Effect of Plant densities and Spraying with Ethephon on Some Growth Characteristics of Sorghum (Var. Bohooth .70)

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Abstract

A field experiment was conducted at the research station in Wasit Agriculture Directorate during spring and autumn seasons of 2021 to study the effect of planting density (80000, 66666 and 50000)plant.ha^{-1} ,three stages of ethephon spraying to(4, 8 and 12) leave per plant^{-1} and three concenteration of ethephon (0, 800 and 1600 ppm) on growth traits and their relationship with lodging in Sorghum(var. Bohooth .70). The experiment was applied using (R.C.B.D) arranged in split-split-plots with three replications. Plant densities were used as main-plot, while spraying stages were used as sub-plot and ethephon concenterations were used as sub-sub- Plot. Results showed that low plant density resulted in a significant reduction in plant height reached 14.6%, 8.6% in spring season and 7.7% , 4.5% in autumn season compare with medium and high density respectively, plants in low density also produce shorter internodes in lower parts of the stem in contras, Low density resulted in increment in stem diameter, this may be in ture lead to reduce the % of lodging .Spraying of ethephon at high concentration 1600 ppm resulted in decreases of internode length when it's sprayed at 4 and 8 leaves stage. There was significant relationship between increases of ethephon concentrions and the reduction of each, internodes length, % of lodging in contrast, increase of ethephon lead to increase stem diameter especially when it is spray at 8 leave stage. Stage it can be concluded from this study, that it low be contral on excessive vegetative growth at this devriety by using low density of sowing with ethephone spraying during early growth stages to produce economic grain.

Keywords: sorghum ,plant density, ethephon,

Part of Ph.D. Dissertation of the 1st author.

Introduction:

Sorghum is one of the most important crops that can be cultivated in a wide range of environmental conditions and tolerate high temperatures and abiotic stresses. This crop gives abundant yield in tropical and semi-arid regions[19]. As well as its importance as fodder crop, which contributes significantly meet the need animal needs of forage, making silage and hay, it is the fifth crops in the word, especially importance and in the production of grains. The sorghum is relatively tolerant to drought and salinity[7 and 18]. Due to the scarcity of green fodders in Iraq during the summer season, further a new variety (Bohooth .70) was registered and approved as the best forage variety in the production of green fodder [20]. The problem that this variety from is during the production of its grains, which may reach more than three meters, that increases its prone to its lodging and causes a loss in grain yield. Therefore, this study was conducted to solve this problem, using the planting density and ethephon spraying. Increasing plant density is a major measure for improving grain yield. At high density, however, plants may compete for light and soil resources available [22]. Plant growth regulators are synthetic compounds that can beneficially modify plant growth and development. These compounds function by altering hormonal activity, including plant growth inhibitors[5]. Ethephon is classified as anti-gibberellin, therefore it breaks the apical dominance which in imposed by gibberellin and auxin, as well as plays a role of in inhibition the cells division and

elongation[16]. Therefore, the aim of this study was to shorter plant height, control of vegetative growth and reduce lodging of Sorghum (var. Bohooth .70).

Materials and methods

A field experiment was conducted at the Research station in Wasit Agriculture Directorate during spring and autumn seasons of 2021. Soil samples were taken from depths of 0 – 30 cm[8], prior to sowing of crop and analyzed to determine the chemical and physical properties which are shown in Table (1).

Table.1. Some chemical and physical properties of soil field experiment (depth 0 - 30 cm) for the both seasons 2021.

