# EFFECT OF MUNGBEAN RESIDUE AND NITROGEN LEVELS ON BARLEY

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### Abstract

A field experiment was conducted to evaluate response of barley to mungbean residue (0, 10, 20 and 30 Mg ha<sup>-1</sup>), nitrogen levels (0, 25, 50 and 75 kg ha<sup>-1</sup>) and their interaction. Emergence  $m^{-2}$  (50), plant height (109 cm), leaf area tiller<sup>-1</sup> (106 cm<sup>2</sup>), lodging score (5.55), termites attack (3.4%), grains spike<sup>-1</sup> (67), biological yield (12.80 Mg ha<sup>-1</sup>) and grain yield (2.32 Mg ha<sup>-1</sup>) were significantly (p=0.05) higher for 30 Mg ha<sup>-1</sup> mungbean residue compared to other levels. Similarly plant height (110 cm), lodging score (5.29) and biological yield (13.75 Mg ha<sup>-1</sup>) were higher at 75 kg ha<sup>-1</sup> N compared to other levels of N. Productive tillers m<sup>-2</sup>, grains spike<sup>-1</sup>, 1000 grain weight, grain yield and harvest index were optimum at 50 kg ha<sup>-1</sup> N as compared to 75 kg ha<sup>-1</sup> N that encouraged lodging. Interaction between residue and nitrogen indicated that 10 Mg residue and 50 kg N ha<sup>-1</sup> is recommended to achieve maximum net return under comparable conditions.

#### Introduction

Barley (*Hordeum vulgare* L.) is the second most important winter cereal in Pakistan (Ahmad *at al.*, 2008). It is used as a major animal feed crop, as traditional food crop in Africa while in US and many other developed countries used for malting and is a key ingredient in beer and whisky production. A small amount is used in health foods and a coffee substitute (Wikipedia, 2009).

Many researches have been conducted on various residue or nitrogen applications to soil. These studies for example, (Salem (2006), Ahmad *et al.*, (2008), Andraski & Bundy (2008), Majumder *et al.*, (2008), Coulter & Nafziger (2008) and Nyiraneza *et al.*, (2009) have shown the practical importance of residue alone or in combination with N to improve soil productivity. However, there is lack of research work on the combine used of mungbean residue and N on barley.

Keeping in view the importance of crop residue and nitrogen, the present study was conducted to evaluate response of barley to incorporation mungbean residue and nitrogen application.

#### **Materials and Methods**

Field experiment was conducted at Malakandher Research Farm, NWFP Agricultural University, Peshawar during rabi season 2003-04 in randomized complete block design with split plot arrangement. In the experiment levels of mungbean residue (0, 10, 20 and 30 Mg ha<sup>-1</sup>) were applied to main plot, while levels of nitrogen (0, 25, 50 and 75 kg ha<sup>-1</sup>) were applied to subplot (2.75 m x 4.5 m) for their effect on barley (cv. Frontier-87). Sowing was done on 1st November 2003 at seed rate of 80 kg ha<sup>-1</sup> with row-to-row distance of 25 cm. The mungbean residue (containing 1.46% total N) levels were incorporated one month before sowing while N was applied in two splits, half at time of sowing and the remaining half was applied 90 days after sowing. Phosphorus @ 25 kg ha<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> at time of sowing was applied uniformly.

**Statistical analysis:** Data recorded for various parameters was individually subjected to the ANOVA and LSD using MSTATC computer software. Dynamic of various parameters was fitted in regression equations that were selected on the basis of  $R^2$  values (Steel & Torrie, 1980).

