture Faisalabad, Pakistan during the year 2014-15. Experimental site lies between 30.35 - 41.47°N latitude and 72.08 - 73.40°E longitude with an elevation of 184.4 m from sea level. The experiment was laid out in randomized complete block design (RCBD) with factorial arrangements using three replications. The experiment comprised two oat cultivars (Scott and S-2000) and different nitrogen levels control, 50, 60, 70, 80, 90 and 100 kg ha^{-1}.When the soil reached at the proper moisture level, the seed bed was prepared by cultivating the soil two times with tractor mounted cultivator each followed by planking. The crop was sown at well prepared seed bed on December 3, 2014 by applying seed @ 75 kg ha^{-1}. Hand drill was used for sowing in lines. The fertilizer was applied as different nitrogen levels, respectively. Complete phosphorous and half of the nitrogen fertilizer was applied at the time of sowing in the form of DAP (diammonium phosphate) and urea. Remaining nitrogen was applied with first irrigation. All the other agronomic practices were kept normal and uniform. Four irrigations were applied to the crop according to the crop requirements. First irrigation was applied at 15 days after sowing and subsequent irrigations were applied according to the need. The crop was harvested on the 10th March 2015 when 50% of flowering had been occurred.

Data regarding germination count was recorded two weeks after the start of emergence by counting all the plants in one square meter at three randomly selected places. Plant height of ten randomly selected plants was measured from the soil level to the highest leaf tip with the help of a measuring tape. Number of tillers was recorded by counting all the tillers in one square meter at three randomly selected places with the help of meter quadrate. The leaves of ten randomly selected plants were removed and counted and from these leaves 10 g sub samples were taken for measuring leaf area using leaf area meter. Leaf to stem ratio was determined by using the formula (weight of leaves/weight of stem). Harvested plants from each plot weighed to measure the fresh forage yield (kg) of the sample of each plot. Then it was converted into t ha^{-1}. For calculating the dry matter percentage a sample of 300 g was taken from each plot. The samples were dried for 5 days and then were oven dried at 80°C until the constant weight was achieved. Samples were reweighed and dry matter percentage was calculated by formula (dry weight/fresh weight) ×100. For calculating quality parameter like crude protein, crude fiber and ash contents were determined by following the protocol of AOAC (1990). Economic analysis of experimental treatment was done by following CIMMYT (1988). The gross income and total expenditure was calculated in local currency (Rs.). It was calculated by using formula BCR= Gross income (Rs.)/Total expenditure (Rs.). The collected data was analyzed statistically by employing the Fisher analysis of variance technique (Steel et al., 1997) and treatment's means were compared by using Least Significance Difference (LSD) test at 5% probability level.

3. Results and Discussion

3.1. Germination count (m^{-2})

Different nitrogen levels and oat cultivars showed significant variation in germination count. Maximum germination count (193.47 m^{-2}) was recorded in cultivar Scott while cultivar S-2000 showed 189.81 m^{-2} germination count (Table 1). Regarding the various levels of nitrogen on germination count statistically maximum germination count (217.21 m^{-2}) was observed with nitrogen application rate of 80 kg ha^{-1} which was followed by nitrogen application rate of 90 kg ha^{-1} with germination count (211.01 m^{-2}) which was statistically at par with 100 kg ha^{-1} with germination count 210.91 m^{-2}, while minimum (159.35 m^{-2}) germination count was observed in control. The interactive effect for oat cultivars and nitrogen levels on germination count also revealed significant differences. More germination count (224.47 m^{-2}) were recorded where cultivar Scott with 80 kg N/ha were applied while minimum germination count was substantially decrease as lowest (153.10 m^{-2}) in cultivar S-200with no nitrogen application.

Maximum germination count in oat with various nitrogen levels might be due to the optimum availability of nitrogen as it enhances the germination process. Naeem et al. (2005) also reported significant difference between the cultivars according to germination count (m^{-2}). Similarly, Abbasdokht (2008) also revealed that promoting impact of nitrogen inoculation on seed germination. The significant differences may be due to soil type and other climatic prevailing conditions. When seed imbibed, emergence of the radical resulted due to initiation of chain of metabolic events thus results incompletion of germination. There after major stored reserves within the seed are mobilized, provides nutrient to support early seedling growth (Bewley, 1994).

