Enhancement of Plant Stand Establishment through Seed Priming and Seed Treatment on Growth, Seed Yield and Quality in Foxtail Millet [Setaria italica (L.) Beauv.]

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ABSTRACT

The field experiment was conducted during kharif 2018-19 at seed farm, College of Agriculture, Vijayapur to study the effect of seed priming and seed treatment on seed yield and quality in foxtail millet. The field experiment consisted of two factors. Factor I Seed priming Control (P1), Hydro priming for 8hr (P2), VIGRO-S (seaweed extract) (P3), 2 per cent CaCl₂ (P4), 20 per cent Pseudomonas (P5). Factor II seed treatment with insecticides with Thiamethoxam 25 WG @ 2g/kg (S1), Imidacloprid 70 WG @ 5g/kg (S2), Chlothidine 50 WG @ 2g/kg (S3), Acetamiprid 20 SP @ 2g/kg (S4) replicated three times and laid out in Factorial Randomized Block Design. The results of the investigation indicated that significantly higher field emergence (93.4, 91.3, respectively), shoot fly incidence (4.94, 4.55, respectively) recorded due to seed priming with CaCl₂ and seed treatment. Significantly higher growth parameters such as plant height and SPAD value (92.2, 26.75) at 90 DAS and dry matter (35.29) produced due to seed treatment with thiamethoxam 25 WG @ 2g/kg of seeds. The higher seed yield (19.47 q/ha), seed germination (95.75 %) was maximum with seed priming with 2 per cent CaCl₂ followed by hydro priming for 8 hrs with better seed quality. The seed yield and quality parameters were varied significantly with the seed treatments. The higher seed yield (18.23 q/ha), seed germination (93.53 %) was obtained with seed treatment of Thiamethaxam 25 WG @ 2g/kg of seeds followed by Imidacloprid 70 WG @ 5g/kg of seeds. The interaction effect due to seed priming and seed treatment did not varied significantly. However, the higher seed yield of 31.1 per cent (20.10 q/ha) obtained with seed priming of 2 % CaCl₂ along with Thiamethaxam 25 WG @ 2g/kg of seeds followed by Imidacloprid 70 WG 5g/kg of seeds.

Keystwords
Foxtail millet, Seed priming and seed treatment and seed quality

Article Info
Accepted: 24 August 2019
Available Online: 10 September 2019

Introduction
Foxtail millet (Setaria italica L.) is a versatile crop known for being genetically closely related to biofuel grasses, for its C4 photosynthesis and for its tolerance to abiotic stresses. Quality seed production is the main goal for successful agriculture, which demands each and every seed should be readily germinable and produce a vigorous
seedling ensuring high yield. “Care with the seed and joy with the harvest” and “Good seed doesn’t cost it always pays” are the popular adage which enlightens the importance of the quality seed. The farmers always very much interested in the best seed management practices which are safe, environmentally sound and scientifically proven technologies. Understandably, in view of the importance of quality seeds in Agriculture, both as a product and as a means of establishing a crop, most attention at all levels of investigation has been directed to crop seeds. Seed enhancements is defined as post-harvest treatments that improve germination or seedling growth, or facilitate the delivery of seeds and other materials required at the time of sowing. Seed enhancement is a range of treatments of seeds that improves their peformance after harvesting and conditioned, but before they are sown. Seed enhancement include priming, hardening, pre germination, pelleting, encrusting, film coating etc, but excludes treatments for control of seed borne pathogens (Black et al., 2006).

Millets require very little water for their cultivation just around 25–30% of the annual rainfall required by crops such as rice and sugarcane. Thus, millets do not require irrigation and power for their production. In addition, millets also not require any synthetic fertilizers and are completely pest-free crop as none of the millets attracts any pests. Thus, the production of millets is very economical for farmers because of almost nil expenditure on irrigation, fertilizers, and pesticides. Importantly, seeds of most millets can be stored for longer period and are not affected by storage pests. Nutritionally, millets are several times superior to other cereal crops such as rice and wheat (Lata et al., 2013). “On-farm seed priming involving soaking of seeds in water that can be enhancing the crop establishment throughout life cycle (Harris, 2010). Hydro priming has been used as a technique of seed priming in the current research. Hydro priming is achieved by adding a restricted amount of water to the seeds continuously or successively. It is a very significant method that results in fast germination and consistency in different plants (Adebisi et al., 2013). Seed germination and seedling development through the hydro priming method have been revealed to be enhanced. Hydro priming enhanced barley and chickpea results in the field (Rashid et al., 2006). Because easy water is used, it is a very easy, economical and environmentally friendly method. Seed priming with PGPR results in higher germination and improves the initial crop establishment of seedlings. It initiates the germination physiological process but prevents plumule and radicle from emerging. Physiological process helps to establish and proliferate PGPRs on the spermphere (Sridevi et al., 2016). Organic seed priming with bacterial antagonists increases the antagonist population load to a maximum of 10 times on the plants, thus protecting the insect pest.