## **Results and Discussion**

The summarized analysis of variance (Table 1) indicated that mungbean residue had significantly (p=0.05) affected emergence m<sup>-2</sup>, plant height, leaf area tiller<sup>-1</sup>, lodging score, termites damage, grains spike<sup>-1</sup>, 1000-grain weight, biological yield and grain yield of barley, while N levels and interaction significantly affected all the mentioned parameters except emergence m<sup>-2</sup> and termites damage.

| Table 1. Summary of two-way analysis of variance of barley as affected by | y different levels of mungbean |
|---|--------------------------------|
| residue and nitrogen levels.  |                                |

|   | Source of variance   |               |                        |  |  |  |
|---|----------------------|---------------|------------------------|--|--|--|
| Parameter   | Residue (R)          | Nitrogen (N)  | Interaction<br>(R x N) |  |  |  |
| Emergence m <sup>-2</sup>                         | 1621.52 <sup>*</sup> | 7.10          | 4.29                   |  |  |  |
| Plant height (cm)                                 | $726.85^{*}$         | $1144.02^{*}$ | $28.42^{*}$            |  |  |  |
| Leaf area tiller <sup>-1</sup> (cm <sup>2</sup> ) | $2182.22^{*}$        | 2335.72*      | $405.04^{*}$           |  |  |  |
| Lodging score                                     | $69.70^{*}$          | 54.42*        | $4.38^{*}$             |  |  |  |
| Termites damage (%)                               | $25.02^{*}$          | 0.15          | 0.28                   |  |  |  |
| Productive tiller m <sup>-2</sup>                 | 1732.68*             | $2010.02^{*}$ | 3038.11*               |  |  |  |
| Grains spike <sup>-1</sup>                        | 73.77*               | 116.97*       | $180.96^{*}$           |  |  |  |
| 1000-grain weight (g)                             | $27.30^{*}$          | $27.42^{*}$   | $62.52^{*}$            |  |  |  |
| Biological yield (Mg ha <sup>-1</sup> )           | $50.87^{*}$          | $109.71^{*}$  | $4.96^{*}$             |  |  |  |
| Grain yield (Mg ha <sup>-1</sup> )                | $2.10^{*}$           | $2.57^{*}$    | $4.46^{*}$             |  |  |  |

Note: Value in the 2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup> columns represent mean squares.

\*Denotes the level of significance (p=0.05)

The averaged effects of residue on various parameters of barley are shown in Table 2, which shows that emergence  $m^{-2}$  increased with residue levels. Highest emergence  $m^{-2}$  (50 seedlings) was recorded at the highest level (30 Mg ha<sup>-1</sup>) of residue while lowest emergence  $m^{-2}$ (27 seedlings) was recorded in the control plots that revealed favourable effect of mungbean residue for more emergence  $m^{-2}$ . The favourable effect of residue is supported by Singh *et al.*, (2008). Leaf area tiller<sup>-1</sup> showed increase with increase in residue level. Maximum leaf area tiller<sup>-1</sup> of 106 cm<sup>2</sup> was recorded with 30 Mg ha<sup>-1</sup> of residue, followed by 94 cm<sup>2</sup> tiller<sup>-1</sup> with 20 Mg ha<sup>-1</sup> residue, while lowest leaf area tiller<sup>-1</sup> (78 cm<sup>2</sup>) was found in plots grown without residue. The result was probably due to effects of residue on soil quality, soil nitrogen dynamics (Kumar & Goh, 2002).

| Table 2. Effe | ct of different | levels of mung | bean residues or | 1 various | parameters of barley. |
|---------------|-----------------|----------------|------------------|-----------|-----------------------|
| Table 2. Life | ct of uniterent | icvers of mung | ocun residues of | i various | parameters of bariey. |

