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Effects of different levels of DAP fertilizer on agronomic characteristics and yield of mung bean at agro-ecological climatic conditions of Kabul

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Abstract
Mung bean (*Vigna radiata* L. Wilczek) is an important short-season grain legume known for its high protein content. Despite the importance of mungbean, the lack of recommendations for fertilizer use in local practices in Afghanistan leads to the decline of mungbean in the country. This study aims to investigate the effect of different phosphorus applications on the agronomic characteristics and yield of mung bean in the agro-climatic conditions of Kabul. Over two years (2021-2022), we analyzed four phosphorus applications (0 kg ha^{-1} or control, 20 kg ha^{-1}, 40 kg ha^{-1}, and 60 kg ha^{-1} DAP fertilizer). These treatments were set up in a Randomized Complete Block Design arrangement, with the DAP rates introduced during Mung bean seeding. Results highlighted significant improvements in agronomic characteristics such as plant height, leaf count, and branch count per plant when applying 60 kg ha^{-1} of DAP fertilizer. Specifically, the tallest plant height was achieved using the 60 kg ha^{-1} rate, showing a notable difference from the other DAP levels. Concerning yield and its components, the 60 kg ha^{-1} application led to a significant yield difference compared to other treatments. Additionally, yield metrics like number of branches per plant, pods per plant, seeds per pod, seed weight per plant, thousand seed weight, overall seed yield, and pod length were highest with the 60 kg ha^{-1} application. Therefore, for optimal Mung bean production in Kabul and regions with similar agroecology, we recommend using 60 kg ha^{-1} DAP fertilizer.

Keywords: DAP (Diammonium phosphate), mung bean, yield

1. Introduction
Mung bean (*Vigna radiata*) is a member of the Fabaceae family. This family is quite large and is the third-largest family of flowering plants, with approximately 650 genera and nearly 20,000 species (Doyle, 1994) [28]. Mung beans have many names: "mung bean, mash, golden bean, mung bean". Mung beans are also one of the agricultural products of Afghanistan. Mung bean (*Vigna radiata* (L.)) is an important crop in Afghanistan. Compared to other legumes, mung beans have advantages because they are nutritious, easy to digest, and non-irritating.
It is grown for its protein-rich edible seeds (Haq, 1989) [29]. Its seeds contain 24.7% protein, 0.6% oil, 0.9% fiber, and 3.7% ash (Potter and Hotchkiss, 1997) [30]. An important feature of soybean is that it can establish a cooperative relationship with certain bacteria to produce N2 fixation in root nodules and increase the N2 requirement of the plant (Mahmood and Athar, 2008) [31]. Mung beans are drought-tolerant and short-lived and can grow well in a variety of conditions (water- and rain-fed). Additionally, Muhammed *et al*. (2016) [32] reported that vermicompost application (2 t ha^{-1}) could significantly affect the amount of phosphate fertilizer (75 kg P ha^{-1}) on mung bean yield. Economic significance was found with treatment using half dose fertilizer (37.5 kg P ha^{-1}) and 2 t ha^{-1} vermicompost, Yadav *et al*. (2017) [33] showed more capsule ink^{-1} and measured the weight of summer mung beans. Treated with 40 kg P and PSB + *Aspergillus awamori*. In the interaction between phosphorus and biological inoculants, the combined application of 40 kg P and PSB + *Aspergillus awamori* application significantly increased the seed yield and straw yield, while the combined application of 40 kg P_2O_5 + *Aspergillus awamori* and 40 kg P + PSB application achieved the same level.
Finally, an important part of crop management is understanding how fertilizers affect DAP yield and the individual characteristics of mung bean rice.
Crop yield can be increased by optimizing the DAP application to make the most of available resources and increase productivity.

However, finding the best balance between DPA implementation and resource availability is critical to achieving maximum benefits. This study aims to deepen our understanding of this relationship by revealing the relationship between the effect of diammonium phosphate fertilizer on mung bean rice yield and crop productivity.

The main reason for low productivity is lack of productivity, soil pollution, inadequate use of organic and inorganic fertilizers, especially diammonium phosphate fertilizers, invasive insects and weeds, etc. it could be. Local farmers have negative opinions about mungbean, a legume plant; It does not need fertilizer, resulting in very large crops. However, the use of nutrients required for bean plants from organic and inorganic sources plays an important role in providing economic benefit.

