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Research Article

Effect of Some Growth Regulators and Water Stress on Seed Yield Of Soybean (*Glycine max L. Merrill*) At Eastern Sudan

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Abstract

Afield experiment was conducted for summer seasons during 2017and 2018 on the Demonstration Farm of the Faculty of Agriculture, University of Kassala at Halfa Elgadidh. To investigate the effects of watering intervals, plant growth regulators on yield and yield components of soybean. The watering regimes treatments were irrigation every 10 and 20 days, and eight plant growth regulators levels (for gibberellins hormone GA3) were designated as GA_0, GA_{50} ,GA_{75} and GA_{100} corresponding to 0,50, 75 and 100 ppm, respectively. Also, NAA levels were designated as NAA_0, NAA_{20}, NAA_{25} and NAA_{30} corresponding to 0, 20, 25 and 30 ppm, respectively. The experiment was arranged as split plot trail in RCBD with three replications. Characters studied were number of seeds and yield per plant and per unit area, straw yield in addition to harvest index. The results showed that prolonged watering interval significantly reduced yield attributes. It reduced grain yield by more than 26.0%, while spraying soybean with $GA_{100}$and NAA_{25}significantly increased reduced yield by more than 17.0% and 60.0% in both seasons as compared to GA_{75} and control (GA_0NAA_0). The significant increase in yield due to plant growth regulators under frequent irrigation was associated with significant increase in most of the yield components (number of branches, number of seeds and pods plant^{-1}, and 100-seed weight.

Keywords: *Water Stress, Growth regulators, seed yield, HI, Soybean.*

Introduction

Soybean *Glycine max.* (L.) Merrill is a legume belongs to a family (leguminace) that grows in tropical, subtropical and temperate climate. It. Due to its numerous utilities it is known as "Cow of the Field","Gold from Soil" and "Yell ow Jewel" in China and"Cinderella crop" in USA (Shivakumar, B. *et al*., 2005). In Sudan, soybean trials started as earlier 1925 at Gezira Research Farm, where low yield was obtained. This low yield was attributed to lack of adaptable cultivars to the Sudan agro-ecological conditions (Tony, N. *et al.,* 2013). The country currently, is importing vegetable oils for local consumption, thus the introduction of a new oil crop will cut these imports. protein balanced meal will be of a great significance for the dairy and poultry industries. The number of seeds/pod, weight of the seeds were affected by water deficits (Andriani, J.M. *et al*., 1991). Water deficit significantly reduced the number of seeds per pod in control in all the four soybean genotypes studied as reported by (Mimi, A. *et al*., 2016). (Kadhem, F.A. *et al*., 1985b) Also, observed a significant increase in 100-grain weight with increasing level of irrigation. Different studies have shown that irrigation significantly increased seed yield and number of seed per unit harvested area for all soybean cultivars in most experiments (Manavalan, L.P. *et al*., 2009; Marko, J. *et al*., 2012). Also, Ali, D. A. *et al*., 2017) reported high values of harvest index (HI) with frequent irrigation compared to prolonged watering intervalPlant growth regulators sofar have emerged as "magic

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chemicals" that couldincrease agricultural production at an unprecedented rate and help in removing andcircumventing many of the barriers imposed by genetics and environment.Given the positive role of growth regulators incrops and since little research has been conducted on the application of growth regulators as prefreatment for LegumesSuchas beans. On the other hand Khatun, S. *et al*., 2016) stated that, the different plant growth regulators (GA3, NAA) showed significant effect on most of the yield components in soybeans. Despite of high yielding potential and various advantages of soybean, the yield per unit area of the crop is low which indicates that there is great scope in improving theproductivity potential by using suitable measuresparticularly, the use of plant growth regulators.

Therefore, these are great need to increase the efficiency of irrigation water by increasing crop water use efficiency (Ahmed, F. E. *et al*., 2007). The time and amount of irrigation water play an important role in the production of crops in the arid and semi-arid regions of Sudan. Adequate water must be available during germination and critical growth periods which include flowering and seed filling, therefore, soil moisture depletion is the primary cause of reduced crop growth and yield (Ahmed, B. A. 2014). These factors interrelate providing an important insight to study their interaction on soybean production. Therefore, the objectives of this study are to:

- Investigate interactive effects of water stress and plant growth regulators, namely Gebralinne GA and Nephthaline Acetic Acid NAA, on yield of soybean.
- Determine the critical levels of water stress and plant growth regulators on the overall responses of soybeans.

Materials and Methods

To evaluate the impact Plant growth regulators on stressed Soybean (*Glycine max* l. Merrill) on Morphological, Physiological and Biochemical parameters.

