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Effect of nitrogen fertilizers on yield and quality of oats: A Review

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Abstract
Oat crop responds significantly to application of nitrogen. Application of nitrogen resulted in significant increase in plant height where short stature varieties increased in plant height more with nitrogen application than several taller cultivars. Application of nitrogen resulted in significant increase in yield. As the dose of nitrogen increases, there is increase in green and dry matter yield. Spiklet number of oats increased with increase in nitrogen levels. Application of nitrogen improved the panicles/m^2 and grains/panicle. Application of nitrogen also significantly increased the protein content of oats. Application of nitrogen lead to increase in grain crude protein content.

Keywords: Oat, nitrogen, yield and spikelet

Introduction
Oat (*Avena sativa* L.) is an important cereal crop which is mainly grown for fodder during *Rabi* season. Oat provides a very nutritious fodder (protein 13- 15%) especially suited to milch animals. The ever-rising demand for fodder and feed for sustaining livestock production can be met through increasing productivity of fodder. The profitable production of oat crop may be affected by many factors and among these factors, soil fertility to produce good fodder and seed is of practical significance. The poor yield of oat crop in our country is mainly ascribed to low fertility of soil, inadequate manuring and cultural practices. Our soils have exhausted in respect of major and minor elements hampering the yield of crops. The new varieties of the crop require higher amounts of nutrients for realizing their inherent yield potential. Proper and optimum application of fertilizers not only increases the yield but also favorably affects the quality of the produce All the crops in general and non-legumes in particular use nitrogen in large quantity. Apart from the other roles played by nitrogen, it is a major constituent of protein and chlorophyll of green plant. Nitrogen content of fodder has been said to be the best single index for forage digestibility. However, higher dose of nitrogen because lodging of crop and may also result in nitrate poisoning to animals. Nitrogen, because of its consumption by the crop in large quantity, plays a vital role in fodder production. The adequate nitrogen supply is associated with high photosynthetic activity, vigorous growth and a dark green colour of fodder and known to help in carbohydrate utilization and increasing succulence of the fodder. Keeping the above stated aspect in the view, the present article was reviewed to study the influence of N fertilizer for Oats.

Effect on growth
Oat crop responds significantly to application of nitrogen. Ohm (1976) [44] reported that application of nitrogen resulted in significant increase in plant height where short stature varieties increased in plant height more with nitrogen application than several taller cultivars. Gill *et.al.* (1976) [21] concluded that plant height and number of tillers increased with increasing dose of nitrogen from 0-80 Kg ha^{-1}. Similar results were obtained by Ghosh (1985) [20]. Rao and Patil (1979) [59] observed the increase in leaf area /shoot (cm^2) up to 80 Kgha-1. Reddy and Tomar (1985) [65] reported that number of shoot and plant height was markedly increased with each increase in the levels of nitrogen up to 120 Kgha-1. Similar results were obtained by Vyas *et.al.* (1988) [98], Pradhan and Mishra (1994) [55] and Chakraborty *et.al.* (1999) [8].

Patel and Rajgopal (1998) concluded that application of nitrogen up to 75 Kg ha-^{1}increased the plant height of oats plant, number of shoots and leaves per meter row length but significant response was recorded only up to 50 Kg Nha-1. Hasan and Shah (2000) [23] Reported that plant height and number of tillers improved with increasing levels of nitrogen up to 160 Kgha-1.