2. Materials and Methods

A study titled "Effects of different diammonium phosphate fertilizers on the agronomic characteristics and yield of mung bean in the agro-ecological climatic conditions of Kabul" was conducted during the summer growing season. The geographical area of Kabul is 34.528′ latitude and 69.172′, with an altitude of 1,800 meters. The trial areas were productive and balanced because they were planted in the previous season. The trial was carried out in 2021 and 2022 in the agriculture department of Kabul University Faculty of Agriculture. A randomized complete block design was used to create 3 replicates with 4 treatments (T_1 control, T2 20 kg h^{-1}, T3 40 kg h^{-1}, and T4 60 kg h^{-1}). Treat plants as needed and give five waterings on non-rainy days throughout the growing season. Collect observations of mung bean plants at different growth stages and determine their various agronomic parameters. Three plants were selected from a specific area of each plot and marked to record observations during the study. The following observations were recorded during the experiment.

2.1 Plant height

During the mung bean growing cycle, careful measurements a re used to record plant height. We measured the height of the plant using a tape measure. Use standard procedures to ensure accuracy. After random selection from each plot, the height of each plant was measured from the base of the plant to the tip of its longest leaf. All selected plants were measured multiple times to fully understand changes within and between treatment groups. A spreadsheet containing data on plant pressure was then created for future research and interpretation. Number of branches per plant from three plants of Mung beans, the number of branches was counted and then the mean number of branches was recorded and counted as branches per plant.

2.2 Thousand seed weight

To assess the impact of DPA fertilizer on the weight of Mung bean seeds and their constituent parts, the measurement of thousand seed weight was carried out. A random sample of mature Mungbean plants was taken from each treatment plot to get precise and reliable measurements of the weight of the Thousand Seeds. To achieve adequate representation, the sample size was chosen by statistical recommendations.

The straw from the chosen Mungbean plants was thoroughly r emoved, being cautious to take out any crooked or damaged g rains. Each sample of 1,000 seeds was weighed using a digital balance that was calibrated to an accuracy of 0.01 grams. To a ccount for variability, each measurement was taken three time s, and the average was computed for each plot.

Standardized procedures were followed throughout the process to guarantee uniformity and reduce errors. We carefully check the ingredients or ingredients that differ from the average and, if necessary, remove them from the final analysis.

Using these rigorous measurements, we hope to finally genera te accurate and reliable data for analysis to gain a deeper unde rstanding of the impact of the plant group on corn grain and it s products.

2.3 Grain yield

A methodical sampling methodology was used to gather data measurements to evaluate the grain yield of Mungbean. The study area was separated into several plots, each of which represented a particular DAP fertilizer level. A certain number of sample plants were randomly chosen from each plot. To obtain the actual grain yield, the chosen plants were carefully harvested at the maturity stage. Each sampled plot's Mungbean plants were painstakingly plucked and separated throughout the Harvesting process. The plants' pods were hand-collected, thoroughly cleaned, and dried in the air to remove any extra moisture. To remove the grains from the pods, the dried Mung bean pods were shelled.

The grains were carefully and precisely weighed using a digital scale after being shelled. Each sample's weight was noted, and grain yield was estimated by adding the weights of each sample within a specific plot. For each plot, the weighing procedure was carried out three times, with the average weight being used for analysis.

This systematic process of gathering data allowed for a thorough analysis of the impact of DAP fertilizer on Mungbean grain production and its constituent parts, producing trustworthy and meaningful results for the study.

2.4 Harvest Index (HI %)

The harvest index was calculated as the ratio of grain yield and biological yield. Its value was expressed in percentage, using the following formula.

$$HI\% = \text{Grain yield kg ha}^{-1}/\text{Biological yield kg ha}^{-1} \times 100$$

3. Results and Discussion

The observations were made at various phases of crop growth, and the statistical analysis of the final data determined the amount of variance resulting from various types of treatments. For both years of study completed and combined at the proper places, tables, and charts are used to depict the pattern of crop plant behavior under various treatments.

3.1 Plant Height

The results of the 2021 study showed that the use of DAP sign ificantly ($p<0.05$) affected tree height. According to the DAP results, the results of this study showed that plants planted in s oil with 60 kg h^{-1} DAP had the highest plant height (38.78 cm), while plants grown in soil without DAP (control) were the shortest. (36.22). centimeter). Plant height increased by increasing the amount of DAP from 0 kg (control) to 60 kg ha^{-1}

The results obtained in 2022 showed that the use of DAP changed as much as it affected tree height ($p<0.05$). The DAP

results analysis results of this study showed that plants planted in soil containing 60 kg /ha DAP had the highest plant height (38.56 cm), while plants grown in soil containing no DAP (control) had the highest number of plants. (34.89). centimeter). Tree height was increased by increasing the DAP level from 0 kg (control) to 60 kg ha^{-1}.