3.2. Plant height (cm)

Significant variation of different nitrogen levels was observed regarding plant height. Different oat cultivars showed non-significant behavior regarding the plant height (Table 1). Regarding various levels of nitrogen, statistically maximum plant height noticed (148.99 cm) where nitrogen application at 80 kg ha^{-1} was applied and it was followed by (143.79 cm) by the application of 100 kg N ha^{-1}.

Table 1: Influence of various nitrogen levels on the yield related traits of different oat cultivars

	Germination count (m^{-2})	Plant height (cm)	Number of tillers (m^{-2})	Number of leaves ($tiller^{-1}$)	Leaf area per tiller (cm^2)
			Oat Cultivar (C)		
Scott	193.47 a	140.19	743.59 a	5.97	183.71
Variety S-2000	189.81 b	137.61	736.92 b	5.82	183.33
			Nitrogen Levels (N)		
Control	159.35 e	124.83 e	686.04 d	5.33 c	139.77 e
50 kg ha^{-1}	177.06 d	137.54 d	704.58 d	5.65 c	161.23 d
60 kg ha^{-1}	175.69 d	135.615 d	766.60 b	6.08 b	193.64 b
70 kg ha^{-1}	190.26 c	138.78 cd	723.89 c	5.58 c	176.18 c
80 kg ha^{-1}	217.21 a	148.99 a	800.31 a	6.85 a	224.72 a
90 kg ha^{-1}	211.01b	142.78 bc	732.83 c	5.7 bc	193.49 b
100 kg ha^{-1}	210.91 b	143.79 b	767.48 b	6.05 c	195.61 b
LSD (C) ($p \leq 0.05$)	3.04	NS	5.32	NS	NS
LSD (N) ($p \leq 0.05$)	5.70	4.85	18.78	0.38	10.23
C×N ($p \leq 0.05$)	8.06	6.86	26.56	NS	14.47

Any two means within a column followed by same letters are not significant at $p \leq 0.05$. n = 3 (number of replication).

The minimum plant height (124.83 cm) was observed in control plots. The interactive effect between oat cultivars and various nitrogen levels was also significant. Maximum plant height (151.96 cm) was recorded in cultivar Scott when nitrogen application rate at 80 kg ha^{-1} and whereas the lowest plant height (122.96 cm) was recorded in cultivar S-2000 with no nitrogen application.

The more plant height might be due to optimum nitrogen application response, subsequent increase in all growth stages of crop because of main constituent of synthesis of food materials, consequences cell elongation and cell division. Kumar et al., (1997) studied that better growth and development of forage oat can be associated with the better use efficiency of nitrogen resulting in maximum plant height. Similarly, Nadeem et al., (2009) who revealed that height of plant significantly increased with increase in nitrogen application levels. Similarly, Gasim (2001) indicated that the fact to increase plant height with nitrogen application sources contribute increasing the number and length of internodes and promote plant growth which results in increase of plant height. The increase in the plant height due to the application of nitrogen in oat might be due to enzyme activity such as functional, structural and regulatory reason. Similar results were also observed by Nofal et al., (2012) and Angadi et al., (2002).

3.3. Number of Tillers (m^{-2})

Statistically significant differences were marked out regarding various levels of nitrogen and oat cultivars on number of tillers (Table 1). Maximum number of tillers was observed in Scott cultivar (743.59 m^{-2}) as compared to the Variety S-2000 (736.92 m^{-2}). Regarding nitrogen levels more number of tillers (800.31 m^{-2}) were recorded with application of 80 kg N ha^{-1} and it was followed by number of tillers (767.48 m^{-2}) with application of 100 kg N ha^{-1}. Minimum number of tillers (686.04 m^{-2}) were noticed when nitrogen was not applied. Moreover, for interactive effect the oat cultivars and nitrogen application rates showed significant results regarding the number of tillers per square meter. Maximum numbers of tillers (810.33 m^{-2}) were observed when cultivar Scott was treated at 80 kg of nitrogen per hectare, while minimum number of tillers (683.22 m^{-2}) was recorded in cultivar Scott with no nitrogen application.

