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# Performance of Niger [*Guizotia abyssinica* (L.f.) Cass.] under different seed priming and liquid manure options in Eastern plateau and hill zone of India

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## ABSTRACT

*A pot experiment was conducted at the campus of Ramakrishna Mission Vivekananda Educational and Research Institute, Ranchi during early winter season of 2023 to study the influence of seed priming and liquid manure spray on growth and seed yield of Niger crop. The experiment was placed in factorial completely randomized design using 4 seed priming options ($P_0$: control or no priming, $P_1$: hydro priming, $P_2$: halo priming, $P_3$: biopriming with Trichoderma @10%) and 4 liquid manure options ($M_0$: control or no liquid manure, $M_1$: Jiwamrit@10%, $M_2$: Kunapajala@10%, $M_3$: Panchagavya@10%), replicated thrice. Results revealed that seed biopriming with Trichoderma @10% achieved maximum plant growth, yield attributes and seed yield (1.54 g/plant) of Niger. Hydro priming was the second best option (seed yield: 1.40 g/plant). Application of Kunapajala@10% also ensured maximum plant growth, yield attributes and seed yield (1.56 g/plant) of Niger, closely followed by Panchagavya @10% (1.45 g/plant). Altogether, seed biopriming with Trichoderma @10% and spraying of Kunapajala@10% at 15, 30 and 45 days after sowing recorded the maximum plant height, number of leaves/plant, various yield attributes and seed yield (1.78 g/plant) of Niger and can be recommended for cultivation of Niger in Eastern plateau and hill region of India.*

**Keywords:** Kunapajala, Liquid manure, Niger, Seed priming, Trichoderma, Yield

## INTRODUCTION

Since ancient times, oilseeds, especially, the edible ones have played a significant role in human life. The use of nutrient-dense edible oils in everyday cooking and other applications is growing in response to the growing calorie needs of the world's population. Oilseeds in this nation continue to be neglected as a result of the greater focus given to the production of food grains to meet the need of the second-largest population in the globe. As a result, there is a shortage of edible oilseeds relative to demand. Among different edible oilseeds, Niger can play a key role in uplifting the Indian economy as well as can bridge the demand and supply of edible oil. In different parts of the country, Niger [*Guizotia abyssinica* (L.f.) Cass.], despite being a minor oilseed crop, is significant because its seeds contain 32–40% high-quality oil and 18–24% protein. Niger oil is used as an illuminant, paint, food, and soap as well as edible oil. Apart from various agro-techniques for successful crop production, a crucial goal that must be accomplished is proper stand establishment, especially considering the changing environment. In this sense, seed priming has a lot of promise these days for many different crops in addition to Niger. Seed priming is an inexpensive method of pre-planting controlled hydration that aims to modify the biochemistry and physiology of seeds to trigger metabolic activities without enabling them to emerge (Rosental *et al.*, 2014). It guarantees consistent and quick germination, strong vigour for appropriate stand establishment, growth, and increased production (Khan *et al.*, 2002). Research suggests that seed priming accelerates seed germination and seedling growth, which in turn influences improved field performance, particularly in unfavourable agroclimatic conditions (Black and Bewley, 2000). Oilseeds like rapeseed-mustard has previously employed a variety of seed priming techniques, including hydro-priming, halo-priming, osmo-priming, hormonal priming, etc. (Basra *et al.*, 2003) and it can be tested for minor oilseeds like Niger now.

The Indian soil has become damaged due to a persistent reliance on chemical-based agriculture (Biswas *et al.*, 2019, Kumar and Singh, 2019). Organic farming is now being taken seriously after nearly a century of neglect and has immense promise for the future (Kumari

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*et al.*, 2024). Organic liquid manures and formulations are gaining a lot of attention these days among other organic sources of nutrients. Many liquid manures, made from locally accessible resources, such Jiwamrit, Panchagavya, Kunapajala, etc., are exhibiting promising results in agriculture as these function as bio-stimulants to improve soil and crop health, leading to both qualitative and quantitative crop production. These liquid formulations have already shown to be beneficial in a variety of crops (Solanki *et al.*, 2015), and it is anticipated that these formulations will also increase the growth and yield of Niger crop. Keeping these in mind, under organic farming system, the present pot experiment was conducted with the anticipation that integration, and implementation of both seed priming as well as liquid manure can create a win-win situation to ensure good growth and productivity of the oilseeds like Niger as well as environmental safety.

