Research Article

Yield and Nutritional Status of Mungbean as Influenced by Molybdenum and Phosphorus

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Abstract | Legumes are most important crops after cereals having provide a range of essential nutrients and nitrogen fixation for soil fertility particularly for the subsequent crops and yield productivity. In order to improve the nutritional profile of mungbean a study was arranged at Agronomy Research Farm, Agriculture University of Peshawar in summer season 2018. The objectives of the study is to find out impact of different doses of molybdenum and phosphorus application on productivity and nutrients status of mungbean (*Vigna radiate* L.). The trial was laidout in randomized complete block design having three replicates. The experimental findings revealed that all the nutritional attributes and yield were significantly influenced with molybdenum and phosphorus addition except potassium uptake by grains and straw. Higher seed yield (772.45 kg ha^{-1}) and harvest index (26.18 %) with application of 1.5 kg ha^{-1} molybdenum while more protein content (21.91 %), carbohydrates (60.36 %), nitrogen content in grain (3.76 %) and straw (1.10 %), phosphorus uptake in grain (0.380 %) and straw (0.186 %) was achieved with molybdenum applied at rate of 2.5 kg ha^{-1}. Whereas in case of phosphorus use maximum seed yield (810.88 kg ha^{-1}) and harvest index (26.92 %) was observed with 60 kg ha^{-1} P application while highest protein content (22.08 %), carbohydrates (60.37 %), nitrogen content in grain (3.60 %) and straw (1.19 %), phosphorus uptake in grain (0.418 %) and straw (0.21 %), potassium uptake in grain (1.96 %) and straw (1.30 %) was achieved with P applied at 90 kg ha^{-1}. Higher doses of phosphorus and molybdenum enhance all the quality attributes of mungbean. It concluded from the experimental findings that mungbean crop with (1.5 kg ha^{-1} Mo and 60 kg ha^{-1} P) for seed yield and (2.5 kg ha^{-1} Mo and 90 kg ha^{-1} P) for enhancement of nutrients uptake of mungbean performed better than other doses and thus recommended for higher productivity and qualitative attributes in agro climatic condition of study area.

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Introduction

Food security is threatened to our country and faced by agriculturists. For this food items in higher quantity with good quality are needed to be formed. Amongst food crops, pulses are playing a significant role in achieving food security (Padhi and Pattanayak, 2018). Pulses due to nutritional status contribute in improving human health by lowering the risk of different types of diseases like diabetes, obesity and cardiovascular diseases (Vega *et al*., 2010). Demand of pulse crops are increasing due to increasing population rate in Pakistan. Pulses are the second most important crops after cereals. Mungbean (*Vigna radiata* L.) is a short duration legume crop. It contains high protein content (24%) with good digestibility compared with other pulse crops (Ali *et al*., 2010). Mungbean is used as food, fodder as well as green manure crop (Sarwar *et al*., 2004). It is a short duration crop and tolerant to drought that can survive under hostile environmental scenario and thus effectively grown in rainfed zones (Anjum *et al*., 2006). Mung bean is an important and major conventional kharif legume crop grows in Pakistan (Khattak *et al*., 2004). In Pakistan mungbean was grown about 133 thousand hectares with total production of 102 thousand tons, while in KPK it was grown about 9 thousands hectares with average productivity of 06 thousand tons (MNFSR, 2017).

In legume crops micronutrients play a vital role and positive response for achieving higher yield through biological nitrogen fixation and their positive influenced on plant growth. The deficiency of micronutrients effects plant growth and yield. A trace element molybdenum (Mo) is necessary for development of animals and plants and other biological organisms (Westermann, 2005). Molybdenum performs vital role in plant growth and crucial for nitrogenase enzymatic activity and nitrate reductase. Molybdenum required required by rhizobium (nitrogen fixing bacteria) for biological nitrogen fixation as it's a part of nitrogenase enzymes (Westermann, 2005). Legumes required Mo for protein synthesis through the nitrate reductase (Kaiser *et al*., 2005). In root nodules of legumes molybdenum is also required for the fixation of nitrogen by the rhizobium bacteria. Molybdenum as part of nitrogenase enzymes is required for the conversion of atmospheric nitrogen into ammonium nitrogen. Therefore, in legumes the reason of molybdenum deficiency is more than other crops (Bailey and Ladlaw, 2000). In nutrient deficient soil molybdenum application enhances formation of nodules and thus for nitrogen fixation (Rahman *et al*., 2008). Molybdenum performed positively for enhancing quantity, quality and nodule formation in legume crops. Application of molybdenum into the soils increases the contents of potassium, phosphorus and crude protein (Anonymous, 2005).