The increase in number of tillers may be due to optimum nitrogen use efficiency which lead to increased number of tillers per square meter. Increase in the number of tillers with the increasing of nitrogen application may be due to the role of nitrogen in quick response of vegetative growth of plant. These results are also in line with of Ashraf et al., (2001) who showed that cultivars are different in their production potential. Similar results were also observed by Jayanthi et al., (2002) reported that the application of nitrogen is the combined source of organic and inorganic fertilizer which showed more number of tillers per meter square in oat crop.

3.4. Number of Leaves $Tiller^{-1}$

Regarding the number of leaves per tillers different nitrogen levels showed significant behavior while the oat cultivars showed non-significant results (Table 1). For nitrogen levels more number of leaves per tiller (6.85) was recorded by application of 80 kg nitrogen per hectare whereas minimum number of leaves per tiller (5.33) was observed in control. The interaction between oat cultivars and nitrogen application rates on number of leaves per tiller were also showed statistically non-significant differences. The increase in number of leaves per tiller might be due to nitrogen application, stimulate vegetative growth of crop which effect to increase plant height, number of node and inter-node thus production of more leaves per plant. This result are also in line to Ayub et al., (2010a) who reported that increase in nitrogen application rates lead to significant increase in number of leaves per tiller.

3.5. Leaf Area $Tiller^{-1}$ (cm^2)

Different nitrogen levels showed significant variation in leaf area per tiller. However, oat cultivars and the interactive effect of nitrogen levels and oat cultivars showed non-significant results (Table 1). Results revealed that higher leaf area per tiller (224.72 cm^2) was observed when nitrogen was applied at 80 kg per hectare followed by (195.61 cm^2) where 100 kg N $ha^{-1}$was applied which was statistically at par with the treatments where 90 and 60 kg N ha^{-1} was applied. The increase or decrease in the leaf area might be due to the better availability of nutrients which ultimately results in the better vegetative growth of the oat cultivars. Similar results were also observed by Ayub et al., (2010a) who concluded that nitrogen application rate can significantly increases the leaf area per plant.

3.6. Leaf to Stem Ratio

Statistically significant results were observed by application of various nitrogen levels in the leaf to stem ratio of different oat cultivars (Table 2). However, oat cultivars and the interactive effect of nitrogen levels and oat cultivars showed non-significant behavior.

Table 2: Influence of various nitrogen levels on the yield and quality related traits of different oat cultivars

	Leaf-stem ratio	Green forage yield (t ha^{-1})	Dry matter yield (t ha^{-1})	Crude protein (%)	Crude fiber (%)
Oat Cultivar (C)					
Scott	0.39	71.96 a	10.22	9.38 a	33.48 a
S-2000	0.39	66.16 b	9.80	8.85 b	32.34 b
Nitrogen Levels (N)					
Control	0.36 e	49.55 g	6.59 f	7.15 e	29.63 d
50 kg ha^{-1}	0.37 d	58.68 f	7.97 e	8.47 d	31.23 c
60 kg ha^{-1}	0.40 c	64.06 e	9.16 d	9.14 c	32.60 b
70 kg ha^{-1}	0.38 d	70.79 d	10.26 c	8.30 d	32.63 b
80 kg ha^{-1}	0.43 a	82.60 a	12.63 a	11.20 a	35.21 a
90 kg ha^{-1}	0.39 c	76.14 c	11.45 b	9.58 bc	34.35 a
100 kg ha^{-1}	0.41 b	78.26 b	12.03 ab	9.97 b	34.71 a
LSD (C) ($p \leq 0.05$)	NS	0.91	NS	0.29	0.61
LSD (N) ($p \leq 0.05$)	0.009	1.71	0.99	0.54	1.15
C×N ($p \leq 0.05$)	NS	2.42	NS	NS	NS

Any two means within a column followed by same letters are not significant at $p \leq 0.05$. n = 3 (number of replication).

Results related to nitrogen levels indicated that higher leaf to stem ratio (0.43) was observed with application of 80 kg N/ha and it was followed by application of 100 kg N/ha. While minimum leaf to stem ratio (0.36) was recorded in control. Results showed that linear increase was observed in leaf to stem ratio by the application of nitrogen. The increase in nitrogen application increased the leaf to stem ratio. It might be due to more number of leaves per tiller and fresh weight of leaves. Similar findings were also observed by Backiyavathy et al., (2006) who reported that increase in nitrogen application significantly increase in leaf to stem ratio. Similar results were also observed by Piri and Tavassoli (2012).

