



Influence of nutrient sources and spray schedule on growth, dry matter accumulation, yield, quality and economics of hydroponic fodder maize

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ABSTRACT

The experiment was conducted at AICRP for Dry Land Agriculture, University of Agricultural Sciences, GKVK, Bengaluru to study the influence of nutrient sources and spray schedule on growth, dry matter accumulation, yield, quality and economics of hydroponic fodder maize during 2017–18. The experiment was laid in Completely Randomized Design with factorial concept with three replications each using four different nutrient sources (urea @ 1%, MOP @ 1%, urea and MOP each @ 1% and 19:19:19 @ 1%) and two levels of spray schedules (one spray at 6 DAS and two sprays at 3 and 10 DAS) and no spray was taken as control. The results revealed that two sprays of urea and MOP each @ 1% at 3 and 10 DAS recorded significantly higher shoot length, root length, total dry matter accumulation, fodder yield and superior quality parameters, viz. crude protein, total carbohydrates and crude fibre. Higher returns (₹ 204/m²) and B : C ratio (2.41) were noticed with same treatment combinations and accounted for 17.22% higher fodder yield over control.

Keywords: Fodder maize, Foliar spray, Fresh fodder yield, Hydroponics, Nutrient source

In India, livestock plays an important role for nutritional and livelihood security of small and marginal farmers. The increased livestock population demands higher fodder in the country. The scarcity of water due to erratic rainfall distribution and land allocation for cultivation of green fodder leads to reduced productivity of livestock. In recent years, India has experienced shortage of feed for livestock due to shortage of water and frequent droughts. Therefore hydroponic technology can improve the water use efficiency and productivity under limited available water resources. Hydroponically grown fodders are rich in vitamins, minerals, enzymes and contains about 85 to 90% digestible protein. Sprouting of grains increases the enzymatic activity, total protein and changes in amino acid profile, sugars, crude fibre, certain vitamins and minerals and decrease starch (Lorenz 1980). Maize is an important cereal having diversified usage. Nutrition is an important primary factor which influences the growth and development of crop and also decides the crop yield. These nutrients are required in definite proportion for optimum dry matter production. Hence, an experiment on influence of nutrient sources and spray schedule on growth yield, quality and economics of hydroponic fodder maize was conducted.

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MATERIALS AND METHODS

The experiment was conducted at hydroponic fodder production facility at AICRP for Dryland Agriculture, UAS, GKVK, Bengaluru during 2017–18 and was laid out with Completely Randomized Design with factorial concept in three replications having four different nutrient sources (urea @ 1%, MOP @ 1%, urea and MOP each @ 1% and 19:19:19 @ 1%) and 2 levels of spray schedules (one spray at 6 DAS and two sprays at 3 and 10 DAS) and no spray was taken as control. Experiment was conducted in two batches; the first batch was in the month of November 2017 and second batch during January 2018. The fodder growth unit consisted 30 trays, made with vinyl fibre of dimensions 2.5×1.5×0.15 ft. The seed rate of 2.5 kg/m² was adopted in the study. Seeds were soaked in water for a day and incubated for germination in gunny cloth bags. Germinated seeds were sown on trays and allowed to grow for 14 days. The automated fogging was adopted in the study and the automation was set at an interval of 1 min for every 2 h. Water soluble fertilizers were used for the foliar spray included urea, MOP and 19 : 19 : 19. One gram of water soluble fertilizer was dissolved in 100 ml of water and made in to 1% solution. For each tray, 100 ml of 1% solution of fertilizer was sprayed with hand sprayer on 3 DAS, 6 DAS and 10 DAS according to treatment schedule. Fodder was harvested at 14th day from each treatment, converted into metre basis and expressed as kilograms. The data pertaining

to growth parameters, viz. shoot length, root length, seedling vigour, dry matter accumulation were recorded with five plants taken randomly from each treatments at 5, 10 DAS and at harvest. Seedling vigour was calculated as per the formula given by Abdul and Anderson (1973).

