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# Growth and Nutrient Uptake of Indian Mustard as Influenced by Residual Effect of Green Leaf Manuring and Nitrogen Fertilization

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**ABSTRACT: We studied the growth, biological yield and nutrient uptake of Indian mustard under residual effect of different green leaf manuring and nitrogen levels applied to preceding rice crop. The results indicated that residual effect of *Gliricidia sepium* green leaf manuring @ 10 t ha$^{-1}$ resulted in significantly higher growth characters at 60 days after sowing, biological yield and nutrient uptake at harvest. However, it was found statistically at par with *Leucaena leucocephala* and *Sesbania aculeata* regarding growth and biological yield while, with *Leucaena leucocephala* for nutrients uptake. Among N levels, the residual fertility of 100% RDN fetched significantly higher growth, biological yield and nutrients uptake by succeeding mustard crop. It was remained statistically at par with lower N levels *i.e.* 75 and 50% RDN in terms of growth and biological yield. Green leaf manuring maintained gradually high N mineralization rates throughout the rice-mustard sequence and it is the best alternative to cut down the nitrogenous fertilizer use in rice based production systems.**

**Keywords:** Green leaf manuring, growth, mustard, nutrient uptake and residual effect.

## INTRODUCTION

Indian mustard (*Brassica juncea* L.) is the leading edible oilseed crop which occupies almost 70 per cent of the area under rapeseed-mustard group of crops grown in India. India occupies the third position in rapeseed-mustard production in the world after China and Canada. It plays a significant role in the oilseed economy of the country (Jat *et al.,* 2019). Owing to lower yields, mustard production does not meet the requirement of the growing population of the country. India meets 60 per cent of the domestic edible oil requirements through imports (Jat *et al.,* 2021). The mustard production system is mainly suffers due to excessive and imbalanced nutrient management and repetitious cropping system which increase the resource degradation and cost of production (Lal *et al.,* 2016). Yield potential of mustard can be realized by the balanced and efficient use of organic and inorganic sources of nutrients (Meena *et al.,* 2016).

A balanced nutrient availability was observed with green leaf manuring of nitrogen fixing trees (NFTs) *viz. Gliricidia sepium* and *Leucaena leucocephala* to succeeding crops (Das *et al.*, 2010). Mustard is grown during the dry winter season and has a deep taproot system, which helps in the uptake of leftover nutrients after harvest of rice crop. Green leaf manures not only helps to sustain crop yield but also plays a key role by exhibiting both direct as well as indirect effect on the nutrients availability by improving the soil organic matter (Yadav *et al.,* 2019). Information regarding residual effect of green leaf manuring and nitrogen levels on mustard is scare under Varanasi region of Eastern Uttar Pradesh. Therefore, an attempt has been made to assess the growth of mustard on residual fertility of green leaf manures and nitrogen levels so that all the leftover nutrients can be utilized efficiently.

## MATERIAL AND METHODS

A field experiment was conducted at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (25°20′N, 83°03′E and 128.9 meters above mean sea level) during two consecutive *rabi* season of 2018 and 2019. Soil of the experiment field had sandy clay loam in texture, slightly alkaline in reaction, low in electrical conductivity, low in organic carbon, available nitrogen and medium in available phosphorus and potassium. The total rainfall of 34.6 and 85.2 mm were received during crop growing season of 2018 and 2019, respectively. The experiment was laid out in split-plot

design taking five green leaf manuring v*iz. Sesbania aculeata, Leucaena leucocephala, Gliricidia sepium, Cassia siamea* and *Pongamia pinnata*in main plots and four N levels *viz.* without nitrogen, 50% RDN (Recommended dose of nitrogen), 75% RDN and 100% RDN in subplots with three replications. Green leaf manures were incorporate done week before transplanting of rice in well puddle plots with the help of spade after proper chopping @ 10 t $ha^{-1}$ on fresh weight basis. N levels was applied as per treatments though urea in three equal splits. The recommended dose of fertilizers for rice was applied through urea for nitrogen, di-ammonium phosphate for phosphorus, muriate of potash for potash, 120, 60 and 60 kg $ha^{-1}$, respectively. After harvest of rice, mustard was grown on residual fertility with 50% of RDF (50 kg N, 25 kg $P_2O_5$, 25 kg $K_2O$ $ha^{-1}$). A seed rate of 5 kg $ha^{-1}$ was used for sowing Indian mustard variety NRC-HB-101 and the fixed layout plan was kept for both the years.