Singh *et.al.* (2002) [83] observed highest plant height and number of tillers with $N_{80}P_{40}$ Kgha-1 application. Ana *et.al.* (2003) revealed that plant height, number of tillers per meter row length increased significantly with each increment of 40 Kg N from 0-120 Kg N ha-^{1}over the preceding one. Kumar and Ramavat (2006) [36] studied that the application of 100 per cent recommended NPK (80-60-30 kg ha-^{1}) resulted in more plant height, shoot number per unit area of oat during all the years than 75 per cent recommended dose of NPK. Sharma (2009) revealed that 150 kg Nha-^{1}significantly increased the growth attributes leading to higher dry matter (11.13 ton ha^{-1}). Rawat and Agarwal (2010) [61] studied that an application of nitrogen significantly increased the growth and yields of fodder oat. The maximum plant height and number of leaves per plant (103.3 cm, 25.7/plant) respectively, were recorded under 100 kg N ha^{-1}. However, it was at par with 80 kg N ha^{-1}with respect to plant height but significantly superior to rest of the levels. Waheed *et al.* (2012) [99] recorded that statistically maximum plant height (146.3 cm), number of leaves per plant (6.867), number of tillers per plant (8.023), number of tillers m^{-2} (336), leaf area per plant (128 cm2), fresh weight per tiller (30.1g), dry weight per tiller (5.01 g) and green fodder yield (74.67 t ha^{-1}) were recorded in inorganic fertilizers (N:P_2O_5 @ 150:60) providing nutrients in sufficient amount for the growth as compared to control. Midha *et al.*, 2015 [56] also observed that application of nitrogen @ 120 kg ha^{-1}significantly increased the oat plant height from 89.9 to 126.8 cm, tillers row length/m from 68.6 to 88.1, respectively, over 40.0 and 80 kg N ha^{-1}. Harikesh *et al.*, 2015 revealed that addition of 110 kg N ha^{-1}significantly enhanced the crop growth rate and dry fodder yield of oat crop. Godara *et.al.* (2016) [22] reported that all growth parameters were influenced significantly by increasing levels of nitrogen from 40 to 120 kg ha-^{1}. Whereas leaf: stem ratio and tillers number per metre row length were increased up to 80 kg N ha-^{1}. Sheoran *et al* (2017) [75] revealed that number of tillers/m row length were influenced significantly with increasing levels of nitrogen from 40 to 120 kg ha^{-1}, whereas plant height was increased up to 80 kg Nha^{-1} only.

Effect on forage yield

Ohm (1976) [44] observed that application of nitrogen resulted in significant increase in yield. Gill *et.al.* (1976) [21] reported that as the dose of nitrogen increases, there is increase in green and dry matter yield up to 80 Kg ha-^{1}. Similar results were obtained by Borgohain (1978) [5], Rao and Patil (1979) [59], Ghosh (1985) [20], Thakuria and Rafique (1993) [92], Darwinkel *et al*. (1995) [12], Singh *et.al*. (1998) [86] and Sharma and Bhunia (2001) [69]. Joon *et al.* (1988) [27] observed increased dry matter accumulation with successive level of nitrogen upto 160 kg per ha. Boruah and Mathur (1979) [6] observed that green and dry matter yield increased significantly with increasing levels of nitrogen from 0-120 Kg N ha^{-1}. Similar results were obtained by Reddy and Tomer (1985) [62], Vyas *et al.* (1988) [98], Dalwadi *et al.* (1987) [11], Patil *et al.* (1993) [53], Singh *et al.* (1994), Pradhan and Mishra (1994) [55], Joshi *et al.* (1996) [36], Srivastava and Singh (1996) [85], Joshi *et al*. (1997) [30] and Singh *et al.* (1999) [82]. Chakaraborty *et al.* (1999) and Mukherjee *et al.* (1981) [43] showed that application of 120 Kg N ha-^{1} harvested at 50% flowering stage, produced the highest fresh forage yield.

Increasing nitrogen dose from 0-150 Kg N ha-^{1} increased fresh fodder and dry matter yield of oats (Dubey *et.al.*, 1995) [16]. Similar results were obtained by Bali *et al.* (1998). Moreira (1989) [42] concluded that application of 100 Kg N ha^{-1} and harvested at soft dough stage produced high green and dry matter yield. Highest green fodder yield can be obtained with 60-90 Kg N ha-^{1}observed by Ganai *et.al.* (1989) [18]. Nitrogen application up to 112 Kg ha^{-1}increased the forage yield (Collin *et al.* 1990) [10].