## MATERIALS AND METHODS

The pot experiment was conducted at the campus of Ramakrishna Mission Vivekananda Educational and Research Institute (RKMVERI), Morabadi, Ranchi, Jharkhand (23.39°N latitude, 85.34°E longitude and 628 m above the mean sea level) during late *kharif* season of 2023. The soil used for pot experiment was well drained, highly fertile (0.52% organic carbon, 211.2 kg/ha available N, 48.2 kg/ha available $P_2O_5$ and 141.3 kg/ha available $K_2O$), clay loam textured, laterite and slightly acidic in nature (pH 6.67). The meteorological data during the period of investigation have been depicted in Fig 1. The experiment followed factorial completely randomized design having 4 seed priming options as factor 1 ($P_0$: control or no priming, $P_1$: hydro priming, $P_2$: halo priming, $P_3$: biopriming with Trichoderma @10%) and 4 liquid manure options as factor 2 ($M_0$: control or no liquid manure, $M_1$: Jiwamrit@10%, $M_2$: Kunapajala@10%, $M_3$: Panchagavya@10%), replicated thrice. Niger variety 'Birsa Niger-1' were subjected to seed priming prior to sowing for 24 hours and thereafter, sown on 18$^{th}$ September 2023 in pots filled with soil and vermicompost mixture (soil: 6.25 kg and vermicompost: 0.75 kg/pot) at a plant-plant spacing of 5-6 cm and a depth of 2-3 cm @2-3 seeds/hill. The experiment was carried out using organic farming inputs and practices. The pots were sprinkled with water immediately after sowing. One week after sowing onwards, subsequent waterings were provided at 4 days' interval for one month and at 2 days' interval thereafter up to the month November. No water watering was made in December to hasten the maturity. Other agronomic and plant protection measures were followed as per the standard organic practices done by the Niger growers of this region. The crop was harvested on 14$^{th}$ December 2023.

Table 1: Details of preparation of organic liquid manures (Biswas *et al.*, 2023)

| Organic liquid manure | Preparation |
|---|---|
| Jiwamrit | 10 kg fresh cow dung, 10 litres of cow urine, 2 kg jaggery, 2 kg pulse flour, a fist of organically cultivated soil and 200 litres of water were taken and mixed thoroughly in a container. This mixture was kept in shade for fermentation for 48 hours with regular stirring twice a day (morning and evening), clockwise and anti-clockwise. |
| Kunapajala | It contained cow dung, cow urine, water and any animal flesh like part of fishes, poultry birds or animals. Fresh cow dung, cow urine, animal waste (flesh of fishes, poultry birds etc.) and water were added in a plastic container at 1:1:1:2 ratio and mixed properly. Then, the mixture was fermented in a shady place for 25-30 days aerobically (stirring twice a day). |
| Panchagavya | Five cow-based ingredients *i.e*. cow dung, cow urine, milk, curd and ghee were added in a plastic container @ 5:3:2:2:1 ratio and fermented for 7-9 days at 30±2°C and relative humidity of 80-85%. The mixture was stirred with a stick every day two times during morning and evening, clockwise and anti-clockwise. |

Except for the control, seeds were subjected to hydropriming, halo priming and biopriming with Trichoderma @10%. In case of hydro priming 45 seeds were soaked in 100 ml of tap water taken in a beaker for 24 hours. In case of halo priming, 45 seeds were soaked in 50 mM of NaCl solution (0.2925 g of NaCl add 100 ml of distilled water) taken in a beaker for 24

hours. In case of bio- priming, 45 seeds were soaked in solution prepared by mixing 10 g of Trichoderma in 90 ml of distilled water taken in a beaker for 24 hours. Liquid manures viz. Jiwamrit, Kunapajala and Panchagavya were prepared (Table 1) and each applied @10% at 15, 30 and 45 DAS as per the treatments.

Observations on growth attributes comprised plant height (cm) and number of leaves/plant at 30, 45, 60, 75 days after sowing (DAS) and at harvest. Yield attributes viz. number of flowers/plant; number of seeds/flower, 1000 seeds' weight (g) and seed yield/plant (g) were also recorded at harvest of the crop. Data obtained from the field were statistically analyzed using analysis of variance method given by Panse and Sukhatme (1985). The treatment means were compared using critical difference (C.D.) values at 5% level of significance (*p=0.05*).

