Yield and economics response of two cultivars of mungbean (*Vigna radiata* L.) to different potassium levels

Qudratullah Ehsan[1*], Dr. Mohammad Yosof Amini[2], Hikmatullah Obaid[1], Khalilullah Zaryal[1], Rahmatullah Nazir[1], Karamatullah Fazil[1], Wakil Ahmad Serat[1].

[1]Department of Agronomy, Faculty of Plant Science, Afghanistan National Agricultural Sciences & Technology University (ANASTU), Kandahar, Afghanistan.
[2]Department of Plant Protection, Faculty of Agriculture, Herat University, Herat, Afghanistan.
*Corresponding author: qudrat.ehsan@gmail.com, qudrat.ehsan@anastu.edu.af

Abstract

A field experiment was conducted at the experimental farm of the Agriculture Faculty, Kandahar University, during May–August, 2019 to assess the yield and economics of two Mungbean genotypes under semi-arid conditions in Kandahar. The experiment was laid out in complete randomized block design with three replications and consisted of five treatments of potassium fertilizer levels (0, 20, 40, 60, and 80) K_2O kg ha^{-1} on two Mungbean genotypes (*viz*., NM-94 and *'Kunduzy'*). The result indicate that significant higher grain yield (1,438.2 kg ha^{-1}), stover yield (3,208.7 kg ha^{-1}), biological yield (4,646.8 kg ha^{-1}), Gross returns (116,717.3 AFN ha^{-1}), Net returns (85,642.3 AFN ha^{-1}), and B:C ratio (3.72) were recorded for NM-94. Application of 80 kg K_2O ha^{-1} significantly higher yield such as grain yield (1,813.0 kg ha^{-1}), stover yield (3,250.0 kg ha^{-1}) and biological yield (5,063.0 kg ha^{-1}) were recorded and Significantly higher value of economic parameters gross returns (143,160.0 AFN ha^{-1}), net returns (106,085.0 AFN ha^{-1}) and B:C ratio (3.86%) were recorded with 80 kg K_2O ha^{-1}. Furthermore, K_2O application at the rate of 80 kg ha^{-1} increased grain yield, Stover yield, and biological yield at 107.0, 22.7, and 43.6% compared to control plots, respectively. Overall, NM-94 is the most suitable variety and application of 80 kg K_2O ha^{-1} in order to achieve optimum yields, profitability, and resource-use efficiency under the semi-arid conditions of Kandahar, Afghanistan.

Keywords: Fertilization, Mungbean, Potassium, Profitability, Yield.

ماش (مې) (*Vigna radiata* L.) د دوو مختلفو ورایټیو پر حاصل او عایداتو باندي د پوتاشیم د بېلا بېلو اندازو اغېزې

پوهندوي قدرت الله احسان[۱*]، پوهاند دوکتور محمد یوسف امیني[۲]، پوهنمل دوکتور حکمت الله عبید[۱]، پوهنمل خلیل الله زریال[۱]، پوهنیار رحمت الله نذیر[۱]، پوهنیار کرامت الله فاضل[۱]، پوهنیار وکیل احمد سیرت[۱]

[۱]اګرونومي څانګه، نباتي علومو پوهنځي، د افغانستان د کرنیزو علومو او تکنالوژي ملي پوهنتون، کندهار، افغانستان.

[۲]نبات ژغورني څانګه، کرهڼه پوهنځي، هرات پوهنتون، هرات، افغانستان.

