Original Research Article

Effect of integrated nutrient management on nutrient content and their uptake by mung bean crop (*Vignaradiata* L.) under mid hill conditions of Himachal Pradesh

ABSTRACT

Aim: To study the effect of integrated nutrient management on nutrient content and uptake by mungbean crop under mid hill conditions of Himachal Pradesh.

Study design: Randomized block design.

Place and duration of study: One yearfield experiment atResearch Farm, School of Agriculture, Abhilashi University, Chail Chowk, Mandi, (H.P.), during *kharif*of 2023.

Methodology: The experiment was conducted with three replications and eight treatments *viz.*T_1= Absolute control, $T_{2=}$ 100% RDF + biofertilizers, T_3= 75% RDF + biofertilizers, T_4= 75% RDF + 25% N by poultry manure + biofertilizers, T_5= 75% RDF + 25% N by vermicompost + biofertilizers, T_6= 50% RDF + 50% N by poultry manure + biofertilizers, T_7= 50% RDF + 50% N by vermicompost + biofertilizers, T_8= 50% RDF + 50% N by poultry manure + vermicompost + biofertilizers.

Results: The study of the data revealedthat the non-significant effect of integrated nutrient management practiceswas found on nitrogen, phosphorus and potassium content in grains and straw of mungbean, whereas, the maximum content of these nutrients was found under treatment $T_{2.}$However, the application of treatment T_2 recorded significantlythe highest uptake of N, P and K by grains, straw and total uptake by mungbean crop, which was statistically at par with treatment T_5 and T_4.The minimum content of N, P and K in grains and straw along with their uptake by grains, straw and total uptake by mungbean crop were found under the treatment T_1 during the field experiment.

Conclusion: This study showed that the different integrated nutrient management practices had non-significant effect on the nutrient content but it has significantly affected the uptake of nutrientsby mungbean crop.

Keywords: *Mungbean, integrated nutrient management, biofertilizers, vermicompost, nutrient content and uptake.*

1. INTRODUCTION

Mung bean is an important pulse crop in all tropical and subtropical regions of the world. Mung bean belongs to Fabaceae family, is an annual crop and is also known as green gram and moong. Mung bean is a rich source of protein (21-24 g), carbohydrates (56.72 g), fiber (4.11 g), fat (1.31 g), minerals (3.48 g) such as calcium (124 mg), phosphorous (326 mg), iron (4.42 mg) and supplies a good amount of energy (334 kcal) **(Dhakal et al. 2015) [1]**.

More than 90 per cent of mungbean production comes from 9 states of Rajasthan, Madhya Pradesh, Maharashtra, Karnataka, Bihar, Odisha, Gujarat, Andhra Pradesh and Tamil Nadu**(Anonymous, 2022) [2]**.It is grown in *summer*, *kharif* and *rabi* seasons in the different regions of the country. In dry and semi-arid regions of India, mung bean is one of the main pulse crops that is grown. Due to limitation of improved cultural practices, cultivation in marginal and sub-marginal lands of poor fertility, high use of inorganic fertilizers, high sensitivity to pests and diseases and non-availability of organic materials into the soil being major factors responsible for the low yield of mungbean crop.Non-availability of quality seeds of improved and short duration varieties, growing under marginal and less fertile soil with low input supply and without management of pest and diseases properly, growing of mungbean under moisture stress conditions, unscientific post-harvest practices and storage under unfavourable conditions etc. are the major factors contributing to low yields of mungbean in India. The productivity of this crop is very low because of its cultivation on marginal and sub marginal lands having lesser soil fertility and also little attention is paid to proper fertilization **(Saravanan et al. 2013)[3]**. The scope for improving the production potential of this crop can be increased with the use of inorganic manures, organic manures and biofertilizers in conjugation or in different combinations.

The mungbean crop is increasingly adopted by farmers because of its short duration nature which makes it suitable for intensive crop rotation. Despite nutritional benefits, it helps in reducing soil erosion; enhance fertility of the soil through atmospheric nitrogen fixation **(Bansal, 2009) [4]**. Farmers use imbalanced chemical fertilizers for individual crop without considering integrated nutrient management approach. As a result, productivity and soil biodiversity has been affected. Recently, the growth and yield of mung bean have been affected by poor management and low soil fertility **(Bradl, 2004) [5]**.