| Mungbean<br>residue<br>(Mg ha <sup>-1</sup> ) | Emergence<br>(m <sup>-2</sup> ) | Leaf area<br>tiller <sup>-1</sup> (cm <sup>2</sup> ) | Plant height<br>(cm) | Lodging<br>score | Termites<br>damage (%) | Productive<br>tillers (m <sup>-2</sup> ) | Grains<br>spike <sup>-1</sup> | 1000-grain<br>weight (g) | Biological<br>yield<br>(Mg ha <sup>-1</sup> ) | Grain yield<br>(Mg ha <sup>-1</sup> ) |
|---|---------------------------------|--|----------------------|------------------|------------------------|--|-------------------------------|--------------------------|---|---------------------------------------|
| 0   | 27 d                            | 78 d   | 94 d                 | 0.84 d           | 0.7 b                  | 59 c                                     | 62 c                          | 37.0 b                   | 8.64 d  | 1.47 c                                |
| 10  | 32 c                            | 86 c   | 98 c                 | 1.55 c           | 0.09 b                 | 73 b                                     | 65 b                          | 39.6 a                   | 10.09 c                                       | 2.01 b                                |
| 20  | 40 b                            | 94 b   | 104 b                | 3.11 b           | 1.3 b                  | 82 a                                     | 65 b                          | 39.7 a                   | 11.44 b                                       | 2.10 b                                |
| 30  | 50 a                            | 106 a  | 109 a                | 5.55 a           | 3.4                    | 80 a                                     | 67 a                          | 39.4 a                   | 12.80 a                                       | 2.32 a                                |
| LSD(0.05)                                     | 4.0                             | 4.0  | 3.0                  | 0.62             | 0.8                    | 6.0                                      | 1.0                           | 2.1                      | 0.85  | 0.21                                  |

Plant height showed an increasing trend with various levels of residue application. Residue applied @ 30 Mg ha<sup>-1</sup> showed maximum plant height of 109 cm, while lowest plant height of 94 cm was observed in plots without residue incorporation. The increasing trend of plant height was reasoned to favourable condition of growth provided by residue. Lodging score was maximum (5.55) @ 30 Mg ha<sup>-1</sup> residue, while minimum lodging score (0.84) was observed in plots without residue incorporation. The increasing trend in lodging score was consequence of increased plant height. Percent plants affected by termites revealed that maximum termite damage (3.4%) was recorded with 30 Mg residue ha<sup>-1</sup>, while lowest percent plants affected by termites (0.7%)were observed with no residue application. This was reasoned to attraction of termites toward the residue (Nwilene et al., 2008). Productive tillers m<sup>-2</sup> increased with increase in residue level up to 20 Mg ha<sup>-1</sup> but no further increase was noticed at 30 Mg ha<sup>-1</sup>. Highest number of productive tillers m<sup>-2</sup> (82) were recorded with 20 Mg residue ha<sup>-1</sup>, while lowest number of productive tillers  $m^{-2}$  (59) were observed without residue incorporation. Grains spike-1 increased with residue incorporation. More grains spike<sup>-1</sup> (67) were recorded with 30 Mg residue ha<sup>-1</sup> and it was at par with 20 Mg residue ha<sup>-1</sup>, while lowest number of grains spike<sup>-1</sup> (62) were observed without residue application. Thousand grain weight showed increase with residue up to 20 Mg ha<sup>-1</sup> while beyond that it did not increase with increase in residue level. Minimum 1000 grain weight (37 g) was observed in plots without residue application. Biological yield indicated increasing trends in response to residue levels. Increase in biological yield was noticed with increase in residue level. Highest biological yield (12.80 Mg ha<sup>-1</sup>) was observed with 30 tons residue ha<sup>-1</sup>, while lowest biological yield (8.64 Mg ha-1) was recorded in control plots. The results are supported by the findings of shah et al., (2003) who reported that application of residue increased dry matter yield. Grain yield significantly increased with application of residue. Highest grain yield (2.32 Mg ha<sup>-1</sup>) was obtained with 30 Mg residue ha<sup>-1</sup>, while lowest grain yield (1.47 Mg ha<sup>-1</sup>) was observed when no residue was used. Increase in various yield components and grain yield with application of residue has been reported by many researchers (Kumar & Goh, 2002; Shah et al., 2003; Shafi et al., 2007; Jan et al., 2010; Khan et al., 2010).

