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Effect of seed priming and foliar nutrition on growth, yield and quality of hydroponic fodder maize

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Abstract
A hydroponic experiment was conducted at Agricultural College and Research Institute, Killikulam from February 2022 to April 2022 to study the effect of seed priming and foliar nutrition on growth, yield and quality of fodder maize. The experiment was laid out in factorial completely randomized design with two factors. Whereas, Factor A is seed priming *viz*., hydropriming (S_1), 2% humic acid priming (S_2) and 1% moringa leaf extract priming (MLE) (S_3) and factor B is foliar nutrition such as control (F_1), humic acid (HA) @ 0.1% (F_2), vermiwash @ 20% (F_3), Azophos @ 1% (F_4) and 19:19:19 WSF @ 1% (F_5) at 5 DAS. The results of the experiment indicated that seed priming with 1% moringa leaf extract recorded the highest germination percentage (91.5%) and it was followed by 2% humic acid seed priming (83.0%). The higher growth parameters, green fodder yield and superior proximate fodder quality were recorded in 2% humic acid seed priming and it was followed by 1% MLE seed priming. With regard to foliar nutrition, 0.1% Humic acid spray at 5 DAS recorded higher growth parameters, green fodder yield and superior proximate fodder quality. On Interaction, 2% humic acid seed priming along with 0.1% Humic acid foliar spray influenced significantly and recorded higher growth parameters, higher green fodder yield and superior proximate fodder quality.

Keywords: Hydroponics, maize, seed priming, foliar nutrition

1. Introduction
Fodder production and livestock feeding are the two major components of the sustainable production and productivity of animal husbandry (Gupta, 2014) [7]. The total livestock population in India is 536.76 million which is showing an increasing trend of 4.8% over the 2012 census (Singh, 2020) [15]. There is insufficient green fodder, dry fodder and concentrates are available in India to meet the demand of animal population. Our country has 395.20 million MT of green fodder. However, the total quantity of green fodder required is roughly 1061 million MT. The deficit gap is about 665.80 million MT (62.76 per cent) of green fodder. The lack of fodder was also caused by the transition from forage crops to commercial crops (Grover *et al.*, 2012) [6]. Because of this increased human pressure on the land to produce cereal, oilseeds, and pulses hence it is difficult to increase the production of fodder. In this situation, one of the best alternative way to produce the green fodder is hydroponic fodder production to meet the demand of green fodder. Hydroponic fodder production is year-round fodder production technology for farmers who is suffering without grazing land, irrigation facilities and also facing water scarcity (Jemimah *et al.*, 2015) [9]. Hydroponic fodders are sprouted grains rich in protein, metabolizable energy and highly digestible by most animals. Seed is the major input cost in hydroponic fodder production. To minimize the seed cost we should aim to improve the germination and productivity of seeds. Priming is an approach that involves treating the seeds with different organic or inorganic chemicals and which stimulate various metabolic processes that improve germination and emergence (Pawar *et al.*, 2018) [13]. Nutrition is an important primary factor that influences the growth and development of crops and also decides the fodder yield and quality. The nutrients are required in definite proportion for optimum dry matter production (Ningoji *et al.*, 2020). [12] Hence, we aimed to study the effect of seed priming and foliar nutrition on growth, yield and quality of fodder maize under a hydroponic system.

2. Materials and Methods
2.1. Experiment site and Treatment details
A hydroponic experiment was conducted at Agricultural College and Research Institute, Killikulam during February 2022 to April 2022.

The experimental unit was situated in the Southern zone of Tamil Nadu. Which is geographically placed at 8^0 46' N latitude and 77^0 42' E longitude and an altitude of 40m above mean sea level and delineated under East Coast Plains and Hills of the agroclimatic zone of India. The low-cost hydroponic system was built with PVC pipes and the base of the pipes are concreted using cement. The system is fully covered with a High-density polyethene shade net which provides a 50% shading effect and also protects the hydroponic fodder from natural disturbances like rain, wind, frost, snow, rats and birds. The water spraying system was made by using a 0.5 hp water pumping motor, supreme PVC pipes, 16mm poly connector black lateral pipes, 6mm micro connector and 30 Litres per hour blue jet spray. The automatic spraying of water was facilitated by using a low-cost automatic timer with 16 on/off provisions per day. The perforated plastic tray dimensions of 40 cm length, 30 cm width and 5cm depth is used for this experiment. A seed rate of 4.16 Kg m^{-2} was used. Maize seeds of 80% germination were purchased from the local farm and used for this experiment. The experiment was laid out in Factorial Completely Randomized Design (FCRD) with two factors such as

