Effect of Nitrogen Fertilizer Doses and Pre Sowing Seed Treatments on Yield and Yield Attributing Characters in Foxtail Millet (*Setaria italica* L. Beauv)

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**ABSTRACT**

**Background:** Foxtail millet is considered as a nutriti-cereal and source of food, feed and fodder. Though it is grown in marginal conditions it can provide the best production with the proper nutrient management for its cultivation. The objective of study was to identify the suitable seed quality enhancement method to increase grain yield of foxtail millet.

**Methods:** During kharif 2017 and 2018 on black cotton soils at Regional Agricultural Research Station, Nandyal, the experiment was conducted in field and laboratory with split plot design with four nitrogen doses as main plots such as N<sub>0</sub> control, N<sub>1</sub> 125 kg neem+1250 kg vermi compost /ha, N<sub>2</sub> 50 kg urea+50 kg super phosphate and 50 kg muriate of potash /ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray, N<sub>3</sub> N<sub>2</sub> + N<sub>4</sub> and four pre sowing seed treatments as sub plots. The treatments were P<sub>0</sub>-control, P<sub>1</sub>- soaking in water for 8 hours by adopting seed to solution of 1:1 ratio, P<sub>2</sub>-seed treatment with 20% liquid Pseudomonas fluorescens. After pre sowing seed treatment, seed were sown in field with different nitrogen doses.

**Result:** Results revealed that application of 50 kg urea+ 50 kg super phosphate and 50 kg muriate of potash/ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray recorded significantly higher seed yield (3148 kg/ha) and in pre sowing seed treatment with 2% KH<sub>2</sub>PO<sub>4</sub> for 8 hours by adopting seed to solution of 1:1 ratio, P<sub>2</sub>-seed treatment with 20% liquid Pseudomonas fluorescens (3019 kg/ha) than other treatments.

**Key words:** Foxtail millet, Germination, Nitrogen doses, Seed treatment, Yield.

**INTRODUCTION**

Foxtail millet (*Setaria italica* L. Beauv) is one of the millet crop has got importance in the diet of diabetic patients. Hence its cultivation is increasing year by year. During 2016-17 in India small millets area 619.11 thousand hectares, production 441.94 thousand tons, productivity 714 Kg ha<sup>-1</sup>. In Andhra Pradesh area 31.00 thousand hectares, production 24.00 thousand tons, productivity 774 Kg ha<sup>-1</sup> (Annual Progress report 2018-19). It is grown in arid and semiarid regions as it is drought tolerant, short duration and low cost consumptive crop and provides proteins and minerals. Small millet grains are cooked like rice and then utilized. In some areas the grains are ground to flour and used in the form of chapathies. Fox tail millet grain contains 12.3% proteins, 4.7% fat, 60.6 percent carbohydrates and 3.2 percent ash. Millets is known to be 'crops of the future' as they can be well adapted and cultivated under harsh environment of arid and semi-arid region (RESMISA, 2012). Nitrogen is the major nutrient required by the millets which positively increases the growth, yield attributes and finally improve the yield Prasad et al.(2014). Foxtail millet realizes maximum potential yield with optimum nitrogen management and optimum nutrients. The maximum yield potential can be achieved by growing high yielding varieties with improved tolerance to drought, resistance to pests & diseases and response to higher rates of fertilizer applications. Priming treatments are used to synchronize the germination of individual seeds where in germination-related processes are initiated, priming generally results faster germination and emergence, especially under adverse conditions Paparella et al. (2015). Hence to identify suitable seed soaking treatment and nitrogen fertilizer dosage for maximization of yield present investigation was carried out. After harvest the crop produce seeds kept for germination to know seed influenced by nitrogen doses and pre sowing treatments. Seed is a tool for delivery of improved technologies and is a mirror for portrayal of inherent genetic potential of a variety/ hybrid. Seed offers to integrate production, protection and quality enhancement technologies through a single entity, in a cost-effective way. Seed can play a pivotal role in achieving higher productivity. The use of quality seeds alone
could increase productivity by 15-20% which highlights the important role of seed in agriculture. In modern agriculture, advance technologies are being deployed for breaking yield barriers and enhancing crop productivity. Devising varied seed enhancement technologies is an important domain assuring uniform field emergence, better crop stand and realization of higher yield in various crops. Seed enhancements may be defined as “postharvest treatments that improve germination or seedling growth or facilitate the delivery of seeds and other materials required at the time of sowing” Seed priming is a technique of controlled hydration (soaking in water) and drying that result in more rapid germination when the seeds are re imbibed. Bio-priming is a process of biological seed treatment that refers to a combination of seed hydration and inoculation of the seeds with beneficial microorganisms. It improves seed viability, germination, vigour indices, plant growth and subsequent protection against diseases and finally enhances crop yield (Chauhan and Patel, 2017).

