Impact of Phoshporus Levels on Yield and Yield Attributes of Mungbean Cultivars under Peshawar Valley Conditions

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Abstract
The objective of this study was to determine the effects of phosphorus levels on yield and yield components of mungbean cultivars (*Vigna radiata* L.). Therefore the field experiment was carried out at New Developmental Farm of The University of Agriculture, Peshawar, Pakistan during summer 2013. The experiment was laid out in randomized complete block design with three replications. Six level of phosphorus in the form of SSP (0, 20, 40, 60, 80 and 100 kg ha^{-1}) and three cultivars of mungbean (NM-98, NM-92 and NM-54) were used. Phosphorus application was significant for all the parameters. Plots treated with 80 kg P ha^{-1} produced maximum nodules plant^{-1} (25), pods plant^{-1} (22), seeds pod^{-1} (11), 1000 grains weight (40.2 g), grain yield (1139 kg ha^{-1}) and harvest index (28.6 %) as compared with control plots but seeds pod^{-1}, 1000 grains weight, grain yield and harvest index was statistically at par when plots treated with 100 kg P ha^{-1}. The cultivar NM-98 had the maximum nodules plant^{-1} (21), pods plant^{-1} (20), seeds pod^{-1} (11), 1000 grains weight (38.4 g), grain yield (1030 kg ha^{-1}) and harvest index (28.2 %) as compared with other mungbean cultivars. It was concluded from the present research work that cultivar NM-98 treated with 80 kg P ha^{-1} improved mungbean productivity and thus, it is recommended for general practice in agro-climatic conditions of Peshawar valley.
Keywords: Mungbean (Vigna radiata L.), phosphorus, cultivars, grain yield, yield components

INTRODUCTION

Mungbean (*Vigna radiata* L.) is an important legume and short duration pulse crop of Pakistan and South Asian Countries. It is highly prised for its rich protein contents 24% with excellent digestibility as compared with soybean (Sarwar *et al.,* 2004). Mungbean contains 1-3% fats, 50.4% carbohydrates, 3.5-4.5% fibers and 5.5% ash, while calcium and phosphorus are 132 and 367 mg per 100 grams of seed, respectively (Frauque *et al.,* 2000). Mungbean is one of the most important conventional and major kharif crop grown in Pakistan (Khattak *et al.,* 2004). In Pakistan mungbean was grown on an area of 137.4 hectare with average production 76.2 tons per hectare during 2011. In Khyber Pakhtunkhwa the mungbean was grown on of 8.5 hectare with average yield 600 kg ha^{-1}(MINFA 2012). Our farmers have a wrong concept that mungbean, being as a legume crop does not need fertilizers. Phosphorus plays a remarkable role in the formation and translocation of carbohydrates, root development, crop maturation and resistance to pathogens. Thus phosphorus increases the mungbean yield and improves its quality (Arya and Kalara, 1988). While nitrogen uptake and protein content of mungbean increase with increasing rate of applied phosphorus (Dewangan et al., 1992). Growth and development of crops depend largely on the development of root system. Phosphorus (P) is one of the three macronutrients that plants obtain from the soil. Phosphorus is a major component of compounds whose functions relate to growth, root development, flowering, and ripening (Raboy, 2003). Most of the soils throughout the world are P deficient (Batjes, 1997), soils of Pakistan are generally alkaline in reaction and calcareous in nature. These types of soils usually contain trace elements. Moreover, with the introduction of high yielding cultivars, increased cropping intensity further reduced nutrient status of the soil (Khan *et al*., 2004). Hence, the effect of phosphorus on root development is well known (Hossain and Hamid, 2007). Addition of P fertilizer improve root development, which enhance the act of other nutrients and water to the growing parts of the plants, resulting in an increased photosynthetic and more dry matter production. The application of phosphorus to mungbean has been stated to increase dry matter at harvest, number of pods plant^{-1}, seeds pod^{-1}, 1000 grain weight, seed yield and total biomass (Mitra *et al*., 1999). The yield and quality of mungbean can be improved by applying best agronomic practices and use of high yielding cultivars. Cultivars of mungbean vary in yield and yield components. Ayub et al. (1999) obtained significantly higher seed yield of mungbean cultivars. NM-92 over NM-54 due to higher number of pod bearing branches plant^{-1}, number of pods and number of seeds pod^{-1}, However, Khan et al. (1999) found statistical difference between the yield components of mungbean cultivars under observation. For every climate, there are cultivars of different crops. Yaday and Warsi (1988) found significant differences in yields and yield components of different mungbean cultivars. Keeping in view the importance of phosphorus levels and mungbean cultivars, the present research was designed to investigate the effect of P levels on yield and yield components of mungbean cultivars.

