Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(2): 1129-1131
Received: 20-01-2018
Accepted: 23-02-2018

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Effect of split application of nitrogen on growth and yield of *Kharif* maize (*Zea mays* L.)

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Abstract
In this study, N application to maize tended to improve vegetative growth. Excessive use of nitrogenous fertilizers and other chemical fertilizers affect these invaluable soil microflora and the result is barren land with less or no water holding capacity increases tissue succulency in crop plants and make them vulnerable to diseases and pests. The increased condition succulency of plant tissues helps in pests and pathogens entry and multiplication easier therefore increasing the susceptibility. Split nitrogen (N) fertilizer applications can play an important role in a nutrient management strategy that is productive, profitable and environmentally responsible. With the help of split application we can minimize the denitrification, volatilization and leaching lossess. By more specifically synchronizing nitrogen supply with a plant's ability to utilize nutrients, split application can be an important component of 4R Nutrient Stewardship — right source, right rate, right time and right place. Split-applying nitrogen fertilizer is one way to confront these challenges. In this review, we focus on total nitrogen requirement is supplied at-planting application, most of the N must be waste. By postponing a portion of the N treatment until the crop is better able to utilize the nutrient, plants take up the nitrogen more quickly and efficiently.

Keywords: Maize, Nitrogen use efficiency, Split application

Introduction
Maize (*Zea mays* L) is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions and successful cultivation in diverse seasons and ecologies for various purposes. Globally, maize is known as "Queen" of cereals because it has the highest genetic yield potential among the cereals. Maize is also known as Drosophila of crops. It efficiently utilizes solar energy and has immense potential for higher yield, so called as "Miracle crop". Maize ranks third in India in terms of production among cereals, among the three major fertilizers, nitrogen, phosphate and potassium, application of nitrogenous fertilizers is the maximum. It is reported that China, India and Pakistan together consume approximately 70% of nitrogen fertilizer consumed globally. These figures of nitrogen fertilizer consumption point towards emerging environmental pollution issues. Excessive nitrogenous fertilizer application results increase disease-pest infestation and various kinds of nitrogen losses. Split and delayed basal fertilizer applications are possible strategies to improve the crop yield and reduce nutrient loss through leaching in sandy soils, but their effectiveness under high rainfall regimes to produce a maize growth response needs further investigation. The primary purpose is to adjust the nitrogen supply according to the demand of a growing crop. This can improve nitrogen use efficiency. Split application reduces the risk of losses through leaching. Split application of nitrogen can increase grain yield and grain protein content. Split application is a N management strategy that will likely gain momentum in the next 5 to 10 years.

For the split application of nitrogen to be successful, the farmer has to make many decisions in the planning stage and specify the plans during the growing season. Split application is the process of matching nitrogen supply for a pre-established target yield and a given level of soil moisture, and then supplying the remaining nitrogen as moisture conditions improve. Split application**s** of nitrogen give producers greater flexibility in their fertilizer program. This practice minimizes the risk of placing all the nitrogen at the time of seeding. By providing nitrogen to meet the changing demands of a growing crop, producers can potentially increase nitrogen use efficiency. Split application reduces the exposure of nitrogen in saturated soils where the potential for losses such as leaching and denitrification are increased. It also reduces the amount of product a producer must handle during the busy seeding period. Finally, proper timing and placement of nitrogen may help reduce nitrous oxide emissions. Split application of nitrogen fertilizer may substantially improve corn nitrogen use efficiency, particularly during wet growing seasons.

Corn extracts less than 15% of its seasonal nitrogen uptake before rapid vegetative growth begins.

Split application of nitrogen is one of the methods to improve nitrogen use by the crop while reducing the nutrient loss through leaching and volatilization (Tolessa *et al.,* 1994) [3]. Split-application is an essential approach to increase the N use efficiency in crops including maize (Muthukumar *et al.,* 2007) [1]. It improves the maize grain yield and increased the economic benefit from increased grain yield. Corn shows large responses to nitrogen (N) fertilizer application, depending on weather, soil characteristics, water supply, crop uniformity and the nutrient responses of the cultivated varieties.

Nitrogen is vital for most plant metabolic activities and plays an important role in tillering, stalk elongation and photosynthesis.Maize is one of the important cereal crops and contributes to the larger extent in the world agricultural economy both as food for human beings and feed for animals. One of the most costly and important inputs in corn production is nitrogen fertilizer. Research was conducted at the Monmouth Learning Centre to evaluate the yield response of corn to application timing and nitrogen use rates.

Needs of split application of nitrogen

Farmers traditionally apply nitrogen to the soil in a single pass during either the fall or in the spring before planting. However, early nitrogen application can result in significant losses due to weather factors (e.g. warm, moist soils). Research has shown that a split application of nitrogen – one application in the fall or around the time of planting and a second application after planting when there is the greatest demand for N from the crop – can reduce total nitrogen use (savings to the farmer) and/or reduce nitrogen loss to the environment (savings to society). There are some risks involved with a split nitrogen application strategy. Greater costs are incurred because two passes through the field are required. Additionally, the second application (if conducted using ground application equipment) may be hindered due to weather conditions. If soils are too wet during the time when a second application of nitrogen is needed, insufficient nitrogen may result in lower yields. With the Corn Split N tool farmersnow have a way of quantifying the costs and benefits of post-planting nitrogen applications.

