

Growth and yield characteristics of bread wheat varieties as a result of spraying with colchicine alkaloid

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Abstract

This study was conducted in the Field Crops Research Station at the College of Agriculture - University of Diyala, during winter season 2020-2021. The experiment included two factors, the first is the varieties (Gad, Thuraya, Adana, and Ibaa-99), and the second factor is spraying with colchicine mutagen (without spraying, the first spray and second spray), the aim of this research was to study the effect of genotypes and spraying with colchicine mutagen on growth and yield components characteristics of wheat plants. The experiment was applied using Randomized Complete Block Design in factorial experiment arrangement with three replicates. The results showed that varieties had a significant impact on the traits where Ibaa-99 cultivar recorded the highest rate of plant height (90.73 cm) and the flag leaf area of the Gad cultivar reached the highest rate (35.48 cm), whereas Thuraya cultivar gave the highest rate of grain / spike reached (61.93 grains/spike). The results of the experiment showed the superiority of spraying with colchicine alkaloid at a rate of two sprays significantly for the traits of plant height (84.87 cm), flag leaf area (31.27 cm), number of spikes in the middle lines (162.6 spikes) and weight of 1000 seeds (42.94 g. (

Introduction

Wheat is considered one of the oldest crops that humans have cultivated and improved for thousands of years until the present day (29), as it ranks second in global grain production after corn, and first in terms of cultivated areas in the world, and the global harvested area has reached In 2018, about 215.33 million hectares, with a production of about 730.55 million tons. The European Union, China, India, Russia, the United States of America, Canada and Australia are among the countries that produce it the most (28.(

Due to its nutritional importance, wheat is at the forefront of strategic crops, and the most important crop for food security at the global level. It constitutes a food source for more than 35% of the world's population and provides about 20% of the protein and calories that humans consume (15;27) and wheat

grains are used as a raw material in many food industries such as bread, pastries, biscuits, pasta, and semolina, and the straw resulting from the wheat crop can be used as animal feed. Due to the significant increase in population, there is a need to increase global production by 1.6% annually to cover the increasing needs for this crop (20;5), there has been demands to search for new ways to increase its production and productivity by using new genetic sources in genetic improvement programs for wheat on the one hand, and applying scientific research methods in its cultivation and production programs on the other hand (16.(

Ali and others (3) pointed out that the phenotypic behavior of the genotype does not have to be the same under different environmental and agricultural conditions. Some genotypes may show good performance

under certain environmental conditions, while they do not respond or fail to perform under different environmental conditions. Therefore, a good genotype cannot show its characteristics unless it is provided with appropriate environmental conditions. Likewise, a weak genotype cannot give good characteristics in the best environments. Furthermore, appropriate environmental conditions must be available for a good genotype to give distinct characteristics, and this represents the genetic-environmental interaction. Therefore, the study of Genetic-environmental interaction (GXE) is very important in developing or evaluating crop varieties.

Hebert et al. (13) showed that producing and improving the wheat crop variety under different environments requires developing breeding programs based on evaluating the varieties in terms of their adaptation to the environment and their production capacity. Varieties evaluation is considered one of the important steps in plant breeding programs. Therefore, several standards have been developed for high productivity that serve as selection indicators, the most important of which are the number of grains per ear, the weight of grains per plant, and the number of stalks bearing the spikes

The results of the study by Hucl and Baker (17), which included 53 genotypes of spring wheat, showed that the genotypes varied in the number of spikes they produced per unit area, which ranged between 231 and 493 spikes m⁻², as well as in the number of branches m⁻², which ranged between 132 and 362 branches, and the percentage of branches death ranged between 31.3 and 48.8%. He also indicated that there are significant differences in this trait due to the influence of the genetic factor and with an average difference between the

varieties of 308 spike m⁻². The results of Amer (6) showed that there was a significant difference between the varieties in the number of spike grains, as the Ibaa-99 variety excelled, recording the highest average for this trait with an average of 38.38 grains, while the Adnaniya 3 variety recorded the lowest average for this trait with a rate of 44.64 grains.

