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Combined application of manure and mineral fertilizers weakens the impact of manure on soil biochemical properties

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Manure application has been considerably emphasized to mitigate global soil degradation and improve soil fertility. Though there have been investigations on the contribution of manure application on soil properties in comparison with mineral fertilization, a comprehensive understanding of manure application on soil organic matter (SOM), total nitrogen (TN), microbial biomass carbon (MBC) and nitrogen (MBN) and activities of 7 enzymes is yet to be identified. This study extensively quantified the response of soil biochemical properties to manure application based on a meta-analysis of 83 articles including 460 observations with time span from days to years. The impact of explanatory factors (i.e. climatic factors, experimental types, soil properties and manure characteristics) was also elucidated. Manure application increased SOM, TN, MBC and MBN by $27 \pm 3\%$ and $41 \pm 5.3\%$, $87 \pm 4.3\%$ and $88 \pm 6.7\%$. Soil C/N ratio did not vary but MBC/MBN ratio decreased after manure application, indicating a shift in microbial community. The activities of β -glucosidase, dehydrogenase, acid phosphatase, alkaline phosphatase, N-acetyl- β -D-glucosaminidase, urease and sulfatase were also elevated by 150%, 110%, 40%, 110%, 59%, 106% and 221%, respectively. Besides, all soils were neutralized following manure application, suggesting that manure accelerates soil nutrient cycling by adjusting pH to optimum. When mean annual temperature is within the range of 10-20 °C or initial soil pH within 6-8, the highest increase of enzyme activities was revealed. Furthermore, composting manure has stronger impact on soil enzyme activities compared to non-composted manure, which was attributed to beneficial microbial community composition as well as favourable soil organic compound composition in the compost. Contrarily, combined application of manure with mineral fertilizers induces an antagonistic effect and weakens the impact of manure on soil biochemical properties as compared to only manure application. This weakening effect may mitigate the competition between microbes and plant roots for nutrients. In conclusion, necessary differentiation of only manure and manure + chemical fertilizers application is required when developing and modeling the influence of management practices on arable lands.