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FLORAL CHARACTERISTICS OF MUNG BEAN (*VIGNA RADIATA* L.) AS AFFECTED BY PLANTING DATES AND BRASSINOLIDE SPRAYING

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Abstract

A field experiment was carried out in the experiments field, Department of Field Crops, College of Agriculture Engineering Science, University of Baghdad, during the autumn season 2017. In order to study the effect of temperature on the floral characteristics of *Vigna radiata* L. by planting it at different dates and reducing the flowers shedding with Brassinolide spraying. The experiment was implemented according to Randomized Complete Block Design in split plot arrangements with three replicates, the main plots included the planting treatments at different dates, which were 15 and 31 July and 15 August, while the sub plots included four spray concentrations of the growth regulator Brassinolide, are 0, 1, 2 and 3 $mg.L^{-1}$. The results showed that the planting date (15 July) was superior significantly through recording the highest average of fertility percentage, No. of racemes, No. of flowers and the least number of days until 100% flowering of plants, as well as the lowest shedding percentage. The Brassinolide contributed significantly improved the floral characteristics and the concentration of 1 $mg.L^{-1}$ gave the highest average No. of racemes amounted to 31.37 $raceme.plant^{-1}$, the number of flowers 109.10 flower/plant, and the fertility percentage was 60.93% compared to control treatment. Therefore, the recommendation was to plant *Vigna radiata* L. in mid-July and spraying by 1 $mg.L^{-1}$ of Brassinolide to increase the fertility percentage and reduce the flowers shedding.

Key words : Planting date, Brassinolide, the flowers shedding, *Vigna radiata* L.

Introduction

Vigna radiata L. is a legume crop characterized by a short growing season, planted for the purpose of obtaining seeds of high nutritional value for humans and animals, where the protein percentage in its seeds is 24-26% and carbohydrates 65%, as well as it is used as a green feed and a green fertilizer for soil property improvement (Chadha, 2010). The setting of appropriate planting dates considered as one of the most important growth inputs in managing crop production programs to exploit the inherent genetic potential of each cultivar in every region of the world, especially in Iraq's environment. Planting at the appropriate time has a clear impact at the different stages of plant growth, its development and the improvement of the yield components in order to increase the crop efficiency in exploiting the available climatic conditions during the season such as temperature, relative humidity, intensity, duration of lighting, etc., which are reflected positively on the yield average increasing, according to the objective of crop planting and its growth season (Al- Muini and Al-obeidi, 2018). When the temperatures raised above 40°C during the flowering stage, its caused a flowers shedding by more than 60% due to its effect on the reproductive organs of the flower, which is already reflected in the yield (Khattak *et al.,* 2009). shedding flowers and pods is an active physiological process occurring after flowering in most plants. It is considered as a major problem and economically influential in the legume family plants, as a large number of unfertilized flowers shedding from inflorescence, and the fertilized flowers may also shedding during the growth season, causing great losses in the economic yield (Patrick and Stoddard, 2010). Brassino-steroids (BRs) are the sixth group of phytohormones that has the potential to stimulate growth due to its effect on many physiological processes within the plant.

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Especially when its added in appropriate concentration and at suitable growth stage, where it increase the enzymatic activity and has a role in the evolutionary processes of reproductive plant organs such as the emergence of flowers, flowering, shedding reduction, growth of the pollen tube, the fruit set and its ripening (Shamul and Ahmed, 2003; Bajgus and Shamsul, 2009). The role of Brassinolide is to increase the proportion of gibberellins that have a role in the flowering process through its association with Anthesin and the production of the flowering hormone Florigen, which has a role in inducing the flowering (Matusmoto *et al.*, 2016). Therefore, this study was carried out in order to investigate the effect of temperature on the floral characteristics of the *Vigna radiata* L. by planting it at different dates and reducing the flowers shedding with Brassinolide spraying.

