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Improving the Growth and Productivity of Two Varieties of Mung Bean (*Vigna radiata* L.) by using Different Cultivation Methods and Dates

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ABSTRACT

Background: Mung bean is characterized by its ability to withstand water scarcity due to its short life span, so it can be introduced into agricultural rotation systems *and* despite especially when there is a lack of humidity and contemporary environmental changes. Despite the importance of this crop, its productivity rate in Iraq is still low compared to global production. The dates and methods of cultivation of the mungbean crop must be determined accurately to suit the specifications of local varieties adapted to the changing environmental conditions.

Methods: The field study was applied in two fields: the first in Nineveh Governorate and the second in Erbil Governorate / Republic of Iraq. Three factors included, first: two varieties of local mung bean (black and green), second: different cultivation methods (furrow and lines) and the third: planting dates (May 15, June 15 and July 15). The study was designed as a factor experiment a design (R.C.B.D) with three replicates.

Result: The first variety superior significantly in the two sites with the qualities of plant height, leaf area, leaf area index, seed yield, biological yield and harvest index. From the results of the dates, we note a significant superiority of the first date number of seeds.pod^{-1} while the third date significantly outperformed the germination percentage for the two sites. First planting method significant superiority in most of the studied characterists and for the two research sites. Significant superiority was recorded for the interactions of research factors and their levels.

Key words: Changes, Environmental fabaceae, Quality, Two sites.

INTRODUCTION

Green and black varieties for (*Vigna radiate* L.) play a distinct role in securing part of the requirements of food security in light of the increasing population in the world, as they are characterized by containing a high percentage of protein 19-29%, in addition to their ability to stabilize atmospheric nitrogen by their root nod and the amount ranges from 35-180 kg nitrogen per hectare per year (Torabian *et al*., 2019). The production capacity of any variety, whatever its specifications, is affected by the service processes applied according to the correct scientific foundations. Therefore, it was necessary for specialists to invest ways to raise the productivity of these compositions and improve their quality and one of the most important ways to achieve this goal is to pay attention to the date of planting, as the best date for planting mung bean varies according to the environment and the requirements of the variety. One of the studies conducted to find out the extent of variation between varieties is the study of Ali *et al*. (2021) in their experiment, which included studying the characteristics of two varieties of mungbean, reached the superiority of the variety (AZRI, 2006) in the characteristics: plant height, leaf area, leaf area index, number of branches, seed yield and number of seeds. (Ali, 2021; Rai *et al.,* 2024) when comparing two varieties of mungbean, as the (Shewa, Robi) varieties significantly outperformed the characteristics of plant height and number of pods / plant (Abdulqader *et al.,* 2021; Ali *et al.,* 2021). There were variances between each characteristic and significant superiority in the traits. Khatik *et al.* (2022) stated in their experiment that included the study of 7 varieties of mung bean that the two varieties (Opal-AU, Jade-AU) outperformed the rest of the varieties in the description of the leaf area index. Ali *et al.* (2023); Dikr (2023); Ali *et al.* (2023); Christian *et al.* (2023); Priya and Babu, (2024); Arya *et al.* (2024) showed in a comparative experiment varieties of mung bean significantly superior to the (Arkebe) variety in the seed yield traits over the rest of the varieties used in the study.

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The planting date is of great importance in the cultivation of the crop, as it varies according to the sites where the crop is grown. The height of the plant is important for leguminous crops because of its direct impact on the components of the yield, especially the characteristics of the number of pods and the number of fruit branches in the plant, as well as its direct relationship to resistance to lying down and suitability for mechanical harvesting. The study by Rehman *et al.* (2009) indicated that optimal planting time improves the growth and yield qualities of the mungbean crop that correspond to optimal environmental conditions. While early planting of mungbean varieties achieves the best vegetative growth before flowering, this improves the formation of the best number of pods (Singh and Singh, 2011). From previous studies on planting dates, From the results of the experiment of (Ali *et al.,* 2021; Eshanee *et al.* 2023) to study planting dates, where it is noted that there are differences between dates and the superiority of the early date by giving the highest significant averages for the characteristics of plant height, number of branches, seed yield, number of seeds.pod, biologcal yield and harvest index.