Results in 2021-2022 show that the use of DAP significantly affects Plant height (p<0.05). Regarding the DAP results, the results of this study showed that plants planted in soil containing 60 kg ha^{-1} DAP had the highest plant height (38.7 cm), while plants grown in soil containing no DAP (control) had shorter plant height (35.6 cm). Further increasing DAP from 0 kg (control) to 60 kg ha^{-1} increased plant height.

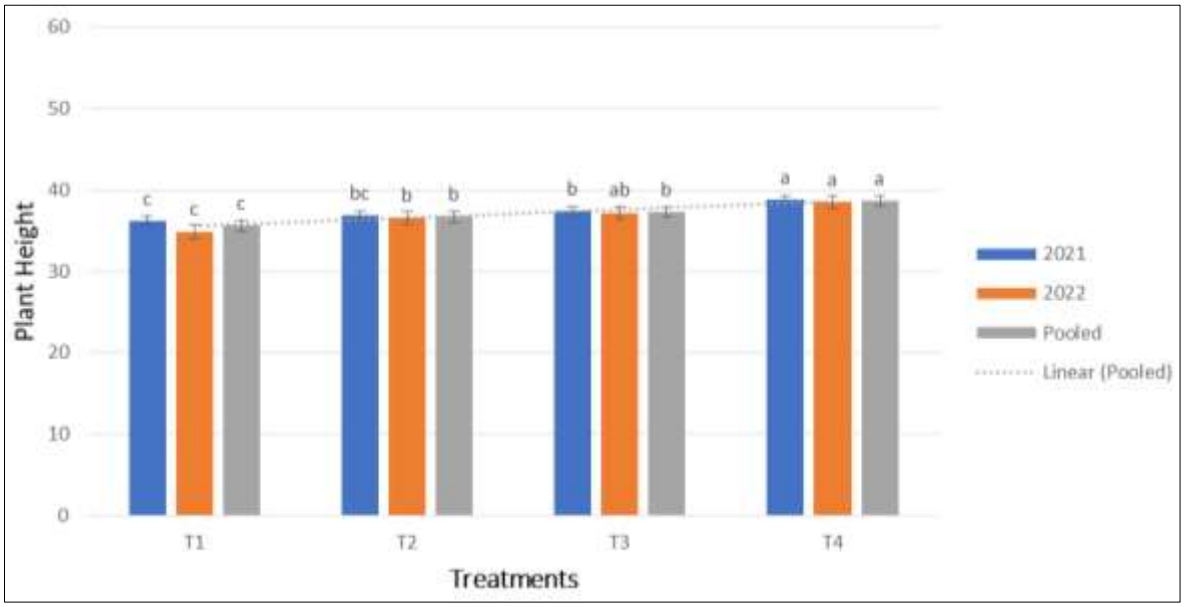

Fig 1: Combined effect of treatment on Plant Height during the years 2021 and 2022. Different letters mean significant differences at LSD (p<5%)

Number of branches per plant

The average number of branches plant^{-1} was significantly influenced by the main effects of DAP rates (p<0.05). The plant treated with 60 kg ha^{-1} DAP had the most branches (32), whereas the control plant had the fewest (14.14). The plants treated with 20 kg ha^{-1} DAP had branches (17.45) and 40 kg ha^{-1} DAP had branches (21.22), both of which differed significantly from the control and 60 kg ha^{-1} DAP, respectively.

The 2022 results indicate that the effects of DAP rates significantly (p<0.05) influenced the mean number of branches plant^{-1}. The highest number of branches plant^{-1} (21.88) was observed on a plant treated with 60 kg ha^{-1} DAP. In contrast, the lowest number of branches (17.8) was recorded at control, where 20 kg ha^{-1} DAP was showed (19.5) branches and 40 kg ha^{-1} DAP were showed (21.5) branches, that showed a significant difference from control and 60 kg ha^{-1} DAP respectively.