لنډیز

دا څېړنه په 1398 ل. کال د ثور په میاشت کي د کندهار پوهنتون کرهڼي پوهنځی د څېړنیز فارم په ساحه کي شروع او د 1398 ل. کال د اسد په میاشت کښي سرته ورسېده. څېړنه د (CRBD) په ډیزاین کښي ترتیب سوې وه، چي دوې ورایټۍ پنځه د پوتاشیم بېلابېلي اندازې (0, 20, 40, 60 and 80 Kg/ha) او 10 فلاټه او درې تکراره درلوده. د ماش د اصلاح سوې (NM-94) او محلي (*'Kunduzy'*) ورایټیو څخه د نباتاتو د ودي په بېلابېلو وختونو کښي د حاصلاتو او عایداتو ارقام راټول سوي، د کمپیوټري پروګرامونو په مرسته جدول بندي، ترتیب او انلایز تر سره سوې. د ماش نباتاتو اصلاح سوې (NM-94) ورایټۍ د تخمونو حاصلات (1438.2 Kg ha^{-1}) کیلو ګرام پر هکتار، پروړ (3208.7 Kg ha^{-1}) کیلو ګرام پر هکتار او بایو ماس (4646.9 Kg ha^{-1}) کیلوګرام پر هکتار ارقام نست و محلی (*'Kunduzy'*) ورایټي ته ډیر دي. د اصلاح سوي ورایټۍ ټوله عایدات (116717 AFN ha^{-1})، خالص عاید (85642 AFN ha^{-1}) هم زیات دي، چي ترمحلي ورایټۍ ئې 17% سلنه ډیر حاصلات تولید کړي دي. د ماش نباتات پر حاصلاتو باندي د پوتاشیم اندازو څخه د 80 کیلو ګرامه پوتاشیم پر هکتار په احصائیوی توګه توپیر لري، چي د تخمونو حاصلات (1813 Kg ha^{-1}) کیلو ګرام پر هکتار، پروړ (3250 Kg ha^{-1}) کیلو ګرام پر هکتار او بایو ماس (5063 Kg ha^{-1}) کیلوګرام پر هکتار نسبت و 0 کیلو ګرامه پر هکتار ته زیات دي. د 80 کیلو ګرامه پوتاشیم پر هکتار په علاوه کوولو سره ټوله عایدات (143160 AFN ha^{-1})، خالص عاید (106085 AFN ha^{-1}) هم نسبت و 0 او 20 کیلو ګرامه پر هکتار پوتاشیم علاوه کوولو ته زیات دي. په پایله کښي د ماش اصلاح سوي (NM-94) ورایټۍ او 80 کیلو ګرامه پوتاشیم پر هکتار په علاوه کوولو سره د ماش نباتاتو پر حاصلاتو، د استعمال سوو زیرو پر وړتیا او عایداتو کښي زیاتوالی لیدل کیږی. او دغي اصلاح سوي (NM-94) ورایټۍ د کندهار په آب او هوا کښي ښه نتیجه ورکړېده.

کلیدي کلیمي: پوتاشیم، حاصل، عایدات، ماش، ورایټۍ.

Introduction

Mungbean [*Vigna radiata* (L.) Wilczek], is an important food legume with rich source of proteins, vitamins, and minerals where protein and micronutrient paucity are most omnipresent. Afghanistan's geographic location contributes different ecological and biological diversity. It is possible to grow a wide crop varieties in this ecosystem, which exhibits nearly every type of climate. From this vantage point, the significance of mungbean must be emphasized, which are grown in different parts of the world and locally grown in small areas in our country. Plants are the major source of nutrition for all living things, and different plant species have different uses for their seeds, fruits, tubers, roots, leaves stems, and flowers. According to (Ülker and Ceyhan, 2008; Harmankaya et al., 2009; Harmankaya et al., 2010; Varankaya and Ceyhan, 2012 & Harmankaya et al., 2016) legumes are one of the families with the greatest number of species and important nutrient value.

Legumes are now widely recognized as an important source of nutrients due to their sufficient amount of protein, starch, fiber, vitamins, and microelements. By physically disassembling legumes into their component parts starch, protein and fiber and using the end products as food additives to boost the meal's nutritional value, increasing the added value of legumes, Ceyhan, (2004), Ceyhan et al., (2014), Doruk Kahraman and Kahraman, (2023). Thus, according to (Onder et al., 2011; Ibrahimi et al., 2017; Küçük and Ceyhan, 2022; Tamüksek and Ceyhan, 2022 and Tekin and Ceyhan 2022), Legumes are essential to food safety and sustainability.