The basic concept of integrated nutrient management is the supply of the required plant nutrients for sustaining the desired crop productivity with minimum deleterious effect on soil health environment. Integration of organic manures and inorganic fertilizer materials has been found to be promising not only in maintaining higher productivity of crops and for providing stability in crop production, besides improving soil physical conditions **(Hati et al. 2007) [6]**. They supply N, P, K and micronutrients like Fe, S, Mo and Zn etc. in available form to the plants through biological decomposition and improve the physical and chemical properties of soil, slow release of nutrients, increase the cation exchange capacity (CEC) of soil and enhance the microbial activities, crop growth and yield. Organic manures provide a good substrate for the growth of microorganisms and maintain a favourable nutritional balance and soil physical properties.

The integrated nutrient management is the integration of inorganic fertilizers such as urea, DAP, MOP etc. and organic manures such as FYM, vermicompost, poultry manure, biofertilizers etc. Vermicompost serves as an excellent organic manure in the integrated nutrient management of field crops as well as many other crops. Vermicompost is a sustainable manure formed from organic residue using earthworms. Because of these microbes working on the organic matter, decomposition of the organic matter takes place and there is release of CO_2 gas and formation of organic and carbonic acids from the decomposition and respiration process. It also enhances the fertilizer use efficiency of the crop which in turn lowers down the further requirement of fertilizers. Vermicompost is nutritionally rich organic natural manure. It contains a good proportion of exchangeable Ca, Mg, Na and many micronutrients. It also helps in increasing organic carbon in the soil and releases the nutrients slowly which fulfils the nutritional requirement of crop for a long time. It also contains many growth hormones and vitamins. It acts as a powerful biopesticide against diseases and nematodes besides improving physical conditions of soil. Vermicompost is nutrient rich product of non-thermophilic biodegradation through the interaction by microorganisms of the organic materials **(Aira et al. 2002) [7]**. However, the information on integrated use of organic manures, chemical fertilizers and bio-fertilizers on plant morphology and productivity of mung bean are meager **(Meena et al. 2015) [8]**. Earthworms break down organic waste materials to create vermicompost, which has a fine particle structure and readily absorbable nutrients for plants. It has a significant impact on raising the yield and growth of several field crops. It contains higher amounts of organic carbon which boosts the growth of the plants and improves the structure of the soil.

These days, poultry manure is becoming more and more popular in our nation. Poultry manure is a rich source of organic material helpful to provide plentiful nutrients to the crop along with the addition of organic matter into the soil. Poultry manure is helpful to increase the yields of the crops. In addition to providing primary, secondary and micronutrients for crop productivity, poultry manure is essential for enhancing soil fertility. Poultry manure contains nitrogen (4.5 to 5.0%), phosphorous (2.5 to 2.98%), potassium (2.04 to 2.33%), calcium (2.4 to 8.8%), magnesium (0.44 to 0.67%), 0.13-0.15%S, 235-450 ppm Zn, 98-150 ppm and Cu 150-450 ppm **(Richa et al. 2020) [9]**.

Micro-organisms are important biological organisms helping nature to maintain nutrient flows from one system to another and also minimize environmental degradation. Biofertilizers can be used to increase the availability of nitrogen into the soil. Biofertilizers are the living organisms which are helpful to fix the nutrients within the soil. Biofertilizers are environment friendly and play a crucial role to the development and yield of the pulses and some other crops. Biofertilizers are cheaper than chemical fertilizers and also a renewable source of energy. They are helpful in maintaining the long-term fertility of the soil and thus increases crop growth effectively. Inoculation of *Rhizobium* and plant growth-promoting bacteria improved the growth of common beans and also demonstrated the capacity to increase nitrogen uptake effectively**(Olivera et al. 2011)[10]**.There are no doubt bio-fertilizers like *Rhizobium* and PSB play a significant role in nitrogen fixation and solubility of phosphorus, respectively in soil. But it initially requires huge amount of energy for increasing their population and their activity like nitrogen fixation and solubility of phosphorus in soil **(Hubbell and Kidder, 2009) [11]**.

The highest use of chemical fertilizers in intensive farming system led to reduction in soil quality, deterioration of soil and environmental health's through volatilization, runoff and leaching **(Naeem et al. 2006) [12]**, and also increases the cost of crop production. Chemical fertilizers, even with balanced use, could not maintain high yield level over the years because of deterioration of the physical, chemical and biological properties of soil conditions due to low content of organic matter in soils **(Javaria and Khan, 2010) [13]** and making it acidic or saline. The supply of nutrients through organic sources cannot maintain and synchronize the required supply of nutrients to growing plants due to slow release of lesser quantity of nutrients in time by their mineralization **(Akhtar et al. 2011) [14]**.