## RESULTS

### Growth attributes

### Effect of seed priming options

The experimental findings revealed that plant height and number of leaves/plant significantly varied among different seed priming options at various observation intervals (Table 2 and 3).

Table 2: Effect of seed priming and liquid manures on plant height of Niger

| Treatments | Plant height (cm) | | | | |
|---|---|---|---|---|---|
| | 30 DAS | 45 DAS | 60 DAS | 75 DAS | Harvest |
| *Levels of seed priming (P)* | | | | | |
| $P_0$ | 13.3 | 22.9 | 32.1 | 35.8 | 37.0 |
| $P_1$ | 16.1 | 26.6 | 33.9 | 38.3 | 39.5 |
| $P_2$ | 15.3 | 25.6 | 33.0 | 37.6 | 38.8 |
| $P_3$ | 16.9 | 27.3 | 34.7 | 39.2 | 40.5 |
| S.Em ± | 0.03 | 0.08 | 0.13 | 0.10 | 0.09 |
| C.D. (*p= 0.05*) | 0.1 | 0.2 | 0.4 | 0.3 | 0.3 |
| *Levels of liquid manure (M)* | | | | | |
| $M_0$ | 13.2 | 24.1 | 31.3 | 35.8 | 37.0 |
| $M_1$ | 15.6 | 25.3 | 32.8 | 37.3 | 38.5 |
| $M_2$ | 16.7 | 26.9 | 35.2 | 39.4 | 40.8 |
| $M_3$ | 16.1 | 26.0 | 34.4 | 38.3 | 39.5 |
| S.Em ± | 0.03 | 0.08 | 0.13 | 0.10 | 0.09 |
| C.D. (*p= 0.05*) | 0.1 | 0.2 | 0.4 | 0.3 | 0.3 |
| *Interaction between seed priming and liquid manure options (P × M)* | | | | | |
| $P_0M_0$ | 11.5 | 21.6 | 30.3 | 34.1 | 35.2 |
| $P_0M_1$ | 13.4 | 22.8 | 32.1 | 35.7 | 36.7 |
| $P_0M_2$ | 14.3 | 24.2 | 33.2 | 37.0 | 38.4 |
| $P_0M_3$ | 14.0 | 23.3 | 32.8 | 36.3 | 37.6 |
| $P_1M_0$ | 13.9 | 25.2 | 31.9 | 36.3 | 37.5 |
| $P_1M_1$ | 16.9 | 26.4 | 32.7 | 37.9 | 39.2 |
| $P_1M_2$ | 17.1 | 27.7 | 36.0 | 40.4 | 41.6 |
| $P_1M_3$ | 16.6 | 27.0 | 35.2 | 38.6 | 39.8 |
| $P_2M_0$ | 13.2 | 24.2 | 31.0 | 35.5 | 36.8 |
| $P_2M_1$ | 15.5 | 25.2 | 32.1 | 37.1 | 38.3 |
| $P_2M_2$ | 16.5 | 26.8 | 34.8 | 39.3 | 40.6 |
| $P_2M_3$ | 16.1 | 26.1 | 34.2 | 38.6 | 39.8 |
| $P_3M_0$ | 14.3 | 25.6 | 32.1 | 37.4 | 38.6 |
| $P_3M_1$ | 16.8 | 26.8 | 34.2 | 38.7 | 39.9 |
| $P_3M_2$ | 18.9 | 29.1 | 36.9 | 41.1 | 42.6 |
| $P_3M_3$ | 17.7 | 27.7 | 35.5 | 39.7 | 41.0 |
| Interaction | P × M | P × M | P × M | P × M | P × M |
| S.Em ± | 0.06 | 0.16 | 0.25 | 0.19 | 0.17 |
| C.D. (*p= 0.05*) | 0.2 | 0.5 | 0.7 | 0.6 | 0.5 |

*[$P_0$: No priming (dry seed), $P_1$: Hydro priming, $P_2$: Halo priming, $P_3$: Bio priming, $M_0$: No liquid manure, $M_1$: Jiwamrit @10%, $M_2$: Kunapajala @10%, $M_3$: Panchagavya @10%]*

It was also found that as compared to control, plant height and number of leaves/plant of Niger were higher under any seed priming option. At 30, 45, 60, 75 DAS and at harvest, the highest plant height and number of leaves/plant were obtained when bio priming with Trichoderma @10% ($P_3$) was applied (plant height: 16.9, 27.3, 34.7, 39.2 and 40.5 cm; number of leaves/plant: 5.7, 10.3, 12.3, 10.2 and 10.0), closely followed by hydro priming ($P_1$) and halo priming ($P_2$). Control ($P_0$), on the other hand, recorded the lowest plant height (13.3, 22.9, 32.1, 35.8 and 37.0 cm) and number of leaves/plant (4.7, 9.1, 11.2, 10.2 and 8.8).

