CROP GROWTH PARAMETERS INFLUENCED BY ZINC IN AROMATIC RICE

*PRANEETH KUMAR, S.; NARENDER REDDY, S. AND SIVA SANKAR, A.

DEPARTMENT OF CROP PHYSIOLOGY
COLLEGE OF AGRICULTURE
PROFESSOR JAYASHANKAR TELANGANA STATE AGRICULTURAL UNIVERSITY
RAJENDRANAGAR, HYDERABAD - 500 030 TELANGANA, INDIA

*EMAIL: suvarnapraneeth@gmail.com

ABSTRACT

To study the crop growth parameters influenced by zinc in aromatic rice with three treatments of zinc viz., 0, 25 and 50 kg $ZnSO_4$ /ha^{-1} and 4 aromatic rice genotypes viz. Chittimutyalu, Sumathi, Sugandha Samba and RNR 2354. The experiment was laid out in Randomized block design with factorial concept and replicated thrice. The results showed that basal application of zinc at 50 kg $ZnSO_4$ /ha and among the genotypes Chittimuthyalu (V_1) and Sugandha Samba (V_3) have recorded highest crop growth rate.

KEY WORDS: Crop growth rate, Leaf area index, Rice, Zinc

INTORDUCTION

Rice (*Oryza sativa* L.) is the second highest in worldwide production, after maize accounting for 20 per cent of world rice production. As a cereal grain, it is the most important staple food for a large part of the world's human population. The aromatic rice varieties occupy a prime position in national and international markets due to their excellent quality characters namely aroma, fineness and kernel length for cooking. The majority of scented rice are short grained, some are medium grained, and only a very few are long grained. These varieties are highly thermo photosensitive, they are mostly tall, long duration types, low yielding and prone to lodging.

Zinc is an essential micro nutrient for crop plants. Zn is essential for several biochemical processes in rice plant, such as cytochrome and nucleotide synthesis, auxin metabolism, chlorophyll production, enzyme activation and membrane integrity. Zn enrichment leads to more root surface area and the ability to change chemistry and biology of rhizosphere by releasing phytosiderophores from roots which ultimately increases Zn uptake by plants (Jat *et al*., 2008). In India 50 per cent of the soils is zinc deficient. The universal deficiency of nitrogen and phosphorus is followed by Zn deficiency (Keram *et al.*, 2014). Zinc application in rice increased crop productivity and nutritional value. Zinc required in small amount, and is essential for carbon dioxide evolution and utilization of carbohydrate and phosphorus metabolism and synthesis of RNA (Sharma *et al.*, 2013).

Realizing the importance of zinc in plant growth and at the same time seriousness of its deficiency in soils and plants, the current investigation has been made to study the crop growth parameters influenced by zinc in aromatic rice.

MATERIALS AND METHODS

The field experiment was laid out in a Factorial Randomized Black Design with three replication with four aromatic rice genotypes [Chittimuthyalu (V_1), Sumathi (V_2), Sugandha Samba (V_3) and RNR 2354 (V_4)] and three treatments [$ZnSO_4$ 0 kg (Zn_0), $ZnSO_4$ 25 kg/ha (Zn_{25}) and $ZnSO_4$ 50 kg/ha (Zn_{50})]. Leaf area was measured by using LI 3100 Leaf area meter (LICOR-Lincoln, Nebraska, USA). Five hills in the third row of every plot were uprooted and leaves are separated and area was measured. From the leaf area of these five hills, LAI was calculated. Growth parameters were calculated by using the following formulae described by Watson (1952) and Radford (1967).

$$LAI = \frac{\text{Leaf area}}{\text{Ground area}}$$

$LAD = (LA_2 + LA_1)\,(t_2 - t_1) \times 1 / 2$

Where,

LA_1 & LA_2 are the leaf area at time t_1 and t_2

$CGR = (W_2\text{-}W_1) / (t_2\text{-}t_1) \times (1/P)$

Where,

W_1 and W_2 are total dry weight of plant at times t_1 and t_2 and p is the land area

