REVIEW ARTICLE

Nitrogen management in maize in semi-arid region

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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.

Key Words: *Leaf colour chart; Maize; Nitrogen use efficiency; Split application*

INTRODUCTION

In this study, Nitrogen (N) application to maize tended to improve vegetative growth. The response to nitrogen increased as level of nitrogen applied increased. Thus it is feasible to recommend nitrogen application to maize under similar conditions. In our survey area, the main fertilizer used at seeding is Diammonium Phosphate (DAP) and the main topdressing fertilizer is nitrogen, including predominant use of urea and ammonium bicarbonate. Potassium fertilizer application has been largely ignored on grain crops. Urea and other nitrogenous fertilizers are the need of the hour due to increased population and nutritional demand, but not at the cost of environmental health and life of living organisms. The blind use of nitrogenous fertilizers is only due to lack of scientific knowledge and awareness, poor management practices, greediness and illiteracy among farmers [1].

In case of semi-arid regions, due to high accumulation of soil NO_3-N were indicated the leaching losses by the excessive nitrogen applications and residual soil NO_3-N contents after harvest and apparent nitrogen losses markedly increased with increased nitrogen fertilizer rate. Excessive use of nitrogenous fertilizers and other chemical fertilizers affect these invaluable soil microflorae and the result is unproductive land with less or no water holding capacity increases tissue succulence in crop plants and make them susceptible to diseases and pests. The increased condition succulence of plant tissues helps in pests and pathogens entry and multiplication easier therefore increasing the susceptibility. The nutrients lost by runoff and leaching due to excessive application of chemical fertilizers also adds to environmental pollution. This excess nitrogen reaches water bodies destroying flora and fauna and causes many deadly diseases to human beings and water and air contaminated [2].

LITERATURE REVIEW

In recent years concern has grown over the contribution of Nitrogen (N) fertilizers to the environmental problems of nitrate pollution of waters and the pollution of the atmosphere with nitrous oxide, other oxides of nitrogen and ammonia. considering of these concerns, proposals to mitigate these problems have been considered and others will be advancing. When they have been used in high amounts, fertilizers and animal manures have created problems of nitrate pollution. Nitrous oxide (N_2O) is a greenhouse gas and may also contribute to the destruction of the stratospheric ozone when it is converted to nitric oxide. N_2O is primarily produced in the biological processes of nitrification and denitrification. Nitric oxide and nitrogen dioxide are also produced in biological processes and are important in atmospheric reactions in the troposphere and stratosphere. There is little indication that nitrogen fertilizers contribute very much to the production of nitrous oxide.

More research is needed to characterize and measure the emissions of the oxides of nitrogen and ammonia and to make better estimates of global emissions based on process-related models. More efforts to increase the efficiency of nitrogen fertilizer use through modifications or use of inhibitors of biological processes as well as better management of rates, timing and incorporation are needed to ensure increased food production while conserving natural resources. Different agronomic options are being recommended which make a way of precision application of nitrogen by using split application at different stage of crop cycle.

Further leaf colour chart and Normalized Difference in Vegetative Index (NDVI) and pursue usefulness for real time nitrogen management by matching time of fertilizer application with maize plant need. Leaf Color Chart (LCC) for maize is under development and being standardized for a number of varieties by Punjab Agricultural University (semi-arid region), Ludhiana. By matching the leaf color of their crop from 10-12 randomized sites in their field (by passing the diseased plants) with the color of chart; farmers can find the required dose of fertilizers application at specific site or plant. By using standard leaf color chart we can predict the amount of nitrogen required in the field or the individual plant [3]. This will have a check on the undue use of urea in the field.

Recent methods of application like fertigation would help in increasing the nutrient use efficiency along with reducing the losses. Fertigation is a method of fertilizer application in which fertilizer is incorporated within the irrigation water by the drip system. In this system fertilizer solution is distributed evenly in irrigation. The availability of nutrients is very high therefore the efficiency is more. In this method liquid fertilizer as well as water soluble fertilizers are used. By this method, fertilizer use efficiency is increased from 80%-90%. Practicing fertigation is beneficial to farmers in timely and site specific application of nutrients. Application of exact quantity of fertilizers according to soil nutrient status based on soil tests will not only result in proper supply of deficient nutrient elements essential for profitable crop production but also saves cost by supply of precise amount of nutrients as per the nutrient supplying capacity of the soil. New schemes like soil health cards (launched in February, 2015) by the government of India to improve the soil health of the individual farmer's land. Advice on handling particular kinds of soil are then handed over in form of soil health cards to the farmers to serve as a guiding tool to apply fertilizers for various crops. Mobile van soil testing facility is also available under the scheme [4].

