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Response of Mungbean to Various Levels of Biochar, Farmyard Manure and Nitrogen

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Abstract: The experiment was conducted at the Agronomy Farm of The University of Agriculture, Peshawar, Pakistan during summer 2014 in a randomized complete block design (RCBD) with split plot arrangement having three replications. The experiment comprised of 13 fertilizer treatments. Biochar application at three levels (0, 25 and 50 ton ha^{-1}), farmyard manure (FYM) at two levels (5 and 10 ton ha^{-1}) and nitrogen (N) at two levels (recommended and half of the recommended i.e. 30 and 15 kg N ha^{-1}) and a control with all the three at nil level were included in the experiment. Biochar application at the rate of 25 ton ha $^{-1}$ resulted in higher seed yield (639 kg ha^{-1}) as compared to control (579 kg ha^{-1}) and 50 ton ha^{-1} (626 kg ha^{-1}). Nitrogen at the rate of 30 kg ha^{-1} produced higher seed yield (625 kg ha^{-1}) as compared to 15 kg ha^{-1} (605 kg ha^{-1}). Similarly, FYM which produced higher seed yield (631 kg ha^{-1}) at 10 ton ha^{-1} as compared to 5 ton ha^{-1}(599 kg ha^{-1}). All the parameters were significantly affected by FYM and mineral nitrogen, except emergence m^{-2} for both and number of seeds pod^{-1} for FYM only. Higher branches plant^{-1} (10.50), pods plant^{-1} (20.06), number of seeds pod^{-1} (11.94), thousand seed weight (48.93 kg ha^{-1}), seed yield (631 kg ha^{-1}) and biological yield (4390 kg ha^{-1}) was counted in plots treated with FYM at the rate of 10 ton ha^{-1} as compared to 5 ton ha^{-1} which gives lower number of branches plant^{-1} (9.86), pods plant^{-1} (18.92), number of seeds pod^{-1} (11.56), thousand seed weight (45.67 kg ha^{-1}), seed yield (599 kg ha^{-1}) and biological yield (4135 kg ha^{-1}). Number of branches plant^{-1} (10.52), pods plant^{-1} (20.24), number of seeds pod^{-1} (12.22), thousand seed weight (49.11kg ha^{-1}), seed yield (625 kg ha^{-1}) and biological yield (4330.94 kg ha^{-1}) were higher in plots fertilized with N at the rate of 30 kg ha^{-1} as compared to N at rate of 15 kg ha^{-1} which gives lower number of branches plant^{-1} (9.84), pods plant^{-1} (18.74), number of seeds pod^{-1}(11.28), thousand seed weight (45.49 kg ha^{-1}), seed yield (605 kg ha^{-1}) and biological yield (4135 kg ha^{-1}). Hence application of biochar at the rate of 25 ton ha^{-1} in combination with FYM and mineral nitrogen at the rate of 10 ton ha^{-1} and 30 kg, respectively is recommended for improving mungbean productivity.

Key words:

INTRODUCTION

Mungbean (*Vigna radiata* L.) is an important pulse crop mainly grown in summer. Its seeds is main source of protein and carbohydrates. It contains 51% carbohydrates, 26% proteins, 10% moisture, 4% mineral and 3% vitamins. It can be used as a food and feed crop and its residues have manure value. Pakistan is an Agricultural country with limited land and water resources and high population growth rate. Growing more food is the demand of the day and we have to produce more food due our large house population. Our cropping pattern mainly depends on cereal crops in order to meet the increased demand of food. Besides this, due to high population pressure the total cultivable land is decreasing day by day for housing. That's why pulses cultivation has shifted to marginal land because farmers are not interested to use their fertile land in pulses cultivation. Pulses cultivation loses its importance because of low yield and production. Being major food crops, cereal are given importance over pulses in cropping system of Pakistan especially Khyber Pakhtunkhwa. Besides this, continuous cereal farming also affects soil fertility and productivity because they are exhaustive crops.