MATERIALS AND METHODS
The field experiment was conducted during consecutive kharif 2017 and 2018 at Regional Agricultural Research Station, Nandyal. Andhra Pradesh located at 18° 29’ N latitude, 78° 29’ E longitude and at an altitude of 202 m above mean sea level with an average rainfall 772 mm. The experimental plot was black cotton soil with P \( \text{O}_4 \) 8.3 and E.C 0.26 ds m-1, having low available nitrogen (186 Kg ha\(^{-1}\)), medium in available \( \text{P}_2\text{O}_5 \) (42.5 kg ha\(^{-1}\)) and high available \( \text{K}_2\text{O} \) (357 Kg ha\(^{-1}\)). The experiment design was split plot with three replications. The treatments consists of four Nitrogen fertilizer doses main plots i.e., \( \text{N}_1 \), Control, \( \text{N}_2 \)- 125 kg neem+1250 kg vermi compost /ha, \( \text{N}_3 \) 50 kg urea+ 50 kg super phosphate and 50 kg murate of potash per ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray, \( \text{N}_4 \) \( \text{N}_2 \) + \( \text{N}_3 \) and four pre sowing seed treatments as sub plots i.e \( \text{P}_1 \)- control, \( \text{P}_2 \)- soaking in water for 8 hrs by adopting seed to solution of 1:1 ratio and then mixing in 2.5-3 gm/kg of Carbendazim with the seeds, and leaving the mixture for 24 hrs before sowing, \( \text{P}_3 \)-seed soaking with 2% KH\( _4 \text{PO}_4 \) for 8 hr by adopting seed to solution of 1:1 ratio and then mixing in 2.5-3 gm/kg of Carbendazim with the seeds, and leaving the mixture for 24 hrs before sowing, \( \text{P}_4 \)- seed treatment with 20% liquid \textit{Pseudomonas fluorescens}. The variety SIA-3156 was sown on July 11th 2017 and July 16th 2018. Seeds were sown with spacing of 30 cm x 10 cm. After harvesting the crop, the following observations were recorded viz., germination percent (ISTA, 1999), shoot length (cm), seedling length (cm), seedling dry weight (g), seedling vigour index \( \text{I}^1 \), vigor index II\(^{\text{th}} \) Abdul-Baki and Anderson, 1973) under laboratory conditions. Statistical analysis of the data recorded was done as per split plot design (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

Growth and yield parameters

Effect of nitrogen fertilizer doses

Significantly higher field emergence (98%) was recorded in control, application of 125 kg neem+1250 kg vermi compost /ha and application of 125 kg neem+1250 kg vermi compost