Materials and Methods

A field experiment was carried out in the experiment farm, Department of Field Crops, College of Agriculture Engineering Science, University of Baghdad, Jadiriya, during the autumn season 2017 in a soil, silt clay that have the physical and chemical properties as listed in Table 1. In order to understand the effect of temperature on the floral characteristics of the *Vigna radiata* L. by planting it at different dates and reducing the flowers shedding with brassinolide spraying. A split plot arrangements were carried out according to RCBD design with three replicates, where the main plots contained three planting dates (15 and 31 July and 15 August). While the sub plots contained four spray concentrations of the growth regulator Brassinolide, are 0, 1, 2 and 3 mg.L^{-1}, and sprayed twice, the first one was at the vegetative growth stage (2 to 4 leaves), and the second at the beginning of flowering. Soil managements were carried out from plowing, harrowing and leveling, and then the experiment land was divided into experimental units, with an area of 4m^2 (2mx2m), which contained 5 lines. The distance between them 40 cm and the distance between one plant and another 30 cm, the plant density becomes 83333 plant.h^{-1}, then the experiment was fertilized according to the recommended (Ministry of Agriculture, 2011). Spraying the growth regulator Brassinolide was carried out according to the used concentrations for each one, using a 20 liter knapsack sprayer and by adding a0.15 ml.L^{-1} of dishwashing liquid as a diffuser material to reduce the surface tension of the water, and to ensure the complete wetness of the leaves, which increases the efficiency of the spray solution in penetrating the outside surface of the leaf. Moreover, the following characteristics were investigated as follows : the number of days from planting till 100% flowering of plants, the number. of racemes in plant (raceme.plant^{-1}), the number of flowers in plant (flower/plant), fertility percentage %, and the shedding percentage %. Finally, the data were analyzed according to the statistical program Genstat, and the least significant difference was used at the level of 5% to compare between the treatment averages (Steel and Torrie, 1960).

Table 1: Some chemical and physical characteristics of the study soil for the autumn season 2017.

Characteristic		The autumn season
Soil separators Mg. Kg^{-1} soil	Sand	21.8
	Clay	30.6
	Silt	47.6
Soil texture		Silty clay soil
Degree of soil reaction PH		7.53
E.C.ds.m^{-1}		2.6
N ppm		84.0
P ppm		22.5
K ppm		551
g.kg^{-1} O.M		0.9

Results and Discussion

Number of days from planting to 100% flowering (days)

The results of table 2 showed that there was a significant difference between planting dates and concentrations of Brassinolide spray, and their interaction in the number of days of planting until 100% flowering of mung bean, the first date plants (July 15), gave the minimum number of days to reach 100% of flowering by 47.0 days compared to the plants of the third date (15 August). The variation in the number of days to reach this stage comes from the effect of temperature difference at different dates either by the slow or rapid current vital activities in the plant. Where the increase of temperatures at the date 15th July as shown in Appendix 1, lead to a short duration to reach of 100% plants flowering because of the effect of increasing the speed of all the vital activities that take place inside the plant, which induced it to accelerate the process of being flowering. This was consistent with the results of (Mir *et al.*, 2009 ;Madhu 2013). As for the concentrations of Brassinolide spray in this characteristic, the first concentration plants 1 mg.L^{-1} gave the lowest number of days to reach 100% flowering amounted to 47.3 days, which did not differ significantly from the treatment of the second concentration 2 mg.L^{-1} which gave 48.6 days. This was due to the role of the Brassinolide in stimulating the flowering and the transition of plant from vegetative phase to reproductive phase, as well as its role in regulating flowering time by interaction with the gibberellin hormone (Domagalska *et al.,* 2010).

Number of racemes (raceme.plant^{-1})

Table 2 indicates that there were a significant difference between the dates of planting and Brassinolide spray treatments and the interaction between them in Number of racemes in the plant. the Number of racemes at plant increased in the first date compared to the third date, as the first date gave the highest No. of racemes, which reached to 32.32 raceme.plant^{-1}, while the third date gave the lowest No. of racemes which reached 25.95 raceme.plant^{-1}. The reason for the decreasing in the No. of racemes was due to the decrease in the total number of branches, when the date of planting delays. As for Brassinolide spraying treatments, the first concentration was superior in giving the highest No. of racemes reached to 31.37 raceme.plant^{-1}, while the third concentration gave the lowest No. of racemes reached to 27.34 raceme.plant^{-1}. This was due to the role of Brassinolide (in the few concentrations used) as an encouraging regulator for growth and photosynthesis, as its addition has increased the efficiency of this process, while in the higher concentrations act as a growth inhibitor.