Factor A (Seed priming)

S_1	:	Hydropriming
S_2	:	Seed priming with 2% Humic acid
S_3	:	Seed priming with 1% Moringa Leaf Extract (MLE)

Factor B (Foliar nutrition)

F_1	:	No foliar spray as control
F_2	:	Foliar spray of Humic acid @ 0.1% at 5 DAS
F_3	:	Foliar spray of Vermiwash @ 20% at 5 DAS
F_4	:	Foliar spray of Azophos @ 1% at 5 DAS
F_5	:	Foliar spray of 19:19:19 (water soluble) @ 1% at 5 DAS

2.2. Observations recorded

2.2.1. Growth parameters

Biometric observations *viz*., shoot length and root length were measured using biometric scale on 4 & 8 DAS and expressed in centimetres. Germination percentages was recorded for each seed priming treatment and expressed in percentage. Seedling vigour of hydroponic fodder was calculated by multiplying germination percentage with shoot length and root length (cm) at 4 & 8 DAS.

2.2.2. Green fodder yield

The hydroponic fodder was harvested at 8 DAS, weighed and expressed in Kg m^{-2}.

2.2.3. Proximate fodder quality

The proximate analysis of fodder sample *viz*., crude protein, crude fibre, crude fat, Total ash and Nitrogen Free Extract (NFE) were determined according to the standard methods and procedures recommended by AOAC (Cunniff, 2005) [3].

3. Results and discussion

3.1. Growth parameters

The observation regarding germination is presented in Table 1. Germination percentage was significantly influenced by seed priming. The maize seeds primed with 1% Moringa leaf extract recorded a higher germination of 91.5 per cent which was followed by 2% humic acid priming (83.0%). Similar results were observed by Afzal *et al*. (2012) [1] priming the maize seeds with moringa leaf extract (MLE) enhanced germination percentage. It could be due to seed priming stimulates a number of biochemical processes in the seed such as hydrolysis, enzyme activation, dormancy breaking and enhances the seed germination (Farooq *et al.*, 2010) [5].

Table 1: Effect of Seed priming and foliar nutrition on Germination percentage of hydroponic fodder maize

Treatment	Germination (%)
S_1 – Hydropriming	80.5
S_2 – Seed priming with 2% Humic acid	83.0
S_3 – Seed priming with 1% Moringa Leaf Extract	91.5
SEd	0.45
CD (0.05)	0.95

The observations regarding shoot length, root length and seedling vigour were presented in table 2 and table 3. The growth parameters such as shoot length, root length and seedling vigour were significantly influenced by seed priming at 4 DAS. Seeds primed with 2% Humic acid recorded higher shoot length (10.8 cm), root length (8.8 cm) and seedling vigour (1651) and it was followed by 1% MLE seed priming. It might be due to humic acid carried essential nutrients and water to the seeds and had a positive effect on physiological process of seeds (Sheriff, 2002) [14].

Shoot length, root length and seedling vigour were significantly influenced by seed priming and foliar nutrition at harvest. Seed priming with 2% Humic acid significantly influenced higher shoot length (30.3 cm), root length (20.0 cm) and seedling vigour (4200) and it was followed by 1% MLE seed priming. With regard to foliar nutrition, Foliar spray of Humic acid @ 0.1% at 5 DAS significantly recorded higher shoot length (30.8 cm), root length (20.3 cm) and seedling vigour (4356) and it was followed by 20% Vermiwash spray.

