Evaluation of fertigation and foliar spray of nutrients for the performance of bottle gourd [*Lagenariasiceraria* (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 [*Lagenariasiceraria* (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 site is Situated in the subtropical region at $22^0$42’ North latitude and $77^0$02’ East longitude and at an altitude of 307.42 m above mean sea level with average annual precipitation was 944.4 mm. Experimental field is situated at the latitude of 20^0 40' 35'' North and longitude of 76^0 59' 10'' East. The experiment was laid out in factorial randomized block design with twelve treatments combinations and three replications. The two factors *i.e*., fertigation levels and foliar spray levels *i.e*. soil application with S_1 (200:100:100 kg ha^{-1}) NPK through fertigation in ten equal doses along with two foliar spray of F_3($ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25%) at flower initiation and fruit setting (S_1F_3) 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 (S_2F_3) soil application of S_2 (150:75:75 kg ha^{-1}) NPK through fertigation in ten equal doses along with foliar application of F_3 ($ZnSO_4$ @ 0.25% + $FeSO_4$ @ 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 S_1 (200:100:100) kg NPK along with foliar spray of F_3 (foliar spray of ZnSO4 @ 0.25% + FeSO4 @ 0.25%).

Keyword: yield,quality,economics,fertigation,bottle gourd,vegetable crop,ascorbic acid

INTRODUCTION

“Bottle gourd (*Lagenariasicerariа*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”(iswas et al 2023,

G. P. Chimonyo V et al, 2013) . “This vegetable can provide multiple medicinal benefits.They contain the pharmaceutically active compounds used to treat acne, hyper-seborrhea, BHP, hirsutism and alopecia” (Piccirilli*et al* ., 2007; Prashar *et al*., 2014,BHUVANESHWARI S et al, 2023).

“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” (Chungheddon*et al.,* 1999,Kumar P et al 2022,).

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.

“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 µg, 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” (Bairwa*et al.,* 2013).

"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 investigation the "Evaluation of fertigation and foliar spray of nutrients for the performance of bottle gourd [*Lagenariasiceraria* (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 [*Lagenariasiceraria* (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 $22^0$42' North latitude and $77^0$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 20^0 40' 35'' North and longitude of 76^0 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 S_1- 200:100:100N,P_2O_5,K_2O through drip irrigation (10 splits at 10 days interval), S_2-150:75:75 N,P_2O_5,K_2O through drip irrigation (10 splits at 10 days interval) and S_3- 100:50:50 N,P_2O_5,K_2O through drip irrigation (10 splits at 10 days interval) and Factor B for F_0- Water Spray, F_1- Two foliar spray of $ZnSO_4$ @ 0.5 % at the time of flower initiation and fruit set, F_2- Two foliar spray of $FeSO_4$ @ 0.5 % at the time of flower initiation and fruit set and F_3- Two foliar spray of $ZnSO_4$ @ 0.25 % + $FeSO_4$ @ 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}, $CaCO_3$ (%) 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}. The soil samples were analysed for soil pH and EC (Jackson,1973), $CaCO_3$ (Piper 1966),Organic carbon by Walkley and Black method (Nelson and sommers, 1982), available N using modified kjeldhal method described by Subbiah and Asija (1956), available P (Watanable and Olsen ,1965), Available KFlame photometer (Jackson

1967), Available S turbidmetric method (piper, 1966) and micro nutrients DTPA (Lindsay and Norvell 1978).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 07thJuly 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.

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) andlowest 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 gourdindicated that, the significantly highest fruit yield (25.44 t ha^{-1}) was recorded in F_3 (foliar spray of $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25%) followed by F_1, (Two FS of $ZnSO_4$ @ 0.5 %) and F_2 (Two FS of $FeSO_4$ @ 0.5 %), F_1 andF_2 were at par with each other.

Similar results of yield were also observed by Leghari *et al,* (2014) in bottle gourd, Sajjan and Prasad , (2009) in pumpkin, 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 affect 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 $ZnSO_4$ @ 0.25 % + $FeSO_4$ @ 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 $ZnSO_4$ @ 0.25 % + $FeSO_4$ @ 0.25 % at the time of flower initiation and fruit set. Significantly lowest yield (19.38t 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_2The 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 $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 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 S_1 (200:100:100 $kgha^{-1}$ NPK) followed by the treatment S_2 (150:75:75 $kgha^{-1}$ NPK). The highest B:C ratio i.e. (2.17) was recorded inS_1 where 200:100:100 $kgha^{-1}$ 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 $ZnSO_4$ @ 0.25 % + $FeSO_4$ @ 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 karuthamani*et 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 S_1 and foliar spray levels of F_3 and also the combination of S_1 and S_2 along with F_3. 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 $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 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 $ZnSO_4$ @ 0.25% + $FeSO_4$ @ 0.25%.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1.

2.

3.

