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EFFECT OF FIVE NITROGEN LEVELS IN GROWTH AND YIELD OF FOUR MUNG BEAN GENOTYPES (*VIGNA RADIATA* L.)

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Abstract

A field experiment was carried out in the loamy sand soil during the spring season of 2013 in Dhabitiyah region- Khairat district, Garma/ Anbar Governorate- Iraq. It aimed to know the response the growth and the yield of four genotypes of mung bean (Local cv., VC 6144 B-1224, VC 6173 B-1319 and VC 6089 A10) to five level of nitrogen fertilizer (0, 40, 80, 120, and 160 Kg N ha^{-1}) which were added as urea (46% N). A split plot arrangement was used in RCBD in conducting this experiment with three replications, the nitrogen levels were put in the main plots while mung bean genotypes occupied the subplots. The results of the study indicated that the genotypes were significantly varied in all studied traits. The genotype VC 6137 B-1319 gave the highest average seed yield (1.52 ton ha^{-1}), biological yield and harvest index (54.07%). The nitrogen fertilizer significantly affected in most studied traits, the level 160 kg h^{-1} gave the highest average of the number of pods per plant (23.99 pod $plant^{-1}$), seed yield in area unit (1.44 ton ha^{-1}) and biological yield (2.44 ton ha-1). The two-way interaction of the study factors of the study significantly affected in all traits under study except the weight of 100 seed. The genotype VC 9137 B-1319 that was fertilized with 160 kg N ha^{-1} gave the highest average of the number of pods in the plant (27.27 pod $plant^{-1}$), seed yield (1.99 ton ha^{-1}) and biological yield.

Key words: Mung bean, Nitrogen fertilizer, Mung bean productivity

Introduction

Mung bean (*Vigna radiata* L.) is one of the summer legumes that sown for its seeds which have nutritional values. Its seeds are used in making soup as well as they can be mixed with rice in some countries because they containing minerals, proteins (19-29%), carbohydrates (62-65%) as well as oil (1-1.5%) (Ali *et al*., 1990). However, mung bean can be used as fodder in animal nutrition as well as its usage as green fertilizers in order to improve soil characteristics. In spite of the importance of this crop, its productivity in Iraq still low in comparison with the global production and this keeps pushing researchers to investigate all method that might lead to increase its productivity, from which inbreed new genotypes beside the local varieties which have been characteristics with impurity and prone to diseases. Therefore, there is a necessity to produce new cultivars that could utilize environmental factors ideally as well as converting photosynthetic products from vegetative parts into reproductive parts which in turn contribute in increasing the fertility and reduce the abortion of flowers then increase the number of seeds in the pod, eventually increase its yield. The use of fertilizers also can be one of the good practices that may increase the productivity of this important crop, of which is nitrogen. Nitrogen contributes to the induction of cell divisions and its elongation, improving leaf area and its index and also its role in fertility of flowers as well as a number of pods in the plant. Nitrogen also has a role in other elements absorption because it increases from root growth and distribution (Essa, 1990) eventually all these reflect the high productivity of this crop. According to a aforementioned a field experiment was conducted and included three introduced mung bean genotypes beside the local cultivar with five level of nitrogen fertilizer in order to determine best genotype and nitrogen level which lead to better growth and yield of this crop.

Materials and Methods

A field experiment was conducted in loamy sand soil in the spring season of 2013 in Dhabitiyah region- Khairat district- Garma/ Anbar governorate in order to study the

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response of four mung bean genotypes (Local cultivar, VC 6144 B-1224, VC 6173 B-1319 and VC 6089 A10) to five nitrogen levels (0, 40, 80, 120 and 160 Kg ha^{-1}). The genotypes were provided from General Commission for Scientific Agricultural Research. The arrangement of this experiment was according to the split-plot that conducted in a randomized complete block design (RCBD) with three replications. Nitrogen levels were put in main plots while genotypes occupied the subplots. The field of the experiment was prepared according to the good practices from tillage, softening and leveling, then samples from the soil were taken randomly in order to investigate some physical and chemical characteristics of it (Table 1). Samples were taken to the laboratory of Soil and Water Department, Agriculture College-University of Anbar in order to do all necessary analysis. However, the field was divided according to the used experimental design into experimental units (6 m^2), each unit contained 5 rows with the length of 4 m and the planting space was 0.3 m between rows and 0.25 between each hole and another. The plant density was 133333 plant ha^{-1}.

