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IMPACT OF SEED PRIMING AND ORGANIC SPRAY ON THE GROWTH OF *KHIRNI* (*MANILKARA HEXANDRA* ROXB.)

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ABSTRACT

The experiment entitled "Impact of Seed Priming and Organic Spray on the Growth of *Khirni* [*Manilkara hexandra* (Roxb.)]" was conducted in 2022 at the Regional Horticultural Research Station, ASPEE College of Horticulture, Navsari Agricultural University, Gujarat. The study was laid out in a factorial Completely Randomized Design with twenty treatment combinations, comprising five seed priming treatments cow dung slurry (3%), cow urine (3%), *Bijamrut* (3%), *Amritpani* (3%) and water soaking and four organic sprays *Bijamrut* (1%), *Amritpani* (1%), Novel organic liquid nutrients (1%) and an untreated control each replicated three times. Results demonstrated that seed priming with 3% *Bijamrut* for 72 hours combined with foliar application of 1% novel organic liquid nutrients at 45 and 60 days after sowing significantly enhanced growth parameters of *Khirni*, both individually and in interaction.

Key words : *Khirni*, Seed priming, Novel Organic Liquid Nutrients, *Bijamrut* and Leaf area.

Introduction

Khirni is a member of the sapotaceae family and is known by its botanical name, *Manilkara hexandra* (Roxb.). The genus *Manilkara* comprises approximately 70 genera and around 800 species worldwide. In India, *Manilkara hexandra* is locally referred to as "*Khirni*" or "Rayan" by tribal communities across several states. It is generally regarded as being of Indian origin (Stewart and Brandis, 1992). *Khirni* holds considerable commercial importance as a tropical fruit tree, serving as both a nutritional resource and a source of livelihood for tribal populations. Owing to its economic significance, as well as its recognized medicinal and health-promoting properties, *Khirni* is widely cultivated in India as an avenue tree and is frequently grown in home gardens, community spaces, public parks and farmers' fields.

In India, *Manilkara hexandra* (Roxb.), commonly known as *Khirni*, is widely utilized as a rootstock for sapota (*Manilkara zapota*). Previous studies have demonstrated that *Khirni* rootstock exhibits greater vigour and productivity compared to sapota seedlings (Chadha and Parekh, 2010). A range of rootstocks is used for sapota propagation, including mahua (*Madhuca latifolia*), mee tree (*Madhuca longifolia*), sapota (*M. zapota*) and rayan or *Khirni* (*M. hexandra*). Among these, *M. hexandra* is considered the most suitable rootstock, as it ensures a stronger stock-scion compatibility and contributes to the production of superior-quality fruits. Most Indian workers stated that sapota on *Khirni* rootstocks produced more yield than or equal to those grafted on sapota (Randhawa and Kohli, 1966). *Khirni* caused dwarfing and early bearing in sapota. There are no reports of incompatibility.

Khirni is commercially propagated through seeds. Seeds from freshly harvested fruits are collected and sowed during the rainy season to produce seedlings. Dormancy in *Khirni* seeds is primarily attributed to their hard seed coat, which restricts water uptake and gaseous exchange. In addition, the recalcitrant nature of these seeds results in poor sprouting and limits their storage potential, as they possess a short shelf life that complicates long-term conservation and reduces the availability of bulk planting material. Another major constraint is the inherently slow seedling growth rate, with plants requiring 2-3 years to reach graftable size, thereby limiting large-scale propagation. Consequently, standardization of seedling production methods and strategies to enhance growth are essential. Pre-sowing treatments aimed at improving germination and reducing germination time have been widely studied in several tree species (Prasad *et al.*, 2011). Among these, organic seed priming techniques show considerable promise in improving germination performance and ensuring better establishment of *Khirni* seedlings.

Seed priming with organic substances has been reported to impart protection against bacterial, fungal and viral pathogens, in addition to enhancing seed vigor and germination. Such treatments not only promote early and uniform germination but also strengthen root systems and improve seedling resilience during the critical transplanting stage. Organic inputs such as cow dung slurry, cow urine, *Amritpani* and *Bijamrut* contain beneficial microorganisms that safeguard seeds from seed-borne and soil-borne diseases. Among these, *Bijamrut* has been identified as a highly effective bio-formulation, promoting rapid and higher germination, stimulating root development and providing protection to emerging shoots and seedling roots against pathogenic attacks (Chaudhary, 2023). Hence, the adoption of standardized organic seed priming methods is crucial for achieving early germination, higher germination and survival rates and for enabling seedlings to reach graftable size within a shorter period.

