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ORIGINAL ARTICLE

The Effect of Rate and Time of Nitrogen Application on Quality of Summer Maize (*Zea mays* L.)

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ABSTRACT
A field experiment was conducted at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari to study the effect of rate and time of nitrogen application on quality of summer maize. The treatments of the study included three rates (60, 90 and 120 kg N ha^{-1}) of nitrogen and three timings (two equal splits at sowing and 30 DAS, three equal splits at sowing, 30 and 45 DAS and four equal splits at sowing, 30, 45 and 60 DAS).Protein content was determined by estimating the total nitrogen content of the sample by modified Kjeldahl's method. The estimated nitrogen was multiplied with conversion factor 6.25 to convert total nitrogen in terms of protein. Oil content of the seed was determined by using Soxhlet apparatus. Total carbohydrate content (%) of grain was determined by Phenol sulphuric acid method. Protein content was affected significantly and the maximum value (9.96 %) was recorded under 120 kg N ha^{-1}, which remained at par with 90 kg N ha^{-1}. Nitrogen application in four splits significantly improved protein content (9.94 %) in grain as compared to nitrogen application in two splits. Carbohydrate and oil content remained non-significant.
Key Words: Carbohydrate, Kjeldahl's method, oil content, Protein,Soxhlet apparatus

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INTRODUCTION

Maize (*Zea mays* L.) also known as corn belongs to family Poaceae is one of the important cereal crops of the world due to its high value as staple food as well as straw demand for animal feed. It is one of the most versatile crops having wider adaptability and grown under varied agro-climatic conditions, diverse seasons and ecologies for various purposes. Globally, maize is known as "queen of cereals" because of its highest genetic yield potential among the cereals [10]. It is cultivated on nearly 183 m ha in the world with production of 1065 million tons with a productivity of 5820 kg ha^{-1} [3]. It is grown in more than 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36 per cent to the global grain production. USA is the largest producer of maize contributing nearly 35 per cent of the total maize production in the world [11]. Maize is considered to be the driver of the US economy. The USA has the highest productivity ($\geq$ 10.96 t ha^{-1}) which is double of the global average (5.82 t ha^{-1}). Maize is the third most important food crop of India after rice and wheat. In India, it is cultivated in 9.63 m ha mainly during Kharif season which covers 80 per cent area. Current maize production is 25.90 million tons, with an average productivity of 2689 kg ha^{-1} [4].

Nitrogen plays a key role in several physiological and metabolic processes. The most important role of N in the plant is its presence in the structure of the protein and nucleic acids and is essential for enzymatic, biochemical and physiological reactions in plant metabolism. Yield and protein concentration in maize seed increased with increase in nitrogen dose [13]. Quality characteristics of maize such as protein content in seed were improved with optimum nitrogen level [2]. However, both low as well as high nitrogen dose have adverse effect on quality of maize [18]. Therefore, it is necessary to give optimum dose of nitrogen for improving quality of maize [9].

The time of nitrogen application at appropriate crop growth stage when it is needed most and taken up at high rates by plants could enhance nitrogen use efficiency by reducing the immobilization, denitrification and leaching losses [13]. Optimum and efficient time of N application can increase the recovery of applied N upto 58-70 per cent and hence, increase grain yield and quality of the crop [6]. Silva *et al.* [17] reported that N fertilisation at booting and silking stages caused significant increments in grain yield and crude protein content. There is little information available on nitrogen requirement and its time of application for summer maize. In view of the above, the present experiment was carried out.

MATERIAL AND METHODS

A field experiment was conducted during summer 2018 at college farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari to assess the quality prameters of maize. The soil of the experimental site was clayey in texture (62.17 %), medium in organic carbon (0.56 %), low in available nitrogen (192.86 kg ha^{-1}), medium in available phosphorus (49.58 kg ha^{-1}) and available potassium (501.42 kg ha^{-1}). The soil reaction was slightly alkaline (pH 8.15) with normal electrical conductivity.

Nine treatment combinations, consisting of three rates (60, 90 and 120 kg N ha^{-1}) and three timings (two equal splits at sowing and 30 DAS, three equal splits at sowing, 30 DAS and 45 DAS and four equal splits at sowing, 30 DAS, 45 DAS and 60 DAS) of nitrogen application were evaluated in factorial randomized block design with four replications. Before the experiment, pigeon pea was grown in the field and harvested in January and kept fallow prior to maize sowing. The maize variety GM-6 was sown on February 19, 2018. A seed rate of 25 kg ha^{-1} was used by keeping row to row distance of 60 cm and plant to plant distance of 20 cm. Sowing was done manually by maintaining plant to plant spacing with the help of marked stick (20 cm) as per the treatments. Seeds were covered with soil and irrigation was given immediately after sowing.