Table 1: Some physical and chemical characteristics of the study soil before planting.

Character		Unit	Value
pH		----------	8.1
EC		Desiminesm^{-1}	3.1
Organic matter		g Kg^{-1}	8.4
Gypsum		g Kg^{-1}	7
$CaCo_3$		g Kg^{-1}	2.49
CEC		Centimole Kg^{-1}	11.3
Total N		mg Kg^{-1}	20
Total P		mg Kg^{-1}	8.1
Available K		mg Kg^{-1}	200
Soil Texture	Sand	g Kg^{-1}	111
	Silt		501
	Clay		388

The experiment was planted in 10th April 2013 and the phosphate fertilizer was added at once at planting (Al-Fahdwai, 2004), while the nitrogen fertilizers were added by three equal portions. The first portion of the nitrogen fertilizer was added after 100% germination while the second portion was added at the beginning of the flowering stage and the third portion was applied at the pod and formation stage. The irrigation was applied after sown date directly and it was repeated according to the need, soil moisture, and plant status. After two weeks from the third nitrogen portion was added, leave the area (ds^2) was taken from six plants from the middle rows from each experimental unit according to Johnson (1967). At the harvest eighteen plants from the middle rows of each experimental unit were taken; plant dry weight (g) also was taken after drying plants in the electric oven at 65 to 70 C^0, after the steady if their weight, weight was recorded. The weight (g) was counted as the average of same taken plants. A number of pods per plant were calculated as the average same of plants. Then, 100-seed weight was measured (g) by using sensitive balance. The seed yield in a unit area (ton ha^{-1}) was taken by harvesting all remained plants from the middle rows. After threshing their pods, their seeds were added to the yield of the 18 plants seed from each experimental unit and then were weighed, and then the weight was converted to the area of a hectare. As for biological yield (ton ha^{-1}) was calculated through adding the dry matter weight of the vegetative growth to the seed yield for the area unit, while the harvest index (Parameter of genotype efficiency to convert photosynthetic products to economical yield) was calculated according to this equation:

Harvest index (%) = seed yield / Biological yield × 100

Statistical analysis: The studied traits data were analyzed according to ANOVA table based on the used experimental design and the significant differences were investigated according to L.S.d at the probability of 0.05 (Al-Rawi and KhalafuAllah, 1980).

Results and Discussion

Leaf area (ds^2 $plant^{-1}$):

It is clear from table 2 that the genotypes VC 6144 B-1224 and VC 6089 A10 achieved the highest average of leaf area (39.71 and 39.31 ds^2 $plant^{-1}$ respectively) and they significantly differed from each other but they were significantly different from VC 6173 B-1319 (34.56 ds^2 $plant^{-1}$) which in turn was significantly different from local cultivar that gave the lowest average of leaf area (28.01 ds^2 $plant^{-1}$). The difference in this trait among genotypes belongs to their difference in dry leaf weight which is the base of this trait. Researchers have found significant differences among genotypes of mung bean (Islam and Razzaque 2010, Al-Mehemdi, 2012 and Razzaque *et al*, 2017). Table 2 shows that there is a significant increase in the average of leaf area with the increase of nitrogen levels up to 80 Kg ha^{-1} which got to 38.71 ds^2 $plant^{-1}$ with the increasing percentage of 0.6 and 35% over 40 Kg N ha^{-1} and control that gave the lowest average of leaf area (28.64 ds^2 $plant^{-1}$) respectively. This increase as the effect of nitrogen fertilizer that leads to increasing in the average of cell division and expanding and this reflected in the increased leaf area of the plant. In this regard, many researchers have found a significant increase in leaf area of mung bean under application of nitrogen fertilizer (Al-Mehemdi, 2012, Achakazi *et al.*, 2012 and Jalali *et al.*, 2017).

