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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(12): 602-602
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www.thepharmajournal.com
Received: 02-09-2021
Accepted: 09-10-2021

Impact of soil and foliar nutrient management practices on soil fertility in sweet corn *(Zea mays* var. *saccharata*)

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Abstract
Maize productivity is relatively better than other major cereal crops but its current productivity is still far below than its potential productivity. The rate and time of N application are among the major abiotic factors limiting the productivity of the crop. Because of such gaps, the experiment was carried out to study the impact of soil and foliar nutrient management practices on soil fertility in sweet corn (Zea mays var. saccharata). The factors consisted of three level of nitrogen (F_1: 50% RDN, F_2: 75% RDN and F_3: 100% RDN) and two levels of split application (S_1: two splits with basal and 30 DAS, S_2: three splits with basal, 20 and 40 DAS) with and without foliar application of nitrogen (N_0: control and N_1: 2% urea at 50 DAS). The result showed that soil application of nutrient in different levels and splits gave significant effect on nitrogen availability in soil after harvest. Available nitrogen in soil after harvest was found significantly enhanced with application of 100% RDN (F_3) as well as application of N with three splits (at basal, 20 and 40 DAS) (S_2). Application of N in different splits reduced the losses of nitrogen which becomes available for longer period and increased its use efficiency and efficient uptake while foliar application increases immediate availability of nitrogen at later growth stage.

Keywords: Sweet corn, split application, foliar application, 100% RDN, DAS

1. Introduction
Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals which has third rank in total world production after wheat and rice. It is principal staple food in many countries, particularly in the tropics and subtropics (FAO, 1999) [4]. It is an annual grass in the gramineae family. Maize primarily used for feed (60%), human food (24%), industrial (starch) products (14%), beverages (1%), and grain (1%). Thus, maize has attained an important position as industrial crop because 75% of its produce is used in starch and feed industry (Anonymous, 2012) [1].

Sweet corn is a form of maize which is incapable of completing the formation of normal corn starch or has been expressed tersely; sweet corn is field corn in an arrested state of development. It has been designated as an agricultural species, *Zea saccharata* by Sturtevant and as distinct species, *Zea rugosa* by Bonafice. For diversification and getting more valuable crops, presently greater emphasis is being given on cultivation of sweet corn to augment the income for farming community dwelling in the outskirts of big cities and metropolis. In India, the green cob of sweet corn consumed directly as roasted or boiled cob in and around cities. It has been developed into a multi-dollar business because of its potential as a value added product for export and a good food substitute. It has potentiality not only in domestic market but also in an international market. It contains energy of 90 kcal, carbohydrates (19 gm), sugar (3.2 gm), dietary fiber (2.7 gm), fat (1.2 gm), protein (3.2 gm), vitamin A (10 µg), folate (Vit.B9) (46 µg), vitamin C (7 mg), iron (0.5 mg), magnesium (37 mg) and potassium (270 mg) nutritional value per 100 g sweet corn seed.

Among the primary nutrients, nitrogen is very important as it is intimately involved in the process of photosynthesis and thus directly related to total dry matter production. Lack of proper splitting of N applications, and many a times over or under application N than the crop need is one important reason for low N-use efficiency. As N requirement of maize plant is not same throughout the growth period it is necessary to adjust N fertilizer application with the timings of plant N requirement to enhance N-use efficiency in maize.

The real time N management approach can help increase N use efficiency by matching time of fertilizer application with plant need (Mathukia *et al.*, 2014) [10]. Hence, application of N resulting in higher biomass is commonly increased. Optimum rate and time of N application can enhance yield productivity and nutrient use efficiencies while reducing the environmental pollution (Fernßndez *et al.*, 2009 and Nielsen 2013) [5, 11].

Time of N application at appropriate crop growth stage is also another main focus to enhance N use efficiency and increase maize productivity. All applied N is not absorbed by the crop since leaching is one of the main challenges for N loss in high rainfall areas. Research reports had shown that about 50% and even more than this figure at higher doses of applied N remain unavailable to a crop due to N loss through leaching (Jamal *et al.*, 2006) [8]. This leaching loss may be determined by a quantity of N applied, inappropriate time of application, soil permeability, and quantity of rainfall drops in the area (Fageria and Baligar, 2005) [3]. However, an optimum and efficient time of N application can increase the recovery of applied N up to 58–70% and hence increase yield and grain quality of the crop (Jamal *et al.* 2006 and Haile *et al.* 2012) [8 6].

Foliar application of nutrients, conceptually over 100 years old, is gaining importance in many crops. Foliar nutrition is recognized as an important method of fertilization, since foliar nutrients usually penetrate the leaf cuticle or stomata and enter the cells facilitating easy and rapid utilization of nutrients. Foliar sprays are used for three main purposes. They are (i) to maintain optimum nutrition of a particular nutrient, (ii) to give a crop nutritional boost at a critical junctures of different phenophases and (iii) to correct deficiency disorders (Wittwer and Teubner, 1959). In many cases aerial spray of nutrients is preferred and gives quicker and better results than the soil application (Jamal *et al*., 2006) [8]. Recently foliar application of nutrients has become an important practice in the production of crops while application of fertilizers to the soil remains the basic method of feeding the majority of the crop plants. So, there is no single strategy to fit every grower's situation, but supplementing a traditional nitrogen-fertility program with split and foliar applications may give growers more management options.

Materials and Methods

Location

A field experiment entitled "Soil pH, EC and NPK status under sweet corn as influenced by soil and foliar nutrient application" was conducted during *rabi* season of the year 2017-18. The Navsari Agricultural University campus is geographically located at 20º57′ N latitude and 72º54′ E longitude at an altitude of 10 m above the mean sea level.