The tagged randomly selected five plants in the net plot area were used for recording growth parameters at 60 days after sowing (DAS). Total harvested above ground plant parts from each net plot were carefully bundled after sun drying, tagged and taken to threshing floor. Each bundles was weighed to record the biological yield $plot^{-1}$ and finally converted into tonne $ha^{-1}$. Nutrient uptake in seed and stover samples was calculated by multiplying per cent nutrient content with their respective dry matter accumulation and total nutrient uptake were drown by adding. The data relating to each character were analyzed as per the procedure of analysis of variance and significance was tested by "F" test (Gomez and Gomez 1984).

## RESULTS AND DISCUSSIONS

**Growth characters.** Growth parameters *viz.* plant height and dry matter accumulation of mustard (Table 1) positively influenced after 60 days of sowing under the residual effect of green leaf manuring and N levels during both the years of experimentation. Significantly higher plant height was recorded under residual effect of *Gliricidia sepium* green leaf manuring (108.47 and 113.56 cm) followed by *Leucaena leucocephala* and *Sesbania aculeate* during both the years. Statistically higher dry matter accumulation (Table 1) also observedunder residual effect of *Gliricidia sepium* green leaf manuring (226.75 and 246.60 g $m^{-2}$) followed by *Leucaena leucocephala.* During both the years of investigation the higher values of SPAD (39.05 and 40.14) and leaf area index (3.10 and 3.21) were noted under the residual effect of *Gliricidia sepium* green leaf manuring but the difference was found to be non-significant. However, the lowest values for all growth characters were found under the residual effect of *Pongamia pinnata* green leaf manuring.

Among the N levels, significantly higher residual effect on growth indices of mustard was observed under 100% RDN during both the years of studies (Table 1). The higher plant height (106.85 and 112.07 cm) and dry matter accumulation (217.64 and 241.67 g $m^{-2}$) were registered under the residual effect of 100% RDN during both the years of studies. However, it remained statistically at par with other lower levels of N fertilization. However, leaf area index (Table 1) and SPAD value (Table 2) could not reach the level of significance during both the years. The lowest values were noted under N control during both the years of experimentation. Results obtained showed the addition of *G. sepium* green leaf manure to previous rice cropled to higher growth characters of succeeding mustard as compared to the other green leaf manures, this can be explained by the fact that the *G. sepium* has a low C: N ratio, especially leaves of *G. sepium*, favoring faster decomposition and later supply of N to the crop (Oliveira *et al.*, 2018). In addition, the mixture with twigs may have favored a greater synchronism in the release of nutrients, thus undergo a slower regular release over a longer period (Semwal *et al.,* 2003; Bayala *et al.*, 2005; Oliveira *et al.,* 2018).

**Table 1: Residual effect of GLM and N levels on growth characters of mustard (60 DAS) under rice-mustard cropping sequence.**