It is clear from table 2 that the interaction between genotypes and nitrogen levels has affected significantly in this trait. The genotype VC 6089 A10 that fertilized with 80 Kg N ha^{-1} gave the highest average of leaf area (49.02 ds^2 $plant^{-1}$) and it was not significantly different from VC 6144 B-1224 that fertilized with 80 and 120 Kg N ha^{-1} (48.71 and 46.41 ds^2 $plant^{-1}$) respectively, but it was significantly different from other interaction treatments with increasing percentage of 181% over the local cultivar with control that gave the lowest average of leaf area (17.42 ds^2 $plant^{-1}$).

Plant dry weight (g $plant^{-1}$):

It is clear from table 3 that the genotypes were significantly varied among them in this trait. The genotype VC 6089 A10 gave the highest average of plant dry weight (10.04 g $plant^{-1}$) and it was not significantly different with VC 6144 B-1224 (9.92 g $plant^{-1}$), furthermore, it was significantly different with VC 6173 B-1319 (9.60 g $plant^{-1}$). However, all introduced genotype was significantly different from local cultivar which gave the lowest average of plant dry weight (7.05 g $plant^{-1}$). The supremacy of Indian genotypes in leaf area (Table 2) reflected positively in the efficiency of light objection and its absorption, eventually leads to increase of photosynthesis products that were participated as dry matter. This result was consistent with the finding of other researchers that found significant differences in plant dry weight among the genotypes (Islam and Razzaque 2010, Zare *et al.*, 2.13 and Razzaque *et al.*, 2017). Plant dry weight has increased significantly with the increase of nitrogen levels up to 80 Kg N ha^{-1} which got to 9.94 g $plant^{-1}$ with the increasing percentage of 10 and 29% in comparison with the level of 40 Kg N ha^{-1} and control that gave the lowest average of plant dry weight (8.98 and 7.69 g $plant^{-1}$) respectively. This increase came as result of its supremacy in leaf area (table 2) which in turn increased the efficiency of light objection and increase in energy production (ATP and NADPH) that are required for CO_2 reduction into organic compounds that accumulated as dry matter in the plant. This result came in consistency with findings of other researchers who found that the application of nitrogen leads to significant increase in plant dry weight of mung bean crop (Al-Mehemdi, 2012, Mainul *et al.*, 2014 and Razzaque *et al.*, 2017).

It is also clear from the aforementioned table that the interaction between study factors was significant for this trait. The genotype VC 6144 B-1224 that fertilized with 80 Kg N ha^{-1} gave the highest average of plant dry weight (12.36 g $plant^{-1}$) and it was not significantly different from VC 6089 A10 that fertilized with the same level (11.70 g $plant^{-1}$), however it was significantly different from other interaction treatments with increasing percentage of 154% in local cultivar with control treatment which gave the lowest average of this trait (4.86 g $plant^{-1}$).

Number of pods per plant:

Table 4 showed that all genotypes were significantly varied in this trait. The genotype VC 6089 A10 gave the highest average of a number of pods (22.23 pod $plant^{-1}$) but was not significantly different from VC 6173 B-1319 (21.88 pod $plant^{-1}$), however, it was significantly different from local cultivar (21.24 pod $plant^{-1}$). All the aforementioned genotypes were different significantly from VC 6144 B-1224 which gave the lowest average of this trait (18.27 pod $plant^{-1}$). The reduction of the number of pods in the last genotype belongs to the reduction in its harvest index (table 8) and eventually

Table 2: Effect of genotype and nitrogen level and their interaction in the mean of leaf area (ds^2 $plant^{-1}$)

Genotypes	Nitrogen level Kg N ha^{-1}					Mean (Genotypes)
	0	40	80	120	160	
Local Cultivar	17.42	27.89	26.71	34.01	34.01	28.01
VC 6144 B-1224	29.49	33.64	48.71	46.41	40.32	39.71
VC 6173 B-1319	35.44	44.51	30.38	24.95	37.53	34.56
VC 6089 A10	32.22	39.96	49.02	37.91	37.46	39.31
Mean (N)	28.64	36.50	38.71	35.82	37.33	
LSD 0.05	Genotypes		Nitrogen levels			Genotypes × Nitrogen Levels
	1.16		2.00			2.85

Table 3: Effect of genotype and nitrogen level and their interaction in the mean of plant dry matter (g $plant^{-1}$)