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Therefore, to control soil degradation and deterioration, inclusion of pulses especially mungbean getting importance in the cropping pattern of Khyber Pakhtunkhwa especially southern areas. Also among the pulse crops, mungbean has supreme importance in intensive cropping of Pakistan for its short growing period and best utilization of summer gape in most regions of the country.

Mungbean play key role in supplementation of protein in the cereal-based low-protein diet of Pakistan peoples, but the acreage and production of mungbean is steadily declining. There are many reasons of lower yield of mungbean. Fertilizer management is the imperative one that unanimously affects the growth, development and yield of mungbean. Being leguminous crop, mungbean has the ability to fix atmospheric nitrogen. There is evident that application of N fertilizers becomes helpful in improving mungbean yield. Nitrogen is important for mungbean because it's the major component of protein and amino acid. In order to overcome its lag phase mungbean responds well to added nitrogen fertilizers. Nitrogen influences the uptake of other nutrients by promoting root growth and nodulation in mungbean [1]. However, Commercial fertilizers are harmful to soil and aerial environment and a threat to entire globe, because the inorganic fertilizers mainly contain major nutrients NPK in large quantities and are neglecting the use of organic manures and bio-fertilizers and hence have paved the way for deterioration of soil health and in turn ill-effects on plants, human and livestock.

In spite of the fact that inorganic fertilizers boost the crop yield, however, continuous application of inorganic fertilizers could not be adopted because it degrades soil health. In such situation organic fertilizers (FYM) could be supplemented in combination with inorganic fertilizers. Application of FYM with synthetic fertilizers has been observed to improve fertilizer use efficiency in Pakistan. Crop productivity of marginal land could be restored by application of FYM with inorganic fertilizer. Crop residues and application of FYM to soil, both could affect the diversity of soil microbial community and increase the crop growth and yield.

Biochar is considered as soil conditioner that convincingly affects various soil physio-chemical properties and ultimately improves crop yield and production [2]. Biochar hold great promise as a source of multiple nutrients and ability to improve soil characteristics. It also preserves the ecosystem by carbon sequestration [3]. By charring (burning) the organic material, much of the carbon becomes "fixed" into a more stable form and when the resulting biochar is applied to soils, the carbon is effectively sequestered. It is estimated that use of this method to "tie up" carbon has the potential to reduce current global carbon emission by as much as 10%, with the application of biochar optimum soil biological activities could be ensured to maintain soil fertility and improve crop yield.

In order to improve mungbean yield and at the same time maintain soil health, the present study was conducted to investigate the suitable levels of organic and inorganic sources of nutrients at different levels of biochar.

MATERIALS AND METHODS

The experiment was conducted at Agronomy Research Farm of The University of Agricultural Peshawar during summer 2014. Biochar application at three levels (0, 5 and 10 tons ha^{-1}), farmyard manure (FYM) at two levels (5 and 10 ton ha^{-1}) and nitrogen (N) at two levels (recommended and half of the recommended i.e. 30 and 15 kg N ha^{-1}) and a control with all the three at nil level were included in the experiment. We studied the residual effect of biochar while FYM was applied at the time of sowing. Half of nitrogen was applied at sowing and the remaining with 2nd irrigation. The details of the treatments are given in Table 1. Phosphorus was applied at the rate of 60 kg ha^{-1} as a basal dose. Urea and single super phosphate (SSP) were used as sources of N and P, respectively.

The experiment was laid out in randomized complete block design with three replications. The plot size of 4 m x 4.5 m with strong bunds around each plot was used. Row to row and plant to plant distance was 30 and 10 cm, respectively. The field was ploughed twice up to the depth of 30 cm with the help of cultivator followed by planking to break the clods and level the field, while care was taken not to disturb the bunds and shift the soil from one plot to another. Mungbean was sown at the seed rate of 25 kg ha^{-1} on 1st July, 2014. Recommended irrigation schedule was followed for the crop; however changes were made according to weather condition as and when needed. Weeds were controlled manually by hoeing. All other standard agronomic practices were applied uniformly to each experimental unit. Data were recorded on the following parameters:

- Emergence m^{-2}
- Plant height (cm)
- Number of branches $plant^{-1}$

Table 1: The details of the treatment combinations of biochar, FYM and N.

