J. Bangladesh Acad. Sci. 47(1); 61-68: June 2023 DOI: https://doi.org/10.3329/jbas.v47i1.66025

Journal of Bangladesh Academy of Sciences

Journal homepage: http://www.bas.org.bd/publications/jbas.html

Research Article

The growth and yield performances of mungbean (*Vigna radiata* L.) as influenced by the use of cow dung and chemical fertilizers

Md. Mahamudul Hasan, Saima Sultana* and Mst. Afrose Jahan

Department of Soil Science, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh

ARTICLE INFO

Article History

Received: 10 May 2023
Revised: 22 May 2023
Accepted: 11 June 2023

Keywords: Inorganic fertilizer, Cowdung, Mungbean, Growth, Seed yield

ABSTRACT

To investigate the effect of cow dung and chemical fertilizers on the growth and yield performances of mungbean (BARI Mung 6), an experiment was carried out in the research field of the Sher-e-Bangla Agricultural University, Dhaka, during the kharif season of 2020. The experiment was laid out as a randomized complete block design (RCBD) with three replications comprising seven manure-fertilizer treatments. The results showed that the different levels of cow dung and fertilizers significantly influenced mungbean growth parameters and seed yield. The highest plant height (48.2 cm), number of leaves plant^{-1} (10.3), number of branches plant^{-1} (3.9), maximum number of pods plant^{-1} (19.3), seeds pod^{-1} (10.4), 1000-seed weight (43.4g), and the highest seed yield (1.42 t ha^{-1}) were obtained from the application of 80% of the recommended dose of fertilizers (RDF) plus 20% cow dung. It is concluded that applying 20% cow dung (1.2 t ha^{-1}) coupled with 80% of the recommended amount of fertilizers together produced superior results for the growth and yield of mungbean compared to applying fertilizer or cow dung alone.

Introduction

Mungbean (*Vigna radiata* L.), also known as green gram, is Bangladesh's important traditional pulse crop. It belongs to the family Leguminosae and the sub-family Papilionaceae. Mungbean ranks first in market price and third in production among the pulse crops grown in Bangladesh (BBS, 2021). Due to its high nutritional value, ease of digestion, and non-flatulent nature, it has an advantage over other pulses. It is mostly cultivated for its edible seeds, which are high in protein. Its seed contains 3.7% ash, 0.6% fat, 0.9% fiber, and 24.7% protein (Potter and Hotchkiss, 1997). Over the past 20 years, the area used to produce mungbean globally has expanded at a 2.5% annual rate. In Bangladesh, only 0.65 million tons of pulses are produced, against a demand of 2.7 million tons. Mungbean contributed 27% of the total pulse production (BBS, 2021). The low yield potential of mungbean is mostly caused by poor farming practices, unbalanced use of nutrients, insufficient plant protection measures, and the low use of high-yielding varieties (Rupa et al., 2014). By using chemical fertilizers judiciously and managing the organic manure effectively, the yield and quality of mungbean can be increased.

As a leguminous crop, one of the key characteristics of mungbean is its capability to enhance soil nitrogen and productivity by fixing atmospheric nitrogen (N_2) through a symbiotic association with *Rhizobium* bacteria (Mahmood and Athar, 2008; Mandal et al., 2009). Therefore, mungbean requires a low amount of nitrogen (N) and an optimum amount of phosphorus (P), potassium (K), sulphur (S0, zinc (Zn), and Boron (B) (FRG, 2018). Recently, emphasis has been given to the usage of organic fertilizers in order to produce crops with sustainable yields (Tejada et al., 2009). Organic materials have a great potential to significantly enhance the soil's

*Corresponding author: <saimasultana@sau.edu.bd>

qualities and act as a source of several nutrients (Moller, 2009; Gadi et al., 2017). Ecosystems are preserved through organic farming.

In contrast, synthetic fertilizers harm soil and the ecosystem and threaten the entire planetsince they primarily include the major nutrients NPK in high concentrations while ignoring the use of organic fertilizers. As a result, the soil's quality has declined, negatively impacting animals, plants, and people (Palai et al., 2019). In order to address this problem of low soil fertility and productivity, the management of soil organic matter is a critical concern. Nutrient availability in soil is influenced by many factors, the most important of which is fertilizer balance. The proper amount of fertilizer ensures that the plant has access to other essential nutrients while also assisting in the growth and development of crops. Hence, the balanced use of fertilizer and manure is vital to obtain the maximum yield and maintain soil health. Therefore, the present study was carried out to (i) evaluate the effect of cow dung and chemical fertilizers on the growth and yield of mungbean and (ii) determine the best combination of cow dung and fertilizer doses for improved yield and quality of mungbean.