| Treatments | Plant height (cm) | | Dry matter accumulation (g $m^{-2}$) | | Leaf area index (LAI) | |
|---|---|---|---|---|---|---|
| | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 |
| **Green leaf manuring @ 10 t $ha^{-1}$** | | | | | | |
| *Sesbania aculeata* | 100.43 | 105.61 | 209.44 | 226.93 | 3.03 | 3.11 |
| *Leucaena leucocephala* | 103.66 | 107.89 | 212.42 | 231.78 | 3.05 | 3.16 |
| *Gliricidia sepium* | 108.47 | 113.56 | 226.75 | 246.60 | 3.10 | 3.21 |
| *Cassia siamea* | 98.28 | 103.43 | 203.95 | 221.32 | 2.96 | 3.06 |
| *Pongamia pinnata* | 97.43 | 101.58 | 200.55 | 215.05 | 2.95 | 3.04 |
| SEm± | 2.50 | 2.70 | 4.64 | 5.79 | 0.09 | 0.10 |
| LSD (*P*=0.05) | 8.14 | 8.82 | 15.14 | 18.89 | NS | NS |
| **Nitrogen levels** | | | | | | |
| Control (N0) | 93.57 | 97.97 | 198.31 | 207.42 | 2.94 | 3.04 |
| 50% RDN | 101.03 | 106.23 | 211.72 | 228.09 | 3.01 | 3.11 |
| 75% RDN | 105.17 | 109.38 | 214.82 | 236.17 | 3.04 | 3.15 |
| 100% RDN | 106.85 | 112.07 | 217.64 | 241.67 | 3.07 | 3.17 |
| SEm± | 1.62 | 1.73 | 3.93 | 4.06 | 0.09 | 0.09 |
| LSD (*P*=0.05) | 4.67 | 4.99 | 11.36 | 11.73 | NS | NS |

**Biological yield.** Residual effect of green leaf manuring and N levels significantly influenced the biological yield of succeeding mustard crop (Table 2). Like seed and stover yield, the residual effect on biological yield was more prominent in second year compared to first year. The significantly higher biological yield (4.73 and 4.90t ha$^{-1}$) of mustard was recorded under residual effect of *Gliricidia sepium* treatment during *rabi* 2018 and 2019, respectively. However, it was found to be statistically at par with *Leucaena leucocephala* and *Sesbania aculeata.* The lowest residual effect on biological yield of succeeding mustard crop was noted with *Pongamia pinnata* during both the years.

In case of N levels, significantly higher residual effect on biological yield (4.71 and 4.87 t ha$^{-1}$) was observed with 100% RDN during 2018 and 2019, respectively. The residual effect of *G. sepium* green manuring is more prominent, this might be due to the higher nutrients transfers into the soil and also increases the decomposition rate of the indigenous soil organic nitrogen, both of which are favorable to the growth of succeeding crops, ultimately resulted in higher biological yield (Hood, 2001). Similar results also noted with the findings of Laxminarayana *et al.,* (2006); Zaharah *et al.,* (2008); Oliveira *et al.,* (2018).

**Table 2: Residual effect of GLM and N levels on Chlorophyll content (SPAD value) at 60 DAS and biological yield (t ha$^{-1}$) of mustard under rice-mustard cropping sequence.**

| Treatments | Chlorophyll content (SPAD value) | | Biological yield (t ha$^{-1}$) | |
|---|---|---|---|---|
| | 2018 | 2019 | 2018 | 2019 |
| **Green leaf manuring @ 10 t ha$^{-1}$** | | | | |
| *Sesbania aculeata* | 38.25 | 39.35 | 4.42 | 4.58 |
| *Leucaena leucocephala* | 38.44 | 39.46 | 4.51 | 4.67 |
| *Gliricidia sepium* | 39.05 | 40.14 | 4.73 | 4.90 |
| *Cassia siamea* | 37.45 | 38.38 | 4.31 | 4.43 |
| *Pongamia pinnata* | 37.38 | 38.34 | 4.14 | 4.20 |
| SEm± | 0.58 | 0.66 | 0.10 | 0.11 |
| LSD (*P*=0.05) | NS | NS | 0.34 | 0.36 |
| **Nitrogen levels** | | | | |
| Control (N0) | 37.28 | 38.25 | 3.96 | 4.10 |
| 50% RDN | 37.99 | 39.06 | 4.41 | 4.52 |
| 75% RDN | 38.44 | 39.44 | 4.61 | 4.74 |
| 100% RDN | 38.74 | 39.77 | 4.71 | 4.87 |
| SEm± | 0.59 | 0.48 | 0.09 | 0.09 |
| LSD (*P*=0.05) | NS | NS | 0.26 | 0.27 |