Foliar nutrient application provides a rapid and targeted approach for supplementing plant nutrition and stimulating metabolic activity. The use of organic foliar sprays has been recognized as an effective method for delivering additional macro- and micronutrients, phytohormones, and growth-promoting substances. The Novel Organic Liquid Nutrient developed and patented by Navsari Agricultural University, is formulated from banana (*Musa* spp.) pseudostem sap. Its composition includes nitrogen (0.062%), phosphorus (0.018%), potassium (0.180%), calcium (0.031%), magnesium (0.092 %), and sulfur (0.010%), along with trace elements such as iron (109.3 ppm), manganese (5.73 ppm), zinc (2.92 ppm) and copper (0.40 ppm). In addition to its mineral content, Novel Organic Liquid Nutrients contains bioactive compounds and beneficial microbial populations (Desai *et al.*, 2016). Seed priming combined with the application of organic foliar sprays is commonly practiced to enhance seedling growth and improve survival rates.

Materials and Methods

The present study, titled "Impact of Seed Priming and Organic Sprays on the Growth of *Khirni* [*Manilkara hexandra* (Roxb.)]," was conducted at the Regional Horticultural Research Station, ASPEE College of Horticulture, Navsari Agricultural University, Gujarat, during 2022. The experiment was arranged in a Completely Randomized Design (CRD) with a factorial arrangement, comprising twenty treatment combinations. These included five seed priming treatments: S - 3% cow dung slurry, S_2 - 3% cow urine, S_3 - 3% *Bijamrut*, S_4 - 3% *Amritpani* and S_5 - water soaking; and four organic spray treatments: F_1 - 1 % *Bijamrut*, F_2 - 1% *Amritpani*, F_3 - 1% Novel Organic Liquid Nutrients and F_4 - control, each replicated three times. Data significance was assessed following the method of Panse and Sukhatme (1985). Statistical analysis and figure preparation were performed using GRAPES software and treatment means were compared using Duncan's Multiple Range Test (DMRT).

Seeds were soaked according to the respective treatments for 72 hours and subsequently dried in the shade for 2 hours. Foliar spray was applied at 45 and 60 days after seed sowing. For preparation of 3 % cow dung slurry, cow urine, *Bijamrut* and *Amritpani*, 30 ml of each was dissolved in 1 litre of water. For preparation of 1% *Bijamrut*, *Amritpani* and Novel Organic Liquid Nutrients, 10 ml of each were dissolved in 1 litre of water.

Preparation of solution for seed priming and organic spray : Cow dung slurry was prepared by mixing cow dung and water in a 1:2 ratio. For the cow urine treatment, freshly collected cow urine was used.

Bijamrut was prepared by cow dung, cow urine, lime and handful soil from the bund of the farm. For preparation of *Bijamrut* first put 5 kg fresh cow dung in a cloth bag and suspend in a container filled with water to extract soluble ingredients of cow dung. Then 50 g lime added in 1 lit water separately. After 12 to 16 hours squeeze the bag to collect extract and added 5 litre of cow urine, 50 g soil, lime water and other 20 litre water and keep it for 8 to 12 hours and filter the contents for use of seed priming and foliar application.

Amritpani was prepared by combining cow dung, honey, ghee and water. Initially, 10 kg of cow dung was mixed thoroughly with 500 g of honey to form a uniform paste. Subsequently, 250 g of desi cow ghee was incorporated and the mixture was diluted with 200 liters of water to obtain the final solution.

Novel Organic Liquid Nutrients were sourced from the Banana Pseudostem Processing Unit, Soil and Water

Management Research Unit, Navsari Agricultural University and the required amount was directly dissolved in water prior to application.

Crop growth rate (g/m²/day) : It represents the increase in dry matter per unit area of the crop over a specified period. It was calculated using the following formula:

$$CGR = \frac{W_2 - W_1}{(t_2 - t_1)S}$$

Where,

W_1 and W_2 are plant dry weight (g) at time t_1 and t_2, respectively

S is land are (m²) over which dry matter was recorded.