Afield experiment was carried out during winter and summer seasons of 2017and 2018, at the Faculty of Agriculture and Natural Resources Farm, Kassala University, Halfa Elgadidah, Sudan. A soybean cultivar; William was used in this study. The watering tress treatments were irrigation every 10 (W1) and 20 days (W2), and eight plant growth regulators levels (0,50, 75 and 100 ppm designated as GA_0, GA_{50} ,GA_{75} and GA_{100} (gibberellins) also, NAA_0, NAA_{20} ,NAA_{25} and NAA_{30} corresponding to 0, 20, 25 and 30 ppm, respectively. The experiment was arranged as split plot trail in RCBD with three replications. Plant growth regulators rates were applied on shoots of all observations after 35 days from the sowing date in the two seasons. Ten plants were randomly selected and tagged in each subplot.

The two inner ridges in each sub- plot were used for the determination of the following yield components:

Number of capsules per plants, number of seeds per capsule, seed weight per plant, 100-seed weight and yield per unit area. Also, straw yield per unit area was determined.

Data were statistically analyzed according to the analysis of variance (ANOVA) for RCBD design of split plot trial using a computer software package. Mean comparisons were worked out by Duncan's Multiple Range Test (DMRT) at 5% level of probability.

Results and Discussion

The highest capsules and seed number per plant and the heavier seeds per plant as well as highest 100seeds weight were recorded in the shorter watering interval particularly with GA_{100} and NAA_{25} in both seasons as compared to their relative treatments (Table 1).

Also, the lower watering interval significantly increased yield per unit area, particularly with, (GA_{100}) as compared to respective treatments in both seasons (Table2). The magnitude of growth regulator (GA_{100}) on seed yield was significantly greater under normal watering regime, in this regard, GA_{100} increased yield by more than average of 17.0%

and 60.0% in both seasons as compared to GA_{75} and control (GA_0NAA_0), respectively. While W_1 increased the mean seed yield relative to W_2 by more than 26% (Table 2).

The heavier straw and higher HI values were recorded under normal watering particularly with higher levels of gibralinne (Table 2). In this regard, The highest straw weight per hectare (more than 2.86 tons/ha) was produced in (W_1) solely or with GA_{100} (Table 2). However, sowing soybeans under frequent watering with high GA level resulted in a significantly greater HI than both treatments when they were added solely (Table 2).

Table 1: Interactive effects of Water stress and Plant growth regulators on mean seed No/plant, seed weight plant^{-1} (g) and 100 –seed weight (g) during 2017 and 2018 seasons

Parameters		**seed No/plant**		**seed weight plant^{-1} (g)**		**100 –seed weight (g)**	
seasons Treatments		2017	2018	2017	2018	2017	2018
W_1		79.59	114.87	4.07	5.48	5.52	6.89
W_2		69.86	81.14	3.13	4.52	5.11	6.38
$LSD_{0.05}$		5.71	16.85	0.79	0.73	0.33	0.45
GA_ONAA_0		65.4	82.08	2,62	4.02	4.7	6.16
GA_{50}		72.44	93.49	3.32	4.72	5.19	6.52
GA_{75}		78.80	97.97	3.94	5.39	5.66	6.82
GA_{100}		74.17	91.99	3.38	4.78	5.67	8.44
NAA_{20}		75.04	86.66	3.49	4.89	5.21	6.54
NAA_{25}		73.87	102.86	3.81	5.21	5.42	6.76
NAA_{30}		83.24	131.07	4.62	5.99	5.84	7.19
$LSD_{0.05}$		6.79	9.67	2.42	0.44	0.42	0.45
W1	**GA_ONAA_0**	69.68	92.40	3.03	4.43	4.83	6.41
	NAA_{20}	70.27	106.60	3.35	4.75	5.42	6.76
	NAA_{25}	82.82	107.20	4.56	6.05	6.01	7.35
	NAA_{30}	80.22	102.00	4.05	5.45	5.47	6.80
	GA_{50}	82.55	107.80	3.96	5.36	5.18	6.51
	GA_{75}	79.70	119.92	4.08	5.48	5.55	6.88
	GA_{100}	91.80	168.20	5.46	6.86	6.14	7.49
W2	**GA_ONAA_0**	61.12	71.76	2.20	3.60	4.57	5.91
	NAA_{20}	74.60	80.25	3.29	4.69	4.95	6.28
	NAA_{25}	74.98	88.75	3.32	4.72	5.30	6.30
	NAA_{30}	68.12	81.99	2.72	4.12	4.83	6.09
	GA_{50}	67.52	65.52	3.02	4.42	5.22	6.56
	GA_{75}	68.03	85.80	3.54	4.94	5.29	6.63
	GA_{100}	74.60	93.95	3.79	5.12	5.54	6.88
	$LSD_{0.05}$	10.64	7.28	0.89	0.86	0.63	0.70

Table 2: Interactive effects of Water stress and Plant growth regulators on mean seed and hay yield (kg/ha) and hay yield (ton ha^{-1}) with HI during2017 and 2018 seasons

