Biological Forum – An International Journal **14(2): 1563-1566(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of various Maize Crop Residue Management Practices and Fertility Levels on Physiological Growth Parameters of Direct Seeded Rice in Rice-maize Sequence

Billa Suresh Kumar[1*], M. Martin Luther[2], K. Chandrasekhar[3], P. Venkata Subbaiah[4] and K. Jayalalitha[5]

[1]Ph.D. (Ag.) Scholar, Department of Agronomy, Agricultural College, Bapatla, ANGRAU (Andhra Pradesh), India.
[2]Dean of Student Affairs, ANGRAU, Lam, Guntur (Andhra Pradesh), India.
[3]Professor, Department of Agronomy, Agricultural College, Bapatla, ANGRAU (Andhra Pradesh), India.
[4]Senior Scientist, Department of Soil Science and Agricultural Chemistry, Saline Water Scheme, Agricultural College Farm, Bapatla, ANGRAU (Andhra Pradesh), India.
[5]Professor, Department of Crop Physiology, Agricultural College, Bapatla, ANGRAU (Andhra Pradesh), India.

(Corresponding author: Billa Suresh Kumar)*
(Received 26 April 2022, Accepted 20 June, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: The present investigation was carried out during *kharif* season of 2020-21 on a sandy clay loam soil at the Agricultural College Farm, Bapatla to study the effect of various maize residue management practices and fertility levels on physiological growth parameters of direct seeded rice. The experiment was laid out in split-plot design with four maize residue management techniques (M_1: Exportation of maize stover, M_2: *In-situ* burning of maize stover (farmers practice), M_3: Mulching of maize stover with rotary mulcher and M_4: Incorporation of maize stover with rotovator) as main plot treatments and three fertility levels (100% RDF, 75% RDF and 50% RDF) as sub plot treatments. Mean values for maize crop residue management practices revealed that CGR and RGR only at 30-60 DAS of direct seeded rice were maximum with incorporation of maize stover with rotovator (M_4), but however it was comparable with mulching maize stover with rotary mulcher (M_3). Mean values for fertility levels revealed that highest CGR and SPAD values of direct seeded rice were recorded with 100% RDF (S_1). Thus, incorporation of maize stover with rotovator (M_4) with 100% RDF (S_1) is an optimum and sustainable approach to enhance the physiological growth parameters of direct seeded rice in rice-maize system.

Keywords: Maize crop residue, Fertility levels, CGR, RGR and Direct seeded rice.

INTRODUCTION

Rice (*Oryza sativa* L.)-Maize (*Zea mays* L.) system is seen as one of the potential alternatives of rice-pulse systems. Growing demand from poultry sector and tightening of the world export-import market justifies inclusion of maize in the rice-based cropping systems and currently rice-maize (RM) is one of the most important cropping system of the country. Overall in India, rice and maize production was 122.27, 31.51 Million tonnes from the area 45.07, 9.86 Million ha with the productivity of 2713, 3195 kg ha^{-1}, respectively (Directorate of Economics and Statistics, 2021).

High-yielding Rice-Maize system extract more nutrients, particularly N, P, or K, than do rice-rice systems or rice-wheat (Yadvinder Singh *et al.*, 2005). Assuming 7 Mg ha^{-1} of rice yield and 8 Mg ha^{-1} of maize yield, rice-maize system will remove around 519 kg NPK ha^{-1}, when all the residues are removed from the field (Setiyono *et al.*, 2010). The relation between removal of stover to C returned to the system has to be considered to address economic concerns regarding increases in nutrient removal rates and replacement costs specially for nutrients such as N, P and K. Timsina *et al.* (2010) reported that in rice-maize crop systems, a very little crop residue is returned to the soil and other organic inputs are low, which results in the loss of soil organic. India generates 516 mt of total crop residue (CR) annually, whereof, maize contribute 110 mt, respectively (Sahu *et al.*, 2021).