The process of artificially inducing chromosomal duplication is one of the methods used for a long time to improve field and horticultural crops, which has become an interest for plant breeders because of its importance in developing and improving crop characteristics, such as large flowers, thick and dark green leaves, increasing the width of the leaf relative to its length, and prolonging the flowering period. Chromosomal duplication also leads to the production of sterile triploid plants, which is useful for ensuring that no seeds are produced and for prolonging the flowering life of the flowers. The colchicine alkaloid, which is extracted from the corms of the bark plant (*Colchicum autumnale* L.) and its chemical composition is C₂₂H₂₅NO₆, is the most widely used mutagen in this field, as it has the property of being effective against the activity of microtubules in the cell, which hinders the formation of the spindle apparatus during cell division, and that high concentrations of colchicine are associated with plant cell death due to the high toxic effect of the anti-cell division agent, which modifies the process of cell differentiation

In a study conducted by Barnabas and others (10) on three hybrid varieties of yellow corn, where concentrations of (0.02% and 0.03%) were used, they observed an increase in the level of fertility in plants sprayed with colchicine at a rate of 0.3% and an increase in

mitotic division with high efficiency compared with colchicine at a concentration of 0.02%.

Also, Essel and others (11) noted in a study of the effect of colchicine on the germination of cowpea seeds, at concentrations (0.05, 0.10, 0.15, and 0.20 g/dL), that the percentage of germination was high with a concentration of (0.05 g/dL), and significant differences were found for most of the quantitative traits, such as number of leaves, branches, and seeds for each plant. Additionally, Nura et al. (22) showed, using four concentrations of colchicine (0.1, 0.5, 1.5, and 2.0 ml) for two

varieties of sesame. that quantitative characteristics such as germination rate, height in maturity, number of leaves produced, leaf area, and number of The pods/plant, the number of seeds/pod, and the weight of 1000 seeds were decreased with increasing concentrations of colchicine. This study aimed at evaluating several genotypes in the characteristics of growth, yield, and to determine the most appropriate number of sprays suitable for the colchicine mutagen on wheat plants.

Materials

This experiment was carried out in the field of the Field Crops Department at the College of Agriculture / University of Diyala during the 2020-2021 growing season, to study the effect of genotypes and spraying with colchicine mutagen on the growth characteristics and yield of wheat plants. A factorial experiment arrangement was used in a randomized complete block design (RCBD) with three replications. The averages were compared using the Least Significant Difference (L.S.D.) test at a 0.05% probability level (9.)

The experiment included two factors: the first varieties {Gad, Thuraya, Adana , Ibaa 99} and the second was spraying with the colchicine mutagen {without spray, one spray and two spray} on the growth characteristics and yield of wheat plants, and the interaction between the two factors resulted in:- 4 varieties * 3 spray levels = 12 combination treatments, each treatment repeated 3 times, thus, the experiment consisted of 36 experimental units..

The land was irrigated by flooding, until its moisture content reached a certain degree that

and

Methods

would allow plowing. The land was plowed at the site of the College of Agriculture - University of Diyala using a rotary plow. After harrowing and leveling, the land was divided into three sectors, and each sector contained 12 treatments, the length of the experimental unit was 1m. The distance between planting lines is 0.20 m, between one treatment and another is 0.50 m, and between one plant and another is 5 cm. The area of the experimental unit is 1 m² and the number of plants in the experimental unit is 80. Nitrogen fertilization in the form of urea was added at a rate of 200 kg/h. in three batches according to the stages of growth, and the compound fertilizer NPK was added at a rate of 160 kg/h. before planting (7.)

The seeds were obtained from one of the agricultural Research offices in Iraq. Their germination was tested by placing the seeds in Petri dishes, adding a little water, and recording the number of germinating seeds. The germination rate was 90%. The seeds were planted on 12/19/2020, 16 grams of seeds were placed in one plot, which is equivalent to 40 kg/d at a depth of 3-4 cm. After placing the seed, a soft layer of soil was

applied, and the soil was irrigated afterward. Weeds growing with the crop throughout the vegetative growth period were manually removed, and the plants were harvested after reaching maturity..