Parameters		**seed yield (kg/ha)**		**hay yield (ton ha^{-1}**		**HI**	
seasons Treatments		2017	2018	2017	2018	2017	2018
W_1		331.85	445.60	2.29	2.65	12.69	14.57
W_2		253.06	367.21	1.98	2.25	11.38	13.65
$LSD_{0.05}$		59.43	59.60	0.15	0.31	1.30	0.74
$GA_O NAA_0$		213.54	326.63	1.78	2.13	10.61	13.27
GA_{50}		269.84	363.59	2.04	2.34	11.68	13.86
GA_{75}		324.19	437.94	2.16	2.51	13.11	14.98
GA_{100}		275.30	389.05	2.08	2.34	11.68	13.81
NAA_{20}		283.56	397.31	2.34	2.53	10.86	12.93
NAA_{25}		309.81	423.56	2.8	2.43	13.05	14.95
NAA_{30}		370.92	486.74	2.51	2.56	13.27	14.99
$LSD_{0.05}$		33.53	35.14	0.19	0.21	1.74	1.59
W1	**$GA_O NAA_0$**	246.46	360.21	1.91	2.26	11.43	13.75
	NAA_{20}	272.19	385.94	2.05	2.41	11,70	13.85
	NAA_{25}	378.08	491.83	2.26	2.61	14.44	15.99
	NAA_{30}	329.33	443.08	2.11	2.45	13.55	15.29
	GA_{50}	321.75	435.50	2.56	2.90	11.19	13.03
	GA_{75}	331.50	445.25	2.34	2.69	12.41	14.25
	GA_{100}	443.63	557.38	2.85	3.20	14.13	15.82
W2	**$GA_O NAA_0$**	180.63	293.04	1.65	2.00	9.79	12.78
	NAA_{20}	267.50	381.25	2.02	2.27	11.68	13.81
	NAA_{25}	270.29	384.04	2.05	2.40	11.78	13.96
	NAA_{30}	221.27	335.02	2.04	2.23	9.80	12.32
	GA_{50}	245.37	359.13	2.12	2.16	1o.53	12.88
	GA_{75}	288.11	401.86	1.81	2.16	13.68	15.64
	GA_{100}	298.21	416.11	2.17	2.52	12.42	14.16
	$LSD_{0.05}$	69.12	70.53	0.29	0.39	2.55	2.17

Under limited soil moisture conditions, water stress is a more yield limiting factor than other contributing factors for soybean production particularly under hot dry environments. The reduction in seed yield obtained under prolonged watering intervals was associated with significant decrease in all yield components measured in this study. This could be attributed to the reduction in number of seeds per capsule and 100-seed weight under water stress condition. These results are in agreement with those reported by (Farooq, M. *et al.*, 2009). They concluded that, the reduction in these characters could be attributed to the fact that water deficit severely affected pollination process and caused floret abortion, while lack of assimilate needed for seed filling may reduce seed weight capsule^{-1} also, might be due to reduction of leaf area under water stress condition.

In this study, reduction of leaf area resulted in shortening of grain–filling period due to water stress and decrease of transferring assimilates in to grains due to water stress as two major reasons for reduction of soybean grain weight and 100- seed weight, as was described by (Royot. *et al.*, 200). The greater harvest index (HI) may be due to increase in 100-seed weight in all treatments as was reported by (Carpenter, A. C. *et al.*,1997b).

The present study revealed that application of PGRs significantly increased the number of pods, seeds and seed weight per plant aswellas100-seed weight and finally seed yield per plant which are the most yield determine components in the soybeans. This might be due to the fact that GA3 during podfilling may provide a usefull tool to increase soybean seed yield by delaying growth arrest and N2-fixation decline. Further, these results were confirmed by those reported by (Merlo, D. *et al*., 1987; Upadhyay, R. G. *et al*.,1993) who stated that NAA (20ppm) and GA3 (≥100 ppm) application on soybean at flowering increased number seeds per plant and average pod weight, but latter ap plication increased, 100 seeds, seed yield per unit area. Also, (Khatun, S. *et al*., 2016) concluded that the different plant growth regulators (GA3,NAA) showed significant effect on number of seeds,100-seed weight, seed yield of soybean.The increase in HI values due to normal watering, observed in this study, agreed with (Ali, D. A. *et al*., 2017) who observed increases of high value of harvest index (HI) with frequent irrigation compared to prolonged watering interval. On the other hand, The increased in HI observed in this study due to application of GA3 at high levels or NAA with low levels might be due to increase in seed yield per plant. Inthis respect, (Khatun, S. *et al*., 2016) stated that, the different plant growth regulators (GA3, NAA) showed significant effect on harvest index in soybeans.

Conclusion

Based on results Spraying soybean plants with GA100 or NAA25 significantly increased yield components and particularly under frequent watering regime which was associated with significant increases in final seed and straw yieldperuint area.

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