Evaluation of the effect of different soil fertilizers on rice plants using a hyperspectral imaging system

L. Marinoni1\*, T.M.P. Cattaneo1, V. Picchi1, A. Calzone1, E. Romano2

1 Research Centre for Engineering and Agro-Food Processing, CREA - Via G. Venezian, 26 –

20133 Milano, ITALY, [laura.marinoni@crea.gov.it](mailto:Laura.marinoni@crea.gov.it); [tiziana.cattaneo@crea.gov.it](mailto:Tiziana.cattaneo@crea.gov.it); [valentina.picchi@crea.gov.it](mailto:valentina.picchi@crea.gov.it); [antonella.calzone@crea.gov.it](mailto:Antonella.calzone@crea.gov.it)

2 Research Centre for Engineering and Agro-Food Processing, CREA - Via Milano, 43 – 24047

Treviglio (BG), ITALY, [elio.romano@crea.gov.it](mailto:elio.romano@crea.gov.it)   
\*Corresponding author: [laura.marinoni@crea.gov.it](mailto:laura.marinoni@crea.gov.it)

Municipal solid waste can be adequately treated producing sewage sludge (SS), rich in organic and inorganic plant nutrients, and exerting beneficial effects on soil properties (Donatello and Cheeseman, 2013). Soil samples were collected at the Penati Farm (Basiglio, Italy). After drying, sifting, and mixing with three different SSs (R10 sludge; carbonate of defecation; defecation plaster), soils were used for a pot experiment (15 kg each) from April to July 2021. The greenhouse experiment (5 treatments) was carried out at the University of Milan, for the assessment of the impact of innovative fertilizers on rice (*Oryza sativa* L. var. Sirio CL) plants. SSs were compared with unfertilized soil (control) and mineral fertilizer. The amount of urea and fertilizers were calculated to provide the same total nitrogen for each treatment. Alterations in physiological performance of the plant growth using spectroscopic indices obtained by hyperspectral imaging system data were studied. Selecting 11 spectral bands, the values of four indices highly correlated with chlorophyll (chl) content were calculated on 330 images: NDVI, Chlred-edge, MCARI, TCI (Ranghetti et al., 2020). From images of the indices, the average indices were calculated from three sub-samples in different areas of each leaf. The differences between the treatments did not indicate statistical significance in any of spectral indices. Similar results were obtained from VIS-NIR spectra (400-1000 nm). A positive correlation was found between NDVI, MCARI and TCI, while the Chlred-edge index showed a negative but significant (p-value <0.001) correlation. As expected, the highest correlation value was found between NDVI and Chlred-edge (R = 0.935; R2 = 0.874). These results indicated that the chl content was not affected by the administration of SSs as alternative fertilizers, suggesting that the treatments did not reduce plant health compared to chemical fertilizer.

**Keywords:** rice, fertilizers, hyperspectral imaging, plant health, physiological performance.

**Acknowledgements:** Authors gratefully acknowledge receiving funding from programme POR – FESR 2014-2020, Regione Lombardia, project BIOMASS HUB (ID 1165247).

REFERENCES

Donatello S., Cheeseman C.R.., 2013. Recycling and recovery routes for incinerated sewage sludge ash (ISSA): A review. Waste Manage. 33, 2328–2340. https://doi.org/10.1016/j.wasman.2013.05.024

Ranghetti L., Boschetti M., Nutini F., Busetto L., 2020. "sen2r": An R toolbox for automatically downloading and preprocessing Sentinel-2 satellite data. Comput and Geosci, 139, 104473. doi: 10.1016/j.cageo.2020.104473