Cultivation methods play an important and distinctive role in most of the characteristics of the mungbean and therefore have a clear impact on the productivity of this crop more than others and from previous studies on this subject we connect (Singh *et al.,* 2011) by studying the response of the mungbean crop to two methods of cultivation, namely furrow and broadcasting, where the method of furrow excelled in giving the best seed yield. Ram *et al.* (2018) mentioned when studying the effect of mungbean cultivation methods (boards and furrow), as the method of cultivators significantly excelled in the characteristic of plant height, number of branches and weight of 100 seeds, while no significant differences were recorded between the cultivation methods for the yield characteristic and some of its components. From the results of Mota *et al.* (2021) when comparing two methods of planting mash (furrow and gore), as the planting method outperformed morally in the characteristic of the yield and its components over the prose method. As a result of the above. The study aimed to study the varieties, their cultivation methods *and* their planting dates, as they are among the practices and processes available to all farmers in Iraq.

MATERIALS AND METHODS

The field study was carried out in two sites, the first is a field in Nineveh Governorate and the second is in Erbil Governorate / Republic of Iraq. Table 1 show properties of soil in two locations, to find out the effect of three factors on the productivity of the mungbean crop The first factor: the two local varieties of mungbean (black and green), the second factor: cultivation methods (furrow and lines), the third factor: three planting dates and three planting dates (May 15, June 15 and July 15). Phosphate fertilization was added at once before planting in the form of triple superphosphate (45% P_2O_5) and 75 kg P_2O_5. ha^{-1}, while nitrogen fertilizer was added in the form of urea (46% N. $ha^{-1.}$) 16 days after planting, add both types of fertilizer (N and P) by broadcasting. The study was designed as a factor experiment with a design (R.C.B.D) with 3 replicates.

The experimental land was plowed orthogonally plowed and then divided into experimental units with dimensions of 3×1.8 m. The experimental unit contained 6 lines or furrow with a length of 3 meters and the distance between the lines or furrow is 30 cm. Immediately after planting, the experiment was irrigated and then the irrigation process was repeated depending on the plant's need and soil moisture. I have studied the following qualities: germination percentage, number of branches. $plant^{-1}$, plant height (cm), leaf area (cm^2. $plant^{-1}$), leaf area index, pod length (cm), number of pods.$plant^{-1}$, number of seeds. pod^{-1}, weight of 1000 seeds (gm), bioyield yield (gm. $plant^{-1}$), seed yield (gm.$plant^{-1}$) and harvest index (%). The data were analyzed by the design used and the averages were compared using the L.S.D. test by Genstat program.

RESULTS AND DISCUSSION

First location

The results of the statistical analysis indicated that the differences were significant between the two varieties of mungbean used in this study and shown in (Table 2) for the first site, as the significant superiority was in favor of the second variety of mungbean in the characteristics of number of branches.$plant^{-1}$, (4.717 branches.$plant^{-1}$), leaf area (1323.2 cm^2, $plant^{-1}$), leaf area index (3.308), number of seeds.pod^{-1}, (10.71 seeds.pod^{-1}), weight of 1000 seeds (44.54 gm), seed yield (8.60 gm) and biological yield 26.52 gm). while the first variety significant superiority in traits plant height (61.50 cm), (pod length (9.44 cm), number of pods.$plant^{-1}$, (21.77 pods.$plant^{-1}$) and harvest index (32.54%) and this is proven by the studies of [Abdulqader *et al.* (2021); Ali *et al.* (2021); Khatik *et al.* (2022); Ali *et al.* (2023);, Christian *et al.* (2023); Dikr (2023); Ali *et al.* (2023); Priya and Babu (2024)].

The results of Table (2) indicated the significant impact of planting dates, as planting in the third date has significantly surpassed the other dates in the

Table 1: Properties of soil in two locations.

Properties	Nineveh	Erbil
Soil texture	Silty	Silty clay
Electrical conduction (EC)	0.96 (dc/m)	0.97 (dc/m)
Nitrogen	54.47 ppm	59.96 ppm
Available phosphorous	45.02 ppm	49.47 ppm
pH	7.4	7.6
Organic matter	17.8%	19.5%

characteristics of germination % (81.92%), pod length (9.96 cm), weight of 1000 seeds (44.88 gm) and harvest index (33.88%). While the second date outperformed the other dates for the characteristics of plant height (65.83 cm), number of branches.plant$^{-1,}$ (5.650 branches.plant^{-1}), leaf area (1328.2 cm^2, plant^{-1}), leaf area index (3.330), Number of pods.plant^{-1} (22.09 pods.plant^{-1}), seed yield (9.17 gm) and biological yield (28.99 gm) and recorded a significant superiority for the first date over the rest of the dates in this study for the number of seeds.pod^{-1} (9.97 seeds.pod^{-1}) this

Table 2: Effect of study factors on the studied characteristics of the first site.

