Effect of Phosphorus and Nitrogen fertilizer applications on growth and yield traits of Mung Bean (*Vigna Radiata* L.) under northern Iraq conditions

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Abstract

A field experiment was carried out at the Farmer Field, Al-Abbasiya, Mosul, Iraq, during the growing season of 2023 to evaluate the effect of cultivars and combinations of Phosphorus and Nitrogen levels and their interaction on grain yield and its components of Ming bean. The experiment included two Mung bean cultivars (Black-gram and Green-gram), and four combinations of Phosphorus and Nitrogen fertilizer applications (P_0/N_0, P_{50} /N_{25}, P_{25} /N_{50}, P_{50} /N_{50} kg/ha), and their interactions. The current experiment was laid out with a Randomized Complete Block Design (R.C.B.D) with three replications. Among the Mung bean cultivars, Green-gram cultivar produced a higher branch number (4.14 branch/plant), Pod number (26.00/pod/plant), grain number (5.80 grain/pod), 100-grain weight (3.97 g), grain yield (6.12 g/plant). Under the combination of phosphorus and nitrogen fertilizer, the treatment P_{50} /N_{50} produced the maximum value in most studied traits. However, the interaction of Green-gram cultivars and the combination of phosphorus and nitrogen fertilizer (P_{50}/N_{50}) was significant in most studied traits. It is concluded that selecting the suitable cultivar and applying the proper combination of phosphorus and nitrogen fertilizer can improve grain yield and its components of Mung bean grown under North Iraqi conditions.

KEYWORDS: Mung bean, Cultivars, Phosphorus and Nitrogen fertilizer

Introduction

Mung bean (*Vigna radiata* L.) is one of the world's most important foods, belongs to the leguminous family and is usually called green grain. It can make a symbiotic relationship with particular types of bacteria to improve the biological N-fixation that supports the plant by Nitrogen requirement (20). Mung bean grain is highly nutritious and contains about 25 % protein, 0.9 % fiber, 0.6 % fat, 3.7 % ash, 69.30 % carbohydrates and high caloric value with high digestibility for direct human consumption (21, 15). In Iraq, it is grown in an area of about 13.84 thousand hectares, with a total annual production of approximately 11.49 thousand tonnes between 1970-2010 (9). Improve mung bean production could be achieved by selecting the proper sowing time, agronomic management practices and fertilizer application (11). Phosphorus and Nitrogen fertilizer applications are critical factors and, play essential roles in growth development and significantly affect many mung bean traits (4, 12,16). Phosphorus is an essential part of nucleic acid and phospholipids that encourage grain development, flowering, protein synthesis, and regulate photosynthesis (14) In Mang bean, the Phosphorus fertilizer is required to enhance the ability of the plant to fix atmospheric nitrogen, which improves the grain yield and quality (6, 7). Phosphorus significantly improves the number and weight of effective

ISSN 2072-3857

nodules, the fresh importance of nodules and the nitrogenase activity of mung bean (27). On the other hand, Nitrogen element is an essential factor determining growth and productivity in most crops because it is an essential component of cytoplasmic proteins, nucleic acids, cell walls and chlorophyll content in the leaf tissue (18). Mung bean cannot properly fix atmospheric Nitrogen because it contains only a few nodules during the early growth stage (25). Therefore, applied Nitrogen fertilizer at the early growth stage is required to promote vegetative growth, leading to high grain yield. Several studies (19, 8) reported that mung bean's Phosphorus and Nitrogen uptake efficiency could be much higher by optimizing fertilizer application management.

To sum up, the current study was conducted to determine the optimum level of Phosphorus and Nitrogen fertilizer applications on the growth and yield traits of Mung Bean under northern Iraq conditions.