Seedling vigour index = Germination (%) $\times$ Seedling length (cm)

Yield parameters were recorded by taking samples at harvest. The randomly selected samples were first dried under shade and then in oven at 60°C till attaining constant weight on the basis of weight of these samples. The green fodder maize yield was converted into dry matter yield (kg/m²). The crude protein was calculated by multiplying nitrogen content with factor 6.25 (Crompton and Harris 1969). The crude fibre was analysed with successive acid alkali digestion and washing method (AOAC 2000). The total carbohydrate was estimated by anthrone method (Hedge and Hofreiter 1962). The experimental data obtained were statistically analysed as mentioned by Gomez and Gomez (1984) at 1% probability level. CRD design with factorial concept at Two way analysis of variance (ANOVA) was worked out to elicit the individual effect of nutrient source and spray schedule considering 8 treatment combinations (4 nutrient sources $\times$ 2 spray schedules) besides one way ANOVA for 9 treatments including control

for comparison.

RESULTS AND DISCUSSION

The experiment was conducted in two batches. The pooled data of two batches are presented considering the similarities in results during both the batches.

Growth parameters of fodder maize as influenced by nutrition under hydroponics: Shoot length of hydroponically grown maize was significantly higher with combined foliar spray of urea and MOP each @ 1% as compared to MOP @ 1% spray. Among spray schedules, shoot length was significantly higher with two foliar spray of nutrients at 3 and 10 DAS compared to one spray at 6 DAS. Root length was significantly higher with foliar application of urea and MOP each @ 1% as compared to urea @ 1% spray. Among spray schedules, root length was significantly higher with two spray of foliar nutrients at 3 and 10 DAS compared to one foliar spray at 6 DAS. Among interactions, significantly higher root length was recorded with two foliar spray of urea and MOP each @ 1% at 3 and 10 DAS as compared to control. (Table 1). The interaction effect of source of nutrient and spray schedule is non-significant. Application of nitrogen and potassium increased the shoot length due to improved meristematic activity in terms of increased cell division and elongation. Greater cell

Table 1. Growth parameters of fodder maize as influenced by foliar nutrition under hydroponics

Treatment	Shoot length (cm)			Root length (cm)			Seedling vigour		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
<i>Nutrient source</i>									
A ₁ : Urea @ 1%	31.31	30.82	31.07	27.28	27.18	27.23	5569	5502	5536
A ₂ : MOP @ 1%	29.66	30.78	30.22	27.09	27.57	27.33	5415	5572	5494
A ₃ : Urea @ 1% and MOP @ 1%	32.08	32.39	32.23	28.64	28.96	28.80	5788	5861	5824
A ₄ : 19:19:19 @ 1%	30.19	30.87	30.53	27.75	27.81	27.78	5536	5569	5553
SEm.±	0.44	0.32	0.27	0.30	0.31	0.22	56.39	36.68	33.63
CD @ 1%	1.84	1.32	1.06	1.23	1.30	0.84	232.93	151.50	130.26
<i>Spray schedule</i>									
B ₁ : One spray at 6 DAS	29.51	30.46	29.98	27.24	27.31	27.27	5403	5483	5443
B ₂ : Two spray at 3 and 10 DAS	32.10	31.98	32.04	28.15	28.45	28.30	5751	5769	5760
SEm.±	0.31	0.23	0.19	0.21	0.22	0.15	39.87	25.93	23.78
CD @ 1%	1.30	0.93	0.75	0.87	0.92	0.59	164.71	107.12	92.11
<i>Interaction (A$\times$B)</i>									
A ₁ B ₁	30.19	30.29	30.24	27.25	26.86	27.06	5460	5421	5441
A ₁ B ₂	32.43	31.36	31.89	27.31	27.50	27.41	5679	5583	5631
A ₂ B ₁	28.71	30.24	29.47	27.94	27.58	27.76	5395	5497	5446
A ₂ B ₂	30.61	31.33	30.97	26.24	27.56	26.90	5435	5647	5541
A ₃ B ₁	30.31	31.15	30.73	26.93	27.95	27.44	5452	5639	5546
A ₃ B ₂	33.84	33.63	33.74	30.35	29.96	30.16	6123	6083	6103
A ₄ B ₁	28.83	30.15	29.49	26.82	26.86	26.84	5304	5373	5339
A ₄ B ₂	31.54	31.59	31.57	28.68	28.77	28.72	5768	5766	5767
SEm.±	0.63	0.45	0.39	0.42	0.44	0.31	79.75	51.87	47.57
CD @ 1%	NS	NS	NS	1.73	NS	1.18	329.41	NS	184.21
Control	27.76	28.34	28.05	26.67	26.08	26.38	5156	5158	5157
SEm.±	0.69	0.45	0.42	0.40	0.46	0.31	81.86	50.00	48.64
CD @ 1%	2.80	1.81	1.60	1.61	1.88	1.19	333.22	203.55	187.37