	Treatments BC (ton ha^{-1})	FYM (ton ha^{-1})	N (kg ha^{-1})
T1	0	0	0
T2	0	5	15
T3	0	5	30
T4	0	10	15
T5	0	10	30
T6	5	5	15
T7	5	5	30
T8	5	10	15
T9	5	10	30
T10	10	5	15
T11	10	5	30
T12	10	10	15
T13	10	10	30

- Seeds pod^{-1}
- Thousand seed weight (g)
- Seed yield (kg ha^{-1})
- Biological yield (kg ha^{-1})

Procedure for Data Recording

Emergence m^{-2}: Emergence data were recorded by counting total number of plants emerged in one meter row length at three randomly selected rows in each sub plot. The data were then converted into emergence m^{-2}.

Plant Height: Height of the plants was measured as the distance from base to the tip of the plant of five randomly selected plants in each sub-plot and was averaged.

Number of Branches per Plant: The data on number of branches $plant^{-1}$were by counting total number branches $plant^{-1}$ in five randomly selected plants in each sub plot and were averaged.

Seeds Pod^{-1}: For this data, grains from ten randomly selected pods were counted and converted into number of seeds pod^{-1} through average.

Thousand Seed Weight: Hundred seeds were counted at random from sample of each sub plot of mungbean and were converted into thousand grain weight.

Seed Yield: For recording seed yield data, four central rows were harvested in each subplot with the help of a sickle. Samples were sun dried, threshed by hands and seeds were weighed with the help of an electronic balance and the data were converted into kg ha^{-1} by using the following formula:

$$\text{Seed yield (kg ha}^{-1}\text{)} = \frac{\text{Seed weight of four central rows}}{\text{Row length x R-R distance x no. of rows}} \text{ x } 10{,}000$$

Biological Yield: Four representative rows were harvested at their maturity from each subplot, tied into bundles separately for mungbean. The bundles were sun dried and weighed by spring balance for calculating biological yield. The data were converted into kg ha^{-1} by using the following formula:

$$\text{Biological yield (kg ha}^{-1}\text{)} = \frac{\text{Biological yield in four central rows}}{\text{Row length x R-R distance x no. of rows}} \text{ x } 10{,}000$$

Statistical Analysis: The data were analyzed statistically using analysis of variance techniques appropriate for randomized complete block design. Means were compared using LSD test at 0.05 level of probability, when the F-values were significant according to Jan *et al.* [4].

RESULTS AND DISCUSSION

Emergence m^{-2}: Emergence m^{-2} data as affected by residual biochar, FYM and mineral nitrogen levels are presented in Table 2. Statistical analysis of data revealed that biochar, FYM and mineral nitrogen application did not bring significant variation in emergence m^{-2} of mungbean. All the interactions were found non significant. Contrast for control vs rest was non significant. Though the effect of biochar, mineral nitrogen and FYM was not significant however, higher emergence m^{-2} (24.08) was noted in plots where no biochar was applied followed by application of biochar at the rate of 25 ton ha^{-1} (23.58). Low emergencem^{-2} may be due to high biochar application rate might be attributed to the negative effect of biochar on soil C:N ratio [5]. Also addition of FYM initially slow down the mineralization process and improve immobilization which caused deficiency of mineral N to crop and adversely affect crop growth.