Genotypes	Nitrogen level Kg N ha^{-1}					Mean (Genotypes)
	0	40	80	120	160	
Local Cultivar	4.86	6.52	7.64	8.69	7.56	7.05
VC 6144 B-1224	7.68	9.27	12.36	10.87	9.44	9.92
VC 6173 B-1319	9.22	10.72	8.05	8.66	11.37	9.60
VC 6089 A10	9.01	9.40	11.70	9.84	10.24	10.04
Mean (N)	7.69	8.98	9.94	9.51	9.65	
LSD 0.05	Genotypes		Nitrogen levels			Genotypes × Nitrogen Levels
	0.40		0.41			0.85

reduction in its efficiency of converting photosynthetic products from the vegetative growth to floral parts which in turn leads to infertility of flowers which reflected negatively in pods number per plant. In this regard, Essa (1990) indicated that plant can set up pods and seed through the aid of photosynthesis. This result also was consistent with findings of many researchers (Rasul *et al.*, 2012, Mesele *et al.*, 2015, Rahman *et al.*, 2016 and Umata, 2018).

The nitrogen level 160 Kg ha^{-1} gave the highest average of a number of pods in the plant (23.99 pod plant^{-1}) and by this, was superior over all other levels of nitrogen from which the control that gave 17.91 pods plant^{-1}. The superiority of this level of nitrogen in leaf area and plant dry matter (table 2 and 3) reflected in providing the sat up flowers with their requirements of products which lead to increase the fertility in the flowers (Essa, 1990). This result was in consistency with the results of other researchers that found significant differences among nitrogen levels in increasing pods number in mung bean (Lahmood *et al.*, 2012, Maniul *et al.*, 2014, Hossen *et al.*, 2015 and Razzaque *et al.*, 2017).

It is clear from the results presented in the same table that the interaction between the study factors was also significant. The interaction between each of VC 6173 B-1319 and Local cultivar with 160 Kg N ha^{-1} gave the highest average of this trait (27.27 and 27.10 pod plant^{-1} respectively) and they were not significant from VC 6089 A10 that fertilized with 80 Kg N ha^{-1} (26.79 pod plant^{-1}), but all aforementioned genotypes were superior to all other interaction treatments with the increase of 13 pods over the local cultivar that was not fertilized with nitrogen (14.10 pod plant^{-1}).

100-seed weight (g):

Table 5 showed significant variation in this trait among genotypes under study. The VC 6089 A10 and VC 6173 B-1319 genotypes gave the highest average of 100-see weight, 7.50 and 7.36g respectively and both did not vary significantly from VC 6144 B-1224 (6.85 g) which in turn was superior over local cultivar that gave the lowest average of this trait (4.04 g). The superiority of the aforementioned genotypes in seed weight might belong to their superiority in harvest index (table 8) which means their efficient converting photosynthetic products from source (leaves and vegetative parts of the plant) to sink (seed) then reflected the weight of the seed (Essa, 1990). This result was consistent with findings of other studies that found significant differences among mung bean genotypes in seed weight (Parvez *et al.*, 2013, Buriro *et al.*, 2015, Yeasmin *et al.*, 2016 and Khan *et al.*, 2017). However, nitrogen fertilizer and its interaction with genotypes did not significantly affect this trait.

Table 4: Effect of genotype and nitrogen level and their interaction in the mean of pods number (Pod plant^{-1})

Genotypes	Nitrogen level Kg N ha^{-1}					Mean (Genotypes)
	0	40	80	120	160	
Local Cultivar	14.10	17.73	22.17	25.09	27.10	21.24
VC 6144 B-1224	15.27	20.63	19.79	17.61	18.03	18.27
VC 6173 B-1319	24.20	19.87	20.00	18.08	27.27	21.88
VC 6089 A10	18.07	20.00	26.79	22.70	23.57	22.23
Mean (N)	17.91	19.56	22.19	20.87	23.99	
LSD 0.05	Genotypes		Nitrogen levels			Genotypes × Nitrogen Levels
	0.82		0.70			1.69

Table 5: Effect of genotype and nitrogen level and their interaction in the mean of the weight of 100-seed (g)

