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Effect of lime, micronutrient and spraying schedule on growth and yield of broccoli variety *Palam Samridhi*

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ABSTRACT

Field experiment was conducted at department of Vegetable Science, OUAT, BBSR during Rabi 2018-2019, to study the effect of lime, micronutrients (B and Zn) and spraying schedule on growth and yield of broccoli variety "PalamSamridhi". The field experiment was conducted by adopting split – split plot design replicated thrice. 12 treatments consist of lime in main plot (0.2 LR and 0.3 LR), micronutrients as subplot (viz; 3 levels: foliar application of boron @ 0.2 %, $ZnSO_4$ @ 0.5 % and their combinations i.e. borax @ 0.2 % + $ZnSO_4$ @ 0.5 %) and 2 levels of spraying schedule as sub-sub plot (once and twice).The results indicated that application of lime @ 0.2 LR significantly increased not only the vegetative growth (plant height- 58.07 cm)but also yield (143.98 q ha^{-1}) and yield attributing traits (secondary head weight - 135.06 g) as compared to application of lime 0.3LR irrespective of micronutrient and spraying schedule. Among micronutrients results indicated that combined application of borax @ 0.2 % + $ZnSO_4$ @ 0.5 % significantly increased vegetative growth (plant height-61.71 cm, plant girth- 10.22 cm, leaf area- 440.35 cm^2); head yield attributing parameters (viz. weight of central head- 266.03 g ; secondary head weight- 150.29 g and total head weight- 416.32 g) with head yield (145.76 q ha^{-1}), compared to sole application irrespective of lime application and spraying schedule. Results also showed that invariably spraying of micronutrients once recorded better vegetative growth and yield attributing characters than spraying thrice, irrespective of lime application and spraying schedule.Thus it may be concluded that soil application of lime @ 0.2 LR, along with combined single spray application of $ZnSo_4$ and borax not only increases vegetative growth and yield attributing parameters but also yield in Broccoli variety " PalamSamridhi".

Keywords: Boron, broccoli, growth, lime, quality, yield and zinc

Broccoli (*Brassica oleracea* var. *italica* L.) is considered as one of the most important cole crop in the world and so also more nutritious among the cruciferous vegetables (Yoldas *et al.*, 2008). Fresh broccoli contains almost twice vitamin C than that of cabbage and cauliflower (Islam *et al.*, 2015). Broccoli was introduced recently to Indian sub-continent towards 1990 and is treated as most potential export oriented vegetable by APEDA. Thus, there is urgency to increase the yield and quality of broccoli not only for domestic consumption but also export to foreign countries.

Foliar application of micronutrients during active crop growth stage was successfully used for correcting their deficits and improving the mineral status of the plants as well as increasing the crop yield and quality (Kolota and Osinska, 2001).Boron and zinc are the most important micro-nutrients and are essential for cell division, nitrogen and carbohydrate metabolism and water relation in plant growth (Brady, 1990).Application of boron significantly increases curd diameter, weight of curd, yield and quality of cauliflower (Kumar *et al.*, 2002). Zinc represents a co-factor of the myrosinase in broccoli and results in the formation of sulphoraphane at the initial reaction as concluded by Liang *et al*. (2006). In broccoli cultivation, soil acidity is another limiting factor resulting in poor crop productivity, mainly due to accompanying effect of aluminum and manganese toxicity and nutrient deficiencies and their consequential detrimental effects on crop growth and yield. Liming has been an integral part of cultural practices developed from the intensive agricultural use of acid soils (Osemwota *et al*., 2000). Hence, field experiment was conducted to study the effect of B, Zn and lime on lateritic soil on growth and yield of broccoli.

MATERIALS AND METHODS

The field experiment was conducted during the *Rabi* season of 2018-19 at the research plots of Department of Vegetable Science, College of Agriculture, Bhubaneswar under Odisha University of Agriculture and Technology. The experiment was laid out in split-split plot design with three replications. There were two treatments in main plot and three treatments of micronutrients in sub plots as well as two spraying schedule in sub-sub plot and each treatment was allocated randomly in each plot during the year of research(Table 1).Recommended package of practices were adopted uniformly to all the treatments in order to raise a good crop. All the biometrical observations were recorded from randomly selected plants and were subjected to statistical analysis (Panse and sukhatme, 1978).