Most of agricultural land of Pakistan are basically alkaline and calcareous in nature. Generally, 95% of Pakistani soils have deficiency of phosphorous availability (Nisar *et al*., 2010). Phosphorous deficiency can cause severe reduction in productivity of mungbean crop in early stage of development (Yadav *et al*., 2017). Phosphorous use efficiency is reduced due to continuous cultivation although P should be applied in sufficient amount to fields. In macronutrients phosphorus plays a leading role and important for optimum production. It is clearly verified statement from science that for every type of life growth phosphorous plays major role (Ryan *et al*., 2012). Different factors like poor soil fertility, weeds and insect pest infestation and inadequate application of fertilizer are the main reasons for productivity of mungbean crop (Khan *et al*., 2015). Application of fertilizers at proper timing through proper method in balanced ratio shows positive response for higher productivity (Alam *et al*., 2002).

Keeping in view the importance of molybdenum and phosphorus on yield productivity and nutrient uptake of mungbean, the current experiment was planned to explore the best combination of molybdenum and phosphorus fertilizer for improving productivity of mungbean.

Materials and Methods

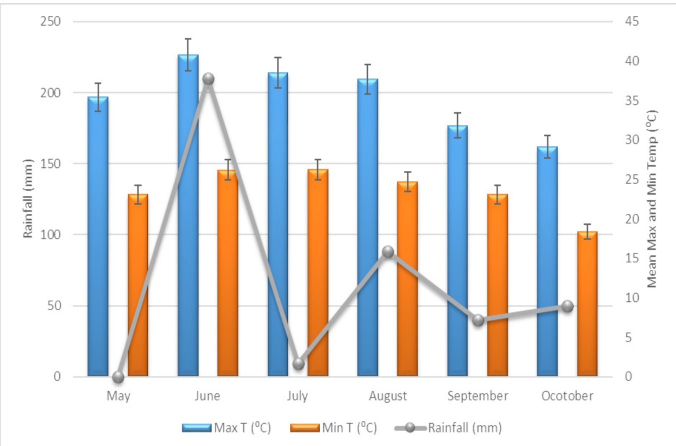
A field experiment entitled with "Yield and nutritional status of mungbean as influenced by molybdenum and phosphprus" was assessed at Agronomy Research Farm, Agriculture University Peshawar in Kharif season summer 2018. Sowing was done at second July whereas harvesting was performed at 25th September. The study was carried out in randomized complete block design and replicated thrice. Plot size of 3m x 1.8m having 6 rows with row to row distance of 30 cm and plant to plant distance of 10 cm was maintained. Various doses of molybdenum and phosphorus was used during the trial. With objectives to find out impact of different molybdenum levels (0, 0.5, 1.5 and 2.5 kg ha^{-1}) and phosphorus levels (0, 30, 60 and 90 kg ha^{-1}) application. Treatment were compared with each other and applied to their respective plots. Single super phosphate and sodium molybdate was used as a source for phosphorus and molybdenum. Variety used Ramzan-92 of mungbean was grown at the rate of 25 kg ha^{-1} during trial and spread with the help of seed drill. Initial dose of nitrogen was used 25 kg ha^{-1}. In whole season three irrigations were applied to field, 1st irrigation was applied after seven days sowing of crop, second irrigation before flowering stage and third was done at pods filling stage. Water requirements for the particular crop were fulfilled by supplying over surface irrigation in addition to rainfall.

Molydenum and phosphorus application

Sodium molybdate and (SSP) used as source for molybdenum and P. For even distribution of molybdenum levels in field, sodium molybdate was mixed with soil (1g sodium molybdate with 5g of soil) and then applied through band placement on single side of each row at sowing time. While all the mentioned phosphorous levels were applied at the time of sowing.