| Treatments | Field Emergence (%) | Plant height at harvest (cm) | SCMR at 40 days | Days to 50% flowering | Number of tillers / plant | 1000 seed weight (g) |
|------------|---------------------|-----------------------------|-----------------|-----------------------|--------------------------|---------------------|
| \( \text{N}_1 \): Control          | 98                  | 114.6                       | 43.7            | 45                    | 4                        | 2.4                 |
| \( \text{N}_2 \): 125kg Neem + 1250 kg V.C | 98                  | 115.0                       | 44.2            | 46                    | 4                        | 2.2                 |
| \( \text{N}_3 \): 50kg Urea + 50 kg SSP + 50 kg MOP/ha + top dressing urea at 3-4 WAT+ 2% Borax spray | 97                  | 114.8                       | 45.4            | 45                    | 4                        | 2.6                 |
| \( \text{N}_4 \): \( \text{N}_2 \) + \( \text{N}_3 \) | 98                  | 117.1                       | 43.8            | 46                    | 4                        | 2.3                 |
| SEM±             | 0.1                 | 0.9                         | 0.8             | 0.2                   | 0.3                       | 0.05                |
| CD (0.05)        | 0.5                 | 3.0                         | NS              | NS                    | NS                       | 0.2                 |
| Seed soaking treatments (P) |
| \( \text{P}_1 \): Control          | 98                  | 115.6                       | 44.1            | 46                    | 4                        | 2.4                 |
| \( \text{P}_2 \): Water soaking for 8 hrs | 98                  | 112.3                       | 45.7            | 46                    | 4                        | 2.4                 |
| \( \text{P}_3 \): 2% KH\( _4 \text{PO}_4 \) for 8 hrs | 97                  | 115.0                       | 43.0            | 45                    | 4                        | 2.4                 |
| \( \text{P}_4 \): 20% liquid \textit{P. fluorescens} | 97                  | 116.3                       | 44.2            | 45                    | 4                        | 2.4                 |
| SEM±             | 0.2                 | 1.1                         | 1.1             | 0.3                   | 0.1                       | 0.03                |
| CD (0.05)        | NS                  | NS                          | NS              | NS                    | NS                       | NS                  |

Table 1: Growth and yield attributes in foxtail millet as influenced by different nitrogen fertilizer doses, pre sowing seed treatments and their interactions during 2017-18 & 2018-19 (Pooled).
Effect of Nitrogen Fertilizer Doses and Pre Sowing Seed Treatments on Yield and Yield Attributing Characters in Foxtail... /ha + 50 kg urea+ 50 kg super phosphate and 50 kg murate of potash / ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray (Table 1). Application of 125 kg neem+1250 kg vermi compost /ha recorded significantly higher plant height (115 cm) was at par with application of 50 kg urea+ 50 kg super phosphate and 50 kg murate of potash per ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray (114.8 cm) and control (114.6 cm). Application of different nitrogen doses did not influenced SPAD Chlorophyll meter readings (SCMR) at 40 DAS. It ranged from 43.7 to 45.4. Days to 50% flowering and number of tillers per plant were not significantly influenced by the treatments. Significantly higher 1000 seed weight 2.6 g was recorded in application of 50 kg urea+50 kg super phosphate and 50 kg murate of potash / ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray which is on par with the result of Ojha et al. (2018). The results are similar with the findings of Basavarajappa et al. (2002) in foxtail millet.

Significantly higher seed yield (3148 kg/ha) was recorded with application of 50 kg urea+ 50 kg super phosphate and 50 kg murate of potash per ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray and seed soaking in water for 8 hrs by adopting seed to solution of 1:1 ratio (2800 Kg/ha) were recorded. Under seed soaking treatments the per cent yield increase over control was in soaking in water for 8 hrs by adopting seed to solution of 1:1 ratio (1.2), seed soaking with 2% KH$_4$PO$_4$ for 8 hr by adopting seed to solution of 1:1 ratio (2.2), seed treatment with 20% liquid P. fluorescens (9.1). Similar results were recorded by Iswaraiya et al. (2019) barnyard millet, Raj et al. (2004) in pearl millet and Srivastava et al. (2010) in tomato. Seed treated with 20 per cent P. fluorescens of the present investigation recorded the significant and faster speed of germination and seedling length which could be attributed to the quicker uptake of water coupled with early initiation of high metabolic changes.

With reference to interaction effects (Table 3) significantly higher seed yield (3355 kg/ha) was recorded with application of 50 kg urea+ 50 kg super phosphate and 50 kg murate of potash per ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray and seed treatment with 20% liquid P. fluorescens was on par with application of 125 kg neem+ 1250 kg vermi compost /ha and 50 kg urea+ 50 kg super phosphate and 50 kg murate of potash /ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray where as 6.8% lower yield was recorded with application of 125 kg neem+1250 kg vermi compost /ha was bellow the control. The results were corroborating with the findings of Khan and Krishna (2016) and Ramyasri et al. (2018) in foxtail millet.