The combined data for 2021 and 2022 showed that the primary effects of DAP rates considerably (p<0.05) altered the mean number of branches plant^{-1}. The plant treated with 60 kg ha^{-1} DAP had the highest number of branches (26.96), while the control plant had the fewest branches (15.9). The plants treated with 20 kg ha^{-1} DAP had branches (18.5) and 40 kg ha^{-1} DAP had branches (21.39), which both markedly varied from control and 60 kg ha^{-1} DAP.

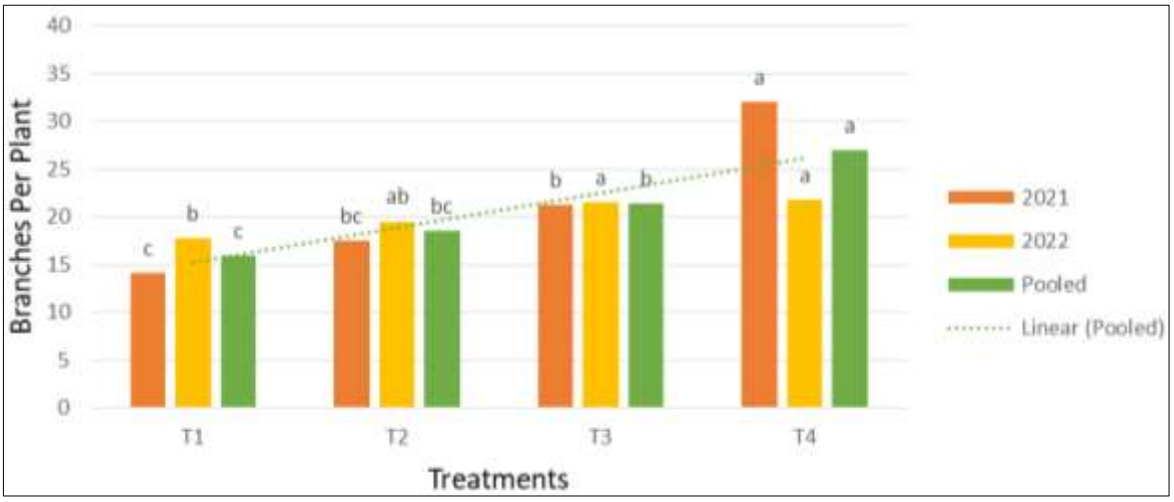

Fig 2: Combined effect of treatment on Number of Branches per Plant during the years 2021 and 2022. Different letters mean significant differences at LSD (p<5%)

Thousand Seeds weight

The weight of the thousand seeds was significantly (p<0.05) influenced by variation in DAP rates, the highest thousand seed weight (64.33 gr) was observed from 60 kg ha^{-1} DAP. In contrast, the lowest thousand seed weight (55 gr) was recorded from the control, whereas the weight of a thousand seed at 20 kg ha^{-1} was observed (56.33 gr) and the weight of a thousand seed at 40 kg ha^{-1} was observed (56.67 gr), which showed a decrease from 60 Kg application of DAP.

The 2022 study found that variations in DAP rates had a significant (p<0.05) effect on the weight of the thousand seeds. The highest thousand seed weight (62 gr) was recorded from 60 kg ha^{-1} DAP, whereas the lowest thousand seed weight (46.7 gr) was recorded from the control. At this point, the weight of the thousand seeds at 20 kg ha^{-1} was observed (58.67 gr), and the weight of the thousand seeds at 40 kg ha^{-1} was observed (54.7 gr).

The combined results from 2021 and 2022 showed that DAP rates significantly (p<0.05) influenced the weight of a thousand seeds. The highest thousand seed weight (63.16 gr) was recorded from 60 kg ha^{-1} DAP, whereas the lowest thousand seed weight (50.8 gr) was recorded from control. In contrast, the weight of thousand seeds at 20 kg ha^{-1} and 40 kg ha^{-1} were both observed to be (57 gr) and (55.7 gr), respectively.

