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Agronomic Indices Assessment for Horse bean (*Vicia faba* L.) based on Seed Stimulation by Gibberellin and Varieties

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ABSTRACT

Background: *Vicia faba* L. equina belong to medium size seeds group which is considered one of the main pulse crop which are widely and mainly used it's pods, fresh and dry seeds in cooking, especially by a large section of poor people as a source of expensive animal protein compensation.

Methods: A field experiments carried out at agricultural researches and experiments station affiliate of the College of Agriculture, University of Kirkuk - Kirkuk Province, Iraq, Randomized complete block design with three replicates used to perform this experiment. For determination following seed presoaking before sowing in gibberellin (GA3) 50, 100 and 150 mg L^{-1} concentrations in addition to seed presoaking in tap water as control treatment and two imported horse bean varieties included Aguadulge (Italy) and French (France) variety.

Result: Seed presoaking in two gibberellin concentrations 100 and 150 mg L^{-1} before sowing had a significant influence on plant growth and seed yield. Aguadulge variety exceeds significantly upon on French variety in most of seed yield and it is related. 100 mg L^{-1} gibberellin × French variety and 150 mg L^{-1} gibberellin × Aguadulge variety gave the highest seed yield and its components. The findings hint that seed presoaking technique before sowing in gibberellin was useful to enhancement agronomical indices of horse bean varieties, so it could be suggests that increasing gibberellin concentration up to100 mg L^{-1} for French variety and up to150 mg L^{-1} for Aguadulge variety increase the horse bean seed yield and its components.

Key words: Gibberellin growth regulator, Seed presoaking technique, *Vicia faba* L. varieties.

INTRODUCTION

Vicia faba L. equina belong to medium size seeds group, which called Horse bean. It is considers one of the main pulse crops that are widely and mainly used pods, fresh and dry seeds in cooking, especially by a large section of poor people as a source of expensive animal protein compensation. The seeds are rich in protein (23 to 42%), fat, fibers, minerals and vitamins (AL-Bayaty and AL-Dawdi, 2009; Asadova, 2019 and Mohamed *et al*., 2020).

Seed presoaking (in growth regulators, fertilizers, amino acids, vitamins, salts… *etc*.) for a certain period before sowing is a presowing strategic technique for impacting seedling development with amendment pregermination metabolic previous activity to radicle emergence, enhances seedling emergence and performance of the plant to giving high vigor and best yield. In general there are three common seed presoaking techniques include hydro, halo and osmo presoaking (Singh *et al*., 2018 and Diya *et al*., 2024). Plant hormones play a vital role in seed germination through its role construction and destruction process during seed germination through effectiveness the enzymatic system (Abood, 2019). Gibberellin (Gibberellic acid-GA3) growth regulators hormone widely use as seed germination and plant growth stimulating through its role in seed germination speed and the seedling growth speed in addition to its function in stimulating cells division and expansion, increasing in radicle and coleoptile length and growth which reflected on increase in crop growth and yield (Al-Obaidi, 2021).

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Experiments have proven amply that improved varieties alone could contribute fifty percent more yield, but local varieties of horse bean are unavailability of high yielding varieties and do not possess high yield potential and low response to irrigation, fertilizers and other improved production technologies (Majumar, 2011). So it is necessary to enhance efficient agronomic management with right choice of highly production variety and best adequate to environmental conditions of area import modern varieties with high productivity, where the horse bean varieties varied in their agronomical indices because the variation in genetic type, environmental conditions and interaction between them. Increasing horse bean seed yield can be obtains by selection or imported high yielding varieties (Alwan *et al*., 2019; ALAzzi and AL-Obaidy, 2019; Debnath *et al*., 2024).

There is limited information available about study on seed presoaking in seeds germination stimuli by farmers.

Hence, the existing study undertaken to estimate the variation rates of agronomic indices of horse bean based on seed presoaking technique treatments in gibberellin, potential of imported varieties and their interaction impact on improving growth and productivity of horse bean crop to select best imported variety that suits to environmental conditions.