Leaf area index (cm²/plant): LAI was determined by dividing the total leaf area per plant by the ground area occupied by the plant:

$$LAI = \frac{Leaf\ area}{Ground\ area}$$

Leaf area duration (days) : It quantifies the duration for which leaf area is maintained per unit area of land, reflecting the crop's ability to sustain leaf development over time. It was computed as:

$$LAD = \frac{LAI_1 + LAI_2}{2} \times (t_2 - t_1)$$

Where,

LAD = Leaf Area Duration between time t_2 and t_1

LAI_1 = Leaf Area Index at time t_1

LAI_2 = Leaf Area Index at time t_2

Leaf production rate (leaf/day/g): LPR was estimated by counting the number of leaves on tagged plants at regular intervals:

$$LPR = \frac{L_{n2} + L_{n1}}{(t_2 - t_1)}$$

Where,

L_{n1} = Number of leaves at time t_1

L_{n2} = Number of leaves at time t_2

Net assimilation rate (g/day/m²): It represents the rate of net photosynthesis and was calculated using the following formula:

$$NAR = \frac{(W_2 - W_1) \times (InL_2 - InL_1)}{(t_2 - t_1) \times (L_2 - L_1)}$$

Where,

L_1 and W_1 = Leaf area and dry weight of the plant, respectively at time t_1

L_2 and W_2 = Leaf area and dry weight of the plant, respectively at time t_2

Biomass duration (g.days/plant): The BDM is the integral of total biomass over a growth period and is expressed in g.days/plant.

$$BMD = \frac{TDM_1 - TDM_2}{2} \times (t_2 - t_1)$$

Where,

BDM = Biomass duration between time t_1 and t_2

TDM_1 = Total dry matter at time t_1

TDM_2 = Total dry matter at time t_2

Results and Discussion

Effect of seed priming

Analysis of the data presented in Table 1 indicated that different seed priming treatments significantly influenced the incremental growth in seedling height and girth. The highest increases in seedling height (0.57, 2.62 and 5.46 cm) and girth (0.31, 0.94 and 1.66 mm) were observed in seeds treated with 3% *Bijamrut* (T_3). This enhanced growth may be attributed to the macro- and micronutrients in *Bijamrut*, which promote seedling vigor and facilitate greater elongation. *Bijamrut* contains beneficial microbial groups, including free-living N_2-fixing bacteria, phosphorus-solubilizing microorganisms and bacteria that produce plant growth-promoting substances, as well as microbes with biocontrol activity. The combined effect of these nutrients and microbial populations likely contributed to the observed increases in seedling height. These findings are in agreement with previous reports by Sreenivasa *et al*. (2009), Boricha *et al*. (2020) in guava and Sujin *et al*. (2021) in mango.

The data presented in Table 1 revealed that different seed priming treatments significantly influenced the number of leaves, leaf area and survival percentage of seedlings. The highest number of leaves (4.13, 6.43 and 9.06), leaf area (10.73, 17.02 and 31.61 cm²) at 60, 90 and 120 DAS, respectively and maximum survival (81.75%) at 120 DAS were recorded in seedlings treated with 3% *Bijamrut* (T_3). This enhanced performance may be attributed to the beneficial microorganisms in the organic formulation, which convert nutrients into forms

Table 1 : Effect of seed priming and organic spray on growth and survival of *Khirni* seedlings.

Treatments	Incremental seedling height (cm)			Incremental seedling girth (mm)			Number of leaves			Leaf area (cm^2)			Survival (%)
	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	
Seed Priming (S)													
S_1 :	0.47	2.11	4.89	0.29	0.83	1.38	4.05	6.17	8.53	9.73	15.04	26.94	76.39
S_2 :	0.43	1.95	4.46	0.27	0.74	1.19	3.77	5.63	8.37	9.03	14.20	25.09	75.41
S_3 :	0.57	2.62	5.46	0.31	0.94	1.66	4.13	6.43	9.06	10.74	17.02	31.61	81.75
S_4 :	0.44	1.95	4.50	0.28	0.76	1.33	3.88	5.50	8.02	9.70	14.87	26.11	69.44
S_5 :	0.38	1.64	4.24	0.24	0.70	1.19	3.65	5.18	7.77	8.54	13.80	24.62	65.16
S.Em. ±	0.005	0.026	0.063	0.004	0.009	0.022	0.038	0.092	0.116	0.114	0.257	0.449	0.920
C.D. at 5%	0.02	0.07	0.18	0.01	0.03	0.06	0.11	0.26	0.33	0.33	0.73	1.28	2.63
Organic Spray (F)													
F_1:	0.47	2.20	5.00	0.27	0.82	1.37	3.92	5.85	8.76	9.70	15.28	28.52	77.42
F_2:	0.33	1.91	4.30	0.26	0.72	1.24	3.37	5.44	8.03	8.60	13.86	24.75	70.42
F_3:	0.80	2.53	5.95	0.37	0.98	1.64	4.25	6.59	8.87	11.64	17.59	31.91	81.46
F_4:	0.25	1.59	3.58	0.23	0.67	1.14	3.69	5.25	7.73	8.24	13.21	22.34	65.22
S.Em. ±	0.004	0.023	0.056	0.004	0.008	0.020	0.034	0.082	0.104	0.102	0.230	0.402	0.823
C.D. at 5 %	0.01	0.08	0.16	0.01	0.02	0.05	0.10	0.24	0.30	0.29	0.66	1.15	2.35
Interaction (S × F)													
S.Em. ±	0.011	0.051	0.125	0.008	0.019	0.045	0.076	0.184	0.231	0.228	0.513	0.898	1.840
C.D. at 5 %	0.03	0.15	0.36	0.02	0.05	0.13	0.22	0.52	0.66	0.65	1.47	2.57	5.26
C.V. %	4.05	4.37	4.64	5.14	4.10	5.77	3.38	5.50	4.80	4.16	5.94	5.79	4.33