Materials and Methods

The field experiment was conducted during kharif 2018-19 at seed farm, College of Agriculture, Vijayapur to study the effect of seed priming and seed treatment on seed yield and quality in foxtail millet and it is located at a latitude of $16^0 55' 1$ North, longitude of $75^0 58' 1$ East and an altitude of 593 meters above mean sea level. The experimental site comes under the Northern Dry Zone of Karnataka (Zone 3). The field experiment consisted of two factors. Factor I Seed priming Control (P$_1$), Hydro priming for 8hr (P$_2$), VIGRO-S (sea weed extract), (P$_3$) 2 per cent CaCl$_2$(P$_4$), 20 per cent Pseudomonas(P$_5$). While Factor II seed treatment with with Thiamethoxam 25 WG @ 2g/kg (S$_1$), Imidacloprid 70 WG @ 5g/kg (S$_2$), Chlotridin 50 WG @ 2g/kg (S$_3$), Acetamiprid 20 SP @ 2g/kg (S$_4$) with
three replications laid out in Factorial Randomized Block Design. Seed sown with a Spacing 30 cm × 10 cm and the cultivar DHFT-333 was used. The data collected from the experiment on different aspects was subjected to statistical analysis as described for Factorial Randomized Block Design given by Gomez and Gomez (1984). The level of significance used in F test was 0.05. A critical difference value was calculated wherever the ‘F’ tests found to be significant. The seedling vigour index was computed by adopting the method suggested by Abdul-Baki and Anderson (1973) and expressed as an index numbers.

\[ \text{SVI} = [\text{Root length (cm)} + \text{Shoot length (cm)}] \times \text{Germination (per cent)} \]

**Results and Discussion**

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads.

**Field emergence and shoot fly incidence**

Field emergence differed significantly due to seed priming with CaCl₂ and recorded significantly higher field emergence (93.4 %) and reduced shoot fly incidence (4.94 %) followed by hydro priming for 8 hrs. While lower field emergence and higher shoot fly incidence was recorded in control. Seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds significantly improved higher field emergence (91.30 %) and shoot fly incidence (4.55 %) followed by seed treatment of imidacloprid @ 5g/kg of seeds. While the lower field emergence and shoot fly incidence was seen in acetamiprid 20 SP @ 2g/kg of seeds. Interaction effect did not varied significantly due to seed priming and seed treatment. However, seed priming with 2 per cent CaCl₂ along with seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds recorded higher field emergence (96 %) and reduced shoot fly incidence (1.87 %) followed by seed priming with 2 per cent CaCl₂ along with seed treatment of imidacloprid @ 5g/kg of seeds while the lowest field emergence and shoot fly incidence was seen in no priming but seed treated with acetamiprid 20 SP @ 2g/kg of seeds. The field emergence of foxtail millet was influenced significantly due to seed priming treatments. The maximum field emergence was showed in seed priming with 2 per cent CaCl₂. This might be due to seed priming being one of the most significant innovations to assist speedy and uniform germination, reducing the time of germination and enhancing the uniformity of development so that seeds are efficient in promoting the seedling establishment's quicker development. Similar results obtained by Venkatesh et al., (2018). The shoot fly incidence of foxtail millet was significantly influenced by seed treatment. The lowest shoot fly percent incidence (4.55 %) was seen in seed treatment with thiomethaxam 25 WG @ 2g/kg of seeds, followed imidacloprid 70 WG 5g/kg of seeds (6.32 %), chlothidian 50 WG @ 2g/kg of seeds (7.90 %). Whereas the maximum shoot fly incidence (10.38 %) was noticed in acetamiprid 20 % SP @ 2g/kg of seeds. In earlier reports also improved germination and better seedlings growth was observed with imidacloprid and thiamethoxam seed treatment in sorghum and maize due to phyto- tonic effects (Jindal and Hari, 2008). Similar result were also obtained by Bhupender singh et al., (2017).

**Growth parameters**

Growth parameters differed significantly due to seed priming with CaCl₂ recorded significantly higher plant height and SPAD value at 90 DAS (93.1 cm) and (26.83) respectively, and plant dry matter (37.22 g) followed by hydro priming for 8 hrs. While
lower growth parameters was recorded in control. Seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds significantly improved higher growth parameters higher plant height and SPAD value at 90 DAS (92.2 cm) and (26.75) respectively and plant dry matter (35.29 g) followed by seed treatment of imidacloprid @ 5 g/kg of seeds. While the lower growth parameters was recorded in acetamiprid 20 SP @ 2 g/kg of seeds. Interaction effect did not varied significantly due to seed priming and seed treatment. However, seed priming with 2 per cent CaCl$_2$ along with seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds recorded higher growth parameters plant height and SPAD value at 90 DAS (96.5 cm) and (31.31) respectively and plant dry matter (40.77 g) followed by seed priming with 2 per cent CaCl$_2$ along with seed treatment of imidacloprid @ 5g/kg of seeds while the lowest growth parameters was seen in no priming but seed treated with acetamiprid 20 SP @ 2g/kg of seeds. Seed priming improve the crop growth parameters due to the redistribution of nutrient resources that lead to cell enlargement and increased ordinary cell division, increases the efficiency of water level even under stress condition during vegetative growth of the plant. Effective role in improving morphophysiological characters and easy approach to enhance the seed performance. Similar results obtained by Prajapati et al., (2017).