Materials and Methods

The field experiment carried out during 2018-2019 winter sowing season under supplementary irrigation in the agricultural researches and experiments station, College of Agriculture, University of Kirkuk, Kirkuk Governorate, Iraq. Which is located between 35°23′34.43°N and 44°20′ 27.12°E with an altitude of 331 m. The study included two factors, the first was horse bean seeds presoaking in gibberllic acid (GA3) Chinese origin with three concentrations (50, 100 and 150 mg L^{-1}) for eight hours, in addition to control treatment which include seeds presoaking in tap water only for six hours. Then the seeds left for air-drying at room temperature until sowing time. In addition, the second factors included two imported commercial horse bean varieties, Aguadulge variety (imported from Italy) and French variety (imported from France). The seeds of both varieties belong to a medium-sized seeds group (Equina group). The experiment designed with Randomized Complete Block with three replications. The horse bean seeds on December 6 sowed in rows on 40 cm distance between each 2 rows and 25 cm distance between each 2 pits within rows on 5 cm soil depth. Left 100 cm distance between each 2 blocks and 50 cm between each 2 plots within blocks, each plot contained five rows and putted three seeds in each pit on rows then thinned in to one seedling in each pit after month from sowing time. The experiment field fertilized with urea fertilizer (46% N) in quantity 100 kg N ha^{-1} in two equal payments at sowing time and 40 days after sowing time, also triple superphosphate (46% P_2O_5) fertilizer has been add in quantity 120 kg P_2O_5 ha^{-1} in one payment at soil preparing and smoothing stage. Weed control performed manually several times during the crop growth season. Crop plants harvested manually on May 15 to take the measurement on yield components and seed yield.

At full plants maturity (BBCH: 89 stages) in accordance with BBCH growth scale (Meier 2001) ten plants selected randomly from the three inner plant rows for each plot to assessment the following agronomical indices: Plant height (cm), plant primary offshoots number, plant pods number, pod seeds number, plant seeds number, pod seeds weight (g). Single-seed weight (g) which estimated dividing plan seed weight by plant seeds number, seed index (100 seeds were randomly selected and weighed by a sensitive electronic digital scale with gram measuring unit), plant seeds weight (g). Seed yield. ha^{-1} (Mg) estimated from the harvesting three inner rows of each plot and then adjusted to seed yield with Mega gram measuring unit per hectare.

The statistical analysis done for all studied indices according to a factorial experiments design with R.C.B.D. by using analysis of variance and the significant differences between treatments means were done by using Duncan multiple range test (DMRT) with a 0.05 significant level.

Results and Discussion

Seed presoaking in gibberellin

Data in Table 2 shows that horse bean seeds presoaking in gibberellins concentrations before sowing had a significant impact on increase plant offshoots number (4.3) and plant pods number (7.5) at 150 mg L^{-1} concentration compared to seeds presoaking in tap water. Also the highest plant seeds number (25.6), plant seeds weight (29.8 g) and seed yield (2.49 mg ha^{-1}) was recorded at 150 mg L^{-1} concentration which did not differed significantly than 100 mg L^{-1} concentration. The results about plant offshoots number may be due to role of gibberellin growth regulator in increasing of roots formation inducing, roots length, number and thickness, which reflected on increase in plant offshoots number by taking enough water and nutrients by plants. Gibberellin growth regulator has a role in breaking the apical sovereignty, increasing photosynthesis, thus provides substances needed to build new tissues and increasing in vegetative growth and then increase plant offshoots number as mentioned by Raheed (2018). Seed presoaking in gibberellin was the major factor accountable for biggest part (47.1%) of the total plant offshoots number compared with variety (1.7%) and interaction (10.1%) impact (Table 3). These results in harmony with Abdel-Aziz (2018) and Fadhil and Almasoody (2019) results. Plant pods number increased significantly, when seeds presoaked in gibberellin solution before sowing as a result in role of gibberellin in an increasing plant offshoots number and its role as a growth regulator in flowering and fruit setting by reduce flowers and pods abscission percent (Al-Bayaty, 2018) thus increase of pod formation. The findings are in agreement with Fouda (2017), Zalama and Leilah (2019) findings.