that are readily absorbable by plants, thereby promoting efficient nutrient utilization. Improved nutrient availability supports better vegetative growth, increases leaf and branch formation and consequently enhances leaf number, leaf area and seedling survival (Kruppaswamy and Perumal, 2013).

As depicted in Fig. 1, the crop growth rate was highest (2.43 g m^{-2} day^{-1}) in seedlings treated with 3 % *Bijamrut* (T_3). The presence of nutrient-transforming microorganisms in the formulation likely facilitated efficient nutrient uptake, leading to improved vegetative growth, increased photosynthate redistribution and higher fresh and dry weight accumulation, which collectively contributed to the enhanced crop growth rate of the seedlings.

It is evident from the data presented in Figs. 2, 3 and 4 that different seed priming treatments significantly influenced leaf area index, leaf area duration and leaf production rate at 60, 90 and 120 DAS, respectively. The highest leaf area index (0.09, 0.14, and 0.26 cm^2/plant), leaf area duration (2.76, 3.51 and 6.05 days) and leaf production rate (0.067 leaf/day/plant) were recorded in seedlings treated with 3% *Bijamrut* (T_3) at all observation periods. This improvement may be attributed to the microorganisms present in the organic formulation, which convert nutrients into forms readily absorbable by plants, enhancing nutrient use efficiency, promoting vegetative growth and increasing the number of branches and leaves. These effects contributed to higher leaf area, resulting in increased leaf area index, which, in turn, elevated leaf area duration and leaf production rate (Sreenivasa *et al*., 2009). Similar observations were reported by Sujin *et al*. (2021) in *Mangifera indica*.

It is evident from the data presented in Fig. 5 that different seed priming treatments significantly affected the net assimilation rate between 90 and 120 DAS. The highest net assimilation rate (5.73 g day^{-1} m^{-2}) was recorded in seedlings treated with 3% *Bijamrut* (T_3) during this period. This enhancement may be attributed to the production of indole-3-acetic acid (IAA) and gibberellic acid (GA) by bacteria present in *Bijamrut*, which likely stimulated seedling elongation, leading to increased fresh and dry weight (Sreenivasa *et al*., 2009). Additionally, the microorganisms in the organic formulation convert nutrients into readily absorbable forms, improving nutrient use efficiency, promoting vegetative growth and increasing the number of branches and leaves, which in turn enhanced leaf area (Sreenivasa *et al*., 2009). The combined increase in leaf area and

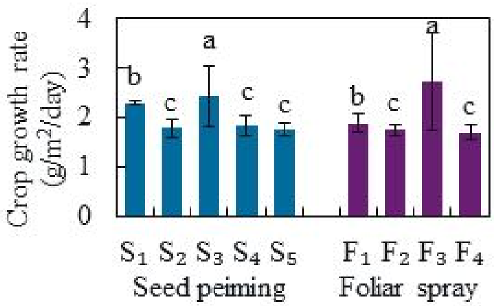

Fig. 1 : Effect of organic seed priming and foliar application on crop growth rate (g/m^2/day) of *Khirni* seedlings.

seedling dry weight contributed to the higher net assimilation rate observed in *Bijamrut* treated seedlings. Similar results were reported by Sujin *et al.* (2021) in *Mangifera indica*.