Measured Character	Value for spring season	Value for autumn season	Measuring unit
pH	7.8	7.9	
Electrical conductivity (EC)	6.2	5.8	dS m^{-1}
Available Nitrogen	20	16	mg kg^{-1}
Available Phosphorus	13.2	11	mg kg^{-1}
Available Potassium	230	250	mg kg^{-1}
Soil texture	Silt Loam		

The experiment was conducted using a randomized complete block design with split-split-plots arrangement and three replications, the area of each plot was 9 m^2. The treatments considered in the study were as follows: planting density (80000, 66666 and 50000) plant.ha^{-1}(D_1, D_2 and D_3), three stages of ethephon spraying to (4, 8 and 12) leave per $plant^{-1}$(S_1, S_2 and S_3) and three concentrations of ethephon (0, 800 and 1600 ppm) (C_0, C_2 and C_3). Sorghum (var. Bohooth .70) was planted on 2th Apr and 20th Jul 2021 during spring and autumn seasons respectively. The phosphate fertilizer was added at one time before planting with the reality of (150 Kg. ha^{-1} P_2O_5), whereas recommended dose 320 kg. ha^{-1} of urea (46% N), was applied in three equal doses, first when at planting, second after 30 days of the germination and last during flowering[9 , 10 and 15], Pest control weed and irrigation were carried out as needed determined according of plant needs and environmental conditions[13, 20]. Diazenon was applied to protect the sorghum plant from Sesamia cretica[14] Plants from each plot were counted at completely maturity on 21th Jul and 15th Nov during spring and autumn seasons respectively. The data of the following parameters: Higher internode length, lower internode length, plant height, stem diameter and % of lodging. The data analysis were performed using GenStat program and mean comparison were carried out by using the least significant difference (LSD) test at probability levels of 0.05.

Results and Discussion

1. Higher internode length (cm):- The results illustrated in (Table 2) showed that the higher internode length of sorghum was not affected by planting density, stages, ethephon concentrations and their interaction during spring season. As for the autumn season (Table 3) the results indicated that the treatments and their interaction had high significant effect on this trait. The lowest higher internode length value (14.3 cm) was obtained in D_1 treatment, the highest value (15.1 cm) was observed in D_2 treatment. Because of the increase in the concentration of auxin in the meristematic sites, it increased cell division in cooperation with gibberellins, thus increasing the expansion and elongation of cells, as well as increasing the length of higher internode length[6], and this result agrees with[1 and 4]. Also, the early stages of spraying had a significant effect on reducing length of internodes, as spraying at the stage of 4 leaves gave the lowest value (13.9 cm), while spraying at the stage of 8

leaves gave the highest value (15.1 cm). Table (3) ethephon concentrations indicated highly significant decrease on higher internode length, as the percentage of decrease at concentrations of 800 and 1600 ppm was 17.3% and 20.8%, respectively. The reason is due to the action of ethylene released from the ethephon in plant tissues, which work to inhibition auxin transport in stem tissues and reduce internode elongation[21]. The results in (Figure 1) revealed that the interactions between the plant densities and the spraying stages of the ethephon indicated highly significant effect, the reason for interactions is the difference in relative response of different spraying stages for certain plant densities.

Figure (2) illustrated that the interactions between the plant densities and ethephon concentrations significant effect, and due is the difference in the relative response to concentrations with the different plant densities. Figure (3) also explained that the interactions between the stages and concentrations of ethephon spraying significant effect, because is the difference in relative response to concentrations of ethephon in different stages of spraying. While Figure (4) indicated that the interactions between the treatments significant effect, and the reason for the difference in relative response of plant density at different concentrations and stages of spraying ethephon.

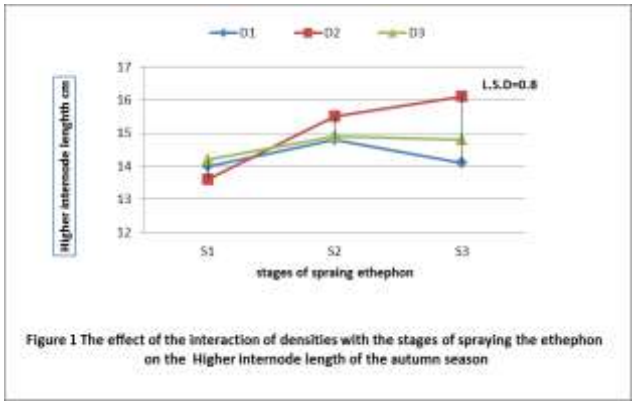

Figure 1 The effect of the interaction of densities with the stages of spraying the ethephon on the Higher internode length of the autumn season