Number of Branches $Plant^{-1}$: Data regarding number of branches $plant^{-1}$ of mungbean are presented in Table 3. Application of N and FYM significantly affected number of branches $plant^{-1}$, while the effect of biochar remained non significant. Planned mean comparisons showed that all contrasts were found significant. Similarly, all interactions except BC x FYM were found non significant. Planed mean comparison for control vs rest indicated that branches $plant^{-1}$ were higher in treated plots. Branches $plant^{-1}$ increased as N application increased

Table 2: Emergence m^{-2} of mungbean as affected by biochar, FYM and mineral nitrogen

Biochar ($kg\ ha^{-1}$)	Nitrogen ($kg\ ha^{-1}$)	FYM ($15kg\ ha^{-1}$)	F YM ($30kg\ ha^{-1}$)	B x N
0	15	24.00	25.00	24.50
0	30	24.33	23.00	23.67
25	15	23.67	23.33	23.50
25	30	23.33	24.00	23.67
50	15	24.00	22.33	23.17
50	30	22.67	21.33	22.00
	15	23.89	23.56	23.72
	30	23.44	22.78	23.11
00		24.17	24.00	24.08
25		23.50	23.67	23.58
50		23.33	21.83	22.58
		23.67	23.17	
	Control	23.67		
	Rest	23.42		

Table 3: Number of branches $plant^{-1}$ of mungbean as affected by biochar, FYM and mineral nitrogen

Biochar($kg\ ha^{-1}$)	Nitrogen($kg\ ha^{-1}$)	FYM ($15kg\ ha^{-1}$)	F YM($30kg\ ha^{-1}$)	B x N
0	15	7.73	10.33	9.03
0	30	10.00	11.00	10.50
25	15	9.67	10.00	9.83
25	30	10.43	10.67	10.55
50	15	11.00	10.33	10.67
50	30	10.33	10.67	10.50
	15	9.47	10.22	9.84 b
	30	10.26	10.78	10.52 a
0		8.87	10.67	9.77
25		10.05	10.33	10.19
50		10.67	10.50	10.58
		9.86 b	10.50 a	
	Control	7.07		
	Rest	10.18		

$LSD_{(0.05)}$ for N= 0.553704

$LSD_{(0.05)}$ for FYM= 0.55370

Means followed by different letters in the same column are significantly different at ($P \leq 0.05$)

from 0 to 30 kg ha^{-1} and more branches $plant^{-1}$ (10.52) were counted in plots where N was applied at the rate of 30 kg ha^{-1} as compared to 15 kg ha^{-1} (9.84). Number of branches $plant^{-1}$ was increased as FYM application increased from 5 to 10 ton ha^{-1}. Higher branches $plant^{-1}$ (10.50) was counted in plots treated with FYM at the rate of 10 ton ha^{-1} as compared to 5 ton FYM ha^{-1} (9.86). The BC x FYM interaction revealed that as biochar application rate increased from 0 to 10 ton ha^{-1} branches $plant^{-1}$ (10.67) increased where 10 ton FYM ha^{-1} was used. Nitrogen is an integral part of plant chlorophyll and thus play key role in the process of photosynthesis and plant vegetative growth which resulted in more branches $plant^{-1}$ [6]. Improvement in branches $plant^{-1}$ of mungbean in FYM amended plots could be attributed to timely and slowly release of nutrient throughout the growing season Jama *et al*. [7]. These results are in line with the findings of Deotale *et al.* [8], who concluded that cow manure alone and in combination with mineral nitrogen was useful in improving the branches $plant^{-1}$ of green gram.

Number of Pods Plant^{-1}: Data on number of pods $plant^{-1}$ of mungbean are presented in Table 4. Statistical analysis of the data showed that application of N was highly significant and FYM was significant while the effect of biochar was not significant on number of pods $plant^{-1}$. All the interactions were non significant. Planned mean comparison indicated that contrast for control vs rest was highly significant. The planned mean comparison of control vs rest showed that control plots resulted in lower pods $plant^{-1}$ as compared treated plots. Pods $plant^{-1}$ was higher (20.06) in plots where FYM was incorporated at the rate of 10 ton ha^{-1} as compared to 5 ton ha^{-1} (18.92).