**Yield parameters**

Yield parameters differed significantly due to seed priming with CaCl$_2$ recorded significantly higher panicle length (16.10 cm), panicle diameter (1.41 cm), seed yield (19.47 q/ha), Stover yield (4.23 t/ha) and test weight (3.56 g) followed by hydro priming for 8 hrs. While lower yield parameters was recorded in control. Seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds significantly improved higher panicle length (15.40 cm), panicle diameter (1.34 cm), seed yield (18.23 q/ha), stover yield, (4.06 t/ha) and test weight (3.34 g) followed by seed treatment of imidacloprid @ 5 g/kg of seeds. While the lower yield parameters was recorded in acetamiprid 20 SP @ 2 g/kg of seeds. Interaction effect did not varied significantly due to seed priming and seed treatment. However, seed priming with 2 per cent CaCl$_2$ along with seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds recorded higher panicle length (17.53 cm), panicle diameter (1.57 cm), seed yield (20.10 q/ha), stover yield, (4.70 t/ha) and test weight (3.82 g) followed by seed priming with 2 per cent CaCl$_2$ along with seed treatment of imidacloprid @ 5g/kg of seeds while the lowest yield parameters was seen in no priming but seed treated with acetamiprid 20 SP @ 2g/kg of seeds. The higher seed yield of 22.37 per cent over control recorded due to seed priming with CaCl$_2$. The increased seed yield mainly attributed higher dry matter at 60 DAS, test weight, seed yield and Stover yield (37.22 g, 3.56 g, 19.47 q/ha, 4.23t/ha respectively) as compared to control followed by hydro priming for 8 hrs, seed priming with *pseudomonas florescence* 20. While the lowest Dry matter at 60 DAS, test weight, seed yield and Stover yield recorded in control (30.04 g, 2.83 g, 15.91 q/ha, 3.04 t/ha respectively). Due to increases all the yield attributing characters and high partitioning of the plant assimilates towards the sink so increases the yield parameters. Similar results obtained by Prajapati et al., (2017) and Kunal et al., (2012). The higher seed yield of 7.17 per cent over control. Recorded due to seed treatment with thiomethaxam 25 WG @ 2g/kg of seeds. The increased seed yield mainly attributed higher dry matter at 60 DAS, test weight, seed yield and Stover yield recorded in control (30.04 g, 2.83 g, 15.91 q/ha, 3.04 t/ha respectively) as compared to control, followed by imidacloprid 70 WG 5g/kg of seeds. While the lowest Dry matter at 60 DAS, test weight, seed yield and Stover yield recorded in Acetamiprid 20 SP (31.56 g,
Due to seed treatment with insecticides were did not affect the toxic to the plants and increases all the yield attributing characters and high partitioning of the plant assimilates towards the sink so increases the yield parameters. Similar results obtained by Kumar and Prabhuraj (2007). The Dry matter at 60 DAS, test weight, seed yield and Stover yield was not significantly influenced by the seed priming and seed treatments. The higher seed yield of 31.11 percent over control. The increased seed yield mainly attributed higher Dry matter at 60 DAS, test weight, seed yield and Stover yield (40.77g, 3.82g, 20.10 q/ha, 4.70 t/ha) respectively was recorded in seed priming with 2 per cent CaCl₂ along with seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds followed by seed priming 2 per cent CaCl₂ along with seed treatment of imidacloprid 70 @ 5g/kg of seeds. While the minimum seed yield was noticed in control no primed seed with acetamiprid 20 SP @ 2g/kg of seeds (29.00g, 2.73g, 15.33 q/ha, 2.63 t/ha). Due to high partitioning of the plant assimilates towards the sink so increases the yield parameters.

