Pak. J. Bot., 43(4): 1905-1908, 2011.

EFFECT OF MUNGBEAN RESIDUE AND NITROGEN LEVELS ON BARLEY

AMANULLAH JAN[1], IHSANULLAH DAUR[2], ZAR MUHAMMAD[1] AND IJAZ AHMAD KHAN[3]

[1]*Department of Agronomy, NWFP Agricultural University Peshawar, Pakistan.*
[2]*Department of Arid Land Agriculture, Faculty of Meteorology, Environment, and Arid Land Agriculture, King Abdul Aziz University, Saudi Arabia*
[3]*Department of Weed Science, NWFP Agricultural University Peshawar, Pakistan.*

Abstract

A field experiment was conducted to evaluate response of barley to mungbean residue (0, 10, 20 and 30 Mg ha^{-1}), nitrogen levels (0, 25, 50 and 75 kg ha^{-1}) and their interaction. Emergence m^{-2} (50), plant height (109 cm), leaf area tiller^{-1} (106 cm²), lodging score (5.55), termites attack (3.4%), grains spike^{-1} (67), biological yield (12.80 Mg ha^{-1}) and grain yield (2.32 Mg ha^{-1}) were significantly (p=0.05) higher for 30 Mg ha^{-1} mungbean residue compared to other levels. Similarly plant height (110 cm), lodging score (5.29) and biological yield (13.75 Mg ha^{-1}) were higher at 75 kg ha^{-1} N compared to other levels of N. Productive tillers m^{-2}, grains spike^{-1}, 1000 grain weight, grain yield and harvest index were optimum at 50 kg ha^{-1} N as compared to 75 kg ha^{-1} N that encouraged lodging. Interaction between residue and nitrogen indicated that 10 Mg residue and 50 kg N ha^{-1} 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^{-1}) were applied to main plot, while levels of nitrogen (0, 25, 50 and 75 kg ha^{-1}) 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^{-1} 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^{-1} P_2O_5 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^{-2}, plant height, leaf area tiller^{-1}, lodging score, termites damage, grains spike^{-1}, 1000-grain weight, biological yield and grain yield of barley, while N levels and interaction significantly affected all the mentioned parameters except emergence m^{-2} and termites damage.

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

Parameter	Source of variance		
	Residue (R)	Nitrogen (N)	Interaction (R x N)
Emergence m^{-2}	1621.52*	7.10	4.29
Plant height (cm)	726.85*	1144.02*	28.42*
Leaf area tiller^{-1} (cm²)	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^{-2}	1732.68*	2010.02*	3038.11*
Grains spike^{-1}	73.77*	116.97*	180.96*
1000-grain weight (g)	27.30*	27.42*	62.52*
Biological yield (Mg ha^{-1})	50.87*	109.71*	4.96*
Grain yield (Mg ha^{-1})	2.10*	2.57*	4.46*

Note: Value in the 2nd, 3rd, and 4th 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^{-1}) 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 $tiller^{-1}$ showed increase with increase in residue level. Maximum leaf area $tiller^{-1}$ of 106 cm^2 was recorded with 30 Mg ha^{-1} of residue, followed by 94 cm^2 $tiller^{-1}$ with 20 Mg ha^{-1} residue, while lowest leaf area $tiller^{-1}$ (78 cm^2) 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. Effect of different levels of mungbean residues on various parameters of barley.

Mungbean residue (Mg ha^{-1})	Emergence (m^{-2})	Leaf area $tiller^{-1}$ (cm^2)	Plant height (cm)	Lodging score	Termites damage (%)	Productive tillers (m^{-2})	Grains $spike^{-1}$	1000-grain weight (g)	Biological yield (Mg ha^{-1})	Grain yield (Mg ha^{-1})
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^{-1} 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^{-1} 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^{-1}, 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^{-2} increased with increase in residue level up to 20 Mg ha^{-1} but no further increase was noticed at 30 Mg ha^{-1}. Highest number of productive tillers m^{-2} (82) were recorded with 20 Mg residue ha^{-1}, while lowest number of productive tillers m^{-2} (59) were observed without residue incorporation. Grains $spike^{-1}$ increased with residue incorporation. More grains $spike^{-1}$ (67) were recorded with 30 Mg residue ha^{-1} and it was at par with 20 Mg residue ha^{-1}, while lowest number of grains $spike^{-1}$ (62) were observed without residue application. Thousand grain weight showed increase with residue up to 20 Mg ha^{-1} 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^{-1}) was observed with 30 tons residue ha^{-1}, 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^{-1}) was obtained with 30 Mg residue ha^{-1}, while lowest grain yield (1.47 Mg ha^{-1}) 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^{-2} was not affected by N levels. Leaf area $tiller^{-1}$ increased from 77 to 99 cm^2 $tiller^{-1}$ 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^{-1}, 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^{-1}, 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^{-2} indicated a quadratic response to increase in N level. Maximum number of productive tillers m^{-2} (87) were recorded with 50 kg N ha^{-1}, while lowest number of productive tillers (64) were recorded with no N application. Productive tillers m^{-2} decreased when nitrogen was increased up to 75 kg ha^{-1}. Grain $spike^{-1}$ showed quadratic increase with increase in N. Maximum number of grains $spike^{-1}$ (67) were observed with 50 kg N ha^{-1}, which was at par with 25 kg N ha^{-1}. Lowest number of grains $spike^{-1}$ (62) were observed without N application. Thousand grain weight increased with increase in nitrogen level up to 50 kg ha^{-1} 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^{-1} 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^{-1}) was observed with 75 kg N ha^{-1}, while lowest biological yield (7.48 Mg ha^{-1}) 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^{-1}) was recorded with 50 kg N ha^{-1}; however it was at par with 25 kg N ha^{-1}. Lowest grain yield of 1.61 Mg ha^{-1} was observed in control plots. It was reasoned to the fact that nitrogen beyond optimum could not increase yield (López-Bellido *et al*., 2000).

