Post-harvest Soil Available Nutrient Status and Microbial Load as Influenced by Graded Levels of Nitrogen and Biofertilizers

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A B S T R A C T

A field experiment was conducted in sandy clay loam soil of S.V. Agricultural College Farm, Tirupati with three levels of nitrogen viz., 75, 100, 125 % RDN and five biofertilizers viz., Azospirillum, phosphorus solubilizing bacteria (PSB), potassium solubilizing bacteria (KSB), zinc solubilizing bacteria (ZnS) and combined application of Azospirillum + PSB + KSB + ZnS each applied @ 5 kg ha\(^{-1}\) in randomized block design with factorial concept in kharif maize. The experimental results revealed that significantly higher grain yield of maize and post-harvest nutrient status of soil as well as soil microbial load of bacteria, fungi and actinomycetes were recorded with 125 % RDN followed by 100 % RDN. All the above parameters at their highest with the combined application of azospirillum + PSB + KSB + ZnS each applied 5 kg ha\(^{-1}\).

Keywords
Post-harvest Soil, Nitrogen, Biofertilizers

Introduction

Maize (Zea mays L.) is a miracle and industrial crop. It is also called as “queen of cereals” for its relative productive potential among other cereal crops. It is a C\(_4\) plant that effectively utilize the inputs and respond well to growth resources. It is an exhaustive and nitropositive crop which needs higher quantity of nitrogen for its maximum yield potential. Nitrogen has its dominant role for growth and development as well as yield of maize. The escalating cost of chemical fertilizer has led to considerably lower net returns and continuous application of fertilizers alone in agricultural system deteriorates the soil health and negatively impacts crop productivity (Kannan et al., 2013). Biofertilizers can either fix atmospheric nitrogen for plant or can mobilize unavailable phosphorus, potassium and zinc to the available pool. Low cost and ecofriendly biofertilizers have tremendous potential for supplying nutrients. Azospirillum is known to fix atmospheric nitrogen and increase grain yield in maize by 10-15 per cent (Patil et al., 2001). Keeping in view of the above, the field experiment was conducted to identify the optimum nitrogen level along with suitable biofertilizer to kharif maize in sandy clay loam soil.
Materials and Methods

A field experiment was conducted in maize during kharif, 2019 at wetland farm of S.V. Agricultural College, Tirupati in a randomized block design with factorial concept and replicated thrice. The soil of the experimental field was sandy clay loam with available nitrogen of 251 kg ha\(^{-1}\), available phosphorus (180 kg ha\(^{-1}\)), available potassium (234 kg ha\(^{-1}\)) and available zinc (3.21 ppm). The initial soil microbial load viz., bacteria (21 x 10\(^{6}\) CFU g\(^{-1}\) soil), fungi (3 x 10\(^{3}\) CFU g\(^{-1}\) soil) and actinomycetes (7 x 10\(^{5}\) CFU g\(^{-1}\) soil). The treatment consisting three levels of nitrogen viz., 75, 100 and 125 % recommended dose of nitrogen (RDN) and five biofertilizers viz., Azospirillum, phosphorus solubilizing bacteria (PSB), potassium solubilizing bacteria (KSB) and zinc solubilizing bacteria (ZnS) and combined application of Azospirillum + PSB + KSB + ZnS each 5 kg ha\(^{-1}\). Recommended dose of nitrogen was fixed based on soil test value. All biofertilizers were applied at 5 kg ha\(^{-1}\) to soil. Rest of the package of practices were adopted as per the package of practices of Acharya N.G. Ranga Agricultural University. Post-harvest soil available nitrogen (Subbiah and Asija 1956), available phosphorus (Olsen et al., 1956), available potassium (Jackson, 1973) and zinc (Tandon, 1993) were estimated. Soil microbial load of soil viz., bacteria, fungi and actinomycetes were estimated by serial dilution plate count technique (Pramer and Schenmdt, 1965).

Results and Discussion

Grain yield of maize was significantly influenced with application of different nitrogen levels and biofertilizers as well as their interaction (Table 1). Application of 125 % RDN resulted in higher grain yield, which was at par with 100 % RDN. This might be due to better growth and yield attributes with higher dose of nitrogen. The increase in grain yield due to application of 125 % RDN was 16.44 per cent compared to 75 % RDN. Similar results were also reported by Athokpam et al., (2017) and Mohammadi et al., (2017). The lowest grain yield was obtained with application of 75 % RDN due to sub-optimal dose of nitrogen. The highest grain yield was obtained with combined application of Azospirillum + PSB + KSB + ZnS each applied 5 kg ha\(^{-1}\), which was at par with application of Azospirillum and PSB alone each 5 kg ha\(^{-1}\).

