

Evaluation of fertigation and foliar spray of nutrients for the performance of bottle gourd [*Lagenaria siceraria* (Molina) Standl.] on yield, quality and Economics.

ABSTRACT

The field experiment entitled “Evaluation of fertigation and foliar spray of nutrients for the performance of bottle gourd [*Lagenaria siceraria* (Molina) Standl.] on yield, quality and economics” was conducted during *Kharif* season from 2020-21 to 2022-2023 at Chilli and Vegetable Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra). The experiment was laid out in factorial randomized block design with twelve treatments combinations and three replications. The two factors *i.e.*, fertigation levels and foliar spray levels *i.e.* soil application with S₁ (200:100:100 kg ha⁻¹) NPK through fertigation in ten equal doses along with two foliar spray of F₃ (ZnSO₄ @ 0.25% + FeSO₄ @ 0.25%) at flower initiation and fruit setting (S₁F₃) was found better for maximum highest yield and B:C ratio (2.17) of bottle gourd followed by statistically at par with the treatment with (S₂F₃) soil application of S₂ (150:75:75 kg ha⁻¹) NPK through fertigation in ten equal doses along with foliar application of F₃ (ZnSO₄ @ 0.25% + FeSO₄ @ 0.25%) at flower initiation and fruit setting. Similarly, the quality parameters like reducing, non-reducing sugars (g/100g) and ascorbic acid content (%) were significantly improved with fertigation level of S₁ (200:100:100) kg NPK along with foliar spray of F₃ (foliar spray of ZnSO₄ @ 0.25% + FeSO₄ @ 0.25%).

Keyword: yield, quality, economics, fertigation, bottle gourd.

INTRODUCTION

Bottle gourd (*Lagenaria siceraria* L.) is an important vegetable crop cultivated in several tropical and subtropical countries for its edible fruit. It is one of the most important cucurbitaceous vegetable crop with chromosome number 2n=22. Among gourds, bottle-gourd (*Lagenaria siceraria* L.) commonly known as “lauki”, “kaddu” or “dudhi” is grown extensively in India. Immature, tender bottle gourd fruit is used as a fresh vegetable and in preparation of pickles and other products. This vegetable can provide multiple medicinal benefits (Harika *et al.*, 2012). They contain the pharmaceutically active compounds used to treat acne, hyper-seborrhea, BHP, hirsutism and alopecia (Piccirilli *et al.*, 2007; Prashar *et al.*, 2014).

It is cultivated in several tropical and sub-tropical countries for its edible fruit. It needs a well distributed rainfall of 600-1500 mm and is adopted to semi-arid conditions. The optimum temperature for germination is 20-25 °C however, germination rates decline below 15 °C and above 35°C. It tolerates low temperature but if the temperature falls below 10 °C flowering often reduced due to its intolerance to frost.

It grows in a wide range of soils, but prefer well aerated, fertile soils with pH 6-7 (Chungheddonet *et al.*, 1999).

In India, it is grown extensively in the state of Bihar, Uttar Pradesh, Haryana, Madhya Pradesh, Chhattisgarh, Odisha and Punjab. Bihar is the leading state in both area (40.3 thousand hectare) and production (631.60 thousand tones) with the productivity of 25.4 tones ha⁻¹. It is gaining importance due to high yielding potential, steady market price throughout the season and export potential as well (Singh and Joshi,2002).

The composition of immature fruits of bottle gourd per 100 gm of fresh edible portion consists of water 93.99 gm, energy 21 kcal, protein 0.5 gm, fat 0.1 gm, carbohydrate 5.2 gm, fiber 0.6 gm, P 34 mg, Fe 2.4 mg, β carotene 25 μ g, thiamin 0.03 mg, niacin 1.2 mg and ascorbic acid 10 mg. The leaves per 100 mg of fresh edible portion comprise 4.4 gm, fat 0.3 gm, carbohydrate 8.3 gm, fiber 1.8 gm, Ca 560 mg, P 88 mg and Fe 7.4 mg (Leghari *et al.*, 2014). The N, P, K concentrations in leaves of bottle gourd ranged from 3.45 to 3.86%, 0.32 to 0.34%, and 3.50 to 3.94% respectively, (Ibrahimand El-kader, 2015). Zinc content in bottle gourd seed range from 32.71 to 38.11 ppm (Bairwa *et al.*, 2013).

