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Effect of neem coated urea on growth and yield attributes of barley (*Hordeum vulgare* L.)

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Abstract
A field experiment was conducted during *Rabi* season of 2020-21 at SHUATS, Prayagraj to study the effect of applied Neem coated urea over normal urea with respect to various doses and time of application on Barley (*Hordeum vulgare* L.). The experiment was laid out in Randomized Block Design with ten treatments which were replicated thrice. Application of 125% RDN as neem coated urea (NCU) at 50% basal followed by 25% at 25 DAS and 25% at 45 DAS recorded significantly higher plant height (86.11 cm) and plant dry weight (20.35 g/plant). 125% RDN as NCU (33.33% Basal + 33.33% at 25DAS + 33.33% at 45 DAS) resulted in significantly higher number of tillers/m2 (424.00) as well as yield and yield attributes except for test weight *i.e.,* spike length cm), Grain yield (5.43 t/ha), Straw yield (8.13 kg/ha) and Harvest Index (40.04%). This might be due to uniform availability of nitrogen at later growth stages because of higher and even splits during time of tillering and maximum growth due to slower release of nitrogen as a result of using neem coated urea. Significantly higher test weight (53.67 g) was recorded with 100% RDN applied as NCU (33.33% Basal + 33.33% at 25DAS + 33.33% at 45 DAS). Agronomically, application of neem coated urea resulted in 23.6% higher grain yield than normal urea.

Keywords: NCU, NU, RDN, time of application, splits, NUE, grain yield

1. Introduction

Barley (*Hordeum vulgare* L.) is the fourth most important cereals of the world after wheat, rice and maize accounting 7% of the total worldwide cereal production (Pal *et al*., 2012) [13] with a productivity of 22.45 q/ha in India. This nutritious cereal with high protein content is grown in environments ranging from the desert of the Middle East to the high elevation of Himalayas (Hayes *et al*., 2003) [7]. Barley is a major source of food for large population of cool and semi-arid areas of the world, where wheat and other cereals are less adapted, under adverse environment conditions barley is more productive than other cereals (Alazmani, 2014) [2], due to tolerance to drought and salinity barley has potential to replace wheat crop dominance. Barley is also considered as poor man's crop because of its low input demands, such as water requirement (Malakooti *et al*., 2005) [9] and it's more adaptability to adverse conditions such as droughts, salinity and alkalinity (FAO, 2002) [5] and it thrives well under rainfed conditions. Barley is also used for preparing malt syrup, beer, alcohol, vinegar, mainly used as feed for animals and poultry birds. Its flour is also used to make chapattis, sometimes mixed with wheat or gram for preparing better quality chapatis. About 73% of world barley is used, 22% for malting and 5% for food use. Six rowed barley is generally used for food purposes due to higher protein content, while two rowed barley is preferred for malting and beverages industry. Nitrogen (N) is the most limiting nutrient for crop production in the majority of the world's agricultural areas. Barley reacts quickly to insufficient nitrogen supply and is highly responsive to nitrogen fertilization. Higher nitrogen improves leaf area, tiller formation, leaf area index and duration and these increasing results in greater production of dry matter and grain yield (Ryan *et al*., 2009) [16]. Nitrogen is needed for early tiller development of barley to set up the crop for a high yield potential (Shafi *et al*., 2011) [17]. However, Over-fertilization has been an alarming issue as per sustainability point of view. Nitrogen Leaching, volatilization, surface runoff and denitrification through Nitrate or Ammonia highly concerns Nitrogen use efficiency, which is well below 50% in present scenario. Several techniques have been tried to increase nitrogen use efficiency (NUE) including the use of split N application, slow-release N fertilizers and nitrification inhibitors (NIs). In early 1970s, it was observed that oil extracted from the seeds of neem (*Azadirachta indica* A. Juss) and the cake left after oil extraction possess nitrification inhibition properties. Neem oil is an incredible inhibitor;

whenever urea is covered, it brings about a progressively constant supply of urea, helping plants by increased availability of Nitrogen and prompting better return. Neem coated urea (NCU) have been reported to increase the growth, yield, uptake, and use efficiency of applied nitrogen fertilizer in various crops such as rice, wheat and bajra where the mean increase in grain yield by replacing urea with NCU or NOCU is found to be 5 to 6% (Singh *et al*., 2019) [20]. Recently, in 2015 the Government of India has made it mandatory for the manufacturer to produce neem coated urea.