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Table 1: Details of treatment

Treatment	Treatment details
T_1	Lime @ 0.2 LR + Boron @ 0.2 % borax as foliar spray once
T_2	Lime @ 0.2 LR + Boron @ 0.2 % borax as foliar spray twice
T_3	Lime @ 0.3 LR + Boron @ 0.2 % borax as foliar spray once
T_4	Lime @ 0.3 LR + Boron @ 0.2 % borax as foliar spray twice
T_5	Lime @ 0.2 LR + Zinc @ 0.5 % $ZnSO_4$ as foliar spray once
T_6	Lime @ 0.2 LR + Zinc @ 0.5 % $ZnSO_4$ as foliar spray twice
T_7	Lime @ 0.3 LR + Zinc @ 0.5 % $ZnSO_4$ as foliar spray once
T_8	Lime @ 0.3 LR + Zinc @ 0.5 % $ZnSO_4$ as foliar spray twice
T_9	Lime @ 0.2 LR + Foliar spray of 0.2 % Borax + 0.5 % $ZnSO_4$ once
T_{10}	Lime @ 0.2 LR + Foliar spray of 0.2 % Borax + 0.5 % $ZnSO_4$ twice
T_{11}	Lime @ 0.3 LR + Foliar spray of 0.2 % Borax + 0.5 % $ZnSO_4$ once
T_{12}	Lime @ 0.3 LR + Foliar spray of 0.2 % Borax + 0.5 % $ZnSO_4$ twice

RESULTS AND DISCUSSION

Effect of lime and micronutrients on vegetative growth parameters

The data presented in table 2, revealed significant variations for vegetative growth parameters as influenced by soil application of lime and foliar spray of micronutrients. Invariably, significantly highest plant height was recorded with application of lime @0.2 LR(58.07cm) than application of lime @0.3 LR(53.94 cm). Similarly relatively higher plant girth of 9.84cm was recorded with application of 0.2 LR than 0.3 LR (9.47cm). However they were statistically non-significant. On the other hand higher leaf area was recorded with application of lime @0.3 LR (402.29 cm^2) than lime @0.2 LR (400.44). Both are non-significant statistically, irrespective of micronutrient and spraying schedule. This result is in close agreement with Osemwota *et al.*(2000), Kumar *et al.* (2012), Sen *et al.* (2017), Singh *et al.* (2015), as well as Shivran*et al.* (2017) in broccoli.

Results indicated significantly, highest plant height (61.71cm) and plant girth (10.22cm) with combined application of borax @ 0.2% + $ZnSO_4$ @ 0.5 % as compared to sole application. Similar results are also reported by Sitapara *et al.* (2011) and Kant *et al.* (2013) in cauliflower. Although similar trend was observed for leaf area but they are statistically non-significant**.**

Significantly highest plant height (56.86cm) was recorded with single spray of micronutrient than spraying of twice (55.16cm) irrespective of lime and souces of micronutrient. Similar trend was also recorded for plant girth (9.79cm), leaf area (416.86cm^2) with single spray than spraying twice (9.52cm and 385.87cm^2 respectively), However, both were non-significant statistically. Regards to interaction of lime, micronutrient and spraying schedule results indicated non-significant effect.

Effect of lime and micronutrient on head yield attributing parameters

The data presented in table 3, indicated significant variations among the treatments with variation of micronutrients only for average weight of central head, secondary head and head weight $plant^{-1}$. Invariably, higher average weight of central head (250.38gm), secondary head (133.56gm) and average weight of head $plant^{-1}$(383.94gm) was recorded with soil application lime @ 0.2 LR than lime @ 0.3 LR (242.03g, 128.89g and 370.92g, respectively), irrespective of sources of micronutrient and spraying schedule.