The first spraying of the colchicine mutagen was on March 25th, and the second spray on April 3rd, at a rate of one spray and two sprays during the growing season. The foliar spray method was used at a concentration of 0.1 g/L. Experimental measurements of vegetative growth were conducted at the end of the growing season on ten plants taken randomly in each experimental unit and included:-:

Plant height (cm) -1

-2 Number of leaves/plant

- 3 Number of tillers / plant

)Length of spike (cm- 4

Flag leaf area (cm)- 5

- 6Number of grains per spike

) Weight of 1000 grain (g-.7

Results and Discussion

)Plant height (cm- 1

The results of Table (1) showed that there are significant differences between the genotypes in the average of plant height. The Ibba-99 variety gave the highest average of (90.73 cm), while the Gad variety gave the lowest

rate of this trait, amounting (70 cm). The difference in the plant height characteristic is associated with the differences in their genetic composition and the difference between them in the number of nodes and the length of the internodes, especially the upper internodes, which is one of the important characteristics in distinguishing the varieties, as well as the environmental conditions, especially the availability of water and soil fertility (15;25(Table (1) also showed that the effect of spraying with the mutagen material on the plant height trait was significant, as the treatment sprayed with the mutagen excelled at an average of two sprays, which amounted to (84.87 cm), compared to the unsprayed treatment, which gave the lowest average for this trait, as it reached (76.43 cm). The reason for this is due to the positive role of the mutagen through its direct effect in the metabolic and functional processes of the plant, which leads to an increase in cell division and cell elongation (23), and this is consistent with (26.(

As for the effect of interaction between varieties and spraying with colchicine on plant height in wheat, Table (1) shows that there are significant differences, where the Ibba-99 variety and the second spraying recorded the highest average of plant height of (95.10 cm), while the first treatment with the unsprayed treatment recorded the lowest average of (58.90 cm).(

Table (1) Effect of genotypes and spraying with colchicine on plant height (cm.)

Spray Varieties	Without spraying	The first spray	The second spray	Means
Gad	58.90	72.30	78.80	70
Thuraya	77.70	76.20	80.10	78
Adana	82	83.20	85.10	83.43
Ibaa-99	87.10	90	95.10	90.73
average	76.43	80.43	84.78	
L.S.D (0.05)%	1.41=Varieties	1.62= spray	Interference =2.82	

- Number of tillers/plant²

The results of Table (2) showed that there were no significant differences between the genotypes in the average number of tillers. Thuraya variety gave the highest average of (6.700 tillers/plant), while the Adana variety gave the lowest average of this trait, amounting to (5.833 tillers/plant).

Table (2) also showed that the effect of spraying with the mutagen material on the trait of the number of tillers in plant is not significant, as the treatment sprayed with the mutagen material excelled at a rate of two sprays, which amounted to (6.775 tillers/plant)

compared to the non-sprayed treatment, which gave the lowest average for this trait, as it reached (5.550 tillers/plant).

As for the effect of interaction between varieties and spraying with colchicine on the number of tillers/ plant in wheat, Table (2) shows that there are no significant differences, as the Thuraya variety and the second spraying recorded the highest average of plant length, amounting to (7.100 tillers/plant), while the Adana variety with the unsprayed treatment recorded lowest average rate reached (5.00 tillers/plant).

Table (2) Effect of genotypes and spraying with colchicine on the number of tillers/plant

Spray Varieties	Without spraying	the first spray	the second spray	Means
Gad	5.100	5.800	6.700	5.867
Thuraya	6.100	6.900	7.100	6.700
Adana	5.000	6.000	6.500	5.833
Iba99	6.000	6.100	6.800	6.300
Rate	5.550	6.200	6.775	
L.S.D (0.05)%	2.52= Varieties	=2.61 Spray	Interference =4.91	

Number of leaves/plant-3

The results of Table (3) showed that there were no significant differences between the genotypes in the average number of leaves per plant. Ibaa-99 variety gave the highest average of (5.733 leaves/plant), while Gad variety gave the lowest average of this trait, amounting to (5.233 leaves/plant..(

Table (3) also showed that the effect of spraying with the mutagen on the trait of the number of leaves in the plant is not significant,

as the treatment sprayed with the mutagen excelled at the application of two sprays, which amounted to (5.825 leaves/plant) compared to the non-sprayed treatment, which gave the lowest average for this trait, as it reached (5.150 leaves/plant, (

As for the effect of interaction between varieties and spraying with colchicine on the number of leaves per plant in wheat, Table (3) shows that there are no significant differences,

as the variety Ibaa 99 and the second spray recorded the highest average of plant length, amounting to (6,200 leaves/plant), while the

variety Thuraya with the unsprayed treatment recorded the lowest average, where it reached (5.00 leaf/plant)

Table (3) Effect of genotypes and spraying with colchicine on the number of leaves/plant.