Table 4: Number of pods plant^{-1} of mungbean as affected by biochar, FYM and mineral nitrogen

Biochar (kg ha^{-1})	Nitrogen (kg ha^{-1})	FYM (15kg ha^{-1})	F YM (30kg ha^{-1})	B x N
0	15	18.00	19.00	18.50
0	30	19.77	20.00	19.88
25	15	16.67	19.33	18.00
25	30	18.67	21.00	19.83
50	15	19.43	20.00	19.72
50	30	21.00	21.00	21.00
	15	18.03	19.44	18.74 b
	30	19.81	20.67	20.24 a
0		18.88	19.50	19.19
25		17.67	20.17	18.92
50		20.22	20.50	20.36
		18.92 b	20.06 a	
	Control	16.67		
	Rest	19.49		

LSD $_{(0.05)}$ for N= 1.019701

LSD $_{(0.05)}$ for FYM= 1.019701

Table 5: Number of seeds pod^{-1} of mungbean as affected by biochar, FYM and mineral nitrogen

Biochar (kg ha^{-1})	Nitrogen (kg ha^{-1})	FYM (15kg ha^{-1})	F YM (30kg ha^{-1})	B x N
0	15	9.67	11.00	10.33
0	30	12.33	13.67	13.00
25	15	11.33	12.33	11.83
25	30	11.00	12.00	11.50
50	15	13.33	10.00	11.67
50	30	11.67	12.67	12.17
	15	11.44	11.11	11.28 b
	30	11.67	12.78	12.22 a
0		11.00	12.33	11.67
25		11.17	12.17	11.67
50		12.50	11.33	11.92
		11.56	11.94	
	Control	9.33		
	Rest	11.75		

LSD $_{(0.05)}$ for N= 0.904742

LSD $_{(0.05)}$ for FYM= 0.904742

Means followed by different letters in the same column are significantly different at ($P \leq 0.05$).

Plots fertilized with N at the rate of 30 kg ha^{-1} resulted in higher number of pod plant^{-1} of mungbean (20.24) followed by 15 kg N ha^{-1}.N decreases C:N ratio of organic matter and enhance mineralization process which in turn increase mungbean yield components i.e. pods plant^{-1}. Synergetic effect of FYM on mungbean pods plant^{-1} could be attributed to the positive impact of FYM on soil microbial activities. Increase in microbial activities improves nitrogen fixing ability of mungbean. Addition of combined application of organic and inorganic fertilizers increased organic matter content in the soil that provide carbon source and other nutrients for microbes responsible for the process of BNF. Similar results were reported by Manna *et al.* [9], who concluded that microbial activities significantly increased and bean pods plant^{-1} were directly affected by the balanced and combined application of FYM and inorganic fertilizers. These results are in line with the finding of Patel and Parner [10], who reported that number of pods plant^{-1} of mungbean were increased with the application of nitrogen fertilizer. Basu and Bandyapadhyay [11] reported that inoculation and nitrogen fertilizer rates up to 30 kg ha^{-1} increased number of pods per plant of mungbean.

Number of Seeds Pod^{-1}: Data regarding number of seeds pod^{-1} are shown in Table 5. Analysis of the data indicated that N level significantly affected seeds pod^{-1} while the effect of biochar and FYM were not significant. The BC x N interaction was significant, whereas all the other interactions were found non significant. Planned mean comparison showed that all contrasts were found significant. The planned mean comparison of control vs rest showed that control treatment resulted in lower seeds pod^{-1} as compared to rest of the treatments. N application at the rate of 30 kg ha^{-1} resulted in higher seeds pod^{-1} (12.22) as compared to 15 kg ha^{-1} (11.28). Lehmann *et al.* [12] studied the effect of nitrogen and organic manure application on the productivity of mungbean genotype and reported that both nitrogen application and FYM had significant positive effect on yield components of mungbean.