Mungbean *(Vigna radiate)* is called green gram, golden gram in English, and *Mash* in Pashto (Ehsan et al., 2017c). One of the most important edible legumes is mungbean Toker et al., (2002), Kahraman et al., (2015), which is an annual herbaceous plant that grows upright or semi-upright. Additionally the plant is small, branched, hairy, and can reach the plant height of 25 to 125 cm. The leaves are broad, opposite, and typically oval in three different forms. During the emergence period, a narrow leaf appears, and the petiole is long and oval. It has big, yellow-brown colored flowers. Bunches of five to fifteen flowers adorn each hill, and the main stem and branches have flower stalks that are 2–10 cm long. Most of the flowers are self-pollinated. During the ripening period, the long, narrow pods turn brown, gray, or black. Pods can be glabrous or widely hairy. Seed testa are typically flat, shiny, or dull, and can occasionally be brown or blackish in color. There are 2–8 grams in 100 seeds (Anonymous 1981, 1982, 1983).

Nowadays, Mungbean is cultivated over the entire world, while it has been cultivated in India since ancient time. Meanwhile, it is still widely cultivated in Australia, South America, Africa, and Southeast Asia. It was additionally cultivated as a "Chickasaw pea" in America in 1835s, according to some sources. It is also called after the chop suey bean, golden gram, and green gram. Although mung beans are mostly grown for human consumption, Stover yields are also used for animal feeding (Oplinger et al. 1990).

Mungbean is grown for a variety of purposes, including salad dressing with greens and sprouts, high protein content in the seeds, and ease of digestion. Other noteworthy qualities include its high lysine content, drought tolerance, wide range of adaptability, and capacity to prevent gas from building up in the stomach. West India, Australia, Asia, South America, and tropical and subtropical Africa are the regions where it is most commonly grown commercially (Anonymous 1988). Furthermore, because of its symbiotic relationship with the bacterium *Bradyrhizobium japonicum*, Mungbean can fix 55-110 kg ha^{-1} of nitrogen in the soil (Singh and Singh 2011). Mungbean have 23.67% protein, 1.44% fat, and 71.82% carbs, according to Jomduang (1985). On a dry weight basis, Mungbean contain 25-28% protein, 1-1.5% fat, 3.5-4.5% cellulose, 4.5-5.5% ash and 62-65% carbohydrates. However, the genotype and environmental factors affect the protein content, which ranges from 19.0 to 29.0%. It goes without saying that eating them with grains will result in a more balanced diet in addition to their nutritional value as legumes (Ehsan et al., 2017a), (Doruk Kahraman and Gokmen 2021).

Newly developed varieties of Mungbean (nearly 3 million hectare area) are cultivated in China, Bangladesh, India, Bhutan, Myanmar, Nepal, Pakistan, Sri Lanka, and Thailand. According to Mogotsi (2006), the main producing countries are Indonesia and the Philippines. Mungbean have been the subject of numerous studies both domestically and internationally. Akdağ (1995) determined the seed yield per plant as 4.99-5.16 g, the plant height as 25-45 cm, the number of pods10-35 and the weight of 1000 seeds as 30-40 g. Various studies found that the seed yield was 1420 kg ha^{-1} (Ehsan et al., 2017b), 720-920 kg ha^{-1} (Ihsanullah et al., 2002), 1090.0 kg ha^{-1} (Sharar et al., 1999), 897.0 kg ha^{-1} (Ahmad, 2001), and 24.06 g $plant^{-1}$ (Dalkılıç, 2010).

The possibility of different crops alternating in irrigated areas gradually increases with the gradual introduction and reveals an important production potential in Kandahar, the largest agricultural region in Afghanistan. This study's goal was to determine how potassium doses administered to two genotypes of Mungbean affected yield and important yield parameters under the ecological conditions of Kandahar.