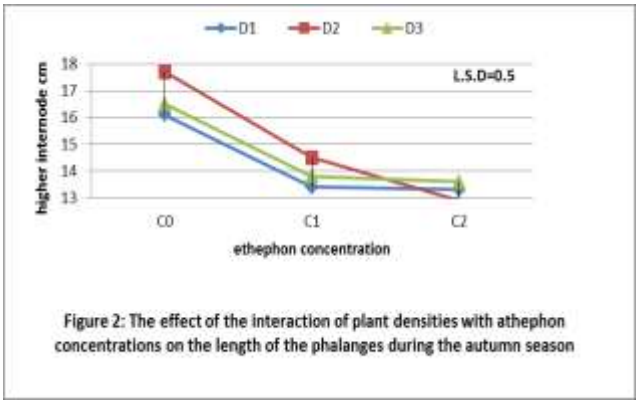

Figure 2: The effect of the interaction of plant densities with athephon concentrations on the length of the phalanges during the autumn season

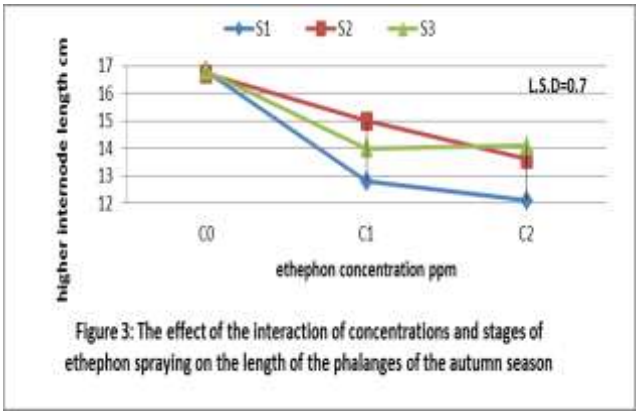

Figure 3: The effect of the interaction of concentrations and stages of ethephon spraying on the length of the phalanges of the autumn season

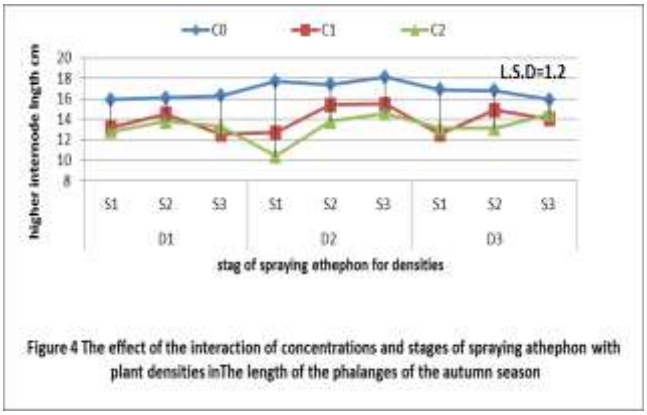

Figure 4 The effect of the interaction of concentrations and stages of spraying athephon with plant densities inThe length of the phalanges of the autumn season

2. Lower internode length (cm):- The results in tables (2 and 3) plant density indicated highly significant effect on lower internode length in the spring season without the autumn season, as the high density D_1 gave the highest value (12 cm), while the low density gave the lowest value (11.1 cm). Perhaps the reason is due to increased competition for nutrients and light at higher plant densities and because of the misleading that increased the elongation of the plant .The stages of spraying ethephon had a significant effect on lower internode length and for both seasons. The spray treatment in the S_2 stage gave the lowest value for this trait, while the spray treatment in the S_3 stage gave the highest value for both seasons. Early spraying hindered growth and elongation lower