Genotypes	Nitrogen level Kg N ha^{-1}					Mean (Genotypes)
	0	40	80	120	160	
Local Cultivar	3.98	3.73	3.97	4.17	4.33	4.04
VC 6144 B-1224	7.04	7.18	6.37	6.87	6.78	6.85
VC 6173 B-1319	7.43	7.27	7.10	7.77	7.25	7.36
VC 6089 A10	7.92	7.55	7.46	7.13	7.44	7.50
Mean (N)	6.59	6.43	6.23	6.49	6.45	
LSD 0.05	Genotypes		Nitrogen levels			Genotypes × Nitrogen Levels
	0.32		N.S			N.S

Table 6: Effect of genotype and nitrogen level and their interaction in the mean of seed yield in area unit (ton ha^{-1})

Genotypes	Nitrogen level Kg N ha^{-1}					Mean (Genotypes)
	0	40	80	120	160	
Local Cultivar	0.5	0.73	1.03	1.13	1.18	0.91
VC 6144 B-1224	0.92	1.71	1.25	1.16	1.19	1.25
VC 6173 B-1319	1.68	1.34	1.33	1.23	1.99	1.52
VC 6089 A10	1.27	1.24	1.61	1.34	1.39	1.37
Mean (N)	1.09	1.25	1.30	1.22	1.44	
LSD 0.05	Genotypes		Nitrogen levels			Genotypes × Nitrogen Levels
	0.04		0.04			0.08

Seed yield per area unit (ton ha^{-1}):

Table 6 indicated that all genotypes significantly varied in their seed yield. The genotype VC 6173 B-1319 gave the highest average of seed yield (1.52 ton ha^{-1}) and varied significantly from VC 6089 A10 (1.37 ton ha^{-1}) which turn was superior over VC 6144 B-1224 (1.25 ton ha^{-1}). It is clear from the table results that the aforementioned genotypes were superior by 610, 460 and 340 Kg seed in hectare respectively over the local cultivar which gave the lowest average of seed yield, 0.91 ton ha^{-1}. The superiority of VC 6173 B-1319 in seed yield might belong to its superiority in a number of pods per plant and weight of 100-seed (table 4 and 5), as well as its superiority in harvest index, 54.07% (table 8) all of the aforementioned traits, contributed to its seed yield. This result was consistent with the findings of other researchers who found that mung bean genotypes significantly varied in their seed yield per unit area (Azadi *et al.*, 2013, Zirak *et al.*, 2015, Rahman *et al.*, 2016, Rajput and Rajput, 2017 and Umata, 2018).

Table 6 showed that the level 160 Kg N ha^{-1} gave the highest average of this trait (1.44 ton ha^{-1}) and by this was superior over all other levels with an increase of 350 Kg over control that gave the lowest average of yield (1.09 ton ha^{-1}). The superiority of this level is due to its superiority in number of pods per plant (table 4), as well as it is superiority in leaf area, plant dry matter and harvest index (table 2, 3 and 8), all these traits contributed directly or indirectly to increasing of seed yield in unit of area. In this regards, many researchers confirmed the significance of nitrogen effects in increasing seed yield of mung bean (Latheeth *et al.*, 2011, Al-Mehemdi, 2012, Mojaddam *et al.*, 2014, Hossen *et al.*, 2015 and Jalali *et al.*, 2017).

Also, the two-way interaction between the study factors was significant in its effect on seed yield. The genotype VC 6173 B-1319 that fertilized with 160 Kg N ha^{-1} achieved the highest average of this trait (1.99 ton ha^{-1}) and was superior over all other interactions by an increase of 1.49 ton over the local cultivar that was not fertilized with nitrogen which gave the lowest average of seed yield (0.50 ton ha^{-1}). Through this result, it is clear that the Indian genotypes under all nitrogen levels were superior over local cultivar, and this was consistent with the result that indicated that Indian genotypes response in a better way than local cultivars to the nitrogen.