Thousand Seeds Weight (g): Data regarding thousand grain weights are presented in Table 6. Statistical analysis of the data indicated that N and FYM levels caused significant variation in thousand seeds weight while the effect of biochar was not significant. Similarly, all interactions were found non significant. Contrasts for control treatment vs the rest was significant. The planned mean comparison of control vs rest showed that control treatment resulted in lower thousand seeds weight (38.33g) as compared to treated plots (47.30g). Plots fertilized with N at the rate of 30 kg ha^{-1} resulted in higher thousand seeds weight (49.11g) (45.49g) followed by 15 kg N ha^{-1}. Likewise, FYM application at the rate of 10 ton ha $^{-1}$ resulted in higher thousand seeds weight (48.93g) as compared to 5 ton ha^{-1} (45.67). Reduction in thousand seeds weight due to high biochar application rate might be attributed to the negative effect of biochar on soil C:N ratio. Due to its high C:N ratio it might have caused immobilization of available nitrogen and plant might have faced N deficiency [12].

Seed Yield (kg ha^{-1}): Application of biochar, nitrogen and FYM significantly affected seed yield of mungbean (Table 7). All interactions were found non significant. Planed mean comparison showed that all contrasts were found significant. The planned mean comparison of control vs rest showed that control plots resulted in lower seed yield (359 kg ha^{-1}) as compared to treated plots (615 kg ha^{-1}). Higher seed yield (625 kg ha^{-1}) was recorded in plots where N was applied at rate of 30 kg ha^{-1} followed by N application at the rate of 15 kg ha^{-1} (606 kg ha^{-1}). Control plots resulted in lower seed yield (339 kg ha^{-1}). Incorporation of FYM at the rate of 10 ton ha^{-1} resulted in higher seed yield (631 kg ha^{-}) as compared to 5 ton ha^{-1} (599 kg ha^{-1}). Possible reason for higher seed yield in high N plots might be due to higher number of pods plant^{-1}, number of seeds pod^{-1} and higher 1000- seed weight. Reduction in yield due to lower fertilization might be attributed to nutritional imbalance and deficiency of certain important plant growth nutrients at various important growth stages like that of flowering, grains formation and seeds maturity. Also mung bean has the ability to fix atmospheric nitrogen, however, microorganisms initially need energy for fixation and therefore N application improves efficiency of microorganism Tahir *et al.* [13]. Timely and slowly release of nutrients from FYM throughout the growing season might be the possible reason for improving seed yield in FYM amended plots [14]. Biochar application improved grain yield and it could be attributed to the positive impact of biochar on soil properties of the experimental plots.

Biological Yield (kg ha^{-1}): The effects of BC, N and FYM on biological yield were highly significant (Table 8). The BC x FYM interaction was highly significant and the interaction of BC x N was significant while all other interactions remained non significant. Planed mean comparison showed that contrast between control vs rest was significant. The planned mean comparison of control vs rest showed that control plots resulted in lower (3189 kg ha^{-1}) biological yield as compared to treated plots (4263 kg ha^{-1}). Higher biological yield (4330 kg ha^{-1}) was recorded in plots where N was applied at the rate of 30 kg ha^{-1} followed by 15 kg N ha^{-1}. Control plots resulted in lower biological yield (3189 kg ha^{-1}). Likewise, higher biological yield (4578 kg ha^{-1}) was recorded in plots treated with FYM at the rate of 5 ton ha^{-1} as compared to 10 ton ha^{-1} (4197 kg ha^{-1}). The BC x FYM interaction revealed that biological yield of rnungbean increased as biochar application rate increased from 0 to 25 ton ha^{-1} under 5 and 10 ton FYM ha^{-1} treated plots. Increasing biochar application rate from 25 to 50 ton ha^{-1}, biological yield of mung bean decreased under both levels of FYM. Being leguminous crop, mungbean does not require higher N fertilizer, however, starter dose of N fertilization is needed to ensure better crop growth and improve activities of nitrogen fixing microbes. Mungbean biological yield increased with increasing N, FYM and biochar levels. Addition of biochar beyond 25 ton ha^{-1} did not enhance biological yield of mungbean.