Quantitative and temporal management of fertilizer is important for maximum profit, as nitrogen use efficiency highly depends on the time of nitrogen application. Time of application of nitrogen is known to exert considerable influence on the yield and quality of crop. Application of nitrogenous fertilizers should be suitably adjusted so as to match the maximum uptake rate in relation to amount of dry matter accumulation (Sharma *et al*., 1998) [18]. The application of nitrogen with higher proportion at tillering stage gives profitable yield (Ramos *et al*., 1995) [15]. The split nitrogen application reduces leaching losses and increases fertilizer use efficiency and nitrogen uptake efficiency (Sinebo *et al*., 2004) [19] which increases the yield. The quality and yield of barley is determined by the nitrogen therefore, choice of cost-effective nitrogen source, total amount of nitrogen and its split applications at the proper growth stage can contribute significantly towards lucrative, high quality barley production (Morojele and Kilian, 2015) [11]. Due to the lack of information regarding dose and split schedule of neem coated urea in barley, this study was undertaken to quantify rate of application of Neem coated Urea, altering the split doses according to the crop growth stages may synchronize the supply of nitrogen with that of the plant demand.

2. Materials and Methods

The field experiment was conducted during *Rabi* season of 2020-21 at Crop Research Farm, NAI, SHUATS, Prayagraj, India. The soil of the experimental field is sandy loam in texture, nearly neutral in soil reaction (pH 6.8), low in organic carbon (0.34%), available N (110.8 kg/ha), available P (6.9 kg/ha), available K (119.2 kg/ha). The experiment was laid out in Randomized Block Design with ten treatments *viz*. 100% RDN as NU [50% as Basal +25% at 25 DAS + 25% at 45 DAS], 75% RDN as NCU [50% Basal + 50% at 25 DAS], 100% RDN as NCU [50% Basal + 50% at 25 DAS], 125% RDN as NCU [50% Basal + 50% at 25 DAS], 75% RDN as NCU [50% Basal + 25% at 25 DAS + 25% at 45 DAS], 100% RDN as NCU [50% Basal + 25% at 25 DAS + 25% at 45 DAS], 125% RDN as NCU [50% Basal + 25% at 25 DAS + 25% at 45 DAS], 75% RDN as NCU [33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS], 100% RDN as NCU [33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS] and 125% RDN as NCU [33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS] which were replicated thrice. Barley variety DWRB-160, was sown on December 1st, 2020 in lines at 20 cm apart with a seed rate of 120 kg/ha. Treatment combinations were applied accordingly at sowing and the Nitrogen was applied as per treatments, whereas whole Phosphorus and Potassium were applied as basal in form of Single Super Phosphate and Muriate of Potash. Different intercultural operations were done as and when necessary following standard practices. To reduce crop-weed competition one hand weeding was carried out at 40 days after sowing. Two irrigations were provided at 40 days interval. The observations pertaining to growth attributes were recorded using standard procedure at 20 days intervals, and presented at 100 DAS. Yield parameters were observed on the day of harvest, 31st March, 2021. All the attributes were recorded and analysed statistically by using appropriate analysis of Variance adopting Gomez and Gomez (1984) [6].