cm, centimetres; DAS: days after sowing; MOP, murite of potash.

elongation resulted in increased shoot length. Nitrogen plays a role in protein synthesis and translocation of growth hormones and act as stimuli for triggering growth and development. This is in line with the findings of Mutum and Surve (2017a) and Gunasekaran *et al.* (2017).

Yield parameters: Combined application of urea and MOP each @ 1% recorded significantly higher fodder maize yield as compared to individual spray MOP @ 1% spray. Foliar spray with different nutrients at 3 and 10 DAS recorded significantly higher fodder maize yield as compared to one spray at 6 DAS (Table 2). Significantly higher fodder yield of maize was recorded with the two combined sprays of urea and MOP each @ 1% at 3 and 10 DAS as compared to control. The dry matter accumulation at harvest was significantly higher with combined foliar spray of urea and MOP each @ 1% compared to MOP @ 1% spray. Among spray schedules, significantly higher dry matter was recorded with two sprays of foliar nutrients at 3 and 10 DAS as compared one spray at 6 DAS. The interaction effect was found significant on dry matter accumulation at harvest. At harvest, significantly higher dry matter accumulation was recorded with two foliar spray of urea and MOP each @ 1% at 3 and 10 DAS as compared to control. Increased fodder yield of maize is associated

with combined spray of urea and MOP each at 1% is mainly due to combined application of nitrogen and potassium which had cumulative effect on growth and development of fodder maize. Nitrogen plays a dominant role in the meristematic activity and cell division which in turn increased the number of cells leading to improved vegetative growth and dry matter accumulation, whereas potassium was activates enzymes which are involved in protein synthesis and carbohydrate translocation which might have helped for vigorous root development, growth and development of plant leading to increased fodder yield. Mutum and Surve (2017b) also stated that application of foliar nutrients increased fodder yield of white and yellow maize significantly compared to control.

Fresh weight of green fodder (g/m^2): Significantly higher shoot, root and total fresh weight were obtained with combined foliar application of urea and MOP each @ 1% as compared MOP @ 1% spray (Table 3). The combined spray of urea and MOP each @ 1% recorded 22.02% higher total fresh yield than control. The higher shoot length and root length also lead to increased dry matter accumulation. Two foliar sprays of nutrients at 3 and 10 DAS recorded 1.25 times higher total fresh weight compared to control. Application of nutrients two times in growth cycle meets

Table 2. Yield, yield per kg seed and dry matter accumulation of fodder maize as influenced by foliar nutrition under hydroponics