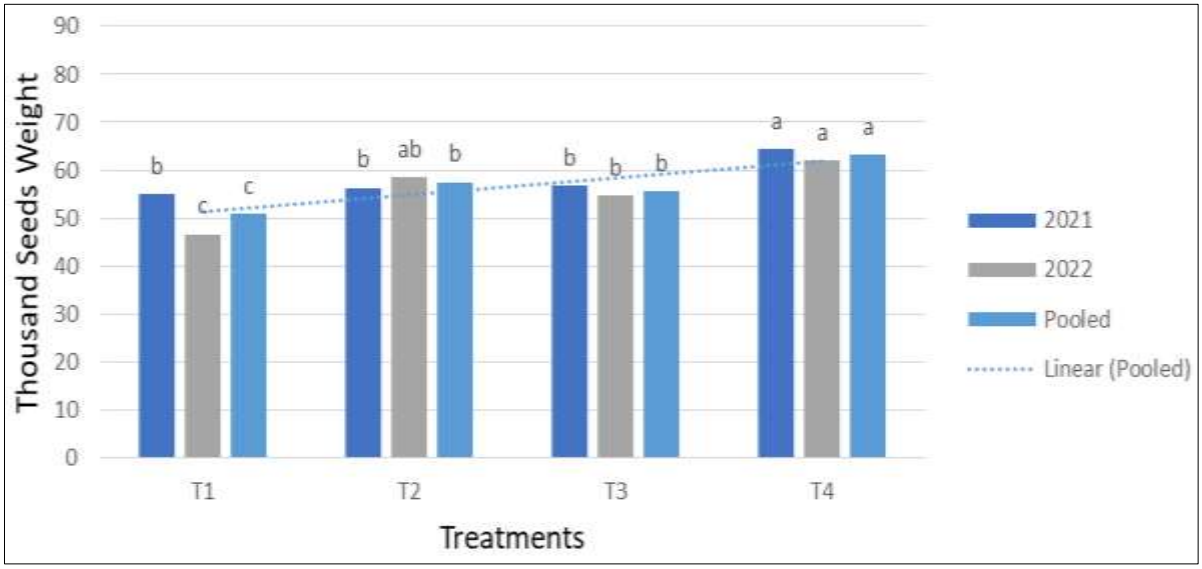

Fig 3: Combined effect of treatment on thousand seeds weight during the years 2021 and 2022. Different letters mean significant differences at LSD (p<5%)

Seed yield

In response to DAP rates for the season of 2021, seed yield had substantial (p<0.05) effects. When applying DAP at a rate of 60 kg ha^{-1}, the highest seed yield (1.203 T/ha) was attained. While the lowest seed yield (0.61 T/ha) was recorded in the control, 40 kg ha^{-1} of DAP was produced (1 T/ha) and 20 kg ha^{-1} of DAP produced (0.99 T/ha) of seed yield, which demonstrated an increase in production when compared to the control while decreasing when 60 kg ha^{-1} of DAP was applied.

In response to DAP rates, the 2022 study on seed yield revealed substantial (p<0.05) effects. DAP was given at a rate of 60 kg ha^{-1} to provide the highest seed output (1.21 T/ha). While the minimum seed yield (0.59 T/ha) was recorded in the control, additionally, 40 kg ha^{-1} of produced (1.02 T/ha) and 20 kg ha^{-1} of produced (0.97 T/ha) DAP-produced seed yield, showed an increase in yield compared to the control, while showed a decrease compared to 60 kg ha^{-1} of DAP application.

The effects of DAP rates on seed yield were statistically significant (P<0.05). Based on observation of combined data of 2021 and 2022 it pup that the maximum seed yield (1.205T/ha) was obtained when applied DAP at the rate of 60 kg ha^{-1}, While the minimum seed yield (0.6 T/ha) was recorded in control, in addition, 40 kg ha^{-1} DAP produced (1.01T/ha) and 20 kg ha^{-1} DAP produced (0.98 T/ha) seed yield, that showed yield increment juxtaposed to control, while showed decrement compared 60 kg ha^{-1} DAP application.

Harvest index

The application of different DAP rates had a significant impact on the 2021 assessment of the harvest index (p<0.05). The application of 60 kg ha^{-1} of DAP produced the highest harvest index 36.3 kg ha $^{-1}$, while the application of 40 kg ha^{-1} of DAP resulted in a harvest index of 30.9 kg ha^{-1} and a harvest index of 33.1 kg ha^{-1}, respectively. The lowest harvest index (20.9) kg ha^{-1} was noted in the control.

The harvest index was influenced significantly (p<0.05) by the application of various DAP rates under the 2022 season of the research. The highest harvest index (32.7) kg ha^{-1} was obtained from 60 kg ha^{-1} DAP, whereas the lowest harvest index (19.8) kg ha^{-1}was recorded in control, in addition, with the application of 40 kg ha^{-1} DAP produced (30.4) kg ha^{-1} and application of 20 Kg ha^{-1} was (29.8) kg ha^{-1}, effects of harvest index respectively.