**Seed quality parameters**

Seed quality parameters differed significantly due to seed priming with CaCl₂ recorded significantly higher seed germination (95.75 %), root length (2.12 cm), shoot length (8.94 cm), seedling length (11.06 cm), seedling dry weight (30.38 mg), SVI (852) electrical conductivity (0.35 dSm⁻¹), seed protein (11.16 %), total sugar (5.55 %), non reducing sugar (3.71 %) and reducing sugar(1.85 %) followed by hydro priming for 8 hrs. While lower quality parameters was recorded in control. Seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds significantly improved higher Seed quality parameters viz., seed germination (93.53 %), root length (1.87 cm), shoot length (8.33 cm), seedling length (10.20 cm), seedling dry weight (30.15 mg), SVI (782), electrical conductivity (0.37 dSm⁻¹), followed by seed treatment of imidacloprid @ 5 g/kg of seeds. While the lower quality parameters was recorded in acetamiprid 20 SP @ 2 g/kg of seeds. Interaction effect did not varied significantly due to seed priming and seed treatment. However, seed priming with 2 per cent CaCl₂ along with seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds recorded higher Seed quality parameters viz., seed germination (97.00 %), root length (2.41 cm), shoot length (9.48 cm), seedling length (11.89 cm), seedling dry weight (31.33 mg), SVI (921) electrical conductivity (0.32 dSm⁻¹), followed by seed priming with 2 per cent CaCl₂ along with seed treatment of imidacloprid @ 5g/kg of seeds while the lowest yield parameters was seen in no priming but seed treated with acetamiprid 20 SP @ 2g/kg of seeds. Seed quality parameters were influenced significantly due to the seed priming treatments. The significantly higher seed germination of 9.81 per cent over control due to seed priming with 2 per cent CaCl₂. The increased seed germination mainly attributed to higher shoot length, root length, seedling length, seedling dry weight, vigour index and lower electrical conductivity were recorded in seed priming with 2 per cent CaCl₂(2.12 cm, 8.94 cm, 11.06 cm, 30.38 mg, 852, 0.35 dSm-1 respectively) followed by hydro priming for 8 hrs, seed priming with pseudomonas florescence 20 %. While the lower seed quality parameters was recorded in control (1.28 cm, 6.97 cm, 27.42 mg, 8.24 cm, 621, 0.47 dSm-1 respectively). Due to seed priming increases the better performance of the seed, higher test weight of the seeds and other food reserves in the endosperm of the seeds so ultimately higher seed quality. Similar results obtained by (Prabhu et al., 2015), (Venkatesh 2018). Seed quality parameters were influenced significantly due to the seed treatments. The significantly higher seed quality parameters.
Table 1 Effect of seed priming and seed treatment with insecticides on field emergence and shoot fly in foxtail millet

| Priming | Field emergence (%) | Shoot fly (%) |
|---------|---------------------|---------------|
|         | Seed treatment      | Seed treatment |
|         | S₁      S₂  S₃  S₄  Mean | S₁      S₂  S₃  S₄  Mean |
| P₁      | 84.3   83.3  81.0  79.7  82.1 | 7.13(15.43)* 8.37(16.78) 9.87(18.26) 12.40(20.58) 9.44(17.76) |
| P₂      | 93.3   92.0  91.0  89.7  91.5 | 2.40(8.88) 4.77(12.60) 6.77(15.04) 9.13(17.59) 5.77(13.53) |
| P₃      | 90.7   88.7  87.3  83.0  87.4 | 6.37(14.59) 7.80(16.20) 9.07(17.51) 11.73(20.02) 8.74(17.08) |
| P₄      | 96.0   94.0  92.3  91.3  93.4 | 1.87(7.84) 3.97(11.49) 5.90(14.04) 8.03(16.46) 4.94(12.46) |
| P₅      | 92.3   91.3  89.3  88.0  90.3 | 4.97(12.87) 6.70(15.00) 7.90(16.32) 10.60(19.00) 7.54(15.80) |
| Mean    | 91.3   89.9  88.2  86.3 | 4.55(11.92) 6.32(14.41) 7.90(16.24) 10.38(18.73) |

For comparing the means of

| S.Em±  | CD at 5 % | CV |
|--------|-----------|----|
| P      | 2.6       | 7.4 | 10.1 |
| S      | 2.3       | 6.6 | 0.28 | 0.82 | 12.71 |
| P X S  | 5.2       | NS | 0.57 | NS |

Note:
NS - Non significant
*Figures in parenthesis indicate Arc sine transformed values

Priming

P₁ - Control
P₂ - Hydro priming for 8hr
P₃ - Seed priming with VIGRO-S (sea weed extract)
P₄ - Priming with 2 per cent CaCl₂
P₅ - Seed priming with 20 per cent Pseudomonas

Seed treatment

S₁ - Seed treatment with thiamethoxam 25 WG @ 2g/kg
S₂ - Seed treatment with Imidacloprid 70 WG @ 5g/kg
S₃ - Seed treatment with chlothidin 50 WG @ 2g/kg
S₄ - Seed treatment with Acetamiprid 20 SP @ 2g/kg
Table 2 Effect of seed priming and seed treatment with insecticides on plant height in foxtail millet