Methods and Materials

The study was conducted in the research farm, of Agriculture Faculty of Kandahar University, located in Kandahar at 65˚42'02" East longitude, 31˚38'34" North latitude and is situated at an altitude of 1010 meters above the sea level. Results of physico-chemical property analysis of soil (0 - 30 cm deep soil) showed that the soil texture was sandy clay loam with NH_4-N (10 mg kg^{-1}), NO_3^-N (29 mg kg^{-1}), phosphorus (21 kg ha^{-1}), total potassium (65 kg ha^{-1}) and 0.11% organic matter.

Using a Complete Randomized Block Design, ten treatment combinations of two varieties (NM-94 and local verity/*'Kunduzy'*) and five potassium levels (0, 20, 40, 60, and 80) kg K2O ha-1 were used in the experiment, which was replicated three times. Full doses of potassium (K_2O) were applied through broadcast method at the time of planting as per the treatments to each experimental plot. Seeds were sown at a spacing of 10×30 cm. Irrigation was applied immediately after sowing and subsequent irrigations were given as per the requirement of the crop. Every other cultural practice for every treatments were done uniformly.

Observations of yield and economic parameters like (grain yield), Stover yield) and economics of production (Gross and Net returns and B:C). Data on number of seeds per plant, 1000 seeds weight, seeds weight $plant^{-1}$ and seed yield h^{-1} were collected at the time of harvest. The data obtained were subjected to statistical analysis using the analysis of variance by SPSS statistical package version 24 at 5 percent level of significance (95 percent confidence limit) for the analysis of variance.

Gross margin analysis was used to calculate the economic significance of yield as affected by potassium application. The average price of one kg of mash/Mungbean was taken as 70 Afghani. The price of potassium sulphate was estimated at 75 Afghani kg^{-1} based on the cost at the time of purchase. Therefore, to apply 80 kg of K_2O you need to have 160 kg sulphate of potash. The total of all costs that are variable to a particular treatment relative to the control was computed as the total variable cost. Gross margin was calculated by subtracting total variable cost from the gross revenue.

Results

Grain yield ($kgha^{-1}$): Data exhibited in table.1 showed that the grain yield was significantly influenced by varieties and potassium levels. Among the Mungbean varieties NM-94 produced significantly higher grain yield (1,438 kg ha^{-1}) while the lowest grain yield was recorded from *'Kunduzy'* variety. Significantly higher grain yield was recorded from the plots receiving 80 kg K_2O while it was statistically at par with application of 60 kg K_2O, the data illustrate that with increasing potassium level the grain yield was continuously increased. The interaction effects between varieties and K_2O found to be significantly, application of 80 kg K_2O with NM-94 variety produced significantly higher grain yield (1,813.0 kg ha^{-1}) over the rest of treatment combination. Stover yield kg ha^{-1}: the data in table.1 showed that application K_2O significantly affected Stover yield, among the potassium levels, application of 80 kg K_2O ha^{-1} recorded significantly higher Stover yield (3,250.0 kg ha^{-1}). The result exhibited that varieties were failed to have significant effects on Stover yield, although, statistically higher (3,208.7 kg ha^{-1}) Stover yield was recorded from NM-94 variety, while the lowest Stover yield was recorded from *'Kunduzy'* variety. Biological yield kg ha^{-1}: it can be observed from table.1 that biological yield of Mungbean was significantly affected by varieties and potassium levels. Among the Mungbean varieties NM-94 produced significantly higher biological (4,646.9 kg ha^{-1}) yield over other varieties. The data also exhibited that with increasing potassium level the biological yield was increased, application of 80 kg K_2O recorded significantly higher biological yield over while it was statistically at par with 20, 40 and 60 kg K_2O ha^{-1}, the lowest biological yield was recorded from control plot. The interaction effects between potassium levels and Mungbean varieties found to be significantly differ, application of 80 kg K_2O ha^{-1} with NM-94 found to be significantly higher over the rest of treatment combination.