Spray Varieties	Without spraying	The first spray	The second spary	Means
Gad	5.100	5.400	5.200	5.233
Thuraya	5	5.300	5.800	5.367
Adana	5.200	5.300	6.100	5.533
Iba99	5.300	5.700	6.200	5.733
Rate	5.150	5.425	5.825	
L.S.D (0.05)%	0.920= Varieties	1.10==Spray	Interference = 2.09	

- Flag leave area (cm)⁴

The results of Table (4) showed that there significant differences between the genotypes in the average leaf area (cm). Gad variety gave the highest average of (35.48 cm), while the first variety gave the lowest average of this trait, amounting to (25.30 cm²). The reason for this is attributed to the difference between varieties in their genetic behavior and their effect on that trait (24.)

Table (4) also showed that the effect of spraying with the mutagen on the leaf area

characteristic of the plant was significant, as the treatment sprayed twice with the mutagen excelled, which amounted to (31.27 cm), compared to the unsprayed treatment, which gave the lowest average for this traits, as it reached (26.99 cm). This is due to the effect of the positive element in increasing the efficiency of carbon assimilation and the transfer of assimilation products to the areas of the plant where they are needed, which is reflected in an increase in cell division and

elongation of the leaves, and then an increase in their leaf area (8.(

As for the effect of interaction between varieties and spraying with colchicine on the leaf area traits of wheat plant, Table (4) showed that there were significant differences,

as the Gad variety with two time spraying recorded the highest average of flag leaf area, reaching (40.36, cm) while the variety Ibaa-99, whereas the unsprayed treatment recorded the lowest average of (23.72, cm(

Table (4) Effect of genotypes and spraying with colchicine on flag leaf area (cm.(

Spray Varieties	Without spraying	The first spray	The second spray	Means
Gad	29.35	36.72	40.36	35.48
Thuraya	26.63	30.80	30.22	29.22
Adana	26.03	25.76	24.10	25.30
Iba99	25.95	23.72	30.39	26.69
Rate	26.99	29.25	31.27	
L.S.D (0.05)%	1.82= Varieties	2.07== spray	Interference =3.92	

- Length of spikes (cm)5

The results of Table (5) showed that there were no significant differences between the genotypes in the average length of spike. The Ibaa-99 variety gave the highest average of (11.13 cm), while the Adana variety gave the lowest average for this trait of (10.47 cm.(

Table (5) also showed that the effect of spraying with the mutagen on the length of

spikes of plants was not significant, as the treatment sprayed with the mutagen with two sprays excelled, which amounted to (11.18 cm), compared to the unsprayed treatment, which gave the lowest average for this trait, as it reached (10.55 cm.(

As for the effect of the interaction between varieties and spraying with colchicine on the length of spikes, Table (5) showed that there

were no significant differences, as the Gad variety and the second spray recorded the highest rate of spike length, reaching (11.70

cm), while the Adana variety with the unsprayed treatment recorded the lowest average reached (9.90 cm.)

Table (5) Effect of genotypes and spraying with colchicine on the length of spike (cm.)

Sprays Varieties	Without spraying	The first spray	The second spray	Means
Gad	10.60	10.80	11.70	11.03
Thuraya	10.70	10.90	10.50	10.70
Adana	9.90	10.30	11.20	10.47
Iba99	11	11.10	11.30	11.13
Rate	10.55	10.78	11.18	
L.S.D (0.05)	4.98=Varieties	5.75==Spray	Interference =9.96	

- 6Number of grains/spike

The results of Table (6) showed that there significant differences between the genotypes in the average number of grains / spike of the plant. The Thuraya cultivar gave the highest average of (61.93 grains/spike), while the Ibaa-99 variety gave the lowest average for this trait, amounting to (54.63 grains/spike). The difference between the varieties under study in this trait is due to the difference in their genetic composition and their ability to improve growth characteristics (4). The number of grains in a spike and then in a plant

is determined by many factors, the most important of which are the length of the spike, the number of spikelets per spike, the number of fertile florets in it, as well as the efficiency of the pollination process, the degree of crowding of the spike, the type of spike (major or secondary), and the amount of moisture and dry matter available during the period of Florets formation and development, and the prevailing environmental factors during the panicle formation stage (1;19). The trait of the number of grains per spike is positively related to genetic factors as well as environmental

factors that stimulate the wheat plant to produce good photosynthesis sufficient to provide the plant's requirements during the stages of differentiation of the developing apex and growth of the spike, which contributes to the formation of more grains (21.)

