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Journal of Agriculture and Ecology

ISSN: 2456-9410
Volume: 7

Journal of Agriculture and Ecology (2019) 7: 96-102
http://doi.org/10.53911/JAE.2019.7110

Journal of Agriculture and Ecology, 2019, Vol.7, 96-102
http://saaer.org.in

Research Article Open Access

Effect of zinc and boron on yield and quality of onion (*Allium cepa* L.) in alifisols of Tamirabarni tract

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Article Info

Article history
Received: 03 September 2018
Accepted: 10 September 2018
Available online: 15 June 2019

Key Words: Onion, STCR, zinc and boron, yield and bulb quality.

Abstract

A field experiment was conducted at Agriculture College and Research Institute, Killikulam, Tamil Nadu during *Rabi* season crop, 2017-18 to determine the effect of zinc and boron as well as soil test crop response (STCR) application of N, P and K for achieving higher yield and better quality. The results showed that yield parameters like bulb lets clump^{-1} (6.4), polar diameter (3.35 cm), equatorial diameter (2.98 cm), weight of bulb (85.2g) and bulb yield (16.85 t ha^{-1}) and bulb qualities such as total soluble solids (15.7 ^{o}Brix), ascorbic acid content (13.95 mg 100g^{-1}), protein (8.46%) and pyruvic acid content (4.82 µmol g^{-1}) was better in application of STCR (106:97:54 kg of NPK ha^{-1}) + $ZnSO_4$ @ 25 kg ha^{-1} with 0.5% foliar spray. This treatment recorded the highest net income (254243 ha^{-1}) and B: C ratio (4.07).

Preferred citation: Sethupathi S & Paramasivan M. 2019. Effect of zinc and boron on yield and quality of onion (*Allium cepa* L.) in alifisols of Tamirabarni tract. *Journal of Agriculture and Ecology*, 7: 96-102; http://doi.org/10.53911/JAE.2019.7110.

Introduction

Onion (*Allium cepa L.*), 'Queen of Kitchen' is one of the major important bulb crop, belongs to the family *Alliaceae*. In Tamil it is called as 'Venkayam'. It is cultivated for food, medicines, religious, spices and condiments purpose since beginning. Onion is one of the oldest cultivated species and it has been use as a food source over 5000 years. Onion is a cool season crop. However, it can be grown under wide range of agro-climatic conditions. India ranks second position in area and production after China in the world. The total area under onion production in India during 2016-17 was 12.94 lakhs ha and 217.18 lakhs tons with the productivity of 16.8 t/ha. In Tamil Nadu, the total area was 34.08 thousand ha with the production of 347.03 MT and 10.18 t/ha productivity (INDIASTAT 2016-17).

In India, it is treated as most important export oriented vegetable crop, exporting to the tune of 2,415,757 MT at □ 310,650 lakhs during 2016-17 (NHB 2017). In India, the different parts are predominance of Zn deficiency as more than 60 %. Zinc deficiency

in Tamil Nadu was estimated about 70 percent. Deficiency of boron also occurs widely in different states of India viz., Tamil Nadu, Gujarat and Bihar. The low production of onion is due to improper application of fertilizers and growing unsuitable varieties under different agro-climatic conditions. Different level of nutrients affects the yield and taste of onion bulbs even with in a variety. The essential macronutrients and micronutrients especially zinc and boron is necessary for good growth and higher yield. Zinc and boron are important micronutrient having different function in plants. They play a major role in plant metabolism *viz.*, the formation of auxin, amino acid, protein and translocation of sugars. However, the information on the use of zinc and boron with inorganic fertilizers for onion is scanty in Tamil Nadu especially in southern districts. Keeping these in view, the present study was planned to elucidate the effect of zinc and boron with inorganic on yield and quality of onion in Alifisols of Tamirabarni tract.