Combined application of Borax @ 0.2% + $ZnSo_4$ @ 0.5% significantly increased average weight of central head (266.03g), secondary head (150.29g) and average weight of head $plant^{-1}$ (416.32g) than sole application (229.69-242.91g, 106.34-137.04g and 336.02-379.95g, respectively). However, $ZnSo_4$ @ 0.5% recorded second best result for head weight.Application of micronutrient enhances the vegetative growth and head development in Broccoli. In this study, combined application of B and Znenhancing, the rate of absorption of N, P , K and other nutrients in Broccoli. This is in accordance with findings of Saha *et al.* (2010) and Sing *et al.* (2017).

Invariably spraying of micronutrients recorded better average weight of central head (250.32gm), secondary head (135.06g) and average weight of head $plant^{-1}$ (385.37g) by single spray than spraying twice (242.10g, 127.39g and 364.49g, respectively). However, significant effect was only recorded with average weight of secondary head.

The interaction effect of Lime, micronutrients and spraying schedule was non-significant statistically.

Effect of lime and micronutrient on head yield

The result presented in table 4, indicated that application of lime@0.2 LR recorded relatively higher head yield (134.11q ha^{-1}) with lower unmarketable head yield(9.87q/ha) and higher total head yield(143.98q ha^1) than application of lime @0.3 LR (123.79q ha^{-1}, 11.54q $ha^{-1}$and 135.32q ha^{-1}, respectively) irrespective of source and spraying schedule of micronutrients.

Table 2: Response of lime, micronutrients and spraying schedule on vegetative growth parameters of broccoli var. *Palam Samridhi*

Treatment	Plant height (cm)					Plant girth (cm)					Leaf area (cm^2)				
	A1		A2		Grand	A1		A2		Grand	A1		A2		Grand
	C1	C2	C1	C2	Mean	C1	C2	C1	C2	Mean	C1	C2	C1	C2	Mean
B_1	55.53	54.90	50.00	47.73	**52.04**	9.26	9.15	9.03	8.87	**9.08**	382.50	344.42	380.49	335.92	**360.83**
B_2	57.67	56.30	51.63	51.50	**54.28**	9.92	9.88	9.46	9.39	**9.66**	396.19	398.93	431.08	385.45	**402.91**
B_3	63.50	60.53	62.83	59.97	**61.71**	10.75	10.05	10.29	9.77	**10.22**	466.02	414.60	444.87	435.91	**440.35**
Mean	**58.90**	**57.24**	**54.82**	**53.07**		**9.98**	**9.69**	**9.59**	**9.34**		**414.90**	**385.98**	**418.81**	**385.76**	
	A1	**58.07**	**C1**	**56.86**		**A1**	**9.84**	**C1**	**9.79**		**A1**	**400.44**	**C1**	**416.86**	
	A2	**53.94**	**C2**	**55.16**		**A2**	**9.47**	**C2**	**9.52**		**A2**	**402.29**	**C2**	**385.87**	

	SEm(±)	LSD (0.05)	SEm(±)	LSD (0.05)	SEm(±)	LSD (0.05)
Factor A (Lime)	0.65	4.01	0.09	NS	9.37	NS
Factor B (Micronutrients)	0.86	2.79	0.26	0.85	21.51	NS
Interaction (Lime x Micronutrients)	1.21	NS	0.37	NS	30.42	NS
Factor C (Spraying)	0.42	1.28	0.17	NS	10.75	NS
AxC (Lime x Spraying)	0.59	NS	0.24	NS	15.20	NS
BxC (Mif1 cronutrients x Spraying)	0.72	NS	0.29	NS	18.61	NS
AxBxC (Lime x Micronutrients x Spraying)	1.02	NS	0.40	NS	26.32	NS

- *A1: Lime @ 0.2 LR; A2: Lime @ 0.3 LR*
- *B1: Foliar spray of borax @ 0.2 %; B2: Foliar spray of $ZnSO_4$ @ 0.5 % ; B3: Combined foliar spray of borax @ 0.2 % + $ZnSO_4$ @ 0.5 %*
- *C1: Spraying of micronutrients – Once; C2: Spraying of micronutrients – Twice*