Materials and Methods

The experiment was conducted at the farmer field at Al-Abbasiya, which is located 11 kilometers northeast of Nineveh Governorate, Iraq (longitude 36°27'22.8 North, latitude 43°11'26.1 East), to determine the effect of cultivars and Phosphorus and Nitrogen fertilizer combinations on the growth and productive traits of Mung Bean under northern Iraq conditions. The experiment was designed using a completely randomized block design with three replications. The experiment included two local mung bean cultivars (Black-gram and Green-gram) and four levels of Phosphorus and Nitrogen fertilizer combinations (P_0/N_0 (Control), P_{50} /N_{25}, P_{25} /N_{50}, P_{50} /N_{50} kg/ha). A single super phosphate (18 % P_2O_5) and urea (46% N) were used as sources of Phosphorus and Nitrogen fertilizer, respectively. The total number of plots was 2x4x3=24 plot. The experimental unit size was 2.0 m x 1.5 m. Each experimental unit contains four lines with a distance between line to line 0.5 m. The distance between replications was 1 m, while the distance between plots was 0.5 m. The crop was sown on a well-prepared seedbed on the 7 of June, 2023. The plant height was measured from the soil surface to the longest leaf tip per plot at harvest. The branch number was estimated from the average branch number of selected ten plants per plot at harvest. The pod number was counted from selected ten plants per plot at harvest. The pod length was estimated from the selected ten pods' lengths per plot. The grain number/pod was determined from the selected ten pods, and grain numbers were counted from each plot. 100-grain weight was randomly counted from each plot and weighed by using a digital sensitive balance. The grain yield was determined by harvesting the whole plot at maturity.

The physical and chemical characteristics of the experimental soil are shown in Table 1.

Table (1) Results of soil samples analysis at Al-Abbasiya

Location	Clay %	Silt %	Sand %	Textural	N (ppm)	P (ppm)	K (ppm)	Organic matter %	PH	EC us/cm
Al-Abbasiya	42.65	41.75	15.60	Silty-clay	0.033	9.58	8.143	1.424	7.1	1080

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ISSN 2072-3857

The data were statistically analyzed using the analysis of variance technique by GenStat software. The averages were compared using the LSD ($p<0.05$) test, and the standard deviation of cultivars, Phosphorus and Nitrogen fertilizer combinations and the interactions were utilized to determine significant means.

Result and Discussion

Plant height trait was significantly affected by Mung bean cultivars, the combinations of Phosphorus and Nitrogen fertilizer applications and their interaction, as shown in Tables (2 and 3). Black-gram produced the highest value of plant height (45.16 cm), while Green-gram produced the lowest value of plant height (42.96 cm). It seems possible that these results are due to the varying genetic makeup of Mang bean cultivars (5, 12). Under combinations of Phosphorus and Nitrogen fertilizer applications, the maximum value was received from P_{50}/N_{50} treatment (51.13 cm), while the lowest was given from the control treatment P_0/N_0 (36.95 cm). A possible explanation for this might be the effect of Phosphorus and Nitrogen fertilizer applications on cell division and elongation, improving the efficiency of the photosynthesis process, which leads to an increase in the above-biomass accumulation (4, 13). The interaction between cultivars and the Phosphorus and Nitrogen fertilizer combinations, the highest value was obtained from Black-gram and P_{50}/N_{50} (52.47 cm), while the lowest value was produced from Black-gram and P_0/N_0 (36.23 cm).

(Table 2) Effects of cultivars and the combination of phosphorus and nitrogen fertilizer on grain yield and its components of Mung bean

Cultivars	Plant height (cm)	Branch Number/ plant	Pod Number/ plant	Pod length (cm)	Grain Number/ Pod	100-grain Weight (g)	Grain yield g/plant
Black-gram	45.16	3.95	24.42	6.03	5.45	3.67	5.02
Green-gram	42.96	4.14	26.00	5.70	5.80	3.97	6.12
Test F	0.002	0.012	0.007	0.03	0.006	<.01	<.001
L.S.D	1.256	0.143	1.066	0.295	0.229	0.155	0.291
P X N Treatment							
P_0/N_0	36.95	3.07	20.67	4.78	4.75	3.39	3.33
P_{50}/N_{25}	41.00	4.02	25.17	6.20	5.45	3.69	5.10
P_{25}/N_{50}	47.15	3.93	26.00	5.97	6.43	4.11	6.90
P_{50}/N_{50}	51.13	5.17	29.00	6.52	5.87	4.09	6.95
Test F	<.001	<.001	<.001	<.001	<.001	<.001	<.001
L.S.D	1.776	0.202	1.508	0.418	0.325	0.220	0.412