It is evident from the data presented in Fig. 6 that biomass duration was highest in seedlings treated with 3% *Bijamrut* (T_3), measuring 17.44 and 23.13 g·days/plant between 0-90 DAS and 90-120 DAS, respectively. This increase may be attributed to the production of indole-3-acetic acid (IAA) and gibberellic acid (GA) by bacteria present in *Bijamrut*, which likely stimulated seedling elongation, leading to higher fresh and dry weight accumulation and consequently, enhanced biomass duration (Sreenivasa *et al.*, 2009).

Effect of organic spray

The results presented in Table 1 demonstrate that the application of different organic sprays significantly influenced the incremental height and girth of *Khirni* seedlings. Seedlings treated with 1% Novel Organic Liquid Nutrients (F_3) exhibited the greatest increases in height (0.80, 2.53 and 5.95 cm) and girth (0.37, 0.98 and 1.64 mm) at 60, 90 and 120 DAS, respectively. This improvement can be attributed to the presence of growth-promoting substances, such as gibberellic acid (GA_3) and cytokinin, which enhance cell division and elongation, thereby contributing to greater seedling height and girth. Moreover, the nutrient-rich formulation likely facilitated better nutrient absorption, supporting overall seedling vigor. Comparable findings have been reported in banana by Gujar *et al.* (2017) and in acid lime by Patel *et al.* (2019), underscoring the positive impact of organic nutrient sprays on early seedling growth.

The data presented in Table 1 indicate that different organic sprays significantly influenced the number of leaves, leaf area, and survival percentage of *Khirni* seedlings. Among the treatments, seedlings treated with 1 % Novel Organic Liquid Nutrients (F_3) recorded the highest number of leaves (4.25, 6.59 and 8.87) and leaf area (11.64, 17.59 and 31.91 cm²) at 60, 90 and 120 DAS,

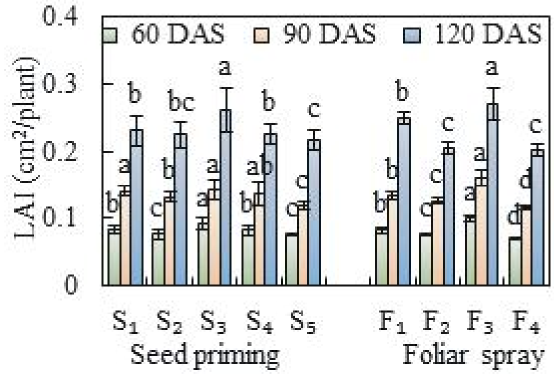

Fig. 2 : Effect of organic seed priming and foliar application on leaf area index (cm^2/plant) of *Khirni* seedlings.

respectively, along with the maximum survival rate of 81.46 % at 120 DAS. These improvements may be attributed to the nitrogen content in the formulation, which promoted vegetative growth and facilitated enhanced leaf development, greater leaf area and improved seedling survival (Gujar *et al.*, 2017).

The data presented in Fig. 1 revealed that the crop growth rate was highest (2.75 g m^{-2} day^{-1}) in seedlings treated with 1 % Novel Organic Liquid Nutrients (F_3) at 120 DAS. This increase may be attributed to the nitrogen content in the formulation, which enhanced vegetative growth, as well as the presence of plant growth regulators such as gibberellic acid (GA_3) and cytokinins, which promote cell division and elongation. The combined effect of improved nutrient availability and enhanced cellular growth likely increased the fresh and dry weight of both shoots and roots, ultimately resulting in a higher crop growth rate (Desai *et al.*, 2016). Similar trends have been reported by Thejaswini *et al.* (2020) in mango, Patel *et al.* (2019) in acid lime and Patel *et al.* (2022) in Kagzi lime.

The data presented in Figs. 2 and 3 indicate that different organic sprays significantly influenced leaf area index (LAI) and leaf area duration (LAD) of *Khirni* seedlings at 60, 90 and 120 DAS. Among the treatments, seedlings receiving 1% Novel Organic Liquid Nutrients (F_3) recorded the highest LAI (0.09, 0.16 and 0.27 cm²/plant) and LAD (3.00, 3.89 and 6.45 days) at 60, 90 and 120 DAS, respectively. These improvements may be attributed to the nitrogen content in the formulation, which enhanced vegetative growth, leading to greater leaf expansion and prolonged leaf area duration (Gujar *et al.*, 2017).

The data presented in Fig. 4 indicate that the maximum leaf production rate (0.07 leaf/day/plant) was observed in seedlings treated with 1% Novel Organic Liquid Nutrients (F_3) at 60, 90 and 120 DAS. This increase may

Table 2 : Interaction effect between seed priming and organic spray on growth and survival of *Khirni* seedlings.