Climate of the site

The-climatic condition of the site area is semiarid. The experimental site is located at 34.01°-N latitude and 71.35°-E longitude, at an altitude of 350 m above sea level in Peshawar valley. Soil of the experimental site is clay/silt loam with low level of organic matter (0.87%), phosphorus (6.57mg-kg^{-1}), potassium (121 mg-kg^{-1}), alkaline (pH 8.2) while nature of soil is calcareous. Other soil physiochemical properties were derived and given in Table 1 (Amanullah *et al*., 2009).



Rainfall and temperature data from May 2018 to October 2018.

Data studied

Data were taken on seed yield by harvesting central four rows of each plot. The harvested rows were bundled and sundried in open field for ten days. The bundles were weighed, sundried, threshed and samples of grains were taken and weighed with weighing balance and transformed to kg ha^{-1} through certain formula. Crop harvest index was measured by dividing economic yield on biomass yield while multiplying with 100 to achieve the value in %. Grain nitrogen content and straw nitrogen content were determined via Kjeldahl process (Bremmer and Mulvaney, 1996). Sample seeds was grinded with sieved from 0.2 mm sieve for getting the clear and fine powder for nitrogen determination contents. The sample seed powder of 0.2g in the presence of digestion mixture and digested with concentrated H_2SO_4 (3ml) at temperature of 350°C till the light greenish color of the samples appeared. The mixture was diluted upon cooling. 20 ml of the diluted digested was distilled with 40% NaOH solution and mixed indicator, and then titrated against HCl solutions, and calculation was made after adjusting for blank reading. Seed and straw phosphorus and potassium content were also determined in the laboratory of the university as per suggested protocol by (Kadwe *et al*., 1974). Protein content was determined by Kjeldhal method (AOAC, 1990). The percentage of nitrogen was calculated as under:

$$N\,(\%)\;((V1-V2) \times 14.01 \times 0.5\,)/(\text{Sample in mg}) \times 100$$

V1= Titration reading of sample, V2 = Titration reading of blank, 14.01 = Atomic weight of Nitrogen. The crude protein was determined for seed samples by multiplying the nitrogen content of the sample by 6.25.

Table 1: *Pre-sowing soil physico-chemical properties (0-30 cm depth).*

Soil properties	Unit	Value
Clay	%	12.5
Silt	%	49.7
Sand	%	36.8
Textural class	-	Slit loam
pH	-	7.78
EC	d S m^{-1}	0.16
Organic matter	%	0.83
Total nitrogen	%	0.067
Phosphorus	mg kg^{-1}	2.33
Potassium	mg kg^{-1}	106.3

Statistical analysis

All the taken data were statistically examined over the appropriate technique for the analysis of variance specifically for the design of randomized complete block. Average of data were linked by means of LSD test at P < 0.05 level of probability (Jan *et al*, 2009).

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Results and Discussion

Seeds yield (kg ha^{-1})

Seeds yield is a final production of every crop in study and based on several features. The present study indicated that seed yield varied significantly with different application treatments of molybdenum and phosphorus Table 2. The maximum seed yield was noted in plots gaining with 1.5 kg of Mo ha^{-1} followed by 2.5 kg of ha^{-1} (Figure 4). This growth in yield of seed could be because of molybdenum that improved rhizobium activity, nitrogen fixation, and vegetative growth and yield components in mungbean. Need critical discussion. Review and discussion are two different things. Molybdenum has a prominent role in the effectiveness of the nodules, which made the soil environment favorable for the absorption of other nutrients from the soil, promoted nitrogen fixation and played a positive role in flowering, pod formation and other performance attributes (Chattarjee and Bhandyopadhy, 2017). These consequences are in agreement with those conveyed by Pattanayak *et al*. (2000) and Anwar *et al*. (2018) who confirmed that the yield of mung bean grain increased with increasing molybdenum levels compared to the control. Similarly, in form P, more seed production of fertilized plots 60 kg of P ha^{-1} was achieved, tailed by fertilized treatments having 90 kg of P, while seed yield more low was noted in the control plots. The reason for the increase in seed yield with higher phosphorus could be due to the development of the root, the greater absorption of nutrients and a greater accumulation of dry matter during the growth period and the translocation of more photosynthesis to the seed (Ahmad *et al*., 2018). Phosphorus fertilizer helped the crop create extra seeds and other reproductive measures that eventually subsidized to yield (Rani *et al*., 2016; Ahmad *et al*., 2018). The consequences are also in line with Tariq *et al*. (2007) they showed a more seed production with higher doses of P to mungbean.