Table 6: Thousands seeds weight (g) of mungbean as affected by biochar, FYM and mineral nitrogen

Biochar (kg ha^{-1})	Nitrogen (kg ha^{-1})	FYM (15kg ha^{-1})	F YM (30kg ha^{-1})	B x N
0	15	41.53	48.00	44.77
0	30	47.30	50.00	48.65
25	15	42.33	48.40	45.37
25	30	47.53	53.33	50.43
50	15	47.53	45.17	46.35
50	30	47.80	48.67	48.23
	15	43.80	47.19	45.49 b
	30	47.54	50.67	49.11 a
0		44.42	49.00	46.71
25		44.93	50.87	47.90
50		47.67	46.92	47.29
		45.67 b	48.93 a	
	Control	38.33		
	Rest	47.30		

LSD $_{(0.05)}$ for N= 3.217224

LSD $_{(0.05)}$ for FYM= 3.217224

Table 7: Grain seed (kg ha^{-1}) of mungbean as affected by biochar, FYM and mineral nitrogen

Biochar(kg ha^{-1})	Nitrogen(kg ha^{-1})	FYM (15kg ha^{-1})	F YM(30kg ha^{-1})	B x N
0	15	558.67	590.67	574.67
0	30	582.00	587.00	584.50
25	15	617.00	645.67	631.33
25	30	631.00	665.67	648.33
50	15	590.00	631.00	610.50
50	30	618.00	668.00	643.00
	15	588.56	622.44	605.50 b
	30	610.33	640.22	625.28 a
0		570.33	588.83	579.58
25		624.00	655.67	639.83
50		604.00	649.50	626.75
		599.44 b	631.33 a	
	Control	359.00		
	Rest	615.39		

LSD $_{(0.05)}$ for N= 17.50478

LSD $_{(0.05)}$ for FYM= 17.50478

Means followed by different letters in the same column are significantly different at ($P \leq 0.05$)

Table 8: Biological yield (kg ha^{-1}) of mungbean as affected by biochar, FYM and mineral nitrogen

Biochar (kg ha^{-1})	Nitrogen (kg ha^{-1})	FYM (15kg ha^{-1})	F YM (30kg ha^{-1})	B x N
0	15	3690.00	4100.33	3895.17
0	30	3841.67	4424.67	4133.17
25	15	4323.33	4661.33	4492.33
25	30	4570.33	4759.00	4664.67
50	15	4189.67	4209.33	4199.50
50	30	4200.00	4190.00	4195.00
	15	4067.67	4323.67	4195.67 b
	30	4204.00	4457.89	4330.94 a
0		3765.83	4262.50	4014.17 c
25		4446.83	4710.17	4578.50 a
50		4194.83	4199.67	4197.25 b
		4135.83 b	4390.78 a	
	Control	3189.67		
	Rest	4263.31		

LSD $_{(0.05)}$ for N= 65.85869

LSD $_{(0.05)}$ for FYM= 65.85869

Means followed by different letters in the same column are significantly different at ($P \leq 0.05$).

CONCLUSIONS AND RECOMMENDATION

Conclusions: Following conclusions were made from the findings of this research.

Biochar application improved, except seed yield and biological yield of mungbean.

Higher level of FYM also performed better than lower level of FYM in terms of increasing yield and yield components of mungbean.

Likewise, higher dose of nitrogen was also better than lower dose of nitrogen and increased yield and yield components of mung bean.

Recommendation: Application of biochar at the rate of 25 ton ha^{-1} in combination with FYM at the rate of 10 tons ha^{-1} and N at the rate of 30 kg ha^{-1} is recommended for improving mungbean growth and yield.

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