internode, which arose before spraying at the stage of 12 leaves more than after it. Also, the concentrations ethephon a significant effect on reducing the lower internode length for the spring and autumn seasons, as the percentage of decrease for this trait when spraying with a concentration of 800 and 1600 ppm compared to the control treatment for the spring season was 10.2% and 14.1%, respectively, in the autumn season the percentage of decrease was 16.9% and 28.2%, respectively, and perhaps the reason is the effect of the ethephon in reducing cellular expansion and inhibiting cell elongation and its reflection on the shortening of the internode**.** Figure (5) explained that the interactions between the stages and concentrations of ethephon spraying significant effect for the autumn season without the spring season. Perhaps the reason for the significant interactions is the difference in the relative response of plant densities in different spraying stages. Figure (6) illustrated that the interactions between the plant densities and ethephon concentrations significant effect for both seasons, perhaps the reason for the difference in the relative response of different levels of ethephon concentrations to plant densities. Figure (7) indicated that the interactions between the stages and concentration of spraying ethephon for the autumn season without the spring season, and perhaps the reason for the difference in the relative response of different levels of ethephon for certain spraying stages. Figure (8) illustrated that the interactions between the experimental factors significant effect for the autumn season without the spring season. The reason for the interaction may be due to the difference in the relative response of the plant density to the different concentrations and stages of ethephon.

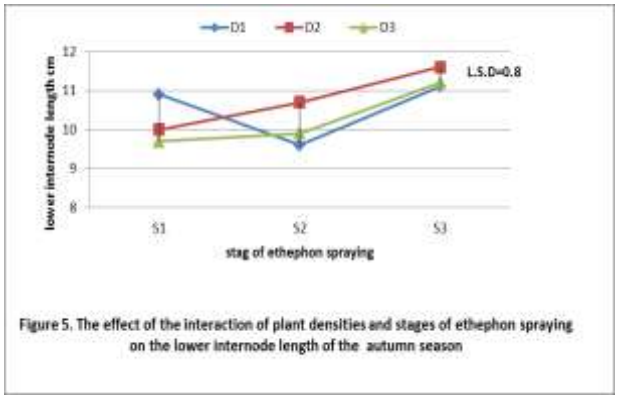

Figure 5. The effect of the interaction of plant densities and stages of ethephon spraying on the lower internode length of the autumn season

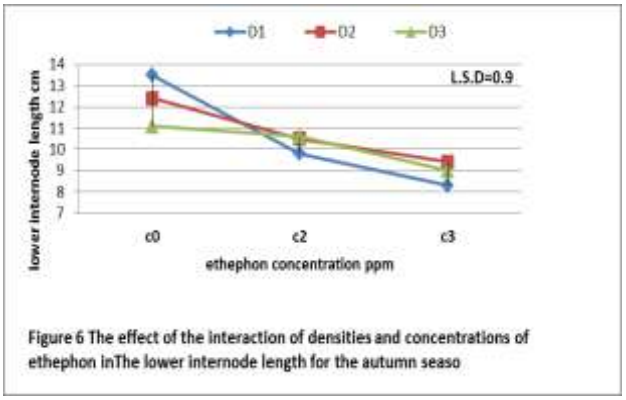

Figure 6 The effect of the interaction of densities and concentrations of ethephon inThe lower internode length for the autumn seaso

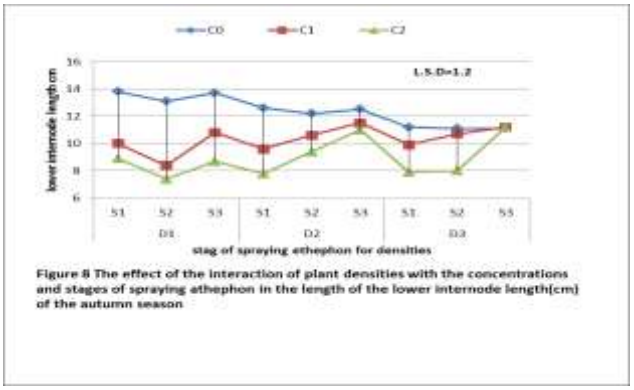

Figure 8 The effect of the interaction of plant densities with the concentrations and stages of spraying ethephon in the length of the lower internode length(cm) of the autumn season