On interaction, combining effect of seed priming with 2% Humic acid and foliar nutrition of humic acid @ 0.1% significantly influenced and recorded higher shoot length (33.3 cm), root length (22.2 cm) and seedling vigour (4627) and it was followed by seed priming with 2% Humic acid and foliar spray of 20% vermiwash. The similar results of seedling vigour were observed by Kadhim *et al.*, (2021) [10] found that maize seeds soaked with humic acid 1 ml L^{-1} for 18 hours enhanced seedling vigour. The findings of shoot and root growth were in accordance with the study conducted by Eyheraguibel *et al.* (2008) [4] found that humic substances enhances root (25%) and shoot growth (75%) of hydroponically grown maize crop. Al-bahrani (2015) reported that, Humic acid is a major source of carbon required for the activity of microorganisms. Humic acid spraying on plants promotes the root growth and has a hormonal influence on cell protoplasm and cell walls that accelerates cell division and growth.

3.2. Green fodder yield

The observations regarding green fodder yield was presented in table 4. Green fodder yield was significantly influenced by seed priming and foliar nutrition. Seed priming with 2% humic acid significantly influenced and recorded higher green fodder yield (15.3 kg m^{-2}) and it was followed by 1% MLE seed priming**.** With regard to foliar nutrition, Foliar spraying of humic acid @ 0.1% at 5 DAS significantly recorded the

higher green fodder yield of 15.3 kg m^{-2} and it was followed by 20% Vermiwash spray.

On interaction, combining effect of seed priming with 2% Humic acid and foliar nutrition of humic acid @ 0.1% significantly influenced the higher green fodder yield and recorded 17.0 kg m^{-2} and it was followed by seed priming with 2% Humic acid and foliar spray of 20% vermiwash**.** The results were in accordance with the study conducted by Eyheraguibel *et al.* (2008) [4] to evaluate the effect of humic substances on corn seeds under hydroponic conditions. The higher green fodder yield might be due to humic acid primed seeds could utilize nutrients and water more efficiently than other seed priming agents. Also, humic acid is rich in essential nutrients and capable of stimulating growth hormones which facilitates active physiological process (Trevisan *et al.*, 2010) [16]. While combining seed priming with foliar nutrition of humic acid in maize fodders utilized the nutrients and water more efficiently and produced higher green fodder yield.

3.3. Proximate quality of fodder

The observations regarding proximate fodder quality was presented in table 4 and table 5. The proximate qualities of hydroponically grown maize fodder were significantly influenced by seed priming and foliar nutrition. Seed priming with 2% humic acid significantly influenced proximate fodder quality and recorded superior proximate quality *viz.*, crude protein (13.4%), crude fibre (12.0%), crude fat (3.4%), Total ash (2.5%) and NFE (68.7%) and it was followed by 1% MLE seed priming. With regard to foliar nutrition, foliar spray of 0.1% humic acid at 5 DAS significantly recorded superior proximate quality *viz.*, crude protein (13.4%), crude fibre (12.0%), crude fat (3.4%), Total ash (2.5%) and NFE (68.8%) it was followed by 20% Vermiwash spray.

On interaction, combination of 2% Humic acid seed priming with 0.1% foliar nutrition of humic acid significantly influenced the superior proximate fodder quality *viz.*, crude protein (14.8%), crude fibre (13.7%), crude fat (3.8%), Total ash (2.9%) and NFE (64.9%) and it is followed by Seed priming with 2% humic acid with foliar spray of 20% vermiwash. The efficient nutrient utilization could be the reason for superior fodder quality in S_2F_2 (Seed priming with 2% Humic acid + Foliar spray of Humic acid 0.1% @ 5 DAS). Jamal *et al.* (2006) [8] reported that, foliar application of nutrients will increase the yield and also improves the quality of cereal crops.