Bio-compost at 5 t ha^{-1} was applied on the experimental field before sowing and mixed well. Nitrogen was applied as per the treatments. Common application of 40 kg P_2O_5 ha^{-1} was made as basal. The sources of nitrogen and phosphorus were urea and single super phosphate, respectively. Total seven irrigations were given during the crop period.

Protein contain of grains from each plot was determined by estimating the total nitrogen content of the sample by modified Kjeldahl's method [7]. The estimated nitrogen was multiplied with conversion factor 6.25 to convert total nitrogen in terms of protein. A representative sample of seeds was taken from each net plot produce for analysis of oil content (%). Oil content of the seed was determined by Soxhlet apparatus as per the method described by Ajayi *et al.* [1]. Total carbohydrate content (%) of grain from each plot was determined by estimating the total carbohydrates by Phenol sulphuric acid method [15].

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussion have been summarized under following heads:

Protein content (%)

The different levels of nitrogen had a significant effect on the protein content in maize grain(Table 1).Application of 120 kg N ha^{-1} recorded the maximum protein content (9.96 %) in grain which was statistically at with 90 kg N ha^{-1} (N_2) and recorded significantly higher protein content (9.03 %) in grain as compared to 60 kg N ha^{-1} (N_1). The increase in protein content in grain might be due to higher nitrogen content in grain. The findings were in accordance with Sharma *et al.* [16].

The time of nitrogen application significantly influenced the protein content in grain. The protein content increased with increasing number of splits. Application of nitrogen in four equal splits at sowing, 30 DAS, 45 DAS and 60 DAS (T_3) produced significantly higher grain protein content (9.94 %) compared to nitrogen application in two equal splits at sowing and 30 DAS (T_1) (9.05 %) but remained statistically at par with nitrogen application in three equal splits at sowing, 30 DAS and 45 DAS (T_2). The higher protein content in grain might be due to higher nitrogen content in grain.The similar findings were reported by Nemati and Sharifi [12] and Verma [19].

Carbohydrate content (%)

Different levels of nitrogen application failed to show significant effect on total carbohydrate content (%) in maize grains (Table 1). The maximum carbohydrate content in grain (68.10 %) was recorded under 60 kg Nha^{-1} (N_1) whereas the minimum carbohydrate content (66.72 %) was recorded under 120 kg Nha^{-1} (N_3).

Further, the data (Table 1) indicated that the split application of nitrogen had no significant effect on total carbohydrate content (%) of the maize. The carbohydrate content varied from 68.19 per cent under nitrogen application in four equal splits at sowing, 30 DAS, 45 DAS and 60 DAS (T_3) to 67.71 per cent under two equal splits at sowing and 30 DAS (T_1).

3.3 Oil content (%)

Mean data of oil content (Table 1) revealed non-significant effect of nitrogen levels on oil content (%) in maize grains. The range of oil content in maize grains varied from 4.27 per cent under 60 kg Nha^{-1} to 4.32 per cent under 120 kg Nha^{-1}.The similar results were obtained by Aulakh et al. [5] and Kaur and Kumar [8].

Further, the split application of nitrogen had no significant effect on oil content (%) of the maize grains. The oil content varied from 4.29 per cent under nitrogen application in two equal splits at sowing and 30 DAS (T_1) to 4.31 per cent under nitrogen application in four equal splits at sowing, 30 DAS, 45 DAS and 60 DAS (T_3).

Table 1: Effect of rate and time of nitrogen application on protein, carbohydrate and oil content in grain of summer maize

Treatment	Protein (%)	Carbohydrate (%)	Oil (%)
Rate of N application (N)			
N1 : 60 kg N ha-1	9.03	68.10	4.27
N2 : 90 kg N ha-1	9.75	67.54	4.30
N3 : 120 kg N ha-1	9.96	66.72	4.32
SEm±	0.25	0.50	0.03
CD at 5%	0.72	NS	NS
Time of N application (T)			
T1 : Two equal splits (at sowing and 30 DAS)	9.05	68.19	4.29
T2 : Three equal splits (at sowing, 30 DAS and 45 DAS)	9.74	67.71	4.30
T3 : Four equal splits (at sowing, 30 DAS, 45 DAS and 60 DAS)	9.94	66.46	4.31
SEm±	0.25	0.50	0.03
CD at 5%	0.72	NS	NS
Interaction (N x T)			
SEm±	0.43	0.86	0.05
CD at 5%	NS	NS	NS
CV %	8.96	4.61	3.87

CONCLUSIONS

Protein content was significantly affected by rate and time of nitrogen application while, carbohydrate and oil content remained non-significant. Protein content was affected significantly and the maximum value (9.96 %) was recorded under 120 kg N ha^{-1}, which remained at par with 90 kg N ha^{-1}. Nitrogen application in four splits significantly improved protein content (9.94 %) in grain as compared to nitrogen application in two splits.

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