Treatments	Incremental seedling height (cm)			Incremental seedling girth (mm)			Number of leaves			Leaf area (cm^2)			Survival (%)
	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	
S_1F_1	0.52	2.47	5.22	0.28	0.92	1.39	4.13	6.33	8.87	9.68	15.71	29.88	83.66
S_1F_2	0.34	1.90	4.46	0.27	0.73	1.33	3.87	5.67	8.27	9.22	13.85	25.32	72.89
S_1F_3	0.78	2.38	6.13	0.37	0.98	1.61	4.40	7.00	9.20	11.63	17.48	32.21	83.88
S_1F_4	0.26	1.70	3.74	0.25	0.70	1.17	3.80	5.67	7.80	8.36	13.09	20.35	65.11
S_2F_1	0.50	1.94	4.78	0.26	0.73	1.19	3.73	5.87	9.00	8.97	14.49	27.11	81.89
S_2F_2	0.31	1.93	4.27	0.25	0.68	1.08	3.53	5.60	7.93	7.87	13.48	23.71	70.88
S_2F_3	0.68	2.32	5.28	0.37	0.90	1.50	4.27	6.00	9.00	11.34	16.33	28.01	82.66
S_2F_4	0.24	1.60	3.49	0.19	0.63	0.99	3.53	5.07	7.53	7.92	12.50	21.52	66.22
S_3F_1	0.53	3.01	5.69	0.29	0.94	1.60	4.20	6.13	8.93	11.58	17.14	32.02	84.66
S_3F_2	0.37	2.25	4.48	0.28	0.81	1.57	3.87	5.93	8.83	9.25	14.62	26.69	80.77
S_3F_3	1.08	3.54	7.78	0.43	1.24	2.11	4.60	7.73	10.00	13.41	21.56	41.90	90.44
S_3F_4	0.30	1.70	3.85	0.26	0.78	1.36	3.87	5.87	8.47	8.68	14.75	25.84	71.11
S_4F_1	0.42	1.96	4.81	0.28	0.77	1.46	3.93	5.53	8.80	9.48	14.82	27.06	72.55
S_4F_2	0.30	1.81	4.30	0.27	0.70	1.17	3.80	5.00	7.80	8.92	14.01	25.15	65.22
S_4F_3	0.80	2.33	5.37	0.34	0.94	1.57	4.00	6.60	7.87	12.18	17.41	29.48	77.44
S_4F_4	0.25	1.68	3.52	0.25	0.64	1.13	3.80	4.87	7.60	8.19	13.22	22.78	62.55
S_5F_1	0.37	1.60	4.49	0.25	0.72	1.21	3.60	5.33	8.20	8.75	14.23	26.51	64.33
S_5F_2	0.30	1.64	3.99	0.22	0.67	1.06	3.53	5.00	7.33	7.71	13.32	22.84	62.33
S_5F_3	0.65	2.07	5.19	0.33	0.84	1.44	4.00	5.60	8.27	9.62	15.16	27.93	72.88
S_5F_4	0.19	1.27	3.26	0.17	0.58	1.05	3.47	4.77	7.27	8.04	12.47	21.19	61.11
S.Em. ±	0.011	0.051	0.125	0.008	0.019	0.045	0.076	0.184	0.231	0.228	0.513	0.898	1.840
C.D. at 5%	0.03	0.15	0.36	0.02	0.05	0.13	0.22	0.52	0.66	0.65	1.47	2.57	5.26
C.V. %	4.05	4.37	4.64	5.14	4.10	5.77	3.38	5.50	4.80	4.16	5.94	5.79	4.33

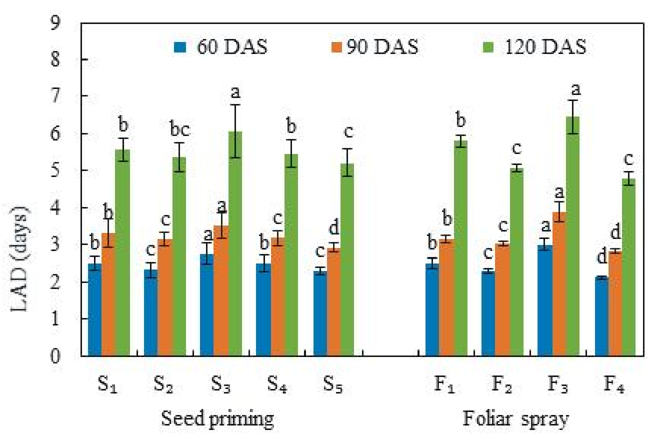

Fig. 3 : Effect of organic seed priming and foliar application on leaf area duration (days) of *Khirni* seedlings.

be attributed to the nitrogen content in the formulation, which promoted vegetative growth and consequently enhanced leaf emergence and overall leaf production (Patel *et al*., 2022).