Plant seeds number increased significantly for plants developed from presoaked seeds in high concentrations of gibberellin depending on the plant pods number indices, moreover the seeds presoaking factor explained (39%) of the total variability of studied indices which is had the main effect compared with variety (8.8%) and interaction (30%) effect. From our study results for seeds presoaking in gibberellin factor, it was could be stated that gibberellin concentrations had a more significant impact on number of offshoots, pods and seeds per plant than weight of pod seeds, single-seed and seed index (Table 1 and 2). The increments in plant seeds number under impact of seeds presoaking in gibberellin treatments are similar to those obtained by Ali (2019) and Emam and semida (2020).

Plant seeds weight increased when seeds presoaked in gibberellin solution before sowing especially concentrations 100 and 150 mgL^{-1} compared to concentration 50 mgL^{-1} and seeds presoaked in tap water. This happened because of responsibility of high concentrations of gibberellin in

increasing plant pods number and plant seeds number (Table 2). Seeds presoaking in gibberellin factor had a main effect on plant seeds weight and explained (35.5%) of total variability compared to 23% for variety and 31.7% for interaction for this indice (Table 1). Sharief and El-hamady (2017) and Zalama and Leilah (2019) they reported similar results.

High horse bean seed yield obtained from high gibberellin concentration used for seeds presoaked before sowing. The seeds presoaking in gibberellin before sowing factor significantly explained high percentage (36.4%) of the total sum of squares compared to (22.7%) for variety and (27.3%) for interaction and seed yield indice consider third indice after plant offshoots number and plant seeds number more affected by seed presoaking in gibberellin before sowing (Table 1). The findings are similar to Zalama and Leilah (2019) and Saleh and Saleh (2020) findings.

Variety

The two varieties revealed significant different performance (Table 3), Aguadulge variety was the best performance under Kirkuk environmental conditions compared to French variety and significantly excellence in all significant indices with highest value for pod seeds number (3.7), plant seeds number (24.9), pod seeds weight (4.3g), seed index (122.5 g), plant seeds weight (29.2g) and seed yield (2.43 mg ha^{-1}). The two seed yield components pod seeds number and seed index revealed a high impact on plant seeds number, pod seeds weight and plant seeds weight which was the reason for Aguadulge variety superiority and an increasing in seed yield per unit area (Table 3). Significant variation among horse bean varieties for yield and its components also stated by Janusauskaite and Razbadauskiene (2021), Papastylianou *et al*. (2021), Abed *et al*. (2021), Abbas *et al*. (2022), Abo-Hegazy and Badawy (2022), Al-Azee *et al*. (2023), Raheem *et al*. (2024) and Thamaraiselvi *et al* (2024).

Seed presoaking in gibberellin and variety Interaction

The impact of seeds presoaking × variety interaction were significant for all studied indices except plant offshoots number and pod seeds number (Table 4). Seed presoaking by variety interaction (50 mgL^{-1}× Aguadulge, 150 mgL^{-1} × French, 0 and 100 mgL^{-1} × French) showed highest means in plant height (53.4, 53.0 and 52.5 cm) respectively, the interaction impact on this indice mainly responsible for

Table 1: Contribution of sum of squares (%) of seed presoaking in gibberellins, variety and their interaction to total variance in agronomical indices of horse bean and significance.

Indices	Seed presoaking (A)	Variety (B)	A × B	Total	C.V.%
Plant height (cm)	8.9ns	1.0ns	47.3**	57.2	4.7
Plant offshoots number	47.1**	1.7ns	10.1ns	58.9	9.2
Plant pods number	19.7*	2.8ns	53.3**	75.8	6.8
Pod seeds number	14.5ns	13.7 *	15.8ns	44	10.8
Plant seeds number	39.1**	8.8*	30.0**	77.9	5.4
Pod seeds weight (g)	10.7ns	17.9*	47.9**	76.5	11.7
Single-seed weight (g)	2.5ns	7.5ns	46.2*	56.2	10.6
Seed index (g)	2.0ns	9.4**	81.3**	92.7	2.9
Plant seeds weight (g)	35.5**	23.0**	31.7**	90.2	4.4
Seed yield (mg ha^{-1})	36.4**	22.7**	27.3**	86.4	5.8

ns: No significant, *: Significant at P. 0.05 and **: Significant at P. 0.01 according to analysis of variance (F-test).
The values represent % variation estimate (Seed presoaking, Variety and their interaction) of sum of squares to total variance sum of squares.