2. MATERIAL AND METHODS

A field experiment was carried out at the Research Farm of the School of Agriculture, Abhilashi University, Chail Chowk, Mandi (H.P.) during *kharif* of 2023. The experimental farm is situated at 30^0 32' N latitude and 74^0 53' E longitudes, with an elevation of 1391 m above mean sea level. The pH of the experimental field was slightly acidic in reaction(5.56) with electrical conductivity of 0.010 dSm^{-1},medium in organic carbon (0.75%), medium in nitrogen (242.37 kg ha^{-1}), low in phosphorus (9.79 kg ha^{-1}) and medium in potassium (271.15 kg ha^{-1}). The experiment was laid out in a randomized block design (RBD) with eight treatments and three replications. The treatments include- T_1= Absolute control, $T_{2=}$ 100% RDF + biofertilizers, T_3= 75% RDF + biofertilizers, T_4= 75% RDF + 25% N by poultry manure + biofertilizers, T_5= 75% RDF + 25% N by vermicompost + biofertilizers, T_6= 50% RDF + 50% N by poultry manure + biofertilizers, T_7= 50% RDF + 50% N by vermicompost + biofertilizers, T_8= 50% RDF + 50% N by poultry manure + vermicompost + biofertilizers. The nutrients were applied according to the various integrated nutrient management treatments. The recommended doses of nitrogen, phosphorus and potassium were applied through Urea, DAP and MOP. The seeds are treated with *Rhizobium*before the sowing of seeds. The vermicompost and poultry manure were applied two weeks prior to sowing of the seeds of the mungbean crop. After the harvest of the crop, the samples were collected from every plot and were cleaned and dried under the shade. After the drying of the samples under shade, the samples were oven-dried at 60 ± 50 °C for 24 to 48 hours until their weight was constant and the samples were finely powdered with a mixer grinder. After the grinding process, the samples were used for the analysis of nitrogen, phosphorus and potassium content and their uptake by mungbean crop. The Kjeldahl digestion and distillation method was used to determine the nitrogen content described by **(Jackson, 1973)[15]**. The venadomolybdate phosphoric yellow color method was used for determining the phosphorus content given by **(Jackson, 1973)[15]**. The flame photometer method was used for determining the potassium content given by **(Jackson, 1973)[15]**. The nitrogen, phosphorus and potassium (kg ha^{-1}) uptake by grains and straw of mungbean crop in each treatment was calculated by multiplying the N, P and K content (%) with yields of grains and straw (q ha^{-1}). The total uptake of different nutrients was calculated after summing their uptake by grain and straw of mungbean crop.

3. RESULTS

Nitrogen (N) content (%) and uptake (kg ha^{-1})

The nitrogen contentand uptake by mungbean crop are presented in Table- 1 and Fig.- 1.The study of the datashowednon-significant effect on content of nitrogen in the grains and straw of the mungbean crop. However, treatment T_2 (100% RDF + biofertilizers) recorded the highest nitrogen content in grains (3.31 %) and straw (1.89 %) of mungbean crop. While, treatment T_1 (Absolute control) noted the lowest nitrogen content in grains (3.19 %) and straw (1.70 %) of mungbean crop during the field experiment.

The study of the data showed significant effect on the nitrogen uptake by grains, straw and total uptake by mung bean crop. During the investigation, application of treatment T_2 (100% RDF + biofertilizers) recorded maximum nitrogen uptake by grains, straw and total uptake by mungbean crop (46.09 kg ha^{-1}, 46.70 kg ha^{-1} and 92.79 kg ha^{-1}, respectively), which was statistically at par with treatments T_5 (75% RDF + 25% N by vermicompost + biofertilizers) (42.29 kg ha^{-1}, 44.22 kg ha^{-1} and 86.51 kg ha^{-1}, respectively) and T_4 (75% RDF + 25% N by poultry manure + biofertilizers) (40.88 kg ha^{-1}, 42.79 kg ha^{-1} and 83.67 kg ha^{-1}, respectively). However, under treatment T_1 (Absolute control), the lowest uptake of nitrogen by grains, straw and total uptake was noted (16.16 kg ha^{-1}, 16.20 kg ha^{-1} and 32.36 kg ha^{-1}, respectively) during the study.