Materials and Methods

Site and soil description

The experiment was conducted at the Sher-e-Bangla Agricultural University (SAU) research field, Dhaka during the period from March to June 2020. This region is situated between 23º46' N latitude and 90º22' E longitude. The experimental site belongs to the Tejgaon soil series under the agroecological zone Madhupur Tract (AEZ-28). The area experiences a sub-tropical monsoon climate characterized by heavy rainfall from June to September, with a little rain during the rest of the year.

Texturally the soil (0-15 cm depth) of the experimental site was silty clay loam with a pH of 6.9, 1.05% organic matter, 0.08% total N, 12.8 mg kg^{-1} available P, and 43.29 mg kg^{-1} available K. Cowdung contained 0.9% N, 0.5% P, and 1.1% K.

Treatments and design

There were seven treatments comprising different combinations of chemical fertilizers and cow dung. The 100% rates for urea, triple superphosphate, muriate of potash, gypsum, ZnO, and boric acid as per FRG. (2018) were 45 kg, 90 kg, 40 kg, 55 kg, 8.5 kg, and 10 kg per hectare, respectively. Cowdung was used at 6 tons per hectare.

The seven treatment combinations were: T_0-control, T_1-100% recommended dose of chemical fertilizer (RDF), T_2-100% cow dung, T_3-80% fertilizer and 20% cow dung, T_4-60% fertilizer and 40% cow dung, T_5-40% fertilizer and 60% cow dung, T_6-20% fertilizer and 80% cow dung.

The experiment was laid out following a randomized complete block design (RCBD) with three replications. The experiment had 21 unit plots (7 treatments × 3 replications), and each plot size was 3m × 2m. The experimental fields were tilled with a power tiller and plowed twice, followed by laddering. Then weed stubble and crop residues were removed from the field. Finally, the land was leveled, and the experimental plot was partitioned into unit plots following the experimental design.

Crop management

The entire amounts of well-decomposed cow dung, urea, triple superphosphate, muriate of potash, gypsum, ZnO, and boric acid were applied as per treatments during final land preparation.

The BARI mung-6 variety was used for the study. On 21 March 2020, mungbean seeds at the rate of 35 kg ha^{-1} were sown by hand as uniformly as possible in furrows. The line-to-line distance was maintained at 30 cm. Weeding cum thinning was done 12 days after sowing (DAS), and the second wedding was performed at 35 DAS. The plant-to-plant distance was maintained at 10 cm. The crops were harvested at a time due to the synchronous maturity of pods. Firstly, 50% of the early-maturing pods were manually picked up 55 days after sowing, and the rest 50% were harvested plot-wise a few days later in June.

Data collection

From each plot, four plants were randomly selected prior to maturity and were tagged for recording data which included plant height (cm), number of leaves per plant, branches per plant, pods per plant, seeds per pod, 1000- seed weight(g), seed yield per plot (g). The latter was converted to yield per hectare (t).

Statistical analysis

Data of the growth and yield parameters were statistically analyzed following the 'F' test using statistix-10 software. The means of the different treatments for the parameters where the 'F' value was significant were compared by Duncan's Multiple Range Test (DMRT) at a 5% probability level (Gomez and Gomez, 1984).

Results and Discussion

Effects of cow dung and chemical fertilizers on growth parameters of mungbean

Plant height

The combined application of cow dung and chemical fertilizers greatly influenced mungbean's plant height at different growth stages (Table 1). The highest plant height at 30 days after sowing (DAS), 40 DAS, and at harvest was recorded as 30.0 cm, 39.9 cm, and 48.2 cm were observed with treatment T_3 (80% RDF+20% cow dung), followed by treatment T_1 (100% RDF). The significantly lowest plant height at all the growth stages (22.9 cm, 32.3 cm, and 43.4 cm, respectively) was noted for the T_0 (control) treatment, where no fertilizer or cow dung was used. This finding is in agreement with the previous finding of Armin et al. (2016), who reported that the combined application of organic and inorganic fertilizers significantly increased the plant height of mungbean compared to the sole application at different growth stages. Comparable outcomes were observed by Rajkhowa et al. (2002) in the cases of green gram, who stated that using a combination of organic and inorganic fertilizers was preferable to using only inorganic fertilizers.