Materials and Methods

The investigation was carried out during *rabi season* 2017-18 at Agricultural College & Research Institute, Killikulam, Thoothukudi District of Tamil Nadu to study the effect of Soil test crop response, application of N, P, K along with zinc and boron. Killikulam is situated in the southern agro climatic zone of Tamil Nadu in Thoothukudi district at $80^{o}46'$ latitude and $77^{o}42'$ longitude and at an altitude of 40 m above MSL. The mean annual rainfall at Agricultural college and research institute, Killikulam is 750 mm. The minimum and maximum temperature prevailed during the crop growing season are from $26.3^{o}C$ to $35^{o}C$ respectively. The initial soil fertility was recorded nearly neutral pH value of 6.68, low in EC (0.22 dSm^{-1}), low in organic carbon (0.46 per cent), available N (236 kg ha^{-1}), P (16.8 kg ha^{-1}) and K (245 kg ha^{-1}) of the soil were grouped as low, medium and medium respectively. The available zinc was 1.02 mg kg^{-1} and boron 0.32 mg kg^{-1}.

Treatment details

There were eight treatments each replicated thrice in RBD design *viz.*, T_1 - Soil Test Crop Response dose (STCR) as 106:97:54 kg of NPK ha^{-1}, T_2 - STCR (106:97:54 kg of NPK ha^{-1}) + $ZnSO_4$ @ 25 kg ha^{-1}, T_3 - STCR (106:97:54 kg of NPK ha^{-1}) + $ZnSO_4$ @ 0.5% foliar spray, T_4 - STCR (106:97:54 kg of NPK ha^{-1}) + $ZnSO_4$ @ 25 kg ha^{-1} + 0.5% foliar spray, T_5 - STCR (106:97:54 kg of NPK ha^{-1}) + borax @ 10 kg ha^{-1}, T_6 - STCR (106:97:54 kg of NPK ha^{-1}) + borax @ 0.5% foliar spray, T_7 - STCR (106:97:54 kg of NPK ha^{-1}) + borax @ 10 kg ha^{-1} + 0.5% foliar spray, T_8 – control. Hence, the foliar application was done at 30 and 45 days after transplanting.

The crop was transplanted at 45 **x** 12 cm spacing in 20 m^2 plots (5m ***x*** 4m). The cultivation practices were followed as per the guide lines of Crop Production Guide of Tamil Nadu Agricultural University (2013). The fertilizer sources used were urea for N (46% of N), single super phosphate for P (16% water soluble P_2O_5), muriate of potash for K (60 % of K_2O) and zinc sulphate for Zn (22 % of Zn**)** and borax for B (11.36 % of B)**.** Full

dose of P, K, Zn, B and half dose of N were applied to onion as basal at the time of transplanting. The remaining dose of N was top dressed at 45 days after transplanting. Growth, yield and quality attributes were recorded as per standard procedures. The cost of cultivation, net returns and benefit: cost ratio was calculated on the basis of prevailing market price of different inputs and outputs. The post harvested soil sample was collected from 0-20 cm depth for analyzing available nutrient status. Soil sample were analyzed for alkaline permanganate oxidizable N, 0.5 M $NaHCO_3$ - extractable P and 1N NH_4OAc exchangeable K. The recorded values were analyzed statistically for drawing out definite conclusion.

Result and Discussion

Yield and yield attributes

The yield attributes such as bulb lets/clump, polar & equatorial diameter, weight of bulb and yield were significantly influenced by various treatments (Table 1). The maximum number of bulb lets clump^{-1} (6.4 clump^{-1}), polar (3.35 cm) and equatorial diameter (2.98 cm) and weight of bulb (85.2g) was better in application of soil test crop response (STCR) recommendation as 106:97:54 kg of NPK ha^{-1}and $ZnSO_4$ @ 25 kg ha^{-1} with 0.5% foliar spray followed by the treatment of soil test crop response (STCR) recommendation as 106:97:54 kg of NPK ha^{-1} with borax @ 10 kg ha^{-1} and foliar spray 0.5 % which recorded the next maximum bulb lets per clump^{-1} (6.1 clump^{-1}), (2.97 and 2.62 cm, respectively), bulb weight (81.5g) compare to the control. This might be due to the translocation and storage of food materials from leaf to bulb for which micronutrients were the responsible factors. These findings are in agreement with the findings of Alam et al. (2010), Ballabh & Rana (2012) and Ballabh et al. (2013).