Traits / Treatments	Germination %	Plant height (cm)	Number of branches plant^{-1}	Leaf area (cm^2, plant^{-1})	Leaf area index	Pod length (cm)
Varieties						
Variety 1	80.22	61.50	4.712	1286.0	3.221	9.44
Variety 2	80.17	57.17	4.717	1323.2	3.308	8.26
Test F	N.S	0.002	0.003	0.005	0.009	001
L.S.D	N.S	2.547	0.339	24.68	0.062	0.389
Dates						
Date 1	79.67	52.83	4.392	1289.5	3.224	8.47
Date 2	79.00	65.83	5.650	1328.2	3.330	8.12
Date 3	81.92	59.33	4.925	1296.1	3.250	9.96
Test F	001	001	001	0.032	0.043	001
L.S.D	0.871	3.120	0.416	30.22	0.076	0.476
Methods						
Method 1	80.22	59.83	5.017	1333.5	3.340	9.26
Method 2	80.17	58.03	4.161	1275.7	3.189	8.44
Test F	N.S	0.041	0.050	001	001	001
L.S.D	N.S	1.547	0.200	24.68	0.062	0.389
Interaction						
V * D	001	0.014	N.S	N.S	N.S	N.S
V * M	N.S	001	N.S	0.020	0.035	N.S
D * M	N.S	N.S	0.014	0.041	0.029	N.S
V * D * M	N.S	001	0.015	001	001	N.S

Traits / Treatments	Number of pods plant^{-1}	Number of seeds pod^{-1}	Weight of 1000 seeds (gm)	Seed yield (gm. plant^{-1})	Biological yield (gm. plant^{-1})	Harvest index (%)
Varieties						
Variety 1	21.77	7.93	41.41	8.24	24.51	32.54
Variety 2	19.23	10.71	44.54	8.60	26.52	30.76
Test F	001	001	001	0.029	0.033	0.048
L.S.D	0.847	0.550	0.883	0.255	1.236	1.024
Dates						
Date 1	19.59	9.97	42.13	7.51	24.11	30.97
Date 2	22.09	9.16	42.93	9.17	28.99	32.11
Date 3	20.83	9.13	44.88	8.12	24.34	33.88
Test F	0.014	0.049	0.010	001	001	0.020
L.S.D	1.037	0.515	1.081	0.600	0.938	1.630
Methods						
Method 1	21.30	9.76	45.80	8.90	27.90	32.35
Method 2	19.71	8.88	40.15	7.64	23.73	31.96
Test F	001	0.003	001	001	001	0.550
L.S.D	0.847	0.550	0.883	0.490	0.766	1.331
Interaction						
V * D	N.S	N.S	001	001	001	001
V * M	0.054	0.031	001	001	N.S	001
D * M	001	0.001	001	001	001	001
V * D * M	N.S	N.S	001	001	001	001

is confirmed by the result of Abdulqader *et al.* (2021); Ali *et al.* (2021); Eshanee *et al.* (2023).

While the results of the statistical analysis in Table (2) indicated that there can be significant variations in the methods of cultivation, as it significant superiority the first cultivation method and for all the studied traits plant height (59.83 cm), number of branches.plant^{-1} (5.017 branches.plant^{-1}), leaf area (1333.5 cm^2, plant^{-1}, leaf area index (3.340), pod length (9.26 cm), number of pods.plant^{-1} (21.30 pods.plant^{-1}), number of seeds.pod^{-1} (9.76 seeds.pod^{-1}), weight of 1000 seeds (45.80 gm), seed yield (8.90 gm) and biological yield (27.90 gm), except for the germination % and harvest index traits, no significant differences were recorded between the cultivation methods for this site and the result agreed with Singh *et al.* (2011); Ali, (2021); Ram *et al.* (2018).

Second location

Through the results of this study, the statistical results in Table (3) showed that the varieties have a significant effect, as they significantly superiority the second vareity in the characteristics of germination % (80.46%), leaf area (1278.8 cm^2, plant^{-1}), leaf area index (3.197), number of pods (20.72 pods.plant^{-1}), seed yield (8.301 gm) and biological yield (25.99 gm), while the first vareity significantly outweighed plant height (58.83 cm), number of branches.plant^{-1} (58.83 branches.plant^{-1}), pod length (10.345 cm), number of seeds.pod^{-1} (9.98 seeds.pod^{-1}), weight of 1000 seeds (43.79 gm) and harvest index (33.77%). This result is similar to the research results of (Ali *et al.,* 2021; Dikr, 2023).