Number of flowers (flower.plant^{-1})

Table 2 data indicate that there was a significant effect of planting dates and Brassinolide spraying treatment and the their interaction in the number of flowers in the plant. The plants of the first date produced the highest number of flowers, which reached to 112.71 flower.plant^{-1}. Moreover, the number of flowers decreased in the third date, reaching to 99.28 flower.plant^{-1}, this decreasing may be due to the unfavorable temperature effect (Appendix1), where the temperature appropriate for reproductive growth is 27-32°C (Tzudir *et al.,* 2014), which delays the appearance of flowers. The first concentration 1 mg.L^{-1} gave the highest average of 109.10 flower.plant^{-1} while the third concentration 3 mg.L^{-1} gave the lowest average was 105.14 flower.plant^{-1}. The increase in the number of flowers may be due to the fact that the plants of the first concentration treatment exceed 1 mg.L^{-1}in the No. of racemes that contributed positively to increasing the flowers number, due to the physiological role of the Brassinolide in the evolutionary processes of the plant's reproductive organs such as the emergence of flowers, flowering, reduce its shedding, the growth of the pollen tube, the fruit set and its ripening (Shamul and Ahmed 2003 ; Khafaji, 2014), which was

Table 2: Effect of planting dates and spraying with Brassinolide concentrations and their interaction on the floral characteristics of autumn season 2017.

Number of days from planting to 1 flowering of plants (day)					No. of racemes (raceme.plant^{-1})				
BRs Concen-trations	Planting date			Average	BRs Concen-trations	Planting date			Average
	15 July	31July	15 August			15 July	31July	15 August	
0	47.7	51.0	59.3	52.7	0	31.77	30.60	23.94	28.77
1	43.3	47.0	51.7	47.3	1	34.73	32.53	26.85	31.37
2	46.3	49.3	50.0	48.6	2	33.15	31.36	28.15	30.89
3	50.7	52.7	55.3	52.9	3	29.63	27.53	24.85	27.34
L.S.D $_{0.05}$	2.84			1.82	L.S.D $_{0.05}$	1.127			0.683
Average	47.0	50.0	54.1		Average	32.32	30.51	25.95	
L.S.D $_{0.05}$	1.10				L.S.D $_{0.05}$	1.002			
Number of flowers (flower.plant^{-1})					**Fertility percentage %**				
BRs Concen-trations	Planting date			Average	BRs Concen-trations	Planting date			Average
	15 July	31July	15 August			15 July	31July	15 August	
0	112.37	108.26	97.74	106.79	0	62.12	61.64	53.14	58.97
1	115.15	111.69	100.46	109.10	1	64.72	63.71	54.36	60.93
2	114.19	110.66	100.86	108.57	2	63.41	63.64	55.35	60.80
3	109.13	105.24	98.04	105.14	3	61.54	61.04	53.82	58.80
L.S.D $_{0.05}$	1.627			0.905	L.S.D $_{0.05}$	0.844			0.514
Average	112.71	108.96	99.28		Average	62.94	62.51	54.17	
L.S.D $_{0.05}$	1.209				L.S.D $_{0.05}$	0.486			

***** Table 2 results indicated that there were a significant effect for studied treatments and their interactions.

Table 3: Effect of planting dates and spraying with Brassinolide concentrations and their interaction on the shedding percentage (%) of autumn season 2017.

Shedding percentage (%)				
BRs concen-trations	Planting date			Average
	15 July	31July	15 August	
0	37.91	38.42	46.90	41.07
1	35.30	36.31	45.62	39.07
2	36.62	36.40	44.73	39.25
3	38.50	39.02	46.21	41.24
$L.S.D_{0.05}$	2.010			1.182
Average	37.08	37.53	45.86	
$L.S.D_{0.05}$	1.321			

consistent with the results of (Matwa 2017). With regard to the effect of the interaction, the number of flowers during spraying by the first and second concentration 1 and 2 mg.L^{-1} increased on the first date of 15 July, where the averages reached to 115.15 flower.plant^{-1}, while the treatment of non-addition 0 mg.L^{-1} when planting by the third date 15 August for autumn season 2017 has achieved the lowest average 97.74 flower.plant^{-1}.