Table 3: Effect of seed priming and liquid manures on number of leaves/plant of Niger

| Treatments | Number of leaves/plant | | | | |
|---|---|---|---|---|---|
| | 30 DAS | 45 DAS | 60 DAS | 75 DAS | Harvest |
| *Levels of seed priming (P)* | | | | | |
| $P_0$ | 4.7 | 9.1 | 11.2 | 9.1 | 8.8 |
| $P_1$ | 5.5 | 9.9 | 12.0 | 9.9 | 9.5 |
| $P_2$ | 5.1 | 9.8 | 11.6 | 9.8 | 9.3 |
| $P_3$ | 5.7 | 10.3 | 12.3 | 10.2 | 10.0 |
| S.Em ± | 0.04 | 0.04 | 0.04 | 0.08 | 0.05 |
| C.D. (*p= 0.05*) | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 |
| *Levels of liquid manure (M)* | | | | | |
| $M_0$ | 4.9 | 9.2 | 11.2 | 9.2 | 8.9 |
| $M_1$ | 5.3 | 9.8 | 11.8 | 9.7 | 9.4 |
| $M_2$ | 5.7 | 10.2 | 12.2 | 10.1 | 9.8 |
| $M_3$ | 5.2 | 10.0 | 11.9 | 10.0 | 9.6 |
| S.Em ± | 0.04 | 0.04 | 0.04 | 0.08 | 0.05 |
| C.D. (*p= 0.05*) | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 |
| *Interaction between seed priming and liquid manure options (P × M)* | | | | | |
| $P_0M_0$ | 4.2 | 8.9 | 10.8 | 8.8 | 8.6 |
| $P_0M_1$ | 4.7 | 9.1 | 11.2 | 8.9 | 8.9 |
| $P_0M_2$ | 5.1 | 9.4 | 11.5 | 9.3 | 9.1 |
| $P_0M_3$ | 4.8 | 9.2 | 11.3 | 9.3 | 8.7 |
| $P_1M_0$ | 5.1 | 9.5 | 11.5 | 9.4 | 9.1 |
| $P_1M_1$ | 5.7 | 9.9 | 12.2 | 10.0 | 9.4 |
| $P_1M_2$ | 5.9 | 10.2 | 12.3 | 10.0 | 9.9 |
| $P_1M_3$ | 5.3 | 10.1 | 12.0 | 10.2 | 9.6 |
| $P_2M_0$ | 4.7 | 9.2 | 10.9 | 9.3 | 8.8 |
| $P_2M_1$ | 5.0 | 9.8 | 11.6 | 9.7 | 9.5 |
| $P_2M_2$ | 5.5 | 10.1 | 12.1 | 10.2 | 9.6 |
| $P_2M_3$ | 5.2 | 10.0 | 11.8 | 10.0 | 9.6 |
| $P_3M_0$ | 5.5 | 9.3 | 11.6 | 9.2 | 9.0 |
| $P_3M_1$ | 5.9 | 10.3 | 12.4 | 10.4 | 9.8 |
| $P_3M_2$ | 6.1 | 11.0 | 12.7 | 10.9 | 10.7 |
| $P_3M_3$ | 5.4 | 10.7 | 12.4 | 10.5 | 10.4 |
| Interaction | P × M | P × M | P × M | P × M | P × M |
| S.Em ± | 0.08 | 0.07 | 0.08 | 0.15 | 0.09 |
| C.D. (*p= 0.05*) | 0.2 | 0.2 | 0.2 | 0.4 | 0.3 |

*[$P_0$: No priming (dry seed), $P_1$: Hydro priming, $P_2$: Halo priming, $P_3$: Bio priming, $M_0$: No liquid manure, $M_1$: Jiwamrit @10%, $M_2$: Kunapajala @10%, $M_3$: Panchagavya @10%]*

**Effect of liquid manure applications**

Throughout the observation intervals, plant height and number of leaves/plant of Niger significantly varied among different liquid manure types and control (Table 2 and 3). At 30, 45, 60, 75 DAS and at harvest, the highest plant height and number of leaves/plant were obtained when Kunapajala @10% ($M_2$) was applied (plant height: 16.7, 26.9, 35.2, 39.4 and 40.8 cm; number of leaves/plant: 5.7, 10.2, 12.2, 10.1 and 9.8), closely followed by Panchagavya @10% ($M_3$) and Jiwamrit @10% ($M_1$). Control ($M_0$), on the other hand, recorded the lowest plant height (13.2, 24.1, 31.3, 35.8 and 37.0 cm) and number of leaves/plant (4.9, 9.2, 11.2, 9.2 and 8.9).