Table 1. Effect of integrated nutrient management on nitrogen content (%) and their uptake (kg ha^{-1}) by mungbean crop

S.N.	Treatments	Nitrogen content (%)		Nitrogen uptake (kg ha^{-1})		
		Grain	Straw	Grain	Straw	Total
T_1	Absolute control	3.19	1.70	16.16	16.20	32.36
T_2	100% RDF + biofertilizers	3.31	1.89	46.09	46.70	92.79
T_3	75% RDF + biofertilizers	3.27	1.83	38.58	39.93	78.51
T_4	75% RDF + 25% N by poultry manure + biofertilizers	3.28	1.86	40.88	42.79	83.67
T_5	75% RDF + 25% N by vermicompost + biofertilizers	3.27	1.88	42.29	44.22	86.51
T_6	50% RDF + 50% N by poultry manure + biofertilizers	3.24	1.72	31.68	31.40	63.07
T_7	50% RDF + 50% N by vermicompost + biofertilizers	3.25	1.74	33.32	33.27	66.59

T_8	50% RDF + 50% N by poultry manure + vermicompost + biofertilizers	3.26	1.78	36.13	36.51	72.64
	SEm±	0.10	0.06	1.79	1.41	3.34
	CD (*P* = .05)	NS	NS	5.47	4.31	10.24

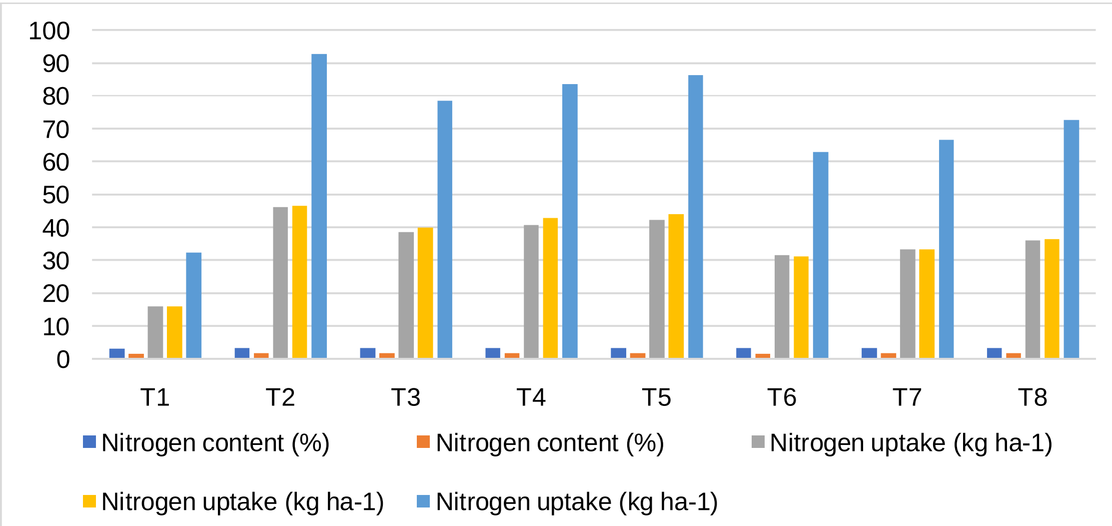

Fig. 1. Effect of integrated nutrient management on nitrogen content (%) and their uptake (kg ha^{-1}) by mungbean crop

Phosphorus (P) content (%) and uptake (kg ha^{-1})

The phosphorus content and uptake by mungbean crop are presented in Table- 2 and Fig.- 2. According to the study, the amount of phosphorus in the grains and straw of the mungbean crop did not significantly change between treatments. However, treatment T_2 (100% RDF + biofertilizers) had the highest phosphorus content in grains (0.41 %) and straw (0.25 %), while treatment T_1 (Absolute control) had the lowest phosphorus level in grains (0.29 %) and straw (0.20 %).