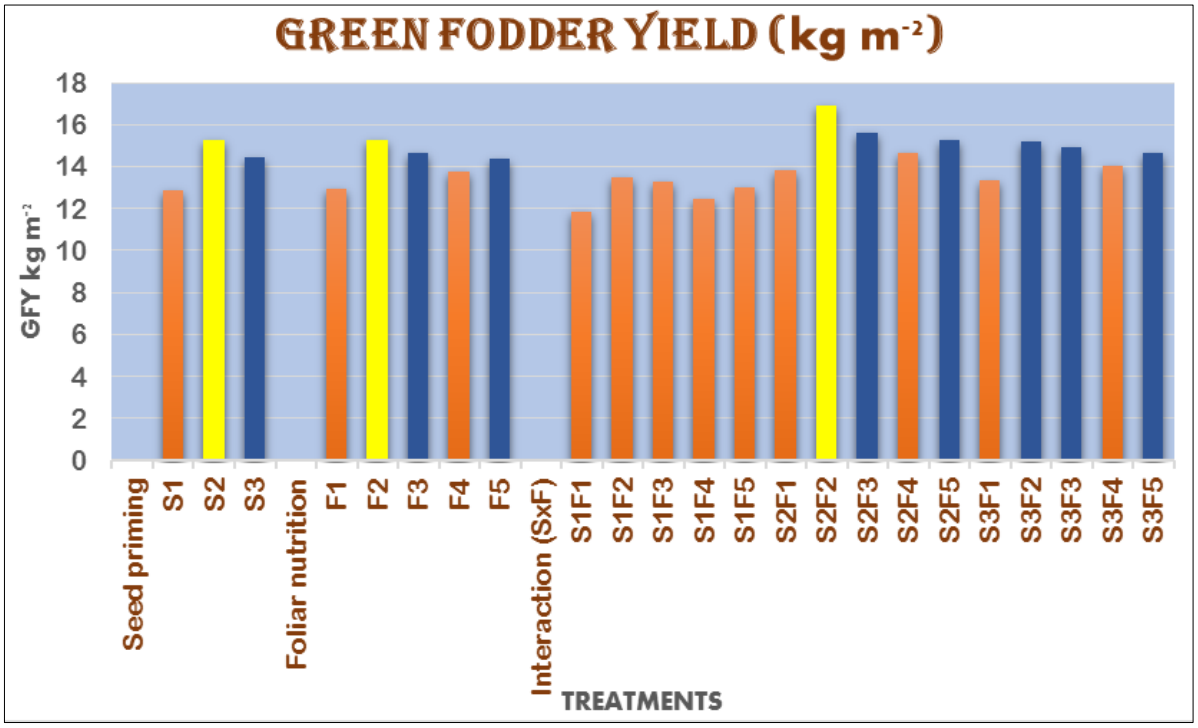

Fig 1: Effect of Seed priming and foliar nutrition on green fodder maize yield in hydroponic

Table 2: Effect of seed priming and foliar nutrition on shoot and root length of hydroponic fodder maize

Treatments	Shoot length (cm)												Root length (cm)											
	4 DAS						At harvest						4 DAS						At harvest					
	Foliar nutrition						Foliar nutrition						Foliar nutrition						Foliar nutrition					
Seed priming	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**
S_1	8.4	8.4	8.6	8.3	8.2	8.4	26.4	28.7	28.3	27.6	28.4	27.9	5.7	5.6	5.7	5.7	5.6	5.6	15.9	19.0	18.9	16.6	17.9	17.7
S_2	10.8	10.7	11.3	10.7	10.5	10.8	28.5	33.3	30.7	29.3	29.8	30.3	8.9	8.7	8.8	8.9	8.8	8.8	17.7	22.2	20.7	19.1	20.4	20.0
S_3	9.8	9.4	9.7	9.5	9.8	9.6	27.6	30.4	30.1	29.0	30.0	29.4	6.1	6.0	6.1	6.1	6.0	6.1	17.0	19.6	19.2	17.6	18.1	18.3
Mean	9.7	9.5	9.9	9.5	9.5		27.5	30.8	29.7	28.6	29.4		6.9	6.8	6.9	6.9	6.8		16.9	20.3	19.6	17.8	18.8	
	S	F	S x F				S	F	S x F				S	F	S x F				S	F	S x F			
SEd	0.1	0.2	0.3				0.2	0.2	0.4				0.3	0.4	0.6				0.1	0.1	0.2			
CD(p=0.05)	0.3	NS	NS				0.3	0.6	0.9				0.6	NS	NS				0.2	0.2	0.4			