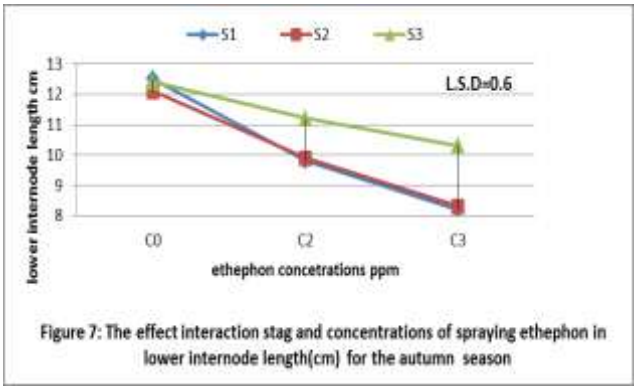

Figure 7: The effect interaction stag and concentrations of spraying ethephon in lower internode length(cm) for the autumn season

3. Plant height (cm):-The results in table (2 and 3) plant density explained highly significant effect on plant height. The plant density D_3 gave the lowest plant height (219 cm and 263 cm), while the plant density D_1 gave the highest height (256.1 cm and 285.0 cm) for both seasons. The plant responds to a change in plant density as a result of competition for penetrating light within the vegetative cover[17], that increasing shading activates the action of gibberellins and auxins to increase plant

height, and this result agrees with[1 and 11]. The spraying stages also significantly affected the plant height, as the plant height decreased in the early stages of spraying and the height increased in the late stages.The concentrations of ethephon also affected this characteristic .The high concentration C_2 gave the lowest plant height, while the control treatment C_0 gave the highest height.This is because the ethephon inhibits the biosynthesis of gibberellin produced inside the plant cells and tissues, so the stem internodes are shortened, and thus the plant height decreases. These results agree with [2 and 12]. Figures (9 and 10) indicated that the interactions between the stages and concentration of spraying ethephon for both seasons, as plant height decreased when spraying for the early stages with increasing concentration of ethephon. The reason may be due to the difference in the relative response of different levels of ethephon to certain stages when spraying.

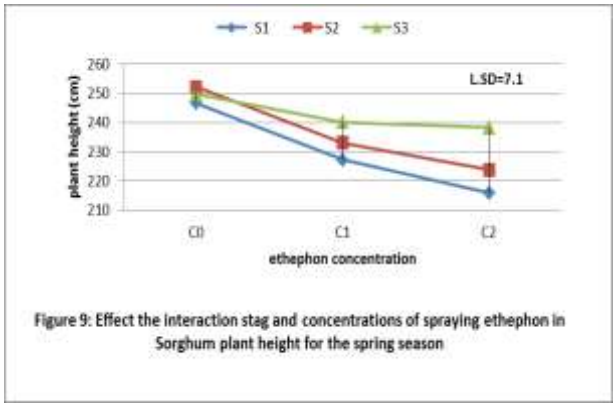

Figure 9: Effect the interaction stag and concentrations of spraying ethephon in Sorghum plant height for the spring season

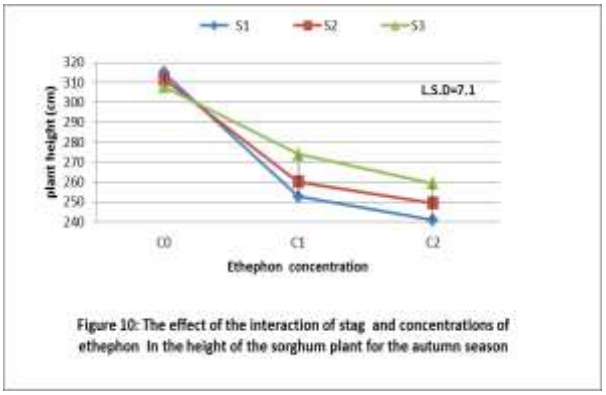

Figure 10: The effect of the interaction of stag and concentrations of ethephon In the height of the sorghum plant for the autumn season