Among the various factors involved in bottle gourd production, nutrient supply is an important for realizing higher crop yield. Experimental evidences showed that the response of bottle gourd is high due to nitrogen application and moderate to phosphorus application. Soil management practices have recently been changed as farmers utilizing huge amount of NPK fertilizers to increase crop yield. Fertilizer application plays a major role in harnessing optimum and good quality fruits in bottle-gourd. Although chemical fertilizers particularly nitrogenous and phosphatic fertilizers contribute a lot in fulfilling the nutrient requirement but the cultivation of crop requires balance supply of plant nutrients.

Indiscriminate use of chemical fertilizers will lead to wide spread nutrient deficiency in soils, disturbed soil reaction, development of nutrient imbalance in plants, increase susceptibility to plant diseases, reduced soil organic matter, lesser occurrence of soil micro-organisms and increased environmental pollution as well as human health hazards (Das *et al.*, 2015). Excessive continuous application of inorganic fertilizers to vegetable crops can cause harm to the soil and surrounding

environment and continuous use of inorganic fertilizers alone cannot sustain high levels of vegetable crop productivity (Dass *et al.*, 2008).

Considering the above facts, the present study was undertaken to investigate the “Evaluation of fertigation and foliar spray of nutrients for the performance of bottle gourd [*Lagenaria siceraria* (Molina) Standl.] on yield, quality and economics”

MATERIALS AND METHODS

A field experiment entitled “Evaluation of fertigation and foliar spray of nutrients for the performance of bottle gourd [*Lagenaria siceraria* (Molina) Standl.] on yield, quality and economics” was carried out during *Kharif* season from 2020-21, 2021-2022, and 2022-23 at Chilli and Vegetable Research Unit, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra). The site is situated in the subtropical region at 22°42' North latitude and 77°02' East longitude and at an altitude of 307.42 m above mean sea level with average annual precipitation was 944.4 mm. Experimental field is situated at the latitude of 20° 40' 35" North and longitude of 76° 59' 10" East. Initial composite soil sample was collected from the experimental site and analyzed for soil properties. The experiment was laid out in Factorial Randomized Block Design (FRBD) with two factors: Factor A for S₁-200:100:100N,P₂O₅,K₂O through drip irrigation (10 splits at 10 days interval), S₂-150:75:75 N,P₂O₅,K₂O through drip irrigation (10 splits at 10 days interval) and S₃-100:50:50 N,P₂O₅,K₂O through drip irrigation (10 splits at 10 days interval) and Factor B for F₀- Water Spray, F₁- Two foliar spray of ZnSO₄ @ 0.5 % at the time of flower initiation and fruit set, F₂- Two foliar spray of FeSO₄ @ 0.5 % at the time of flower initiation and fruit set and F₃- Two foliar spray of ZnSO₄ @ 0.25 % + FeSO₄ @ 0.25 % at the time of flower initiation and fruit set as foliar spray. The initial soil status of the experiment is pH 7.74, EC 0.23 dSm⁻¹, organic carbon 5.25 gm kg⁻¹, CaCO₃ (%) 4.95, available nitrogen 247 kg ha⁻¹, phosphorus 13.6 kg ha⁻¹, potassium 364 kg ha⁻¹ and sulphur 9.53 mg kg⁻¹, Zn 0.64 mg kg⁻¹, Cu 0.49 mg kg⁻¹, Fe 4.54 mg kg⁻¹, Mn 4.07 mg kg⁻¹. In fertigation major nutrients *i.e.*, N, P, and K were supplied through drip irrigation. Bottle gourd variety (Co-1) was sown at spacing 2.0 m X 0.60 m by the dibbling method. The seed was sown at the seed rate of 1.5 kg ha⁻¹ in the 07th July 2020, 28th June 2021 and 30th June 2022. The picking of tender and marketable healthy fruits was done at an interval of 3 to 4 days. The numbers of pickings were twelve in (2020-21), Eighteen (2021-22) and Seventeen (2022-23) respectively. The experimental data were recorded and analyzed statistically using Panse and Sukhatme (1985).

Results and discussion:

Effect of fertigation and foliar spray of nutrients on yield of bottle gourd are presented in Table 1.

Effect of fertigation

The data regarding yield of bottle gourd (Table 1) indicated that, the significantly highest fruit yield (25.20 t ha^{-1}) was recorded in S_1 (200:100:100 NPK) followed by S_2 (150:75:75 NPK) and lowest fruit yield (19.87 t ha^{-1}) was recorded in S_3 (100:50:50 NPK).