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Split Nitrogen (N) fertilizer applications can play an important role in a nutrient management strategy that is productive, profitable and environmentally responsible. Dividing total nitrogen application into two or more treatments can help growers enhance nutrient efficiency, promote optimum yields and mitigate the loss of nutrients. Study in Marathwada region have shown that splitting of total recommended nitrogen into three equal proportions and applying as basal, 30 Days After Sowing (DAS) and at 60 DAS found to produce highest yield attributes along with high Nitrogen Use Efficiency (NUE) and observed that band placement of the fertilizer showed the better results, instead of other methods. Band placement reduce the denitrification, volatilization and leaching losses. 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. Depending on soil type, climate, agronomic practices and other factors, nitrogen fertilizer can be vulnerable to loss. Denitrification, leaching and volatilization impose costs that include lost productivity and negative environmental impact. Split-applying nitrogen fertilizer is one way to confront these challenges. When a crop's total nitrogen requirement is supplied with a single pre-plant or at planting application, most of the nitrogen must wait for the target crop's future needs and that means the window for potential loss remains open longer. By postponing a portion of the nitrogen treatment until the crop is better able to utilize the nutrient, plants take up the nitrogen more quickly and efficiently. That means growers get more from their fertilizer investment and fertilizer losses that can contribute to environmental concerns are lessened [5].

DISCUSSION

Enhanced nitrogen efficiency with split applications

Agriculture faces the daunting challenge of meeting food, forage and fiber needs in a manner that is both environmentally and economically sustainable while striving to increase productivity with more efficient use of resources. 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 nitrogen requirements with a single treatment prior to or at planting. When all of the nitrogen is supplied ahead of crop growth, more of that 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. By splitting the nitrogen application and put a portion on later, almost all of that second application will be taken up by the plant [6].

Consider split application crop-by-crop

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.

Source and placement important

As in all fertilization strategies, source, rate, time and place should be the foundation of split fertilization decisions. Although various forms of nitrogen granular, liquid and anhydrous can be utilized in a split application scenario, their placement is critical. Anhydrous for example, can be used on row crops but should be injected into the soil and therefore, protected from loss. Urea spread over the top for the second in-season application is vulnerable to surface volatilization. Just like the crops they nourish, different nitrogen sources have different characteristics. Ammonium forms are less likely to emit Greenhouse Gases (GHG) and 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.

Better yields, less nitrogen loss

We get a lot of denitrification in our area and if we don't use the nitrogen, we lose it. 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 10-12 inches tall, 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, in the form of anhydrous, as close to planting as possible in order to minimize nitrogen losses. A starter is used through the planter and the application at 10-12 inches provides the final boost for optimum yields.

Use research-based recommendations

Split application should not exceed total test-based nitrogen recommendations. While split-applying nitrogen 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 Best Management Practices (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 nitrogen 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 nitrogen management as producing more efficient plants and more efficient management [7-9].

Research is needed to better understand and manage microbial mediated processes, e.g. the manipulation of Microbial Inoculant Technology (MIT) and dissimilatory nitrate reduction to ammonia to reduce denitrification and conserve nitrogen. 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 nitrogen has a greater influence on drainage water nitrate losses than any other nitrogen management factor including application timing, placement, source or nitrification inhibitors. Many studies show drainage nitrate concentration and loading decrease as nitrogen fertilization rate decreases and improving the nutrient management by the strategic approaches, precision farming and nitrification inhibitors [10].

CONCLUSION

In conclusion, Maize (*Zea mays* L) is a highly adaptable and productive crop with significant genetic yield potential, making it a key player in global cereal production. However, the extensive use of nitrogen fertilizers, particularly in countries like China, India and Pakistan, raises significant environmental risks, including water pollution and greenhouse gas emissions. This study underscores the importance of optimizing nitrogen use through split applications and precision methods to enhance NUE while mitigating adverse environmental impacts. Split nitrogen application, when timed appropriately, can maximize nutrient uptake and reduce losses through denitrification, volatilization and leaching. Incorporating tools like the LCC and adopting advanced techniques such as fertigation can further improve nutrient management. Additionally, research into MIT and real-time nutrient sensors can provide valuable insights and support precision agriculture practices. Effective nutrient management ensures higher yields while protecting environmental health, aligning agricultural productivity with ecological stewardship.

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