Table 2. Effect of integrated nutrient management on phosphorus content (%) and their uptake (kg ha^{-1}) by mungbean crop

S.N.	Treatments	Phosphorus content (%)		Phosphorus uptake (kg ha^{-1})		
		Grain	Straw	Grain	Straw	Total
T_1	Absolute control	0.29	0.20	1.49	1.87	3.36
T_2	100% RDF + biofertilizers	0.41	0.25	5.75	6.10	11.85
T_3	75% RDF + biofertilizers	0.37	0.23	4.40	5.02	9.42

T_4	75% RDF + 25% N by poultry manure + biofertilizers	0.38	0.24	4.74	5.51	10.25
T_5	75% RDF + 25% N by vermicompost + biofertilizers	0.40	0.24	5.18	5.72	10.90
T_6	50% RDF + 50% N by poultry manure + biofertilizers	0.32	0.21	3.16	3.83	6.99
T_7	50% RDF + 50% N by vermicompost + biofertilizers	0.34	0.22	3.49	4.21	7.69
T_8	50% RDF + 50% N by poultry manure + vermicompost + biofertilizers	0.35	0.23	3.85	4.65	8.50
	SEm±	0.03	0.01	0.38	0.30	1.68
	CD (*P* = .05)	NS	NS	1.17	0.93	5.14

The study of the data showed significant effect on the phosphorus uptake by grains, straw and total uptake. The study found that treatment T_2 (100% RDF + biofertilizers) had the highest phosphorus uptake by grains, straw and total uptake (5.75 kg ha^{-1}, 6.10 kg ha^{-1} and 11.85 kg ha^{-1}, respectively), which was statistically comparable to treatment T_5 (75% RDF + 25% N by vermicompost + biofertilizers) (5.18 kg ha^{-1}, 5.72 kg ha^{-1} and 10.90 kg ha^{-1}, respectively) and T_4 (75% RDF + 25% N by poultry manure + biofertilizers) (4.74 kg ha^{-1}, 5.51 kg ha^{-1} and 10.25 kg ha^{-1}, respectively). Conversely, under treatment T_1 (Absolute control), the mungbean crop's grains, straw and total uptake showed the lowest phosphorus uptake (1.49 kg ha^{-1}, 1.87 kg ha^{-1}and 3.36 kg ha^{-1}, respectively).

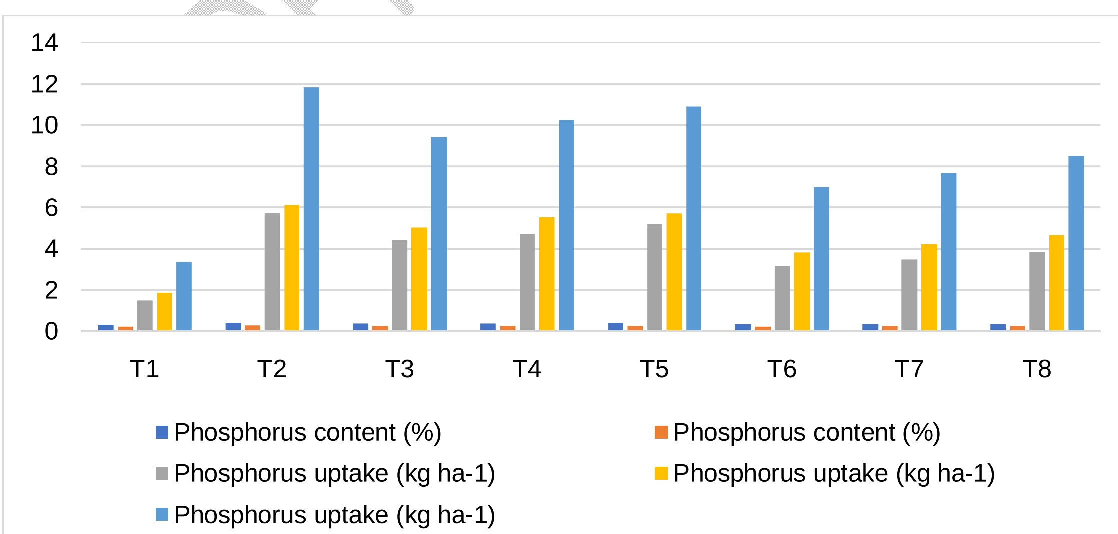

Fig. 2. Effect of integrated nutrient management on phosphorus content (%) and their uptake (kg ha^{-1}) by mungbean crop

Potassium (K) content (%) and uptake (kg ha^{-1})

The potassium content and uptake by mungbean crop are presented in Table- 3 and Fig.- 3. The potassium content of mungbean grains and straw was shown to be significantly constant.On the other hand, treatment T_2 (100% RDF + biofertilizers) showed the highest potassium content in grains (1.22 %) and straw (2.33 %) of the mungbean crop, while treatment T_1 (Absolute control) showed the lowest potassium content in grains (1.10 %) and straw (2.19 %).