Management of stover after maize harvests poses an enormous challenge to all maize farmers around the globe. The maize stover is most often harvested in dried condition and packaged in large heaps to use as fodder in later date or in lean seasons. Now a days, the use of maize stalk as animals fodder gradually decreasing and instances of on field burning of stover increasing due to non availability of agriculture labor for timely

harvesting, increase in transportation costs, lack of sufficient time to take up next season crops. Instead of resorting to such practices, if managed to slash, shred and spread in the field evenly using machinery, this help in protecting soil and land resources from erosion. Fertilizer application is one of the largest expenses for farmers growing cereal crops and yet much of the N, P and K used to supplement crop needs are lost to the environment due to the low nutrient use efficiency of cereal crops. Over or under N, P and K fertilizer application can lead to a reduction in crop yield, in addition to creating conditions which favor nutrient losses to the environment, poor soil quality and plant nutrition. Therefore, there is a need for improved nutrient management strategies, in particular N, P and K under different scenarios like removed, burning, surface retention or incorporated residue management to properly replace nutrients, ensuring adequate plant nutrition and at least sustained grain yield. The present investigation was therefore undertaken to study the effect of various maize residue management practices and fertility levels on physiological growth parameters of direct seeded rice in rice-maize sequence.

MATERIALS AND METHODS

An experiment was conducted with four maize residue management practices M_1: Exportation of maize stover, M_2: *In-situ* burning of maize stover (farmers practice), M_3: Mulching maize stover with rotary mulcher and M_4: Incorporation of maize stover with rotovator) as main plot treatments and three fertility levels (100% RDF, 75% RDF and 50% RDF) as sub plot treatments which was replicated thrice. It was carried out on sandy clay loam soils of Agricultural College Farm, Bapatla during *kharif*, 2020-21 and the soil was slightly alkaline in nature, low in organic carbon and low in available nitrogen, medium in available phosphorus and high in available potassium. During the crop growth period, the weekly mean maximum temperature ranged from 29.8 to 34.0°C with an average of 32°C. The weekly mean minimum temperature ranged from 18.2 to 26.5°C with an average of 24.4°C. A total rainfall of 847.2 mm was received during the crop growth period. The test variety used for sowing was BPT-5204 and crop was sown at 20 cm and 15 cm inter and intra row distance, respectively and adopted all the standard package of practices. Application of nutrients was done as per the treatments in the form of urea, single super phosphate and muriate of potash respectively. Entire quantity of phosphorus and half dose of potassium was applied at the time of sowing. Remaining dose of potassium were applied at PI stage of the crop. After harvest of maize cobs, residues of the maize crop were retained. Maize residues were added as per treatment in the four main plots. In residue removal plots, the residues were completely removed after harvest of the crop. Ninety five days were allowed for decomposition of crop residues during both the years of experimentation. The data on CGR, RGR and SPAD values were recorded as per standard procedures. Statistical analysis of all the data are carried out following the analysis of variance technique for split plot design as outlined by Panse and Sukhatame (1978).

RESULTS AND DISCUSSION

Effect of maize crop residue management practices and fertility levels on Crop growth rate. The calculated mean data related to crop growth rate (CGR) at successive growth stages 30-60, 60-90 and 90-120 DAS as affected by maize crop residue management practices and fertility levels have been summarized and presented in Table 1. The interaction at all the stages of observations was found to be non-significant.

Highest CGR values were recorded with incorporation of maize stover with rotovator (M_4) but however, it was found on par with mulching of maize stover with rotary mulcher (M_3) which in turn on parity with *In-situ* burning of maize stover (farmers practice) (M_2) at all stages of observations except at 60-90 DAS. This might be due to more taller plants, higher number of tillers and more drymatter production per unit area and higher leaf area index (LAI) could have been the reason for higher crop growth rate values. These observations are confirmed by the findings of Vijayaprabhakar *et al.* (2020); Arvind Kumar *et al.* (2016).

With respect to fertility levels, at all stages of observation (30-60, 60-90 and 90-120 DAS), crop growth rate increased with increasing the fertility levels. The highest crop growth rate of rice was recorded with application of 100% RDF (S_1), but, however it was found on par with application of 75% RDF (S_2) except at 30-60 DAS. The lowest CGR values was noticed with 50% RDF (S_3) which was significantly inferior to other treatments. This might be due to high LAI at higher fertility levels functioning during tillering to flowering resulted in high CGR that caused further increase in dry matter accumulation during the reproductive period leading high crop productivity. The results obtained in the present investigation are in line with the findings of Huang *et al.* (2008); Mondal *et al.* (2013).