Treatment	Yield (kg/m^2)			Yield/kg seed (kg)			Dry matter accumulation (g/m^2)		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
<i>A: Nutrient source</i>									
A ₁ : Urea @ 1%	12.08	12.40	12.24	4.83	4.96	4.90	4547	4462	4505
A ₂ : MOP @ 1%	11.83	11.90	11.87	4.73	4.76	4.75	4392	4368	4380
A ₃ : Urea @ 1% and MOP @ 1%	13.19	13.31	13.25	5.28	5.33	5.30	4620	4639	4629
A ₄ : 19:19:19 @ 1%	12.26	12.28	12.27	4.90	4.91	4.91	4575	4474	4525
SEm $\pm$	0.16	0.14	0.11	0.06	0.06	0.04	41.52	43.29	29.99
CD @ 1%	0.66	0.57	0.41	0.26	0.23	0.16	171.51	178.81	116.15
<i>B: Spray schedule</i>									
B ₁ : One spray at 6 DAS	12.01	12.00	12.00	4.80	4.80	4.80	4362	4372	4367
B ₂ : Two spray at 3 and 10 DAS	12.67	12.95	12.81	5.07	5.18	5.12	4705	4599	4652
SEm $\pm$	0.11	0.10	0.07	0.05	0.04	0.03	29.36	30.61	21.21
CD @ 1%	0.47	0.40	0.29	0.19	0.16	0.12	121.27	126.44	82.13
<i>Interaction (AxB)</i>									
A ₁ B ₁	11.70	11.57	11.64	4.68	4.63	4.65	4340	4405	4373
A ₁ B ₂	12.47	13.23	12.85	4.99	5.29	5.14	4755	4518	4637
A ₂ B ₁	11.60	11.67	11.63	4.64	4.67	4.65	4257	4288	4273
A ₂ B ₂	12.07	12.13	12.10	4.83	4.85	4.84	4526	4448	4487
A ₃ B ₁	12.60	12.54	12.57	5.04	5.02	5.03	4340	4365	4352
A ₃ B ₂	13.78	14.09	13.93	5.51	5.64	5.57	4899	4914	4907
A ₄ B ₁	12.14	12.22	12.18	4.85	4.89	4.87	4509	4430	4470
A ₄ B ₂	12.38	12.35	12.36	4.95	4.94	4.95	4641	4517	4579
SEm $\pm$	0.23	0.20	0.15	0.09	0.08	0.06	58.72	61.22	42.41
CD @ 1%	NS	0.81	0.58	NS	0.32	0.23	NS	252.87	164.26
Control	11.57	11.48	11.53	4.63	4.59	4.61	4010	3997	4003
SEm $\pm$	0.22	0.20	0.15	0.09	0.08	0.06	58.61	63.94	43.98
CD @ 1%	0.91	0.82	0.59	0.36	0.33	0.23	238.58	260.28	169.43

cm, centimetres; DAS, days after sowing; MOP, murite of potash.

Table 3. Fresh weight of different parts (g/m²) of fodder maize as influenced by foliar nutrition under hydroponics

Treatment	Shoot			Root			Seed			Total		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
<i>Nutrient source</i>												
A ₁ : Urea @ 1%	7090	6680	6885	2813	2817	2815	2756	2772	2764	12659	12269	12464
A ₂ : MOP @ 1%	6443	6673	6558	2643	2694	2669	2791	2899	2845	11877	12267	12072
A ₃ : Urea @ 1% and MOP @ 1%	7256	7517	7387	3009	3063	3036	2876	2872	2874	13141	13452	13297
A ₄ : 19:19:19 @ 1%	6714	6812	6763	2890	2919	2905	2779	2802	2790	12383	12533	12458
SEm.±	139.93	115.65	90.77	60.53	53.96	40.54	24.43	41.16	23.93	174.34	119.81	105.77
CD @ 1%	577.99	477.69	351.52	250.02	222.87	157.01	NS	NS	NS	720.12	494.90	409.63
<i>Spray schedule</i>												
B ₁ : One spray at 6 DAS	6419	6739	6579	2651	2770	2710	2798	2823	2810	11867	12332	12100
B ₂ : Two spray at 3 and 10 DAS	7332	7102	7217	3027	2977	3002	2804	2850	2827	13163	12929	13046
SEm.±	98.94	81.77	64.18	42.80	38.15	28.67	17.28	29.10	16.92	123.28	84.72	74.79
CD @ 1%	408.70	337.78	248.56	176.79	157.59	111.02	NS	NS	NS	509.20	349.95	289.65
<i>Interaction (A×B)</i>												
A ₁ B ₁	6455	6809	6632	2569	2645	2607	2774	2724	2749	11797	12178	11988
A ₁ B ₂	7725	6552	7138	3058	2989	3024	2738	2820	2779	13521	12361	12941
A ₂ B ₁	6134	6542	6338	2512	2631	2571	2752	2883	2818	11399	12055	11727
A ₂ B ₂	6752	6805	6779	2774	2758	2766	2830	2915	2873	12356	12478	12417
A ₃ B ₁	6705	7166	6935	2744	2919	2831	2855	2832	2843	12303	12916	12610
A ₃ B ₂	7808	7869	7838	3274	3208	3241	2897	2911	2904	13979	13988	13984
A ₄ B ₁	6383	6441	6412	2779	2885	2832	2809	2851	2830	11971	12178	12075
A ₄ B ₂	7045	7183	7114	3002	2952	2977	2749	2752	2751	12795	12888	12841
SEm.±	197.89	163.55	128.36	85.60	76.30	57.34	34.55	58.21	33.85	246.55	169.44	149.58
CD @ 1%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control	5304	5657	5480	1961	2304	2132	2756	2756	2756	10021	10717	10369
SEm.±	198.74	215.31	148.58	102.29	72.55	63.59	34.14	58.55	34.37	235.07	229.22	166.49
CD @ 1%	809.00	876.46	572.35	416.38	295.35	244.96	NS	NS	NS	956.91	933.09	641.34