MATERIALS AND METHODS

The experiment was carried out at New Developmental Farm of The University of Agriculture, Peshawar (34^{o} 00'

N, 71° 30' E, 510 MASL) Pakistan during summer 2013. The experiment was laid out in randomized complete block design with three replications. Six levels of phosphorus in the form of SSP (0, 20, 40, 60, 80 and 100 kg ha^{-1}) and three cultivars of mungbean (NM-98, NM-92 and NM-54) were used with a plot size of 3 m x 3 m with 10 rows and 30 cm spacing. Nitrogen was applied at 30 kg ha^{-1} in the form of urea at the time of sowing. Seeds of these cultivars (NM-98, NM-92 and NM-54) were sowed in the 3rd week of June at seed rate of 20 kg ha^{-1}. Agronomic practices were carried out uniformly for all the experimental units throughout the growing season. Nodules $plant^{-1}$ at the time of pod initiation was counted by uprooting five plants randomly in each subplot and then average was worked out. Number of pods $plant^{-1}$ was counted for ten plants selected randomly in each subplot. Seeds pod^{-1} was recorded by counting seed in ten capsules selected randomly in each sub plot. After threshing data form thousand grains weight (g) were recorded for three seed lots and weighed with the help of electronic balance. Four central rows in each sub plots were harvested, sun dried and threshed. Seed weight was taken with the help of electronic balance and then converted into kg ha^{-1} by the following formula.

$$\text{Grain yield (kg ha}^{-1}) = \frac{\text{Grains weight in four rows (kg)}}{\text{No of rows x Row length x R-R}} \times 10{,}000\ m^2$$

Harvest index was calculated by using the following formula.

$$\text{Harvest Index (\%)} = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1})} \times 100$$

All data collected were subjected to analysis of variance (ANOVA) with the help of statistical software, Statistix 8.0 USA (2005). Upon significant F-Test, least significance difference (LSD) test was used for mean comparison to identify the significant components of the treatment means.

RESULTS AND DISCUSSION

Number of nodules $plant^{-1}$

Data presented in Table 1 indicated that the levels of phosphorus and cultivars had significant effect on number of nodules $plant^{-1}$, while the interaction between P x C had no significant effect on number of nodules $plant^{-1}$. Mean values of data revealed that plots treated with 80 kg P ha^{-1} produced maximum number of nodules $plant^{-1}$ (25), while minimum number of nodules $plant^{-1}$ (11) was recorded in control plots. These results agree with Bhuiyan *et al.* (2008) who reported that P application promotes early root formation and the formation of lateral fibrous and healthy roots, which had positive effect on nodules $plant^{-1}$. Mungbean cultivars had also significant effect on number of nodules $plant^{-1}$. Mungbean cultivar NM-98 produced more number of nodules $plant^{-1}$ (21), while lowest number of nodules $plant^{-1}$ (18) was produced by NM-54. These results were supported earlier by Hussain *et al*. (2001) who studied that improved mungbean cultivars produced more number of nodules $plant^{-1}$ as compared to local cultivars. The difference among the cultivars might be due to genetic makeup and nutrients absorption.

Number of pods $plant^{-1}$

Phosphorus levels and cultivars as well as their interaction had significant effect on number of pods $plant^{-1}$ (Table 2). Mean values of data showed that plots treated with 80 kg P ha^{-1} produced maximum number of pods $plant^{-1}$ (22), while minimum number of pods $plant^{-1}$ (15) were recorded in control plots. These results agree with Malik *et al.* (2004) who reported that P induced significant increased in pods $plant^{-1}$. Naeem *et al.* (2000) who also reported that phosphorus up to 75 kg ha^{-1} significantly increase number of pod $plant^{-1}$. Mungbean cultivars had also significant effect on number of pods $plant^{-1}$. Mungbean cultivar NM-98 produced more number of pods $plant^{-1}$ (20), while lowest number of pods $plant^{-1}$ (18) was produced by NM-54. These findings are supported by Uddin *et al.* (2009) who studied that improved mungbean cultivars produced more number of pods $plant^{-1}$ as compared to local cultivars. The difference among the cultivars might be due to genetic makeup and nutrients uptake. Interaction between P x C indicated that number of pods $plant^{-1}$ of all cultivars increased with increasing phosphorus level up to 80 kg ha^{-1}, further increase in P level decreased number of pods $plant^{-1}$. However a linear increase was recorded for pods $plant^{-1}$ of cultivar NM-98 with increase in P level up to 80 kg ha^{-1} (Fig 1).