| Priming | Plant height (cm) at 30 DAS | Plant height (cm) at 60 DAS | Plant height (cm) at 90 DAS |
|---------|-----------------------------|-----------------------------|-----------------------------|
|         | S1   | S2   | S3   | S4   | Mean  | S1   | S2   | S3   | S4   | Mean  | S1   | S2   | S3   | S4   | Mean  |
| P1      | 32.1 | 29.2 | 27.9 | 26.7 | 29.0  | 73.5 | 71.2 | 65.7 | 59.8 | 67.6  | 88.1 | 86.3 | 73.0 | 60.0 | 76.9  |
| P2      | 36.3 | 35.5 | 33.5 | 31.8 | 34.3  | 81.3 | 79.7 | 76.9 | 75.3 | 78.3  | 94.0 | 93.0 | 92.1 | 86.1 | 91.3  |
| P3      | 31.0 | 30.7 | 30.1 | 32.1 | 31.0  | 75.3 | 72.8 | 71.2 | 62.7 | 70.5  | 90.1 | 89.0 | 88.4 | 72.4 | 85.0  |
| P4      | 38.2 | 36.7 | 34.8 | 33.3 | 35.8  | 84.6 | 81.7 | 79.5 | 78.2 | 81.0  | 96.5 | 95.0 | 92.4 | 88.4 | 93.1  |
| P5      | 33.8 | 32.7 | 31.4 | 30.3 | 32.1  | 78.3 | 75.5 | 73.5 | 73.0 | 75.1  | 92.1 | 91.4 | 90.3 | 74.8 | 87.2  |
| Mean    | 34.3 | 33.0 | 31.3 | 31.1 | 34.3  | 78.6 | 76.2 | 73.4 | 69.8 | 72.2  | 90.9 | 87.3 | 87.2 | 76.4  |

For comparing the means of

|       | S.Em± | CD at 5% | CV
|-------|-------|----------|------|
| P     | 1.0   | 2.8      | 10.5 |
| S     | 0.9   | 2.5      |      |
| P X S | 2.0   | NS       |      |

Note: NS- Non significant  DAS – Days after sowing

**Seed treatment**

- S1 - Seed treatment with thiamethoxam 25 WG @ 2g/kg
- S2 - Seed treatment with Imidacloprid 70 WG @ 5g/kg
- S3 - Seed treatment with chlothidin 50 WG @ 2g/kg
- S4 - Seed treatment with Acetamiprid 20 SP @ 2g/kg

**Priming**

- P1 – Control
- P2 – Hydro priming for 8hr
- P3 – Seed priming with VIGRO-S (sea weed extract)
- P4 – Priming with 2 per cent CaCl$_2$
- P5 – Seed priming with 20 per cent *Pseudomonas*

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Table.3 Effect of seed priming and seed treatment with insecticides on SPAD value at 30, 60 and 90 DAS in foxtail millet

| Priming | SPAD at 30 DAS | SPAD at 60 DAS | SPAD at 90 DAS |
|---------|----------------|----------------|----------------|
|         | Seed treatment | Seed treatment | Seed treatment |
|         |                |                |                |
| P₁      | S₁ 31.40      | S₁ 35.30       | S₁ 23.43       |
|         | S₂ 30.60      | S₂ 33.00       | S₂ 21.80       |
|         | S₃ 29.50      | S₃ 31.30       | S₃ 20.70       |
|         | S₄ 28.40      | S₄ 29.20       | S₄ 18.70       |
|         | Mean 29.99    | Mean 32.22     | Mean 21.18     |
| P₂      | S₁ 37.17      | S₁ 41.43       | S₁ 27.53       |
|         | S₂ 35.50      | S₂ 38.50       | S₂ 25.80       |
|         | S₃ 33.60      | S₃ 35.60       | S₃ 24.20       |
|         | S₄ 32.10      | S₄ 33.50       | S₄ 21.50       |
|         | Mean 34.62    | Mean 37.28     | Mean 24.80     |
| P₃      | S₁ 32.90      | S₁ 36.37       | S₁ 24.63       |
|         | S₂ 31.80      | S₂ 35.10       | S₂ 23.30       |
|         | S₃ 30.40      | S₃ 32.30       | S₃ 21.70       |
|         | S₄ 29.90      | S₄ 29.90       | S₄ 19.30       |
|         | Mean 31.27    | Mean 33.44     | Mean 22.26     |
| P₄      | S₁ 41.25      | S₁ 42.47       | S₁ 31.31       |
|         | S₂ 37.90      | S₂ 41.50       | S₂ 27.80       |
|         | S₃ 35.40      | S₃ 38.20       | S₃ 25.30       |
|         | S₄ 33.40      | S₄ 35.90       | S₄ 22.80       |
|         | Mean 37.02    | Mean 39.71     | Mean 26.83     |
| P₅      | S₁ 34.90      | S₁ 36.70       | S₁ 26.83       |
|         | S₂ 33.40      | S₂ 36.40       | S₂ 24.40       |
|         | S₃ 31.60      | S₃ 33.80       | S₃ 23.00       |
|         | S₄ 30.90      | S₄ 31.60       | S₄ 22.00       |
|         | Mean 32.72    | Mean 34.64     | Mean 24.07     |
| Mean    | S₁ 35.52      | S₁ 38.45       | S₁ 26.75       |
|         | S₂ 33.80      | S₂ 36.90       | S₂ 24.60       |
|         | S₃ 32.10      | S₃ 34.30       | S₃ 23.00       |
|         | S₄ 30.90      | S₄ 32.00       | S₄ 20.90       |
|         | Mean 33.80    | Mean 34.30     | Mean 23.00     |

| For comparing the means of | S.Em ± | CD at 5% | CV | S.Em ± | CD at 5% | CV | S.Em ± | CD at 5% | CV |
|----------------------------|--------|----------|----|--------|----------|----|--------|----------|----|
| P                           | 1.03   | 2.96     | 10.8| 1.81   | 5.17     | 17.6| 0.76   | 2.19     | 11.1|
| S                           | 0.92   | 2.65     |     | 1.62   | 4.63     |    | 0.68   | 1.96     |    |
| P X S                       | 2.07   | NS       | 3.61| NS     | 1.53     |    | NS     |          |    |