Fertility percentage (%)

The first date plants exceeded by giving the highest fertility percentage, which reached to 62.94%, while the lowest fertility percentage was recorded on the third date with an average of 54.17%. This was due to the different environmental conditions between the dates, where the suitability of temperatures (Appendix 1) has increased the efficiency of the carbonic representation and produced as much nutrient as possible, thus feeding emerging flowers, reducing their abortions and then increasing the fertility percentage. There was also a significant differences was observed between Brassinolide spraying transactions in the fertility percentage, where the first concentration spraying treatment plants achieved the highest fertility percentage of 60.93%, while the plants in comparison treatment by spraying with water only gave an average of 58.97%. The reason was that the growth regulator Brassinolide is very important for plants, especially in the stages of reproductive growth, as it is necessary for the growth of pollen tube for pollen grains and increases the plant's chances of producing flowers and fruits (Sharma, 2011). In addition to the role of Brassinolide in improving the growth and development of reproductive tissues through its work as a stabilizer for the pollen tube. Thus increasing the number of active pollen grains and increasing of the number of the produced pods (Vogler *et al.*, 2014). As for the interaction, the plants of the first concentration spraying treatment 1 mg.L^{-1} when planted in the first date, 15 July, achieved the highest fertility percentage, which reached to 64.72%, while the comparison treatment plants during the third date gave the lowest fertility percentage of 53.14%, respectively.

Shedding percentage (%)

Table 3 results indicate that there were a significant difference between the planting dates and the Brassinolide concentrations and the interaction between them in the shedding percentage. As the first date 15 was given the lowest rate of this characteristic 37.08%, which did not differ significantly with the second date, while the third date of August 15 achieved the highest rate of this characteristic reaching to 45.86%. The suitability of temperatures may reduce shedding percentage by increasing the number of branches and leaf area and thus increasing water absorption and necessary elements, especially phosphorus, which is the fertility element of the flowering phase, that considered as the most sensitive stages for heat, resulting in An optimal exploitation of growth factors pushed towards the increase in the manufacture of materials, which provided more favorable conditions and this reflected on the reduction of competition between the pods and thus reduce their shedding. The results of the Table 3 also showed that there was a significant difference between the concentrations of Brassinolide spray in the flowers shedding percentage, where the spray concentration 1 mg.L^{-1} gave the lowest flowers shedding percentage amounted 39.07%, while the concentration of 0 mg.L^{-1} gave the highest shedding percentage of 41.2%. This was due to the role of Brassinolide in stimulating the production of Auxins, cytokines and gibberellins, this reduces inhibitors such as ethylene and ABA, this leads to the success of a set and reduced the flower shedding (Bogerand and Beemster, 2008). Nutrient availability also reduces competition among the leaf sinks, resulting in a reduction in shedding percentage. The Brassinolide is also counterproductive to the accumulation of abscisic acid and also stimulates the production of enzymatic antioxidants and the protection of plastids from the effect of oxidized free radicals as well as its role in inhibiting the ethylene leading to plant aging and in increasing the ratio of carbohydrates to nitrogen, where it plays a role in accelerating the process of flowering (Renu *et al.*, 2014). Brassinolide also plays a role in accelerating the flowering process by inducing flowering of flower buds where it has a role in the associate with amino acids, increasing the absorption of metal elements, and thus reducing competition between formed flowers and reducing their shedding (Ross and Quittenden, 2016).

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Appendix 1: Maximum, minimum and average temperatures (°C) for the season 2017.

The Month	Temperatures		
	Minimum	Maximum	Average
July			
15-19	27.39	46.89	37.14
20-24	27.25	46.16	36.71
25-31	26.31	44.96	35.64
August			
1-5	27.45	47.39	37.42
6-10	26.36	47.43	36.90
11-15	27.53	46.12	36.83
16-20	27.43	45.30	36.36
21-25	25.40	43.42	34.41
26-31	24.31	45.47	34.89
September			
1-5	23.77	44.45	34.11
6-10	22.51	42.36	32.44
11-15	20.87	43.15	32.01
16-20	21.93	44.63	33.28
21-25	23.27	39.42	31.35
26-30	20.67	38.67	29.67
October			
1-5	17.23	33.84	25.54
6-10	15.88	34.69	25.29
11-15	14.99	31.91	23.45
16-20	12.32	30.33	21.32
21-25	15.02	32.80	23.91
26-31	18.07	31.84	24.96
November			
1-5	14.92	28.18	21.55
6-10	16.11	29.96	23.04
11-13	8.54	24.74	16.64