Effect of Foliar spray

The data regarding yield of bottle gourd indicated that, the significantly highest fruit yield (25.44 t ha^{-1}) was recorded in F_3 (foliar spray of $\text{ZnSO}_4 @ 0.25\% + \text{FeSO}_4 @ 0.25\%$) followed by F_1 , (Two FS of $\text{ZnSO}_4 @ 0.5 \%$) and F_2 (Two FS of $\text{FeSO}_4 @ 0.5 \%$), F_1 and F_2 were at par with each other.

Similar results of yield were also observed by Leghari *et al.*, (2014) in bottle gourd, Sajjan *et al.* (2009) in pumpkin, Rajput and Gautam (1997) Das *et al.*, (2014), Meenakshi and Vadivel (2003), Arvind kumar *et al.*, 2012, Karthick *et al.*, (2018) in bitter gourd

Interaction Effect

Interaction effect pertaining to yield of fruit was found significant (Table 1 a). Yield was significantly affected by the interaction effect of fertigation and foliar spray of nutrients. Yield was significantly higher (29.05 t ha^{-1}) in treatment S_1F_3 where 200:100:100 N, P_2O_5 and K_2O was applied in 10 split doses through fertigation along with two foliar spray of $\text{ZnSO}_4 @ 0.25 \%$ + $\text{FeSO}_4 @ 0.25 \%$ at the time of flower initiation and fruit set which was followed by (26.69 t ha^{-1}) treatment S_2F_3 where 150:75:75 N, P_2O_5 and K_2O was applied in 10 split doses through fertigation along with two foliar spray of $\text{ZnSO}_4 @ 0.25 \%$ + $\text{FeSO}_4 @ 0.25 \%$ at the time of flower initiation and fruit set. Significantly lowest yield (19.38 t ha^{-1}) under treatment S_3F_0 where 100:50:50 N, P_2O_5 and K_2O was applied in 10 split doses through fertigation along with two foliar spray of water at the time of flower initiation and fruit set. Similar results were also reported by Meenakshi and Vadivel (2003), Arvind kumar *et al.*, 2012 and Karthick *et al.*, (2018) in bitter gourd..

Effect of fertigation and foliar spray of nutrients on quality characters of bottle gourd. Table 2,3 and 4.

Quality of bottle gourd – reducing sugar, nonreducing sugar and ascorbic acid:

Effect of fertigation

The data regarding reducing sugar, non-reducing sugar and ascorbic acid (Table 2 to 4) indicated that statistically higher values i.e. 4.85 %, 2.94% and 9.38 %, respectively were recorded in S_1 (200:100:100 NPK) followed at par with the treatment S_2 . The above results are in conformity with finding of Das *et al.*, (2015) in bottle gourd and Sumathi *et al.*, (2011) in cucumber.

Effect of Foliar spray

The effect of foliar spray of micronutrients (ZnSO_4 and FeSO_4) on regarding reducing sugar, non-reducing sugar and ascorbic acid indicated that, the significantly higher values were recorded in F_3 (foliar spray of $\text{ZnSO}_4 @ 0.25\% + \text{FeSO}_4 @ 0.25\%$) and lowest values are observed under F_0 where water spray was applied. The similar result was obtained in Karthick *et al.*, (2018) in bitter gourd.

Interaction Effect

Interaction effect all the quality parameters were found significant.

Effect of fertigation and foliar spray of nutrients on economics of bottle gourd Table 5.

Economics of bottle gourd:

Effect of fertigation

The GMR and NMR of bottle gourd (Table 5) were recorded significantly highest in S₁ (200:100:100 kg ha⁻¹ NPK) followed by the treatment S₂ (150:75:75 kg ha⁻¹ NPK). The highest B:C ratio i.e. (2.17) was recorded in S₁ where 200:100:100 kg ha⁻¹ NPK was applied in Factor A.

Effect of Foliar spray

Highest values of COC, GMR, NMR and B:C ratio i.e. Rs 1,79,518, Rs. 6,18,754, Rs. 4,39,236 and 2.43, respectively were recorded where two foliar spray of ZnSO₄ @ 0.25 % + FeSO₄ @ 0.25 % at the time of flower initiation and fruit set were applied in Factor B. Higher yield due to nutrient management was reported earlier earlier in pumpkin by karuthamaniet *al.*(1995) and in cucumber by Bindiya *et al.*(2006).