Table 2: Effect of seed presoaking in gibberellins on horse bean agronomical indices.

Indices	Gibberellins concentrations (mg L^{-1})			
	0	50	100	150
Plant height (cm)	50.0a	50.3a	51.7a	52.2a
Plant offshoots number	3.5b	3.9a	4.2a	4.3a
Plant pods number	6.6b	6.8ab	7.1ab	7.5a
Pod seeds number	3.3a	3.5a	3.6a	3.8a
Plant seeds number	22.6b	23.2b	25.5a	25.6a
Pod seeds weight (g)	3.7a	4.0a	4.0a	4.4a
Single-seed weight (g)	1.13a	1.14a	1.15a	1.19a
Seed index (g)	117.5a	118.7a	119.7a	121.5a
Plant seeds weight (g)	25.2b	26.3b	29.2a	29.8a
Seed yield (mg ha^{-1})	2.05b	2.19b	2.43a	2.49a

The values follow by the similar letters in each row do not differs significantly in accordance with Duncan's test at 0.05 probability.

47.3% of the total variability (Table 1). The interaction of 150 mgL^{-1} × Aguadulge had the highest mean of plant pods number (8.1) and was more indice affected by interaction between two studied factors (53.3%) than seed presoaking factor (19.7%) and variety factor (2.8%) from total variability (Table 1). The findings are in agreement with Fadhil and Almasoody (2019) and Emam and Semida (2020) findings. Furthermore, interaction of 150 mgL^{-1} × Aguadulge, 100 mgL^{-1} × French and 50 mgL^{-1} × Aguadulge recorded highest mean in plant seeds number (26.8, 26.3 and 25.5) respectively and interaction of 150 mgL^{-1} × Aguadulge had a highest mean in pod seeds weight (5.1 g). Moreover, interaction of seeds presoaking by variety responsible of (47.9%) of total variability compared to seeds presoaking factor alone (10.7%) and variety factor alone (17.9%) as shown in (Table 1) for pod seeds weight. This is because of the function of gibberellin in improving photosynthesis process because of its role in improving plants vegetative growth, increasing its products and transfers from leaves to seeds and thus increasing pod seeds weight. This results in line with those reported by Al-Obaidi *et al*. (2021).

Single-seed weight only significantly affected by interaction between two studied factors which accounted for (46.2%) of the total variability compared to (2.5%) for seeds presoaking factor alone and (7.5%) for variety factor alone (Table 1). 150 mgL^{-1} × Aguadulge interaction recorded a highest mean (1.30 g) (Table 4). The reason of this result attributed to role of interaction effect between gibberellin and genetic makeup of Aguadulge variety in increase pod seeds weight, which reflected on increasing single-seed weight in the end. The results agreed with those of Rashed (2018) and Ali (2019). The analysis of variance results in Table 1. confirmed that seed index highly depended on seeds presoaking × variety interaction, where the interaction had a main impact to determining the differences among the treatments (81.3%) versus to (2.0%) for seeds

Table 3: Effect of varieties on horse bean agronomical indices.

Indices	Varieties	
	Aguadulge	French
Plant height (cm)	50.7a	51.4a
Plant offshoots number	3.9a	4.0a
Plant pods number	6.9a	7.1a
Pod seeds number	3.7a	3.3b
Plant seeds number	24.9a	23.6b
Pod seeds weight (g)	4.3a	3.7b
Single-seed weight (g)	1.19a	1.11a
Seed index (g)	122.5a	116.2b
Plant seeds weight (g)	29.2a	26.1b
Seed yield (mg ha^{-1})	2.43a	2.15b

The values represent % variation estimate (seed presoaking, variety and their interaction) of sum of squares to total variance sum of squares. The values followed by the same letters in each row do not differ significantly according to Duncan's test at 0.05 probability.

Table 4: Effect of interaction between seed presoaking in gibberellins and varieties on horse bean agronomical indices.