Note:
- NS – non significant
- DAS – Days after sowing

**Primming**
- P₁ – Control
- P₂ – Hydro priming for 8hr
- P₃ – Seed priming with VIGRO-S (sea weed extract)
- P₄ – Priming with 2 per cent CaCl₂
- P₅ – Seed priming with 20 per cent *Pseudomonas*

**Seed treatment**
- S₁ – Seed treatment with thiamethoxam 25 WG @ 2g/kg
- S₂ - Seed treatment with Imidacloprid 70 WG @ 5g/kg
- S₃ - Seed treatment with chlothidin 50 WG @2g/kg
- S₄ - Seed treatment with Acetamiprid 20 SP @ 2g/kg
**Table 4** Effect of seed priming and seed treatment with insecticides on yield parameters in foxtail millet

| Priming | Plant dry matter (g) | Panicle length (cm) | Panicle diameter (cm) |
|---------|----------------------|---------------------|----------------------|
|         | S<sub>1</sub> | S<sub>2</sub> | S<sub>3</sub> | S<sub>4</sub> | Mean | S<sub>1</sub> | S<sub>2</sub> | S<sub>3</sub> | S<sub>4</sub> | Mean | S<sub>1</sub> | S<sub>2</sub> | S<sub>3</sub> | S<sub>4</sub> | Mean |
| P<sub>1</sub> | 30.70 | 30.77 | 29.70 | 29.00 | 30.04 | 13.23 | 12.97 | 12.53 | 12.07 | 12.70 | 1.07 | 1.00 | 0.93 | 0.83 | 0.96 |
| P<sub>2</sub> | 37.97 | 36.10 | 34.90 | 33.17 | 35.53 | 16.85 | 16.17 | 14.62 | 14.17 | 15.45 | 1.48 | 1.33 | 1.29 | 1.18 | 1.32 |
| P<sub>3</sub> | 32.13 | 32.00 | 31.83 | 30.13 | 31.53 | 14.20 | 13.90 | 13.10 | 12.90 | 13.53 | 1.23 | 1.10 | 1.03 | 0.93 | 1.08 |
| P<sub>4</sub> | 40.77 | 38.77 | 35.17 | 34.17 | 37.22 | 17.53 | 16.67 | 15.39 | 14.80 | 16.10 | 1.57 | 1.50 | 1.36 | 1.21 | 1.41 |
| P<sub>5</sub> | 34.87 | 33.77 | 33.63 | 31.33 | 33.40 | 15.17 | 14.63 | 13.60 | 13.27 | 14.17 | 1.35 | 1.26 | 1.19 | 1.11 | 1.23 |
| Mean | 35.29 | 34.28 | 33.05 | 31.56 | 31.56 | 15.40 | 14.87 | 13.85 | 13.44 | 13.44 | 1.34 | 1.24 | 1.16 | 1.05 |

For comparing the means of

| S.Ed± | CD at 5 % | CV |
|--------|-----------|----|
| P<sub>1</sub> | 1.03 | 2.95 | 10.63 |
| P<sub>2</sub> | 0.92 | 2.64 | 0.40 | 1.16 |
| P X S | 2.06 | NS | 0.90 | NS |

Note:
NS - Non significant

**Primings**
P<sub>1</sub> – Control
P<sub>2</sub> – Hydro priming for 8hr
P<sub>3</sub> – Seed priming with VIGRO-S (sea weed extract)
P<sub>4</sub> – Priming with 2 per cent CaCl<sub>2</sub>
P<sub>5</sub> – Seed priming with 20 per cent *Pseudomonas*

**Seed treatment**
S<sub>1</sub> – Seed treatment with thiamethoxam 25 WG @ 2g/kg
S<sub>2</sub> - Seed treatment with Imidacloprid 70 WG @ 5g/kg
S<sub>3</sub> - Seed treatment with chlothidin 50 WG @2g/kg
S<sub>4</sub> - Seed treatment with Acetamiprid 20 SP @ 2g/kg
**Table 5** Effect of seed priming and seed treatment with insecticides on yield parameters in foxtail millet

| Priming | Seed yield (q/ha) | Stover yield (t/ha) |
|---------|------------------|---------------------|
|         | Seed treatment   | Seed treatment      |
|         | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean | $S_1$ | $S_2$ | $S_3$ | $S_4$ | Mean |
| $P_1$   | 16.47 | 16.07 | 15.77 | 15.33 | 15.91 | 3.43 | 3.17 | 2.93 | 2.63 | 3.04 |
| $P_2$   | 19.10 | 18.73 | 18.47 | 18.00 | 18.58 | 4.33 | 3.97 | 3.76 | 3.53 | 3.90 |
| $P_3$   | 17.33 | 16.93 | 16.47 | 16.13 | 16.72 | 3.80 | 3.47 | 3.36 | 3.13 | 3.44 |
| $P_4$   | 20.10 | 19.67 | 19.27 | 18.83 | 19.47 | 4.70 | 4.47 | 3.93 | 3.83 | 4.23 |
| $P_5$   | 18.13 | 17.60 | 17.27 | 16.73 | 17.43 | 4.03 | 3.70 | 3.59 | 3.30 | 3.66 |
| Mean    | 18.23 | 17.80 | 17.45 | 17.01 |         | 4.06 | 3.75 | 3.52 | 3.29 |         |