Table 3: Response of lime, micronutrients and spraying schedule on vegetative growth parameters of broccoli var. Palam Samridhi

Treatment	Average weight of central head (g)					Average weight of secondary head (g)					Average weight of head plant^{-1}				
	A1		A2		Grand	A1		A2		Grand	A1		A2		Grand
	C1	C2	C1	C2	Mean	C1	C2	C1	C2	Mean	C1	C2	C1	C2	Mean
B1	241.70	222.37	235.67	219.00	**229.69**	115.67	106.67	111.67	91.33	**106.34**	357.37	329.04	347.33	310.33	**336.02**
B2	252.61	243.61	236.47	238.93	**242.91**	141.00	139.00	135.50	132.67	**137.04**	393.61	382.61	371.97	371.60	**379.95**
B3	273.92	268.07	261.53	260.60	**266.03**	153.33	145.67	153.17	149.00	**150.29**	427.25	413.73	414.70	409.60	**416.32**
Mean	**256.08**	**244.68**	**244.56**	**239.51**		**136.67**	**130.45**	**133.45**	**124.33**		**392.74**	**375.13**	**378.00**	**363.84**	
	A1	**250.38**	**C1**	**250.32**		**A1**	**133.56**	**C1**	**135.06**		**A1**	**383.94**	**C1**	**385.37**	
	A2	**242.03**	**C2**	**242.10**		**A2**	**128.89**	**C2**	**127.39**		**A2**	**370.92**	**C2**	**369.49**	

	SEm(±)	LSD (0.05)	SEm(±)	LSD (0.05)	SEm(±)	LSD (0.05)
Factor A (Lime)	2.69	NS	2.84	NS	5.36	NS
Factor B	5.37	17.50	6.05	19.72	8.50	27.70
(Micronutrients)	7.60	NS	8.56	NS	12.03	NS
Interaction (Lime x Micronutrients)						
Factor C (Spraying)	6.82	NS	2.47	7.61	8.16	NS
AxC(Lime x Spraying)	9.64	NS	3.50	NS	11.54	NS
BxC (Micronutrients x Spraying)	11.81	NS	4.28	NS	14.14	NS
AxBxC (Lime x Micronutrients x Spraying)	16.70	NS	6.05	NS	19.99	NS

- *A1: Lime @ 0.2 LR; A2: Lime @ 0.3 LR*
- *B1: Foliar spray of borax @ 0.2 %; B2: Foliar spray of $ZnSO_4$ @ 0.5 % ; B3: Combined foliar spray of borax @ 0.2 % + $ZnSO_4$ @ 0.5 %*
- *C1: Spraying of micronutrients – Once; C2: Spraying of micronutrients – Twice*

Table 4: Response of lime, micronutrients and spraying schedule on vegetative growth parameters of broccoli var. Palam Samridhi