Table I. Number of nodules plant^{-1} of mungbean cultivars as affected by phosphorus levels.

P (kg ha^{-1})	Cultivars			Mean
	NM-98	NM-92	NM-54	
0	12	11	10	11 f
20	17	15	14	15 e
40	21	20	17	19 d
60	24	22	20	22 c
80	27	25	23	25 a
100	25	25	23	24 b
	21 a	20 b	18 c	

LSD (0.05) value for P = 0.59
LSD (0.05) value for V = 0.42
LSD (0.05) value for P x V = ns

Table 2. Number of pods plant^{-1} of mungbean cultivars as affected by phosphorus levels.

P (kg ha^{-1})	Cultivars			Mean
	NM-98	NM-92	NM-54	
0	16	15	13	15 f
20	18	16	15	16 e
40	20	17	17	18 d
60	21	21	20	20 c
80	24	21	22	22 a
100	21	22	21	21 b
	20 a	19 b	18 c	

LSD (0.05) value for P = 0.59
LSD (0.05) value for V = 0.67
LSD (0.05) value for P x V = 1.65
Means of the same category followed by different letters are significantly different from one another using LSD test at 5% level of probability.

Number of seeds pod^{-1}

Statistical analysis of the data indicated that phosphorus levels and cultivars had significant effect on number of grains pod^{-1} (Table 3). Grains pod^{-1} was increased with increase in phosphorus levels. Mean value of the phosphorus level indicated that plot treated with 80 or 100 kg P ha^{-1} produced maximum grains pod^{-1}, while minimum grains pod^{-1} (8) were recorded in control plots. These results agree with those of Malik *et al.* (2004) reported significant differences in number of grains pod^{-1} with various P levels. Cultivars NM-98 produced maximum number of grains pod^{-1} (11), while minimum grains pod^{-1} (9) were produced by NM-54. These results agree with those of Uddin *et al.* (2009) who reported difference in grains pod^{-1} among the cultivars might be due to genetically determined differences in uptake of nutrient especially phosphorus. Interaction between P x C indicated (Fig. 2) that all mungbean cultivars produced maximum number of grains pod^{-1} with increasing phosphorus level up to 80 kg ha^{-1} further increase in P level decreased number of grains pod^{-1}.

Thousand grains weight (g)

Statistical analysis of the data indicated that phosphorus levels and cultivars had significant effect on number of grains pod^{-1} (Table 4). Plots treated with 80 kg P ha^{-1} produced the heaviest grains (40.2 g) being at par with 100 kg P ha^{-1}, while lighter grains (34.5 g) was recoded in control plots. These results agree with those of Kumar *et al.* (2012) who reported that increasing phosphorus application up to 75 kg ha^{-1} significantly increased the seed weight as compared with control plots. Mean values of mungbean cultivars indicated that NM-98 produced the heaviest grains (38.4 g), while lighter grains (35.9 g) was recorded by NM-54. These results were similar to those reported by Uddin *et al.* (2009) that differences among the 1000 grains weight in these cultivars might be due to hereditary superiority, growth rate, crop potential of yield, higher nutrients translocation, assimilation and dry matter partitioning. Interaction between P x C indicated (Fig. 3) that all mungbean cultivars produced heavier 1000 grains weight with increasing phosphorus level up to 80 kg ha^{-1} further increase in P level decreased 1000 grains weight. However a linear increased was recorded for 1000 grains weight of cultivar NM-98 with increase in P level up to 80 kg ha^{-1}.

Table 3. Number of seeds pod^{-1} of mungbean cultivars as affected by phosphorus levels.