Patel and Vihol (1990) [51] observed that application of nitrogen in oats significantly enhanced green and dry forage yield with every successive increase in levels of nitrogen up to 160 kg ha^{-1}. Similar results were obtained by Joon *et al.* (1993) [28] and Hasan and Shah (2000) [23]. Increase in nitrogen levels from 0-120 kg ha^{-1} increased herbage yield significantly which thereafter declined with increase in nitrogen levels from 120 to160 kg ha^{-1}, observed by Joshi *et.al.* (1993). Tripathi (1993) [95] observed that application of 90 kg N + 30 Kg P_2O_5 gave higher total green fodder as well as dry matter yield than 50 kg N ha^{-1}+ 45 kg P_2O_5 ha^{-1}. Tripathi and Hazra (1994) [94] observed that fodder yield increased with nitrogen application up to 80 kg N ha-^{1}. Sood and Kumar (1994) [89] observed that green forage and dry matter yield increases up to 75 kg N ha^{-1}and 75 kg P_2O_5 ha-^{1}. Application of 80 kg N ha-^{1}+ seed inoculation gave the highest green fodder and dry matter yield observed by Singh *et al.* (1996) [32].

Patel and Rajgopal (1998) concluded that application of nitrogen up to 75 kg ha^{-1}increased the green and dry matter yield but significant response was recorded only up to 50 kg N ha-^{1}. Increasing level of nitrogen from 0-40 and 60-80 kg ha^{-1}progressively increased the dry matter yield reported by Desale *et al*. (1999) [13]. Kumar *et al.* 2001) [35] reported that variety UPO-240 recorded significantly higher yield of green forage dry matter with increased levels of N up to 120 kg ha-^{1}. Similar results were obtained by Kumar *et al.* (2001) [35].

Sharma *et.al.* (2001) [66] recorded that nitrogen rates up to 100 kg ha-^{1}significantly increased green fodder and dry matter production. Oat crop responded significantly up to 80 kg N ha-^{1}for green fodder and dry matter yield as reported by Aggarwal *et.al.* (2002). Rana *et al.* (2002) [74] concluded that green forage yield increased significantly with each increment of 40 kg N from 0-120 kg N ha-^{1}over the preceding one. Sharma *et al.* (2002) [67] reported that green forage yield increased significantly up to 100 Kg ha-^{1}and 30 kg P2O5 ha-^{1}over no N and P application. Whereas Patel and Rajgopal (2002) [46] recorded that green and dry forage yields increased significantly up to 50 kg N and 40 Kg P2O5ha-1. Sheoran *et al.* (2002) [83] observed that green and dry matter yield increased significantly with the increasing dose of nitrogen up to 80 kg ha-^{1}. Kakol *et al*. (2003) [33] recorded that linear response to nitrogen fertilization up to 150 Kg ha-^{1} for total green forage and dry matter yields. Mahale *et al.(*2003) [39] observed that nitrogen application at 80 Kg ha-^{1}produced significantly higher green fodder yield as well as dry fodder yield of oats but in 2004, Mahale *et al.* reported that double cut Oat with 120 Kg ha-^{1}recorded higher green and dry forage yield. Rashid *et al*. (2007) [60] recorded that maximum oat fodder yield and dry matter contents obtained were 41.48 t ha $^{-1}$, 20.21% at 0.30 mg P L^{-1} from sandy clay loam soil and 17.87 t ha $^{-1}$, 16.65% at 0.25 mg P L^{-1} from Loamy sand soil. Kumar and Ramavat (2006) [36] studied that the application of