Table 1. Effect of treatments on yield and yield attributes of onion

Treatments	Bulb lets per clump	Polar diameter (cm)	Equatorial diameter (cm)	Bulb weight (g)	Bulb yield (t ha^{-1})
T_1 – STCR as 106:97:54 kg of NPK ha^{-1}	4.3	2.12	1.94	62.8	12.42
T_2 - STCR + $ZnSO_4$ @ 25 kg ha^{-1}	5.6	2.74	2.56	77.6	15.14
T_3 - STCR + $ZnSO_4$ @ 0.5% foliar spray	5.1	2.53	2.32	69.8	13.73
T_4 - STCR + $ZnSO_4$ @ 25 kg ha^{-1} + 0.5% Foliar spray	6.4	3.35	2.98	85.2	16.85
T_5 - STCR + Borax @ 10 kg ha^{-1}	5.3	2.58	2.37	73.7	14.3
T_6 - STCR + Borax @ 0.5% foliar spray	4.8	2.38	2.18	66.6	13.23
T_7 - STCR + Borax @ 10 kg ha^{-1} + 0.5% Foliar spray	6.1	2.97	2.62	81.5	15.92

T_8 – Control	3.7	1.84	1.63	57.8	9.67
SEd	0.11	0.1	0.12	1.74	0.35
CD (0.05)	0.26	0.22	0.26	3.54	0.74

Significantly higher bulb yield (16.85 t ha^{-1}) was recorded with application of soil test crop response (STCR) recommendation as 106:97:54 kg of NPK $ha^{-1}$and $ZnSO_4$ @ 25 kg ha^{-1} with 0.5% foliar spray. The treatment of soil test crop response (STCR) recommendation as 106:97:54 kg of NPK ha^{-1} with borax @ 10 kg ha^{-1} and foliar spray 0.5 % resulted next higher bulb yield (15.92 t ha^{-1}) than the control. The results of present investigation well corroborate with the findings of Abedin *et al.* (2012) in onion. Yield parameters highly responded to zinc and boron with balanced NPK, so application of these two micronutrients provided the higher yield. Similar finding was also reported Yadav et al. (2003), El-Tohamy et al. (2009) and El-Samad et al. (2011).

Quality attributes

Bulb quality parameters like total soluble solids, ascorbic acid content, protein and pyruvic acid content were significantly influenced by various treatments (Table 2). The maximum quantity of total soluble solids (15.7 ^{o}Brix), ascorbic acid content (13.95 mg $100g^{-1}$), protein (8.46%) and pyruvic acid content (4.82 µmol g^{-1}) were recorded in application of soil test crop response (STCR) recommendation as 106:97:54 kg of NPK ha^{-1} and $ZnSO_4$ @ 25 kg ha^{-1} with 0.5% foliar spray followed by the treatment of soil test crop response (STCR) recommendation as 106:97:54 kg of NPK ha^{-1} with borax @ 10 kg ha^{-1} and foliar spray 0.5 per cent (13.9 ^{o}Brix), (12.67 mg $100g^{-1}$), (8.21 %) and (4.52 µmol g^{-1}) respectively. This might be attributed to enhanced metabolic processes involved in biosynthesis process such as carbohydrates, organic acid, amino acid and other inorganic constituents (Acharya et al. 2015). These results are in accordance with the findings of Shrivastava et al. (2005), Kamal et al. (2013) , Diriba-Shiferaw et al. (2014) and Khatemenla (2018).

