Effect of Plant Growth Regulators (GA3, NAA) and Water Stress on Leaf Area and Yield Attributes of Wheat

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Abstract:- In order to investigate the effects of water stress and plant growth regulators PGRs on yield and yield components in wheat, an experiment was conducted on the Demonstration Farm of the Faculty of Agriculture, University of Kassala at Halfa Elgadidah, Sudan. The experiment was arranged in split-plot design with three replications. The watering treatments in this study are designated as W_1 and W_2 where plants were irrigated every 10 and 20 days, respectively. The seven growth regulators levels are designated as G_{50}, G_{75},G_{100} (corresponding to gebbraline hormone rates of 0,50,75 and 100ppm), NA_{50}, NA_{75}, NA_{100} (corresponding to Nephethaline acitic acid rates of 50,75 and 100ppm) and control (G_ON_0)with zero level of PGRs. The results revealed that, $W_1$and application of G_{100} or low level of NAA increased plant height, leaf area and yield attributes (grain filling rate, spike length, number and weight of grains per plant and grain yield per unit area).further, application of GA3at 100 ppm increased grain yield (kg/ha) by more than 69% relative to NAA at the same rate. It was concluded that plant growth regulator (GA_{100} or NAA_{50}) with W1 may be better to achieve higher seed yield and yield components in wheat.

***Keywords**:- Plant Growth Regulators, Water Stress, what, yield.*

I. INTRODUCTION

Wheat (Triticum aestivum L.), is a winter annual grain grass of the family Graminae, generally common to temperate zones grassland Prairies and Savannas[1]. As wheat is an irrigated crop, its production is frequently exposed to water deficits at any stage of the crop development.[2] concluded that increasing irrigation frequencies increased wheat plant height.[3] attributed the decrease in leaf area index under water stress to reduction in leaf development. Different studies have shown that prolonged watering interval decreased grains yield per unit area in wheat [4-6]. Also,[7] stated that, under frequent watering intervals the increase in grain yield of wheat was associated with significant increases in yield components (number of tillers m-2, number of grains spike-1 and 1000-grain weight). Plants encounter a variety of external and internal envi-ronmental changes. Among the external environmental factors critical for survival of plants are water, tempera-ture, light and other organisms. Internal environmental factors include plant hormones such as ABA, auxin, cytokinins, ethylene, gibberellic acid (GA3), Jasmonic acid, and brassino-steriods [8]. PGRs have been implicated in effici ent utilization of nutrients and translocation of photo-assimilates in established sink-source system [9,10].PGRs have potential to increase grain yield and may also alter grain prot ein levels of cereal crops especially wheat 11]. PGRs significantly increased all physiological and yield character[12]. Due to diversity field use of productive land it is necessary to increase the food production and PGRs may be a contributor in achieving the desired goal. Thus combined application of PGRs and adequate irrigation can increase crop productivity. So,the aim of present investigation was to study the effectiveness of Nephtahaline acitic acid (NAA) and Gibberellin (GA3) under water stress condition on growth and yield of wheat crop.

II. MATERIAL AND METHODS

The proposed study was conducted on the Demonstration Farm of the Faculty of Agriculture, University of Kassala at Halfa Elgadidah, Sudan (Latitude 15° 19′ N. Longitude 35° 36′E and Altitude 45 m asl). The experiment was arranged in split-plot design with three replications. The main plots were allotted for watering treatments and the subplots for hormones treatments. Seeds were sown manually at a rate of 120 kg/ha, in three lines 15 cm apart, on the second week of November in both seasons. The watering treatments in this study are designated as W1 and W2 where plants were irrigated every 10and 20 days, respectively. The crop received equal quantities of water at 12 days interval for establishment and the watering treatments were initiated 30 days after sowing. The seven growth regulators levels are designated as**,** GON0**,** G50**,** G75**,**G100 (corresponding to gebbraline hormone rates of 0,50,75 and 100ppm), NA50**,** NA75, NA100**(**corresponding to Nephethaline acitic acid hormone rates of 0,50,75 and 100ppm**),**respectively**.**

III. CHARACTERS STUDIED

Growth attributes: Ten plants were randomly selected and tagged in each pot to determine the following growth parameters.

Plant height (cm)

Plant height was measured using a meter tape from the base of the stem to the youngest leaf or to the tip of the spike. The average plant height was determined from the ten tagged plants in each sub-plot.

Leaf area (LA)

Leaf area per plant will be computed according to [13]method as follows:

Leaf area (LA) = L × W × K

Where:

L ≡ maximum leaf length (cm)
W ≡ maximum leaf width (cm)
K ≡ Adjustment factor (0.8)

Yield attributes: The ten tagged plants in each sub-plot was used for the determination of the following yield components.