Harvest index (%)

The harvest index is image of proportions of seed and biomass production. In the existing discussions, the application of molybdenum and phosphorus responded significantly to the harvest rate of mungbean, while their interaction was not significant Table 2. Treatments received molybdenum (1.5 kg ha^{-1}) resulted more harvest index that is on par with molybdenum applied with 2.5 kg ha^{-1} (Figure 4). These investigations close conformity of Tahir *et al*. (2014), they stated that the application of molybdenum is involved in many physiological and phenological features of mungbean, which ultimately responded at a maximum harvest rate. Singh *et al*. (2014) also found a maximum crop index in mungbean by applying molybdenum over the control. In case of P, treatments gaining with 60 kg of P created a maximum harvest index, whereas lower harvest index was detected in plots gaining with a low phosphorus level. The improvement in the harvest index maybe the results due to improvement in the physiological capability to organize photosynthesis and its translocation in organs that have economic value (Nikfarjam *et al*., 2015). These conclusions are compatible of Ahmed *et al*. (2018) they determined that HI enlarged through the increase in phosphorus.

Table 2: *Shows seed yield, harvest index, protein and carbohydrates content of mungbean as influenced by molybdenum and phosphorus application.*

Phosphorus (kg ha^{-1})	Seed yield (kg ha^{-1})	Harvest index (%)	Protein %	Carbohy-drates (%)
Control	558.56 c	22.28 b	19.42 d	56.42 d
30	601.62 bc	22.01 b	20.47 c	57.39 c
60	810.88 a	26.92 a	21.12 b	58.59 b
90	664.35 b	23.05 b	22.08 a	60.37 a
LSD	84.65	3.35	0.34	0.68
Molybdenum (kg ha^{-1})				
Control	534.95 c	20.95 c	19.57 d	56.70 d
0.5	625.23 bc	22.74 bc	20.35 c	57.25 c
1.5	772.45 a	26.18 a	21.25 b	58.46 b
2.5	702.78 ab	24.38 ab	21.91 a	60.36 a
LSD	84.65	3.35	0.34	0.68

Protein (%)

Data regarding protein (%) content of mungbean is presented in Table 2. Analysis of the data indicated that protein (%) content of mungbean crop has positively influenced with the combined application of phosphorus and molybdenum while the interaction among molybdenum and phosphorus have also positive impact on protein (%) content of mungbean. Protein content of mungbean was observed higher with higher dose of phosphorus application. Phosphorus applied dose of 90 kg ha^{-1} recorded more protein content i.e.

(22.08 %) while in case of no dose of phosphorus applied observed less amount of protein content % i.e. (19.42%). Mehboob *et al.* (2019) stated that protein % is increased with increasing dose of phosphorus application. This increasing trend might be due to the fact that Phosphorus is vital for development of new tissue and the transfer of the genetic information within the plant from one cell to another during cell formation. Similar results were correlated with the investigations of (Rausch *et al.*, 2001; Mehboob *et al.*, 2019; Gruhun *et al.*, 2000) they stated that phosphorus application recorded enhancing in content of protein (%) of mungbean. Similarly, in case of molybdenum addition response with increasing trend to increasing levels of molybdenum. Molybdenum dose applied with the rate of 2.5 kg ha^{-1} recorded higher trend of protein % i.e. (21.91 %) followed by (21.25 %) with application rate of molybdenum at rate of 1.5 kg ha^{-1} while less amount of protein content (19.57%) was observed with no molybdenum addition. It might be due to fact that molybdenum is essential for nitrogenase activities of most of biotic creatures containing plants also (Graham and Stangoulis, 2005). Normally, molybdenum is a vital micronutrient for bacteria and plants also (Williams and Silva, 2002). Meagher *et al.* (1991) conveyed the character of molybdenum in typical incorporation of nitrogen by plants is well known, because molybdenum is a fundamental constituent of nitrate reductase and nitrogenase, which resist to the lessening of mineral nitrate and supports for fixative of N2 to NH3. Thus, molybdenum is the basic to nitrogen fixation and increasing the protein content of by legumes.