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

Mungbean residue (Mg ha^{-1})	Emergence (m^{-2})	Leaf area tiller^{-1} (cm²)	Plant height (cm)	Lodging score	Termites damage (%)	Productive tillers (m^{-2})	Grains spike^{-1}	1000-grain weight (g)	Biological yield (Mg ha^{-1})	Grain yield (Mg ha^{-1})
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 4. Maximum values of interactions for different parameters of barley taken from all possible interactions between residue levels and nitrogen levels.

Parameter	Source of interaction		Maximum value of interaction
	Residue (R)	Nitrogen (N)	
¥Emergence m^{-2}	-	-	-
Plant height (cm)	30	75	116
Leaf area tiller^{-1} (cm²)	30	50	109
λLodging score	30	75	9
¥Termites damage (%)	-	-	-
Productive tiller m^{-2}	20	25	124
Grains spike^{-1}	20	25	75
1000-grain weight (g)	20	25	44
Biological yield (Mg ha^{-1})	30	75	15.36
*Grain yield (Mg ha^{-1})	10	50	3.64

¥Indicate no interaction.
*The interaction was at par with 20 Mg residue x 25 kg N ha^{-1}.
λLowest lodging score of 0.20 was observed without residue and N application

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^{-1}. Leaf area tiller^{-1} showed significant higher leaf area (109 cm²) for 30 Mg residue x 50 kg N ha^{-1}. 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^{-2}, number of grains spike^{-1}, 1000 grain weight showed maximum values of 124, 75 and 44 respectively in plots supplied with 20 tons residue x 25 kg N ha^{-1}.

Biological yield was highest (15.36 Mg ha^{-1}) in combination of 30 tons residue x 75 kg N ha^{-1} while higher grain yield (3.64 Mg ha^{-1}) was recorded with 10 tons residue x 50 kg N ha^{-1} application, which was at par with 20 ton residue x 25 kg N ha^{-1}. 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^{-1} and grain yield on the basis of R^2 showed best fitting in quadratic equations while biological yield in a linear equation.

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^{-1}, 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^{-1} 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^{-1}, lodging score, biological yield and grain yield) derived from data over the crop growth period of barley.

Dependent variable	Regression equation	R^2
Emergence m^{-2}	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^{-1} (cm²)	Leaf area tiller^{-1} = 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^{-2}	Productive tiller = 58.7 + 1.92x - 0.04x^2	0.99**
Grains spike^{-1}	Grains spike^{-1} = 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^{-1})	Biological yield = 8.668 + 0.1383x	0.99**
Grain yield (Mg ha^{-1})	Grain yield = 1.499 + 0.0504x - 0.0008x^2	0.95**

**Significant at p=0.01

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

Dependent variable	Regression equation	R^2
Emergence m^{-2}	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^{-1} (cm²)	Leaf area tiller^{-1} = 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^{-2}	Productive tiller = 62.85 + 1.154x - 0.0148x^2	0.92**
Grains spike^{-1}	Grains spike^{-1} = 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^{-1})	Biological yield = 7.597 + 0.0955x - 0.0002x^2	0.98**
Grain yield (Mg ha^{-1})	Grain yield = 1.5735 + 0.0421x - 0.0005x^2	0.94**

**Significant at p = 0.01

References

Ahmad, R., M. Arshad, Z.A. Zahir, M. Naveed, M. Khalid And H.N. Asghar. 2008. Integrating N-enriched compost with biologically active substances for improving growth and yield of cereals. *Pak. J. Bot.*, 40(1): 283-293.