the nutrient requirements at different growth stages of the crop. The higher total fresh weight of fodder was obtained due to higher weight of shoot and root in the respective treatment. The interaction effect of different nutrient source and spray schedule was found non-significant for fresh weight of different parts of fodder. This is in conformity with Mutum and Surve (2017b).

Dry matter accumulation (g/m²): Dry matter accumulation at harvest was significantly higher with two sprays of foliar nutrients at 3 and 10 DAS as compared to one spray at 6 DAS. Similar trend was also observed during 5 and 10 DAS (Table 4). The higher dry matter accumulation with spray schedule at 3 and 10 DAS may be due to the application of foliar nutrients at initial and later growth stages which might lead to better growth and development due to synchronized nutrient application as per crop demand and in turn increased dry matter accumulation.

There is no significant influence among interaction of foliar treatments and spray schedule on dry matter production at 5 and 10 DAS. The interaction effect of different source of nutrient and spray schedule was found significant on dry matter accumulation at harvest. At harvest, significantly higher dry matter accumulation was recorded with two foliar spray of urea and MOP each @

1% at 3 and 10 DAS as compared to control. The combined foliar spray of urea and MOP at 3 and 10 DAS have additive effect in dry matter accumulation because of supply of required nutrient at required time leading to higher nutrient assimilation, which in turn increased the photosynthates accumulation and their distribution to the different plant parts (Naik *et al.* 2014).

Significantly higher shoot, root and total dry matter accumulation at harvest was recorded with combined foliar spray of urea and MOP each @ 1% as compared to MOP @ 1% foliar spray (Fig. 1). Two foliar spray of nutrients at 3 and 10 DAS recorded significantly higher shoot, root and total dry matter accumulation as compared to one foliar spray of nutrients at 6 DAS. The interaction effect of nutrient source and spray schedule significantly influenced the dry matter accumulation in shoot and their total at harvest, significantly higher dry matter accumulation in shoot and their total was recorded with two sprays of urea and MOP each @ 1% at 3 and 10 DAS as compared to control. Higher dry matter accumulation in shoot and root was resultant of higher photosynthesis and effective translocation of photosynthates because nitrogen enhances the chlorophyll content and photosynthesis, whereas potassium enhances the effective translocation of photosynthates. Hence,

Table 4. Dry matter production (g/m²) of fodder maize at different growth stages as influenced by foliar nutrition under hydroponics