Harvest index%: the data in table.1 showed that application K_2O significantly affected harvest index, among the potassium levels, application of 80 kg K_2O ha^{-1} recorded significantly higher harvest index. The result exhibited that varieties were failed to have significant effects on harvest index, although, statistically higher harvest index was recorded from NM-94 variety, while the lowest HI% was recorded from *'Kunduzy'* variety.

Table 1

Grain, Stover and Biological Yields and HI responses of two cultivars of Mungbean to different potassium levels.

Treatment	Grain yield Kg ha^{-1}	Stover yield Kg ha^{-1}	Biological yield Kg ha^{-1}	Harvest index %
Cultivars				
Local	1,246.3	2,678.7	3,925.0	31.1
NM-94	1,438.2	3,208.7	4,646.9	30.5
SEm±	18.2	45.8	63.5	0.12
SE(d)	25.8	64.8	89.8	0.16
C.D(P=0.05)	54.2	136.2	188.7	NS
Potassium levels (Kg K_2O ha^{-1})				
0	875.8	2,648.3	3,524.2	24.7
20	1,110.0	2,816.7	3,926.7	28.3
40	1,329.2	2,963.3	4,292.5	31.0
60	1,583.3	3,040.0	4,623.3	34.3
80	1,813.0	3,250.0	5,063.0	35.9
SEm±	28.8	72.5	100.4	0.18
SE(d)	40.8	102.5	142.0	0.26
C.D(P=0.05)	85.7	215.3	298.4	0.54
C.V. (%)	5.3	6.0	5.7	1.44

Economic returns significantly varied due to Potassium doses Table 2. The total expenditures of cultivation were ranged from (25,075.0 AFN ha^{-1} to 37,075.0 AFN ha^{-1}) among different treatment arrangements. The maximum gross and net returns were obtained with the application of 80 kg ha^{-1} which was significantly higher from all other K_2O doses. Effect of different varieties on cost of cultivation, gross and net returns and benefit: cost ratio of Mungbean has been indicated in Table 2. Overall, crop productivity and profitability showed a similar trend to gross returns, net returns as well as the B:C ratio, with NM-94 showing the significantly highest gross return (116,717.3 AFN ha^{-1}) and net return 85,642.3 AFN per hectare as well as the B:C ratio (3.7), respectively. It was determined that NM-94 performed better based on net returns and the B:C ratio. Data in Table 2 revealed that gross returns (143,160.0 AFN per hectare) and net returns (106,085.0 AFN per hectare) and B:C ratio (3.86) were remarkably higher in treatment 80 kg K_2O ha^{-1} which existed at par with treatments viz. 20, 40 and 60 kg K_2O ha^{-1}.

Table 2

Economics response of two cultivars of Mungbean to different potassium levels.

Treatment	Cost of cultivation (*AFN ha^{-1})	Gross returns (*AFN ha^{-1})	Net returns (*AFN ha^{-1})	Benefit cost ratio (B:C)
Cultivars				
Local	31,075.0	100,636.7	69,561.7	3.2
NM-94	31,075.0	116,717.3	85,642.3	3.7
SEm±	-	1,497.6	1,497.6	0.05
SE(d)	-	2,117.9	2,117.9	0.08
C.D(P=0.05)	-	4,449.6	4,449.6	0.17
Potassium levels (Kg K_2O ha^{-1})				
0	25,075.0	74,550.0	49,475.0	2.97
20	28,075.0	91,783.3	63,708.3	3.27
40	31,075.0	107,858.3	76,783.3	3.47
60	34,075.0	126,033.3	91,958.3	3.69
80	37,075.0	143,160.0	106,085.0	3.86
SEm±	-	2,367.9	2,367.7	0.09
SE(d)	-	3,348.8	3,348.8	0.13
C.D(P=0.05)	-	7,035.5	7,035.5	0.27
C.V. (%)	-	5.3	7.5	6.47

*(AFN) Afghan currency

Discussion

The current study was carried out to assess the Economic and yield reaction of Mungbean to various potash levels. The current study demonstrated that potash levels and variety had a significant impact on all of the yield traits of Mungbean. The result of potash levels shown that the Mungbean fertilized with 80 kg per hectare potash in addition to suggested rates of N and P, produced better seed yield, biological yield and harvest index.