3. Results and Discussion

Neem coated urea application at various doses and split significantly influenced growth attributes of barley. 125% RDN as NCU (50% Basal + 25% at 25 DAS + 25% at 45 DAS) resulted significantly higher plant height (86.11 cm) and plant dry weight (20.35 g). Whereas, application of 125% RDN as NCU (33.33% Basal + 33.33% at 25DAS + 33.33% at 45 DAS) remained statistically at par. Growth of barley increased significantly with increase in rate of N application (RDN). Since Nitrogen is involved in the stem elongation plant height is affected by the dose of Nitrogen (Tripathi *et al*., 2013) [22]. The plant height increased significantly when nitrogen was applied in three splits at 25 DAS and 45 DAS as compared to two splits at 25 DAS followed by basal application. This may be due to better availability of N and the enhancing effect of N on vegetative growth (Abedi *et al*., 2011) [1]. Gradual release of nitrogen through neem coated urea and maintenance of higher available nitrogen in soil throughout the crop growth period resulting boost in dry matter content through production of photo assimilates via leaves which is the center of plant growth during vegetative stage and later distribution of assimilates to the reproductive organs. The results were in confirmation with findings of Dubey *et al*., (2018) [4]. Application of 125% RDN as NCU (33.33% Basal + 33.33% at 25 DAS + 33.33% at 45 DAS) resulted in significantly higher Number of tillers/m2 (424.00). This may be due to availability of nitrogen at later growth stages because of higher and even splits during time of tillering and maximum growth due to slower release of nitrogen because of Neem coated urea. Application of nitrogen on when the plant can fully utilize it, gives better efficiency and better yields by inhibiting losses. Higher numbers of tillers with higher dose of N might be due to at least plant competition for nutrients caused by sufficient supply of nitrogen which increase the better absorption of nutrients from soil. The results and probable reasons for such results are in conformity with the findings of Patel *et al*., (2004) [14]. Application of neem coated urea performed better than normal urea, might be due to adequate supply of nitrogen which resulted in better partitioning of photosynthates to the mother culm which supplies carbohydrates and their nutrients to developing tillers. The production of tillers might be due to steady and continuous availability of nitrogen through neem coated urea during the entire crop season (Kumari and Chaudhary, 2018) [8].

Among the treatments, 125% RDN as NCU (33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS) produced significantly higher Spike length (9.40 cm), grain yield (5.43 t/ha), straw yield (8.13 t/ha) and Harvest Index (40.04%). Thind *et al*., (2010) [21] and Narolia and Yadav (2013) [12] also observed increase in the yield and yield attributes with different doses and split application of nitrogen. Application of 125% RDN as NCU [50% Basal + 25% at 25 DAS + 25% at 45 DAS] and 100% RDN as NCU [33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS] produced statistically at par grain and straw yield. Abedi *et al*., (2011) [1] reported increase in the yield of crop with increase in doses of nitrogen. Mangat and Narang (2004) [10] found higher crop yield obtained in paddy and wheat when neem coated urea was applied at 100% N application and when NCU was applied at 80% level, the yield was reduced significantly. Application of neem coated urea resulted in 23.6% higher grain yield (4.24 t/ha) in treatment no. 6, 100% RDN as NCU (50% Basal + 25% at 25 DAS + 25% at 45 DAS) than 3.43 t/ha yield in treatment no. 1 when 100% RDN is applied as normal urea (50% as Basal +25% at 25 DAS + 25% at 45 DAS). Nitrogen influenced vegetative growth in terms of plant height and tillers/m2 which increased straw yield. This might be due to increased nitrogen use efficiency and continuous supply of nitrogen boosting vegetative growth. Similar findings were reported by Chawan *et al*., (2017) [3]. Significantly highest test weight of barley (53.67 g) was observed with application of 100% RDN as NCU (33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS). Application of 125% RDN as NCU (50% Basal + 25% at 25 DAS + 25% at 45 DAS) and 125% RDN as NCU (33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS) produced statistically at par test weight which violated the trend followed by spike length, grain and straw yield due to inconsistent accumulation of grain nitrogen.