P (kg ha^{-1})	Cultivars			Mean
	NM-98	NM-92	NM-54	
0	9	8	7	8 d
20	10	9	8	9 c
40	10	9	8	9 c
60	12	10	9	10 b
80	12	12	11	11 a
100	11	11	12	11 a
	11 a	10 b	9 c	

LSD (0.05) value for P = 0.85
LSD (0.05) value for V = 0.61
LSD (0.05) value for P x V = 1.46

Table 4. Thousand grains weight (g) of mungbean cultivars as affected by phosphorus levels.

P (kg ha^{-1})	Cultivars			Mean
	NM-98	NM-92	NM-54	
0	33.8	35.2	34.4	34.5 c
20	38.1	36.5	32.5	35.7 b
40	38.2	35.0	34.4	36.2 b
60	38.2	35.9	35.5	37.1 b
80	41.1	40.7	39.8	40.2 a
100	41.0	39.1	39.1	40.1 a
	38.4 a	37.1 b	35.9 c	

LSD (0.05) value for P = 1.18
LSD (0.05) value for V = 0.84
LSD (0.05) value for P x V = 2.06
Means of the same category followed by different letters are significantly different from one another using LSD test at 5% level of probability.

Grain yield (kg ha^{-1})

Grain yield was significantly affected by phosphorous levels and mungbean cultivars as well as their interaction (Table 5). Mean value of phosphorus levels indicated that plots treated with 80 kg P ha^{-1} produced maximum grain yield (1139 kg ha^{-1}) being at par with 100 kg P ha^{-1}, while minimum grain yield (617 kg ha^{-1}) was recorded in control plots. These results agree with those Hussain *et al*. (2001) who reported increase in grain yield with increase in P level up to 75 kg ha^{-1} further increase in P level slight decrease recorded in grain yield. The increase in grain yield might be due to phosphorus application was attributed to profound branching, better fruiting, increased number of seeds pod^{-1} and heavier grains as a result grain yield increased as compared with control plots. Mungbean cultivars had also significant effect on grain yield. Cultivar NM-98 produced maximum grain yield (1030 kg ha^{-1}), while minimum grain yield (799 kg ha^{-1}) was produced by cultivar NM-54. These results are in agreement with Naeem *et al*. (2000) who reported that differences among the yield in these cultivars might be due to hereditary superiority, growth rate, crop yield potential, higher nutrient translocation, assimilation and dry matter partitioning. The interaction between P x C indicated (Fig. 4) that all mungbean cultivars produced maximum grain yield with increasing phosphorus level up to 80 kg ha^{-1} further increase in P level decreased grain yield. However a linear increased was recorded for grain yield when sown cultivar NM-98 with 80 kg P ha^{-1}.

Harvest index (%)

Statistical analysis of harvest index data showed that phosphorus (P) and mungbean cultivars (C) had significant effect on harvest index, however their interaction (P x C) was not significant (Table 6). With the increase of phosphorus level harvest index increasing significantly and plots treated with 80 kg P ha^{-1} produced the maximum harvest index (28.6%) being at par with 100 kg P ha^{-1}, while minimum harvest index (23.1%) was recorded in control plots. These results agree with the findings of Kumar *et al.* (2012) who reported that increasing rate of phosphorus application significantly increased harvest index over control plots. Cultivar NM-98 recorded with maximum harvest index (28.2%), while cultivar NM-54 produced harvest index (24.2%). It may be due to their genetic as well as phenotypic and hereditary superiority difference from other mungbean cultivars.

Table 5. Grain yield (kg ha^{-1}) of mungbean cultivars as affected by phosphorus levels.

P (kg ha^{-1})	Cultivars			Mean
	NM-98	NM-92	NM-54	
0	628	615	607	617 e
20	745	802	652	733 d
40	1091	891	691	891 c
60	1196	1056	818	1024 b
80	1270	1171	1075	1139 a
100	1246	1066	949	1120 a
	1030 a	934 b	799 c	

LSD (0.05) value for P = 27.14
LSD (0.05) value for V = 19.18
LSD (0.05) value for P x V = 46.99

Table 6. Harvest index (%) of mungbean cultivars as affected by phosphorus levels.

P (kg ha^{-1})	Cultivars			Mean
	NM-98	NM-92	NM-54	
0	22.6	23.0	23.8	23.1 d
20	24.4	27.3	23.2	25.0 c
40	29.7	25.5	20.5	25.2 c
60	29.5	29.2	23.4	27.4 b
80	31.8	29.6	27.9	28.6 a
100	30.1	26.9	24.9	28.4 a
	28.0 a	26.9 b	24.0 c	

LSD (0.05) value for P = 0.95
LSD (0.05) value for V = 0.67
LSD (0.05) value for P x V = ns
Means of the same category followed by different letters are significantly different from one another using LSD test at 5% level of probability.