RESULTS AND DISCUSSION

Data on leaf area (cm^2 /hill) as influenced by zinc supply in rice genotypes is presented in Table 1. With the increase in the zinc levels, there was a significant increase in leaf area. Leaf area increased gradually up to 60 DAT, thereafter declined. Zinc application at 50 kg $ZnSO_4$ /ha has resulted in mean leaf area of 593.38 cm^2 /hill at 30 days after transplanting (DAT) which was increased to 1563.16 cm^2 /hill at 60 DAT and later reduced to 712.18 cm^2 /hill by 90 DAT. Lowest leaf area was recorded in control treatments. Among the genotypes significant difference in leaf area was observed with increased levels of zinc. Genotype RNR 2354 (V_4) has recorded the maximum leaf area at 60 DAT followed by Sugandha Samba (V_3), while the lowest values were recorded with Sumathi (V_2).The interaction effects were significantly different at 45 to 90 DAT. Among the combination treatments, the highest leaf area (1854.65) at 60 DAT was recorded with application of zinc 50 kg $ZnSO_4$ /ha in genotype RNR 2354 (V_4). Lowest leaf area (1151.21) was recorded with control treatment in Sumathi (V_2). The increase in the leaf area can be attributed to increased cell elongation under the influence of AUXIN which might have produced in abundant quantified under sufficient Zn availability.

Influence of zinc levels on leaf area index in aromatic rice genotypes is presented in Table 2. There was significant increase in LAI due to graded levels of zinc application. LAI increased gradually up to 60 days, thereafter declined. Zinc application at 50 kg $ZnSO_4$ /ha has resulted in LAI of 1.98 / plant at 30 days after transplanting (DAT) which increased to 5.21 at 60 DAT and reduced to 2.36 at 90 DAT. The rate of increase was more between 30 to 45 DAT. Plants which were grown in control recorded the lowest LAI throughout the crop growth. Among the aromatic rice genotypes, there was significant difference in LAI at all growth stages of crop growth. Genotype RNR 2354 (V_4) has recorded maximum LAI throughout the crop growth (5.99) followed by Sugandha Samba (V_3) (5.27), while the lowest values were recorded in Sumathi (V_2) (4.19) at 60 days after transplanting. The interaction effects were significantly different at 45 to 75 DAT. Among the combination treatments, the highest leaf area index of 6.18 at 60 DAT was recorded with application at 50 kg $ZnSO_4$ /ha in genotype RNR 2354 (V_4). The lowest leaf area index values were recorded with control treatment in Sumathi (V_2) (3.84). Similar increase in the LAI was attributed to the role of Zn as co-factor in the enzymatic reactions of the anabolic pathways in plant growth. Similar results are reported by Metwally (2007) and Mandal *et al.* (2009).

Influence of zinc levels on leaf area duration in rice genotypes is presented in Table 3. There was significant increase in LAD due to graded levels of zinc application. LAD increased gradually up to 45-60 DAT, thereafter it was declined. Zinc application at 50 kg $ZnSO_4$ /ha has resulted in LAD of 155.17 at 30-45 days after transplanting (DAT) which increased to 227.904 at 60 DAT and reduced to 137.436 at 90 DAT. Plants which were grown in control recorded the lowest LAD throughout the crop growth followed by 25 kg $ZnSO_4$ /ha. Among the aromatic rice genotypes there was significant difference in LAD at all growth stages of crop growth. Genotype RNR 2354 (V_4) has recorded maximum LAD throughout the crop growth period (261.64) followed by Sugandha Samba (V_3) (233.36), while the lowest values were recorded in Sumathi (V_2) (183.54) at 60 days after transplanting. The interaction effect between aromatic rice genotypes and zinc levels on leaf area duration was significant from the 30-45 DAT to 75 to 90 DAT. Among the combination treatments, the highest leaf area duration of 271.06 was recorded at 45 - 60 DAT with application at 50 kg $ZnSO_4$ /ha in genotype RNR 2354 (V_4). The lowest leaf area duration was recorded in control treatment in Sumathi (V_2) (172.46) at 45 – 60 DAT.