Split application enhanced the nitrogen use efficiency of plant

Agriculture faces the different kind of challenges to meet the demand of food, forage and fiberin a manner that is both environmentally and economically. Split application of nitrogen increase the efficiency of plant with the better yield and growth parameter likewise plant height, number of functional leaves, leaf area, dry matter accumulation, stem girth, number of internodes, number of cobs/m^2, weight of cob, length of cob, number of grains cob^{-1} and test weight. Fertilizer is an integral part of this quest and the adoption of research-based best management practices (BMPs), such as split fertilizer application, reward farmers and consumers alike. To "split-apply" nitrogen, growers make two or more fertilizer applications during the growing season rather than providing all of the crop's N requirements with a single treatment prior to, or at, planting. "When all amount of nitrogenous fertilizer is supplied ahead of crop growth, maximum amount of nitrogen is susceptible to denitrification, leaching or volatilization. "Different growing environments pose different potential nitrogen loss conditions - nitrogen leaching beyond the root zone, for instance, is most likely in lighter textured soils not inhibited by a clay layer — but almost all growers face the possibility of losing some of the nitrogen they apply. "When you split your N application and put a portion on later, almost all of that second application will be taken up by the plant.

Split Application response depend on crop nature

Split application offers efficacy benefits on a wide range of crops and forages but its management must be considered on a crop-by-crop basis. The timing of post-planting nitrogen applications is especially critical. The target species must be immature and growing to provide time for the nitrogen to be absorbed and metabolized in order to have the most efficient yield or quality impact. In the case of corn, for instance, all of the nitrogen should be delivered to the plant before ears are set. All crops, however, have different nutrient requirements. Because of a need for continuous, in-season production, forages especially benefit from split-applying nitrogen.

Effect of split application on source and placement method of the fertilizer

As in all fertilization strategies, source, rate, time and place should be the foundation of split fertilization decisions. Although nitrogen available in various forms eg. granular, liquid and anhydrous - can be utilized in a split application, their placement is critical. Application of Urea application instead of spread over use the band placement method than nutrient use efficiency increases. Ammonium forms are less vulnerable to denitrification than are nitrate fertilizers. Preferably, urea-containing fertilizers should be applied when soil incorporation by rainfall or irrigation is likely within 24-48 hours, or incorporated by tillage. This is especially important in environments favorable to ammonia volatilization.

Effect of the split application on the Yields and Nitrogen Loss

By putting nitrogen on when the plant can fully utilize it, we get better efficiency and we see better yields. "When that corn plant is about knee height stage, it's at a stage that it's really ready to charge. It's really ready to take advantage of the nitrogen and it's going to use it up. "The first split application is applied at the time of sowing, second and third knee height stage (30 day after sowing) and tesseling stage (60 DAS) respectively in order to minimize N losses. A starter is used through the planter and the application at 10-12 inches provides the final boost for optimum yields. In maize crop, tesseling is most sensitive growth stage which needs maximum nitrogen among the entire life cycle.

Use research-based recommendations of splits

Split application should not exceed total test-based nitrogen recommendations. While split-applying N can enhance efficiency, it does not change what the plant needs and should not be used to exceed recommendations. Split fertilizer application can be an important part of a successful nutrient management program and can help growers achieve 4R concept. Farmers should consult local or regional agronomic research to identify the BMPs involved with split application as well as its specific use and benefits for the crops they grow. Hence farmers are guided by own wisdom and practices of fellow farmers when it came to application manures and pesticides. They often have no idea what is the soils inherent capacity to supply nutrients and at what it is deficient in and

often end up following the wrong practices. Hence, it is very essential to have knowledge on economic and efficient use of nitrogenous fertilizers so that many adverse effects of excess N usage on living organisms may be avoided without compromising on yield. A large number of new technologies have evolved and are continuously being used in educating farmers on economic use of nitrogen fertilizers and some of these tools and techniques are discussed below for the benefits of farmers. In advance more research work including breeding and technical aspect is required for sustainable maize production with efficient nitrogen management without degradation of environmental components. Plant breeding can be a powerful tool to bring "harmony" between agriculture and the environment, but partnerships and cooperation are needed to make this a reality. The opportunities to improve N management as producing more efficient plants and more efficient management.

Research is needed to better understand and manage microbially mediated processes, nitrate reduction to ammonia to reduce denitrification and conserve N. Sensors to measure real-time nutrient availability driving multi-nutrient decision support systems linked to precision application would improve nutrient use in conventional farming, and plant breeding for NUE, especially for better root distribution and nutrient uptake rather than just yield, would benefit all farm systems. Nutrient management on farms is under the control of the land manger, the most effective of whom will already use various decision supports for calculating rates of application to achieve various production targets. Increasingly, land managers will need to conform to good practice to achieve production targets and to conform to environmental targets if they are to achieve the objective of sustainable farm systems.follow the balanced nutrition practices and Applying the proper rate of N has a greater influence on drainage water nitrate losses than any other N management factor including application timing, placement, source, or nitrification inhibitors. Many studies show drainage nitrate concentration and loading decrease as N fertilization rate decreases and improving the nutrient management by the Strategic approaches, precision farming and Nitrification inhibitors

Acknowledgement

The author is thankful to Dr. B.V. Asewar, Chief scientist of dryland agriculture, Parbhani for providing facilities required for conducting the above experiment.

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