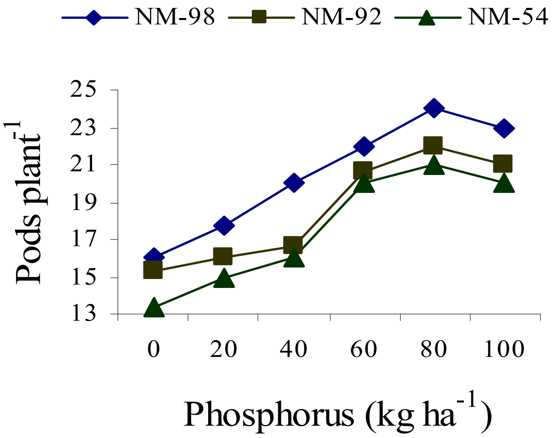

Fig. 1. Pods plant^{-1} as affected by mungbean cultivars and Phosphorus levels

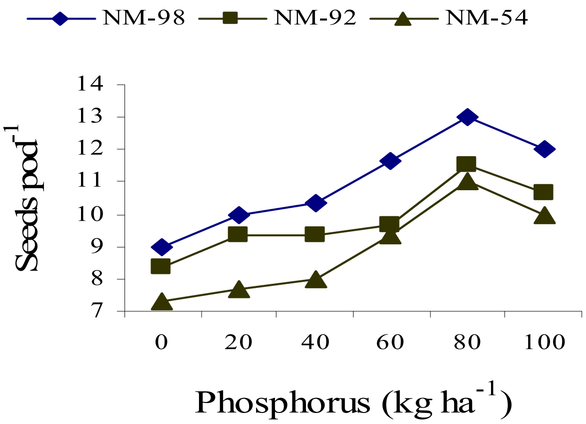

Fig. 2. Seeds pod^{-1} as affected by mungbean cultivars and Phosphorus levels

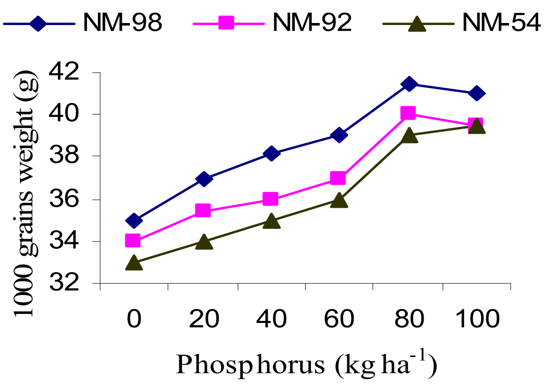

Fig. 3. 1000 grains weight as affected by mungbean cultivars and Phosphorus levels

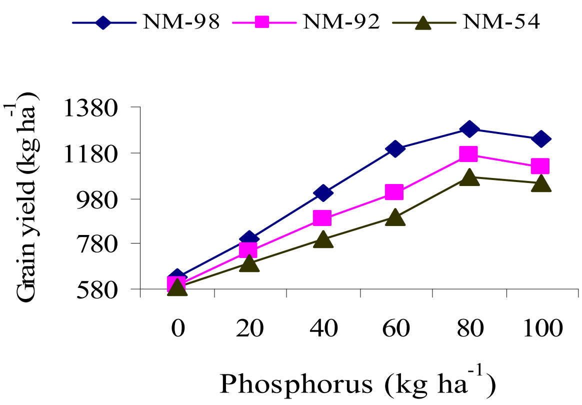

Fig. 4. Grain yield as affected by mungbean cultivars and Phosphorus levels

CONCLUSION AND RECOMMENDATIONS

The results obtained from the present research work indicated that cultivar NM-98 treated with 80 kg P ha^{-1} produced maximum nodules $plant^{-1}$, pods $plant^{-1}$, seeds pod^{-1}, 1000 grain weight, grain yield and harvest index significantly and therefore, it is recommended that cultivar NM-98 should be sown under the Peshawar valley condition with the application of phosphorus 80 kg ha^{-1} for higher yield and yield components.

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