Economics

The economics of field experiment was worked out to revealed the beneficial effect of application of STCR as 106:97:54 kg of NPK ha^{-1} with $ZnSO_4$ soil application @ 25 kg ha^{-1} and 0.5 per cent foliar spray was recorded the best treatment with net income of □ 254243 ha^{-1} with B:C ratio of 4.07 followed by the soil and foliar application of borax @ 10 kg ha^{-1} and 0.5% with STCR as 106:97:54 kg of NPK ha^{-1} recorded next best treatment with net income of □ 234028 ha^{-1} and B:C ration of 3.77 (Table 3). The higher net return in this treatment might be due to the soil application of zinc and boron fertilizer, which were locally availed in abundant resulted to obtaining of higher benefit: cost ratio. The earlier findings of Yadav et al. (2003), Goyal et al. (2015), Singh et al. (2017) support the present investigation.

Table 2. Effect of treatments on quality parameters in onion bulb

Treatments	TSS (^{O}Brix)	Ascorbic acid (mg $100g^{-1}$)	Protein (%)	Pyruvic acid (µmol g^{-1})

T_1 – STCR as 106:97:54 kg of NPK ha^{-1}	10.3	9.72	7.18	3.12
T_2 - STCR + $ZnSO_4$ @ 25 kg ha^{-1}	12.7	12.38	7.92	4.25
T_3 - STCR + $ZnSO_4$ @ 0.5% foliar spray	12.1	10.62	7.42	3.86
T_4 - STCR + $ZnSO_4$ @ 25 kg ha^{-1} + 0.5% Foliar spray	15.7	13.95	8.46	4.82
T_5 - STCR + Borax @ 10 kg ha^{-1}	12.7	11.56	7.68	4.23
T_6 - STCR + Borax @ 0.5% foliar spray	11.2	10.51	7.31	3.56
T_7 - STCR + Borax @ 10 kg ha^{-1} + 0.5% Foliar spray	13.9	12.67	8.21	4.52
T_8 – Control	9.2	7.92	7.03	2.82
SEd	0.4	0.3	0.09	0.1
CD (0.05)	0.85	0.65	0.21	0.22

Table 3. Effect of treatments on benefit cost ratio

Treatments	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	Benefit: Cost ratio
T_1 – STCR as 106:97:54 kg of NPK ha^{-1}	77141	248400	171259	3.22
T_2 - STCR + $ZnSO_4$ @ 25 kg ha^{-1}	80316	301600	219684	3.75
T_3 - STCR + $ZnSO_4$ @ 0.5% foliar spray	79582	274600	195018	3.45
T_4 - STCR + $ZnSO_4$ @ 25 kg ha^{-1} + 0.5% Foliar spray	82757	337000	254243	4.07
T_5 - STCR + Borax @ 10 kg ha^{-1}	81576	286000	204424	3.51
T_6 - STCR + Borax @ 0.5% foliar spray	79937	264600	184663	3.31
T_7 - STCR + Borax @ 10 kg ha^{-1} + 0.5% Foliar spray	84372	318400	234028	3.77
T_8 – Control	67971	193400	125429	2.85

Conclusion

The results of experiment indicated that, the application of STCR as 106:97:54 kg of NPK ha^{-1} with $ZnSO_4$ @ 25 kg ha^{-1} and 0.5 per cent foliar spray (T_4) increased the bulb yield (16.85 t ha^{-1}) and better net income (□ 2,54,243 ha^{-1}) of onion CO (On) 5 in the Alfisols of Tamirabarni tract. Hence, the present study concluded that the application STCR as 106:97:54 kg of NPK ha^{-1} with $ZnSO_4$ @ 25 kg ha^{-1} and 0.5 per cent foliar spray (T_4) is effective to maximize the yield and income of onion cultivating farmers in Alfisols of Tamirabarni tract.

Acknowledgement

This paper is a part of M.Sc. thesis entitled 'Effect of zinc and boron on yield and quality of onion (*Allium cepa* L.) in Alifisols of Tamirabarni tract' of the first author under the guidance of Dr. M. Paramasivan, Chairman of the advisory committee and submitted to Agricultural College and Research Institute, Killikulam, Tamil Nadu, India. Thus, I am obliged to express my deep sense of gratitude and indebtedness to all the member of the advisory committee for their scrupulous guidance, unrelenting encouragement cooperative attitude and productive criticism during the course of the investigation and preparation of this manuscript and also my colleagues and junior friends.

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