Planting dates recorded a significant impact on the studied traits, as it significantly superiority the 3 date of planting in the traits of germination % (80.67%), plant height (61.17 cm) and number of pods (21.93 pods.plant^{-1}), while the first planting date exceeded all other traits, number of branches.plant^{-1} (5.692 branches.plant^{-1}), leaf area (1297.8 cm^2, plant^{-1}), leaf area index (3.245), number of seeds.pod^{-1} (10.20 seeds.pod^{-1}), weight of 1000 seeds (43.97 gm), seed yield (8.848 gm), (26.57 gm) and Harvest index (33.77%) except for the pod length trait (10.422 cm), where it significantly superiority the second planting date. This is similar to what this research showed (Ali *et al.,* 2021).

The second planting method has a significant superiority compared to the first method for the traits of germination % (78.50%), number of pod (20.91 pods.plant^{-1}), while the first method of cultivation significantly superiority in the characteristics of plant height (57.76 cm), number of branches (5.550 branches.plant^{-1}), leaf area (1359.4 cm^2, plant^{-1}), leaf area index (3.398), pod length (10.479 cm), pod length (10.479 cm), number of seeds.pod^{-1} (10.01 seeds.pod^{-1}), weight of 1000 seeds (43.62 gm), seed yield (8.427 gm), biological yield (25.20 gm) and harvest index (33.51 %) all of this is similar to the studies of (Singh *et al.,* 2011; Ram *et al.,* 2018).

Varieties

The nature of the growth of the mungbean differs from other crops due to the diversity of varieties among them and this is reflected in the maturity and seed size (Dodwadiya and Sharma, 2012). The reason for the variation of genetic structures in the studied traits is due to the different genetic nature and thus the difference in their response to the photoperiod, temperature and environmental conditions, that the reason for the superiority of the variety in the characteristics of the yield and its components is due to the superiority of the same variety in the traits of vegetative growth the germination %, plant height, number of branches, leaf area and its evidence tabules (2 and 3), which positively affected the speed of growth and increase the efficiency of photosynthesis and then the products of representation contributed to the formation of new branches on the plant, so an appropriate paper space was formed and thus the processing of sites new evolution with the requirements of growth is less abortion, which helped in the concentration of nutrients processed by photosynthesis, which contributed to increasing the division and elongation of cells these traits have contributed collectively to increasing the transmission of processed photosynthetic products to the seed formed and thus filling and increasing its weight and this result was in line with what was confirmed by Arya *et al.* (2024); Rai *et al.* (2024).

Planting dates

The dates of planting leguminous crops are complex due to the belonging of varieties to multiple maturity groups and are greatly affected by the environment and it is necessary to determine the appropriate date for planting varieties with unknown environmental adaptation in order to obtain compatibility between vegetative and fruitful growth and this is determined by the appropriate planting date for each region (Venkatshwarulu and Soundararajan, 1991). The planting dates of the first or second in this study allowed the plants a better period of vegetative growth, which improved the division of plant cells and elongation more than the late date (third) as a result of the availability of appropriate conditions for growth and the availability of all the necessary needs for that, which led to an improvement of the characteristics of the yield and its components It is known that the date of planting for crops varies from one country to another and from one region to another according to environmental and climatic conditions and the sites in which it is grown. The late planting date is a major reason for the increase in the costs of agricultural operations and at the same time the yield is low due to the short period of the crop growing season and the decrease in net photosynthesis, while planting on time (optimal) ensures the best compatibility between environmental and plant conditions and this contributes significantly to improving the qualities of the crop and thus the yield. The study by Rehman *et al.* (2009) also indicated that optimal planting time improves the growth and yield qualities of the mash crop

that correspond to optimal environmental conditions. While early planting of mash varieties achieves the best vegetative growth before flowering and this improves the formation of the best number of pods (Singh and Singh, 2011).

Cultivation method

It is possible that the superiority of the method of cultivation furrow in the traits of the yield and its components is due to the superiority of this method with all the traits of growth

Table 3: Effect of study factors on the studied characteristics of the second site.