Table 1. Effects of cow dung and chemical fertilizers in different combinations on plant height and number of leaves and branches per plantof mungbean

Treatments	Plant height (cm)			Number of leaves plant^{-1}			Number of branches plant^{-1}
	30 DAS	40 DAS	At harvest	30 DAS	40 DAS	At harvest	At harvest
T_0	22.9^{f}	32.3^{g}	43.4^{e}	3.3^{e}	4.6^{e}	5.3^{c}	0.4^{f}
T_1	29.0^{b}	39.2^{b}	47.9^{ab}	7.6^{b}	8.3^{b}	8.3^{b}	3.0^{b}
T_2	24.7^{e}	34.5^{f}	44.6^{d}	4.6^{d}	5.6^{de}	6.6b^{c}	1.2^{e}
T_3	30.0^{a}	39.9^{a}	48.2^{a}	8.6^{a}	10.3^{a}	10.3^{a}	3.9^{a}
T_4	26.7^{c}	37.8^{c}	46.6^{b}	7.0^{b}	7.6b^{c}	7.3^{b}	3.4a^{b}
T_5	26.37^{cd}	36.6^{d}	46.5^{b}	7.0^{b}	7.3b^{c}	7.3^{b}	2.6^{c}
T_6	25.7^{d}	36.1^{e}	45.5^{c}	5.6^{c}	6.6c^{d}	6.6b^{c}	1.7^{d}
CV (%)	1.74	0.7	1.1	6.34	9.04	13.03	8.04

In a column means having a dissimilar letter(s) differ significantly at 0.05 probability level by DMRT. T_0-control, T_1-100% recommended dose of chemical fertilizers (RDF), T_2-100% cow dung, T_3-80% RDF+ 20% cow dung, T_4-60% RDF+40% cow dung, T_5-40% RDF+60% cow dung, T_6-20% RDF+80% cow dung.

Number of leaves plant^{-1}

T_3 treatment (80% RDF+20% cow dung) demonstrated the highest number of leaves plant^{-1} showing 8.6, 10.3, and 10.3 at 30 DAS, 40 DAS, and maturity, respectively (Table 1). Next to T_3, the T_4 treatment performed the best result. The control treatment (T_0) exhibited the lowest number of leaves per plant with a record of 3.3, 4.6, and 5.3 at different plant growth stages. Salahin et al. (2011) reported that the application of cow dung and chemical fertilizers led to a noticeably greater uptake of nutrients in mungbean, thereby producing the maximum number of leaves per plant.

Number of branches plant^{-1}

The number of branches plant^{-1} at harvest ranged from 0.4-3.9 (Table 1). The highest number of brunches plant^{-1} (3.9) was recorded from the T_3 treatment (80% RDF+ 20% cow dung), whichwas statistically similar (3.43) with the treatment T_4 (60% RDF+40% cow dung). Among the treatments, the T_0 treatment showed the lowest number of branches per plant (0.4) at harvest.

Armin et al. (2016) have observed the positive effect of the integrated use of cow dung and chemical fertilizers on mungbean.

Effects of cow dung and chemical fertilizers on the yield and yield contributing characteristics of mungbean

Pod length

The highest number of pod lengths (7.9 cm) of mungbean at harvest were obtained from the T_3 treatment, i.e., 80% RDF + 20% cow dung, which is statistically different from other treatments (Table 2). In contrast, the lowest pod length (6.91 cm) was obtained from T_0 (control) treatment. Similar findings in mungbean were reported by Salahin et al. (2011) and Mahabub et al. (2016), who demonstrated that the application of cow dung combined with chemical fertilizers noticeably increased the uptake of nutrients, which in turn led to the higher number of pod length.