The response of various parameters of barley to nitrogen levels is shown in Table 3. Emergence m<sup>-2</sup> was not affected by N levels. Leaf area tiller<sup>-1</sup> increased from 77 to 99 cm<sup>2</sup> tiller<sup>-1</sup> for increasing nitrogen level up to 50 kg ha-1. Further increase in nitrogen did not cause significant increase in leaf area tiller-1. Plant height increased with increase in nitrogen level. Maximum plant height of 110 cm was recorded with 75 kg N ha<sup>-1</sup>, while plant height was lowest (91 cm) in plots grown without N application. Lodging score increased linearly with increase in nitrogen level. Maximum lodging score of 5.29 was recorded with 75 kg N ha<sup>-1</sup>, while lodging score was lowest (1.09) in plots grown without N application. Termite damage showed non-significant results to N levels. Productive tillers m<sup>-2</sup> indicated a quadratic response to increase in N level. Maximum number of productive tillers m<sup>-2</sup> (87) were recorded with 50 kg N ha<sup>-</sup> <sup>1</sup>, while lowest number of productive tillers (64) were recorded with no N application. Productive tillers m<sup>-2</sup> decreased when nitrogen was increased up to 75 kg ha<sup>-1</sup>. Grain spike<sup>-1</sup> showed quadratic increase with increase in N. Maximum number of grains spike<sup>-1</sup> (67) were observed with 50 kg N ha<sup>-1</sup>, which was at par with 25 kg N ha<sup>-1</sup>. Lowest number of grains spike<sup>-1</sup> (62) were observed without N application. Thousand grain weight increased with increase in nitrogen level up to 50 kg ha<sup>-1</sup> but decreased at the highest level of N (75 kg ha-1). Highest 1000 grain weight (40 g) was recorded with 50 kg N ha<sup>-1</sup> and it was at par with 25 kg N ha-1. Biological yield increased linearly with increase in nitrogen levels. Maximum biological yield (13.75 Mg ha<sup>-1</sup>) was observed with 75 kg N ha<sup>-1</sup>, while lowest biological yield (7.48 Mg ha<sup>-1</sup>) was observed without N application. Nitrogen is an essential plant nutrient so the increase in various growth and yield components with application of nitrogen to certain level has occurred. Nitrogen did not attract termite while beyond certain level cause lodging. The findings (Table 3) are supported by Khan et al., (2000), López-Bellido et al., (2000), Shah et al., (2003), Salem (2006), Zeidan (2007), Sicher & Bunce (2008). Grain yield gave quadratic response to N application. Highest grain yield (2.44 Mg ha<sup>-1</sup>) was recorded with 50 kg N ha<sup>-1</sup>; however it was at par with 25 kg N ha<sup>-1</sup>. Lowest grain yield of 1.61 Mg ha<sup>-1</sup> was observed in control plots. It was reasoned to the fact that nitrogen beyond optimum could not increase yield (López-Bellido et al., 2000).

| Mungbean<br>residue<br>(Mg ha <sup>-1</sup> ) | Emergence<br>(m <sup>-2</sup> ) | Leaf area<br>tiller <sup>-1</sup> (cm <sup>2</sup> ) | Plant height<br>(cm) | Lodging<br>score | Termites<br>damage (%) | Productive<br>tillers (m <sup>-2</sup> ) | Grains<br>spike <sup>-1</sup> | 1000-grain<br>weight (g) | Biological<br>yield<br>(Mg ha <sup>-1</sup> ) | Grain yield<br>(Mg ha <sup>-1</sup> ) |
|---|---------------------------------|--|----------------------|------------------|------------------------|--|-------------------------------|--------------------------|---|---------------------------------------|
| 0   | 37                              | 77 c   | 91 d                 | 1.09 d           | 1.5                    | 64 c                                     | 62 b                          | 37.5 b                   | 7.48 d  | 1.61 b                                |
| 10  | 40                              | 86 b   | 99 c                 | 1.76 c           | 1.5                    | 79 b                                     | 67 a                          | 39.7 a                   | 10.21 c                                       | 2.18 a                                |
| 20  | 40                              | 99 a   | 105 b                | 2.91 b           | 1.7                    | 87 a                                     | 67 a                          | 40.3 a                   | 11.52 b                                       | 2.44 a                                |
| 30  | 39                              | 103 a  | 110 a                | 5.29 a           | 1.6                    | 65 c                                     | 63 b                          | 38.2 b                   | 13.75 a                                       | 1.66 b                                |
| LSD(0.05)                                     | ns                              | 4.0  | 2.0                  | 0.40             | ns                     | 7.0                                      | 2.0                           | 1.3                      | 0.98  | 0.26                                  |

Table 3.Effect of different levels of nitrogen on various parameters of barley.