For comparing the means of $S.Em \pm$ CD at 5% CV

|         | S.Em± | CD at 5% | CV |
|---------|-------|----------|----|
| $P$     | 0.34  | 0.96     | 11.50 |
| $S$     | 0.30  | 0.86     |       |
| $P \times S$ | 0.67 | NS | 0.23 |

Note: NS- Non significant

**Priming**

- $P_1$ – Control
- $P_2$ – Hydro priming for 8hr
- $P_3$ – Seed priming with VIGRO-S (sea weed extract)
- $P_4$ – Priming with 2 per cent CaCl$_2$
- $P_5$ – Seed priming with 20 per cent *Pseudomonas*

**Seed treatment**

- $S_1$ – Seed treatment with thiamethoxam 25 WG @ 2g/kg
- $S_2$ – Seed treatment with Imidacloprid 70 WG @ 5g/kg
- $S_3$ – Seed treatment with chlothidin 50 WG @2g/kg
- $S_4$ – Seed treatment with Acetamiprid 20 SP @ 2g/kg
Table 6 Effect of seed priming and seed treatment with insecticides on test weight, seed germination, in foxtail millet

| Priming | Test weight (g) | Seed treatment | Seed germination (%) | Seed treatment |
|---------|-----------------|----------------|----------------------|----------------|
|         | S₁  | S₂  | S₃  | S₄  | Mean | S₁  | S₂  | S₃  | S₄  | Mean |
| P₁      | 2.97 | 2.83 | 2.77 | 2.73 | 2.83 | 90.00 | 89.00 | 88.67 | 88.33 | 89.00 |
| P₂      | 3.60 | 3.37 | 3.10 | 3.17 | 3.31 | 96.00 | 95.67 | 94.00 | 93.33 | 94.58 |
| P₃      | 3.03 | 2.93 | 2.87 | 2.83 | 2.92 | 91.33 | 90.67 | 90.00 | 89.67 | 90.42 |
| P₄      | 3.82 | 3.63 | 3.45 | 3.33 | 3.56 | 97.00 | 96.30 | 94.33 | 94.67 | 95.75 |
| P₅      | 3.27 | 3.10 | 2.90 | 3.00 | 3.07 | 93.00 | 92.67 | 91.67 | 90.33 | 91.92 |
| Mean    | 3.34 | 3.17 | 3.02 | 3.01 |       | 93.53 | 92.60 | 91.93 | 91.27 |       |

For comparing the means of

|          | S.Em± | CD at 5% | CV | S.Em± | C.D. at 1% |
|----------|-------|----------|----|-------|------------|
| P        | 0.09  | 0.27     | 10.45 | 0.46  | 1.31       |
| S        | 0.08  | 0.24     |       | 0.41  | 1.18       |
| P X S    | 0.19  | NS       |       | 0.92  | NS         |

Note:
NS- non significant

**Priming**
P₁ – Control
P₂ – Hydro priming for 8hr
P₃ – Seed priming with VIGRO-S (sea weed extract)
P₄ – Priming with 2 per cent CaCl₂
P₅ – Seed priming with 20 per cent Pseudomonas

**Seed treatment**
S₁ – Seed treatment with thiamethoxam 25 WG @ 2g/kg
S₂ – Seed treatment with Imidacloprid 70 WG @ 5g/kg
S₃ – Seed treatment with Chlozolinate 50 WG @ 2g/kg
S₄ – Seed treatment with Acetamiprid 20 SP @ 2g/kg
### Table 7 Effect of seed priming and seed treatment with insecticides on seed quality parameters in foxtail millet