**Interaction between seed priming and liquid manure options**

The experimental findings also stated that plant height and number of leaves/plant significantly varied among different seed priming and liquid manure options at various observation intervals (Table 2 and 3). At 30, 45, 60, 75 DAS and at harvest, the highest plant height and number of leaves/plant were obtained when Kunapajala @10% ($M_2$) was applied in Niger grown through bio-primed seeds with Trichoderma @10% ($P_3M_2$) (plant height: 18.9, 29.1, 36.9, 41.1 and 42.6 cm; number of leaves/plant: 6.1, 11.0, 12.7, 10.9 and 10.7), closely followed by Niger grown under bio-priming and Panchagavya spray @10% ($P_3M_3$) and Niger grown through hydro-primed seeds and under application of Kunapajala @10% ($P_1M_2$). No use of seed priming and liquid manure ($P_0M_0$), on the other hand, recorded the lowest plant height (11.5, 21.6, 30.3, 34.1 and 35.2 cm) and number of leaves/plant (4.2, 8.9, 10.8, 8.8 and 8.6).

**Yield attributes and yield**

**Effect of seed priming options**

The various yields attributes and seed yield of Niger significantly varied among different seed priming types and control (Table 4 and 5). The highest number of flowers/plant (8.3) and 1000 seeds' weight (3.79 g) were obtained *when bio priming with Trichoderma @10% ($P_3$) was applied, closely followed by hydro*

Table 4: Effect of seed priming and liquid manures on yield attributes of Niger

| Treatments | Number of flowers/ plant | Number of seeds/ flower | 1000 seeds' weight |
|---|---|---|---|
| *Levels of seed priming (P)* | | | |
| $P_0$ | 7.1 | 49.8 | 3.46 |
| $P_1$ | 7.7 | 48.0 | 3.74 |
| $P_2$ | 7.6 | 47.6 | 3.66 |
| $P_3$ | 8.3 | 48.6 | 3.79 |
| S.Em ± | 0.04 | 0.43 | 0.02 |
| C.D. (*p= 0.05*) | 0.1 | 1.3 | 0.05 |
| *Levels of liquid manure (M)* | | | |
| $M_0$ | 7.0 | 48.3 | 3.49 |
| $M_1$ | 7.6 | 47.0 | 3.62 |
| $M_2$ | 8.2 | 49.6 | 3.82 |
| $M_3$ | 7.9 | 49.0 | 3.72 |
| S.Em ± | 0.04 | 0.43 | 0.02 |
| C.D. (*p= 0.05*) | 0.1 | 1.3 | 0.05 |
| *Interaction between seed priming and liquid manure options (P × M)* | | | |
| $P_0M_0$ | 6.2 | 55.7 | 3.21 |
| $P_0M_1$ | 7.0 | 49.5 | 3.46 |
| $P_0M_2$ | 7.8 | 45.1 | 3.67 |
| $P_0M_3$ | 7.3 | 49.1 | 3.52 |
| $P_1M_0$ | 7.1 | 45.8 | 3.58 |
| $P_1M_1$ | 7.8 | 45.1 | 3.68 |
| $P_1M_2$ | 8.1 | 52.4 | 3.87 |
| $P_1M_3$ | 8.0 | 48.6 | 3.81 |
| $P_2M_0$ | 7.1 | 46.4 | 3.51 |
| $P_2M_1$ | 7.6 | 44.8 | 3.63 |
| $P_2M_2$ | 7.9 | 50.8 | 3.78 |
| $P_2M_3$ | 7.7 | 48.4 | 3.71 |
| $P_3M_0$ | 7.4 | 45.4 | 3.65 |
| $P_3M_1$ | 8.1 | 48.7 | 3.72 |
| $P_3M_2$ | 9.0 | 50.2 | 3.94 |
| $P_3M_3$ | 8.7 | 50.0 | 3.85 |
| Interaction | P × M | P × M | P × M |
| S.Em ± | 0.07 | 0.87 | 0.03 |
| C.D. (*p= 0.05*) | 0.2 | 2.5 | NS |