Crop growth rate was significantly influenced by the zinc levels (Table 4). Maximum crop growth rate at all the growth stages were recorded with application of 50 kg $ZnSO_4$ /ha. In general, crop growth rate values increased up to 60-75 DAT and there after it were decreased. Zinc application at 50 kg $ZnSO_4$ /ha has resulted in mean crop growth rate of 19.10 g/m^2/day at 30-45 days after transplanting (DAT), which was increased to 28.31 g/m^2/day at 60 -75 DAT and later reduced to 21.25 g/m^2/day by 75-90 DAT. The lowest crop growth rate was recorded in control treatments. Among the genotypes, significant difference in crop growth rate was observed with increased levels of zinc. Genotype Chittimuthyalu (V_1) has recorded maximum crop growth rate (32.12 g/m^2/day) at 60-75 DAT followed by the Sugandha Samba (V_3) (28.04 g/m^2/day), while the lowest values (22.15 g/m^2/day) were recorded with RNR 2354 (V_4). The interaction effects were significantly different from 30-45 DAT to 60-75 DAT. Among the combination treatments, the highest crop growth rate (33.83 g/m^2/day) at 60-75 DAT was recorded with application of zinc 50 kg $ZnSO_4$ /ha in genotype Chittimuthyalu (V_1). The lowest crop growth rate (20.86 g/m^2/day) was recorded in control treatment in Sumathi (V_2). Increase in the crop growth rate might be due to increase in the plant height and increased LAI and leaf area duration which in turn might have participated in photosynthesis and contributed to increase in the dry matter production. Similar results are reported by Mandal *et al.* (2009).

CONCLUSION

Crop growth rate (CGR) was significantly influenced by 50 kg $ZnSO_4$ /ha throughout the crop growth period. The increase in the CGR can be attributed to more leaf area index and leaf area duration. Among the genotypes, highest CGR values were recorded with Chittimuthyalu (V_1) and Sugandha Samba (V_3).

REFERENCES

Jat, S. L.; Shivay, Y. S. and Parihar, C. M. (2008). Zinc fertilization for Improving productivity and zinc concentration in aromatic hybrid rice {*Oryza sativa* L.). *Indian J. Agron.*, **55**(3): 321-322.

Bharma, Jyoti; Gupta, A. K.; Kumar, C. and Gautam, R. K. S. (2013). Influence of zinc, calcium and boron on vegetative and flowering parameters of gladiolus cv. Aldebran. *The Bioscan.* **8**(4): 1153-1158.

Keram, K. S.; Sharma, B. L.; Sharma, G. D. and Thakur, R. K. (2014). Impact of zinc application on its translocation into plant parts of wheat in a vertisol. *The Bioscan*. **9**(2): 491-495.

Mandal, L.; Maiti, D. and Bandyopadhyay, P. (2009). Respons of zinc in transplanted rice under integrated nutrient management in New Alluvial Zone of West Bengal. *Oryza*, **46**(2): 113-115.

Metwally, T. F. (2007). Performance of Sakha 104 rice cultivar as affected by the interaction between Zn and N, P and K fertilizer. *Ph.D. Thesis*, Agronomy Department, Faculty of Agriculture, Kafer El-Sheikh University.

Radford, D. J. (1967_. Growth analysis formulae: Their use and abuse. *Crop Sci.*, **7**: 171-175.

Watson, D. J. (1952). The physiological basis of variation in yield. *Adv. Agron.*, **4**: 101-145.