Table 2. Effects of cow dung and chemical fertilizers in different combinations on yield contributing characteristicsof mungbean

Treatments	Pod length (cm)	Number of pod plant^{-1}	Number of seeds pod^{-1}	1000-seed weight (gm)
T_0	6.9^{g}	9.2^{f}	6.7^{f}	38.6^{f}
T_1	7.7^{b}	15.3^{b}	9.0^{b}	43.2^{ab}
T_2	7.0^{f}	10.8^{e}	7.6^{e}	40.6^{e}
T_3	7.9^{a}	19.3^{a}	10.4^{a}	43.4^{a}
T_4	7.5^{c}	14.5^{c}	8.7^{bc}	42.8^{d}
T_5	7.3^{d}	14.0^{c}	8.4^{c}	42.6^{d}
T_6	7.2^{e}	12.8^{d}	8.0^{d}	42.2^{d}
CV (%)	0.58	3.38	2.23	0.74

In a column means having a dissimilar letter(s) differ significantly at 0.05 probability level by DMRT. T_0-control, T_1-100% recommended dose of chemical fertilizers (RDF), T_2-100% cow dung, T_3-80% RDF+20% cow dung, T_4-60% RDF+40% cow dung, T_5-40% RDF+60% cow dung, T_6-20% RDF+80% cow dung.

Number of pods plant^{-1}

The number of pods plant^{-1} of mungbean at harvest varied significantly due to the different doses of cow dung and inorganic fertilizer (Table 2). The highest number of pods plant^{-1} (19.3) was obtained from the combination of 80% RDF + 20% cow dung (Treatment T_3) followed by the treatment T_1 (100% RDF) and T_5 (40% RDF + 60% cow dung). The lowest number of pods plant^{-1} (9.2) was recorded from the treatment T_0. This might be because using cow dung and inorganic fertilizers in combination improves the physical characteristics of the soil, which creates a healthy environment conducive to improving the efficiency of nutrient absorption. This agrees with the results of Mahabub et al. (2016), who reported that different doses of cow dung significantly increased the number of pods per plant in mungbean.

Number of seeds pod^{-1}

The treatment T_3 (80% RDF + 20% cow dung) produced the highest number of seeds pod^{-1} (10.4), which statistically differs from all other treatments (Table 2).

Like other parameters, T_0 showed the lowest number of seeds pod^{-1} (6.7). Similar results were reported by Pandey et al. (2019), who observed that combining organic and inorganic fertilizers was more effective in increasing the number of seeds per pod of mungbean than using solely chemical fertilizers.

1000-seed weight

Application of different levels of cow dung and fertilizers resulted in a significant variation in the weight of 1000 mungbean seeds at harvest(Table 2). The maximum 1000-seed weight (43.4 g)was observed in treatment T_3 (80% RDF + 20% cow dung), which is statistically identical (43.2 g) to treatment T_1 (100% RDF). The minimum 1000-seed weight (38.6 g) was noted for treatment T_0, i.e., control treatment. Comparable results were reported on mungbean by Choudhary et al. (2011) and on lentils by Singh et al. (2010).

Seed yield

Seed yield is the most critical parameter for judging the contribution of cow dung and chemical fertilizers in mungbean. The seed yield of mungbean per hectare, depending on the treatments, ranged from 0.9 to 1.42 tons (Fig. 1). Among the seven treatments, treatment T_3 receiving 80% RDF+20% cow dung has been found to be significantly better compared to the other treatments. This treatment (T_3) produced the maximum seed yield of 1.42 t ha^{-1}, followed by treatment T_4 (60% RDF+40% cow dung) (1.23 t ha^{-1}), and T_1 (100% RDF) (1.20 t ha^{-1}). Like other plant characters, the lowest yield (0.82 t ha^{-1}) was produced by treatment T_0 (control).

The findings demonstrated that the together use of cow dung and chemical fertilizers increased the seed yield of the mungbean. This could be because cow dung improved the physical and microbiological characteristics of the soil, which, combined with fertilizers, created a favorable environment for normal crop growth and yield. This result is consistent with earlier research findings (Sachan et al., 2020).

Correlation analysis between the growth and yield parameters

The results of the Pearson correlation analysis revealed that the growth and yield contributing parameters of mungbean had a significant positive correlation with the seed yield of the crop (Table 3). These results suggest that the seed yield of the crop was directly dependent on the various growth and yield parameters. The application of cow dung and inorganic fertilizer together strongly influences the mungbean's growth and yield contributing characteristics. Besides,the seed yield(t ha^{-1}) showed a significant and positive correlation with all the growth. It yielded contributing parameters, including the plant height(r=0.94), the number of pods perplant (r=0.97), the number of seeds per pod (r=0.96), and the weight of 1000 seeds (r=0.92), that eventually boosted the overall yield. Comparable results were also observed by Gul et al. (2009) in mungbean and Painkra et al. (2018) in soybean.