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				
S_1-200:100:100 N,P_2O_5,K_2O	25.82	21.94	28.31	**25.20**
S_2-150:75:75 N,P_2O_5,K_2O	23.17	19.71	25.63	**22.84**
S_3-100:50:50 N,P_2O_5,K_2O	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				
F_0 :Water Spray	20.66	17.53	23.08	**20.37**
F_1 :Two FS of $ZnSO_4$ @ 0.5 % at the time of flower initiation and fruit set	23.06	19.63	25.45	**22.62**
F_2 :Two FS of $FeSO_4$ @ 0.5 % at the time of flower initiation and fruit set	22.40	19.17	24.86	**22.12**
F_3 :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

	Foliar Application				
Soil Application	**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	Average
Treatment	**Yield (t ha^{-1}) of bottle gourd (2020-21 to 2022-23)**				
$S_1$200:100:100 N,P_2O_5,K_2O	21.83	25.12	24.82	29.05	**25.21**
$S_2$150:75:75 N,P_2O_5,K_2O	19.91	22.94	21.80	26.69	**22.84**
$S_3$100:50:50 N,P_2O_5,K_2O	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				
S_1-200:100:100 N,P_2O_5,K_2O	4.83	5.06	4.65	**4.85**
S_2-150:75:75 N,P_2O_5,K_2O	4.59	4.82	4.41	**4.61**
S_3-100:50:50 N,P_2O_5,K_2O	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				
F_0 :Water Spray	4.31	4.54	4.13	**4.33**
F_1 :Two FS of $ZnSO_4$ @ 0.5 % at the time of flower initiation and fruit set	4.57	4.80	4.39	**4.59**
F_2 :Two FS of $FeSO_4$ @ 0.5 % at the time of flower initiation and fruit set	4.48	4.71	4.30	**4.50**
F_3 :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				
S_1-200:100:100 N,P_2O_5,K_2O	2.93	3.16	2.75	**2.94**
S_2-150:75:75 N,P_2O_5,K_2O	2.71	2.94	2.53	**2.72**
S_3-100:50:50 N,P_2O_5,K_2O	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				
F_0 :Water Spray	2.44	2.67	2.26	**2.46**
F_1 :Two FS of $ZnSO_4$ @ 0.5 % at the time of flower initiation and fruit set	2.67	2.90	2.49	**2.69**
F_2 :Two FS of $FeSO_4$ @ 0.5 % at the time of flower initiation and fruit set	2.58	2.81	2.40	**2.60**
F_3 :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				
S_1-200:100:100 N,P_2O_5,K_2O	9.29	9.64	9.20	**9.38**
S_2-150:75:75 N,P_2O_5,K_2O	8.63	8.98	8.54	**8.71**
S_3-100:50:50 N,P_2O_5,K_2O	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				
F_0 :Water Spray	8.34	8.70	8.25	**8.43**
F_1 :Two FS of $ZnSO_4$ @ 0.5 % at the time of flower initiation and fruit set	8.69	9.04	8.60	**8.78**
F_2 :Two FS of $FeSO_4$ @ 0.5 % at the time of flower initiation and fruit set	8.66	8.99	8.57	**8.74**
F_3 :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. Ecomonics 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				
S_1-200:100:100 N,P_2O_5,K_2O	193978	614588	420610	2.17
S_2-150:75:75 N,P_2O_5,K_2O	179490	553525	374035	2.08
S_3-100:50:50 N,P_2O_5,K_2O	165002	482603	317601	1.92
SE(m)±	-	21725	21725	-
CDat5%	-	63707	63707	-
Factor B				
F_0 :Water Spray	179406	494959	315553	1.76
F_1 :Two FS of $ZnSO_4$ @ 0.5 % at the time of flower initiation and fruit set	179580	550475	370895	2.06
F_2 :Two FS of $FeSO_4$ @ 0.5 %	179456	536765	357309	1.99
F_3 :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.