Table 3: Effect of Seed priming and foliar nutrition on seedling vigour of hydroponic fodder maize

Treatments	Seedling vigour											
	4 DAS						At harvest					
	Foliar nutrition						Foliar nutrition					
Seed priming	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**
S_1	1136	1135	1156	1136	1113	1135	3419	3852	3809	3572	3736	3678
S_2	1661	1629	1692	1650	1623	1651	3853	4627	4288	4041	4192	4200
S_3	1467	1413	1453	1433	1458	1444	4096	4589	4526	4277	4411	4380
Mean	1421	1392	1433	1406	1398		3789	4356	4208	3963	4113	
	S	F	S x F				S	F	S x F			
SEd	31.4	66.9	70.2				11.4	14.7	25.5			
CD (p=0.05)	66.9	NS	NS				24.3	31.3	54.3			

Table 4: Effect of Seed priming and foliar nutrition on yield and proximate quality of hydroponic fodder maize

Treatments	Green fodder yield (Kg m^{-2})						Crude protein (%)						Crude fat (%)						Crude fibre (%)					
	Foliar nutrition						Foliar nutrition						Foliar nutrition						Foliar nutrition					
Seed priming	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**
S_1	11.9	13.6	13.3	12.5	13.1	12.9	10.4	11.9	11.7	11.0	11.4	11.3	2.7	3.0	3.0	2.8	2.9	2.9	8.6	10.3	10.0	9.2	9.8	9.6
S_2	13.9	17.0	15.6	14.7	15.3	15.3	12.1	14.8	13.7	12.8	13.4	13.4	3.1	3.8	3.5	3.3	3.4	3.4	10.6	13.7	12.3	11.4	12.0	12.0
S_3	13.4	15.3	15.0	14.1	14.7	14.5	11.7	13.4	13.1	12.3	12.9	12.7	3.0	3.4	3.3	3.1	3.3	3.2	10.1	12.0	11.7	10.8	11.4	11.2
Mean	13.0	15.3	14.7	13.8	14.4		11.4	13.4	12.8	12.0	12.6		2.9	3.4	3.3	3.1	3.2		9.7	12.0	11.4	10.5	11.1	
	S	F	S x F				S	F	S x F				S	F	S x F				S	F	S x F			
SEd	0.0	0.1	0.1				0.0	0.1	0.1				0.01	0.01	0.02				0.0	0.1	0.1			
CD (p=0.05)	0.1	0.1	0.2				0.1	0.1	0.2				0.02	0.03	0.04				0.1	0.1	0.2			

Table 5: Effect of Seed priming and foliar nutrition on proximate of hydroponic fodder maize

Treatments	Total ash (%)						NFE (%)					
	Foliar nutrition						Foliar nutrition					
Seed priming	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**	**F_1**	**F_2**	**F_3**	**F_4**	**F_5**	**Mean**
S_1	1.8	2.2	2.1	1.9	2.1	2.0	76.6	72.7	73.3	75.1	73.8	74.3
S_2	2.2	2.9	2.6	2.4	2.5	2.5	72.0	64.9	67.9	70.2	68.6	68.7
S_3	2.1	2.5	2.5	2.3	2.4	2.4	73.1	68.8	69.4	71.5	70.1	70.6
Mean	2.1	2.5	2.4	2.2	2.3		73.9	68.8	70.2	72.3	70.8	
	S	F	S x F				S	F	S x F			
SEd	0.01	0.01	0.02				0.1	0.1	1.8			
CD(p=0.05)	0.02	0.03	0.04				0.2	0.3	3.9			

4. Conclusion

Humic acid application through both seed priming and foliar nutrition at 5 DAS to fodder maize grown under hydroponic conditions significantly recorded higher root length, shoot length, seedling vigour, green fodder yield and superior proximate qualities. Based on this study it has been concluded that, Seed priming with 2% Humic acid and foliar nutrition with either 0.1% humic acid or 20% vermiwash or 1% 19:19:19-WSF at 5 DAS is the effective method to increase the growth, yield and quality of hydroponic fodder maize. However, considering the enhancement in germination 1% MLE proved to be best than other seed priming method.

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