3.7. Green Forage Yield (t ha^{-1})

Regarding the green forage yield different nitrogen levels and oat cultivars and their interactive effect showed significant behavior (Table 2). More green forage yield (71.96 t/ha) was observed in cultivar Scott while (66.16 t/ha) green forage yield were recorded in cultivar S-2000. Regardingnitrogen levels more green forage yield (82.60 t/ha) was recorded when nitrogen was applied at the rate of 80 kg per hectare. While lower green forage yield (49.55 t/ha) were recorded in control. The interactive effect of the oat cultivars and nitrogen levels produced maximum green forage yield (84.90 t/ha) under treatment where 80 kg N/ha in cultivar Scott. By the application of nitrogen, forage yield was also increased. However, when nitrogen application was increased from optimum level it caused the more vegetative growth which caused lodging problem which reduced forage yield. Similar results were observed by Singh and Dubey (2008) who reported that by the application of 80 kg N ha^{-1}in the oat cultivars gave maximum forage yield. May et al., (2004) also reported that by the increase in nitrogen fertilizer, increase in green forage yield of oat cultivars was also observed. Similarly Iqbal et al., (2009) concluded that increase in nitrogen application rate increased all growth and yield parameter but adversely affected green forage yield at high dose of nitrogen rate. The result also quite in line of Haider (2008) who reported the difference in forage yield on oat cultivars is due to different nutrient management practises.

3.8. Dry Matter Yield (t ha^{-1})

Statistically significant results were observed for dry matter yield of different oat cultivars by the application of different nitrogen levels (Table 2). However, oat cultivars and the interactive effect of nitrogen levels showed non-significant behavior. Results regarding to nitrogen levels revealed that significantly maximum dry matter yield (12.63 t/ha) was observed by the application of 80 kg N/ha and it was statistically at par by application of 100 kg nitrogen per hectare (12.03 t/ha) followed by yield (11.45 t/ha) where application of 90 kg N/ha was done. Whereas the minimum (6.59 t/ha) dry matter yield was observed in control. The increase in nitrogen application rate successively increased dry matter yield up to 80 kg N ha^{-1} and where further increase in nitrogen application rate reduced the dry matter yield. These result are in accordance with the findings of Hassan and Shah (2000) who concluded that the increase in nitrogen application up to certain level with each successive increase the dry matter yield while after further increasing adversely affect the dry matter yield. Similarly Iqbal et al., (2009) concluded that the increase in nitrogen application increased all growth and yield parameters while higher doses of nitrogen adversely affected the green forage and dry matter yield.

3.9. Crude Protein (%)

Results regarding to the crude protein showed that different nitrogen levels and oat cultivars showed statistically significant results (Table 2). However, the interactive effect of oat cultivars and various nitrogen levels showed non-significant behavior regarding the crude protein. Results revealed that maximum crude protein (9.38%) were observed in cultivar Scott whereas as compared to S-2000(8.85%). Regarding the nitrogen levels higher crude protein (11.20%) was observed by the application of 80 kg N/ha while minimum (7.15%) was observed in control. From the results it was observed that crude protein was linearly increased by the application of nitrogen. The increase in protein contents might be due to nitrogen as it is the major component of amino acids which are building blocks of protein (Mohammad et al., 1988). Similar results were also observed by Backiyavathy et al., (2006) who reported that crude protein contents of forage oat increased by nitrogen application level up to 120 kg N per ha. In another study Tariq (1998) reported that crude protein contents significantly increased by the increase in nitrogen application rate.