The data presented in Fig. 5 indicate that different organic sprays had a significant effect on the net assimilation rate (NAR) between 90 and 120 DAS. The highest NAR (4.99 g day^{-1} m^{-2}) was observed in seedlings treated with 1% Novel Organic Liquid Nutrients (F_3) during this period. This increase can be attributed to the nitrogen content in the formulation, which enhanced vegetative growth, resulting in greater leaf area and higher dry matter accumulation. The combined effect of improved leaf development and biomass production contributed to the elevated net assimilation rate in F_3 treated seedlings (Gujar *et al*., 2017).

The data presented in Fig. 6 indicate that biomass duration was highest in seedlings treated with 1 % Novel Organic Liquid Nutrients (F_3), measuring 16.65 and 23.94 g·days/plant between 0-90 DAS and 90-120 DAS, respectively. This enhancement may be attributed to the nitrogen content in the formulation, which promoted vegetative growth, along with the presence of plant growth regulators such as gibberellic acid (GA_3) and cytokinins. These substances likely increased fresh and dry weight accumulation in both shoots and roots, ultimately resulting in a longer biomass duration (Desai *et al*., 2016).

Table 3 : Effect of seed priming and foliar spray on growth of *Khirni* seedlings.

Treatments	LAI (g/m^2/day)			LAD (cm^2/g)			CGR (g/m^2/day)	LPR (cm^2/g)	NAR (g/day/m^2)	BMD (g.day/plan)	
	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	60 DAS	90-120 DAS	0-90 DAS	0-90 DAS
S_1F_1	0.08	0.15	0.25	2.50	3.14	5.50	2.30	0.07	4.64	18.61	23.27
S_1F_2	0.08	0.14	0.18	2.38	2.96	5.32	2.21	0.06	4.26	14.31	19.99
S_1F_3	0.10	0.16	0.28	3.01	4.43	6.42	2.38	0.07	4.51	20.18	24.70
S_1F_4	0.07	0.12	0.22	2.16	2.77	5.06	2.27	0.06	3.90	12.84	19.30
S_2F_1	0.08	0.15	0.27	2.32	3.38	6.27	1.75	0.06	3.74	12.61	16.15
S_2F_2	0.07	0.12	0.20	2.03	2.89	4.94	1.62	0.06	4.03	10.77	14.81
S_2F_3	0.10	0.14	0.24	2.93	3.57	5.73	2.32	0.07	4.57	12.99	20.30
S_2F_4	0.07	0.12	0.19	2.05	2.77	4.52	1.49	0.06	3.06	9.53	14.24
S_3F_1	0.10	0.13	0.23	2.99	3.38	5.38	2.03	0.07	5.45	18.28	21.75
S_3F_2	0.08	0.13	0.22	2.36	3.14	5.29	1.72	0.06	5.63	14.43	17.74
S_3F_3	0.12	0.19	0.36	3.47	4.52	8.20	4.47	0.08	6.65	21.67	35.57
S_3F_4	0.07	0.13	0.23	2.24	3.03	5.35	1.52	0.06	5.20	15.38	17.46
S_4F_1	0.08	0.13	0.26	2.45	2.94	5.86	1.64	0.07	4.43	13.79	17.32
S_4F_2	0.08	0.12	0.22	2.31	3.22	5.06	1.61	0.06	3.96	12.83	15.44
S_4F_3	0.10	0.19	0.23	3.15	3.76	6.28	2.46	0.07	5.20	15.88	20.77
S_4F_4	0.07	0.11	0.20	2.12	2.87	4.65	1.67	0.06	3.53	11.54	15.47
S_5F_1	0.08	0.12	0.23	2.26	2.97	6.03	1.78	0.06	3.62	11.90	16.48
S_5F_2	0.08	0.11	0.21	2.37	2.90	4.84	1.61	0.06	3.49	9.32	13.79
S_5F_3	0.08	0.13	0.25	2.49	3.20	5.65	2.10	0.07	4.06	12.53	18.36
S_5F_4	0.07	0.11	0.18	2.08	2.65	4.35	1.60	0.06	3.27	8.75	13.56
S.Em. ±	0.001	0.004	0.007	0.043	0.078	0.155	0.054	0.01	0.123	0.300	0.460
C.D. at 5%	0.01	0.01	0.02	0.12	0.22	0.44	0.16	0.00	0.35	0.86	1.32
C.V. %	4.03	5.73	5.36	3.04	4.20	4.86	4.68	3.52	4.90	3.74	4.24