**Effect of pre sowing seed treatments**

Seed treated with 20% liquid *Pseudomonas fluorescens* recorded significantly higher seed yield (3019 kg/ha) (Table 2), seed soaking with 2% KH$_4$PO$_4$ for 8 hr (2829 kg/ ha) and seed soaking in water for 8 hrs by adopting seed to solution of 1:1 ratio (2800 Kg/ha) were recorded. Under seed soaking treatments the per cent yield increase over control was in soaking in water for 8 hrs by adopting seed to solution of 1:1 ratio (1.2), seed soaking with 2% KH$_4$PO$_4$ for 8 hr by adopting seed to solution of 1:1 ratio (2.2), seed treatment with 20% liquid *Pseudomonas fluorescens* (9.1). Similar results were recorded by Iswaraiya et al. (2019) barnyard millet, Raj et al. (2004) in pearl millet and Srivastava et al. (2010) in tomato. Seed treated with 20 per cent *P. fluorescens* of the present investigation recorded the significant and faster speed of germination and seedling length which could be attributed to the quicker uptake of water coupled with early initiation of high metabolic changes.

**Table 2: Yield in foxtail millet as influenced by different nitrogen fertilizer doses, pre sowing seed treatments and their interactions during 2017-18 & 2018-19 (Pooled).**

| Treatments | Seed yield (kg/ha) | Per cent increase |
|------------|-------------------|------------------|
| **Nitrogen Fertilizer doses (N)** | | |
| N$_{0}$: Control | 2942 | 2382 | 2662 |
| N$_{1}$: 125kg Neem + 1250 kg V.C | 2533 | 2429 | 2481 |
| N$_{2}$: 50kg Urea + 50 kg SSP + 50 kg MOP/ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray | 3608 | 2689 | 3148 |
| CD (0.05) | 48.9 | 34.1 | 28.1 |
| **Seed soaking treatments (P)** | | |
| P$_{0}$: Control | 3148 | 2388 | 2768 |
| P$_{1}$: Water soaking for 8 hrs | 3071 | 2530 | 2800 |
| P$_{2}$: 2% KH$_4$PO$_4$ for 8 hrs | 3058 | 2600 | 2829 |
| P$_{3}$: 20% liquid *P. fluorescens* | 3209 | 2830 | 3019 |
| SEm± | 48.9 | 29.5 | 30.6 |
| CD (0.05) | NS | 86 | 89 |
| **N X P** | | |
| SEm± | 97.8 | 61.3 | 60.1 |
| CD (0.05) | 282 | N.S | 182 |
Effect of Nitrogen Fertilizer Doses and Pre Sowing Seed Treatments on Yield and Yield Attributing Characters in Foxtail...

50 kg murate of potash per ha + Top dressing urea at 3-4 weeks after transplanting + 2% borax spray and seed treatment with 20% liquid *Pseudomonas fluorescens* (3222 kg/ha). Similar results were recorded by Seleestar et al. (2019) who reported that the treatment (RDN through urea + 25%N through poultry manure + Azospirillum) were recorded highest grain yield (2.31 t/ha) in SIA 3156 variety.

### Seed quality parameters after harvest

Seed germination and related seed quality parameters after harvest in foxtail millet as influenced by different nitrogen fertilizer doses and seed soaking treatments were presented in (Table 4). Germination percent and other seed quality parameters like seedling length (cm) and seedling vigour index -I were significantly influenced by different nitrogen fertilizer doses and seed soaking treatments and their interactions. Significantly higher germination percent (93) seedling length (13.1cm) and seedling vigour index -I (1223) were recorded with application of 50 kg urea+ 50 kg super phosphate and 50 kg murate of potash per ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray. In seed soaking treatments significantly higher germination

### Table 3: Interaction effect of different nitrogen fertilizer doses and pre sowing seed treatments on seed yield (kg/ha) in foxtail millet during 2017-18 & 2018-19 (Pooled).