On the basis of seed yield ha^{-1}, the plant supplied with 60 kg ha per hectare of potash classified second for all the traits studied, but it was on par with higher levels of potassium application; on the other hand, potassium application at 40 and 20 kg ha^{-1} and control (without K_2O) classified third, fourth, and fifth, respectively. Different levels of potash had a significant impact on the yield components of Mungbean; the maximum potash level, 80 kg per hectare, produced the highest seed yield per hectare, followed by K_2O at an 80 kg per hectare rate. Therefore, it was determined that the ideal potassium level for procurement economically greater seed yields in Mungbean was 80 kg K2O ha^{-1}. These results are further supported by (Naeem et al., 2006 and Eroğlu & Önder, 2023), who found that NPK at the rite 25,50,50 kg ha^{-1}, poultry manure at the rite 3.5 t per hectare, FYM at the rite 5 t per hectare and Bio-fertilizer at the rite 8 g kg^{-1} seed resulted higher crop yields. In a related investigation, (Tariq et al., 2001; Shivashankar et al., 2023) testified that the amount of pod bearing branches per plant and seed yield was significantly better by potassium application in Mungbean. These outcomes are further supported by Ganjare et al., (2023) who found that irrespective of varieties, seed yield (1,125.7 kg per hectare), Stover yield (2,410.0 kg per hectare) and harvest Index (34.7%), gross income (123,823.7 Rs per hectare), net income (83,552.4 Rs per hectare) and (B:C ratio 2.1) were higher level with the application of 40 kg K_2O per hectare.

The difference between varieties was also significant and NM-94 produced more seed yield kg per hectare, Stover yield kg per hectare, biological yield kg per hectare, gross income, net income and Benefit Cost ratio than *'Kunduzy'*. The above results have been aligned by (Neupane et al., 2023) who reported that The March fifteen to March thirty plantations resulted in significantly rapid emergence, germination, and growth showing a greater yield. *Pant-5* yielded a higher seed yield, which was statistically at par with *Partigya* 2.1 t per hectare and *Partikshya* 2.0 t per hectare. The same was testified by (Fadhel, 2011) who found that the highest yield (1.5 t per hectare) was in 80 K_2O kg per hectare. (Zedan, 2011 and Htwe et al., 2023) Were suggested fertilizer application increased plant dry matter and crops above ground yield was 40 percent greater in the shallow Phosphorus treatment and 77 percent higher in the shallow Phosphorus and Potassium than in the uniform Phosphorus and Potassium treatment. Application of optimum dos K_2O for achieving higher Mungbean yields Chavan et al., (2012), Jahanahmadi & Mojaddam, 2023). Higher income in Mungbean was also reported by Noorzai et al. (2017) who reported that maximum straw yield was recorded in NM-94. Mash-2008 resulted in higher returns followed by Mai-2008 while *'local'* resulted in lowest gross and net returns. Significantly higher benefit cost ratio was detected in Mash-2008 followed by Mai-2008, NM-94, NM-98, and *'local'*, respectively.

CONCLUSION

Regarding to the study results, while the variances between the genotypes were mathematically significant in terms of seed yield, Stover yield, biological yield, HI, gross return, net return and benefit cost ratio, the variances among potassium doses were statistically significant in yield and economic of Mungbean. In terms of seed yield and net return, NM-94 genotype and 80 kg ha^{-1} K_2O found to be significant. Potassium application in Mungbean had optimistic effect on yield. In southern Afghanistan, Mungbean production requires a significant amount of K_2O fertilizer for proper growth and yield. It is recommended that application K_2O at 80 kg per hectare at the time of Mungbean sowing can achieve higher grain yield under semi-arid agro ecological situations southern, Kandahar, Afghanistan.

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