(L.S.D) least significant difference

Branch number/plant was significantly affected by Mung bean cultivars, the Phosphorus and Nitrogen fertilizer combinations, and their interaction (Tables 2 and 3). Among the Mung bean cultivars, Green-gram produced the maximum branch number/plant (4.14 branch/plant), while Black-gram gave the lowest (3.95 branch/plant). The reason might due to the Green-gram cultivar owns a shorter plant height (Table 2), which leads to the availability of a greater amount of energy

ISSN 2072-3857

drives to increasing branches number instead of stem elongation (5, 12, 23). Under fertilizer combinations, the highest branch number was given by P_{50}/N_{50} (5.17 branch/plant), whereas the lowest value was given by P_0/N_0 (3.07 branch/plant). The reason behind that might be the role of Phosphor and Nitrogen elements in developing the above-ground biomass and root system, which is considered an essential source for absorbing water and accumulating nutrients from the soil into the tissue (25, 24).

(Table 3) Effects the interaction of cultivars and the combination of phosphorus and nitrogen fertilizer on grain yield and its components of Mung bean

Cultivars	P x N Treatment	Plant height (cm)	Branch Number/ plant	Pod Number/ plant	Pod length (cm)	Grain Number/ Pod	100-grain Weight (g)	Grain yield g/plant
Black-gram	P_0 /N_0	36.23	3.17	19.33	4.80	4.77	3.30	3.05
	P_{50}/N_{25}	41.93	4.07	24.67	6.70	5.10	3.34	4.20
	P_{25}/N_{50}	50.00	3.50	24.67	5.90	6.00	4.05	5.99
	P_{50}/N_{50}	52.47	5.20	29.00	6.73	5.93	3.97	6.82
Green-gram	P_0 /N_0	37.67	3.07	22.00	4.77	4.73	3.47	3.60
	P_{50}/N_{25}	40.07	3.97	25.67	5.70	5.80	4.04	5.99
	P_{25}/N_{50}	44.30	4.37	27.33	6.03	6.87	4.16	7.81
	P_{50}/N_{50}	49.80	5.17	29.00	6.30	5.80	4.21	7.08
Test F		0.006	<.001	0.202	0.05	0.010	0.047	0.001
L.S.D		2.512	0.286	2.132	0.591	0.459	0.311	0.583

(L.S.D) least significant difference

Moreover, Phosphor and Nitrogen are necessary for motivating the formation of bacterial nodules, which increases Nitrogen fixation in the form of amino acids (1). The maximum branch number of the interaction between cultivars and fertilizer combinations was achieved by Black-gram and P_{50}/N_{50} fertilizer application (5.20 branch/plant), while the minimum was produced by Green-gram and P_0/N_0 fertilizer application (3.07 branch/plant).

There was a significant difference in pod number/plant between the Mung bean cultivars, the combinations of Phosphorus and Nitrogen fertilizer applications, as shown in Table 2. Green-gram cultivar produced the highest pod number (26.00 pod/plant); however, Black-gram cultivar produced the lowest pos number (24.42 pod/plant). This may be due to the Green-gram cultivar owning the highest branch number/plant, which leads to producing more pods/plant (2). Under fertilizer combinations, the maximum pod number was achieved by P_{50}/N_{50} (29 pod/plant), while the minimum pod number was provided by P_0/N_0 (20.67 pod/plant). The reason may be that the high application of phosphate and Nitrogen fertilizer improved the efficiency of nodules to fix atmospheric nitrogen, furthermore increasing the number of branches and flowers number/plant (5, 22). However, the interaction between cultivars and the combination of Phosphorus and Nitrogen fertilizer applications was non-significant for Pod number/plant.