Treatment	Marketable head yield (qha^{-1})					Unmarketable head yield (qha^{-1})					Total head yield (qha^{-1})				
	A1		A2		Grand	A1		A2		Grand	A1		A2		Grand
	C1	C2	C1	C2	Mean	C1	C2	C1	C2	Mean	C1	C2	C1	C2	Mean
B1	130.86	121.98	123.95	119.75	**124.14**	10.22	10.62	12.35	12.59	**11.45**	141.08	132.59	136.30	132.34	**135.58**
B2	136.54	132.84	119.51	118.27	**126.79**	10.27	10.32	11.06	11.70	**10.84**	146.81	143.16	130.57	129.98	**137.63**
B3	142.71	139.75	133.82	127.41	**135.92**	8.84	8.94	10.72	10.82	**9.83**	151.56	148.69	144.55	138.22	**145.76**
Mean	**136.70**	**131.52**	**125.76**	**121.81**		**9.78**	**9.96**	**11.38**	**11.70**		**146.48**	**141.48**	**137.14**	**133.51**	
	A1	**134.11**	**C1**	**131.23**		**A1**	**9.87**	**C1**	**10.57**		**A1**	**143.98**	**C1**	**141.81**	
	A2	**123.79**	**C2**	**126.67**		**A2**	**11.54**	**C2**	**10.831**		**A2**	**135.32**	**C2**	**137.50**	
	SEm (±)	**LSD (0.05)**				**SEm (±)**	**LSD (0.05)**				**SEm (±)**	**LSD (0.05)**			
Factor A (Lime)	**2.26**	**NS**				**0.33**	**NS**				**2.19**	**NS**			
Factor B (Micronutrients)	**2.02**	**6.60**				**0.27**	**0.89**				**2.09**	**6.80**			
Interaction (Lime x Micronutrients)	**2.86**	**NS**				**0.39**	**NS**				**2.96**	**NS**			
Factor C (Spraying)	**1.78**	**NS**				**0.27**	**NS**				**1.79**	**NS**			
AxC (Lime x Spraying)	**2.51**	**NS**				**0.39**	**NS**				**2.53**	**NS**			
BxC (Micronutrients x Spraying)	**3.08**	**NS**				**0.47**	**NS**				**3.10**	**NS**			
AxBxC (Lime x Micronutrients x Spraying)	**4.35**	**NS**				**0.67**	**NS**				**0.38**	**NS**			

- *A_1: Lime @ 0.2 LR; A_2: Lime @ 0.3 LR*
- *B_1: Foliar spray of borax @ 0.2%; B_2: Foliar spray of $ZnSO_4$ @ 0.5% ; B3: Combined foliar spray of borax @ 0.2% + $ZnSO_4$ @ 0.5%*
- *C_1: Spraying of micronutrients – Once; C_2: Spraying of micronutrients – Twice*

Combined application of micronutrients borax @ 0.2% + $ZnSo_4$ @ 0.5% significantly increased marketable head yield (135.92q ha^{-1}) with lowest unmarketable head yield (9.83q ha^{-1}) and highest total head yield (145.76 q ha^{-1}) than sole application (124.14-126.79 q ha^{-1}, 10.84-11.45q ha^{-1} and 135.58-137.63q ha^{-1}, respectively), irrespective of soil application of lime and spraying schedule of micronutrients. The better efficacy of combined application of boron and zinc might be due the beneficial role played by both the micronutrients. The increase in curd weight attributed to their role in enhancing translocation of carbohydrate from sight of synthesis to the storage tissue in the curd in cauliflower(Kant *et al.*, 2013). These findings are in close conformity with those obtained by Sitapara*et al.* (2011). Abd El-All (2014) stated that in general, boron improves the yield of crucifers by reducing the hollowness and inferior curd quality. Slosar*et al.* (2016) and Chaudhari*et al.* (2018) also demonstrated the better efficacy of zinc towards better head yield in broccoli plants.

Although single spray of micronutrients inceased both marketable and total head yield than spraying twice but they are statistically non-significant.

Thus, from the present study, itmay be concluded that soilapplication of lime @ 0.2 LR along with single spraying of borax @ 0.2% + $ZnSo_4$ @ 0.5% not only increased vegetative growth but also total head yield and head yield attributing parameters in broccoli variety "PalamSamridhi", in acidic soil.

REFERENCES

Angles, S., Abd El-All HM. 2014. Improving growth, yield, quality and sulphoraphan content as anticancer of broccoli (*Brassica oleracea* Var. *italic* L.) plants by some fertilization treatment. *Middle East J. Agric.Res.*, **3**(1): 13-19.

Brady, N.C. 1990. The nature and properties of Soils, 8: 621, The Macmillan Publ. Co. New York.

Chaudhari, V.L., Patel, N.K., Patel, G.D., Chaudhari, V.J and Nayak, S.R. 2018. Effect of foliar spray of Micronutrients on Yield of Cabbage (*Brassica oleracea* L. var. *capitata*), *Int. J. Chem. Studies*, (1): 1724-26.