[*$P_0$: No priming (dry seed), $P_1$: Hydro priming, $P_2$: Halo priming, $P_3$: Bio priming, $M_0$: No liquid manure, $M_1$: Jiwamrit @10%, $M_2$: Kunapajala @10%, $M_3$: Panchagavya @10%]*

priming ($P_1$) and halo priming ($P_2$). Control ($P_0$), on the other hand, recorded the lowest number of flowers/plant (7.1) and 1000 seeds' weight (3.46 g). The highest number of seeds/flower obtained when no priming ($P_0$) was done (49.8), closely followed by bio priming with Trichoderma @10% ($P_3$) and both of these were statistically similar. Halo priming ($P_2$), on the other hand, recorded the lowest number of seeds/flower (47.6). The highest seed yield/plant was obtained when bio priming with Trichoderma @10% ($P_3$) was applied (1.54 g), closely followed by hydro priming ($P_1$) and halo priming ($P_2$). Control ($P_0$), on the other hand, recorded the lowest seed yield/plant (1.22 g) (Table 5).

**Effect of liquid manure applications**

The experimental findings revealed that the various yield attributes and seed yield of Niger significantly varied among different liquid manure options (Table 4 an 5). The highest number of flowers/plant (8.2) and 1000 seeds' weight (3.82 g) was obtained when Kunapajala @10% ($M_2$) was applied (8.2), closely followed by Panchagavya @10% ($M_3$) and Jiwamrit @10% ($M_1$). Control ($M_0$), on the other hand, recorded the lowest number of flowers/plant (7.0) and 1000 seeds' weight (3.49 g). The highest number of seeds/flower was obtained when Kunapajala @10% ($M_2$) was applied (49.6), closely followed by Panchagavya @10% ($M_3$) and no priming ($M_0$). Jiwamrit @10% ($M_1$), on the other hand, recorded the lowest number of seeds/flower (47.0). The highest seed yield/plant was obtained when Kunapajala @10% ($M_2$) was applied (1.56 g), closely followed by Panchagavya @10% ($M_3$) and Jiwamrit @10% ($M_1$). Control ($M_0$), on the other hand, recorded the lowest seed yield/plant (1.17 g) (Table 5).

Table 5: Effect of seed priming and liquid manures on seed yield/plant of Niger

| Treatments | Seed yield/plant (g) | | | | |
|---|---|---|---|---|---|
| | $M_0$ | $M_1$ | $M_2$ | $M_3$ | Mean |
| $P_0$ | 1.11 | 1.20 | 1.29 | 1.26 | 1.22 |
| $P_1$ | 1.17 | 1.29 | 1.65 | 1.48 | 1.40 |
| $P_2$ | 1.16 | 1.23 | 1.51 | 1.38 | 1.32 |
| $P_3$ | 1.23 | 1.47 | 1.78 | 1.67 | 1.54 |
| Mean | 1.17 | 1.30 | 1.56 | 1.45 | |
| Main effects | Seed priming (P) | Liquid manure (M) | Interaction | L×M | |
| S.Em ± | 0.01 | 0.01 | S.Em ± | 0.02 | |
| C.D. (*p= 0.05*) | 0.03 | 0.03 | C.D. (*p= 0.05*) | 0.05 | |

*[$P_0$: No priming (dry seed), $P_1$: Hydro priming, $P_2$: Halo priming, $P_3$: Bio priming, $M_0$: No liquid manure, $M_1$: Jiwamrit @10%, $M_2$: Kunapajala @10%, $M_3$: Panchagavya @10%]*

**Interaction between seed priming and liquid manure options**

The various yields attributes and seed yield of Niger significantly varied among different seed priming and liquid manure types and control except 1000 seeds' weight (Table 4 and 5). The highest number of flowers/plant (9.0) and 1000 seeds' weight (3.94 g) were obtained when Kunapajala @10% was applied in Niger grown through bio-primed seeds with Trichoderma @10% ($P_3M_2$) (9.0), closely followed by Niger grown under bio-priming and Panchagavya spray @10% ($P_3M_3$) and hydro priming and Kunapajala spray @10% ($P_1M_2$). No use of seed priming and liquid manure ($P_0M_0$), on the other hand, recorded the lowest number of flowers/plant (6.2) and 1000 seeds' weight (3.21 g). The highest number of seeds/flower was obtained under no use of seed priming and liquid manure ($P_0M_0$) (55.7), closely followed by Niger grown under hydro priming and Kunapajala spray @10% ($P_1M_2$). Halo priming of seeds and spray of Jiwamrit @10% ($P_2M_1$), on the other hand, recorded the lowest number of seeds/flower (44.8).