Data analysis revealed significant effects of cultivar, Phosphorus and Nitrogen fertilizer applications and their interaction on pod length, as presented in Tables (2 and 3). Black-gram cultivar reached the highest pod length (6.03 cm), while Green-gram cultivar had the lowest pos length (5.70 cm). The variation in pod length among two Mung

ISSN 2072-3857

bean cultivars appeared due to varying genetic potential for this trait (5, 22). Under Phosphorus and Nitrogen fertilizer application, the highest pod length was achieved when applied P_{50}/N_{50} (6.52 cm), while the lowest pod length was given by P_0/N_0 (4.78 cm). It may be due to the essential role of Phosphorus and Nitrogen in physiological processes such as photosynthesis, energy transfer and biomass accumulation (10). The maximum pod length was reached by the interaction between Black-gram and P_{50}/N_{50} fertilizer combinations (6.73 cm). In contrast, the minimum pod length was obtained by Green-gram and P_0/N_0 fertilizer application (4.77 cm).

There was a significant difference in the grain number/pod between cultivars, combinations of Phosphorus and Nitrogen fertilizer applications and their interaction, as given in Tables 2 and 3. Green-gram cultivar produced the highest grain number (5.80 grain/pod), while Black-gram cultivar produced the lowest grain number (5.80 grain/pod). These findings can result from the different genetic makeup between the two cultivars (5). Under Phosphorus and Nitrogen fertilizer application, the maximum grain number was obtained from application P_{25}/N_{50} (6.43 grain/pod), while the minimum grain number was given by application P_0/N_0 (4.75 grain/pod). The application of Phosphorus and Nitrogen fertilizer may remobilize the photosynthesis output from tissue to sink (grain), leading to an increase in the number and size of grains (8). The grain number/pod was significantly affected by the interaction between cultivars and fertilizer combinations. The interaction of Green-gram with P_{25}/N_{50} fertilizer application had the highest grain number (6.87 grain/pod); however, the interaction of Green-gram with P_0/N_0 fertilizer application had the lowest grain number (4.73 grain/pod).

The 100-grain weight was significantly affected by cultivars, combinations of Phosphorus and Nitrogen fertilizer applications and their interaction, as presented in Tables 2 and 3. Green-gram produced the maximum 100-grain weight (3.97 g), whereas Black-gram had the minimum 100-grain weight (3.67 g). This may be due to the ability of Green-gram cultivars to accumulate and remobilize nutrients from plant tissue to the grains (4, 26). For Phosphorus and Nitrogen fertilizers, the highest 100-grain weight was obtained from application P_{25}/N_{50} (4.11 g), while the lowest weight was achieved from application P_0/N_0 (3.39 g). The application of Phosphorus and Nitrogen can play an essential role in growth, development and maturity due to regulating and remobilizing the photosynthetic products to the final grain (8, 26, 17). The interaction of Green-gram with P_{50}/N_{50} fertilizer application gave the maximum 100-grain weight (4.21 g), while the interaction of Black-gram with P_0/N_0 fertilizer application had the lowest 100-grain weight (3.30 g).

There was a significant difference in grain yield between the cultivars, Phosphorus and Nitrogen fertilizer application, and their interaction (Tables 2 and 3). Green-gram cultivar produced the maximum grain yield (6.12 g/plant) compared to Black-gram cultivar, which produced the lowest grain yield (5.02 g/plant). The highest grain yield of Green-gram cultivar is due to superiority in most yield components such as branch number, pod number/plant, grain number/pod, and 100-grain weight, which is reflected in the final grain yield as shown in the table 1. Under Phosphorus and Nitrogen fertilizers, the maximum grain yield was achieved from application P_{50}/N_{50} (6.95 g/plant), while the minimum grain yield was obtained from application P_0/N_0 (3.33

ISSN 2072-3857

g/plant). Overall, the high level of Phosphorus and Nitrogen fertilizer application influenced all grain yield components, finally leading to superior grain yield. The interaction of Green-gram with P_{25}/N_{50} fertilizer application produced the maximum grain yield (7.81 g/plant), while the interaction of Black-gram with P_0/N_0 fertilizer application produced the minimum grain yield (3.05 g/plant).

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ISSN 2072-3857