Grain Filling Rate (GFR): calculated as following

GFR= highest dry grain weight(g) / period of grains filling

Spike length (cm)

Ten spikes from each pot selected and the average length of spike was measured.

Number of grains spike^{-1}

The previous spikes will be threshed manually and the average number of grains per spike was determined.

Grains weight (g plant^{-1})

Grains obtain from the 10 randomly selected plants will be weighed using sensitive balance to determine the average grain weight per plant.

Grain yield (kg ha^{-1})

Grains resulted from the previous harvested plants in the sub-plot were weighed and the average grain yield per unit area was determined.

Data were statistically analyzed according to the analysis of variance (ANOVA) and mean comparisons at 5% level of probability for split plot experiment using MStat-C computer software package [14].

IV. RESULTS AND DISCUSSION

The effects of water stress and growth regulators(PGRs) on plants height was highly significant ($P < 0.01$). Frequent watering (W_1) significantly increased wheat plant height particularly in second season while application of gebbraline GA3 at 100 ppm gave the tallest plant (57.85 and 47.31 cm) as compared to other PGRs treatments in both seasons(Table1). Moreover, the magnitude of GA3 at 100 ppm on wheat plant height was significantly greater under frequent watering regime. The increase of plant height might be due to increase of stem internodes under frequent watering as reported by [15]. Also, application of GA3 at high rate increased division and enlargement of cells and as a result increased plant height. The results were agreement with those reported by[16,17] who stated that, Gibberellines (e.g., GA3) primarily enhance cell division in the sub-apical region of the rosette axis, leading to stem elongation. Irrigation wheat plant every 10 days (W_1) significantly increased leaf area (LA).further, application of gebbraline GA3 at higher rates

(75,100 ppm)gave the highest value of LA followed by NAA at rates of 50 and 75 ppm.The increased in LA due to these treatments dominant under frequent watering regime in both seasons (Table 2). The increase in this character with frequent watering interval and GA3 or NAA might be due to the positive effect of water and PGRs on cell enlargement and cell division as reported by[18].

On the other hand, grain filling rate(GFR) significantly increased by more than 6% due to W1 relative to W2 (Table 1). Increasing GA3 rates resulted in higher GFR while no significant differences observed between NAA treatments on GFR. Moreover, the magnitude of GA3 at 100 ppm on GFR was clear under W1 as compared to other interaction treatments in both seasons(Table 1). The increased in GFRmight be due to increased in LA. Also, supporting evidences were reported by[19] in watering and by [20] in growth hormone.

Data presented in table 2 showed means of yield related traits of wheat as affected by water stress, growth regulators (GA3and NAA) and their interactions. Water stress W2 significantly reduced spike length, number (by more than 15%)and weight of grains per plant (by more than 9%) relative to W1. Application of GA3 at high rates(75 and 100ppm) or NAA at low rate (50 ppm) increased spike length. Also, Application of GA100 increased number of grains per plant by more than 24% relative to NA 75 and increase grains weight per plant by more than 19% relative to NAA at the same rate (Table2). The reduction of spike length due to water stress might be due to reduction of leaf area under water stress conditions. Similarly,[21] noticed that application of GA at 75 and 100 ppm increased spike length while higher rateof NAA decreased spike length. The decreased of number and weight of grains per plant under water stress condition could be attributed to the fact that water deficit severely affected pollination process and caused floret abortion ,while lack of assimilate needed for grain filling may reduce grain weight per plant. The increased of aforementioned characters due to application of PGRs at these rates might be due to positive effects of PGRs on leaf area. Supporting evidences were reported by[22,23]. Furthermore, Irrigation wheat plant every 10 days (W_1) significantly increased grain yield (kg/ha)by more than 13% relative to W2 while application of GA3at 100 ppm increased grain yield (kg/ha) by more than 69% relative to NAA at the same rate(Table 2). Also, under frequent watering while application of GA3at high rates increased grain yield (kg/ha) as compared to their relative treatments. Grain yield enhancement resulted in this study could be mainly attributed to positive effects of both frequent watering and PGRs on yield components(spike length, number and weight of grains per plant) reported earlier. Also, supported results reported by[24] in watering treatments and [25,10] in PGRs effects on grain yield per unit area.

V. CONCLUSION

Generally, by application of 100-ppm GA3 was found as the best for all of the parameters related to growth and yield. It was concluded that plant growth regulator (GA_{100} or NAA_{50}) with W1 may be better to achieve higher seed yield and yield components in wheat.