Carbohydrates (%)

Data regarding carbohydrates content of mungbean as influenced by molybdenum and phosphorus application on mungbean crop presented in Table 2. Analysis of variance indicated that both molybdenum and phosphorus and their combined application performed significantly positive response towards carbohydrates contents (%) of mungbean crop. Molybdenum application at the rate of 2.5 kg ha^{-1} enhance carbohydrates contents 6.05 % more than control treatments. While in case of phosphorus application carbohydrates contents were enhanced by phosphorus almost 12.38% than no phosphorus treated plots. Improving carbohydrates contents by molybdenum and phosphorus application might be due to molybdenum enhance the nodulated efficiency of mungbean crop, with greater formation of more nodules in numbers it may be able to fix more atmospheric nitrogen as in their roots and forward these efficiencies to the ultimate production of mungbean grains and play a significant role in amino acids formation of the seeds while phosphorus improve the grains capacity and hardness of mungbean seeds. Further it was explained by Mubarak (2005) they reported that nutritional score of mungbean in case of carbohydrates contents it may be increased up to 10-20% and also by using the FAO/WHO (1973) reference pattern, whereas Tsou *et al.* (1979) explained that mungbean grains have much sufficient amount of amino acids and other adequate nutritional contents. The results were also in conformity with those of El-Adawy *et al.* (2003).

Phosphorus concentration in seeds and straw (%)

Data status of phosphorus profile in seeds of mungbean were evaluated in Table 3. Analysis of the consequences represents that phosphorus contents in seeds of mungbean were significantly enhanced with phosphorus and molybdenum application to mungbean crop. Analysis shows that phosphorus profile increased with increasing dose of phosphorus (Figure 1). Higher dose of phosphorus shows up to 25% improvement in mungbean seeds with respect to P contents while straw phosphorus contents were improved (27.20%) with enhanced doses of phosphorus. Its potency might be due to fact that more P application to legume crops will response back to more content of P in seeds of the different crops because phosphorus plays a significant role for legumes production and seed hardness with quality improvement in grains profile (Naagar *et al.*, 2004) Similarly in case of phosphorus content in straw of mungbean similar trend were found i.e. increasing phosphorus content in mungbean straw with increasing doses of phosphorus addition (Figure 2). Whereas molybdenum also shows a positively response towards improving in straw and seeds phosphorus content of mungbean. Straw and seeds phosphorus content were increased up to 11 % and 10%, respectively when compared with control treatment where no molybdenum was applied. The regulatory effect of phosphorus and molybdenum during carbohydrate metabolism and at the time of photosynthesis in leaves and other plant parts should be considered one of the important and majorly plant limiting factor of plant growth and development particularly when convert to reproductive portion of the plant (Kumawat *et al.*, 2009). The increasing doses of phosphorus at these positions of the crops enhanced starch and sucrose ratio of the leaves and other reproductive organs of the plant (Nagar *et al*., 2008). Khattak *et al*. (2004) observed more phosphorus contents in legume seeds as they enhance phosphorus doses. Results were also further confirmed by (Singh *et al*., 1968; Muhammed *et al*., 2010) they stated that the chemical constituent of mungbean seeds were unevenly distributed with macro nutrient application like phosphorus.

Table 3: *Shows grain and straw NPK % contents as influenced by molybdenum and phosphorus application.*

	Nitrogen %		Phosphorus %		Potassium %	
Phosphorus (kg ha^{-1})	**Grain**	**Straw**	**Grain**	**Straw**	**Grain**	**Straw**
0	2.842 d	0.951b	0.333d	0.153c	1.863d	1.234b
30	3.133 c	0.999ab	0.362c	0.160c	1.903c	1.239b
60	3.391 b	1.076a	0.379b	0.175b	1.934b	1.259b
90	3.603 a	1.196a	0.418a	0.210a	1.968a	1.308a
LSD	0.170	0.081	0.016	0.012	0.030	0.033
Molybdenum (kg ha^{-1})						
0	2.620 c	0.986c	0.360b	0.166c	1.900	1.231
0.5	2.954 b	1.060bc	0.373ab	0.169bc	1.906	1.264
1.5	3.635 a	1.075b	0.380a	0.178ab	1.926	1.271
2.5	3.760 a	1.101a	0.379a	0.186a	1.936	1.273
LSD	0.170	0.081	0.016	0.012	NS	NS