The study of the data showed significant effect on the potassium uptake by grains, straw and total uptake. During the experiment, treatment T_2 (100% RDF + biofertilizers) (17.03 kg ha^{-1}, 57.57 kg ha^{-1} and 74.61 kg ha^{-1}, respectively) recorded the maximum potassium uptake by grains, straw and total uptake which was statistically comparable to treatment T_5 (75% RDF + 25% N by vermicompost + biofertilizers) (15.62 kg ha^{-1}, 54.57 kg ha^{-1} and 70.19 kg ha^{-1}, respectively) and T_4 (75% RDF + 25% N by poultry manure + biofertilizers) (14.83 kg ha^{-1}, 52.90 kg ha^{-1} and 67.73 kg ha^{-1}, respectively). On the other hand, treatment T_1 (Absolute control) yielded the lowest potassium uptake by grains, straw and total uptake (5.59 kg ha^{-1}, 20.87 kg ha^{-1}, 26.46 kg ha^{-1}, respectively).

4. DISCUSSION

The application of different integrated nutrient management treatments at different concentrations enhanced the nutrient content and uptake of nitrogen, phosphorus and potassium by grains and strawof mungbean crop during the field experiment. The increase in nitrogen content and uptake by mungbeancrop over the control treatment might be due to beneficial effect of the integrated nutrient

Table 3. Effect of integrated nutrient management on potassium content (%) and their uptake (kg ha^{-1}) by mungbean crop

S.N.	Treatments	Potassium content (%)		Potassium uptake (kg ha^{-1})		
		Grain	Straw	Grain	Straw	Total
T_1	Absolute control	1.10	2.19	5.59	20.87	26.46
T_2	100% RDF + biofertilizers	1.22	2.33	17.03	57.57	74.61
T_3	75% RDF + biofertilizers	1.17	2.27	13.84	49.53	63.37
T_4	75% RDF + 25% N by poultry manure + biofertilizers	1.19	2.30	14.83	52.90	67.73
T_5	75% RDF + 25% N by vermicompost + biofertilizers	1.21	2.32	15.62	54.57	70.19
T_6	50% RDF + 50% N by poultry manure + biofertilizers	1.13	2.21	11.07	40.28	51.35

T_7	50% RDF + 50% N by vermicompost + biofertilizers	1.14	2.23	11.69	42.57	54.26
T_8	50% RDF + 50% N by poultry manure + vermicompost + biofertilizers	1.16	2.24	12.91	45.88	58.79
	SEm±	0.04	0.07	0.84	2.55	2.47
	CD (*P*= .05)	NS	NS	2.58	7.81	7.55

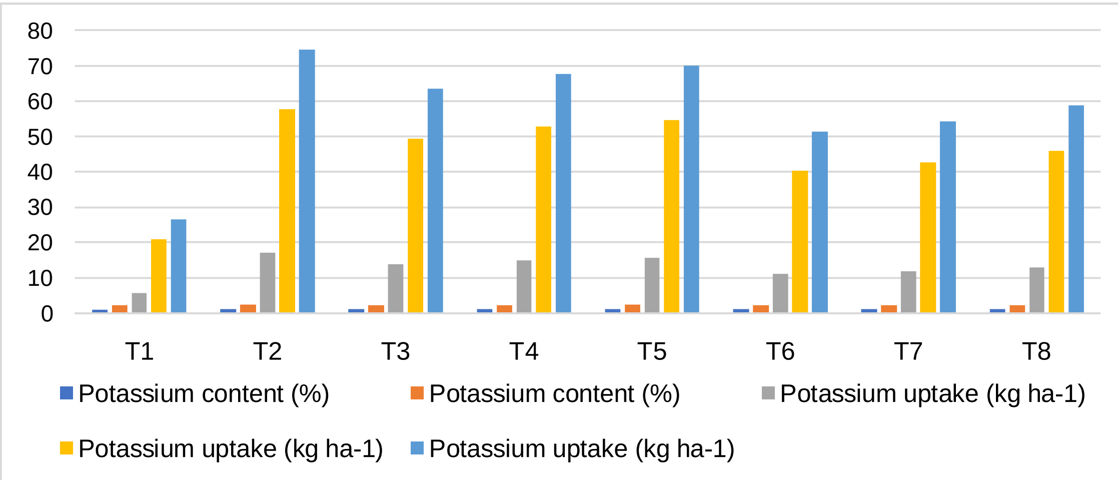

Fig.- 3 Effect of integrated nutrient management on potassium content (%) and their uptake (kg ha^{-1}) by mungbean crop