Islam, M., Hoque, M.A., Reza, M.M and Chakma, S.P. 2015.Effect of boron on yield and quality of broccoli genotypes.*Intl J. Expt Ag.*,**5**(1): 1-7.

Kant, K., Singh, K.P., Singh, V.K and Ranjan, A. 2013.Effect of boron, zinc and their combinations on the yield of cauliflower (*Brassica oleracea* var. *botrytis* L.) hybrid cultivar-Himani.*Asian J. Hort* , **8**(1): 238-40.

Kolota, E and Osinska, M. 2001. Efficiency of foliar nutrition of field vegetables grown at different nitrogen rates. *Acta Hort.*, **563**: 87-91.

Kumar, S., Chaudhury, D.R and Kumar, S. 2002. Effect of FYM, molybdenum and boron application on yield attributes and yields of cauliflower. *Crop Resource*, **24**(3): 494-96.

Kumar, S., Kumar, V. and Yadav, Y.C. 2012. Studies on effect of boron and molybdenum on growth yield and yield attributing characters of cauliflower (Brassica oleracea Var. botrytis L.) cv. Pusa snow ball K-1. *Annals of Hort.*, **5**(1): 53-57.

Liang, H., Yuan, Q.P. and Xiao, Q. 2006. Effects of metal ions on myrosinase activity and the formation of sulforaphane in broccoli seed. *J. Molecular Catalysis* B: Enzymatic, **43**:19-22.

Osemwota, I.O., Okpefa, G.O. and Ogboghodo, A.I. 2000. Influence of liming on nutrient availability and plant growth: A Review. *Agric. Rev.* ,**21**(2): 137-40.

Panse, V.G. and Sukhatme, P.V. 1978. Statistical methods for Agricultural workers, ICAR, New Delhi.

Saha, P., Das, N.R. and Chatterjee, R. 2010. Boron and molybdenum nutrition in sprouting broccoli under terai region of West Bengal. *Asian J. Hort.*, **5**(2): 353-55.

Sen, J., Das, S.P., Ghosh, G.K. and Santra, G. 2017. Nutrient content of cauliflower (Brassica oleracea var. Botrytis L.) as influenced by lime, boron and farmyard manure in acid soil of north central plateau Zone of India. *Trends in Biosci.*, **10**(1) : 240-45.

Shivran, B.C., Meena, M.L., Meena, D.C., Kherwa, R.S and Narolia, S.L. 2017. Impact of bio-fertilizers and zinc on growth and yield of sprouting broccoli (*Brassica oleracea* var. Italica Plenck) under lucknow conditions. *Chem. Sci. Rev. Let.*, **6**(24): 2562-68.

Singh, G., Sarvanan, S., Rajawat, K.S., Rathore, J.S. and Singh, G. 2017.Effect of different micronutrients on plant growth, yield and flower bud quality of Broccoli (Brassica oleraceae var. italica).*Current Ag. Res. J.*, **5**(1): 108-15.

Singh, M.K., Chand, T., Kumar, M., Singh, K.V., Lodhi, S.K., Singh, V.P and Sirodh, V.S. 2015. Response of different doses of NPK and boron on growth and yield of broccoli (*Brassica oleracea* L. var. *italica*). *Int. J. Bioresource Ttress managt*, **6**(1):108-12.

Sitapara, H.H., Vihol, N.J., Patel, M.J. and Patel, J.S. 2011. Effect of growth regulators and micro-nutrients on growth and yield of cauliflower cv. snowball-16. *Asian J. Hort.*, **6**(2):348-51.

Slosar, M., Usher, A., Andrejiva, A. and Jurikova, T. 2016. Selected yield and qualitative parameters of broccoli independence on nitrogen, sulfur and zinc fertilization.*Turkish J. Ag. Forestry*, **40**:465-73.

Yoldas, F., Ceylan, S., Yagmur and Mordogan, N. 2008.Effect of nitrogen fertilizer on yield quality and nutrient content in broccoli. *J. Pl. Nut.*, **31**: 1333-43.