100 per cent recommended NPK (80-60-30 kg ha-^{1}) resulted in high green and dry forage yields of oat during all the years than 75 per cent recommended dose of NPK. Singh and Dubey, 2007 [87] reported that application of 80 kg N ha-^{1}gave highest green fodder yield of 478.0 and 508.1 q ha-^{1} during 1999-2000 and 2000-01, respectively, and found significantly superior over the lower N levels. Pathan *et al.* (2007) [52] concluded that for higher productivity of multi cut oat, variety RO-19 should be grown with application of 120 kg N ha-^{1}. Bhilare and Joshi (2007) [52] studied that application of 120 kg N ha-^{1}recorded significantly higher dry-matter and digestible dry-matter yields, The dry-matter content, digestibility and cell content decreased with successive increase in Nitrogen level from 0 to 160 kg ha-^{1}, whereas, the reverse trend was noticed for crude-protein content, acid-detergent fibre, neutral detergent fibre and hemicellulose content.

Singh and Dubey, 2008 [88] also revealed that an application of nitrogen upto 80 kg ha-^{1}significantly increased the growth and produced 493 and 98.75 q ha-^{1} green and dry fodder yields, respectively. Sheoran *et.al.* (2008) [83] found that increasing rates of nitrogen application up to 120 kg N ha-^{1} significantly enhanced the forage yield over the lower doses of nitrogen. Application of nitrogen levels significantly improved plant growth parameters upto 80 kg N ha-^{1}was reported by Devi *et.al.* (2009) [14]. Rana *et al.* (2009) [57]. Also found that incresed level of N up to 80 kg ha-^{1}resulted in a significant increase in green as well as dry matter yield over the lower doses. Rawat and Aggaarwal, 2010 [61] reported that the maximum green fodder and dry matter yield (361.5 and 100.2 q ha-^{1}), respectively, were recorded under 100 kg N ha-^{1}. However, 80 and 100 kg N ha-^{1}was found at par with each other with respect to green fodder and dry matter yields but significantly superior to rest of the levels. Patel *et al.* (2010) reported that successive increase in nitrogen application increased the yield attributes, leaf: stem ratio, as well as WUE and application of 120 kg N ha^{-1}recorded significantly higher green forage and dry matter yield of oat. Similarly Sheoran and Joshi (2010) [70] also revealed that green fodder as well as dry matter yield of oat plant were significantly increased upto 120 kg N ha-^{1}.

Waheed *et al.* (2012) [99] recorded that maximum green fodder yield (74.67 t ha^{-1}) were recorded in inorganic fertilizers ($N:P_2O_5$ @ 150:60) as compared to control, organic manures and combinations of inorganic and organic fertilizers. Jehangir *et al.* (2013) [26] recorded that the fertility level of 150:70:40 ($N:P_2O_5:K_2O$ kg ha^{-1}) significantly increased both green and dry fodder yield over 125:60:30 and 100:50:20 ($N:P_2O_5:K_2O$ kg ha^{-1}). Midha *et al.* (2015) [56] found that application of nitrogen @ 120.0 kg ha-^{1}significantly increased the green fodder yield of oat from 253.4 to 416.1 q ha-^{1} and dry fodder yield from 52.8 to 89.2 qha-1 respectively, over 40.0 and 80 kg Nha-1. Godara *et.al.* (2016) [22] reported that green fodder as well as dry matter were influenced significantly by increasing levels of nitrogen from 40 to 120 kg ha-^{1}. Sheoran *et al.* revealed that green fodder and dry matter yield were influenced significantly with increasing levels of nitrogen from 40 to 120 kg ha-^{1}.