Table 1 Interaction effect of nitrogen levels and biofertilizers on grain yield of maize during kharif, 2019

| Treatment                                | Recommended dose of nitrogen (%) |
|------------------------------------------|---------------------------------|
|                                          | 75                              | 100     | 125     | Mean  |
| Azospirillum                             | 5376                            | 6120    | 5364    | 5620  |
| Phosphorus solubilizing bacteria (PSB)   | 4764                            | 5568    | 5460    | 5264  |
| Potassium solubilizing bacteria (KSB)    | 3912                            | 4428    | 5172    | 4504  |
| Zinc solubilizing bacteria (ZnS)         | 3228                            | 4836    | 5316    | 4460  |
| Azospirillum + PSB + KSB + ZnS           | 5412                            | 5640    | 5844    | 5632  |
| Mean                                     | 4538                            | 5318    | 5431    |       |

SEm ± CD (P= 0.05)  
Nitrogen levels (N) 133 386  
Biofertilizers (B) 171 499  
Interaction (N x B) 297 864  

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Table 2 Post-harvest available nutrient status and microbial load of soil as influenced by nitrogen levels and biofertilizers in maize during kharif, 2019

| Treatment                  | Post-harvest nutrient status (kg ha⁻¹) | Soil microbial load                                  |
|----------------------------|----------------------------------------|-----------------------------------------------------|
|                            | Available nitrogen | Available phosphorus | Available potassium | Available zinc | Bacteria (10⁶ CFU g⁻¹) | Fungi (10³ CFU g⁻¹) | Actinomycetes (10⁵ CFU g⁻¹) |
| Factor I: Nitrogen levels  |                                        |                                                     |                                                     |               |                     |                     |                        |
| N₁: 75 % RDN               | 152.7 | 50.6  | 101.2  | 0.42     | 132.5       | 10.6       | 26.5                   |
| N₂: 100 % RDN              | 193.2 | 64.1  | 128.1  | 0.61     | 163.9       | 13.0       | 32.3                   |
| N₃: 125 % RDN              | 219.3 | 69.1  | 137.5  | 0.80     | 230.5       | 15.4       | 38.5                   |
| SEm ±                      | 1.03  | 0.52  | 0.99   | 0.01     | 4.77        | 0.3        | 0.8                    |
| CD (P= 0.05)               | 2.98  | 1.50  | 2.89   | 0.03     | 13.89       | 0.9        | 2.4                    |
| Factor II: Biofertilizers  |                                        |                                                     |                                                     |               |                     |                     |                        |
| B₁: Azospirillum           | 186.5 | 61.7  | 123.3  | 0.60     | 169.9       | 13.4       | 33.6                   |
| B₂: Phosphorus solubilizing bacteria (PSB) | 182.9 | 60.7  | 121.3  | 0.55     | 161.9       | 12.8       | 31.7                   |
| B₃: Potassium solubilizing bacteria (KSB) | 174.3 | 57.8  | 115.6  | 0.52     | 157.0       | 11.9       | 29.8                   |
| B₄: Zinc solubilizing bacteria (ZnS) | 165.7 | 53.6  | 107.1  | 0.60     | 139.7       | 10.9       | 27.2                   |
| B₅: Azospirillum + PSB + KSB + ZnS | 232.6 | 72.6  | 144.0  | 0.77     | 249.9       | 16.0       | 40.0                   |
| SEm ±                      | 1.32  | 0.67  | 1.28   | 0.01     | 6.16        | 0.4        | 1.1                    |
| CD (P= 0.05)               | 3.85  | 1.94  | 3.73   | 0.04     | 17.93       | 1.2        | 3.1                    |
| Interaction (N x B)        | NS    | NS    | NS     | NS       | NS          | NS         | NS                     |
These results are in line with the findings of Lakum et al., (2018). Application of ZnS 5 kg ha\(^{-1}\) resulted in lower grain yield. This is possibly due to non-response of zinc solubilizing bacteria. Application of 100 % RDN along with Azospirillum 5 kg ha\(^{-1}\) produced significantly higher grain yield, which was at par with application of 125 % RDN or 100 % RDN with combined application of Azospirillum + PSB + KSB + ZnS each 5 kg ha\(^{-1}\). It clearly indicate that performance of Azospirillum 5 kg ha\(^{-1}\) found to be more responsive to promote growth and development of maize because of the enhanced mineralization and biological nitrogen fixation.

Post-harvest available nutrient status and soil microbial load was significantly influenced by nitrogen levels and biofertilizers, but their interaction was non-significant (Table 2). The highest values of post-harvest available nutrient status and microbial population viz., bacteria, fungi and actinomycetes were noticed with application of 125 % RDN which might be due to sufficient substrate available for growth and multiplication of microorganisms, which inturn increased the mineralization and availability of nutrients in the soil.

These results are corroborative with the findings of Abdullahi et al., (2014) and Navsare (2107). Combined application of Azospirillum + PSB + KSB + ZnS each applied 5 kg ha\(^{-1}\) resulted in higher soil available nutrient status due to enhanced mineralization and solubility of insoluble fixed nutrients. The response of Azospirillum 5 kg ha\(^{-1}\) found to be more responsive than others while zinc solubilizing bacteria was found to be poor. The response of microorganisms are highly location specific. These results are in conformity with the earlier findings of Garcia et al., (2017) and Khambalkar et al., (2017).

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