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**Supplementary Table 1.** The results of analysis of variance (ANOVA) showing means and statistical significance of a two-way interactions [crop phenology (C) × land use system (L)] on the measured soil properties.

| **Interactive effect** | | **Measured soil properties** | | | |
|---|---|---|---|---|---|
| | | **$C_{BSR}$** | **DHA** | **SMC** | **SOC** |
| | | **µg $CO_2$-C $g^{-1}$ soil** | **µg TPF $g^{-1}$ soil 24 $h^{-1}$** | **(%)** | **(%)** |
| Crop phenology (C) | Land use system (L) | | | | |
| BS-1 | Teak-agroforestry | 9.31bc | 3.87a | 15.64c | 0.54a |
| | Aonla-agroforestry | 8.05cd | 3.89a | 11.30d | 0.44a |
| | Sole cropping | 6.29e | 3.07a | 16.19c | 0.32a |
| BS-2 | Teak-agroforestry | 12.21a | 5.73a | 25.89a | 0.55a |
| | Aonla-agroforestry | 10.35b | 5.35a | 20.05b | 0.45a |
| | Sole cropping | 7.69de | 4.26a | 25.32a | 0.33a |
| BS-3 | Teak-agroforestry | 10.35b | 4.62a | 15.96c | 0.55a |
| | Aonla-agroforestry | 9.46bc | 4.59a | 11.60d | 0.45a |
| | Sole cropping | 6.51e | 3.29a | 12.70d | 0.34a |
| MS-1 | Teak-agroforestry | 2.18f | 8.37a | 15.89c | 0.56a |
| | Aonla-agroforestry | 1.04f | 7.02a | 7.94e | 0.48a |
| | Sole cropping | 1.79f | 6.08a | 15.18c | 0.35a |
| MS-2 | Teak-agroforestry | 2.04f | 6.87a | 8.59e | 0.58a |
| | Aonla-agroforestry | 1.46f | 5.77a | 5.61f | 0.50a |
| | Sole cropping | 1.79f | 4.96a | 7.29ef | 0.36a |
| *P-value* | | 0.0001 | 0.526 | 0.003 | 0.100 |
| SE (±) | | 0.51 | 0.38 | 0.80 | 0.027 |

Within each soil property, means followed by uncommon letter are significantly different as per Fisher's LSD. BS-1: Pre-sowing stage of black gram; BS-2: Flowering stage of black gram; BS-3: Maturity stage of black gram; MS-1: Flowering stage of mustard; MS-2: Maturity stage of mustard; $C_{BSR}$: Cumulative basal soil respiration; DHA: Dehydrogenase activity; SMC: Soil Moisture Content; SOC: Soil Organic Carbon

**Supplementary Table 2.** The results of analysis of variance (ANOVA) showing means and statistical significance of a two-way interactions [crop phenology (C) × soil depth (D)] on the measured soil properties.

| Interactive effect | | Measured soil properties | | | |
|---|---|---|---|---|---|
| | | $C_{BSR}$ | DHA | SMC | SOC |
| | | µg $CO_2$-C $g^{-1}$ soil | µg TPF $g^{-1}$ soil 24 $h^{-1}$ | % | % |
| Crop phenology (C) | Soil depth (D) | | | | |
| BS–1 | 0-30 cm | 9.12bc | 4.23de | 15.41c | 0.55a |
| | 30-60 cm | 6.64d | 2.99f | 13.35de | 0.32a |
| BS–2 | 0-30 cm | 11.38a | 5.75c | 25.41a | 0.56a |
| | 30-60 cm | 8.79c | 4.48d | 22.10b | 0.33a |
| BS–3 | 0-30 cm | 10.16b | 4.83d | 14.57cd | 0.56a |
| | 30-60 cm | 7.39d | 3.49ef | 12.28e | 0.33a |
| MS–1 | 0-30 cm | 1.99e | 8.51a | 12.15e | 0.58a |
| | 30-60 cm | 1.36e | 5.80c | 13.86cde | 0.35a |
| MS–2 | 0-30 cm | 2.01e | 7.43b | 7.13f | 0.59a |
| | 30-60 cm | 1.52e | 4.30de | 7.20f | 0.37a |
| *P-value* | | 0.007 | 0.003 | 0.001 | 0.100 |
| SE(±) | | 0.42 | 0.31 | 0.65 | 0.022 |

Within each soil property, means followed by uncommon letter are significantly different as per Fisher's LSD
BS-1: Pre-sowing stage of black gram; BS-2: Flowering stage of black gram; BS-3: Maturity stage of black gram; MS-1: Flowering stage of mustard; MS-2: Maturity stage of mustard; $C_{BSR}$: Cumulative basal soil respiration; DHA: Dehydrogenase activity; SMC: Soil moisture content; SOC: Soil organic carbon

**Supplementary Table 3.** The results of analysis of variance (ANOVA) showing means and statistical significance of a two-way interactions [land use system (L) × soil depth (D)] on the measured soil properties. Within each soil property, means followed by uncommon letter are significantly different as per Fisher's LSD.

| **Interactive effect** | | **Measured soil properties** | | | |
|---|---|---|---|---|---|
| | | **$C_{BSR}$** | **DHA** | **SMC** | **SOC** |
| | | **µg $CO_2$-C $g^{-1}$ soil** | **µg TPF $g^{-1}$ soil 24 $hr^{-1}$** | **(%)** | **(%)** |
| Land use system (L) | Soil depth (D) | | | | |
| Teak–agroforestry | 0-30 cm | 7.94a | 7.11a | 16.95a | 0.71a |
| | 30-60 cm | 6.50a | 4.67a | 15.84a | 0.41c |
| Aonla–agroforestry | 0-30 cm | 6.80a | 6.17a | 12.20a | 0.57b |
| | 30-60 cm | 5.34a | 4.47a | 10.39a | 0.36d |
| Sole cropping | 0-30 cm | 6.05a | 5.16a | 15.65a | 0.43c |
| | 30-60 cm | 3.58a | 3.50a | 15.03a | 0.26e |
| *P-value* | | 0.200 | 0.195 | 0.498 | 0.001 |
| SE (±) | | 0.32 | 0.24 | 0.51 | 0.017 |

$C_{BSR}$: Cumulative basal soil respiration; DHA: Dehydrogenase activity; SMC: Soil Moisture Content; SOC: Soil Organic Carbon