Table 1: Effect of neem coated urea on growth attributes *viz.* plant height, plant dry weight and no. of tillers/m2 of Barley

Treatment No.	Treatment combination	Plant Height (cm)	Plant dry weight (g/plant)	Number of tillers/m2
1.	100% RDN as NU [50% Basal + 25% at 25 DAS + 25% at 4 5DAS]	78.87	13.93	344.67
2.	75% RDN as NCU [50% Basal + 50% at 25 DAS]	81.29	14.41	325.33
3.	100% RDN as NCU [50% Basal + 50% at 25 DAS]	83.09	15.47	358.00
4.	125% RDN as NCU [50% Basal + 50% at 25 DAS]	84.77	16.61	374.00
5.	75% RDN as NCU [50% Basal + 25% at 25 DAS + 25% at 45 DAS]	83.16	16.37	345.67
6.	100% RDN as NCU [50% Basal + 25% at 25 DAS + 25% at 45 DAS]	84.33	17.88	380.67
7.	125% RDN as NCU [50% Basal + 25% at 25 DAS + 25% at 45 DAS]	86.11	20.35	402.67
8.	75% RDN as NCU [33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS	82.80	16.47	376.00
9.	100% RDN as NCU [33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS]	83.97	17.80	388.33
10.	125% RDN as NCU [33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS]	85.36	19.35	424.00
	F-test	S	S	S
	Sem	0.48	0.40	4.73
	CD at 5%	1.43	1.18	14.04

Table 2: Effect of neem coated urea on yield and yield attributes viz. spike length and test weight of Barley

Treatment No.	Treatment combination	Spike length (cm)	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest Index (%)
1.	100% RDN as NU [50% Basal + 25% at 25 DAS + 25% at 45 DAS]	6.27	43.00	3.43	6.03	36.23
2.	75% RDN as NCU [50% Basal + 50% at 25 DAS]	6.17	41.00	3.28	6.90	32.24
3.	100% RDN as NCU [50% Basal + 50% at 25 DAS]	6.40	42.67	3.87	7.12	35.17
4.	125% RDN as NCU [50% Basal + 50% at 25 DAS]	7.03	43.67	4.27	7.83	35.30
5.	75% RDN as NCU [50% Basal + 25% at 25 DAS + 25% at 45 DAS]	7.00	44.33	3.62	6.77	34.77
6.	100% RDN as NCU [50% Basal + 25% at 25 DAS + 25% at 45 DAS]	7.57	45.00	4.24	6.93	37.94
7.	125% RDN as NCU [50% Basal + 25% at 25 DAS + 25% at 45 DAS]	8.20	53.33	5.05	8.04	38.55
8.	75% RDN as NCU [33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS	8.03	45.33	4.04	6.85	37.02
9.	100% RDN as NCU [33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS]	8.47	53.67	5.00	7.54	39.88
10.	125% RDN as NCU [33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS]	9.40	52.00	5.43	8.13	40.04
	F-test	S	S	S	S	S
	Sem	0.17	1.35	0.19	0.22	1.12
	CD at 5%	0.50	4.02	0.57	0.64	3.32

4. Conclusion

On the basis of one *Rabi* season experimentation, application of neem coated urea in three equal splits was more productive (5.43 t/ha grain yield) as compared to other treatments. Application of 125% RDN as NCU (33.33% Basal + 33.33% at 25 DAS + 33.33% at 45 DAS) resulted in higher yield and yield attributes except for Test weight *viz.* Spike length (9.40 cm), Grain yield (5.43 t/ha), Straw yield (8.13 t/ha) and Harvest Index (40.04%). Application of 100% RDN as NCU (33.3% Basal + 33.3% at 25 DAS + 33.3% at 45 DAS) resulted significantly higher test weight (53.67g). However, Application of 125% RDN as NCU (50% Basal + 25% at 25 DAS + 25% at 45 DAS) recorded significantly higher growth in terms of plant height (86.11 cm), plant dry weight (20.35 g/plant). This concludes that higher rate of nitrogen applied in more splits boosts growth and yield; and for higher returns 125% RDN as NCU as 33.3% Basal followed by 33.3% at 25 DAS and 33.3% at 45 DAS may be suggested. The conclusions drawn are based on one season data only which requires further confirmation for recommendation.

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