Table (6) also showed that the effect of spraying with the mutagen on the trait of the number of grains per spike was significant, as the treatment sprayed with the mutagen material with first spray excelled, which amounted to (58.92 grains/spike) compared to the non-sprayed treatment, which gave the lowest average for this trait, as it reached

(55.35 grains/spike). The reason is that colchicine works on double the genome and thus leads to increase the number of grains / spike (6.)

As for the effect of interaction between varieties and spraying with colchicine on the trait of the number of grains per spike in wheat, Table (6) shows that there were significant differences, as the Thuraya variety with second spraying recorded the highest average of grains / spike, amounting to (64.90 grains/spike), while the Adana variety with the unsprayed treatment recorded lowest average reached (52.00 grains/spike.)

Table (6) Effect of genotypes and spraying with colchicine on the number of grains / spike.

Spray Varieties	Without spraying	The first spray	The second spray	Means
Gad	56.20	62.80	58.60	59.20
Thuraya	60.20	60.70	64.90	61.93
Adana	52.00	56.80	55.10	54.63
Ibaa-99	53.00	55.40	56.10	54.83
Rate	55.35	58.92	58.68	
L.S.D (0.05)%	3.21=Varieties	3.32== spray	Interference =6.83	

Weight of 1000 grain (g)-7

The results of Table (7) showed that there were no significant differences between the genotypes in the average weight of 1000 grain. The Thuraya variety gave the highest average, amounting to (41.33 grams), while the Adana variety gave the lowest average for this trait, amounting to (40.20 grams).

Table (7) also showed that the effect of spraying with the mutagen material on the trait of the weight of 1000 grain was significant, as the treatment sprayed with the mutagen with second spray excelled, which amounted to (42.94 grams), compared to the unsprayed treatment, which gave the lowest average for this trait, reaching (38.29 grams). The reason for this increase in this trait is the role played by the mutagen material in increasing cell

growth and division, extending and elongating the internodes, increasing the number of leaves in the stem, in addition to its involvement in the synthesis of amino acids and proteins, and thus the photosynthesis process increases, and vegetative and flowering growth and grain size increase (18). As for the effect of the interaction between varieties and spraying with colchicine on the weight of 1000 grain / plant in wheat, Table 7 shows that there significant differences, where the Ibaa-99 variety with second spray recorded the highest rate of the weight of 1000 grain, amounting to (43.77 grams), while the Adana variety with the unsprayed treatment recorded the lowest average of. (38.23 g.)

Table (7) Effect of genotypes and spraying with colchicine on the weight of 1000 grains (g.)

Spray Varieties	Without spraying	One time spraying	Two spraying time	Means
Gad	38.50	40.80	42.52	40.61
Thuraya	39.14	41.26	43.60	41.33
Adana	38.23	40.55	41.85	40.20
Ibaa-99	37.30	40.10	43.77	40.39
Rate	38.29	40.68	42.94	
L.S.D (0.05)%	2.40=Varieties	2.77== spray	Interference =4.81	

Conclusions

Using colchicine in two sprays led to an increase in plant height, flag leaf area, weight of 1000 grain. The effect of wheat genotypes was variable in giving the highest rate for all the traits studied. The effect of the interaction between planting genotypes and spraying with

colchicine was highly significant on plant height, , area of flag leaf, number of grains per spike, weight of 1000 seeds. It is preferable to grow wheat plants in well-drained, salt-free soil.

Recommendations

It is preferable to spray the wheat plant with two sprays in order to obtain the best vegetative and fruitful growth, strength and vitality of the seed planting new varieties of

wheat in order to obtain the highest yield. Use types of foliar fertilizers and know the extent of the effect of each type on the plant.

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