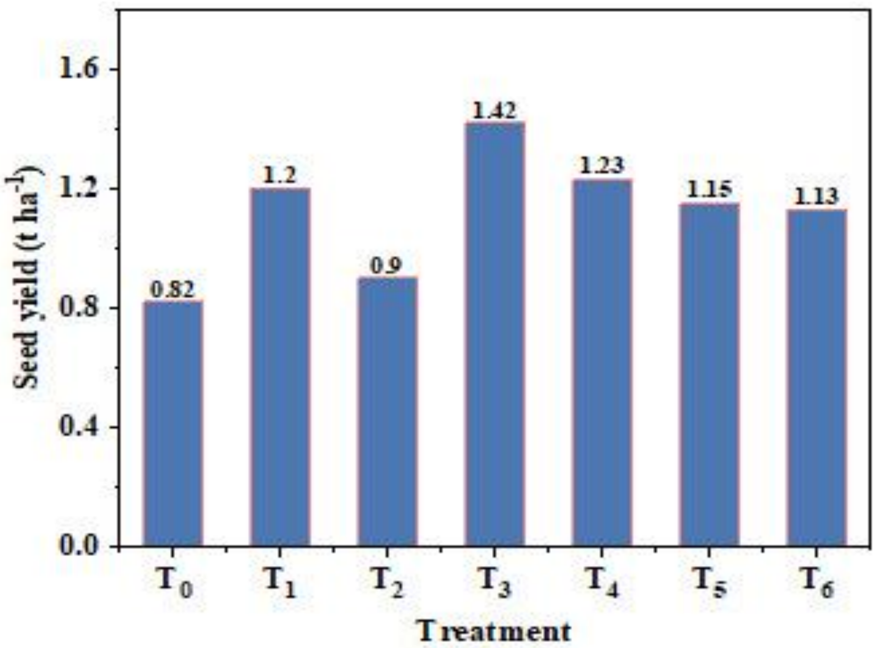

Fig. 1. Effects of cow dung and chemical fertilizers on seed yield of mungbean. T_0 control, T_1-100% recommended dose of chemical fertilizers (RDF), T_2-100 % cow dung, T_3-80% RDF+20% cow dung, T_4-60% RDF+40% cow dung, T_5-40% RDF+60% cow dung, T_6-20% RDF+80% cow dung.

Table 3. Pearson correlation matrix for the growth and yield contributing parameters of mungbean

	PH	NLP	NBP	NPP	NSP	TSW
PH	1					
NLP	0.92^{**}	1				
NBP	0.95^{**}	0.87^{*}	1			
NPP	0.95^{**}	0.97^{**}	0.94^{**}	1		
NSP	0.95^{**}	0.98^{**}	0.93^{**}	0.99^{**}	1	
TSW	0.95^{**}	0.80^{*}	0.92^{**}	0.88^{**}	0.87^{**}	1
SY	0.94^{**}	0.89^{**}	0.95^{**}	0.97^{**}	0.96^{**}	0.92^{**}
SY	0.94^{**}	0.89^{**}	0.95^{**}	0.97^{**}	0.96^{**}	0.92^{**}

PH=Plant height, NLP=Number of leaves per plant, NBP=Number of branches per plant, NPP=Number of pods per plant, NSP=Number of seeds per pod, TSW=1000-seed weight, SY=Seed yield.
** Significant at the 0.01 level (2-tailed); * Significant at the 0.05 level (2-tailed).

Conclusion

The combined use of cow dung and chemical fertilizers was more effective than the sole use of either cow dung or fertilizers for the growth and yield of mungbean. The combination of 80% RDF+ 20% of cow dung was the most suitable combination for achieving the highest seed yield of mungbean.

Author's contribution

Conceptualization: Mst. Afrose Jahan and Saima Sultana; Writing and editing: Saima Sultana and Md. Mahamudul Hasan; Research conduction: Md. Mahamudul Hasan; Data analysis: Md. Mahamudul Hasan and Saima Sultana.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this article.

References

Armin W, Ashraf-Uz-Zaman K, Zamil SS, Rabin MH, Bhadra AK and Khatun F. Combined effect of organic and inorganic fertilizers on the growth and yield of mung bean (Bari Mung 6). *Int. J. Sci. Res. Publ.* 2016; 6(7): 557-561.