management practices, which enhanced the nutrient release and promoted the growth and the yieldwhile the organic manures caused a slow and steady release of nitrogen into the soil which helped in continuous growth of the crop during the experiment. The nitrogen content and uptake might be increased because the steady availability of nitrogen at earlier needed stage by inorganic stage and slower availability through organic manure and this facilitate the ultimately more nitrogen contentin crop plants, however, the nitrogen is also a component of chlorophyll molecule, which enables the plant to absorb sunlight energy by photosynthesis, driving the vegetative growth and higher yield and ultimatelyhigher nitrogen uptake.The results are in close agreement with the findings of **Banik and Sengupta (2014) [16], Choudhary et al. (2011) [17], Biyan et al. (2014) [18], Kumar and Kumawat (2014) [19],** and **Singh et al. (2017) [20]**. The content and uptake of phosphorus might be increased due to the application of integrated nutrient management practices enhanced theefficiency of phosphorus absorbing mechanisms and encourages the root growth which enhanced the phosphorus uptake, while, the organic manures might helpincreasing the microbial activity into the soil, caused higher phosphorus uptake.The increase in the phosphorus content and uptake may be because the application of phosphorus by inorganic and organic sources aids in the synthesis of DNA and RNA, the genetic building blocks, as well as the development, maintenance, and repair of all tissues and cells of the crop plants which enhances the absorption and uptake of phosphorus by crop plants. **Hussain et al. (2012) [21], Jain et al.(2007) [22], Kumawat et al. (2010) [23]**and **Prajapati et al. (2016) [24]**also found the similar findings of phosphorus uptake with their separate experiments.The application of different integrated nutrient management treatments increased the potassium content and uptake that might be due to the enhancement in the photosynthesis, energy transfer and movement of nutrients within the plants due to proper fertilization through the organic and inorganic sources of nutrients.The nitrogen phosphorus and potassium are applied through both organic and inorganic source which might enhanced the absorptions of the different minerals, and resulted in higher carbohydrates mineralization by crop plants which is correlated with potassiumlevels in plants.Similar results were observed by**Barkha et al. (2020)[25],Singh and Pareek (2003) [26], Tarafder et al. (2020) [27] and Verma et al. (2017) [28]**from their experiments**.**The growth and structure of roots, and population and activities of microorganismare also improved into the soils due to the application of organic sources of nutrients*i.e.* organic manures might increases the mineralization process in soils which enables the availability of different nutrients in absorption forms to the crop plants and this is helpful for the higher uptake of the nutrientsby crop plants from the soils.**Jawhara and Owied, 2016 [29]** also found the close results from their study as to this finding.

5. CONCLUSION

The application of different integrated nutrient management treatment failed to show significant effects on the nutrients content *i.e*. N, P and K in grains and straw of mungbean crop. However, the maximum N, Pand K content in grains and straw of mungbean crop were recorded under treatment T_2 (100% RDF + biofertilizers) and minimum under treatment T_1 (Absolute control) of mungbean crop. Whereas, the various integrated nutrient management practices have significant effect on the uptake of N, Pand K by grains, straw and total uptake by mungbean crop. The highestuptake of these nutrientsby grains, straw as well as total uptake were noted under treatment T_2 (100% RDF + biofertilizers), which was statistically at par with treatments T_5 (75% RDF + 25% N by vermicompost + biofertilizers) and T_4 (75% RDF + 25% N by poultry manure + biofertilizers). The minimum nitrogen, phosphorus and potassium content in grains and straw of mung bean crop and their uptake by grains, straw as well as total uptake was found under treatment T_1 (Absolute control) during the field experiment. In conclusion, this field study showsthat the alteration of the nutrient application to the mung bean crop through the inorganic fertilizers and organic manuresare significant to gain the higher nitrogen, phosphorus and potassium content in grains and straw as well as their uptake by the grains, straw and total uptake by mung bean crop.

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