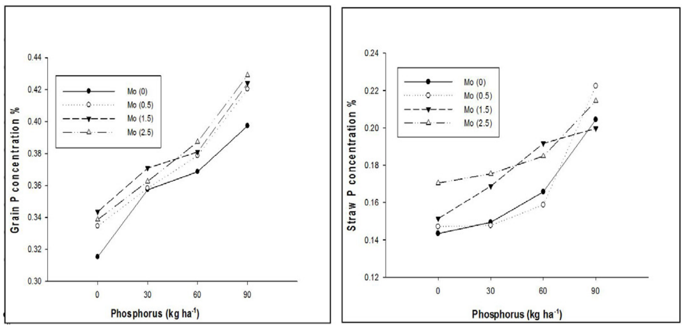

Figure 1: *Shows grains and straw P contents as influenced by molybdenum and phosphorus.*

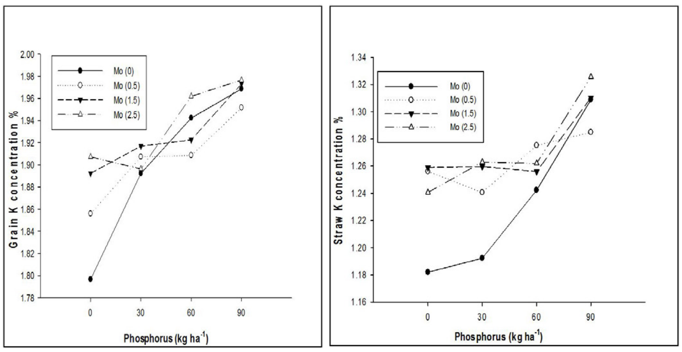

Figure 2: *Shows grains and straw K contents as influenced by molybdenum and phosphorus.*

Nitrogen concentration in seeds and straw (%)

Data on the N content in seeds of mungbean as impacted by the application of molybdenum and phosphorus (Table 3). Analysis proposed that molybdenum, phosphorus and Mo x P influenced significantly the seeds and straw N content. A higher seeds N content was recorded with a higher dose of molybdenum (2.5 kg ha^{-1}) traced by a molybdenum of 1.5 kg ha^{-1}, less seeds N was recorded in controls treatment (Figure 4). In occasion of phosphorus, higher grain N was noted with P usage at 90 kg ha^{-1} traced by P at 60 kg ha^{-1}, whereas minimum was noted in controls (Figure 4). The interactive response of Mo x P displayed a progressive impact on the N amount of grain and increases with rising rates of P and Mo. The highest N of grain was perceived in those plots fertilized by molybdenum at 2.5 kg ha^{-1} and 90 kg P ha^{-1}. Similarly, with higher dose of molybdenum seeds N content were enhanced up to (30.32 %) in seeds of mungbean while (10.43 %) were enhanced in straw of mungbean. Seeds nitrogen content was significantly influenced with molybdenum, phosphorus and Mo x P. Seeds N content was positively improved with increasing levels of molybdenum. Treated plots with greater molybdenum dose of (2.5 kg ha^{-1}) showed significantly higher N content. Particularly grain nitrogen contents were enhanced about (21.13%) whereas straw N content was improved (20.47 %) with higher dose of phosphorus when compared with control. The possible reason for this might be that molybdenum application significantly enhanced nodules efficiency and activate rhizobium for higher fixation of nitrogen from atmosphere for the plant (Agatise and Tayo, 2004). These outcomes are relation to the discoveries of Nautiyal *et al*. (2005) they exposed grain N content was significantly ameliorated with more molybdenum doses. In case of phosphorus, grain N content was enlarged with growing levels of phosphorus. Higher seeds and straw N content was recorded with maximum dose of phosphorus application, whereas seed and straw nitrogen content was decreased with lower dose of phosphorus (Figure 3). Phosphorus as energy source had strong effect on chlorophyll content, photosynthesis and other metabolic activities to enhance grain N content (Alam *et al*., 2002). Hussain *et al*. (2012) conveyed P is crucially essential for many physiological functions of plants. Phosphorus application had significant response in the efficiency of root nodules, soil bacteria and play major role in biological nitrogen fixation (Jabbar and Saud, 2012).