Biological yield per unit area (tonha^{-1}):

Results presented in table 7 showed that all genotypes were significantly varied in this trait. The genotype VC 9173 B-1319 achieved the highest average of the biological yield (2.51 ton ha^{-1}) and were superior to all other genotypes under study. However, local cultivar gave the lowest average of this trait (1.66 ton ha^{-1}). The reason of this might belong to its superiority in seed yield (table 6) as well as its superiority in plant dry matter (table 3). This result was consistent with other researchers' findings that found significant differences among mung bean genotypes in this trait (Al-Mehemdi, 2012, Fooladivanda, 2014, Imran *et al.*, 2016 and Khan *et al.*, 2017).

It is clear from the same table generally that there is an increase the biological yield with the increase of nitrogen levels. The level 160 Kg N ha^{-1} was superior in this trait as it gave the highest average (2.44 ton ha^{-1}) in comparison with the other nitrogen levels. Control treatment gave the lowest average of the biological yield (1.91 ton ha^{-1}). This superiority might belong to the superiority in leaf area, plant dry matter, and pods number per plant and seed yield (table 2, 3, 4 and 6). Other

Table 7: Effect of genotype and nitrogen level and their interaction in the mean of Biological yield in area unit (ton ha^{-1})

Genotypes	Nitrogen level Kg N ha^{-1}					Mean
	0	40	80	120	160	(Genotypes)
Local Cultivar	1.02	1.44	1.84	2.06	1.96	1.66
VC 6144 B-1224	1.75	2.64	2.60	2.37	2.20	2.31
VC 6173 B-1319	2.62	2.49	2.16	2.15	3.15	2.51
VC 6089 A10	2.23	2.24	2.85	2.39	2.46	2.43
Mean (N)	1.91	2.2	2.36	2.24	2.44	
LSD 0.05	Genotypes		Nitrogen levels			Genotypes × Nitrogen Levels
	0.05		0.04			0.09

Table 8: Effect of genotype and nitrogen level and their interaction in the mean of Harvest index (%)

Genotypes	Nitrogen level Kg N ha^{-1}					Mean
	0	40	80	120	160	(Genotypes)
Local Cultivar	43.88	45.55	51.60	49.18	53.91	48.82
VC 6144 B-1224	47.25	58.13	43.18	44.10	48.55	48.24
VC 6173 B-1319	57.83	48.38	55.25	51.91	56.97	54.07
VC 6089 A10	51.34	49.83	50.72	50.70	50.96	50.71
Mean (N)	50.08	50.47	50.19	48.97	52.60	
LSD 0.05	Genotypes		Nitrogen levels			Genotypes × Nitrogen Levels
	1.83		N.S			4.04

researchers have found similar findings (Ahmed *et al.*, 2012 and Jalali *et al.*, 2017).

The two-way interaction between genotypes and nitrogen level was also significant in its effect on biological yield. The genotype VC 6173 B-1319 that fertilized with 160 Kg N ha^{-1} gave the highest average of the biological yield (3.15 ton ha^{-1}) and was superior over other two-way interactions. The rise was 2.13 ton over the local cultivar at control treatment (N0) that gave the lowest average of this trait (1.02 ton ha^{-1}).

Harvest index (%):

Table 8 showed that the genotype VC 9173 B-1319 achieved the highest average of the harvest index (54.07%) followed by VC 6089 A10 (50.71%) which in turn was superior over local cultivar (48.82%) and VC 6144 B-1224 that gave the lowest average of harvest index (48.24%). The superiority of VC 6173 B-1319 in this trait might belong to its superiority in seed yield (table 6). In this regards, other researchers have found significant differences among cultivars of mung bean in the harvest index (Parvez *et al.*, 2013, Buriro *et al.*, 2015, Imran *et al.*, 2016 and Khan *et al.*, 2017). Nitrogen fertilizer did not affect the harvest index.

Table 8 also indicated that the interaction between the study factors significantly affected this trait. The genotype VC 6144 B-1224 that fertilized with 40 Kg N ha^{-1} gave the highest average of harvest index (58.13%) and was did not significantly vary from the genotype VC 6173 B-1319 that fertilized with 0, 80, 160 Kg N ha^{-1} which gave 57.83, 55.25 and 56.97% respectively, while it did not significantly differ from other interactions treatments in increase percentage of 34% over the same genotype that was fertilized with 80Kg N ha^{-1} which gave the lowest average of this trait (43.18%).

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