Gibberellins concentrations (mg L^{-1})	0		50		100		150	
Varieties indices	Aguadulge	French	Aguadulge	French	Aguadulge	French	Aguadulge	French
Plant height (cm)	47.2b	52.5a	53.4a	47.4b	50.8ab	52.5a	51.3ab	53.0a
Plant offshoots number	3.4a	3.5a	4.0a	3.8a	4.1a	4.2a	4.0a	4.5a
Plant pods number	6.7cd	6.4d	6.3d	7.5abc	6.3d	7.7ab	8.1a	6.9bcd
Pod seeds number	3.5a	3.0a	3.3a	3.6a	3.8a	3.3a	4.0a	3.5a
Plant seeds number	22.4bc	22.7bc	25.5a	20.9c	24.7ab	26.3a	26.8a	24.4ab
Pod seeds weight (g)	4.5ab	3.1c	3.4c	4.6ab	4.5ab	3.6bc	5.1a	3.7bc
Single-seed weight (g)	1.26ab	1.00c	1.16a-c	1.11a-c	1.03bc	1.26ab	1.30a	1.07abc
Seed index (g)	121.5b	113.5c	106.5d	130.9a	129.4a	109.9d	132.5a	110.5cd
Plant seeds weight (g)	27.8c	22.6d	29.3bc	23.3d	27.6c	30.8ab	32.0a	27.6c
Seed yield (mg ha^{-1})	2.32b	1.78c	2.44ab	1.94c	2.30b	2.56a	2.67a	2.30b

The values followed by the same letters in each row do not vary significantly according to Duncan's test at 0.05 probability.

presoaking factor and (9.4%) for variety factor. The data in Table (4) shows that 150 mgL^{-1} × Aguadulge, 50 mgL^{-1} × French and 100 mgL^{-1} × Aguadulge interactions had a highest means in seed index (132.5, 130.9 and 129.4 g) respectively. The superior interactions of this indice had a role in increasing pod seeds weight and single-seed weight, which lead to its superior in seed index. Similar results reported by Saber (2016), Fadhil and Almasoody (2019) and Emam and Semida (2020).

Seeds presoaking × variety interaction significantly affected of the plant seeds weight (Table 4), 150 mgL^{-1} × Aguadulge interactions recorded a highest mean (32.0g). The interaction was responsible of (31.7%) of total variability for plant seeds weight indice, versus to (35.5%) for seeds presoaking factor and (23.0%) for variety factor (Table 1). The plant seeds weight increased to increase plant pods number and single-seed weight for same interaction. The results are in agree with Fadhil and Almasoody (2019) and Emam and Semida (2020) results. The interaction of seeds presoaking and variety data in Table 4 demonstrate that the highest mean of seed yield indice was recorded for 150 mgL^{-1} × Aguadulge and 100 mgL^{-1} × French interactions (2.67 and 2.56 Mg ha^{-1}) respectively. Interaction contribution for seed yield indice was (27.3%) than seeds presoaking (36.4%) and variety (22.7%) of the total variability (Table 3). The seed yield increased to increase plant seeds weight for superior interaction. Similar findings stated by Saber (2016), Fadhil and Almasoody (2019) and Emam and Semida (2020).

Conclusion

The obtained results showed that the Aguadulge variety superior over French variety in all studied indices and horse bean seeds pre-soaking in gibberellin before sowing was beneficial to the seed yield and its components. Depending on the results of our study, it could conclude that choosing the Aguadulge horse bean variety for sowing with seeds presoaking before sowing in gibberellin growth regulators at the concentration 150 mg L^{-1} or sowing French variety with seeds presoaking before sowing in gibberellin growth regulators at the concentration 100 mg L^{-1}. To give it the highest seed yield significantly and preferably recommended for its superiority and appropriate response to such environmental conditions. In addition, our study confirms the greatest influence of the interaction in horse bean studied indices compared to the influence of the seeds pre-soaking in gibberellin factor alone or the variety factor alone according to analysis of variance and means comparison. This confirms the impact of genetic-environmental interaction on the studied horse bean indices.

Conflict of interest

All authors declare that they have no conflicts of interest.

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