Potassium concentration in seeds and straw (%)

A significantly and positively response were showed by straw and seed potassium content of mungbean with respect to phosphorus application whereas molybdenum did not play a significant role for improving seeds and straw content of mungbean (Table 3). Statistical analysis of the data indicated that phosphorus applied at higher doses added higher values of potassium in seeds and straw of mungbean. Similarly potassium content were improved about 5.31 % and 5.58 % in grain and straw of mungbean respectively (Figure 2). The analysis shows an increasing trend that both seeds and straw contend of potash were enhanced with increasing doses of phosphorus. These results were in close conformity of with Kumawat *et al*. (2009) who also shows the increasing trend of mungbean potassium content in seeds and straw. Singh and Kapoor (1992) also explained the same variation in mungbean. These results could be due to the importance of phosphorus which shows a great variation in yield and yield component of mungbean as well as with nutrient uptake of different nutrients because the greater availability of phosphorus may guarantee the availability of other nutrients too. Choudhry *et al.* (2003) reported that phosphorus application enhances the nutritional uptake of different nutrients while it improves growth and yield of legumes crops.

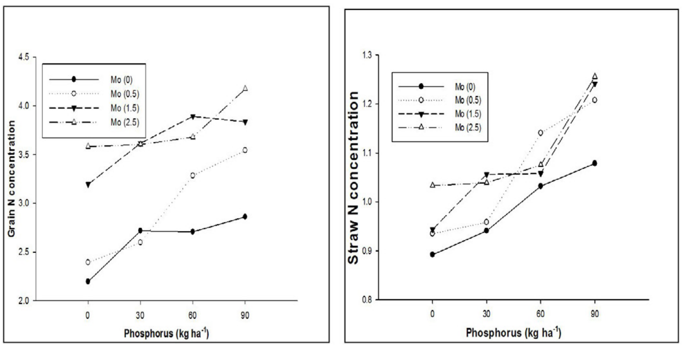

Figure 3: *Shows grains and straw N contents as influenced by molybdenum and phosphorus.*

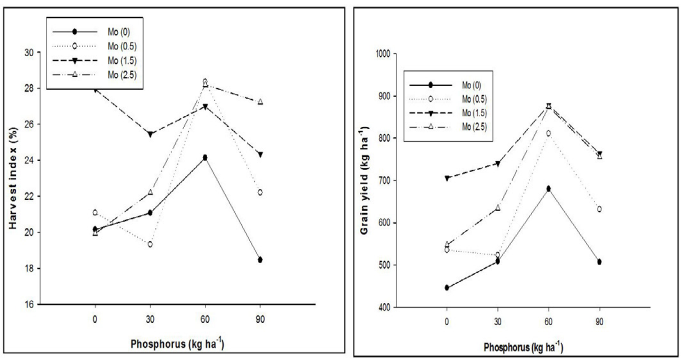

Figure 4: *Shows harvest index % and grain yield of mungbean as influenced by molybdenum and phosphorus.*

Conclusions and Recommendations

From the results of the current experiment and their analysis of the data its concluded that legume crops such as mungbean shows a great response towards molybdenum and phosphorus application. Higher yield of seed was recorded with addition of molybdenum at the rate of 1.5 kg ha^{-1} and 60 kg ha^{-1} phosphorus while all the qualitative attributes of mungbean was recorded higher with highest doses of molybdenum and phosphorus. Therefore, it is concluded from the experimental findings that mungbean crop should be grown for higher seed productivity at 1.5 kg ha^{-1} molybdenum and 60 kg ha^{-1} phosphorus. While for the enhancement of nutritional indices of mungbean (2.5 kg ha^{-1} Mo and 90 kg ha^{-1} P) performed better than other doses and thus recommended for higher productivity and qualitative attributes in agro climatic condition of study area.

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Novelty Statement

The main purpose of this study was to enhance the yield and nutritional indices of mungbean crop. This study will play a major role for enhancing yield, protein, carbohydrates and other nutritional status of mungbean crop and will be followed for citations and literature review as well.

Author's Contribution

Junaid Ahmad: Performed and did overall management of the manuscript.
Shazma Anwar: Designed the experiment.
Anwar Ali Shad and Fazal Yazdan Saleem Marwat: Helps in statistical analysis and result and discussion.
Hamida Bibi: Helps in methodology and lab analysis.
Farhan Ahmad: Help in writing of manuscript.
Wajia Noor and Bibi Sadia: Helps in data entry, data analysis and citations.

Conflict of interest

The authors have declared no conflict of interest.

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