Yield attributes and grain yield

Rao and Patil (1979) [59] found that spiklet number of oats increased with increase in nitrogen levels. Ghosh (1985) [20] observed that application of 80 Kg ha^{-1} improved the panicals/m^2 and grain/panicle. Similarly application of 80 kg ha-^{1}gave highest grain and straw yield was reported by Sencar (1987) [64]. Salmina and Makarova (1998) [63] revealed that grain yield was significantly affected by nitrogen application and gave highest yield with 60 Kg ha-^{1}. Application of fertilizer increased the grain yield and highest grain yield was obtained with 60 Kg N + 45 Kg P_2O_5 + 90 Kg K_2O ha-^{1}was observed by Kubresh and Bezsilko (1990) [34]. Grain yield was highest with application of 80 Kg N ha-^{1} as reported by Thakuria and Rafique (1993) [92]. Patil *et al.* (1993) [53] found that seed yield increased with increase in nitrogen fertilizer rate up to 120 Kg N ha-^{1}. Similar results were observed by Singh *et al.* (1994) [80]. Joon *et al.* (1993) [28] observed that the grain yield of oat increased only up to 80 Kg ha-^{1}and decreased thereafter with increasing N up to 160 Kg ha-^{1}. Singh *et al.* (1998) [2] observed that grain and straw yield increased significantly up to 80 Kg N ha-^{1}. Optimum nitrogen dose was 119 kg ha-^{1}for maximum production of grain as reported by Chalmers *et al.* (1998) [9]. Lapa *et al.* (1998) [37] observed that highest yield of grain was obtained with 60 Kg ha^{-1}. Increasing levels of nitrogen from 0-40 and 60-80 Kg ha-^{1}progressively increased the seed yield as reported by Desale *et al.* (1999) [13]. Sheoren *et al.* (2000) reported that grain and straw yield was significantly increased up to 60 Kg ha^{-1}. Hasan and Shah (2000) [23] reported that grain yield and straw yield were increased significantly up to 80 kg ha-^{1}. Bhat *et al.* (2000) [3] reported that increasing nitrogen rate from 0-90 Kg ha-^{1}resulted in increased grain yield, however straw yield increased significantly up to 150 kg N ha-^{1}. Sharma *et al.* (2001) [66] recorded highest grain yield with 80 Kg N ha-^{1}. Peich *et al.* (2001) reported that increasing fertilization from 50 to 100 kg N ha-^{1}caused increase in grain yield. Sharma *et al.* (2001) [66] revealed that application of 100 Kg N ha-^{1}significantly increased the grains and straw yields and harvest index was significantly reduced by nitrogen fertilization.

Sharma and Bhunia (2001) [69] revealed that increasing level of nitrogen recorded higher yields, yields attributes, net returns and benefit: cost ratio. The highest yield of grain (23.55 and 23.73q ha-^{1} in 2 years) were recorded with 80 Kg N ha-^{1}. Patel *et.al.* (2002) [46] recorded 40 kg N ha-^{1}as the most economical rate for oat seed production as it recorded the highest seed yield (21.84 q ha-^{1}). Rana *et al.* (2002) [74] revealed that seed and straw yield increased significantly with each increment of 40 Kg N from 0-120 Kg N ha-^{1}over the preceding one. Sharma *et al.* (2002) [67] concluded that grain and straw yield increased significantly up to 100 kg N and 30 kg P_2O_5 ha-^{1}over no N and P application. Patel and Rajgopal (2002) [46] reported that yield attributes increased significantly up to 50 kg N and 40 Kg P_2O_5 ha-1. Patel *et al.* (2003) [48] showed that oats for grain production should be fertilized with 40 to 80 kg N ha-^{1}.

Tiwana *et al.* (2004) [93] reported that application of 60 kg N ha-^{1}significantly increased the seed and straw yield of oats. Browne *et al.* (2006) [7] observed that at the higher rates of nitrogen, both number of panicles/m^2 and grains per panicle increased. Mean grain weights were relatively constant and were largely determined by variety.

Mohr *et al.* (2007) [41] showed that low to moderate N rates significantly increased yield with optimum relative yield achieved with a plant-available N supply of approximately 100 kg N ha-^{1}. Increasing N rate also increased lodging and reduced test weight, kernel weight and kernel plumpness, suggesting that optimal N management must balance yield improvement against reductions in grain quality. Pathan *et al.* (2007) [52] concluded that for higher productivity of multi-cut oat, variety RO-19 should be grown with application of 120 kg N ha-^{1}.