| Nitrogen Fertilizer doses (N) | Seed soaking treatments (P) | P1: Control | P2: Water soaking for 8 hrs | P3: 2% KHPO₄ for 8 hrs | P4: 20% liquid P. fluorescens | Mean |
|------------------------------|-----------------------------|-------------|----------------------------|------------------------|----------------------------|------|
| N₁: Control                  |                             | 2561        | 2527                       | 2587                   | 2973                       | 2662 |
| N₂: 125kg Neem + 1250 kg V.C|                             | 2398        | 2502                       | 2498                   | 2528                       | 2481 |
| N₃: 50kg Urea + 50 kg SSP + 50 kg MOP/ha + top dressing urea at 3-4 WAT+ 2% Borax spray |                             | 3137        | 3024                       | 3076                   | 3355                       | 3148 |
| N₄: N₂+ N₃                  |                             | 2975        | 3147                       | 3153                   | 3222                       | 3124 |
| Mean                         |                             | 2768        | 2800                       | 2829                   | 3019                       | 2854 |
| Source                       |                             | SEM±         | CD (0.05)                  |                        |                            |      |
| Nitrogen Fertilizer doses (N) |                             | 28           | 97                         |                        |                            |      |
| Seed soaking treatments (P)  |                             | 31           | 89                         |                        |                            |      |
| NXP                          |                             | 60           | 182                        |                        |                            |      |
| PXN                          |                             | 56           | 186                        |                        |                            |      |

### Table 4: Seed germination and related parameters after harvest in foxtail millet as influenced by different nitrogen fertilizer doses, pre sowing seed treatments and their interactions during 2017-18 & 2018-19 (Pooled).

| Treatments | Germination (%) | Seedling length SL (cm) | Seedling Vigour Index Index II | Seedling Dry Weight (g) | Seedling Vigour Index II | N X P |
|------------|-----------------|--------------------------|-------------------------------|-------------------------|--------------------------|------|
| N₁: Control | 91              | 12.6                     | 1154                          | 0.2                     | 18.8                     |      |
| N₂: 125kg Neem + 1250 kg V.C | 89              | 11.9                     | 1061                          | 0.2                     | 18.8                     |      |
| N₃: 50kg Urea + 50 kg SSP + 50 kg MOP/ha + top dressing urea at 3-4 WAT+ 2% Borax spray | 93              | 13.1                     | 1223                          | 0.2                     | 19.3                     |      |
| N₄: N₂+ N₃ | 91              | 12.8                     | 1172                          | 0.2                     | 19.3                     |      |
| SEM±        | 0.3             | 0.2                      | 21.5                          | 0.009                   | 0.8                      |      |
| CD (0.05)   | 1.0             | NS                       | 74                            | NS                      | NS                       |      |
| N X P       |                 |                          |                               |                         |                          |      |
| SEM±        | 0.7             | 0.4                      | 39.7                          | 0.01                    | 1.8                      |      |
| CD (0.05)   | 2.1             | NS                       | 122                           | NS                      | NS                       |      |

50 kg murate of potash per ha + Top dressing urea at 3-4 weeks after transplanting + 2% borax spray and seed treatment with 20% liquid *Pseudomonas fluorescens* (3222 kg/ha). Similar results were recorded by Seleestar et al. (2019) who reported that the treatment (RDN through urea + 25%N through poultry manure + Azospirillum) were recorded highest grain yield (2.31 t/ha) in SIA 3156 variety.
percent (94) recorded with water soaking for 8 hrs, seedling length (13.5cm) and seedling vigour index -I (1260) in seed treatment with 20% liquid *Pseudomonas fluorescens* were recorded. These results are conformity with Sridevi and Manonmani (2016). They reported that in foxtail, little and proso millet seeds primed with *P. fluorescens* 20% for 8 h showed higher germination, shoot and root length, dry matter production, vigour index and seed metabolic efficiency. The *P. fluorescens* have the potential to proliferate, colonize and producing plant growth regulators during priming procedures. This is an eco-friendly technique for sustainable agriculture.

**CONCLUSION**

Significantly higher seed yield was recorded with 20% liquid *Pseudomonas fluorescens* seed treatment combined with the application of 50 kg urea+ 50 kg super phosphate and 50 kg muriate of potash per ha + top dressing urea at 3-4 weeks after transplanting + 2% borax spray.

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