**Nutrient uptake.** Residual effect of green leaf manuring and N levels significantly influenced the nutrients uptake by mustard crop (Table 3) during both the years of experimentation. In general, the nutrient uptake was slightly higher during second year of experimentation than first year. Significantly higher N (45.55 and 47.78 kg ha$^{-1}$), P (20.31 and 21.27 kg ha$^{-1}$) and K uptake (71.16 and 75.03 kg ha$^{-1}$) was exerted under *Gliricidia sepium* amended plots during *rabi* 2018 and 2019, respectively followed by *Leucaena leucocephala*. While, least residual effect on NPK uptake was found in the *Pongamia pinnata* treated plots. Among the N-doses, significantly higher residual effect on N (44.85 and 47.04 kg ha$^{-1}$), P (20.11 and 21.05 kg ha$^{-1}$) and K (71.02 and 74.44 kg ha$^{-1}$) uptake was observed in 100% RDN fertilized treatment during 2018 and 2019, respectively.

**Table 3: Residual effect of GLM and N levels on NPK uptake (kg ha$^{-1}$) of mustard under rice-mustard cropping sequence.**

| Treatments | N uptake (kg ha$^{-1}$) | | P uptake (kg ha$^{-1}$) | | K uptake (kg ha$^{-1}$) | |
|---|---|---|---|---|---|---|
| | 2018 | 2019 | 2018 | 2019 | 2018 | 2019 |
| **Green leaf manuring @ 10 t ha$^{-1}$** | | | | | | |
| *Sesbania aculeata* | 39.48 | 41.78 | 18.29 | 19.21 | 66.10 | 68.82 |
| *Leucaena leucocephala* | 41.49 | 43.66 | 18.80 | 19.77 | 67.26 | 70.63 |
| *Gliricidia sepium* | 45.55 | 47.78 | 20.31 | 21.27 | 71.16 | 75.03 |
| *Cassia siamea* | 37.04 | 38.62 | 17.41 | 18.09 | 63.92 | 66.21 |
| *Pongamia pinnata* | 33.92 | 35.15 | 16.18 | 16.65 | 60.89 | 62.27 |
| SEm± | 1.17 | 1.33 | 0.43 | 0.43 | 1.36 | 1.86 |
| LSD (*P*=0.05) | 3.80 | 4.33 | 1.40 | 1.41 | 4.43 | 6.06 |
| **Nitrogen levels** | | | | | | |
| Control (N0) | 31.59 | 33.22 | 15.26 | 15.98 | 57.83 | 60.54 |
| 50% RDN | 38.85 | 40.75 | 18.04 | 18.75 | 65.61 | 67.47 |
| 75% RDN | 42.69 | 44.59 | 19.37 | 20.21 | 69.01 | 71.91 |
| 100% RDN | 44.85 | 47.04 | 20.11 | 21.05 | 71.02 | 74.44 |
| SEm± | 0.90 | 0.99 | 0.40 | 0.40 | 1.53 | 1.68 |
| LSD (*P*=0.05) | 2.60 | 2.87 | 1.17 | 1.17 | 4.41 | 4.86 |

However, lowest values were noted under N control treatment during both the years. Nutrient uptake is the multiplicative function of total dry matter and respective nutrient content, thus variation in dry matter accumulation resulted in discrepancy among green leaf manuring for nutrient uptake (Meena *et al.,* 2019). This might be due to higher prolonged nitrogen availability during the crop growth along with greater dry matter production under residual effect of *G. sepium* green leaf manuring led to higher nutrients uptake by mustard. Similar findings were also reported by Mafongoya *et al.,* (2008).

## CONCLUSION

On the basis of present study, it can be inferred that *Gliricidia sepium* green leaf manuring@ 10 t $ha^{-1}$with 120 kg N $ha^{-1}$ to preceding rice crop could have beneficial as residual fertility to succeeding mustard crop in terms of growth, biological yield and nutrient uptake. Thus residual fertility of *Gliricidia sepium* green leaf manuring with 120 kg N $ha^{-1}$ applied to rice crop can be recommended for better growth and nutrients uptake of succeeding mustard crop under agro-climatic conditions of Varanasi region of Eastern Uttar Pradesh.

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**Conflict of Interest.** None.

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