Joshi *et al.* (2015) [29] revealed that the higher production of oat and net realization could be achieved with the application of 90 kg N ha-^{1}.

N, P and K uptake in fodder, grain and straw

Application of nitrogen did not significantly influence the composition of these nutrient in the forage as reported by Ganguli *et al.* (1976) [19]. Similar results were obtained by Sheoran *et al.* (1998) [73]. The nitrogen of oat plant during the growth period depend on fertilizer rates, these results were obtained by Elaskov (1978). Increase in nitrogen rate increased grain N content and uptake of N in grain + Straw as concluded by Singh and Singh (1979) [96]. Nitrogen application increased nitrogen content in forage (Mukherjee *et al*. (1981) [43]. Similar results were obtained by Stirling and Ivory (1981). Kubresh and Bezsilke (1990) [34] concluded that nitrogen application increased the nitrogen content in grain and straw up to 100 Kg N ha-^{1}. Application of N fertilizer increased N concentration and its uptake in forage as reported by Sood and Kumar (1994) [89].

Total uptake of nitrogen in oat fodder was highest with application of 80 Kg N ha-^{1} as observed by Singh *et al*. (1995). Grain N concentration increased significantly with applied N, on an average by 0.12% per 40 Kg N ha-^{1}reported by Chalmers *et al*. (1998) [9]. Sharma *et al.* (2002) [67] reported that application of 100 Kg Nha^{-1}significantly increased N, P content of forage, grain and straw. Patel and Rajgopal (2002) [46] reported the linear response for nutrient uptake up to 75 Kg N and 60 Kg P_2O_5 ha-^{1}. Devi *et al*. (2010) [15] recorded that nitrogen content in fodder, grain and straw as well as in soil after harvest of oats crop was significantly influenced by nitrogen levels. Preeti *et al.* (2015) [56] reported that application of nitrogen and phosphorus significantly increased the copper, Manganese and Iron uptake in oat fodder, grain and straw from with N_{120} + P_{60} over all other treatments.

Effect on quality

Ohm (1976) [44] reported that application of nitrogen significantly increased the protein content of oats. Applied nirtrogen (120 Kg ha-^{1}) increased grain crude protein content as concluded by Zhukova (1977). Similar result was obtained by Singh *et al*. (1996) [32]. Tripathi *et al.* (1979) [96] found that crude protein was highest with 120 Kg N ha-^{1}application. Crude protein content increased with increasing levels of nitrogen significantly up to 120 Kg N ha-^{1} revealed by Verma and Singh (1987). Salmina and Makarova (1988) reported that application of 60 Kg N + 60 Kg P_2O_5 gave highest crude protein in grain i.e. 15%. Nitrogen fertilization significantly increased the protein percentage, the response being linear up to highest level of nitrogen (120 Kg N ha-^{1}) as observed by Vyas *et.al*. (1988) [98]. Similar results were observed by Kumar *et al.* (2001) [35]. Singh *et.al*. (1989) [78] reported that highest crude protein was obtained with highest level of application i.e. 90 Kg N ha-^{1}. Application of 90 Kg N + 30 Kg P_2O_5 ha-^{1}gave highest CP as reported by Tripathi (1993) [95]. Protein concentration increased with nitrogen application (120 Kg N ha-^{1}) as ovserved by Pradhan and Mishra (1994) [55].