4.Stem diameter (cm):- The results in tables (2 and 3) plant density illustrated highly significant effect on the stem diameter. The low density D_3 gave the highest value (2.03 cm and 2.12 cm), while the high density D_1 gave the lowest value (1.85 cm and 1.91 cm) for both seasons. The increase in stem diameter at low density D_3 is due to the lack of competition for growth elements (light and nutrients), and this result agrees with[1 and 11]. The stages of spraying the ethephon also significantly affected the diameter of the stem, where the early spraying stages gave the highest values, while the S3 stage gave the lowest value for this characteristic .Perhaps due to the decrease in the length of the upper and lower phalanges, which affected the diameter of the stem.Increasing the concentrations of spraying ethephon increased the stem diameter for both seasons, as the two ppm concentrations (800 and 1600) for the spring season gave an increase in stem diameter of 14.04% and 22.81%, respectively, while the autumn season gave 10.87% and 19.57% respectively. This is because the ethephon stimulated the enzymes that produce kine and cellulose, thus increasing the thickness and strength of the stem diameter.[23]. These results agree with[2 and 12]. Figure (11) illustrated that the interactions between the plant densities and ethephon concentrations significant effect, and perhaps the reason is the result of the difference in the relative response of different levels of ethephon to different plant densities.

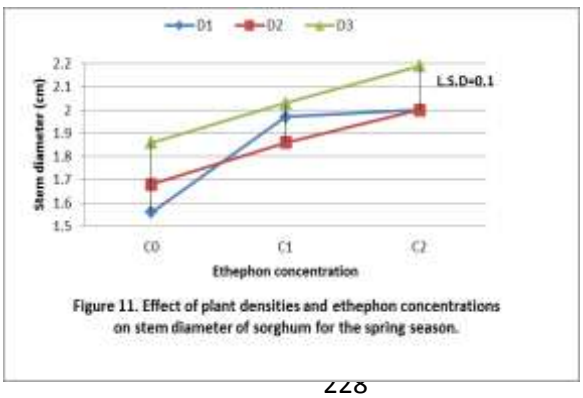

Figure 11. Effect of plant densities and ethephon concentrations on stem diameter of sorghum for the spring season.

5. Lodging%:- Table (2 and 3) plant densities indicated highly significant effect on % of lodging .The low plant density D_3 excelled in reducing the rate of rivalry, while the high density D_1 gave the highest values in % of lodging for both seasons. Similar result was concluded by (Abdul Hassan, 2019). Also, the stages of spraying ethephon had a significant effect on reducing the % of lodging down for both seasons. Where the % of lodging down decreased when spraying in the early stages, while the spraying stage at 12 leaves gave the highest % of lodging for both the spring and autumn seasons.Perhaps the reason for the effect of the ethephon in the early stages is because hormonal and enzymatic activity is at its highest levels .Also, the concentrations of ethephon had a significant effect on this trait and for both seasons. The percentage of lodging for the spring season for the two concentrations (800 and 1600) ppm decreased (33.1% and 41.1%), respectively, while the % of lodging for the autumn season for the two concentrations was 53.8% and 61.8%, respectively, compared to the comparison treatment. The reason is that the ethephon reduced the length of the internodes and increased the diameter of the stem, as a result of stimulating the enzymes producing kinein and thus reducing % of lodging [3]. These results are in agreement with those of [23]. Figure (12) also explained that the interactions between the plant densities and spraying stages for the autumn season in reducing % of lodging percentage. The reason is probably due to the difference in the relative response to spraying stages with different plant density. While figures (13 and 14) also indicated that the interactions between the stages and concentrations of spraying ethephon in reducing the % of lodging and for both seasons, perhaps due to the relative response to the effect of concentrations in different stages of spraying.