The highest seed yield/plant was obtained when Kunapajala @10% was applied in Niger grown through bio-primed seeds with Trichoderma @10% ($P_3M_2$) (1.78 g), closely followed by Niger grown under bio-priming and Panchagavya spray @10% ($P_3M_3$) (1.67 g) and Niger grown under hydro priming and Kunapajala spray @10% ($P_1M_2$) (1.65 g). No use of seed priming and liquid manure ($P_0M_0$), on the other hand, recorded the lowest seed yield/plant (1.11 g) (Table 5).

## DISCUSSION

The result might be because plants responded positively under different seed priming options as well as liquid manure sprays and these resulted positively in the cell division, multiplication etc. resulting in development of meristematic tissues and shoot elongation (Hashim *et al.*, 2015). Improvement of plant height was more during first 75 days, after which it showed negligeable improvement in height. It was perhaps due to partitioning and translocation of most of the dry matter towards reproductive parts in later stages. Control recorded lowest plant height at all observation intervals as it did not receive the advantages of seed priming as well as liquid manure spray. A steady increase in number of leaves/plant of Niger up to 60 DAS was found in this study, after which, a decline in the same. It was speculated that as the crop progressed towards maturity, leaf senescence occurred, resulting in reduction in leaf number at later crop period. No seed priming resulted in poor establishment possibly resulting in less root growth, which finally reflected on less leaf generation and photosynthesis. Seed priming perhaps played a key role in germination and initial plant establishment. It possibly helped the plant to develop roots for better nutrient and water uptakes which were reflected in plant height and leaf number of Niger. Among the seed priming options, biopriming with Trichoderma @10% helped Niger to attain best height and leaf number/plant. It was possibly due to seed membrane stability imposed by the priming, reducing lipid peroxidation, and encouraging anti-fungal and anti-oxidant activities (Vyankatrao, 2019). Trichoderma might also enhance metabolic activities like water intrusion to seeds and breakdown of storage materials of seeds through enzymes like lipase, proteinase, phosphatase, and hydrolase (Bewley and Black, 1985) which had a positive effect on germination and initiation of radicle and plumule from seeds and their early establishment. Also, any early damage to the crop by diseases was supposed to be prevented by the presence of such beneficial microorganism in bio priming (Lim *et al.*, 2013; Tao *et al.*, 2015). Liquid organic manures were sources of multiple nutrients and possible rich in phytohormones, various enzymes, micro-organisms etc. Adequate supply of nitrogen possibly helped in cell division and multiplication, resulting in increment of plant height and synthesis of new leaves.On the other hand, control (no liquid manure application) recorded lowest plant height and number of leaves/plant at all observation intervals as it did not receive benefits of liquid organic manures. Application of liquid manures specially Kunapajala along with seed bio priming with Trichoderma @10% probably developed synergies with soil microbial activities like *rhizobium* (for biological nitrogen fixation), resulting in improvement of soil health and make more nutrients viz. nitrogen available for plant uptake which in turn ensured high shoot elongation and synthesis of leaves.

Various yield attributes of Niger were governed by the genetic traits. However, those were influenced by the seed priming and liquid manure application. It was obvious to obtain most of the lowest yield attributes with no seed priming and no liquid manure spray. Both seed priming and liquid manure application individually and in combination expressed positive impact on yield attributes of Niger. Among the seed priming options, biopriming with Trichoderma @10% helped Niger to generate high yield attributes mostly. Further, liquid organic manures were sources of multiple nutrients, phytohormones, various enzymes, micro-organisms etc. Along with the liquid organic formulations, vermicompost applied additionally at basal might help in the early decomposition and quick release of nutrients at initial growth of the plants which promoted photosynthesis and further partition of dry matter for reproductive part development (Mishra, 2014).Adequate uptake of nutrients, especially nitrogen possibly helped in enhancing photosynthesis activity, resulting in accumulation of dry matter as well as translocation of dry matter from source (vegetative part) to sink (reproductive part), resulting in high yield attributes (Biswas *et al.*, 2020). Mishra (2007) obtained higher plant growth, grains/panicle, panicle length etc. by applying Kunapajala at 10 days' interval on rice.