Treatment	5 DAS			10 DAS			At harvest		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
A: Nutrient source									
A ₁ : Urea @ 1%	3782	3795	3788	4273	4283	4278	4547	4462	4505
A ₂ : MOP @ 1%	3576	3665	3621	4250	4161	4205	4392	4368	4380
A ₃ : Urea @ 1% and MOP @ 1%	3907	3914	3910	4386	4370	4378	4620	4639	4629
A ₄ : 19:19:19 @ 1%	3765	3823	3794	4259	4261	4260	4575	4474	4525
SEm.±	34.40	25.89	21.53	27.15	31.33	20.73	41.52	43.29	29.99
CD @ 1%	142.08	106.94	83.37	112.14	129.41	80.27	171.51	178.81	116.15
B: Spray schedule									
B ₁ : One spray at 6 DAS	3668	3738	3703	4136	4153	4144	4362	4372	4367
B ₂ : Two spray at 3 and 10 DAS	3847	3860	3853	4448	4384	4416	4705	4599	4652
SEm.±	24.32	18.31	15.22	19.20	22.15	14.66	29.36	30.61	21.21
CD @ 1%	100.47	75.62	58.95	79.29	91.51	56.76	121.27	126.44	82.13
Interaction (A×B)									
A ₁ B ₁	3641	3721	3681	4101	4135	4118	4340	4405	4373
A ₁ B ₂	3923	3869	3896	4445	4430	4438	4755	4518	4637
A ₂ B ₁	3462	3546	3504	4060	4059	4060	4257	4288	4273
A ₂ B ₂	3691	3784	3737	4440	4262	4351	4526	4448	4487
A ₃ B ₁	3847	3880	3863	4289	4253	4271	4340	4365	4352
A ₃ B ₂	3968	3947	3958	4483	4486	4485	4899	4914	4907
A ₄ B ₁	3723	3806	3765	4093	4165	4129	4509	4430	4470
A ₄ B ₂	3807	3839	3823	4425	4357	4391	4641	4517	4579
SEm.±	48.64	36.61	30.44	38.39	44.31	29.31	58.72	61.22	42.41
CD @ 1%	NS	NS	NS	NS	NS	NS	NS	252.87	164.26
Control	3547	3603	3575	3920	3789	3855	4010	3997	4003
SEm.±	48.73	38.24	31.41	48.53	84.42	49.38	58.61	63.94	43.98
CD @ 1%	198.36	155.68	121.00	197.57	343.65	190.21	238.58	260.28	169.43

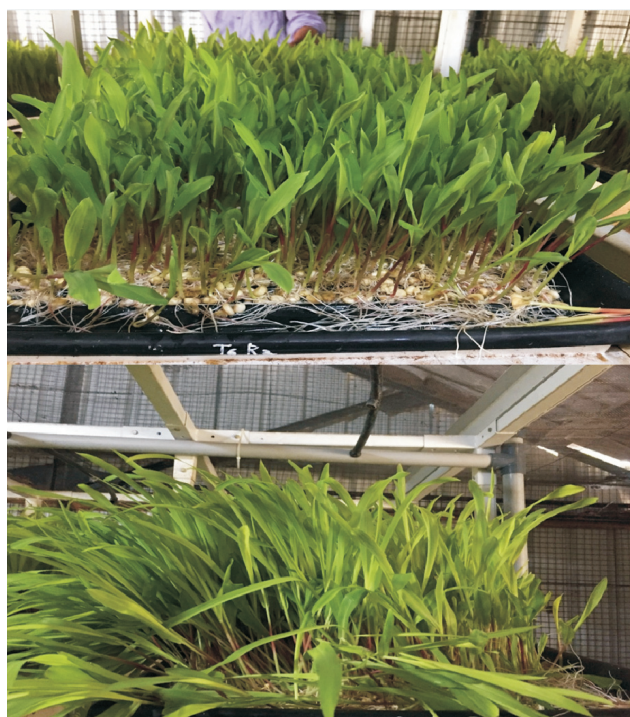


Fig. 1. Appearance of fodder maize grown in hydroponic condition with foliar spray of urea and MOP each @ 1% at 3 and 10 DAS

combined foliar spray of nutrients increased the dry matter accumulation. This is in conformity with the results reported by Gunasekaran *et al.* (2017).