Table 1: Leaf area (cm^2/hill) in aromatic rice genotypes as influenced by zinc supply

Treatments		30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
V_1Zn_0		482.99	1195.83	1267.64	1022.9	448.76
V_1Zn_{25}		507.62	1230.82	1326.6	1037.49	551.41
V_1Zn_{50}		538.08	1287.54	1372.2	1090.37	665.12
V_2Zn_0		550.71	1148.31	1151.21	893.79	344.26
V_2Zn_{25}		589.19	1183.6	1263.4	958.53	470.52
V_2Zn_{50}		606.71	1239.49	1355.54	1063.14	551.46
V_3Zn_0		586.03	1440.69	1433.95	1027.42	632.97
V_3Zn_{25}		607.47	1535.31	1638.47	1142.5	775.96
V_3Zn_{50}		640.95	1615.74	1670.25	1209.26	852.33
V_4Zn_0		510.32	1609.01	1729.97	950.86	655.48
V_4Zn_{25}		540.97	1703.81	1808.51	1061.41	714.23
V_4Zn_{50}		587.77	1759.47	1854.65	1164.77	766.81
Mean of varieties						
V_1		509.56	1238.06	1322.15	1050.26	555.1
V_2		582.2	1190.47	1256.72	971.82	455.42
V_3		611.48	1530.58	1580.89	1126.39	753.75
V_4		546.35	1690.77	1797.71	1059.01	712.18
Mean of treatments						
Zn_0		532.51	1348.46	1395.69	973.74	520.37
Zn_{25}		561.31	1413.39	1509.24	1049.98	628.03
Zn_{50}		593.38	1475.56	1563.16	1131.89	708.93
Variety (V)	SEM $\pm$	3.59	8.09	8.84	11.07	11.08
	CD (0.05)	10.52	23.72	25.94	32.47	32.49
Zinc (Zn)	SEM $\pm$	3.11	7	7.66	9.59	9.59
	CD (0.05)	9.11	20.54	22.47	28.12	28.13
Interaction (Zn x V)	SEM $\pm$	6.21	14.01	15.32	19.17	19.18
	CD (0.05)	NS	41.08	44.93	56.23	56.27

Table 2: Leaf area index (LAI) in aromatic rice genotypes as influenced by zinc supply

Treatments		30 DAT	45 DAT	60 DAT	75 DAT	90 DAT
V_1Zn_0		1.61	3.99	4.23	3.41	1.50
V_1Zn_{25}		1.69	4.10	4.42	3.46	1.84
V_1Zn_{50}		1.79	4.29	4.57	3.63	2.22
V_2Zn_0		1.84	3.83	3.84	2.98	1.15
V_2Zn_{25}		1.96	3.95	4.21	3.20	1.57
V_2Zn_{50}		2.02	4.13	4.52	3.54	1.84
V_3Zn_0		1.95	4.80	4.78	3.42	2.11
V_3Zn_{25}		2.02	5.12	5.46	3.81	2.59
V_3Zn_{50}		2.14	5.39	5.57	4.03	2.84
V_4Zn_0		1.70	5.36	5.77	3.17	2.18
V_4Zn_{25}		1.80	5.68	6.03	3.54	2.38
V_4Zn_{50}		1.96	5.86	6.18	3.88	2.56
Mean of varieties						
V_1		1.70	4.13	4.41	3.50	1.85
V_2		1.94	3.97	4.19	3.24	1.52
V_3		2.04	5.10	5.27	3.75	2.51
V_4		1.82	5.64	5.99	3.53	2.37
Mean of zinc levels						
Zn_0		1.78	4.49	4.65	3.25	1.73
Zn_{25}		1.87	4.71	5.03	3.50	2.09
Zn_{50}		1.98	4.92	5.21	3.77	2.36
Variety (V)	SEM ±	0.0120	0.0270	0.0295	0.0369	0.0369
	CD (0.05)	0.0351	0.0791	0.0865	0.1082	0.1083
Zinc (Zn)	SEM ±	0.0104	0.0233	0.0255	0.0320	0.0320
	CD (0.05)	0.0304	0.0685	0.0749	0.0937	0.0938
Interaction (Zn x V)	SEM ±	0.0207	0.0467	0.0511	0.0639	0.0639
	CD (0.05)	NS	0.1369	0.1498	0.1874	NS