Conclusion

Considering the result of the present investigation, it may be concluded that bottle gourd responded significantly to fertigation levels of S₁ and foliar spray levels of F₃ and also the combination of S₁ and S₂ along with F₃. Highest yield, good quality and B:C ratio (2.17) of bottle gourd was recorded under the combination of soil application with 200:100:100 kg NPK along with two foliar spray of ZnSO₄ @ 0.25% + FeSO₄ @ 0.25% at flower initiation and fruit setting and this treatment is statistically at par with the treatment with soil application of 150:75:75 kg NPK along with foliar application of ZnSO₄ @ 0.25% + FeSO₄ @ 0.25%.

Table 1: Effect of fertigation and foliar spray of micronutrients on yield of bottle gourd.

Treatments	Yield (t ha ⁻¹)			
	2020-21	2021-22	2022-23	Pooled Means
Factor A				
S₁ -200:100:100 N,P ₂ O ₅ ,K ₂ O	25.82	21.94	28.31	25.20
S₂ -150:75:75 N,P ₂ O ₅ ,K ₂ O	23.17	19.71	25.63	22.84
S₃ -100:50:50 N,P ₂ O ₅ ,K ₂ O	20.04	17.13	22.56	19.87
SE(m)±	0.96	0.81	0.93	0.85
CDat5%	2.82	2.38	2.73	2.50
Factor B				
F₀ :Water Spray	20.66	17.53	23.08	20.37
F₁ :Two FS of ZnSO ₄ @ 0.5 % at the time of flower initiation and fruit set	23.06	19.63	25.45	22.62
F₂ :Two FS of FeSO ₄ @ 0.5 % at the time of flower initiation and fruit set	22.40	19.17	24.86	22.12
F₃ :Two FS of ZnSO ₄ @ 0.25 % + FeSO ₄ @ 0.25 % at the time of flower initiation and fruit set	25.92	22.05	28.62	25.44
SE(m)±	1.11	0.94	1.08	0.98
CDat5%	3.25	2.75	3.16	2.88
INTERACTION (S×F)	Sig.	Sig.	Sig.	Sig.

Table 1a: Interaction effect of fertigation and foliar spray of micronutrients on yield of bottle gourd

Soil Application	Foliar Application				Average
	F ₀ : FS Water Spray	F ₁ :Two FS spray of ZnSO ₄ @ 0.5 % at the time of flower initiation and fruit set	F ₂ :Two FS spray of FeSO ₄ @ 0.5 % at the time of flower initiation and fruit set	F ₃ :Two FS of ZnSO ₄ @ 0.25 % + FeSO ₄ @ 0.25 % at the time of flower initiation and fruit set	
Treatment	Yield (t ha ⁻¹) of bottle gourd (2020-21 to 2022-23)				
S₁ 200:100:100 N,P ₂ O ₅ ,K ₂ O	21.83	25.12	24.82	29.05	25.21
S₂ 150:75:75 N,P ₂ O ₅ ,K ₂ O	19.91	22.94	21.80	26.69	22.84
S₃ 100:50:50 N,P ₂ O ₅ ,K ₂ O	19.38	19.78	19.75	20.57	19.87
	20.37	22.61	22.12	25.44	22.64
'F' Test	SA	FA	Interaction (SxF)		
SE(m)±	0.85	0.98	1.70		
CD at 5%	2.50	2.88	4.99		
CV	13.0	13.0	13.0		

Table 2 : Effect of fertigation and foliar spray of micronutrients on reducing sugar content in fruit of gourd

Treatments	Reducing sugar content (g /100 g)			
	2020-21	2021-22	2022-23	Pooled Means
Factor A				
S₁ -200:100:100 N,P ₂ O ₅ ,K ₂ O	4.83	5.06	4.65	4.85
S₂ -150:75:75 N,P ₂ O ₅ ,K ₂ O	4.59	4.82	4.41	4.61
S₃ -100:50:50 N,P ₂ O ₅ ,K ₂ O	4.37	4.60	4.19	4.39
SE(m)±	0.08	0.07	0.08	0.08
CD at 5%	0.24	0.20	0.24	0.24
Factor B				
F₀ :Water Spray	4.31	4.54	4.13	4.33
F₁ :Two FS of ZnSO ₄ @ 0.5 % at the time of flower initiation and fruit set	4.57	4.80	4.39	4.59
F₂ :Two FS of FeSO ₄ @ 0.5 % at the time of flower initiation and fruit set	4.48	4.71	4.30	4.50
F₃ :Two FS of ZnSO ₄ @ 0.25 % + FeSO ₄ @ 0.25 % at the time of flower initiation and fruit set Table	5.02	5.25	4.84	5.04
SE(m)±	0.09	0.08	0.09	0.09
CD at 5%	0.27	0.23	0.27	0.27
INTERACTION (S×F)	Sig.	Sig.	Sig.	Sig.