3.10. Crude Fiber (%)

Different oat cultivars and nitrogen levels significantly increased the crude fiber (Table 2).The interactive effect of oat cultivars and nitrogen levels showed non-significant behavior for the crude fiber of oat. Maximum crude fiber (33.48%) was recorded in cultivar Scott while minimum (32.34%) was observed in cultivar S-2000. Regarding the nitrogen levels maximum crude fiber content (35.21%) was observed by the application of 80 kg N per ha and it was statistically at par with 100 and 90 kg N ha^{-1} where (34.71%) and (34.35%) crude fiber was observed respectively while minimum (29.63%) crude fiber was recorded in control plots. Variation in the crude fiber was observed in the oat cultivars which might be due to genetic makeup of crops and environmental condition. Similar results were observed by the Arvind et al., (2001) who reported that with increase in nitrogen application an increase in crude fiber contents was observed in forage oat. Similar results were also observed by the Zafar (2009) and Ayub et al., (2011).

3.11. Economic Analysis

The economic analysis of improved and updated agronomic practices is vital for the farming community to accept it and subsequently its adoption. Economic benefit always attracts farmers and moreover cost of new technologies with respect to their capital investment. Partial budgeting, cost difference, gross as well as net income and benefit to cost ratio (BCR) are included in the economic analysis. Data related to the cost of production and grain yield of different treatments is presented in Table 3. It was clearly indicated that the maximum net income (Rs. 107813.5) was recorded where nitrogen was applied at the rate of 80 kg N/ha in Scott cultivar. The higher net income in this treatment might be due to the overall better production of forage yield that results in the higher net income.

Table 3.Economic analysis on hectare basis for each treatment combination

Treatments	Green forage yield (t ha^{-1})	Gross income (Rs. ha^{-1})	Total fixed cost (Rs. ha^{-1})	Cost of nitrogen (Rs. ha^{-1})	Total expenditure (Rs. ha^{-1})	Net income (Rs. ha^{-1})	BCR
N_0C_1	52.10	104200	55900	0	55900.0	48300	1.86
N_1C_1	65.63	131260	55900	3804.5	59704.5	71555	2.20
N_2C_1	70.23	140460	55900	4565.4	60465.4	79994	2.32
N_3C_1	75.03	150060	55900	5326.3	61226.3	88834	2.45
N_4C_1	84.90	169800	55900	6086.5	61986.5	107813	2.74
N_5C_1	74.66	149320	55900	6848.1	62748.1	86572	2.38
N_6C_1	74.53	149060	55900	7609.0	63509.0	85551	2.35
N_0C_2	47.00	94000	55900	0	55900.0	38100	1.68
N_1C_2	51.73	103460	55900	3804.5	59704.5	43755	1.73
N_2C_2	57.90	115800	55900	4565.4	60465.4	55335	1.92
N_3C_2	66.56	133120	55900	5326.3	61226.3	71894	2.17
N_4C_2	80.30	160600	55900	6086.5	61986.5	98614	2.59
N_5C_2	77.63	155260	55900	6848.1	62748.1	92512	2.47
N_6C_2	82.00	164000	55900	7609.0	63509.0	100491	2.58

BCR = Benefit cost ratio, CN represent the N for Nitrogen and C for oat Cultivar.

The benefit cost ratio in different treatments depends on gross income and total cost of production of oat per plot. Similar trend was also observed in the BCR. Maximum BCR (2.74) was observed where nitrogen was applied at the rate of 80 kg N/ha in Scott cultivar. Minimum benefit cost ratio was observed in cultivar S-2000 at control nitrogen levels. This minimum benefit cost ratio may be due to less green forage yield and also less gross income. Overall, by the application of optimum nutrients, the oat cultivars showed the better response in the terms of yield that gives the higher net returns, higher gross income and lower cost of production.

4. Conclusion

The findings of this study showed that application of nitrogen at the rate of 80 kg ha^{-1}increase the germination count, plant height, number of leaf per tiller and leaf area per tiller which is to be the optimum dose for obtaining maximum yield and quality of forage oat with cultivar Scott. Although yield and quality parameters were significantly improved at the rate of 100 kg N ha^{-1}, but it increased cost of production. However, N at 80 kg ha^{-1} significantly increases growth and yield of oat. Moreover, beneficial effect of nitrogen application was due to its promoter effects on the vegetative growth, more leaf area and photosynthetic capacity by enhancing biosynthesis of photosynthetic pigments.

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Authors Contribution: IA, SIB and MH planned and conducted field experimentation. IA, SIB, MH and SMUD were involved in laboratory work. IA, SIB, MH and MA analyzed the data and wrote manuscript. All authors approved final draft of manuscript.

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