Table 3: Leaf area duration (dm^2 days) in aromatic rice genotypes as influenced by zinc supply

Treatments		30-45 DAT	45-60 DAT	60-75 DAT	75-90 DAT
V_1Zn_0		125.91	184.76	174.29	112.88
V_1Zn_{25}		130.38	191.81	177.31	119.17
V_1Zn_{50}		136.92	199.48	182.19	129.16
V_2Zn_0		127.43	172.46	153.38	92.85
V_2Zn_{25}		132.96	183.53	166.64	107.18
V_2Zn_{50}		138.47	194.63	181.40	121.10
V_3Zn_0		152.00	215.60	184.60	124.53
V_3Zn_{25}		160.71	238.03	208.57	143.88
V_3Zn_{50}		169.25	246.45	215.96	154.62
V_4Zn_0		158.95	250.42	201.06	120.48
V_4Zn_{25}		168.36	263.42	215.24	133.17
V_4Zn_{50}		176.04	271.06	226.46	144.87
Mean of varieties					
V_1		131.07	192.02	177.93	120.40
V_2		132.95	183.54	167.14	107.04
V_3		160.65	233.36	203.05	141.01
V_4		167.78	261.64	214.25	132.84
Mean of zinc levels					
Zn_0		141.073	205.812	178.333	112.683
Zn_{25}		148.102	219.197	191.942	125.851
Zn_{50}		155.17	227.904	201.503	137.436
Variety (V)	SEM $\pm$	0.64	0.80	1.04	1.14
	CD (0.05)	1.89	2.36	3.05	3.35
Zinc (Zn)	SEM $\pm$	0.56	0.70	0.90	0.99
	CD (0.05)	1.64	2.04	2.64	2.90
Interaction (Zn x V)	SEM $\pm$	1.12	1.39	1.80	1.98
	CD (0.05)	3.28	4.09	5.28	5.80

Table 4 : Crop growth rate (g/m^2/day) in aromatic rice as influenced zinc supply

Treatments		30-45 DAT	45-60 DAT	60-75 DAT	75-90 DAT
V_1Zn_0		15.92	25.97	30.45	18.4
V_1Zn_{25}		17.63	28.03	32.07	20.04
V_1Zn_{50}		19.35	30.71	33.85	22.27
V_2Zn_0		14.03	17.3	20.86	16.83
V_2Zn_{25}		15.18	19.12	24.22	18.21
V_2Zn_{50}		18.49	20.34	25.24	20.86
V_3Zn_0		17.7	22.76	25.34	19.27
V_3Zn_{25}		19.17	26.49	28.19	21.15
V_3Zn_{50}		20.56	28.56	30.59	23.64
V_4Zn_0		13.81	18.12	21.17	15.96
V_4Zn_{25}		16.29	19.23	21.71	17.02
V_4Zn_{50}		17.99	20.3	23.57	18.22
Mean of varieties					
V_1		17.63	28.24	32.12	20.24
V_2		15.9	18.92	23.44	18.63
V_3		19.15	25.94	28.04	21.35
V_4		16.03	19.22	22.15	17.07
Mean of treatments					
Zn_0		15.36	21.04	24.45	17.61
Zn_{25}		17.07	23.22	26.55	19.11
Zn_{50}		19.1	24.98	28.31	21.25
Variety (V)	SEM ±	0.11	0.17	0.19	0.2
	CD (0.05)	0.32	0.49	0.56	0.57
Zinc (Zn)	SEM ±	0.09	0.15	0.16	0.17
	CD (0.05)	0.28	0.43	0.48	0.5
Interaction (Zn x V)	SEM ±	0.19	0.29	0.33	0.34
	CD (0.05)	0.55	0.86	0.96	NS

[MS received : July 07, 2017] *[MS accepted : July 26, 2017]*