According to the pooled seasons research, applying different DAP rates had a significant (p<0.05) impact on the harvest index. The application of 60 kg ha^{-1} of DAP resulted in the highest harvest index 34.4 kg ha^{-1}, whereas the lowest harvest index 20.3 kg ha^{-1} was noted in the control. In addition, the effects of the harvest index were produced by the application of 40 kg ha^{-1} of DAP (30.7) kg ha^{-1} and by the application of 20 Kg ha^{-1} 31.4 kg ha^{-1} respectively.

Table 1: Summary of the Analysis of Variance (ANOVA) of Plant height, Branches per Plant, Number of Pods, Seed Yield for Mung bean at Different Levels of DAP Fertilizer on Agronomic Characteristics and Yield of Mung Bean at Agri-Ecological Climatic Conditions of Kabul-2021-2022

Treatment	Plant height(cm)	Branches Per Plant	Number of Pods	Seed yield (t/h)
T1	35.55667^{c}	15.95833^{c}	17.38833^{b}	0.6^{c}
T2	36.72167^{b}	18.50167^{bc}	19.11167^{a}	0.98^{b}
T3	37.305^{b}	21.39^{b}	19.945^{a}	1.01^{b}
T4	38.66667^{a}	26.96^{a}	20.555^{a}	1.205^{a}
Sig. Level	41.86**	30.99**	9.67*	175.04**
CV%	0.93	7.1	3.98	3.48
LSD (0.05%)	0.69	2.94	1.53	6.61

Table 2: Summary of the analysis of variance (ANOVA) of number of leaves, pod length, seeds per pod, 1000 seed weight, and HI for Mung bean at different levels of DAP fertilizer on agronomic characteristics and yield of Mung bean at agri-ecological climatic conditions of Kabul-2021-2022

Treatment	Number of Leaves	Pod length (Cm)	Seeds Per Pod	1000 seed weight (g)	HI%
T1	36.64167^{c}	11.41667^{c}	11.22167^{b}	50.83333^{c}	20.3^{d}
T2	38.36167^{b}	12.445^{b}	11.38833^{b}	57^{b}	31.4^{c}
T3	40.11^{a}	12.945^{ab}	12.055^{a}	55.66667^{b}	30.7^{b}
T4	40.88833^{a}	13.11167^{a}	12.38833^{a}	63.16667^{a}	34.4^{a}
Sig. Level	15.46**	24.55**	24.13**	40.52**	57.22**
CV%	2.14	2.14	1.65	2.44	1.67
LSD (0.05%)	1.67	0.53	0.39	2.76	10.78

Conclusion

The findings in this study found that there was a statistically significant difference between different levels of DAP. The study aimed to find the effects of Four levels of the DAP fertilizer (Control, 20, 40, 60) Kg/h^{-1}, on yield and agronomical characteristics of Mungbean.

In the mung bean cultivar, the application of 60 kg/h of DAP caused the highest averages of the number of leaves, number of branches, and plant height, compared with the control. Whereas, applying 40 kg/h of DAP caused, the second highest number of leaves, number of branches, plant height, and number of pod/plants compared with the control. These results indicated that the observed improvement in the estimated growth characters was correlated positively with increasing the level of DAP from 20 kg/h to 60 kg/h.

Application of 60 kg/h of DAP fertilizer has produced the highest significant increases in the Pod length, number of pods per plant, number of seeds per pod, 1000 seed weight, the weight of seeds/plant, and yield of Mungbean during both 2021 & 2022 seasons in comparison with the control. Whereas, the application of 40 kg/h was the second highest significant increase in the pod length, number of pods per plant, number of seeds per pod, 1000 seed weight, weight of seeds/plant, and yield of Mungbean. Moreover, the application of 20 kg/h of DAP produced the third highest significant increases in the pod length, number of pods per plant, number of seeds per pod, 1000 seed weight, the weight of seeds/plant, and yield of Mungbean. It is of interest to state that the application of 60 kg/h significantly increased the number of pods, the height of the plant, the number of leaves, seed yield, and weight of seeds/plant in the 2021 and 2022 seasons compared with the control.

Recommendation

The agronomic features and yield of Mungbean accessions treated with fertilizer were superior to those of the control treatment. On the other hand, the application of 60 kg/ha DAP fertilizer is advised for higher Mungbean productivity in the current study region, and similar agroecological settings minimize fertilizer cost and maximize Mungbean output.

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