BBS (2021). Statistical Year Book. Bangladesh bureau of statistics. Statistics Division, Ministry of planning, Govt. of the People's Republic of Bangladesh.

Choudhary HR, Sharma OP, Yadav LR and Choudhary GL. Effect of organic sources and chemical fertilizers on productivity of mungbean *J. Food Legumes,* 2011; 24(4): 324-326.

FRG. Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council (BARC), 2018. Ministry of Agriculture, Govt. of the People's Republic of Bangladesh.

Gadi P, Dawson J and Shankar M. Effect of different organic manures, inorganic fertilizers and growth regulators on growth and yield of green gram (*Vigna radiata* L.*). Bull. Env. Pharmacol. Life Sci*. 2017; 6(1): 67-75.

Gomez KA and Gomez AA. Statistical Procedures for Agricultural Research. 2nd Edition, John Wiley & Sons, New York, 1984. p 680.

Gul R, Khan H, Mairaj G and Ali S. Correlation study on morphological and yield parameters of mungbean (*Vigna radiata*). *Sarhad J. Agric.* 2009; 24(1): 37-42.

Mahabub ST, Khan MS, Maed H, Sarker S and Tereque H. Effect of cow manure on growth, yield and nutrient content of mungbean. *Asian Res. J. Agric*. 2016; 2(1): 1-6.

Mahmood A and Athar M. Cross inoculation studies: Response of *Vigna mungo* to inoculation with rhizobia from tree legumes growing under arid Environment. *Int. J. Environ. Sci. Technol*. 2008; 5: 135-139.

Mandal S, Mandal M, Das A, Pati B and Ghosh A. Stimulation of indoleacetic acid production in a Rhizobium isolate of *Vigna mungo* by root nodule phenolic acids. *Arch. Microbiol.* 2009; 191: 389-393.

Moller K. Influence of different manuring systems with and without biogas digestion on soil organic matter and nitrogen inputs, flows and budgets in organic cropping systems. *Nutr. Cycl. Agroecosystems,* 2009; 84: 179-202.

Painkra P, Shrivatava R, Nag SK and Kute I. Correlation analysis for seed yield and its attributing traits in soybean (*Glycine max* L. Merrill). *Int. J. Curr. Microbiol. App. Sci*. 2018; 7(4): 2034-2040.

Palai JB, Jena J and Maitra S. Prospects of underutilized food legumes in sustaining pulse needs in India- A review. *Crop Res*. 2019; 54 (3 & 4): 82-88.

Pandey OP, Shahi SK, Dubey AN and Maurya SK. Effect of integrated nutrient management of growth and yield attributes of green gram (*Vigna radiata* L.). *J. Pharmacogn. Phytochem*. 2019; 8(3): 2347-2352.

Potter NN and Hotchkiss JH. Food Science. 1997. CBS Publishers, New Delhi, India. pp: 403.

Rajkhowa DJ, Saikia M and Rajkhowa KM. Effect of vermicompost with and without fertilizer on greengram. *Legume Res*. 2002; 25(4): 295-296.

Rupa WS, Miah MS, Shiam IH, Mehraj H and Jamal Uddin AFM. Organic and inorganic fertilizers on growth, yield and nutrient content of mungbean (BARI Mung 5). *Int. J. Bus. Soc. Sci. Res.* 2014; 1(2): 107-11.

Sachan HK, Krishna D and Prasad A. Combined effect of organic and inorganic fertilization on the growth and yield of mung bean (*Vigna radiata*). *Res. Crop,* 2020; 21(4): 676-680.

Salahin N, Islam MS, Begum RA, Alam MK and Hossain KM. Effect of tillage and integrated nutrient management on soil physical properties and yield under tomato- mungbean-t. aman cropping pattern. *Int. J. Sustain. Crop Prod*. 2011; 6(1): 58-62.

Singh G, Aggarwal N and Khanna V. Integrated nutrient management in lentil with organic manures, chemical fertilizers and biofertilizers. *J. Food Legumes*, 2010; 23(2): 149-151.

Tejada M, Hernandez MT and Garcia C. Soil restoration using composted plant residues: Effects on soil properties. *Soil Tillage Res*. 2009; 102(1): 109-117.