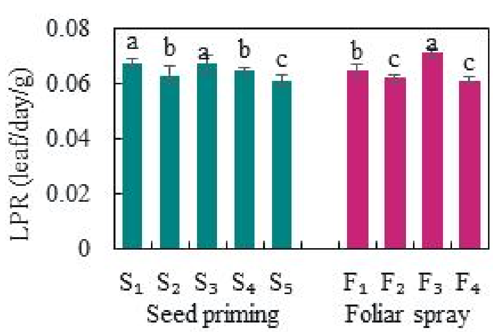

Fig. 4 : Effect of organic seed priming and foliar application on leaf production rate (leaf/day/g) of *Khirni* seedlings.

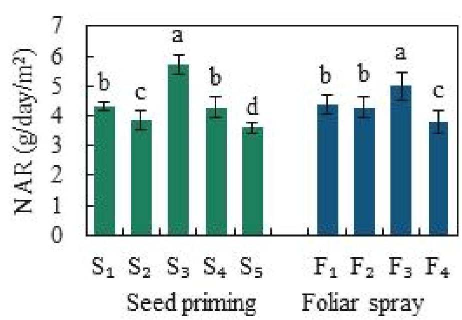

Fig. 5 : Effect of organic seed priming and foliar application on net assimilation rate (g/day/m^2) of *Khirni* seedlings.

Interaction effect

A perusal of data presented in Tables 2 and 3 clearly revealed that interaction between seed priming and organic spray was found maximum incremental seedling height (1.08, 3.54 and 7.78 cm), incremental seedling girth (0.43, 1.24 and 2.11 mm), number of leaves (4.60, 7.73 and 10.00), leaf area (13.41, 21.56 and 41.90 cm^2), leaf area index (0.12, 0.19 and 0.36 cm^2/plant) and leaf area duration (3.47, 4.52 and 8.24 days) were found when seed soaked in 3% *Bijamrut* with organic spray of 1 % Novel Organic Liquid Nutrients treatment (S_3F_3) at 60, 90 and 120 DAS, respectively.

The data presented in Tables 2 and 3 clearly indicated that interaction between seed priming and organic spray was found maximum survival (90.44%), crop growth rate

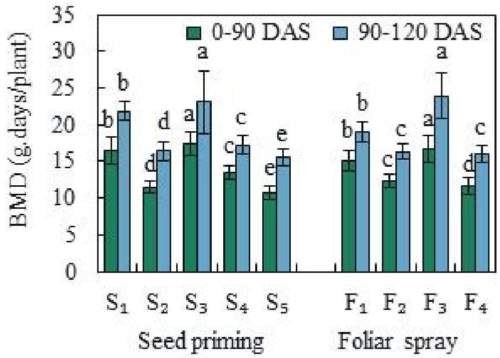

Fig. 6 : Effect of organic seed priming and foliar application on leaf production rate (g.day/plant) of *Khirni* seedlings.

(4.47 g/m^2/day), leaf production rate (0.8 leaf/day/g), net assimilation rate (6.65 g/m^2/day) between 90 - 120 DAS and biomass duration (21.67 and 35.57 g.days/plant) between 0 - 90 DAS and 90 - 120 DAS, respectively were found when seed soaked in 3% *Bijamrut* with organic spray of 1% Novel Organic Liquid Nutrients treatment (S_3F_3).

It is evident from the data presented in Tables 2 and 3 that the maximum crop growth rate, leaf area index, leaf area duration, leaf area production, net assimilation rate and biomass duration were found maximum when seed soaked in 3% *Bijamrut* and organic spray with 1% Novel Organic Liquid Nutrients (S_3F_3). Seed priming of 3% *Bijamrut* for 72 hrs. and organic spray of 1% Novel Organic liquid Nutrients at 45 and 60 DAS gave maximum growth individually. Thus, their combined effects also gave the maximum growth.

Conclusion

On the basis of results obtained from the experiments, it can be concluded that the seed priming with 3 % *Bijamrut* for 72 hours and organic spray of 1 % Novel Organic Liquid Nutrients at 45 and 60 DAS gave maximum growth of *Khirni* seedlings in their combination as well as individually.

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