Effect of maize crop residue management practices and fertility levels on Relative growth rate. Data pertaining to relative growth rate of rice at different growth intervals of crop *viz.*, 30-60, 60-90 DAS and 90-120 DAS as affected by maize crop residue management practices and fertility levels are presented in Table 1. A glance at the data indicates that RGR was non significantly influenced by maize crop residue management practices except at 30-60 DAS, whereas the fertility levels and interaction effect was also found to be non significant.

During 30-60 DAS, highest relative growth rate was observed with incorporation of maize stover with

rotovator (M_4) which was on par with *In-situ* burning of maize stover (M_2) and significantly differed from rest of the treatments. Mulching of maize stover with rotary mulcher (M_3) was on par with exportation of maize stover (M_1). The lowest relative growth rate values were recorded with M_1.

Effect of maize crop residue management practices and fertility levels on SPAD values. The data pertaining to SPAD chlorophyll meter reading at 30, 60, 90 DAS and at harvest are presented in Table 1. The review manifested an increasing trend with the advance of plant growth till 90 DAS, followed by decreasing trend with the lowest SPAD readings at the time of harvesting. The lower values of SPAD during the time of harvest might be the result of degradation of leaf chlorophyll.

Data reveals that, different fertility levels influenced the SPAD values significantly, whereas different maize crop residue management practices and their interaction were non-significant at all growth stages of the crop.

SPAD meter readings differed due to graded doses of fertilizer treatments at all the stages of observations. At all stages of the growth, the highest SPAD meter readings were recorded in 100% RDF (S_1) treatment which was found significantly superior to other treatments except at harvest stage. Application of 75% RDF (S_2) recorded the next best treatment followed by 50% RDF (S_3). The lowest SPAD meter readings were recorded with 50% RDF (S_3). The maximum chlorophyll content in leaf in S_1 treatment might be due to inorganic fertilizer nitrogen which in turn improved the chlorophyll content in the leaf by improving nutrient uptake by the plant. The current findings are also supported by Prakash and Mahajan (2016).

Table 1: Crop Growth Rate (g m^{-2} day^{-1}), Relative Crop Growth Rate (g g^{-1} day^{-1}) and SPAD readings at different growth stages of direct seeded rice as influenced by maize crop residue management practices and fertilizer levels during *kharif*, 2020-21.

Treatments	CGR			RGR			SPAD values			
	30-60 DAS	60-90 DAS	90-120 DAS	30-60 DAS	60-90 DAS	90-120 DAS	30 DAS	60 DAS	90 DAS	At harvest
Maize crop residue management practices										
M_1- Exportation of maize stover	3.98	8.56	13.86	0.039	0.030	0.023	29.17	32.05	34.79	26.89
M_2- *In-situ* burning of maize stover (farmers practice)	4.69	11.35	14.73	0.046	0.034	0.020	26.13	33.01	35.71	28.76
M_3- Mulching of maize stover with rotary mulcher	4.84	13.79	16.12	0.041	0.037	0.019	30.72	36.82	39.07	30.32
M_4- Incorporation of maize stover with rotovator	5.34	14.72	17.54	0.048	0.037	0.020	27.46	38.12	40.06	31.97
S.Em±	0.11	0.45	0.72	0.001	0.002	0.001	0.94	1.35	1.24	1.53
CD (p = 0.05)	0.38	1.54	2.51	0.003	NS	NS	NS	NS	NS	NS
CV (%)	7.04	11.05	13.95	6.17	14.87	19.74	9.93	11.54	9.92	15.58
Fertility levels										
S_1-100% RDF	5.36	13.95	17.19	0.045	0.035	0.020	30.13	37.08	39.41	31.18
S_2- 75% RDF	4.75	12.59	15.50	0.044	0.036	0.020	28.76	35.03	37.36	29.96
S_3- 50% RDF	4.03	9.77	14.01	0.042	0.033	0.022	26.21	32.89	35.45	27.31
S.Em±	0.11	0.47	0.82	0.001	0.001	0.001	0.44	0.64	0.63	0.85
CD (p = 0.05)	0.33	1.42	2.44	NS	NS	NS	1.33	1.91	1.89	2.55
CV (%)	8.09	13.53	18.14	7.13	11.46	15.45	5.42	6.32	5.85	9.98
Interaction										
M × S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S × M	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

CONCLUSION

Based on the above results and discussion, it can be concluded that incorporation of maize stover with rotovator (M_4) and application of 100% RDF (S_1) were found to be the most effective and sustainable approach to enhance the physiological growth parameters of direct seeded rice in rice-maize system.