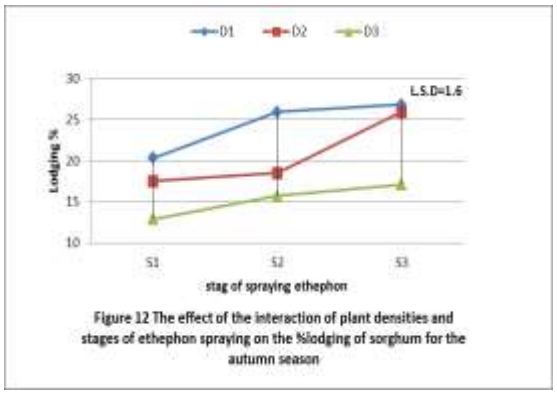

Figure 12 The effect of the interaction of plant densities and stages of ethephon spraying on the %lodging of sorghum for the autumn season

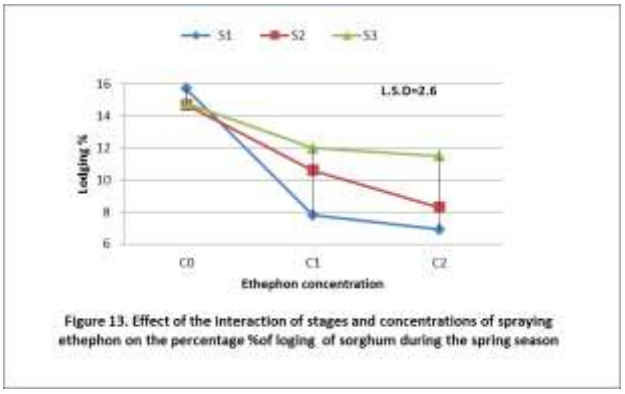

Figure 13. Effect of the interaction of stages and concentrations of spraying ethephon on the percentage %of loging of sorghum during the spring season

Table.2. The studied traits for the spring season of 2021

Treatments	D1	D2	D3	L.S.D	S1	S2	S3	L.S.D	C0	C1	C2	L.S.D
Higher internode length (cm)	14.4	15	14.2	N.S	14.5	15	14	N.S	14.5	14.2	15	N.S
lower internode length(cm)	12	12	11.1	0.3	11.8	10.9	12	0.6	12.8	11.5	11	0.6
plant height(cm)	256.1	234	219	7.02	229.9	236	243	3.8	250	233.5	226	4.4
stem diameter (cm)	1.85	1.9	2.03	0.01	1.92	1.95	1.9	0.07	1.71	1.95	2.1	0.07
% of lodging	15.5	12	6.1	3	10.1	11.2	13	1.7	15.1	10.1	8.9	1.5

Table.3. The studied traits of the autumn season of 2021											
Treatments	**D1**	**D2**	**D3**	**L.S.D**	**S1**	**S2**	**S3**	**L.S.D**	**C0**	**C1**	**C2**	**L.S.D**
Higher internode length(cm)	**14.3**	**15.1**	**14.6**	**0.1**	**13.9**	**15.1**	**15**	**0.5**	**16.8**	**13.9**	**13.3**	**0.3**
lower internode length(cm)	**10.5**	**10.8**	**10.2**	**N.S**	**10.2**	**10.1**	**11.3**	**0.3**	**12.4**	**10.3**	**8.9**	**0.4**
plant height(cm)	**285**	**275.6**	**263**	**3.8**	**269.5**	**274**	**280.3**	**3.7**	**311.4**	**262.2**	**249.9**	**4.4**
stem diameter (cm)	**1.91**	**1.97**	**2.12**	**0.09**	**2.04**	**2.01**	**1.95**	**0.06**	**1.84**	**2.04**	**2.12**	**0.1**
% of lodging	**24.3**	**20.6**	**15.2**	**0.7**	**16.9**	**20**	**23.3**	**1.1**	**32.7**	**15.1**	**12.5**	**1.1**

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