Climatic conditions

Navsari falls in south Gujarat heavy rainfall zone - I (Agro-ecological situation-3). The climate of this region is characterized by fairly hot summer, moderately cold winter and warm humid monsoon with heavy rainfall. The soil of the experimental field was clay in texture and showed low moderately high and very high rating for available nitrogen (180 kg/ha), phosphorus (34 kg/ha), potassium (346 kg/ha), respectively. The soil was slightly alkaline (pH 7.8) with normal electric conductivity (0.38 dS/m) and having 0.72% organic carbon.

Treatment details

The experiment was laid out in Factorial randomized block design with three replications. The factors consisted of three level of nitrogen (F_1: 50% RDN, F_2: 75% RDN and F_3: 100% RDN) and two levels of split application (S_1: two splits with basal and 30 DAS, S_2: three splits with basal, 20 and 40 DAS) with and without foliar application of nitrogen (N_0: control and N_1: 2% urea at 50 DAS).

The seed rate of 10 kg/ha was used for the sweet corn variety Sugar-75 and seeds treated with Azotobacter 2 ml/kg seed before sowing. The entire dose of 60 kg/ha phosphorus and 60 kg/ha potassium was applied as basal application in form of single super phosphate and murate of potash just before sowing. Nitrogen (120 kg/ha) was applied as per treatment.

Chemical analysis

For estimation of pH, EC, available nitrogen, phosphorus and potash in soil before sowing and after harvest of crop, representative soil samples were drawn from each plot at 0-15 cm soil depth and were analyzed with following methods.

Determination	Method employed
EC (1: 2.5) (dS/m)	Conductometric (Jackson, 1973)
Soil pH (1:2.5 soil: water ratio)	Potentiometric pH meter (Jackson, 1973)
Available Nitrogen (kg/ha)	Alkaline $KMnO_4$ method (Subbaiah and Asija,1956)
Available phosphorus (kg/ha)	Spectro photometric (Olsen *et al.*, 1954)
Available potassium (kg/ha)	Flame photometric method (Jackson, 1973)

Statistical analysis

The field experiment was conducted in factorial randomized block design. The different factors as three levels of N, two levels of split and with or without foliar application of N were tested with three replication. The statistical analysis of data recorded for different characters during the course of investigation was carried out through the procedure appropriate to the design of the experiment as described by Panse and Sukhatme (1985) [13]. The significance of difference was tested by 'F' test. Five percent level of significance was used to test the significance of results. The critical differences were calculated when the differences among treatments were found significant in 'F' test. In the remaining cases, only standard error of means was worked out. The co-efficient of variance (CV %) was also worked out.

Results and Discussion

Levels of N

Different nitrogen levels applied to sweet corn found significant variation in available N in soil after harvest of crop and the higher level of available nitrogen in soil after harvest was found in 100% RDN treatment (F_3). However, soil Ph, EC and available phosphorus and potash values were not found to be significant after harvest of sweet corn in soil (Table 1). Available N was increased with increasing nitrogen levels which might be due to sufficient availability of N through applied fertilizer. Results showed that the nutrient status of soil after harvest of crop fluctuated over initial status. These findings were supported by Chaudhary *et al.* (2013) [2] and Kwadzo *et al.* (2016) [9].

Split application of N

The results regarding available nutrients present in the soil after harvest of crop showed that only available N was significantly influenced due to split application of nitrogen. Application of nitrogen in three splits (at basal, 20 and 40 DAS) (S_2) recorded higher value of available N. However, soil pH, EC and available phosphorus and potash value were not found to be significant after harvest of sweet corn in soil (Table 1). This might be due to time of split application of nitrogen that prevented nutrient loss by leaching or volatilization and made continuous availability to crop. These results are in close agreement with those reported by Swamy *et al.* (2016) [15].

Foliar application of N

Soil pH, EC and available N, P_2O_5 and K_2O in soil were non significantly influenced due to foliar application of N (Table 1).

Table 1: Ph, EC, Available N, P_2O_5 and K_2O content of soil (kg/ha) after harvest of sweet corn as influenced by different levels, split and foliar application of nitrogen

Treatments	pH	EC (dS/m)	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
A) Levels of N					
F_1: 50% RDN	7.69	0.34	158.34	31.60	342.71
F_2: 75% RDN	7.66	0.35	163.39	33.24	346.25
F_3: 100% RDN	7.52	0.37	176.07	34.26	369.40
S. Em.±	0.07	0.01	4.37	0.73	8.06
CD at 5%	NS	NS	12.82	NS	NS
B) Split application of N					
S_1: 2 Splits of N (Basal *fb* 30 DAS)	7.58	0.36	156.34	32.85	343.24
S_2: 3 Splits of N (Basal *fb* 20 and 40 DAS)	7.67	0.35	175.52	33.21	362.33
S. Em.±	0.06	0.01	3.57	0.60	6.58
CD at 5%	NS	NS	10.47	NS	NS
C) Foliar application of N					
N_0: Control (No spray)	7.56	0.35	162.69	32.66	343.50
N_1: 2% urea at 50 DAS	7.69	0.36	169.17	33.41	362.08
S. Em.±	0.06	0.01	3.57	0.60	6.58
CD at 5%	NS	NS	NS	NS	NS
Significant Interactions	-	-	-	-	-
CV %	3.20	8.34	9.12	7.69	7.92

Conclusion

So far from these one year experiment, it can be concluded that soil application of nutrient in different levels and splits gave significant effect on nitrogen availability in soil after harvest. Available nitrogen in soil after harvest was found significantly enhanced with application of 100% RDN (F_3) as well as application of N with three splits (at basal, 20 and 40 DAS) (S_2).

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