References

1. Arvind K, Vasudevan SN, Patil MG, Raj rajeshwari C. Influence of NAA tricontenol and Boron spray n seed yield and quality of bitter gourd (*Momordica charantia*) cv. PusaVishesh.The Asian Journal of Horticulture.2012; 7(36):36-39.
2. Bairwa LN, Khandelwal SK. Interaction Effect of Nitrogen and Zinc in Bottle gourd [*Lagenaria siceraria (Mol.)*Standl.].Annals of Agri-Bio Research.2013;18(3): 364-367.
3. Bindiya Y, Reddy IP, Srihari D, Reddy RS, Narayanamma M. Effect of different sources of nutrition on soil health, bacterial population and yield of cucumber. Journal of Research A. N. G. R. A.U. 2006;34:12-17.
4. Chungheddon CS, Chung HD, Choi YJ, Shin SH. Morphological characteristics and germination of the Korean native bottle gourd (*Lagenariasiceraria*Standl.) seeds. Journal of Korean Society of Horticultural Science.1999 40(3): 317-321.
5. Das AK, Lenka US, Patnaik, Sudhishi S. Integrated nutrient management for production, economics, and soil improvement in winter vegetables. Int. J. Veg. Sci.2008; 14: 104-120.
6. Das R, Mandal AR, Priya A, Das SP, Kabiraj J. Evaluation of integrated nutrient management on the performance of bottle gourd (*Lagenariasiceraria*(Molina) Standl.). Journal of Applied and Natural Science.2014; 7 (1), 18-25.
7. Das, R., Mandal, A.R. and Priya, A. (2015). Performance of Bottle gourd [Lagenariasiceraria (Molina) Standl.] under different nutrient management. Progressive Horticulture 47(2): 307-313.
8. Ibrahim EA, Ahmed E, Abd El-Kader.Effect of soil amendments on growth, seed yield and NPK content of bottle gourd (*Lagenaria siceraria*) grown in clayey soil International Journal of Soil Science.2015; 10 (4): 186-194, 2015 ISSN 1816-4978.
9. Jackson ML. Soil Chemical Analysis Prentice Hall of India, Pvt. Ltd New Delhi. 1966.
10. Jackson ML. Soil Chemical Analysis, Printice Hall of India Pvt. Ltd., New Delhi.1973;pp.458.
11. Karthick R, Rajalingam GV, Praneetha S, Sujatha KB, Arumugam T. Studies on the influence of micronutrients on yield , quality and economics of bitter gourd (Momordica charantia) cv. CO 1. Int.J. Chem. Stud. 2018;6:678-681.
12. Karuthamani M, Natarajan S, Thaimburaj S. Effect of inorganic and bio-fertilizer on growth, flowering and yield of pumpkin (Cucurbita moschata) cv. CO_2.South Indian Horticulture.1995; 49: 134-136.
13. Leghari MH, Mugheri AA, Sheikh SA, Wahocho NA. Response of nitrogen levels on the growth and yield of bottle gourd varieties International Journal of Agronomy and Agricultural Research (IJAAR).2014; Vol. 5, No. 6, p. 86-92, 2014

14. Lindsay WL and Norvell WL. Development of DTPA soil test for Zn, Fe, Mn and Cu. Soil Science Society of American Journal.1978; 42, 421-428.
15. Meenakshi, N. and Vadivel, E. (2003). Effect of fertigation on growth and dry matter production of hybrid bitter gourd (Momordica charantia L.). Orissa J. Hortic. 31: 33- 34.
16. Nelson DW, and Sommers LE. In: Methods of Soil Analysis, Part II, Chemical and Microbiological Methods by Page, A. L. R .H. Miller and D. R. Keeney (eds.) Agronomy Monograph No. 9 (2" edition), American Soc. Agronomy and Soil Sci. Soc. of America, Madison, Wisconsin, USA.1982: 570-572.
17. Piccirilli A, Smadja J, Msika P, Grondin I, Piccardi N. Use of an oil of the gourd family for inhibiting 5-alpha-reductage activity. Patent No.US 7238377 B2, United State Patent , Washington,DC,USA.2007;pp:1-9.
18. Piper CS. Soil and Plant Analysis, Hans. Pub, Bombay Asian Ed.1966; Pp 368-374.
19. Prashar Y, Gill NS, Perween A. An updated review on medicinal properties of *Lagenaria siceraria*. Int. J. Univers. Pharma. Bio Sci.2014;3:362-376.
20. Sajjan AS, Prasad M. Effect of fertilizers and growth regulators on seed yield and quality of pumpkin. Agric. Sci. Digest.2009; 29(1): 20-23.
21. Subbiah BV and Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Current Sci.1956; 25: 259-260.
22. Sumathi T, Ponnu SV, Thangamani C, Pugalendhi L. Effect of shade and fertigation on quality of cucumber (*Cucumis sativus* L.). Plant Arch.2011;11(1): 275-279.
23. Watanabe FS and Olsen SR.Test of ascorbic acid method for determining phosphorus in water and sodium bicarbonates extracts of soils. Proc. Soil. Sci. Soc. Am.1965; 29:677-678.
24. iswas A, Prasad VM, Topno SE. Effect of Nano Fertilizer on Growth, Quality and Yield of Bottle Gourd (Lagenariasiceraria) var. Sarita under PrayagrajAgro Climatic Conditions. Int. J.Environ. Clim. Change. [Internet]. 2023 Aug. 1 [cited 2024 Jun. 6];13(9):2557-63. Available from: https://journalijecc.com/index.php/IJECC/article/view/2510
25. G. P. Chimonyo V, T. Modi A. Seed Performance of Selected Bottle Gourd (Lagenariasiceraria (Molina) Standl.). J. Exp. Agric. Int. [Internet]. 2013 Jun. 1 [cited 2024 Jun. 6];3(4):740-66. Available from: https://journaljeai.com/index.php/JEAI/article/view/953

26. Kumar P, Hadole SS, Ramteke PR, Bharti P. Effect of fertigation and foliar spray of nutrients on soil fertility and yield of bottle gourd (Lagenariasiceraria L). Emergent Life Sciences Research. 2022 Jun;8:146-51.
27. BHUVANESHWARI S, ANBURANI A. Effect of soil and foliar application of organic nutrients on growth and yield of bottle gourd (Lagenariasiceraria (Molina) Standl.). Annals of Plant and Soil Research. 2023;25(1):127-32.