| Priming | Seedling length (cm) | Seedling dry weight (g) | SVI | Electrical conductivity (dSm⁻¹) |
|---------|---------------------|-------------------------|-----|-------------------------------|
|         |                     |                         |     |                               |
|         | S₁ | S₂ | S₃ | S₄ | Mean | S₁ | S₂ | S₃ | S₄ | Mean | S₁ | S₂ | S₃ | S₄ | Mean | S₁ | S₂ | S₃ | S₄ | Mean |
| P₁      | 8.93 | 8.40 | 7.93 | 7.70 | 8.24 | 28.77 | 27.63 | 26.90 | 26.37 | 27.42 | 676 | 630 | 597 | 581 | 621 | 0.43 | 0.45 | 0.50 | 0.52 | 0.47 |
| P₂      | 10.83 | 10.37 | 9.79 | 9.31 | 10.08 | 30.22 | 30.13 | 30.03 | 29.61 | 30.26 | 846 | 817 | 756 | 714 | 783 | 0.36 | 0.37 | 0.37 | 0.38 | 0.37 |
| P₃      | 9.41 | 8.85 | 8.40 | 8.07 | 8.68 | 29.50 | 28.43 | 28.10 | 27.57 | 28.40 | 714 | 659 | 631 | 607 | 653 | 0.41 | 0.44 | 0.48 | 0.50 | 0.46 |
| P₄      | 11.89 | 11.39 | 10.72 | 10.24 | 11.06 | 31.33 | 30.40 | 30.23 | 29.53 | 30.38 | 921 | 883 | 813 | 793 | 852 | 0.32 | 0.34 | 0.33 | 0.38 | 0.35 |
| P₅      | 9.93 | 9.32 | 8.73 | 8.50 | 9.12 | 30.17 | 29.97 | 28.17 | 27.90 | 29.05 | 755 | 699 | 654 | 626 | 684 | 0.37 | 0.38 | 0.39 | 0.41 | 0.39 |
| Mean    | 10.20 | 9.67 | 9.12 | 8.76 | 9.85 | 30.15 | 29.35 | 28.70 | 28.20 | 28.70 | 782 | 738 | 690 | 664 | 682 | 0.37 | 0.39 | 0.42 | 0.44 | 0.44 |

**Note:**
- NS - Non significant

**Priming**
- P₁ – Control
- P₂ – Hydro priming for 8hr
- P₃ – Seed priming with VIGRO-S (sea weed extract)
- P₄ – Priming with 2 per cent CaCl₂
- P₅ – Seed priming with 20 per cent *Pseudomonas*

**Seed treatment**
- S₁ – Seed treatment with thiamethoxam 25 WG @ 2g/kg
- S₂ – Seed treatment with Imidacloprid 70 WG @ 5g/kg
- S₃ – Seed treatment with chlothidin 50 WG @ 2g/kg
- S₄ – Seed treatment with Acetamiprid 20 SP @ 2g/kg
The higher seed germination of 2.47 per cent over control due to seed treatment with thiomethaxam 25 WG @ 2g/kg of seeds. The increased seed germination mainly attributed to maximum shoot length, root length, seedling length, seedling dry weight, vigour index and minimum electrical conductivity were recorded in seed treatment with thiomethaxam 25 WG @ 2g/kg of seeds. (1.87 cm, 8.33 cm, 10.20 cm, 30.15 mg, 782, 0.37 dSm$^{-1}$ respectively) followed by imidacloprid 70 WG 5g/kg of seeds. While the lower seed quality parameters was recorded in Acetamiprid 20 SP (1.51 cm, 7.25 cm, 28.20 mg, 8.76 cm, 664, 0.44 dSm$^{-1}$ respectively). Due to seed treatment with insecticides were did not affect the cumulative germination rate and suppressing root system development in the cotyledon stage. Similar results obtained by Balikai et al., (2010). Seed quality parameters were not differed significantly due to the seed priming and seed treatments. The higher seed quality parameters. The higher seed germination of 9.85 per cent over control due to seed priming with 2 per cent CaCl$_2$ along with seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds. (97 %, 2.41 cm, 9.48 cm, 11.89 cm, 31.33 mg, 921 and 0.32 dSm$^{-1}$). This might be due to seed priming increases the better performance of the seed and other food reserves in the endosperm of the seeds so ultimately higher seed quality. The shoot fly percent incidence of foxtail millet was not differed significantly due to the interaction of seed priming and seed treatment. The lower shoot fly incidence (1.87 %) was recorded in seed priming with 2 per cent CaCl$_2$ along with seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds. Followed by hydro priming for 8 hours along with thiomethaxam 25 WG @ 2g/kg of seeds (2.40 %), seed priming 2 per cent CaCl$_2$ along with seed treatment of imidacloprid 70 @ 5g/kg of seeds (3.97 %). Whereas the maximum shoot fly incidence (10.60 %) was recorded in no primed seed with acetamiprid 20 SP @ 2g/kg of seeds.

Finally seed priming with 2 per cent CaCl$_2$ coupled with seed treatment of thiomethaxam 25 WG @ 2g/kg of seeds produced higher growth, seed yield with better quality, enhanced plant stand establishment, lower shoot fly incidence and reduces the time of germination.

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How to cite this article:

Ashok S. Sajjan, Lokesh, S. B. Patil and Patil, M. B. 2019. Enhancement of Plant Stand Establishment through Seed Priming and Seed Treatment on Growth, Seed Yield and Quality in Foxtail Millet [*Setaria italica* (L.) Beauv.] *Int.J.Curr.Microbiol.App.Sci.* 8(09): 2674- 2687. doi: [https://doi.org/10.20546/ijcmas.2019.809.309](https://doi.org/10.20546/ijcmas.2019.809.309)