 Table 4. Maximum values of interactions for different parameters of barley taken from all possible interactions between residue levels and nitrogen levels

|   | ieveis.     |              |                         |  |
|---|-------------|--------------|-------------------------|--|
|   | Source of   | Maximum      |                         |  |
| Parameter   | Residue (R) | Nitrogen (N) | value of<br>interaction |  |
| <sup>¥</sup> Emergence m <sup>-2</sup>            | -           | -            | -                       |  |
| Plant height (cm)                                 | 30          | 75           | 116                     |  |
| Leaf area tiller <sup>-1</sup> (cm <sup>2</sup> ) | 30          | 50           | 109                     |  |
| <sup><i>\lambda</i></sup> Lodging score           | 30          | 75           | 9                       |  |
| <sup>¥</sup> Termites damage (%)                  | -           | -            | -                       |  |
| Productive tiller m <sup>-2</sup>                 | 20          | 25           | 124                     |  |
| Grains spike <sup>-1</sup>                        | 20          | 25           | 75                      |  |
| 1000-grain weight (g)                             | 20          | 25           | 44                      |  |
| Biological yield (Mg ha <sup>-1</sup> )           | 30          | 75           | 15.36                   |  |
| *Grain yield (Mg ha <sup>-1</sup> )               | 10          | 50           | 3.64                    |  |

<sup>¥</sup>Indicate no interaction.

\*The interaction was at par with 20 Mg residue x 25 kg N ha<sup>-1</sup>.

<sup>λ</sup>Lowest lodging score of 0.20 was observed without residue and N application

Biological yield was highest (15.36 Mg ha<sup>-1</sup>) in combination of 30 tons residue x 75 kg N ha<sup>-1</sup> while higher grain yield (3.64 Mg ha<sup>-1</sup>) was recorded with 10 tons residue x 50 kg N ha<sup>-1</sup> application, which was at par with 20 ton residue x 25 kg N ha<sup>-1</sup>. The results for interaction may be reasoned to the fact that N is only source of nutrient while residue improves overall soil properties for better crop production (Chen *et al.*, 2004; Nyiraneza *et al.*, 2009).

Regression equations for response of various parameters to application of residue levels are shown in Table 5. The relationships of emergence, leaf area, plant height, lodging score, termites attack, productive tiller, grains spike<sup>-1</sup> and grain yield on the basis of  $R^2$  showed best fitting in quadratic equations while biological yield in a linear equation.

Maximum values of RxN interactions are presented in Table 4. The interaction of RxN for plant height showed that maximum plant height of 116 cm was recorded with 30 Mg residue x 75 kg N ha<sup>-1</sup>. Leaf area tiller<sup>-1</sup> showed significant higher leaf area (109 cm<sup>2</sup>) for 30 Mg residue x 50 kg N ha<sup>-1</sup>. Maximum lodging score of 9 was recorded with 30 tons residue x 75 kg N ha-1, while lowest lodging score of 0.20 was observed without residue and N application. The interaction study for number of productive tillers m<sup>-2</sup>, number of grains spike<sup>-1</sup>, 1000 grain weight showed maximum values of 124, 75 and 44 respectively in plots supplied with 20 tons residue x 25 kg N ha<sup>-1</sup>.

Like residue levels regression equations for effect of nitrogen levels on various barley parameters is shown in Table 6. In these regression equations all except termites attack fitted on a linear equation on basis of  $R^2$  while all other parameters (emergence, leaf area, plant height, lodging score, grains spike<sup>-1</sup>, 1000-grain weight, biological yield and grain yield) showed best fitting in quadratic equations.

It can be concluded from the present study that application of crop residues significantly increased the plant growth, yield and yield components of barley. The residue application has interaction with N as 10 Mg residue and 50 kg N ha<sup>-1</sup> was recommended to achieve maximum net return. Mungbean in rotation with barley may the option to directly apply mungbean residue and minimize dependency on fertilizer N application for enhanced growth and yield of barley.