Quality parameters

Crude protein (%): Significantly higher crude protein content was recorded with foliar spray of urea and MOP each @ 1% as compared to MOP @ 1%, which is at par with urea @ 1%. Among different spray schedules, two sprays at 3 and 10 DAS recorded significantly higher crude protein as compared to one spray at 6 DAS (Table 5). The increase in nitrogen content increased the amount of crude protein in the seedlings. The interaction effects are non-significant with respect to crude protein in the seedlings at harvest with different source of nutrients and spray schedule. The higher crude protein was recorded with two sprays of urea and MOP each @ 1% at 3 and 10 DAS and lower potassium content was noticed with control. This was mainly attributed to availability and uptake of nitrogen and thereby corresponding increase in protein content of herbage. Apart from this, nitrogen plays an important role in plant metabolism as a constituent of amino acids (DNA and RNA), it transfers genetic transformation and regulates cellular metabolism of amino acids and protein that form structural units and biological catalyst of phosphorylated compounds which are involved in energy transformation.

Table 5. Quality parameters of fodder maize at harvest as influenced by foliar nutrition under hydroponics

Treatment	Crude protein (%)			Crude fibre (%)			Total carbohydrates (%)		
	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled	Batch 1	Batch 2	Pooled
A: Nutrient source									
A ₁ : Urea @ 1%	14.51	15.43	14.97	11.10	11.12	11.11	65.74	63.36	64.55
A ₂ : MOP @ 1%	12.88	13.12	13.00	12.26	11.89	12.07	62.03	63.13	62.58
A ₃ : Urea @ 1% and MOP @ 1%	16.16	16.31	16.24	13.16	13.38	13.27	67.54	66.61	67.07
A ₄ : 19:19:19 @ 1%	13.15	13.67	13.41	12.30	12.38	12.34	63.67	62.92	63.30
SEm. ±	0.65	0.54	0.42	0.24	0.36	0.22	0.85	0.60	0.52
CD @ 1%	2.67	2.21	1.63	1.00	1.48	0.84	3.50	2.47	2.01
B: Spray schedule									
B ₁ : One spray at 6 DAS	13.23	13.75	13.49	11.77	11.63	11.70	63.34	63.49	63.42
B ₂ : Two spray at 3 and 10 DAS	15.12	15.52	15.32	12.65	12.75	12.70	66.15	64.51	65.33
SEm.±	0.46	0.38	0.30	0.17	0.25	0.15	0.60	0.42	0.37
CD @ 1%	1.89	1.56	1.15	0.71	1.05	0.59	2.48	NS	1.42
Interaction (A×B)									
A ₁ B ₁	13.30	14.43	13.86	10.91	10.62	10.77	64.46	62.76	63.61
A ₁ B ₂	15.71	16.44	16.08	11.29	11.61	11.45	67.03	63.95	65.49
A ₂ B ₁	12.43	12.54	12.48	11.74	11.23	11.49	61.66	63.15	62.40
A ₂ B ₂	13.34	13.69	13.52	12.78	12.54	12.66	62.41	63.12	62.77
A ₃ B ₁	14.29	15.07	14.68	12.60	12.45	12.53	65.18	66.02	65.60
A ₃ B ₂	18.03	17.56	17.79	13.71	14.30	14.01	69.89	67.19	68.54
A ₄ B ₁	12.89	12.95	12.92	11.81	12.20	12.01	62.08	62.05	62.06
A ₄ B ₂	13.42	14.38	13.90	12.79	12.57	12.68	65.27	63.79	64.53
S. Em.±	0.91	0.76	0.59	0.34	0.51	0.31	1.20	0.85	0.73
CD @ 1%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control	11.20	11.61	11.40	10.64	10.54	10.59	59.51	60.42	59.96
SEm.±	0.87	0.73	0.57	0.35	0.49	0.30	1.18	0.81	0.73
CD @ 1%	3.52	2.96	2.21	1.43	1.98	1.17	4.79	3.31	2.79

cm, centimetres; DAS, days after sowing; MOP, murite of potash.