Ahmad, Z., S.U. Ajmal, M. Munir, M. Zubair and M.S. Masood. 2008. Genetic diversity for morpho-genetic traits in barley germplasm. *Pak. J. Bot*., 40(3): 1217-1224.

Andraski, T.W. and L.G. Bundy. 2008. Corn residue and nitrogen source effects on nitrogen availability in no-till corn. *Agron. J*., 100: 1274-1279.

Chen, C., M. Westcott, K. Neill, D. Wichman and M. Knox. 2004. Row configuration and nitrogen application for barley–pea intercropping in Montana. *Agron. J*., 96: 1730-1738.

Coulter, J.A. and E.D. Nafziger. 2008. Continuous corn response to residue management and nitrogen fertilization. *Agron. J*., 100: 1774-1780.

Jan, M.T., M.J. Khan, A. Khan, M. Arif, M. Shafi and Farmanullah. 2010. Wheat nitrogen indices response to nitrogen source and application time. *Pak. J. Bot.*, 42(6): 4267-4279.

Khan, A., M. Khan and M. Azam. 2000. Agro-economic traits of dryland barley as influenced by NP fertilizer application. *Pak. J. Biol. Sci*., 3(10): 1637-1638.

Khan, A., M.T. Jan, K.B. Marwat and M. Arif. 2009. Organic and inorganic nitrogen treatments effects on plant and yield attributes of maize in a different tillage systems. *Pak. J. Bot.*, 41(1): 99-108.

Kumar, K. and K.M. Goh. 2002. Crop residues and management practices: Effects on soil quality, soil nitrogen dynamics, crop yields and nitrogen recovery. *Advances in Agron*., 68:197-317.

López-Bellido, L., R.J. López-Bellido, J.E. Castillo and F.J. López-Bellido. 2000. Effects of tillage, crop rotation, and nitrogen fertilization on wheat under rainfed Mediterranean conditions. *Agron. J.*, 92: 1054-1063.

Majumder, B., B. Mandal, P.K. Bandyopadhyay, A. Gangopadhyay, P.K. Mani, A.L. Kundu and D. Mazumdar. 2008. Organic amendments influence soil organic carbon pools and rice–wheat productivity. *Soil Sci. Soc. Am. J*., 72: 775-785.

Nwilene, F.E., T.A. Agunbiade, A. Togola, O. Youm, O. Ajayi, S. O. Oikeh, S. Ofodile and O.O. Falola. 2008. Efficacy of traditional practices and botanicals for the control of termites on rice at Ikenne, Nigeria. *Int. J. of Trop. Insect Sci*., 28(1): 37-44.

Nyiraneza, J., M.H. Chantigny, A. N'Dayegamiye and M.R. Laverdière. 2009. Dairy cattle manure improves soil productivity in low residue rotation systems. *Agron. J*., 101: 207-214.

Salem, A.K.M. 2006. Effect of nitrogen levels, plant spacing and time of farmyard manure application on the productivity of rice. *J. of Applied Sci. Res*., 2(11): 980-987.

Shafi, M., J. Bakht, M.T. Jan and Z. Shah. 2007. Soil C and N dynamics and maize (*Zea mays*) yield as affected by cropping systems and residue management in Northwestern Pakistan. *Soil and Till. Res*., 94: 520-529.

Shah, Z., S.H. Shah, M.B. Peoples, G.D. Schwenke and D.F. Herriedge. 2003. Crop residue and fertilizer N effects on nitrogen fixation and yields of legume–cereal rotations and soil organic fertility. *Field Crops Res*., 83: 1-11.

Sicher, R.C. and J.A. Bunce. 2008. Growth, photosynthesis, nitrogen partitioning and responses to CO2 enrichment in a barley mutant lacking NADH-dependent nitrate reductase activity. *Physiol Plant*., 134(1):31-40.

Singh, K.K., Ch. Srinivasarao and M. Ali. 2008. Phosphorous and mung bean residue incorporation improve soil fertility and crop productivity in sorghum and mungbean-lentil cropping system. *J. of Plant Nutrition*, 31(3): 459-471.

Steel, R.G.D. and J.H. Torrie. 1980. *Principles and procedures of statistics*. McGraw Hill Book Co., Inc. (New York), 481 pp.

Wikipedia, the free encyclopedia. http://en.wikipedia.org/wiki/Barley. Retrieved on 05 February 2009.

Zeidan, M.S. 2007. Response of some barley cultivars to nitrogen sources and rates grown in alkaline sandy soil. *Res. J. of Agric. and Bio. Sci*., 3(6): 934-938.

(Received for publication 23 January 2009)