Table3:Effect of fertigation and foliar spray of micronutrients on non-reducing sugar content in fruit of bottle gourd

Treatments	Nonreducing sugar content (g ha ⁻¹)			
	2020-21	2021-22	2022-23	Pooled Means
Factor A				
S₁ -200:100:100 N,P ₂ O ₅ ,K ₂ O	2.93	3.16	2.75	2.94
S₂ -150:75:75 N,P ₂ O ₅ ,K ₂ O	2.71	2.94	2.53	2.72
S₃ -100:50:50 N,P ₂ O ₅ ,K ₂ O	2.49	2.72	2.31	2.50
SE(m)±	0.08	0.09	0.08	0.08
CD at 5%	0.23	0.26	0.23	0.23
Factor B				
F₀ :Water Spray	2.44	2.67	2.26	2.46
F₁ :Two FS of ZnSO ₄ @ 0.5 % at the time of flower initiation and fruit set	2.67	2.90	2.49	2.69
F₂ :Two FS of FeSO ₄ @ 0.5 % at the time of flower initiation and fruit set	2.58	2.81	2.40	2.60
F₃ :Two FS of ZnSO ₄ @ 0.25 % + FeSO ₄ @ 0.25 % at the time of flower initiation and fruit set	3.13	3.36	2.95	3.15
SE(m)±	0.09	0.10	0.09	0.09
CD at 5%	0.26	0.29	0.26	0.26
INTERACTION (S×F)	Sig.	Sig.	Sig.	Sig.

Table 4: Effect of fertigation and foliar spray of micronutrients on ascorbic acid content in fruit of bottle gourd

Treatments	Ascorbic acid content (%)			
	2020-21	2021-22	2022-23	Pooled Means
Factor A				
S₁ -200:100:100 N,P ₂ O ₅ ,K ₂ O	9.29	9.64	9.20	9.38
S₂ -150:75:75 N,P ₂ O ₅ ,K ₂ O	8.63	8.98	8.54	8.71
S₃ -100:50:50 N,P ₂ O ₅ ,K ₂ O	8.44	8.79	8.35	8.53
SE(m)±	0.14	0.14	0.15	0.14
CD at 5%	0.41	0.41	0.43	0.41
Factor B				
F₀ :Water Spray	8.34	8.70	8.25	8.43
F₁ :Two FS of ZnSO ₄ @ 0.5 % at the time of flower initiation and fruit set	8.69	9.04	8.60	8.78
F₂ :Two FS of FeSO ₄ @ 0.5 % at the time of flower initiation and fruit set	8.66	8.99	8.57	8.74
F₃ :Two FS of ZnSO ₄ @ 0.25 % + FeSO ₄ @ 0.25 % at the time of flower initiation and fruit set	9.46	9.81	9.37	9.54
SE(m)±	0.16	0.16	0.17	0.18
CD at 5%	0.48	0.48	0.49	0.48
INTERACTION (S×F)	Sig.	Sig.	Sig.	Sig.

Table 5. Economics of Bottle gourd as influenced by Effect of fertigation and foliar spray of micronutrients (Pooled Mean)

Treatments	Economics			
	COC (Rs ha ⁻¹)	GMR (Rs ha ⁻¹)	NMR (Rs ha ⁻¹)	B:C
Factor A				
S₁ -200:100:100 N,P ₂ O ₅ ,K ₂ O	193978	614588	420610	2.17
S₂ -150:75:75 N,P ₂ O ₅ ,K ₂ O	179490	553525	374035	2.08
S₃ -100:50:50 N,P ₂ O ₅ ,K ₂ O	165002	482603	317601	1.92
SE(m)±	-	21725	21725	-
CDat5%	-	63707	63707	-
Factor B				
F₀ :Water Spray	179406	494959	315553	1.76
F₁ :Two FS of ZnSO ₄ @ 0.5 % at the time of flower initiation and fruit set	179580	550475	370895	2.06
F₂ :Two FS of FeSO ₄ @ 0.5 %	179456	536765	357309	1.99
F₃ :Two FS of ZnSO ₄ @ 0.25 % + FeSO ₄ @ 0.25 %	179518	618754	439236	2.43
SE(m)±	-	25086	25086	-
CDat5%	-	73562	73562	-

Rate of bottle gourd: 2020-21 Rs. 1800/qtl, 2021-22, Rs. 2000/qtl, 2022-23 Rs. 2200/qtl.

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