Singh *et al.* (1979) [96] reported that increase in nitrogen level from 0 to 150 Kg ha-^{1}caused an increase in crude protein of oat from 7.23 to 10.87%. Application of 100 Kg N ha-^{1}increased crude protein yield significantly concluded by Bali *et al*. (1998) [2]. Increase in N levels resulted in significant enhancement in both protein content and total protein yield ha^{-1}observed by Singh *et al.* (1999) [82]. Similar results were obtained by Chakarborty *et al*. (1999) and by Hasan and Shah (2000) [23]. Application of nitrogen from 0 to 100 Kg ha-^{1}significantly increased the crude protein contents as observed by Sharma *et al.* (2000). Patel and Rajgopal (2002) [46] found the linear response for crude protein yield up to 75 Kg N and 60 Kg P_2O_5 ha-^{1}. Oat responded significantly up to 80 Kg N ha-^{1}for crude protein yield as reported by Aggarwal *et al.* (2002). Kakol *et al.* (2003) [33] concluded that crude protein increased significantly with increase in nitrogen levels up to 150 kg ha^{-1}. Whereas Walens (2003) [100] found that increasing nitrogen rates (up to 90 Kg N ha^{-1}) increased the percentage of total protein in grains of oats. Bhilare and Joshi (2007) [52] studied that significant increase in crude-protein yield was observed up to 160 kg N ha-^{1}. Sheoran *et al.* (2008) [71] found that increasing rates of nitrogen application up to 120 kg N ha-^{1}significantly enhanced the crude protein and other ancillary characters over the lower doses of nitrogen. Sharma (2009) [65] revealed that 150 kg N ha-^{1}significantly increased the crude protein yields (988.7 kg ha-^{1}). Rana *et al*. (2009) [57] concluded that the crude protein and IVDMD also increased in nitrogen level up to 120 kg ha-^{1}. Rawat and Agrawal (2010) [61] studied that an application of nitrogen significantly increased the crude protein yields (7.37 q ha-^{1}) as recorded under 100 kg N ha-^{1}. Devi *et al*. (2010) [15] recorded that nitrogen content in fodder, grain and straw as well as in soil after harvest of oats crop was significantly influenced by nitrogen levels. Application of nitrogen also improved protein content in fodder, grain and straw during both the years. Sheoran and Joshi (2010) [70] revealed that crude protein content and crude protein yield were significantly increased upto 120 kg N ha-^{1}.

Waheed *et al*. (2012.) [99] Recorded that inorganic sources ($N:P_2O_5$ @ 150:60) responded well for maximum crude protein (10.76%), crude fibre (37.00%) and ash (15.14%) contrast to other treatments.

Jehangir *et.al.* (2013) [26] recorded that the fertility level of 150:70:40 ($N:P_2O_5:K_2O$ kg ha^{-1}) significantly increased crude protein content over 125:60:30 and 100:50:20 ($N:P_2O_5:K_2O$ kg ha^{-1}), however crude fibre content significantly decreased with increase in fertility level. Midha *et al*. (2015) [56] found that application of nitrogen @ 120.0 kg ha-^{1}significantly increased the protein content from 11.9 to 13.6 percent and protein yield from 6.3 to 12.1 q ha^{-1}, respectively, over 40.0 and 80 kg N ha^{-1}. Similarly Godara, 2016 [22] found that crude protein content and its yield revealed increased trend with increasing levels of nitrogen and maximum with 120 kg N ha^{-1}. Similar results were reported by Sheroran *et al*. (2017). Jat and Kaushik (2018) [24] indicated that the application of 110 kg N ha-^{1}significantly increased quality parameters like crude protein 1937.13 kg ha-^{1}, crude fibre 5061.22 kg ha-^{1}, ether extract 303.25 kg ha-^{1}, mineral matter 1277.18 kg ha-^{1}, nitrogen free extract 8877.58 kg ha^{-1}and total digestible nutrient 12595.7 Sheoran *et.al* revealed that crude protein content and its yield increased with increasing levels of nitrogen, maximum being with the application of 120 kg N ha-^{1}.

Conclusion

From the above studies it can be concluded that all the growth parameters, yield attributes, yield and quality parameters increases with increase with nitrogen application but significant effect was found upto 120 kg N/ha.

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