The Niger seed yield reflected the yield characteristics. Application of liquid manure both singly and in conjunction with seed priming had a positive effect on Niger seed output. Trichoderma species have been shown to benefit plants by promoting growth, improving

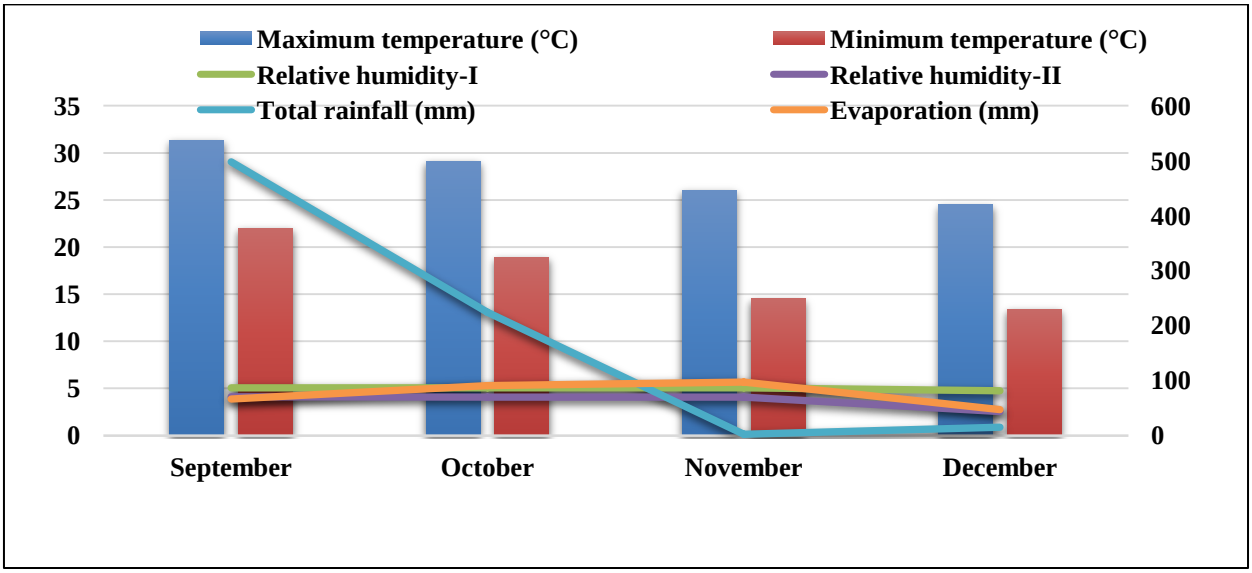


Fig 1: Month wise meteorological data during the period of investigation

root structure and condition, enhancing seed germination and viability, and increasing yield, blooming, and photosynthetic efficiency. By dividing and moving dry matter in their direction, organic liquid formulations have a positive impact on the development of reproductive organs, yield attributes, and yield, which is directly reflected in Niger seed production. The outcome supported Bhat and Vasanthi's (2008) findings about brinjal. Martinez (2008) found in a study that Kunapajala was high in microorganisms such as rhizobium, azotobacter, azospirillum, PSB, trichoderma, and pseudomonas, as well as rich in carbohydrates, proteins, alkaloids, and a good amount of phosphorus, triacylglycerides, esters, sterol ester, and phospholoipids. The greater seed output of Niger was thought to be caused by Kunapajala's higher nutritional and growth-promoting capabilities. Because control did not benefit from the improvements in soil physical, chemical, and biological activities that liquid organic manures brought about, it grew crops at the lowest rate and did not accumulate as much dry matter, which prevented it from moving towards reproductive organs.

## CONCLUSION

Based on the findings from the investigation, it was concluded that application of seed priming specially, with Trichoderma @10% (bio priming) elevated the growth and yield of Niger. Besides, use of liquid manures specially, Kunapajala spray @10% at 15, 30 and 45 DAS ensured best growth and yield of Niger. Therefore, cultivation of Niger using seed bio priming with Trichoderma @10% and Kunapajala spray @10% at 15, 30 and 45 days after sowing can be recommended for realizing best growth, yield attributes and yield of oilseed crop Niger in Eastern plateau and hill zone of India.

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