FUTURE SCOPE

Based on research work done, it can be used as reliable work for further reference. Studies need to be undertaken to evaluate the effect of timing of rice and maize residue incorporation and scheduling of nitrogen through real time nitrogen management practices in rice-maize cropping system.

Acknowledgements. I express gratitude to my Chairman Dr. M. Martin Luther, Co-Chairman Dr. K. Chandrasekhar and every faculty members of the Department of Agronomy for constant support and guidance to hold out the entire experimental research study.

Conflict of Interest. None.

REFERNECES

Arvind Kumar., Jat, M. L., Kumar, K., Tomar, J., Kumar, S., Kushwaha, S. R. and Singh, C. B. (2016). Response of rice residue, tillage and nitrogen management on wheat in rice-wheat cropping system in the Indo-

Gangetic plains of India. *Annals of Agricultural Research New Series*, *37*(2): 141-146.

Directorate of Economics and Statistics. 2021-22. *https://eands.dacnet.nic.in*

Huang, J., He, F., Cui, K., Buresh, R. J., Xu, B., Gong, W. and Peng, S. (2008). Determination of optimal nitrogen rate for rice varieties using a chlorophyll meter. *Field Crops Research*, *105*: 70-80.

Mondal, S., Bauri, A., Pramanik, K., Ghosh, M., Malik, G. C. and Ghosh, D. C. (2013). Growth, productivity and economics of hybrid rice as influenced by fertility level and plant density. *International Journal of Bio-resource and Stress Management*, *4*(4): 547-554.

Prakash, P. and Mahajan, G. (2016). Physiology and yield of rice (*Oryza sativa*) as influenced by integrated nutrient management under rice - wheat cropping system of Eastern Uttar Pradesh. *Environment & Ecology*, *34*(3A): 1189-1192.

Panse, V. G. and Shukhatme, P. V. (1978). Statistical methods for agricultural workers, ICAR, New Delhi, 145-150.

Sahu, S. K., Mangaraj, P., Beig, G., Samal, A., Pradhan, C., Dash, S. and Tyagi, B. (2021). Quantifying the high resolution seasonal emission of air pollutants from crop residue burning in India. *Environmental Pollution Journal*, *286*: 117-165.

Setiyono, T. D., Walters, D. T., Cassman, K. G., Wilt, C. and Dobermann, A. (2010). Estimating the nutrient uptake requirements of maize. *Fields Crops Research*, *118*: 158-168.

Timsina, J., Buresh, R. J., Dobermann, A., Dixon, J. and Tabali, J. (2010). Strategic assessment of rice-maize systems in Asia. IRRICIMMYT Alliance Project "Intensified Production Systems in Asia (IPSA)", IRRI-CIMMYT Joint Report, IRRI, Los Banos, Philippines.

USDA (2021). World Agricultural Production. United States Department of Agriculture. Circular Series WAP 6-21. (Accessed on June, 2021 from *https://apps.fas.usda.gov/psdonline/circulars/production. pdf.*

Yadvinder-Singh, Bijay-Singh and Timsina, J. (2005). Crop residue management for nutrient cycling and improving soil productivity in rice-based cropping systems in the tropics. *Advances in Agronomy*, *85*: 269–407.

Vijayaprabhakar, A., Durairaj, S. N., Hemalatha, M. and Joseph, M. (2020). Study on rice residue management options on growth parameters and growth indices of rice crop. *Journal of Experimental Agriculture International*, *42*(1): 56-63.

How to cite this article: Billa Suresh Kumar, M. Martin Luther, K. Chandrasekhar, P. Venkata Subbaiah and K. Jayalalitha (2022). Effect of various Maize Crop Residue Management Practices and Fertility Levels on Physiological Growth Parameters of Direct Seeded Rice in Rice-maize Sequence. *Biological Forum – An International Journal*, *14*(2): 1563-1566.