It is a major structural constituent of cell wall thus increasing the quality of fodder by improving the protein content. Hence, increased dosage of nitrogen increased the crude protein. It is also due to the increased supply of nitrogen by repetitive application of nitrogen at different growth stages lead to higher nitrogen uptake thereby increased the crude protein. This is in conformity with the findings reported by Naik *et al.* (2014).

Crude fibre (%): At harvest, significantly higher crude fibres was recorded with combined foliar spray of urea and MOP each @ 1% as compared to urea @ 1% and it was at par with 19:19:19 @ 1%. Among different spray schedules, two sprays at 3 and 10 DAS recorded significantly higher crude fibre compared to one spray at 6 DAS. The interaction effect is non-significant with respect to crude fibre at harvest. The higher crude fibre was recorded with two sprays of urea and MOP each @ 1% at 3 and 10 DAS and lower crude fibre was noticed with control (Table 5). The crude fibre content decreased significantly with increased nitrogen levels was mainly due to rapid synthesis of carbohydrates which are converted into proteins and only smaller portion is available for cell wall and might decreased pectin, cellulose and hemi cellulose contents, which are the major constituents of crude fibre. This is in conformity with the results reported by Naik *et al.* (2014).

Total carbohydrates: The total carbohydrate was significantly higher with combined application of urea and MOP each @ 1% as compared to MOP @ 1% and followed by urea @ 1% and 19:19:19 @ 1% (Table 5). Among different spray schedules, two sprays at 3 and 10 DAS recorded significantly higher total carbohydrates compared to one spray at 6 DAS. Non-significant results were obtained among interactions of different source of nutrients and spray schedule. The higher total carbohydrate was recorded with two sprays of urea and MOP each @ 1% at 3 and 10 DAS and lower total carbohydrates was recorded with control. The higher total carbohydrate is mainly due to increased nitrogen content leading to rapid synthesis of carbohydrates, because nitrogen is integral part of nitrogenous bases which are involved in the carbohydrate synthesis.

Economics: The economics of hydroponically grown fodder maize among different nutrient sources and spray schedule are given in Table 6. Application of two sprays of urea and MOP each @ 1% at 3 and 10 DAS recorded higher gross returns, net returns and B:C ratio as compared to control. The higher gross returns and net returns with two sprays of urea and MOP each @ 1% at 3 and 10 DAS was mainly due to higher fresh green fodder yield. Growth and yield parameters helped to achieve higher fodder yield, finally resulted in higher net returns

Table 6. Economics of fodder maize at harvest as influenced by foliar nutrition under hydroponics

Treatment	Cost of cultivation (₹/m ²)	Gross returns (₹/m ²)	Net returns (₹/m ²)	B : C ratio
A ₁ B ₁	145	291	146	2.01
A ₁ B ₂	145	321	177	2.22
A ₂ B ₁	145	291	146	2.01
A ₂ B ₂	145	303	158	2.09
A ₃ B ₁	145	314	170	2.17
A ₃ B ₂	145	348	204	2.41
A ₄ B ₁	146	304	159	2.09
A ₄ B ₂	147	309	162	2.10
Control	145	288	144	1.99

A₁, Urea @ 1%; A₂, MOP @ 1%; A₃, Urea @ 1% and MOP @ 1%; A₄, 19:19:19 @ 1%; B₁, One spray at 6 DAS; B₂, Two spray at 3 and 10 DAS; Control, no spray.

compared to other treatments.

The study revealed that combined foliar spray of urea and MOP each @ 1% at 3 and 10 DAS is useful for enhancing growth, realizing higher fresh fodder yield and better B:C ratio in hydroponically grown fodder maize. The quality parameters, viz. crude protein, crude fibre, total carbohydrates were superior with foliar spray twice with urea and MOP each @ 1% at 3 and 10 DAS.

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