Table 5. Relationship between residue level (X) and dependent variable (emergence, leaf area, plant height, termites attack, grains spike<sup>-1</sup>, lodging score, biological yield and grain yield) derived from

| data over the crop grown period of barley.        |   |                       |  |  |
|---|---|-----------------------|--|--|
| Dependent variable                                | Regression equation                                       | <b>R</b> <sup>2</sup> |  |  |
| Emergence m <sup>-2</sup>                         | Emergence $m^{-2} = 26.95 + 0.395x + 0.0125x^{2}$         | $0.99^{**}$           |  |  |
| Plant height (cm)                                 | Plant height = $93.85 + 0.435x + 0.0025x^2$               | $0.99^{**}$           |  |  |
| Leaf area tiller <sup>-1</sup> (cm <sup>2</sup> ) | Leaf area tiller <sup>-1</sup> = $78.2 + 0.62x + 0.01x^2$ | $0.99^{**}$           |  |  |
| Lodging score                                     | Lodging score = $0.8415 + 0.0271x + 0.0043x^2$            | 1**                   |  |  |
| Termites damage (%)                               | Termite damage = $0.775 - 0.0575x + 0.0048x^2$            | $0.97^{**}$           |  |  |
| Productive tiller m <sup>-2</sup>                 | Productive tiller = $58.7 + 1.92x - 0.04x^2$              | $0.99^{**}$           |  |  |
| Grains spike <sup>-1</sup>                        | Grains spike <sup>-1</sup> = $62.25 + 0.225x - 0.0025x^2$ | $0.90^{**}$           |  |  |
| 1000-grain weight (g)                             | 1000-grain weight = $37.105 + 0.2905x - 0.0072x^2$        | $0.95^{**}$           |  |  |
| Biological yield (Mg ha <sup>-1</sup> )           | Biological yield = $8.668 + 0.1383x$                      | $0.99^{**}$           |  |  |
| Grain yield (Mg ha <sup>-1</sup> )                | Grain yield = $1.499 + 0.0504x - 0.0008x^2$               | $0.95^{**}$           |  |  |
| ** 0  |   |                       |  |  |

\*\*Significant at p=0.01

| Dependent variable                                | Regression equation  | <b>R</b> <sup>2</sup> |
|---|--|-----------------------|
| Emergence m <sup>-2</sup>                         | Emergence $m^{-2} = 37.1 + 0.144x - 0.0016x^2$               | 0.96**                |
| Plant height (cm)                                 | Plant height = $91.05 + 0.342x - 0.0012x^2$                  | $0.99^{**}$           |
| Leaf area tiller <sup>-1</sup> (cm <sup>2</sup> ) | Leaf area tiller <sup>-1</sup> = $76.35 + 0.514x - 0.002x^2$ | $0.98^{**}$           |
| Lodging score                                     | Lodging score = $1.1275 + 0.0037x + 0.0007x2$                | $0.99^{**}$           |
| Termites damage (%)                               | Termite damage = $1.5 + 0.002x$                              | $0.45^{**}$           |
| Productive tiller m <sup>-2</sup>                 | Productive tiller = $62.85 + 1.154x - 0.0148x^2$             | $0.92^{**}$           |
| Grains spike <sup>-1</sup>                        | Grains spike <sup>-1</sup> = $62.05 + 0.282x - 0.0036x^2$    | $0.99^{**}$           |
| 1000-grain weight (g)                             | 1000-grain weight = $37.445 + 0.1398x - 0.0017x^2$           | $0.98^{**}$           |
| Biological yield (Mg ha <sup>-1</sup> )           | Biological yield = $7.597 + 0.0955x - 0.0002x^2$             | $0.98^{**}$           |
| Grain yield (Mg ha <sup>-1</sup> )                | Grain yield = $1.5735 + 0.0421x - 0.0005x^2$                 | 0.94**                |

Table 6. Relationship between nitrogen level (X) and dependent variable (emergence, leaf area, plant height, termites attack, grains spike<sup>-1</sup>, lodging score, biological yield and grain yield) derived from data over the crop growth period of barley.

\*\*Significant at p = 0.01

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