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		Plant height (cm)		Leaf area (cm^2)		Grain filling rate	
Treatments		016/2015	017/2016	016/2015	017/2016	016/2015	017/2016
W1		51.65	46.42	48.29	123.49	4.91	5.12
W2		47.04	45.36	45.69	98.21	4.73	4.82
$LSD_{0.05}$		8.68	2.60	5.77	22.92	0.65	0.18
GON0		46.40	44.08	48.41	103.41	4.25	3.98
G50		48.76	46.45	43.34	122.25	5.18	5.18
G75		49.33	46.60	52.66	123.37	5.38	6.75
G100		57.85	47.31	50.28	136.91	5.15	5.71
NA50		48.75	45.98	49.67	99.33	4.70	4.57
NA75		45.90	45.61	39.89	99.03	4.43	4.50
NA100		48.43	45.20	44.70	91.67	4.68	4.11
$LSD_{0.05}$		4.58	2.12	4.42	9.92	0.90	0.46
W1	GON0	49.56	46.16	49.03	99.86	4.40	4.66
	G50	52.06	46.70	50.86	141.83	5.26	5.30
	G75	51.66	47.06	51.64	144.27	5.26	5.93
	G100	58.80	48.86	53.49	165.88	5.63	7.06
	NA50	52.00	46.33	49.58	120.10	5.23	4.72
	NA75	46.53	45.46	32.91	91.33	4.46	4.46
	NA100	50.93	44.36	50.54	101.19	4.13	3.70
W2	GON0	45.26	45.76	46.86	102.47	4.10	3.30
	G50	47.00	45.83	45.97	106.97	4.73	5.06
	G75	46.60	46.50	50.98	107.34	5.06	5.50
	G100	56.90	46.03	53.68	107.95	5.50	6.43
	NA50	45.43	45.80	40.37	102.66	5.00	4.43
	NA75	43.23	44.90	36.14	77.96	4.40	4.53
	NA100	44.86	42.70	45.85	82.16	4.36	4.53
	$LSD_{0.05}$	10.71	3.60	6.08	24.72	1.31	0.63

Table 1. Mean of Plant height (cm), Leaf area (cm^2) and Grain filling rate as affected by water stress, growth regulators (GA3and NAA) and their interaction on wheat.

Season / Treatments		Spike length (cm)		Grains number per plant		Grains weight per plant(g)		Grains yield (kg/ha)	
		2015 016/	/2016 017	2015 016/	/2016 017	2015 016/	/2016 017	2015 016/	/2016 017
W1		6.55	5.58	35.77	41.69	8.99	9.83	4.51	5.51
W2		6.39	5.39	30.05	36.08	8.06	8.96	4.04	4.87
$LSD_{0.05}$		2.21	0.344	21.97	2.19	5.11	0.33	2.56	0.57
GON0		6.07	5.40	29.51	36.98	7.88	9.00	3.95	4.73
G50		6.68	5.86	33.85	38.50	9.34	9.50	4.62	5.74
G75		6.75	6.00	35.78	43.26	9.49	9.68	4.76	5.87
G100		7.11	6.32	38.58	44.70	9.20	10.55	4.69	6.05
NA50		6.52	5.85	33.46	36.81	9.20	9.11	4.61	5.19
NA75		6.16	5.55	27.18	35.93	7.88	9.10	3.96	5.17
NA100		5.98	5.31	32.01	36.01	6.70	8.81	3.36	3.57
$LSD_{0.05}$		0.96	0.363	9.72	3.04	2.35	0.31	1.18	0.35
W_1	GON0	6.31	5.75	36.00	39.60	8.54	9.20	4.29	5.41
	G50	6.75	5.98	36.66	40.86	9.77	9.91	4.90	6.19
	G75	6.95	6.41	40.33	46.56	10.28	10.21	5.16	6.09
	G100	7.08	6.86	41.36	47.53	9.83	11.89	4.93	6.29
	NA50	6.43	5.95	32.96	40.06	8.96	9.20	4.50	5.56
	NA75	6.30	5.36	30.13	38.43	7.37	9.17	4.11	5.09
	NA100	6.01	5.23	32.93	38.80	8.19	9.19	3.70	3.92
W_2	GON0	5.95	5.40	30.20	33.90	7.56	8.80	4.22	4.05
	G50	6.75	5.78	31.06	36.13	8.56	9.08	4.29	5.30
	G75	6.55	5.73	31.70	39.96	9.45	9.14	4.74	5.65
	G100	7.48	5.78	36.83	41.86	9.21	9.22	4.62	5.82
	NA50	6.28	5.58	30.26	35.20	8.41	9.04	3.79	5.29
	NA75	5.90	5.73	24.23	32.26	6.03	8.41	3.63	4.79
	NA100	5.83	5.06	26.10	33.23	7.23	9.02	3.03	3.22
	$LSD_{0.05}$	2.39	0.563	23.82	4.41	5.59	0.50	2.80	0.69

Table 2. Mean of yield attributes characters as affected by water stress, growth regulators (GA3and NAA) and their interaction on wheat.