Traits / Treatments	Germination %	Plant height (cm)	Number of branches plant^{-1}	Leaf area (cm^2, plant^{-1})	Leaf area index	Pod length (cm)
Varieties						
Variety 1	77.67	58.83	5.494	1215.4	3.100	10.34
Variety 2	80.46	55.50	5.178	1278.8	3.197	10.00
Test F	0.044	001	0.047	0.050	0.050	0.050
L.S.D	2.389	1.622	0.191	37.08	0.092	0.344
Dates						
Date 1	73.67	55.83	5.692	1297.8	3.245	10.00
Date 2	74.25	54.50	5.317	1153.2	3.100	10.42
Date 3	80.67	61.17	5.400	1250.2	3.101	9.85
Test F	0.005	001	0.048	0.045	0.045	0.043
L.S.D	4.150	1.987	0.243	30.97	0.113	0.422
Methods						
Method 1	74.22	57.76	5.550	1359.4	3.398	10.47
Method 2	78.50	56.08	5.322	1194.8	2.987	10.07
Test F	0.043	0.041	0.027	001	001	0.047
L.S.D	3.389	1.622	0.199	43.79	0.092	0.344
Interaction						
V * D	0.177	001	0.005	0.242	0.242	0.232
V * M	0.158	1.000	0.689	0.005	0.005	001
D * M	0.744	0.003	001	0.004	0.004	001
V * D * M	0.901	001	0.117	0.025	0.025	0.041

Traits / Treatments	Number of pods. plant^{-1}	Number of seeds pod^{-1}	Weight of 1000 seeds (gm)	seed yield (gm. plant^{-1})	Biological yield (gm. plant^{-1})	Harvest index (%)
Varieties						
Variety 1	20.27	9.98	43.79	7.038	23.54	33.77
Variety 2	20.72	9.25	42.62	8.301	25.99	31.99
Test F	0.050	0.023	001	0.050	001	0.007
L.S.D	0.461	0.472	0.619	0.363	1.047	1.239
Dates						
Date 1	19.90	10.20	43.97	8.848	26.57	33.97
Date 2	19.66	9.56	43.01	7.556	22.62	31.01
Date 3	21.93	9.42	42.62	7.955	25.11	31.17
Test F	001	0.031	0.004	001	001	0.002
L.S.D	0.565	0.578	0.759	0.363	1.283	1.518
Methods						
Method 1	20.08	10.01	43.62	8.427	25.20	33.51
Method 2	20.91	9.02	42.78	7.812	24.13	32.26
Test F	0.001	0.044	0.010	0.002	0.050	0.049
L.S.D	0.461	0.472	0.619	0.630	1.047	1.239
Interaction						
V * D	0.223	0.460	001	.001	0.025	0.055
V * M	0.004	001	001	.001	0.601	001
D * M	0.002	0.987	001	.001	001	0.039
V * D * M	0.003	0.011	001	.001	001	0.023

(plant height, number of branches, leaf area and leaf area index) because the plants that were planted in the method of furrow gave a significant superiority to the characteristic of plant height and this enabled plants to intercept the largest amount of lighting and thus increase the process of photosynthesis and all processes that improve growth and production and this increases the net photosynthesis and resulted in a significant increase in the characteristic of number of branches, this was reflected in a significant increase in the characteristics of leaf area and leaf area index as a result of the higher place of planting seeds in this way compared to planting with lines and this result was obtained (Singh *et al.,* 2011) when comparing cultivation in furrow and lines. Also, the transplant route in furrow prevents the accumulation of excess water above the plant's need over the soil and thus reduces the oxygen necessary for the respiration of the roots, which has a negative impact on the growth of the roots and the plant in general, especially if the soils are heavy clay.

Other factors may have an impact on the productivity of this crop that we have not addressed and therefore more future research must be conducted.

CONCLUSION

The results of this study encourage Iraqi farmers to plant local green or black varieties of mungbean according to the trait to be improved and to apply the cultivation factors used (the second and third planting dates and the first planting method) in both locations. From these results, farmers conclude that the yield and quality of the varieties will increase by increasing the agricultural area and yield of the mungbean crop. Varieties, dates, or methods yield consistent results across sites this encourages the generalization of the results of this study to additional agricultural areas, this will include Iraqi agricultural environments, especially in light of the conditions of drought and environmental variation, the necessity of creating sustainable cultivation of the mung crop and the corresponding significant increase in food needs.

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Conflict of interest

All authors declare that they have no conflict of interest.

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